Motives and Effects of Quality and Environmental Standards : micro-econometric Analyses of French Firms and Employees

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Les Déterminants et les Effets des Normes de Qualité et d'Environnement : Analyses Microéconométriques à partir de Données Françaises d'Entreprises et de Salariés

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Summary

General Introduction

In recent years, one of the central issues of discussion in economic, management and organisation theories has been the significant shift in patterns of work organisation brought about by dramatic changes in the business environment. These changes have arisen due to a number of global factors, some of which include the spread of market globalisation, severe competition, improvement in communication as well as rapid development and transfer of technology. Such changes have engendered a lively debate about the strategies and policies that are required today for a firm's survival. Since traditional sources of competitive advantage have become limited, firms have needed to accurately understand their global market, precisely satisfy their customers' needs and continuously anticipate and adapt to new market policies in order to maintain a competitive edge. Indeed, the traditional work organisation under mass production (characterised by limited employee participation in decision-making, rigid job standardisation, job simplification and direct control of the workforce) has not provided modern firms with the necessary capabilities to compete on the global market. Both economic (low system performance and high costs) and social factors (low job satisfaction and lack of employee motivation) have put pressure on firms to seek practical alternatives that could outperform systems based on traditional work organisation. In this context, adopting mechanisms that optimize quality approaches, such as ISO 9000 standards or Total Quality Management (TQM), has become a core competency for firms that strive to achieve long-term business success. Consequently, firms have conferred an increasing importance on management practices based on quality, since these aim to eliminate sources of error and inefficiencies, which, in turn, can improve a firm's performance in terms of meeting customer requirements, and increasing organisational performance and employee job satisfaction (Hackman and Wageman, 1995).

Quality Management (QM) theory has been strongly influenced by the ground-breaking research led by 'fathers' of quality theory such as Crosby (1979), Deming, (1982), Ishikawa (1985), Juran (1979) and Feigenbaum (1991). The theory engendered quality approaches that have emerged as a key organisational tool helping firms worldwide to establish rationalised production processes. QM has become a mainstream activity for many firms as opposed to being a set of tools and techniques only used by leading firms. In fact, whereas in the 1980s QM was considered to offer a competitive advantage, today it is perceived by managers to be a competitive necessity (Glover and Noon, 2005).

The QM approach can be defined as a holistic management philosophy that focuses on maintenance and continuous improvement of all functions within an organisation, with a goal of meeting or exceeding customer requirements (Flynn *et al.*, 1994). The premise of such a quality approach is based on improving an organisation's efficiency through high-level coordination of its activities in a rationalised system of end-to-end processes, which includes every aspect of firm's performance (Benner and Tushman, 2002).

There are three main principles on which QM is founded. These include: customer focus (defined as meeting and/or exceeding customer needs), continuous improvement (defined as attempting to obtain performance gains from innovations and changes in organisational processes) and teamwork (defined as collaborating with all firm's members, customers and suppliers) (Dean and Bowen, 1994). Therefore, QM can only be attained if the concept of quality is used in all organisational processes, starting from the acquisition of resources to customer service.

One of the main arguments supporting large-scale diffusion of quality approaches could be attributed to Porter's 'win-win' hypothesis. This view argues that QM approaches refer to flexible work organisation that attains quality, flexibility and economies of scale by systematic organisational learning, elimination of waste, maximised utilisation of employee's skills and initiatives, and improvement of managerial competence. Since all these factors enhance firm's and employee's performance, by adopting quality approaches, firms appear to be in line with the perceptions of modern organisations, and thus increase their legitimacy.

Alongside QM expansion, an increasing public awareness of environmental problems, emerging as a result of global economic activity, has led to a greater political and social demand on firms to adopt Environmental Management (EM) approaches (*e.g.* ISO 14000 standards, EMAS, Responsible Care). Indeed, Corbett and Klassen (2006) argue that facing environmental issues is a natural extension of quality approaches implying that the principles of QM apply equally to environmental performance improvement.

Similarly to quality approaches, a long-term goal of environmental approaches is to encourage firms towards a more proactive stance, which considers environmental aspects in an integrated fashion in areas such as product design, manufacturing process, marketing, product delivery and use, customer service and post-consumer product disposal (Hunt and Auster, 1990). Whilst quality standards aim to improve quality and business objectives of the firm, environmental standards aim to improve environmental performance and the firm's relationships with both market non-market actors (Delmas and Montiel, 2008).

Furthermore, Klassen and McLaughlin observe that the 'cost' of quality includes both the costs of defects and prevention, whilst, similarly, environmental costs include the costs related to both pollution and pollution prevention (Klassen and McLaughlin, 1993). Additionally, a QM goal of 'zero defects' is analogous to the 'no waste' aim of EM approaches. Whilst QM refers to 'waste' as it applies to inefficiencies of processes, EM focuses on pollution in terms of air emissions and solid and hazardous waste (Kleiner, 1991). Importantly, as previously mentioned, QM is based on a holistic view of product and process design, which corresponds to EM importance of life-cycle assessment and process design aimed at pollution prevention rather than simply end-of-pipe correction.

Today, the environmental movement is not just the 'privilege' of specific economic players, but concerns the whole economy. However, the very early stage of environmental policy has been referred to as a 'command-and-control' environmental regulation. This type of environmental regulation tended to focus almost exclusively on pollution control, especially end-pipe pollution control, rather than on the management of economic and environmental interests. Many policymakers found that the first generation of environmental regulations was inflexible and inefficient. Consequently, in 1983, the United Nations set up a commission to re-examine environmental and development problems. The second generation of environmental regulations thus implemented market-based strategies and tools such as pollution taxes, tradable permits and deposit-refund systems (Delmas, 2000). The objective of these new policy tools was to promote technical innovation and improve economic efficiency as well as environmental cost-effectiveness of policy instruments. However, even after the implementation of marked-based strategies, the cost-effectiveness of environmental regulatory instruments continued to be questioned. This influenced the emergence of a new environmental movement that had as an aim not only to change the polluters practices, but also their underlying values, in order to revolutionize the environmental policy system. Thus, the third generation of environmental regulations focused mainly on voluntary environmental initiatives that provide additional flexibility and motivation to tailor individual environmental impact reduction goals, whilst simultaneously reducing compliance and enforcement costs and improving technical information and public recognition (Delmas, 2000).

Environmental Management approaches could be used for implementation of environmental policies since they prescribe a set of techniques and procedures that can be applied by firms in order to monitor and control the impact of their operations on the natural environment. As argued by Darnall *et al.,* (2010), these approaches include intangible managerial innovations and routines that require an organisational commitment towards improving the natural environment, and are not required by law. For instance, these practices include the implementation of environmental policies (Henriques and Sadorsky, 1996), utilisation of internal assessment tools such as bench-marking and accounting procedures (Nash and Ehrenfeld, 1997), establishment of environmental performance goals (Hart, 2005), internal and external environmental audits, employee environmental training and employee compensation based on environmental performance (Welford, 1998). Hence, adopting EM approaches requires both the organisational changes within a firm and internally motivated efforts at environmental self-regulation. This can be achieved by implementing management practices that integrate the environment into production decisions, identify opportunities for pollution (waste) reduction and introduce plans to make continuous improvements in production methods and environmental performance (Khanna and Anton, 2002). Moreover, a systems approach to environmental management requires a holistic view of the environmental field so that its implications in the decision making process are fully understood. Indeed, Florida *et al.,* (2001) remarks that the EM implementation establishes new organisational structures similar to those imposed by the adoption of practices such as High Performance Workplace Practices (HPWPs) or QM approaches.

Both QM and EM approaches need to be properly integrated and managed within the whole business in order to be successful (Klassen and McLaughlin, 1993). Thus, implementation of these approaches typically requires important changes in organisational and work design. Firms that adopt QM or EM approaches significantly alter work organisation, demanding new attitudes, roles and responsibilities for all firm members (Florida *et al.,* 2001; Womack *et al.,* 1990). Hence, firms that adopt QM approaches gain competitive advantage through provision of superior value to customers thereby increasing revenues, sales and market share, reducing costs and waste through better process efficiency and improving of firm’s quality performance and corporate image (Terlaak and King, 2006). Similarly, EM approaches often positively influence the firm’s performance (Hart and Ahuja, 1996; King and Lenox, 2002; Klassen and McLaughlin, 1996). These positive effects result from pollution prevention, which can create savings in input and energy consumption and increase demand for firm’s products or services among environmentally sensitive consumers (*e.g.* Hart 1997). Moreover, quality and environmental approaches, such as ISO 9000 and ISO 14000 standards, can resolve the problem of information asymmetry between uninformed buyers and informed suppliers by providing positive signals regarding the firm’s quality and environmental orientation (Spence, 1973; Grolleau *et al.*, 2007). Thus, organisational changes imposed by the implementation of quality and environmental practices create a ‘win-win’ system which is associated with the ‘mutual gain’ view, whereby not only do such practices benefit employers but also their employees. Indeed, with regards to an employee-based perspective, QM and EM practices contribute to workforce improvement. Working under QM and EM regulations improves employee initiative and flexibility through broadening job classifications, creating flexible assignments, decentralising workplace organisation, offering training and work in groups and involving employees in decision making (Levine and Toffel, 2009). Consequently, a general consensus has emerged that employees may benefit from the adoption of these practices through various forms of opportunities such as increased job satisfaction, improved well-being and working conditions, increased job security and better wages and bonuses.

Contribution of the PhD thesis

This PhD thesis is founded on the analyses of Quality and Environmental Management practices in France at two levels:

(1) An analytical level. By exploring a large body of literature, we wish to answer three main questions:

(a) A firm’s choice to implement quality and environmental practices is an appealing research issue, since theory-based empirical analysis into the determinants of quality and environmental practices can contribute valuable insights into a firm’s organisational behaviour, explaining why specific types of firms seek quality or environmental approaches while others do not. Moreover, the results of such an analysis may have important policy implications that could enable policymakers to better formulate and more effectively propose the application of such approaches. However, despite its contemporary relevance, a study of the drivers of quality and environmental practices adoption has not received much attention in economics literature. Indeed, empirical studies have rather sought to understand the development, implementation and evolution of those practices.

Hence, this PhD dissertation seeks to analyse the factors that contribute to the adoption of quality and environmental practices by empirically examining the following research question:

Q1: What drives firms to adopt quality and environmental approaches?

(b) Conflicting concepts exist in the literature concerning the impact of quality and environmental practices on a firm's performance. On the one hand, quality and environmental standards proponents support the 'win-win' hypothesis (Terlaak and King, 2006; Porter and Van Der Linde, 1995) arguing that quality and environmental approaches are based on the resource productivity concept which leads to an improved firm's performance. On the other hand, there are several studies that have not found any significant impact on a firm's performance and have consequently supported the 'lose-lose' scenario (Konar and Cohen, 2001; Corbett *et al.*, 2005). The latter authors suggest that management practices implementation may be very costly due to duplication of information, higher occurrence of mistakes and less economies of scale due to multi-tasking (Caroli and van Reenen, 2000). Therefore, they argue that the adoption of management practices, such as quality or environmental standards, does not necessarily imply a firm's performance improvement, but, rather, it may decrease firm's competitiveness.

These conflicting and ambiguous arguments demand an improved investigation of the issues associated with the impact of QM and EM approaches on a firm's performance in France. Given this reasoning, we will attempt to answer the following question:

Q2: Whether and how quality and environmental approaches influence firm performance?

(c) There is very little evidence to support the hypothesis that quality and environmental practices improve the welfare of employees, especially when considering the influence of environmental practices on employee outcomes. Nonetheless, a limited but growing literature has been concerned with the effect of quality approaches practices on employee outcomes. However, the evidence presented thus far appears to be rather mixed. In fact, the evidence for positive impact is based on the findings that adoption of quality practices encourages work re-organisation, characterised by job rotation, self-responsible teams, multi-tasking, training and a greater involvement of employees in decision-making, which all positively influence employee outcomes (Levine and Toffel, 2009). In contrast to this view, other researchers have concluded that quality practices have a negative effect on employee welfare since their adoption induces work intensification, higher rates of task repetition and increased monitoring (Askenazy and Caroli, 2010). Moreover, it has also been argued that the adoption of environmental practices often induces changes in work organisation similar to those involved in the implementation of quality practices and would therefore influence employee outcomes in a similar manner. However there is, to the best of our knowledge, no direct evidence which has sought to demonstrate the impact of environmental practices on employee welfare.

There is, undoubtedly, a need to strengthen the current understanding of the relationship between quality and environmental practices, and employee outcomes. Hence, we address the following question in order to bridge the gap in the literature:

Q3: Whether and how quality and environmental practices influence employee outcomes?

(2) A methodological level. This is an applied microeconomics PhD thesis which makes two major methodological contributions:

(a) We use six different databases: the Organisational Changes and Computerisation Survey (Changement Organisationnel et Informatisation, COI, from 1997 and 2006); the Annual Survey of Industry (Enquête Annuelle d'Entreprises, EAE, 1997); data on French chemical firms or production units that were personally collected (2005); Community Innovation Surveys (CIS3, 1998-2000); the Labor Force Survey (Enquête Emploi, EE, 2005) with its complementary survey on working conditions and organisation (Enquête Conditions de Travail, CT, 2005); and the Employer's Annual Declaration of Payroll Data (Déclarations Annuelles de Données Sociales, DADS, 2006). Working with these databases enables us to control for a very detailed set of firm and employee characteristics, hence allowing us to properly isolate the effects of quality and environmental standards. Importantly, specific databases were merged together which provided us with a set of very original and rich databases to work with.

Each chapter will examine different indicators of firm and employee outcomes since we support the view that the impact of quality and environmental approaches will vary depending on different outcome indicators analysed. The crux of our argument is that specific firm or employee performance measures will be more or less important in the context of quality and environmental practices. Therefore, we will pay particular attention to the analyses of different sets of performance measures.

We utilise different statistical and econometric tools in order to obtain empirical evidence concerning the debate in the literature associated with the impact of quality and environmental standards. More precisely, we employ the following econometric strategies: Discrete-Choice models (Binary Logit model and Multivariate Logit model); Propensity Score Matching models (to correct for the bias selection with regards to observable characteristics); Switching models (to address the problem of endogeneity bias in the case of continuous dependent variable; this model enables us to control for both observed and unobserved characteristics); Bivariate and Trivariate Probit models (to address the endogeneity bias of binary dependent variables and when the main independent variable is also a dummy variable).

(b) To the best of our knowledge, a majority of empirical studies on the subject of quality and environmental practices refers to the experience in Anglo-Saxon countries. Given that the institutional setting and varying national characteristics may create a significant difference with regards to the means of introducing and using new organisational systems, this creates a great necessity for empirical studies concerning French firms, since such practices may exert different effects in France as compared to Anglo-Saxon countries. In fact, work structure in France shows certain specificities comparing to Anglo-Saxons countries, such as more state intervention, more protectionism, more rigid hierarchy in firms, more intuitive management, more reliance on an elite (coming from the 'Grandes Ecoles'), limited flexibility and cooperation between different units, less autonomy of workers, centralised collective bargaining and strict employment contracts (*e.g.* Caroli *et al.*, 2010). Another significant difference relates to French regulation of working hours. More precisely, the 35-working hour laws in France have both limited the number of hours worked and introduced more flexibility in the allocation of working hours (Askenazy, 2000). Therefore, our study will attempt to provide empirical insights into the impact of QM and EM practices in France, which may prove to be of use for both academics and industrial professionals.

The PhD Thesis Structure

Based on the three main questions presented above, this PhD dissertation is divided into **three major parts** organised as follows**:**

Part I contains two chapters which describe and analyse economical rationales for the adoption of quality and environmental management practices. Furthermore, this chapter pays particular attention to ISO 9000 and ISO 14000 standards in order to define and characterise these most widespread approaches related to quality and environmental issues, respectively.

Chapter 1 investigates whether there is a difference in the determinants of quality standards between the manufacturing and service sectors using an empirical approach. Special focus is given to ISO 9000 standards, particularly to the emergence, structure, recent changes and global diffusion of ISO 9000 quality standards. Interestingly, despite a worldwide diffusion of quality standards, there is a limited number of economic studies devoted to the determinants of this process, especially at a cross-sector level. To bridge this gap, we examine empirically which factors contribute to quality standards adoption in the manufacturing and service sectors. Moreover, we distinguish three types of adopters of quality standards: Early, New and Non-Adopters. A Multinomial Logit model is applied using a French micro-data survey, the Organisational Changes and Computerisation Survey (Changement Organisationnel et Informatisation, COI) from 2006. Our findings reveal for the first time that the determinants of quality standards significantly differ between manufacturing and service firms. Indeed, our findings show that the determinants of quality standards in the manufacturing and service sectors differ mainly due to different internal strategies of firms in each sector. Interestingly, the evidence obtained also indicates that characteristics of a particular firm, such as size, corporate status and previous experience with similar standards, play a significant role in implementing quality standards in both sectors. Furthermore, indicators of external features (export and customer satisfaction) also have a positive impact on quality certification in both sectors. Moreover, we find that the determinants of quality practices implementation differ among different adopters when examined for both the firm's export level and the cost reduction level. The results of this study have important implications as they could enable policy-makers to formulate regulations more precisely so that they can be applied more effectively as this can impact on the business success of firms in both manufacturing and service sectors.

Due to several environmental catastrophes in the last century (Seveso, 1976; Three Mile Islands, 1979; Bhopal, 1986; Chernobyl, 1986) and the perceived risks associated with its activities, the chemical sector has been under increasing pressure to improve the management of its environmental impact. In response to this pressure, firms have adopted different types of Environmental Management systems. In **Chapter 2**, we discuss the determinants of certification among chemical firms for either ISO 14000 standards or the Responsible Care program. Before considering the economic rationales for the hypotheses presented, we discuss the ISO 14000 standard as the most widely adopted voluntary environmental program, detailing its definition, structure, recent changes and diffusion. In order to identify factors that motivate firms to adopt either ISO 14000 standards or the Responsible Care program, a Logit model is applied to a data sample of French chemical firms that was personally collected in 2005. Interestingly, our results show that although the aims of these two environmental management systems are similar, the factors that influence their adoption are quite different. Indeed, our findings suggest that a firm's size and signaling of unobservable attributes to distant customers are significant determinants of ISO 14000 certification, while environmental factors play a more significant role in the Responsible Care program registration. A firm that has a higher turnover in foreign countries, for instance, is more likely to implement ISO 14000 standards. Therefore, a firm will choose one of these two EM systems depending on its strategy and business aims. Consequently, the findings of the study in this chapter may aid firms to better understand these two environmental practices and thus help them choose the one that corresponds most to its strategy and aims.

The main concern of **part II** of the PhD thesis, which contains four chapters, is to identify *whether and how* Quality and Environmental Management practices impact on firm performance, using a series of firm indicators such as business performance, innovation performance, recruitment and productivity.

From a theoretical perspective, adoption of quality practices is more likely to improve a firm's competitiveness by lowering defect rates, reducing cost of quality and increasing productivity, on-time delivery and customer satisfaction. Similarly, firms implementing environmental practices are more likely to gain competitive advantage by detecting and eliminating inefficiencies in resource use. However, it should be pointed out that several scholars suggest that QM and EM implementation is costly and, as such, could decrease firm's competitiveness (Konar and Cohen, 2001; Corbett *et al.*, 2005). Hence, in order to advance the existing understanding in the literature, **chapter 3** investigates the impact of quality and environmental practices on business performance as measured by the firm's turnover and profit. Moreover, it has been argued that complementarity among different organisational innovations can enhance business performance (Milgrom and Roberts, 1995) by improving efficiency and effectiveness, avoiding duplication of efforts, reducing costs, aligning goals, processes and resources, offering training, and improving communication at all organisational levels (Hanna and Newman, 1995). Hence, in this chapter, we also examine *whether* quality and environmental practices are more likely to increase business performance when implemented together than on their own, *ceteris paribus*. For this purpose, we employ the Organisational Changes and Computerisation (Changement Organisationnel et Informatisation, COI) Survey from 2006. Using a Propensity Score Matching method, we show that the adoption of quality and environmental practices is more likely to improve a firm's turnover but it has no effect on the firm's profits. Our findings also reveal a synergy between QM and EM approaches, that is, when implemented together, quality and environmental standards are more likely to increase the firm's turnover and profits than when these standards are implemented alone.

Quality and innovation performance are considered to be high-profile activities for all kinds of firms and are often associated with a gain of competitive advantage. However, in many firms, barriers to innovation are difficult to overcome without prior implementation of quality practices. This is because, it is often argued, quality practices, in both their human and technological dimensions, help to create an environment and culture that support innovation. Nevertheless, Abrunhosa and Moura E Sà (2008) argue that the relationship between quality practices and innovation is complex, and depends on the specific elements considered in each case. Indeed, the literature presents conflicting arguments concerning the impact of quality practices on innovation performance. One set of arguments supports a positive relationship between quality and innovation, implying that firms that implement quality systems also improve their innovation performance (Prajogo and Sohal, 2004; Abrunhosa and Moura E Sà, 2008; Prajogo and Hong, 2008). The opposite set of arguments claims that quality may hinder firms from being innovative due to several inherent factors that are not congruent with the aim of innovation (Kanter, 1983; Flynn, 1994; Glynn, 1996). The aim of **chapter 4** of this PhD thesis is to empirically examine the impact of quality on innovation performance employing two French microeconomic surveys called the Organisational Changes and Computerisation from 1997 (Changement Organisationnel et Informatisation, COI) and the Community Innovation Surveys (CIS3, 1998-2000). We analyse different innovation areas using nine innovation indicators. Additionally, we use three original Quality Levels, based on either ISO 9000 certification, or additional, or complementary certification, and we consider the network of relationships between the firm and its external environment. We find that the firm’s connections to those firms that have implemented quality standards (*e.g*. its suppliers) may improve the firm’s knowledge about quality issues, which may itself significantly improve its performance. Moreover, having an additional system of certification or total quality may further improve a firm’s performance since it is argued that the firm’s returns from implementing a management practice can be substantially higher when this is combined with implementation of other management practices rather than when introduced alone (Milgrom and Roberts, 1995). Our empirical evidence supports a positive and significant relationship between the adoption of quality practices and innovation performance. However, it does appear that there are specific areas of innovation wherein an adoption of a quality system has no significant effect. This implies that in order for quality systems to achieve their maximum impact across a full range of innovation practices, they have to be integrated with other organisational resources existing within a firm.

As we discussed previously, in line with the Porter hypothesis, several scholars have emphasized possible economic and environmental benefits resulting from well-crafted voluntary initiatives (Porter and Van Der Linde, 1995). Among the economic benefits, a relatively neglected area is *whether and how* environment practices improve human resource management (HRM). A firm’s current and potential human resources are important considerations in the development and execution of its strategic business plans. In fact, it is argued that due to present competitive dynamics, managing human resources appropriately is the only truly sustainable source of competitive advantage (Reich, 1990). The presumption is that more effective systems of HRM practices influence employee skills through the acquisition and development of a firm's human capital, which itself provides a direct and economically significant contribution to a firm's performance (Huselid, 1995). The aim of **chapter 5** is to investigate *whether* HRM practices, specifically recruitment, become enhanced when a firm adopts environmental practices. Such an enhancement would imply that environmental practices deliver more than only environmental benefits, and that firms can strategically use such benefits to generate 'win-win' opportunities. In order to test the hypotheses in this chapter, we employ a Bivariate Probit model. Owing to original French databases (Organisational Changes and Computerisation, COI and the Employer's Annual Declaration of Payroll Data, DADS, both from 2006), we show that voluntary environmental practices improve the recruitment of professional and non-professional employees. These findings suggest that in addition to environmental considerations, the effective management of human resources can also results from the adoption of environmental standards.

Chapter 6 of this dissertation attempts to empirically show that quality standards such as ISO 9000 could be conceptualised as Club Goods. It is widely argued in the literature that voluntary standards such as ISO 9000 can be considered as a Club Good (Potoski and Prakash, 2005) since its adopters derive mutual benefits from sharing production costs, members' characteristics and exclusive benefits (Sandler and Tschirdart, 1997). However, to the best of our knowledge, there has been no empirical study that supports the argument that the ISO 9000 standard can, indeed, be considered as a Club Good. To provide such empirical evidence, we use network term analysis, in which firms are either certified or not, and in which the ties (between the firms) represent an economic relationship. We show that a firm's productivity varies according to a firm's relative position in the network (network effect), which confirms the notion that the ISO 9000 standards could be viewed as Club Goods. This chapter is based on two French surveys called Organisational Changes and Computerisation (Changement Organisationnel et Informatisation, COI) and the Annual Enterprise Survey (Enquête Annuelle d'Entreprises, EAE). Moreover, to account for temporal differences of the ISO 9000 network analysis, we use two editions of those databases from both 1997 and 2006. In performing network analysis on whether the ISO 9000 standards can be seen as Club Goods, we distinguish four types of firms: Direct Complete Adopters (firms and their suppliers certified by ISO 9000); Direct Non Complete Adopters (firms certified while their suppliers not certified by ISO 9000); Indirect Adopters (firms not certified while their suppliers certified by ISO 9000); and Non-Adopters (neither firm nor its supplier certified by ISO 9000). We control for the potential endogeneity bias of ISO 9000 variables using a Switching model. Our results reveal that the productivity of Direct Complete Adopter firms is much higher than that of Direct Non Complete Adopters, which is, in turn, higher than that of Indirect Adopters, which is itself higher than that of Non-Adopters. Hence, we demonstrate that there is a positive and significant relationship between a firm's hierarchical position within the ISO 9000 network and the impact on a firm's productivity resulting from the membership of such a network. These findings support the notion that ISO 9000 standards can be conceptualised as Club Goods.

Although a large body of research has addressed various issues of quality and environmental approaches, the research on *whether and how* these approaches influence employee outcomes remains relatively limited. In order to bridge this gap in the literature, **part III** of the PhD thesis is focused on the impact of quality and environmental practices on employee outcomes as measured by various indicators such as working conditions, well-being and job involvement. **Part III** is comprised of two chapters.

As we noted previously, there is a wide literature that examines the impact of quality and environmental practices on a firm's business performance. However, empirical evidence regarding the impact of quality and environmental practices on employee working conditions is relatively scarce. The rationale for such a link is based on the fact that the adoption of quality and environmental practices induces work re-organisation (characterised by job rotation, self-responsible teams, multi-tasking and greater involvement of employees in decision-making), which itself may positively affect changes in employee working conditions. This subject is of great importance, especially when considering that work-related health problems have greatly increased since the 1990s (Askenazy and Caroli, 2010). Moreover, the existing limited research concerning the effect of management practices on employee working conditions has led to contradicting results (Levine and Toffel 2009; Florida and Davidson, 2001; Askenazy and Caroli, 2010; Brenner *et al.*, 2004). The aim of **chapter 7** is to contribute to an improved analysis of the relationship between quality and environmental practices and working conditions as measured by employee work accidents. Using a Trivariate Probit model to analyse a data sample of French firms from the Organisational Changes and Computerisation Survey (Changement Organisationnel et Informatisation, COI from 2006), we show that employees working for firms that are certified for quality practices bear a higher risk of accidents at work, while working in environmentally certified firms decreases an employee's probability of having accidents at work. Therefore, our findings suggest that it is necessary for a firm to integrate a set of safety approaches alongside quality practices in order to foresee and prevent potential accidents at work. Moreover, based on the analysis of data from the Labour Force Survey (Enquête Emploi, EE from 2005) and its complementary survey on working conditions and organisation (Enquête Conditions de Travail, CT from 2005), using a Bivariate Probit model, we show that the adoption of quality practices is, indeed, more likely to increase work accidents. Another interesting aspect of this research is that we distinguish between accidents at work which led to sick leave or those that did not lead to sick leave. Our findings indicate that the adoption of quality practices increases the probability of accidents at work that did not lead to sick leave, while their adoption has no impact on accidents at work that led to sick leave. Therefore, we conclude that the accidents that employees suffer at work, which are associated with the adoption of quality practices, are not of such nature to require sick leave.

The aim of **chapter 8** is to examine how the use of environmental practices impacts on workers' welfare. Using a French Organisational Changes and Computerisation (Changement Organisationnel et Informatisation, COI, 2006) survey and the Employer's Annual Declaration of Payroll Data (Déclarations Annuelles de Données Sociales, DADS, 2006), we examine the impact of environmental practices on two different aspects of employee working conditions. These include: employee well-being at work (as measured by the employee's sense of usefulness and the sense of being valued) and the level of job involvement (as measured by the employee's application and compensation for additional working hours). A rationale for a positive impact is based on the fact that the implementation of environmental practices can facilitate increased recruitment and motivational level of workers by their inherent pro-social implications. Therefore, we might expect that employees choosing to work for firms registered for environmental standards would be more likely to have a positive view of their job in terms of social utility, better evaluation of their relationship with the employer, increased job involvement and a greater willingness to put in the additional working hours. Our findings unambiguously show that the adoption of environmental practices is associated with an increased level of employee well-being. Hence, employees working for firms that are certified with environmental standards are found to report a greater sense of both usefulness and appreciation at work. In contrast, findings relating to employee job involvement suggest that while employees do not claim to be significantly more involved in their job, 'green workers' are more likely, *ceteris paribus*, to work uncompensated for additional working hours than 'non-green workers'. Based on these findings, we suggest that the overall market equilibrium might balance out the high costs associated with adoption of environmental practices, since the employer's view holds that satisfying employees' interests is more likely to result in an improvement of the firm's financial and economic performance (Freeman, 1984; Porter and Van Der Linde, 1995).

Finally, the **general conclusion** summarizes the main findings of this PhD dissertation, which also includes a discussion on the implications of our findings for both academics and policy-makers. Furthermore, we suggest future lines of research that may stem from this study.

Part I
The Description and Determinants of Quality and Environmental Management Practices

Chapter 1: The Description and Determinants of Adoption of Quality Standards: A Comparison between the Manufacturing and Service Sectors

Chapter 2: The Description and Determinants of Environmental Standards: A Comparison between ISO 14001 and Responsible Care

Introduction of the first part

Despite the large diffusion of Quality and Environmental Management Systems (QMSs and EMSs) worldwide, the number of economic studies devoted to the determinants of their certification is still limited. Such researches are important and necessary because the determinants of quality or environmental practices can generate significant insights to firms' organisational behaviour by helping to explain why specific types of firms seek quality or environmental practices while others do not. To fill this gap, the purpose of **Part I** of this PhD dissertation is to describe and analyse economic rationales for the adoption Quality and Environmental Standards with a particular focus on ISO 9000 and ISO 14000 standards.

The main objective of **Chapter 1** is to use an empirical approach to investigate whether there is a difference in the determinants of Quality Standards between the manufacturing and service sectors. A special focus is given to ISO 9000 standards. The chapter will discuss the emergence, the structure, recent changes and global diffusion of ISO 9000 quality management standards. Furthermore, based on a literature review, we will consider theoretical rationales that predict which factors determine the probability of a firm becoming quality certified. In order to create our empirical model we have used an original French database. Our findings reveal for the first time that the determinants of ISO 9000 certification differ significantly between manufacturing and service firms. The results of this study could enable policy-makers to better formulate and effectively apply regulations affecting the business success of firms in both the manufacturing and service sectors.

In **Chapter 2**, we use survey data to investigate the determinants of chemical firms' registration for the ISO14001 standard or the Responsible Care program. Before presenting rationales for the development of our hypotheses we describe, as in the previous chapter, the ISO 14000 standard as the most widely adopted voluntary environmental program. Furthermore, our findings demonstrate that most determinants are different for the two systems analysed. Thus, the research will help firms to better understand the two practices and therefore choose one that corresponds the most closely to their strategy and business aims.

Chapter I

The Description and Determinants of adoption of Quality Standards: A Comparison between the Manufacturing and Service Sectors[1]

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[1] This chapter is a developed version of the article "The determinants of adoption of quality standards: A comparison between the manufacturing and service sectors" which is accepted in *Journal of Economic Issues*, forthcoming.

1. Introduction

The economic importance of quality systems has grown tremendously over the last decade. The widespread recognition of quality systems has been attributed in great part to the capacity of those systems to assure the survival of firms and the establishment of a superior competitive position for them (*e.g.* Levine and Toffel, 2009). In light of these strengths, it is not surprising that Quality Management (QM) has been increasingly adopted in the last decade, often as part of programs such as Total Quality Management (TQM), the Malcolm Baldridge National Quality Award, EFQM Excellence Model, Six Sigma and ISO 9000 standard.[2] Consequently, the main issue of interest in the economic literature has been the business value of quality practices (Terziovski *et al.,* 2003; Corbett *et al.,* 2005; Terlaak and King, 2006). However, a limited number of empirical studies have sought to understand the determinants of adoption of quality practices. Such studies are important and necessary because theoretically grounded empirical research of the determinants of quality practices can generate significant insights to firms' organisational behaviour by helping to explain why specific types of firms seek quality practices while others do not (Adams, 1999).

Interestingly, even in sectors where such standards are not required by customers, an increasing number of firms have been adopting quality practices. However, one of the criticisms that has been raised about quality practices is that it is not equally applicable to all industry sectors. For instance, it is argued that the concepts of service quality are not well developed as those of manufacturing quality (Ghobadian *et al.,* 1994).

Nonetheless, many service firms have applied quality systems and techniques even though such tools and techniques have originally been designed to improve performance of manufacturing firms. While differences between manufacturing and service firms are well recognised, the issues associated with the applicability of quality practices in these sectors remain significantly under-researched (Prakash *et al.,* 2006). Moreover, previous studies (*e.g.* Adams, 1999) regarding the determinants of quality practices have been primarily based on one sector and relatively few studies (*e.g.* Prakash *et al.,* 2006) have been based on a cross-sector analysis.

[2] The brief description of Total Quality Management (TQM), the Malcolm Baldridge National Quality Award, EFQM Excellence Model, Six Sigma is presented in Appendix 1.1.

The originality of this chapter is three fold. Firstly, an empirical approach has been used to fill a gap in the literature by investigating the likelihood of firms adopting Quality Standards (QSs). In addition, we follow Delmas's argument (2003) suggesting that it is important to analyse the factors that explain the adoption of an international standard at its early stage since they may differ from the factors that explain its later adoption. Moreover, Delmas and Montes-Sancho (2010) indicate that because of the lack of data from the early stage of adoption, research on the ISO 9000 standard focuses mainly on the later stages of adoption. With respect to implementing a management practice, institutional theory suggests that the motivation for management practices adoption differs among Early (first movers) and New Adopters (DiMaggio and Powell, 1983; Tolbert and Zucker, 1983; Fligstein, 1985; Westphal *et al.,* 1997; Zbaracki, 1998; Naveh *et al.,* 2004). Moreover, the literature's findings with regard to many management practices, suggest that Early Adopters customise management practices for efficiency gains, while New Adopters gain legitimacy from adopting the normative form of management practices (Tolbert and Zucker, 1996; Fligstein, 1985; Westphal *et al.,* 1997; Zbaracki, 1998; Naveh *et al.,* 2004). Hence, we will try to empirically examine whether determinants of Quality Standards adoption differ between Early and New Adopters in the time period studied. Secondly, this chapter provides important insights into how the manufacturing and service sectors perceive and engage with the Quality Standards, which may help Quality Standards promoters to improve targeting of their policies rather than adopting a "one-size-fits-all" approach. Finally, we have used an original French database that has permitted us to investigate to what extent the determinants of Quality Standards certification differ among manufacturing and service sectors and Early and New Adopters.

The reminder of this chapter is structured as follows. In the second section, we will define ISO 9000 standards as one of the most widespread standard for quality improvement and provide data concerning its diffusion. The third section provides a theoretical rationale for Quality Standards adoption and formulates hypotheses. The fourth section presents data and methods employed. Section five discusses the results. Section six is devoted to concluding remarks.

2. Description and diffusion of the ISO 9000 standards

The idea that standards should be used to support both social and economic regulations emerged during the late 19th century and early 20th century. The objective of such standards is to limit the uneconomical diversity of components, parts and supplies in order to favour their inter-changeability (Dale, 2002). Indeed, all economic transactions need to be based on a set of common institutions that will serve as a foundation for economic growth. The official definition of standardisation can be found in the ISO/IEC Guide 2 (ISO/IEC, 1991):

Standardisation is the activity of establishing, with regard to actual or potential problems, provisions for common and repeated use, aimed at the achievement of the optimum degree of order in a given context.

The International Standards Organisation (ISO) was established in Geneva, Switzerland in 1947 and has evolved into a major player in standards development. The ISO is a non-governmental organisation with the mission to facilitate worldwide trade through the development of international standards for products and services. In 1987, Technical Committee (TC 176) of the International Organisation for Standardisation published ISO 9000 Quality Assurance Standards. Its origins, however, rest in earlier American (MIL-Q-9858A and MIL-I 45208A) and British standards (BS 5750).

The ISO 9000 family of standards are generic management system standards that can be applied to any organisation regardless of its size, sector of activity, geographic location, product or service being provided. It is not focused on the product/service quality, but on the related processes, enlarging their reach into the entire network of interactions in which the firm is participating. Companies that adopt the ISO 9000 standard can be assured that their quality programs are built on a firm foundation of state-of-the art quality practices (ISO, 2004). The ISO9000 standard is based on eight principles that address the core values and concepts of Quality Management. The main ISO 9000 principles are presented in Table 1.1.

ISO 9000 is seen as a uniform standard, although it consists of a series of nested standards, which changed over time. Originally, the core members of the family, with which firms could actually be certified, were ISO 9001, ISO 9002 and ISO 9003. They differed in terms of the quality system elements they covered. More precisely, ISO 9003 focuses exclusively on final inspection and test standards. ISO 9002 builds on ISO 9003 and in addition targets installation, production and purchasing capabilities, while ISO 9001 was built on the other two standards, including design and after-sales service standards.

Table 1.1: The ISO 9000 standard's principles

Principle	Description
Customer Focus	Organisations depend on their customers and therefore should understand current and future customer needs, meet customer requirements, and strive to exceed customer expectations
Leadership	Leaders establish unity of purpose and the direction of the organisation. They should create and maintain an internal environment in which people can become fully involved in achieving the organisation's objectives
Involvement of People	People at all levels are the essence of an organisation, and their full involvement enables their abilities to be used for the organisation's benefit
Process Approach	A desired result is achieved more efficiently when activities and related resources are managed as a process
Systems Approach to management	Identifying, understanding, and managing interrelated processes as a system contributes to the organisation's effectiveness and efficiency in achieving its objectives
Continual improvement	Continual improvement of the organisation's overall performance should be a permanent objective of the organisation
Factual approach to decision making	Effective decisions are based on the analysis of data and information
Mutually beneficial supplier relationships	An organisation and its suppliers are interdependent and a mutually beneficial relationship enhances the ability of both to create value

Source: Kartha (2004)

Furthermore, according to the rules of the ISO, the ISO 9000 standard undergoes review and revision every 6-8 years. The ISO 9000 underwent a major revision in 2000. The 2000 edition of the ISO 9000 family replaced these three standards with a single one labelled ISO 9000:2000. ISO 9000:2000 describes fundamentals and specifies vocabulary for a Quality Management system and ISO 9004:2000 provides guidelines for performance improvements. Both of them were developed on the basis of previous standards, which they replaced. The revised standards include many new requirements and changes.[3] For instance, some of the requirements have been rewritten to facilitate the integration of other standards such as the ISO 14001 environmental standard.

In November 2008, the ISO published the current revision, which is called ISO 9000:2008.[4] The changes in ISO 9000:2008 are relatively minor. ISO 9000:2008 does not contain any new requirements nor does it contain changes to any of the existing requirements in ISO 9000:2000. Neither does it change the intent of ISO 9000:2000. Further, the structure and outline of ISO 9000:2008 is identical to that of ISO 9000:2000. ISO 9000:2008 only introduces clarifications to the existing requirements of ISO 9000:2000 based on eight years of experience and introduces some changes to the wording intended to improve consistency with ISO 14001:2004. According to the ISO, the benefits of the changes to the wording in ISO 9000:2008 are easier to use, clearer language, easier to translate into other languages and better compatibility with the ISO 14001:2004 environmental management standard.

According to its design, the ISO 9000 only provides a framework without demanding complete change in how the organisation operates. So as to "ensure that nothing important is left out and that everyone is clear about who is responsible for doing what, when, how, why and where" (ISO, 1998). By the end of 2007, the number of ISO 9000 certificates exceeded 900 000 in 175 countries around the world, contributing to its reputation as an international reference for quality requirements in business-to-business dealings (ISO, 2008).

ISO 9000 adoption is a voluntary decision of each firm. Each country has an authoritative body that is responsible for accrediting the registering bodies for that country. The registering bodies are then responsible for certifying the firm that seeks certification. For instance, registering bodies include government laboratories, private testing organisations, firms that already possess ISO certification and industry trade groups. In the certification process, registrars may have different methods of assessment and certification. Nevertheless, the implementation process usually contains 14 steps that are: evaluate the organisations objectives and targets for implementing a QMS; obtain knowledge about the ISO 9000 family and appoint a management representative; organise resources; raise awareness and provide

[3] The list of ISO 9000:2000 requirements is presented in Appendix 1.2.
[4] The current list of standards is presented in Appendix 1.3.

training; initial review/gap analysis; product realisation processes; planning and time frame; draft a quality manual; develop the policy; design the QMS and implement it; draft the documentation; carry out internal audits; conduct a management review; pre-assessment-apply for certification; conduct periodic evaluations and initiate corrective and preventive actions; and evaluation.[5]

The certification process is daunting and lengthy. As a result, the process itself is the main source of criticism of ISO 9000. The time to achieve certification depends on several factors such as firm size and sector, amount of existing documentation, management commitment, etc. Furthermore, according to Johnson (1998), the first three months firms generally spend in planning, organising and training. The next six months are spent documenting their quality system and beginning the internal audits. The system is allowed to operate at least three months prior to certification audit in order to provide evidence for the registrars.

Obtaining certification is not the end of the process since the certification is not given indefinitely. In fact, the firm has to undertake regular audit supervision which usually occurs once or twice a year. The purpose of audit surveillance is to verify that the quality system functions appropriately. As well as these regular audit surveillances, the firm has to submit a complete re-audit every three years which presents a complete assessment of the quality system.

Advantages of the ISO 9000 implementation

Benefits of ISO 9000 certification could be identified on both internal and external levels. Internal advantages include increased customer demand, improved company quality image and competitiveness on the market, compliance with customer requirements. External advantages include streamlined procedures and documentation, increased awareness of preventive and corrective actions and provision of foundation for TQM, lower operating costs or achieving external benefits, higher profitability. The literature suggests that the most prominent reason for implementing the ISO 9000 certification is that customers prefer to buy from firms that are ISO 9000 certified (Rao *et al.*, 1997).

[5] The implementation process flow chart of ISO 9000 implementation is presented in Appendix 1.4.

Disadvantages of the ISO 9000 implementation

Beyond the discussion of the benefits of the ISO 9000 certification, some criticisms have been raised as well. As we discussed previously, one of the main disadvantages of the ISO 9000 certification is the certification process itself. Furthermore, the regulation and implementation of the standards were left up to the participating countries' individual standard organisations, which select the agencies qualified to issue the ISO 9000 certification. Once registrars become accredited, there is no single set of guidelines for them to follow. Hence, the registration process can vary according to the registrars. In the past, not all companies or countries would acknowledge certification from all registrars because standards had been interpreted somewhat variably in different countries. Consequently, companies such as Hewlett-Packard, Motorola, Novell, Microsoft, etc led a self-certification movement, which provided greater flexibility in meeting objectives, reduced costs and heightened customer understanding of the Quality Management systems.

Another issue that has emerged is that ISO 9000 is not industry-specific. Some critics claim it is too general and fails to address the unique problems and issues inherent in some industries. In fact, ISO 9000 registration is strongest in the transportation, chemical, oil, electronics and computer industries.

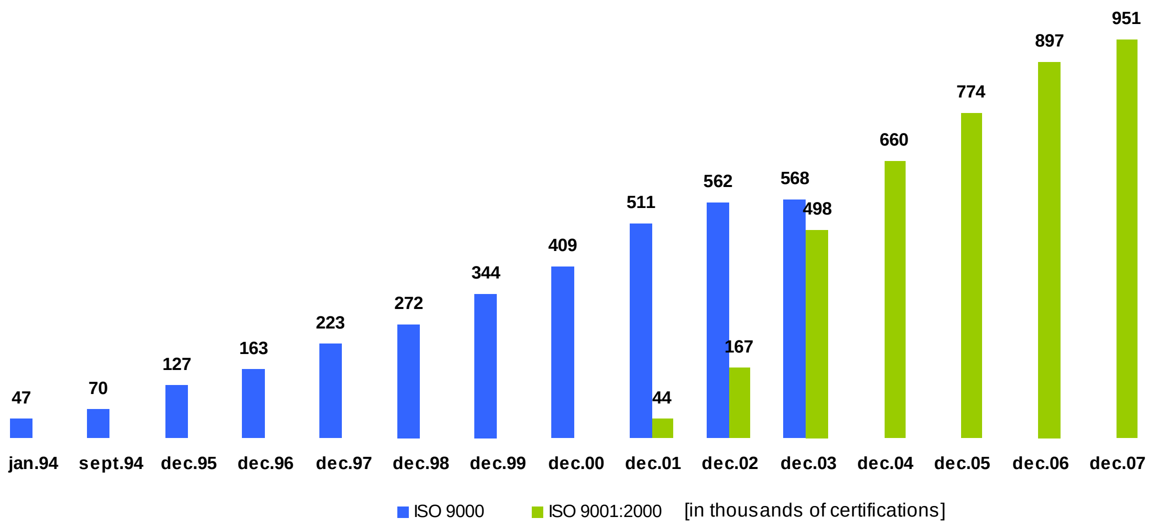
Generally, the most frequently voiced criticisms are the costs of achieving the ISO 9000 certification. Four major factors generate costs in achieving the ISO certification: time, training, consultants and the registration itself. The amount of time needed to become certified ranges from less than a year to more than two years, but usually takes from about a year to 18 months. It depends on many factors, including firm size and sector of activity, current level of work quality, extent of current documentation and degree of management commitment. Furthermore, 6 to 12 months of training is necessary for the firm in order to adapt procedures to the ISO standard. Hiring consultants to facilitate the process also contributes to the costs of the ISO certification. An example of the cost of ISO 9000 certification is given by Anderson *et al.*, (1999). The authors report that obtaining ISO 9000 certification in the manufacturing sector in the U.S. takes from 9 to 28 months and approximately 35-40% of all sites fail the first audit. The costs of the standard adoption and certification are substantial. A medium size manufacturing facility employing 100 people can expect to spend $50 000. For larger firms (sales from $100 million to $500 million), the average cost that the authors report is $300 000. Moreover, adoption of the ISO certification may induce the shadow prices (Diaye *et al.*, 2008) that can be high as the cost of ISO implantation. In order to avoid the shadow prices, managers have to insist on employees' participation and training during implementation process.

The global diffusion of ISO 9000

As we notice from the Figure 1.1, by the end of 2007, the ISO listed 951 468 ISO 9001 certificates in 175 countries. Furthermore, the ISO 9001 growth seems to face a net decline in 2007. Indeed, we observe an increase of 54 557 certificates in 2007 vs 123 062 in 2006 and growth of 6% in 2007 vs 16% in 2006. According to the ISO, the decline could be influenced by various factors such as:

- the changes of methodology;
- the new edition of ISO 9001 induces wait-and-see-attitude of firms, as was the case for ISO 9000:2000 version;
- certain countries have reached full growth or maturity;
- gathering certificates in companies with multi-sites.

Figure1.1: ISO 9001 certification in the world

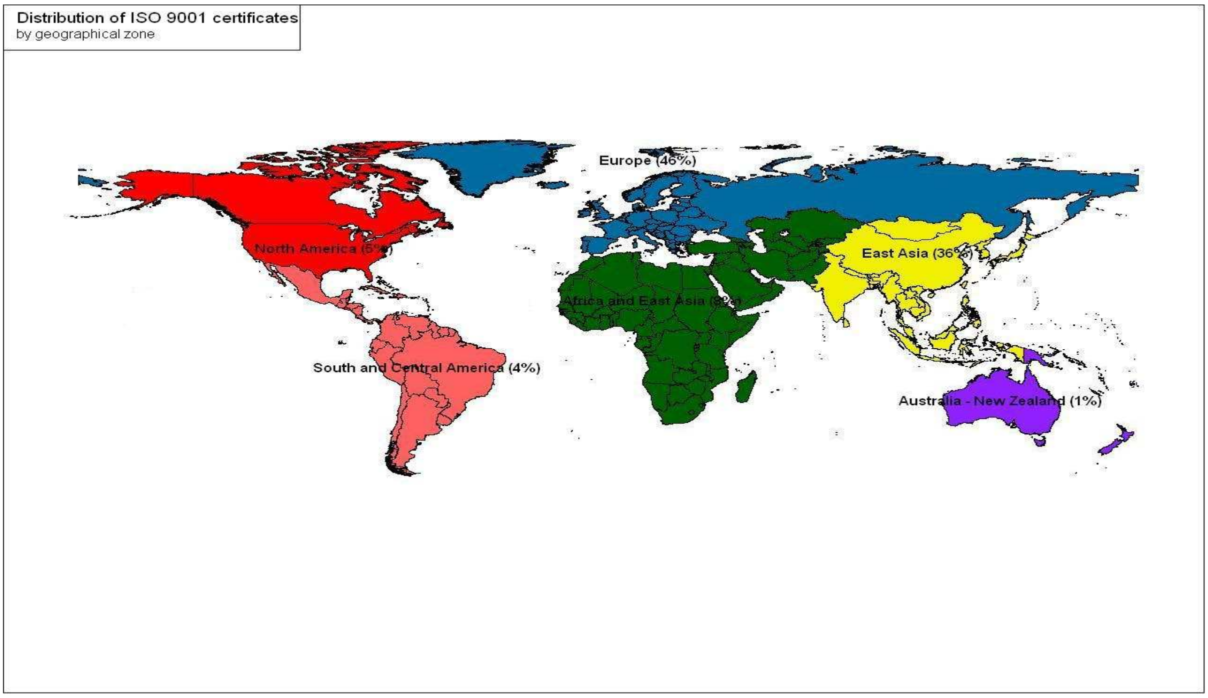


Source: The ISO Survey of Certifications 2007 (17th Cycle)

The diffusion of ISO 9000 standards differs among different geographical regions. The level of ISO certification may sometimes reflect the level of a country's development level. However, the absolute number of ISO certification may hide certain disparities. Therefore, ideally we need an indicator that will measure the number of the certifications by the size of population or by Gross Domestic Product (GDP). The following discussion examines only the absolute number of ISO 9000 standards, hence we can not discuss differing levels of economic development within different countries.

As previously, in 2007, Europe, presents 46% of the ISO 9001 distribution in the world (Figure 1.2). Moreover, we may notice a great increase of ISO 9000 distribution in the countries of the Far East which account for 36% of total world's certificates. Hence, just Europe and the Far East concentrate 82% of the ISO 9001 certificates in the world. North America and Australia-New Zealand have lost 2% and 1%, respectively, compared to the previous year. This loss goes to South and Central America that gain 1% each.

Figure 1.2: Distribution of ISO 9001 certificates by geographical zone on the 31st December 2007



Source: The ISO Survey of Certifications 2007 (17th Cycle)

Figure 1.3 describes how the worldwide number of certificates breaks down into world regions. We remark that in Europe growth in certification declines in 2007, with only 4% of growth or only 17 847 additional certificates (compared to more than 38 000 between 2005 and 2006). The increase is mainly carried by Italy and Spain. If we remove those two countries, the growth would be almost 0 at the European level.

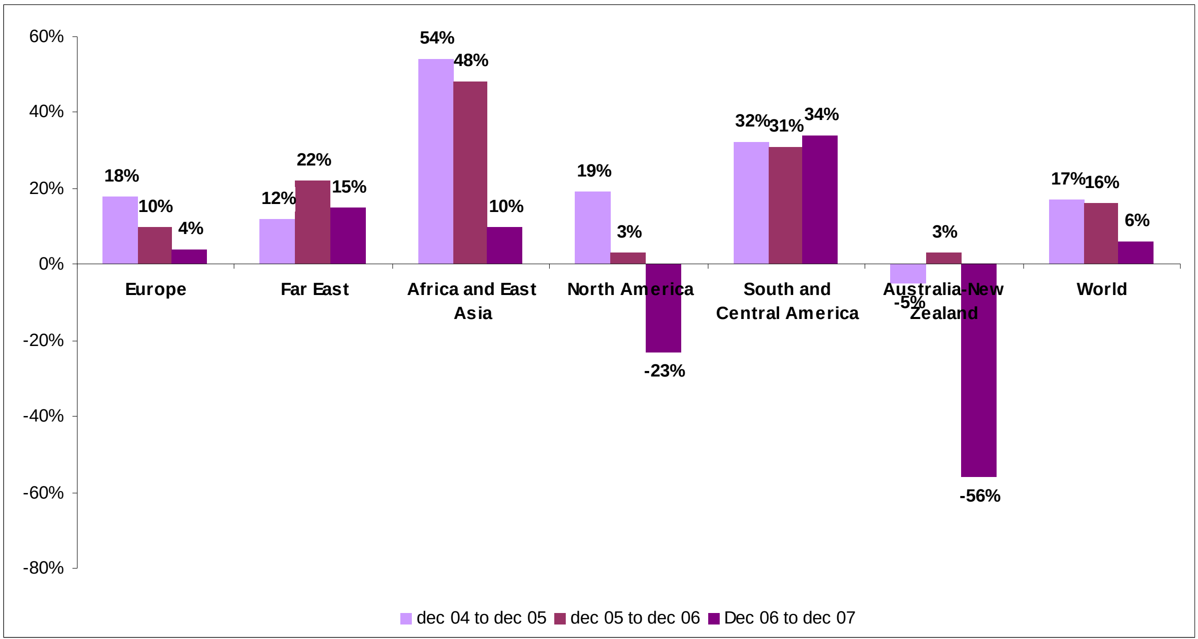
Furthermore, the Far East also sees a decline in the growth of certification, since the number of certificates increases only 15% - almost 45 000 additional certificates. On the top of the world list is China, with 210 773 ISO 9001 certificates at the end of 2007 (or more than 22% of certificates delivered in the world). On the other side, Japan saw a steep decline in the growth of certification. Actually, Japan records a loss of 3 000 certificates during one year.

Africa and East Asia, as well, saw a significant slow down in their growth of certification (only +10%), particularly due to sluggish growth in India. However, with 5 124 additional certificates, India passes from the 7th to the 5th world position in ISO 9001 certification.

South and Central America are the only regions that have maintained a superior growth compared to the previous year (+ 34% or 10 000 additional certificates).

Australia and New Zealand register a significant decrease, with the loss of 56% of certificates in 2007. In the same vein, North America lost 23% of its certificates.

Figure 1.3: Evolution of ISO 9001 growth level in the world



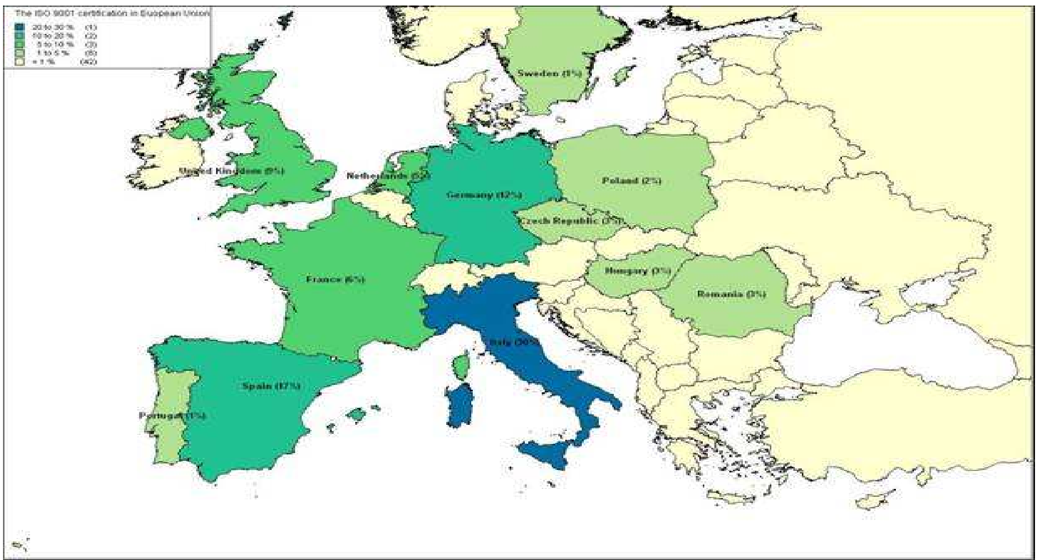
Source: The ISO Survey of Certifications 2007 (17th Cycle)

The analysis of Figure 1.4 is based on the 27 countries that are members of the European Union (EU). The ISO 9001 certificates awarded in the EU countries represent approximately 40% of the certificates awarded in the world or around 385 255 certificates. Hence, the first impression about this data is that EU countries lost 2% of their certificates comparing to 2006.

With 11 359 certificates, Italy pursues its “race” on the top of the list, far from the other countries in the EU and records the strongest progression in 2007, obtaining two additional points comparing to 2006 (a growth of 9% or 9 560 additional certificates). For the third consecutive time, Spain is in 2nd position and represents 17% of the delivered certificates in the EU. It gains 2 additional points compared to the previous year. Portugal is also among the countries with the strongest growth in 2007. The United Kingdom has lost almost 54 000 certificates and declines 3 points in 2007. France preserves the 5th position and represents, as previously, 6% of the delivered certificates of the EU.

Together, the 27 countries of the EU record a growth of 2% during 2007, but the data “hides” significant disparities among the countries. After 3 years of growth, Germany notes a decrease of 3% in 2007. The United Kingdom follows its previous decline and count 35 517 certificates having lost 30 000 certificates in 6 years. It seems that France resists any decrease and it records a growth of 8%. Finally, we have to underline that Bulgaria and Belgium saw a great increase of around 10% in 2007.

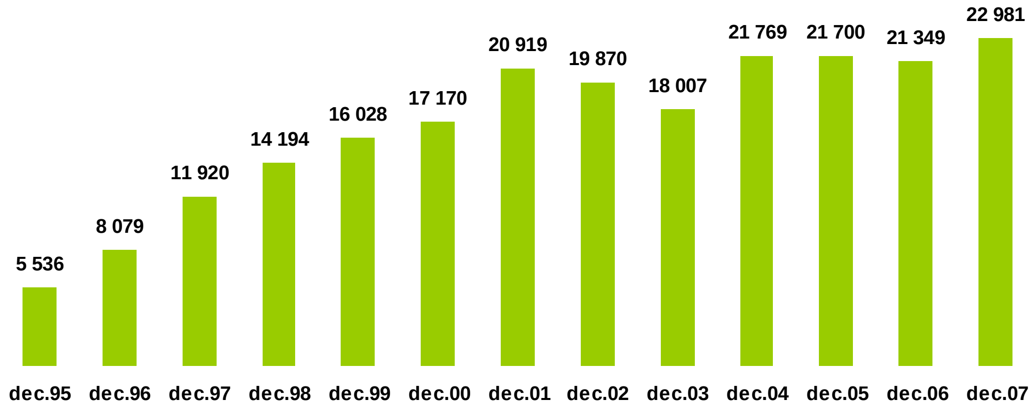
Figure 1.4: The ISO 9001 certification in the European Union



Source: The ISO Survey of Certifications 2007 (17th Cycle)

As we indicated previously, France is still in 5th position on the European level and 9th on the world level with 22 981 certificates at the end of 2007 (Figure 1.5). Hence, it gathers 6% of the certificates delivered in the EU and 2% of the certificates delivered in the world. The ISO data shows that France picks up growth in 2007 (+8% that corresponds to 11 632 additional certificates). Interestingly, between 2000 and 2007 the average increase of certificates has been 830 per year, while between 1995 and 2000 it has been 2 300 certificates per year. This could be explained by different facts. For instance, as indicated by the ISO, the development of specific quality references for specific sectors may have a negative impact on the growth of the ISO 9001 certificates in France.

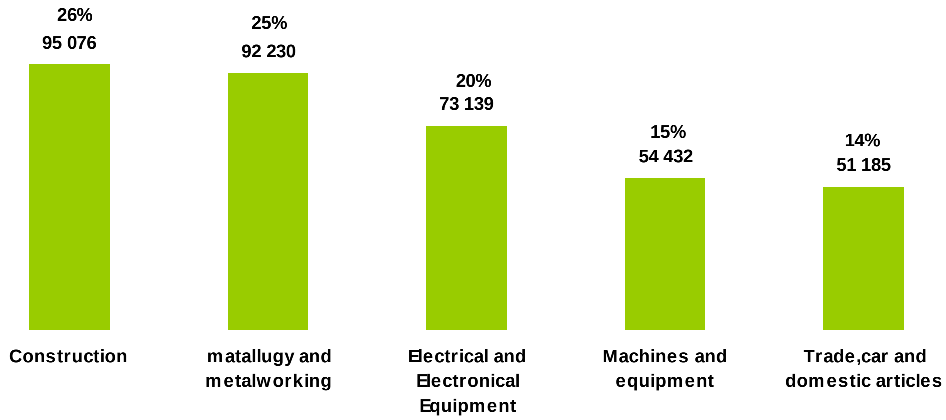
Figure 1.5: The ISO 9001 certification in France



Source: The ISO Survey of Certifications 2007 (17th Cycle)

Figure 1.6 shows that the construction sector keeps 1st position with more than 95 000 ISO 9001 certificates or 13% of certificates at world level, in front of the metallurgy and metalworking sector (12% of world share). Five sectors (construction; metallurgy and metalworking; electronic and electrical equipment; machines and equipment; trade, car and domestic articles) concentrate almost half of the ISO 9001 certificates in the world. As we indicated previously, ISO 9000 was designed with a manufacturing mind set which explains the high share of certificates in manufacturing sectors. Still, the service sector covers a third of the market share with more than 237 000 certificates in the world.

Figure 1.6: The ISO 9001 certification per sector of activity



Source: The ISO Survey of Certifications 2007 (17th Cycle)

3. Related literature and conceptual framework

It is generally accepted that a firm will adopt Quality Standards when the benefits of adoption outweigh the investment costs. Quality Standards aim to improve not only the quality of a firm's processes and outputs, but also its business performance. Based on a review of the literature, let us consider theoretical rationales that define which factors predict the likelihood of a firm becoming quality certified (in the manufacturing and service sectors).

Sector of activity

Quality Standards differ among sectors given their unique nature. Zeithaml *et al.*, (1990) observe that quality in the service sector is identified mainly by non-physical elements, such as courtesy, responsiveness and accessibility. As such, it is difficult for service firms to clearly define customer needs and expectations which are a lot more idiosyncratic than those in the manufacturing sector. In addition, there are several key characteristics that distinguish service firms from manufacturing firms and these may affect the implementation of Quality Standards in service environments. In fact, Parasuraman *et al.*, (1985) referrer to specific characteristics of the service sector such as intangibility, heterogeneity and inseparability that are in contrast to those features in the manufacturing sector that are more measurable and standardised in their specifications. Most services are intangible, they can not be seen, touched or tried and this intangibility factor makes difficulties to firm to understand how customers perceive their services and evaluate service quality (Zeithaml, 1981). Furthermore, services are heterogeneous underlying that their performance often varies from producer to producer, from customer to customer and from day to day what makes difficult to obtain quality consistency of service personnel. Quality occurs during service delivery, usually in an interaction between the customer and the contact person from the service firm what makes production and consumption of many services inseparable. This poses difficulties for service providers in terms of controlling the quality of service outputs before delivery to customers, which in turn may increase the cost of quality in the service sector. Furthermore, Boiral (2003) remarks that the quality system is better adapted to manufacturing firms, for whom this standard was originally designed. As a result, it is argued that manufacturing firms benefit from having had longer experience with Quality Management practices. In this regard, we can presume that firms having longer experience with Quality Standards are expected to lower the implementation costs (*e.g.* through the overlap of documentation) due to factors such as "learning-by-doing" and scale economies. For these reasons, service and manufacturing firms may face unique challenges on the market and may therefore respond quite differently to quality certification. Hence, we propose the following hypothesis:

> *H1: The determinants of Quality Standards differ between the manufacturing and service sectors.*

Firm size

Quality is an essential trait for both customer satisfaction and competitive positioning. This is true for firms of all sizes (Anderson and Sohal, 1999). Unfortunately, resource constraints, including scarce managerial time, limited training funds and lack of quality "know-how," can place a smaller firm at a quality disadvantage (Grolleau *et al.,* 2007). Furthermore, compared to small firms, managers of large firms will probably have a wide range of external contacts (*e.g.* management consultants) that would be able to act as catalysts for and facilitators of quality initiatives (Adams, 1999).

Hence, smaller firms often struggle to achieve world-class Quality Standards. In contrast, larger firms are more likely to realise economies of scale and "learning-by-doing" by investing in certification. Moreover, Grolleau *et al.,* (2007) have argued that larger firms may influence the design of standards in order to raise the cost for their smaller rivals. They concluded that such a strategy can be implemented by introducing a fixed cost of certification that can disadvantage smaller firms.

Finally, as argued by Adams (1999) big firms are also more likely to seek the ISO certification than small ones since Quality Standards may help them to reduce the problem of information asymmetry by enabling their managers to exercise better control and respond more efficiently and effectively to changing circumstances. Given this reasoning, we suggest the following hypothesis:

H2: The probability of the adoption of Quality Standards increases with a firm's size, ceteris paribus.

Group

The corporate status of a firm (either independent or part of a larger concern) may also have an impact on the decision of a firm to adopt new management practices. In fact, the effect of corporate status is likely to be ambiguous (Karshenas and Stoneman, 1993; Gourlay and Pentecost, 2002). On the one hand, independent firms may be better positioned with regard to time needed for implementation. On the other hand, firms that are part of a larger organisation may be better informed and bear less risk in adopting new practices, which in turn may reduce the costs of searching for necessary quality information. Moreover, as propose by Guler *et al.*, (2002), network ties between firms may facilitate the diffusion of new practices through multiple channels.

The existence of a network external to the organisation plays a substantial role in the adoption process, since networking intensifies awareness of innovation and increases the likelihood of its adoption (Abrahamson and Rosenkopf, 1997). Furthermore, membership of a group makes firms more receptive to external factors through attendance at meetings and increasing opportunities for learning and technology adoption (Lai and Guynes, 1997). In addition, the external conformity pressures from parent organisations drive organisational action and may influence subsidiaries in their decision to adopt innovative practices (Westphal *et al.*, 1997). Noteworthy, firms that belong to group have more financial resources available for investment in new practices. In view of these arguments, the following hypothesis is proposed:

H3: The probability of the adoption of Quality Standards increases as a firm belongs to a group, ceteris paribus.

Export

Information asymmetry about quality attributes is generally more important when agents evolve in different institutional environments (distinguished on geographically, culturally and linguistically bases), (King and Lenox, 2001) or when quality level of firms stays unobservable for customers. From a signalling perspective, Quality Standards can provide information on the general capability of a firm to meet the quality expectations of customers and thus make unobservable characteristics more public (Spence, 1973; Grolleau *et al.,* 2007).

Therefore, internationally recognised certification may play a strong role in signalling unobservable characteristics and generating customer trust (Zucker, 1986). Furthermore, Grolleau and Caswell (2003) assert that consumers believe that if claims of high quality attributes are verified, they can assume that any credence claims are also true. In addition, the reputation of consumers' agents (government, third party or retailer) has more influence on consumers than the precise knowledge of quality definition and monitoring. We can therefore establish the next hypothesis:

H4: The probability of the adoption of Quality Standards increases as a firm exports abroad, ceteris paribus.

Customer Satisfaction

It is well recognised that a firm's long-term success depends on how effectively it satisfies customer needs on a regular basis. Based on the literature, we can distinguish four ways in which customer satisfaction impacts on a firm's overall performance.

Firstly, the customer satisfaction-loyalty-retention link has an important impact on a firm's performance because retained customers are generally less costly to serve than new customers (Reichheld, 1993). Secondly, satisfied customers are more loyal and increase their level of purchasing from the firm over time (Reichheld and Sasser, 1990). Thirdly, satisfied customers are less price sensitive as they are more tolerant to price increases and less susceptible to price reductions from competitors (Reichheld and Sasser, 1990). Finally, customer satisfaction also leads to positive "word-of-mouth" (*e.g.* Reichheld, 1993), which can significantly enhance the effectiveness of marketing communication and thus lower the acquisition costs for new customers.

Furthermore, in Quality Management, it is essential to maintain very close links with customers in order to both identify their needs and receive the feedback necessary for the firm to understand to what extent it has succeeded in satisfying those requirements and whether to initiate the relevant improvement activities (Forza and Filippini, 1998). In fact, as argued by Naveh *et al.,* (2004) Quality Standard is a management practice, which aims to get organisations to satisfy customer needs at each stage in the value chain.

Moreover, Quality Management practices are not only used to satisfy customers by delivering high quality products or services but also by delivering products on time. Timeliness of delivery is also found to be a significant outcome of Quality Management (Anderson *et al.*, 1999; Koc, 2007; Lo *et al.*, 2009). In fact, it is argued that a significant improvement of delivery performance is mainly caused by reduction in time for non-value added activities and reduction in delays in production. Based on these findings, the following hypothesis is proposed:

H5: The probability of the adoption of Quality Standards increases with a firm's willingness to satisfy customers concerning delivery performance, ceteris paribus.

Quality Improvement

Quality Standards is based on the classical management practices of "plan, organise, lead and control" which are intended to integrate quality concerns into the firm's daily routine (Boiral, 2003). These practices ensure work method continuity and final product quality (Wealleans, 2000). The rationale for such a link is that if work processes were chaotic, the products and services that were produced would not have acceptable levels of quality (Prakash, 2008). Similarly, according to Withers *et al.,* (1997) firms with solid operations and processes are in the best position to improve the quality of their products, services and processes. In the same vein, Corbett *et al.,* (2005) argue that the foundation of Quality Standards is that well-defined and documented procedures improve consistency of output, what is translated into improved product and service quality. Based on this reasoning, we suggest the following hypothesis:

H6: The probability of the adoption of Quality Standards increases with the firm's willingness to improve quality, ceteris paribus.

Cost Reduction

The importance of low-cost is well established in competitive advantage literature (Porter, 1985). Low cost can be generated from economies of scale, power over suppliers and, in Quality Management terms, from fewer defects and rework (Reed *et al.*, 1996; Koc, 2007). Moreover, Reed *et al.*, (1996) also state that with the implementation of Quality Standards the operations orientation generates increased revenues through enhanced product reliability and reduced costs through process efficiencies, while a complementary customer orientation produces increased revenues and reduced costs through market advantage and product design efficiency, respectively. In the same sense, Ferguson (1996) argues that adoption of Quality Standards produce reduction of operating costs by 10 percent, process testing declines by 30 percent and production defects declines by 20 percent.

Furthermore, according to Juran (1979), quality control has traditionally been based on the economic conformance level (ECL) model whereby there is a balance between prevention and appraisal costs on one hand, and internal and external failure costs on the other. Under this perspective, the optimal ECL is achieved when marginal prevention and appraisal costs equal marginal failure costs. Therefore, there would always be an "acceptable" level of defects and this level would never be at zero. In contrast, the central principle underlying the quality perspective is that an optimal conformance level occurs when the level of defects is at zero. The proponents of this view suggest that higher quality will always result in lower costs (Juran, 1979). Following the above arguments we hypothesize:

H7: The probability for the adoption of Quality Standards increases with a firm's willingness to reduce cost, ceteris paribus.

Innovation

The literature presents conflicting arguments concerning the impact of quality on innovation. One set of argument supports a positive relationship between quality and innovation, implying that firms implementing quality systems also improve their innovation performance (Abrunhosa and Moura E Sa, 2008; Prajogo and Hong, 2008). The opposite set of arguments claims that quality will hinder firms from being innovative due to several inherent factors that are not congruent with the aim of innovation (Flynn, 1994; Glynn, 1996). However, it is argued that in many firms, barriers to innovation are difficult to overcome without quality practices**.** In that sense, quality in its human and technological dimensions can help to create an environment and culture that supports innovation.

The relationship between quality and innovation is highlighted by the fact that the objectives of innovation encompass and conform to the objectives of quality. This argument is based on the observed similarities between the determinants of quality and innovation, especially when considering internal determinants (for detailed review, see Perdomo-Ortiz *et al.,* 2006). Furthermore, Benner and Tushman (2002) indicate that the ISO 9000 standard reduces variance within a firm's routines and influences the selection of innovations. Related to these arguments, we formulate the following hypothesis:

H8: The probability of the adoption of Quality Standards increases with a firm's willingness to improve innovation, ceteris paribus.

4. Data and model specification

4.1 The database

We have used the French Organisational Changes and Computerisation (Changement Organisationnel et Informatisation, COI, 2006) survey.[6] The COI survey is a matched employer/employee survey on organisational changes and computerisation. This survey was conducted in 1997 by researchers and statisticians from the National Institute for Statistics and Economic Studies (INSEE), the Ministry of Labor (DARES) and the Center for Labor Studies (CEE). The questionnaires were prepared based on collective discussion involving researchers in economics, management, sociology, ergonomics and management representatives. Consequently, the survey is doubly rooted in research issues and in social demand. Moreover, this collaboration gathered together a great deal of knowledge, which has

[6] More details about the design and scope of this survey are available on www.enquetecoi.net.

made it possible to put together the surveys of different firms and the survey concerning employees.

The first idea of the survey originated from a seminar on the innovation and performance improvements (organised by Dominique Foray and Jaques Mairesse; for detailed review of main principles of what became the COI survey, see Foray and Mairesse (1999)). Furthermore, Greenan and Mairesse (2001) present the background and details about the surveys that preceded the COI survey (Appendix 1.5).

Two key ideas are behind the COI survey. First, the analysis of information and communication technologies can not be disassociated from the study of organisational changes, since these play a mediating role in the origins of innovative uses of information technology. Hence, in order to construct a robust system for measuring change, it is appropriate to bring together the viewpoints of the company's representatives as well as those of employees. This combination provides a more complete overview of the organisation through articulation of the tools adopted by management as experienced by employees. Actually, the COI survey aims to analyse the on-going changes in work organisation, with particular focus on the use of new technologies, in order to analyse the relationship between computerisation, organisational changes and overall performance (Greenan and Hamon-Cholet, 2000). Therefore, the survey provides a great opportunity to understand the impact of these changes on different indicators of economic performance as well as on employees.

As we indicated previously, the COI survey in 1997 includes an employer survey and a labour force survey. The survey benefited from high response rates both on the employer side (82%) and on the employees' side (71%), which makes this survey an effective representative sample of French firms. The employer survey comprises three different questionnaires relating to the sector of activity it is applied to. In addition, it includes a questionnaire for industrial firms including the agriculture and food sectors, but excluding the energy sector. This questionnaire contains questions relating to the internal organisation of the firm and the way information technology interacts with it. Furthermore, the manager being questioned was asked to describe the choices made by the firm in terms of IT and organisational practices, to specify the difficulties met in their implementation, as well as to explain the general strategy followed by the firm. More precisely, the survey lists a large set of High Performance Workplace Practices such as quality practices, just-in-time delivery and production, work groups or teams, etc. The second questionnaire is devoted to firms from a branch of commerce, while the third is devoted to firms from a branch of the service sector. Those two questionnaires are more oriented to external organisation, vertical networks between firms in the former and horizontal networks in the latter. Importantly, the firms were also asked what they do in 1997 and about changes that occurred between 1994 and 1997.

The manufacturing sample covers about 6 000 firms with more than 20 employees. Surveyed firms have been randomly selected from administrative data files called Annuel Surveys of firms file (Enquete Annuelle d'Enterprise, EAE).

The labor force survey has been conducted by INSEE and DARES. It concerns the employees interviewed in each of the sectors. Actually, the questionnaire follows (from employees' perspective) the evaluation of working conditions, work techniques and work organisations. Moreover, the survey describes the employee's hierarchical position, communication networks, autonomy, work rhythm, strain and technology use. The labour force survey defines the employee's work content at the time of the survey, providing only a few elements dealing with actual changes. The sample was selected from the compulsory file named Annual Declaration of Social file (Declarations Annuelles de Données Social, DADS). In the manufacturing sector, only firms with at least 50 employees were retained for the labour survey, while for the trade and services sectors firms with at least 20 employees were selected. In fact, as explained by Greenan and Hamon-Cholet (2000) the choice of surveying larger firms is intended to protect the anonymity of interviewed employees and to make it difficult to have the same person responding to the two questionnaires. Moreover, two employees were selected in firms with less than 500 employees and three employees in firms with more than 500 employees, which leads to an overall sample of 8 812 employees.

Another advantage of the COI database is that it could be merged with other administrative databases and surveys by using the identification number of firms called SIREN. For instance, the COI database could be merged with Annuel Survey of Firms (EAE), the Financial Link Survey (LIFI), Annual Declaration of Social file (DADS), a database on employment structure (ESE), etc. Greenan and Hamon-Cholet (2000) present further analysis of the COI database and examine results that give a flavour of the type of empirical investigation that the survey proposes.

The COI survey of 2006 is an updated version of previous COI surveys that provides an employer and employee survey, enhanced by outside information. The employer section is a self-administrated questionnaire that describes both work organisational practices in 2006 and the changes that have occurred since 2003. In this survey, firms were interviewed about the economic goals of organisational changes and the economic context in which those decisions were made. Between November 2005 and April 2006, 17 000 firms with 20 or more employees belonging to the private sector were questioned. Of the firms that responded, slightly fewer than 7 000 companies with more than 20 employees served as the basis for the survey of employees. It is representative of the population of French private firms from all industries except agriculture, forestry and fishing. Moreover, the new edition of COI survey contains also the public and hospital sectors. The survey on the public sector provides information on 380 public unites and 1 200 employees, while for the hospital sector, we have data on 800 hospitals and around 2 000 employees.Within each surveyed firm, employees were randomly selected, numbering in total around 14 500 employees. There are two employee questionnaires: the main questionnaire involves employees still employed by the company for which they were selected at the time of data collection; a secondary questionnaire is for employees who have left the company when they are interviewed. This will make it possible to obtain information on the characteristics of employees who leave their company, in association with the company's organisational and IT changes. This part of the data counts around 1 400 employees.

Similarly, as in the previous edition, the employer section of the survey seeks to characterise the company's forms of organisation and recent changes in them stemming from the mobilisation of management tools and IT tools. The labour force section of the survey makes it possible to analyse the concrete organisation of labour, the use of these tools by employees, support for the changes in terms of training and wage policy, and to evaluate their effects on working conditions, employee selection, etc.

Furthermore, as in the previous edition of COI survey, to obtain additional information about firms and workers, the COI survey could be merged with other French administrative databases. Enhancement through other surveys or administrative files also provides information on economic characteristics and on the structure of the company's workforce.

Finally, the COI survey has been used recently by several researchers like Acemoglu *et al.*, (2007), Aubert *et al.*, (2006) and a special issue of Revue Economique directed by Greenan and Mairesse (2006). The present research is based on the second edition of the COI database (COI, 2006). As we previously explained, **chapter 1** will use information only on the manufacturing and service sectors. Therefore, after the deletion of firms that do not correspond to our two sectors and did not answer all the relevant questions for our study, we are left with 8 352 usable observations.

4.2 The variables

Dependent variable

The dependent variable denoted *QUALITY ADOPTERS* is a categoriacal variable.[7] We have used information on the firm's year of quality certification and thus classified firms as Early Adopters in the time period studied (those that are certified since 2003), New Adopters in the time period studied (those that are certified since 2006) or Non Adopters (those that are not certified). On the basis of this classification, we have created a variable *Q1j* that takes the value of *Q1 = 1* if the firm is an Early Adopter, *Q2j* = 2 if the firm is a New Adopter and *Q0j* = 0 if a firm is a Non-Adopter. The lag between the dates at which the firms have adopted Quality Standards can indicate whether the firm's commitment to certification is of a long-term nature or whether the firm's determinants of Quality Standards have changed over time. The total sample accounts for 8 352 firms having more than 20 employees, including 4 622 manufacturing firms and 3 790 service firms. The distribution of each category of Quality Adopters within manufacturing sector is: 57%, 5%, and 38%, respectively. The distribution of each category of Quality Adopters within the service sector is 30%, 6% and 64%, respectively.

Explanatory variables

The hypothesised determinants of Quality Standards may be classified into three categories: the firm's characteristics (firm size and corporate status), features of the firm's

[7] Under this variable it is included ISO 9001, EAQF, etc. Unfortunately, we cannot distinguish between these standards, since in the survey they were put together under the same name, so QS is a reference for this variable. Threfore, we cannot estimate the specific effects of each program.

strategy (quality improvement, cost reduction and innovation) and external features (export and customer satisfaction). To test H1 (main activity of the firm), the surveyed firms were asked to indicate their main activities. We have used a set of six dummy variables for the manufacturing sector (*AGRO-FOOD, CONSUMPTION GOODS, CARS, EQUIPMENT GOODS, INTERMEDIATE GOODS* and *CONSTRUCTION*) and four variables for the service sector (*TRANSPORT, FINANCIAL ACTIVITIES, REAL-ESTATE ACTIVITIES, SERVICE FOR FIRMS* and *INDIVIDUALS*) in order to identify any sector-specific differences in the behaviour of firms towards certification. The sub-sectors were used as control variables.To test hypotheses H2 to H8 we have used eight dummy explanatory variables described in Table 1.2.

Table 1.2: Definition of variables

Variable	Definition
Dependent variables	
QUALITY ADOPTERS	Certified with ISO 9001, EAQF, etc. Dummy variable (=1 if yes)
Independent variables	
SIZE (H2)	SMALL (20 TO 49 Employees) SMEDIUM (50 TO 199 Employees) MEDIUM (200 TO 499 Employees) BIG (more than 500)
GROUP (H3)	Belonging to a group Dummy variable (=1 if yes)
EXPORT (H4)	Share of firm exportation by turnover (Continuous variable)
CUSTOMER (H5)	Under customer policy firm uses contract to assure delivery timeless Dummy variable (=1 if yes)
QUALITY IMPROVEMENT (H6)	Quality strong or very strong strategic importance for product, service and performance Dummy variable (=1 if yes)
COST (H7)	Cost Reduction strong or very strong strategic importance for product, service and performance Dummy variable (=1 if yes)
NEW (H8)	Innovation strong or very strong strategic importance for product, service and performance Dummy variable (=1 if yes)
ACTIVITY (H1)	The main activity of the firm: 9 dummy variables (=1 if agro-food, consumption goods, cars, equipment good, intermediate good, construction, transport, financial activities, real-estate activities, service for firms and service for individuals)[a]

The sectors are considered according to the French nomenclature.
Source: Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample 8 352 firms.

To operationalise H2 hypothesis (firm size), we have used four dummy variables, *SMALL* equals 1 if the number of employees is 20-49, *SMEDIUM* equals 1 if the number of employees is 50-199, *MEDIUM* equals 1 if the number of employees is 200-499 and *BIG* equals 1 if the number of employees is >500. To test H3 hypothesis (corporate status), we have used a dummy variable *GROUP* that has a value of 1 if the firm belongs to a group. The effect of export on certification in H4 hypothesis is measured by a variable *EXPORT* that presents share of firm exportation by turnover. The impact of customer satisfaction on certification in H5 hypothesis is measured by a dummy variable *CUSTOMER* which has a value of 1 when a firm uses contract engagements to deliver products/services to customers on time, and a value of 0 if otherwise. To test how product/service/performance quality improvement impacts on Quality Standards adoption in H6 hypothesis, we have used a variable *QUALITY IMPROVEMENT* that has a value of 1 if the firm's product/service/performance quality is important or very important for the firm's strategy. To test H7 hypothesis (cost reduction), we have used a dummy variable *COST* that equals 1 if the firm considers cost reduction as important or very important for the firm's strategy. Finally, to test hypothesis H8, we have used a dummy variable *NEW* that equals 1 if the firm considers novelty as important or very important for the firm's strategy. The variables used for estimation are indicated in Table 1.2. No problem of multicolinearity has been detected (Appendix 1.6).

4.3 Descriptive Statistics

From Table 1.3, we noticed that the highest percentage of larger firms belongs to the category of Early Adopters (7%) whilst the highest percentage of smaller firms belongs to Non Adopters (71%).

Furthermore, the similar conclusion could be obtained if we look at variable *GROUP*. In fact, the findings indicate that firms that are a part of a larger concern belong to categories of Early (57%) and New (55%) Adopters.

Concerning firms' exports, one can remark that the percentage of export is positively correlated with year of registration. Actually, firms that belong to the category of Early Adopters have the highest percentage of exports. Interestingly, while Early and New Adopters (67% and 61%, respectively) are very concerned about customer satisfaction, results reveal that Non Adopters are almost 20% less concerned about customer satisfaction than two other categories.

Relating the features of firm's strategy (quality improvement, cost reduction and innovation), the results are similar for all three categories of adopters. Hence, we may conclude that approximately 96% of firms find that quality improvement is an important or very important feature of their strategy, around 80% of firms find that cost reduction is an important or very important feature of their strategy and finally around 45% of firms are concerned or very concerned about innovation performance.

Table 1.3: Descriptive Statistics

	EARLY ADOPTERS	NEWADOPTERS	NON ADOPTERS
	Company's Size		
SMALL	48% (a)	59%	71%
SMEDIUM	34%	32%	24%
MEDIUM	11%	6%	4%
BIG	7%	3%	1%
	Corporate status		
GROUP	57%	55%	37%
	Mean export by firm's turnover		
EXPORT	0.13	0.08	0.07
	Customer Satisfaction		
CUSTOMER	67%	61%	39%
	Quality Improvement		
QUALITY IMPROVEMENT	98%	98%	95%
	Cost Reduction		
COST	87%	84%	78%
	Innovation		
NEW	49%	47%	45%
Total	**36%**	**6%**	**58%**

Source: Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample 8 352 firms, weighted by the number of employees.
Lecture: (a) 48% of "Early Adopters" are firms that belong to category of small firms.

4.4 The Empirical Model

We assume that firms choose one of the mutually exclusive alternatives characterised by a categorical variable. This variable reflects three distinct unordered alternatives: Early Adopters (alternative $j = 1$), New Adopters ($j = 2$) and Non-Adopters ($j = 3$). A Multinomial Logit model was used to evaluate an impact of the firm's characteristics on their likelihood of belonging to any of the three categories of adopters. This kind of model assumes that the error terms in the firm utility function are independently and identically distributed (Greene, 2003).

In fact, multinomial logit models are used to model relationships between a multinomial response variable and a set of regressors. These multinomial response models can be classified into two distinct types, depending on whether the response variable has an ordered or an unordered structure.

Therefore, using an unordered multinomial logit model, we want to analyse the probability for a firm to decide to choose one of the three types of adopters.

In the multinomial logit model, the probability that the firm *i* belongs to the category of Adopters *j*, $\forall j = 0, 1, 2$, is defined by:

$$\text{Prob}(Qal_i = j) = \frac{Exp(x_i\beta_j)}{\sum_{k=0}^{2} Exp(x_i\beta_k)} = \frac{Exp(x_i\beta_j)}{1+\sum_{k=0}^{2} Exp(x_i\beta_k)} \qquad (1)$$

where X_i represents the vector of variables for firm *i* (*SECTOR, SIZE,GROUP, EXPORT, CUSTOMER, QUALITY IMPROVEMENT, COST, NEW*); $\beta_1 - \beta_8$ are slope coefficients to be estimated.

where Qal_i represents dependent variables with three categories of Quality Adopters. The idea behind the multinomial logit model is that we directly model the probability that a firm belongs to a specific Quality Adopters category as a function of observed characteristics. We consider three possible outcomes, and hence, three probabilities:

$Qal_i = 1$ *if* Q2003=1 and Q2006=1, representing *Early Adopters*,
$Qal_i = 2$ *if* Q2003=0 and Q2006=1, representing *New Adopters*,
$Qal_i = 0$ *if* $Q2003 = 0$ and Q2006=0, representing *Non Adopters*.

5. Results and discussion

Firstly, we provide a simple comparison between New and Early Adopters (see Appendix 1.7). However, these estimates are less consistent since we did not take into account the third category of adopters (the Non-Adopters category).

The Multinomial Logit estimation results are presented in Tables 1.4 and 1.5 (1.4 manufacturing firms; 1.5 service firms) together with the goodness-of-fit measures (maximum likelihood estimation). The reference category used is the Non-Adopters.

The McFadden R^2 is 0.22 and 0.24 for manufacturing and service sectors, respectively. Therefore, we are in a position to test the validity of each hypothesis on the basis of the statistical significance of their associated parameters.

The first hypothesis (H1) testing whether unique sector characteristics may have a differential impact on a firm's decision to become quality registered yielded a number of interesting differences and similarities. More precisely, comparing results from Tables 1.4 and 1.5, our findings suggest that the determinants of Quality Standards adoption differ between the manufacturing and service sectors mainly when we analyse features of the firms' internal strategies (quality improvement and cost reduction). Based on our results, we can conclude that whilst in manufacturing firms the implementation of quality certification is driven by characteristics such as cost reduction and external factors, the implementation of Quality Standards in the service sector firms depends mainly on characteristics such as service quality improvement and external factors. As discussed previously, some of the differences in the determinants of Quality Standards between manufacturing and service firms may be explained by their different nature, outputs and processes. Furthermore, the longer experience of manufacturing sector firms with Quality Standards suggests that there is a greater level of understanding of the standard in terms of potential improvement areas for the firm. It is important to mention that, even when the variable *QUALITY IMPROVEMENT* is considered as a feature of the firm's internal strategy, quality in the service sector always strongly involves customers, which indicates that in the service sector quality often signifies an external signal rather than an internal signal. Indeed, the service sector firms appear to be more focussed on the quality assurance of factors related to the firm's external strategy than on exploiting possible improvements in the firm's internal strategy.

The second hypothesis (H2) that tested whether that the probability of Quality Standards increase with company size *ceteris paribus* is generally supported for both manufacturing and service sectors and both types of adopters. Our findings are consistent with previous studies which found that the probability of Quality Standards adoption increases with firm size. For instance, Terlaak and King (2006) shows that the probability of ISO 9000 certification increases with firm size.

The third hypothesis (H3) that tested whether the probability of Quality Standards increase as a firm belongs to a group is also strongly supported by our findings since the variable *GROUP* is significant and positive for both manufacturing and service sectors and both types of adopters. It has been argued previously that firms' newsletters and the exchange of personnel across groups can ensure a good information flow within firms which can have the effect of reducing the overall cost of certification via previous experience and scale economy. As a result, as confirmed by our findings, a firm that is part of a group is more likely to implement the Quality Management practices that already exist in certified firms belonging to the same group. Moreover, the findings of Westphal *et al.,* (1997) indicate that in early stage of quality practices implementation, when institutional forces are limited, social network ties may facilitate adoption of quality practices by helping managers to identify quality practices that will promote firm's objective. On the other side, the authors indicate that at later stage of quality practices adoption, the network ties to other adopters are more oriented to conformity rather than customisation of quality practices implementation. Hence, we may conclude that network ties effect does not change over time.

The hypothesis H4 that tested whether the probability of Quality Standards registration increase as a firm exports abroad is supported for the category of Early Adopters in the manufacturing and service sectors. These results can be explained by the fact that the benefits of certification may take some time to be perceived in both sectors. Furthermore, well established standards can encourage managers to explore and use variable options suitable for the firm's improvement.

The hypothesis H5 that tested whether the probability of Quality Standards registration increase with a firm's willingness to satisfy customers, *ceteris paribus* is supported for both manufacturing and service sectors and both types of adopters. Our data indicates that quality registered firms are also willing to satisfy customers on the basis of timeliness of delivery. Similar to our findings, Koc (2007) found that there is a significant improvement in delivery performance among certified firms mainly due to a reduction in time spent for non-value added activities such as set up, waiting for parts, tools and fixtures as well as delays in production.

The hypothesis H6 that tested whether the probability of Quality Standards registration increase with a firm's willingness for quality improvement, *ceteris paribus* is supported only for the service sector for both certification years. As service quality is mainly dependant on customer satisfaction, Quality Standards may help firms to maintain very close links with their customers (Dean and Browen, 1994). On the other side, the results reveal that quality improvement has no impact on Quality Standard adoption in manufacturing sector. The results obtained for manufacturing firms are surprising because the Quality Standards require that all specified inspections and tests have been carried out and that the outcome meets specified requirements ensuring a quality product. However, a possible explanation for this finding could be that if all "win-win" or "free-lunch" opportunities have already been exploited (Palmer *et al.*, 1995), the quality orientation may then be focused on other areas. In other words, it is possible that firms in the manufacturing sector have already reached the "highest" possible quality level and that they are exploiting other possible areas.

The hypothesis H7 that tested whether the probability of Quality Standards adoption increases with a firm's willingness to implement cost reduction, *ceteris paribus* is supported for the manufacturing sector including both types of adopters and only Early Adopters in service sector. Our results are consistent with the previous data reported in the literature claiming that in the manufacturing sector ISO 9000 certification contributes to cost reductions by reducing non-value added activities and by improving operations (Reed *et al.*, 1996; Koc, 2007). On the other hand, the results we obtained for New Adopters in service sector could be explained by the fact that although the benefits of certification are expected to outweigh the investment costs, this may take a long time after the certification has taken place.

The hypothesis H8 that tested whether the probability of Quality Standards increase with a firm's innovation orientation is not supported by our findings. The results are not significant for either of the two types of adopters in the service sector and manufacturing sector. The results could be explained by the fact that innovations require a different model of practices or a different organisational structure under the Quality Standards. In other words, quality systems have to be integrated with other organisational resources to positively influence innovation performance.

In summary, our results reveal empirically, for the first time, that the major differences in the determinants of the Quality Standards between manufacturing and service firms are related to the features of the firm's internal strategy. Moreover, the findings indicate that differences between Early and New Adopters (in the time period studied), exist if we look at variables *EXPORT* and *COST*. Generally, we find that those two variables are significant for Early Adopters while they stay insignificant for New Adopters. Moreover, the results may confirm once again the institutional assumption that Early Adopters are motivated by efficacy gain needs which could also be obtained by an increase of export levels and cost reduction. Additionally, our findings are consistent with Delmas and Montes-Sancho (2010), who found that Early Adopters respond to peer pressure exerted by trade association. Unfortunately, due to database limitations, we are not able to test the second part of our assumption stating that New Adopters in the time period studied seek quality practices in order to achieve greater social legitimacy.

Table 1.4: Determinants of Quality Standards (manufacturing sector)

	EARLY ADOPTERS		NEW ADOPTERS	
Variables	Estimate	z-value	Estimate	z-value
Intercept	-1.81***	-7.21	-3.33***	-6.58
SMEDIUM	0.81***	8.47	0.48***	2.72
MEDIUM	1.61***	11.17	0.74***	2.68
BIG	2.33***	13.15	0.98***	3.67
GROUP	0.54***	6.04	0.46***	3.01
EXPORT	0.78***	4.35	0.04	0.08
CUSTOMER	0.98***	12.51	0.87***	6.21
QUALITY IMPROVEMENT	0.30	1.21	0.22	0.65
COST	0.45***	3.26	0.41*	1.72
NEW	-0.08	-0.78	-0.16	-1.13
AGRO-FOOD	-0.29***	-2.12	0.26	1.09
CONSUMPTION GOODS	-1.87***	-12.14	-1.11***	-4.10
CARS	0.24	0.78	0.24	0.36
EQUIPMENT GOOD	0.09	1.06	0.01	0.05
INTERMEDIATE GOOD	0.11	0.98	0.02	0.11
Adjusted McFadden R2			0.22	
SC			6264.624	
SC(Intercept only)			7857.457	
Likelihood ratio			1845.9909	
Number of observations			4 622	
Number of firms in each category:				
Early Adopters			2624	
New Adopters			253	
Non Adopters			1 745	

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.
Sector reference: CONSTRUCTION.

Table 1.5: Determinants of Quality Standards (service sector)

	EARLY ADOPTERS		NEW ADOPTERS	
Variables	Estimate	z-value	Estimate	z-value
Intercept	-3.07***	-10.41	-4.67***	-7.65
SMEDIUM	0.29**	2.07	0.21	1.05
MEDIUM	0.89***	6.33	0.35	1.43
BIG	1.33***	8.42	0.74***	3.21
GROUP	0.55***	6.01	0.65***	4.07
EXPORT	0.63***	2.42	0.18	0.79
CUSTOMER	0.88***	7.52	0.70***	6.48
QUALITY IMPROVEMENT	0.77***	3.00	1.49***	2.46
COST	0.11*	1.65	0.03	0.42
NEW	0.04	0.41	0.01	0.08
FINANCIAL ACTIVITIES	-0.86***	-3.22	-0.19	-0.42
REAL-ESTATE ACTIVITIES	0.15*	1.65	-0.15	-0.68
SERVICE FOR FIRMS AND INDIVIDUALS	-0.77***	-3.52	-1.16***	-4.16
Adjusted McFadden R2	0.23			
SC	5391.507			
SC(Intercept only)	6133.775			
Likelihood ratio	956.0961			
Number of observations	3 790			
Number of firms in each category:				
Early Adopters	1 134			
New Adopters	226			
Non Adopters	2 370			

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.
Sector reference: TRANSPORT.

6. Concluding remarks

We have extended the existing research working on Quality Standards by exploring two important questions that have been under-researched in prior studies. Drawing on economic and management literature, we first explored the determinants that explain a firm's willingness to become quality registered. Moreover, we provided empirical data that not only contributes to academic debate in terms of understanding the firm's likelihood to become quality registered but that may also have important implications for policy makers. Given that a majority of research on Quality Standards has concentrated on the analysis of one sector, the present framework allows us to empirically identify similar and different potential drivers of quality registration in the manufacturing and service sectors.

The results of this study may have important implications for policy-making. Having provided a detailed analysis of the likelihood of quality registration in manufacturing and service sectors and its relationship to a firm’s characteristics (size and corporate status), features of a firm’s strategy and external signals, these findings could enable policy-makers to better formulate and effectively apply regulations governing the business success of firms in both the manufacturing and service sectors. Moreover, we find that the determinants of the implementation of quality practices differ among adopters when we look at a firm’s export level and a firm’s cost reduction level.

Our data indicates that the “one-size-fits-all” approach is not appropriate for quality registration across different sectors. Indeed, our findings reveal that the determinants of Quality Standards in the manufacturing and service sectors differ mainly between the features of a firm’s internal strategy (quality improvement and cost reduction). On the other hand, the evidence obtained indicates that the characteristics of a firm such as size, corporate status and previous experience with similar standards play a significant role in quality registration in both sectors. Furthermore, indicators of external features (export and customer satisfaction) also have a positive impact on quality registration in both sectors. The present results drive us to the conclusion that while the probability of manufacturing firms becoming quality registered is driven by their characteristics, cost reduction and external factors, quality registration in service firms depends mainly on their characteristics, service quality improvement and external factors. Indeed, service firms seem to primarily use Quality Standards as a tool to promote their unobservable characteristics rather than for strategy improvement.

Despite the above findings, this study has some limitations that can provide a strong basis for the conduct of some important future research. Firstly, future researches should provide more precise data on year of Quality Standards adoption what will offer better understanding of the factors that motive firms to implement Quality Standards in earlier and later phase. Secondly, future lines of study should explore the determinants of Quality

Standards among firms operating in different countries. Another important question that should be explored concerns the evaluation of Quality Standards business value between manufacturing and service sectors.

APPENDICES CHAPTER I

Appendix 1.1: The brief description of main Quality Programs

Appendix 1.2: ISO 9000:2000 Requirements

Appendix 1.3: Current standards from ISO/TC 176 and its subcommittees

Appendix 1.4: The ISO 9000 implementation process flow chart

Appendix 1.5: French government surveys on technological and organisational change: ancestors the COI survey

Appendix 1.6: Pearson correlation coefficients

Appendix 1.7: Determinants of Quality Standards (manufacturing and services sectors)

Appendix 1.1: THE BRIEF DESCRIPTION OF THE MAIN QUALITY PROGRAMS

Total Quality Management (TQM), which origins since 1949, is a synergetic management system which coordinates different activities of an organisation and directs them towards continuous improvement, customer's satisfaction, reducing rework, long-range thinking, increased employee involvement and teamwork, process redesign, competitive benchmarking, team-based problem-solving, constant measurement of results and closer relationships with suppliers (Levner *et al.*, 1998). Its adherents claim that managers can implement TQM in any organisation (manufacturing, service, non profit or government) and that it generates improved products and services, reduced costs, more satisfied customers and employees and improved firm performance (Walton, 1986).

The Malcolm Baldrige National Quality Award (MBNQA) has emerged in 1987 as the standard of excellence for US firms. The Baldrige Award provides a framework for systematically examining products, services and processes. It includes seven categories of criteria for evaluating the firm's strategies employed in implementing quality improvement efforts: leadership, information and analysis, strategic quality planning, human resource development and management, management of process quality, quality and operational results, customer focus and satisfaction.

The EFQM Excellence Model is a framework for organisational management systems, promoted by the European Foundation for Quality Management (EFQM) and designed for helping firms to be more competitive. The EFQM Excellence Model was developed in 1991 using the Baldrige system as a model. It consists of nine criteria for evolution, namely, leadership, policy and strategy, people (employee) management, resources, processes, customer satisfaction, people (employee) satisfaction, impact on society and business results.

Six Sigma is an organised and systematic method for strategic process improvement and new product and service development that relies on statistical scientific methods to make dramatic reductions in customer defined defect rates (Linderman *et al.,* 2003). The concept is developed by Motorola in 1987 in their quest to reduce defects (for detailed review see Harry, 1994). Six Sigma programs follow two project methodologies. The first is used in process improvement and the second is oriented at creating new product or process designs. The major elements of Six Sigma implementation are strong relationship, initial focus on operations, clear performance metrics, aggressive project selection and selecting and training right people.

Even that these programs differ in scope and approach, a central focus of each of these programs is identification of processes and procedures that underlie business activities (Hackman and Wageman, 1995) aiming at quality improvement. Moreover, QM programs follow, generally, organisation inspired by the Deming's Plan-Do-Check-Act cycle.

Appendix 1.2: ISO 9001:2000 REQUIREMENTS

4. Quality Management System
4.1 General requirements
Are processes in place needed for QMS and their application throughout the organisation have been determined?
Has the sequence and interaction of these processes have been determined?
Does the criteria and methods needed to ensure both the operation and control of these processes are effective have been determined?
Does the availability of resources and information needed to support the operation and monitoring of these processes are ensured?
Are these processes are monitored, measured and analysed?
Are actions needed to achieve planned results and continual improvement of these processes is implemented?

4. 2 Documentation Requirements
4.2.2 Quality Manuel
Has a quality manual been established and is it maintained?
Does the scope of the manual include details of and justification for any exclusion?
Does the manual contain or references the documented procedures established for the QMS?
Does the manual contain a description of the interaction between the processes of the QMS?

4.2.3 Control of Documents
Are all QMS documents controlled?
Is a documented procedure established to define the controls needed to:
Approve documents for adequacy prior to issue?
Review and update as needed and re-approve documents?
Ensure that changes and the current revision status of documents are identified?
Ensure that relevant versions of applicable documents are available at points of use?
Ensure that documents remain legible and readily identifiable.
Ensure that documents of external origin are identified and their distribution controlled?
Prevent the unintended use of obsolete documents and to apply suitable identification to them if they are retained for any purpose?

4.2.4 Control of Records
Are records legible, readily identifiable and retrievable?
Has a documented procedure been established to define the controls needed for the identification, storage, protection, retrieval, retention time and disposition of records?

5.1 Management Commitment
Does top management communicate the importance of meeting customer, statutory and regulatory requirements?
Is a quality policy established?
Are quality objectives established?

5.2 Customer Focus
Has top management ensured that customer requirements are determined and are met with the aim of enhancing customer satisfaction?

5.3 Quality policy
Is the policy appropriate to the purpose of the organisation?
Does the policy include a commitment to comply with requirements and continually improve the effectiveness of the QMS?
Does the policy provide a framework for establishing and reviewing quality objectives?
Is the policy communicated among personnel and understood?
Is the policy reviewed for continuing suitability?

5.4 Planning
5.4.1 Quality objectives
Are the quality objectives, incl. those needed to meet requirements for product, established at relevant functions and levels within the organisation?
Are the quality objectives measurable and consistent with the quality policy?

5.4.2 QMS planning
Is the QMS planning carried out in order to meet the requirements given in 4.1, as well as the quality objectives?
Is the integrity of the QMS maintained when changes to the QMS are planned and implemented?

5.5 Responsibility, authority and communication
5.5.1 Responsibility and authority
Are responsibilities and authorities defined and communicated?

5.5.2 Management representative
Has top management assigned a Management representative who reports on the performance of the QMS and needs for improvement?
Does the MR ensure the promotion of awareness of customer requirements throughout the organisation?

5.5.3 Internal communication
Is an appropriate communication processes established?
Is communication taking place regarding the effectiveness of the QMS?

5.6 Management review
5.6.1 General
Does top management reviews the QMS at planned intervals, to ensure its continuing suitability, adequacy and effectiveness?
Does the review include assessing opportunities for improvement and the need for changes to the QMS, including the quality policy and quality objectives?
Are the records from management reviews are maintained?

5.6.2 Review output
Includes results of audits?
Includes customer feedback?
Includes process performance and product conformity?
Includes status of preventive and corrective actions?
Includes follow-up actions from previous management reviews?
Includes changes that could affect the QMS?
Includes recommendations for improvement?

5.6.3 Review output
Includes improvement of the effectiveness of the QMS and its processes?
Includes improvement of product release to customer requirements?
Includes resources needed?

6. Resource Management
6.1 Provision of resources
Is the organisation determined and provided the resources needed to implement and maintain the QMS and continually improve its effectiveness?
Is the organisation determined and provided the resources needed to enhance customer satisfaction by meeting customer requirements?

6.2 Human Resources
6.2.1 General
Are the personnel performing work affecting product quality competent on the basis of appropriate education, training, skills and experience?

6.2.2 Competence, awareness and training
Are the needed competences of personnel to perform work affecting product quality determined?
Has training been provided or other actions taken to satisfy these competency/awareness/training needs?
Has the effectiveness of the actions taken been evaluated?
Are the personnel aware of the relevance and importance of their activities and how they contribute to the achievement of the quality objectives?
Are records of education, training, skills and experience maintained?

6.3 Infrastructure
Has the organisation determined, provided and maintained the infrastructure needed to achieve conformity to product requirements? (This includes, as applicable, buildings, workspace, equipment and supporting services)

6.4 Work environment
Has the organisation determined and manages work environment to achieve conformity to product requirements?

7. Product realisation

7.1 Planning of product realisation
Has the organisation planned and developed the processes needed for product realisation?
Is planning of product realisation consistent with the requirements of the other processes of the QMS?
Is in planning product realisation, the organisation determined to realise the following, as appropriate:
Quality objectives and requirements for the product?
The need to establish processes, documents, and provide resources specific to the product?
Required verification, validation, monitoring, inspection and test activities specific to the product?
Records needed to provide evidence that the realisation processes and the resulting product meet requirements?
The output of this planning is in a form suitable for the organisation s method of operation?

7. 2 Customer-related processes
7.2.1 Determination of requirements related to the product
Are the requirements specified by the customer, including the requirements for delivery and post-delivery activities determined?
Are the requirements not stated by the customer but needed for specified or intended use, where known determined?
Are the statutory and regulatory requirements related to the product determined?
Are additional requirements determined by the organisation determined?

7. 2.2 Review of requirements related to the product
Is the organisation reviewing the requirements related to the product?
Is this review conducted prior to the organisation s commitment to supply a product to the customer ? (*e.g.* submission of tenders, acceptance of contracts or orders, acceptance of changes to contracts or orders)
Does the review ensures that:
Product requirements are defined?
Contract or order requirements differing from those previously expressed are resolved?
The organisation has the ability to meet the defined requirements?
Records of the results of the review and actions arising from the review are maintained?
Where the customer provides no documented statement of requirement, the customer requirements are confirmed by the organisation before acceptance?
Where product requirements are changed, the organisation ensures that relevant personnel are made aware of the changed requirements?

7.2.3 Customer communication
Has the organisation determined and implemented effective arrangements for communicating with customers in relationship to:
Product information?
Enquiries, contracts or order handling, including amendments?
Customer feedback, including customer complaints?

7.3 Design and development
7.3.1 Design and development planning
Does the organisation plans and controls the design and development of product?
Does during the design and development planning, the organisation determines the:
Design and development stages?
Review, verification and validation that is appropriate to each design and development stage?
Does the organisation manage the interfaces between different groups involved in design and development to ensure effective communication and clear assignment of responsibility?

Is planning output updated, as appropriate, as the design and development progresses?

7.3.2 Design and development inputs
Are inputs relating to product requirements determined and records maintained?
Does product requirements include:
Functional and performance requirements?
Applicable statutory and regulatory requirements?
Where applicable, information derived from previous similar designs?
Other requirements essential for design and development?
Are these inputs reviewed for adequacy?
Requirements are complete, unambiguous and not in conflict with each other?

7.3.3 Design and development outputs
Are the outputs of design and development provided in a form that enables verification against the design and development input and shall be approved prior to release?
Do design and development outputs:
Meet the input requirements for design and development?
Provide appropriate information for purchasing, production and for service provision?
Contain or reference product acceptance criteria?
Specify the characteristics of the product that are essential for its safe and proper use?

7.3.4 Design and development review
Are at suitable stages, systematic reviews of design and development performed in accordance with planned arrangements to:
Evaluate the ability of the results of design and development to meet requirements?
Identify any problems and propose needed actions?
Participants in such reviews include representatives of functions concerned with the design and development stages being reviewed?
Records of the results of the reviews and any needed actions are maintained?

7.3.5 Design and development verification
Is verification performed in accordance with planned arrangements to ensure that the design and development outputs met the design and development input requirements?
Are records of the results of the verification and any needed actions maintained?

7.3.6 Design and development validation
Is design and development validation performed in accordance with planned arrangements so that the resulting product is capable of meeting the requirements for the specified application or intended use, where known?
Wherever practicable, is validation completed prior to the delivery or implementation of the product?

7. 3.7 Control of design and development changes
Is design and development changes identified and records are maintained?
Are the changes reviewed, verified and validated, as appropriate, and approved before implementation?
Is the review of design and development changes included in the effect of changes on constituent parts and product already delivered?
Are records of the results of the review of changes and any needed actions maintained?

7. 4 Purchasing
7.4.1 Purchasing process

Does the organisation ensure that the purchased product conforms to specified purchase requirements?
Does the type and extent of control applied to the supplier and the purchased product dependent upon the effect of the purchased product on subsequent product realisation or the final product?
Does the organisation evaluate and selects suppliers based on their ability to supply product in accordance with the organisation s requirements?
Are criteria for the selection, evaluation and re-evaluation of suppliers established?
Are records of the results of evaluations and any needed actions arising from the evaluation maintained?

7.4.2 Purchasing information
Does purchasing information describe the product purchased?
Where appropriate, does purchasing information includes:
Requirements for approval of product, procedures, processes and equipment?
Requirements for qualification of personnel?
QMS requirements?
Does the organisation ensure the adequacy of specified purchase requirements prior to their communication to the supplier?

7.4.3 Verification of purchased products
Has the organisation established and implemented the inspection, or other activities, needed for ensuring that purchased product meets specified purchase requirements?
When the organisation or its customer intends to perform verification at the supplier s premises, does the organisation states the intended verification arrangements and method of product release in the purchasing information?

7.5 Production and service provision
7.5.1 Control provision and service provision
Does the organisation plans and carries out production and service provision under controlled conditions?
Does controlled conditions include, as applicable, the:
Availability of information that described the characteristics of the product?
Availability of work instructions, as needed?
Use of suitable equipment?
Availability and use of monitoring and measuring devices?
Implementation of monitoring and measurement?
Implementation of release, delivery and post delivery activities?

7.5.2 Validation of processes for production and service provision
Does the organisation validate any processes for production and service provision where the resulting output cannot be verified by subsequent monitoring or measurement?
Does the organisation validate any processes for production and service provision where the resulting output cannot be verified by subsequent monitoring or measurement?
Does validation demonstrates the ability of these processes to achieve planned results?
Has the organisation established arrangements for these processes including, as applicable:
Defined criteria for review and approval of the processes?
Approval of equipment and qualification of personnel?
Use of specific methods and procedures?
Requirements of records?
Revalidation?

7.5.3 Identification and traceability

Where appropriate, has the organisation identified the product by suitable means throughout product realisation?
Does the organisation identify the product status with respect to monitoring and measurement requirements?
Where traceability is a requirement, does the organisation controls and records the unique identification of the product?

7.5.4 Customer property (can include intellectual property)
Does the organisation exercise care with customer property while it is under the organisation s control or being used by the organisation?
Does the organisation identifies, verifies, protects and safeguards customer property provided for use or incorporation into the product?
If any customer property is lost, damaged or otherwise found to be unsuitable for use, is this reported to the customer and records are maintained?

7.5.5 Preservation of product
Does the organisation preserves the conformity of product during internal processing and delivery to the intended destination?
Does this preservation include identification, handling, packaging, storage and protection?
Does preservation also applies to the constituent parts of a product?

7.6 Control of monitoring and measuring devices
Does the organisation determines the monitoring and measurement to be undertaken and the monitoring and measuring devices needed to provide evidence of conformity of product to determine requirements?
Has the organisation established processes to ensure that monitoring and measurement can be carried out and are carried out in a manner that is consistent with the monitoring and measurement requirements?
Where needed to ensure valid results, is measuring equipment:
Calibrated or verified at specified intervals, or prior to use, against measurement standards traceable to measurement standards?
Where no such standard exist, the basis used for calibration or verification is recorded?
Adjusted or re-adjusted as necessary?
Identified to enable the calibration status to be determined?
Safeguarded from adjustments that would invalidate the measurement results?
Protected from damage and deterioration during handling, maintenance and storage?
Does the organisation assesses and records the validity of the previous measuring results when the equipment is found not conform to requirements?
Does the organisation take appropriate action on the equipment and product affected?
Are records of the results of calibration and verification maintained?
When used in the monitoring and measurement of specified requirements, is the ability of computer software to satisfy the intended application confirmed. Is this undertaken prior to initial use and reconfirmed as needed?

8. Measurement, analysis and improvement
8.1 General
Does the organisation plans and implements the monitoring, measurement, analysis and improvement processes needed to:
Demonstrate conformity of the product?
Ensure conformity of the QMS?
Continually improve the effectiveness of the QMS?

Does this include determination of applicable methods, including statistical techniques, and the extent of their use?

8.2 Monitoring and measurement
8.2.1 Customer satisfaction
As one of the measurements of performance of the QMS, does the organisation monitors information relating to customer perception as to whether the organisation has met customer requirements?
Has the method for obtaining and using this information been determined?

8.2.2 Internal Audit
Are internal audits conducted at planned intervals?
Are internal audits determine whether the QMS;
Conforms to the planned arrangements to requirements of ISO9001 and to the QMS requirements established by the organisation?
Is the audit program is planned, taking into consideration the status and importance of the processes and areas to be audited, as well as the results of previous audits?
Are the audit criteria, scope, frequency and methods defined?
Is by the selection of auditors and the conduct of audits ensured objectivity and impartiality of the audit process?
Is effectively implemented and maintained?
Do auditors not audit their own work?
Are the responsibilities and requirements for planning and conducting audits, and for reporting results and maintaining records defined in a documented procedure?
Is ensured that actions are taken undue delay to eliminate detected non-conformities and their causes?
Are follow-up activities included in the verification of the actions taken and the reporting of verification results?

8.2.3 Monitoring and measurement process
Does the organisation apply suitable methods for monitoring and where applicable, measurement of the QMS processes?
Are these methods demonstrating the ability of the processes to achieve planned results?
When planned results are not achieved, is correction and corrective action taken, as appropriate, to ensure conformity of the product?

8.2.4 Monitoring and measurement product
Does the organisation monitors and measures the characteristics of the product to verify that product requirements have been met?
Is this carried out at appropriate stages of the product realisation process in accordance with the planned arrangements?
Is evidence of conformity with the acceptance criteria is maintained?
Do records indicate the person(s) authorising product release?
Do product release and service delivery not proceed until the planned arrangements (7.1) have been satisfactorily completed, unless otherwise approved by a relevant authority and, where applicable, by the customer?

8.3 Control of non-conforming product
Does the organisation ensure that product which does not conform to product requirements is identified and controlled to prevent its unintended use or delivery?
Are the controls and related responsibilities and authorities for dealing with non-conforming product defined in a documented procedure?

Does the organisation deals with non-conforming product by one or more of the following ways:
By taking action to eliminate the detected non-conformity?
By authorising its use, release or acceptance under concession by a relevant authority and, where applicable, by the customer?
By taking action to preclude its original intended use of application?
Records of the nature of non-conformities and any subsequent actions taken, including concessions obtained are maintained?
Where non-conforming product is corrected is it subject to reverification to demonstrate conformity to the requirements?
When non-conforming product is detected after delivery or use has started, does the organisation takes action appropriate to the effects, or potential effects, of the non-conformity?

8.4 Control of non-conforming product
The organisation has determined collected and analysed appropriate data to demonstrate the suitability and effectiveness of the QMS and has evaluated where continual improvement of the effectiveness of the QMS can be made.
Customer satisfaction (8.2.1)?
Conformity to product requirements (7.2.1)?
Characteristics and trends of processes and products including opportunities for preventive action?
Suppliers?

8.5 Improvement
8.5.1 Continuous improvement
Does the organisation continually improve the effectiveness of the QMS through the use of the quality policy, quality objectives, audit results, analysis of data, corrective and preventive action and management review?

8.5.2 Corrective actions
Has the organisation taken action to eliminate the cause of non conformities in order to prevent recurrence?
Are corrective actions appropriate to the effects of the nonconformities encountered?
Is a documented procedure established to define requirements for:
Reviewing non-conformities, including customer complaints?
Determining the causes of non-conformities?
Evaluating the need for action to ensure that non-conformities do not recur?
Determining and implementing action needed?
Records of the results of action taken?
Reviewing corrective action taken?

8.5.3 Preventive actions
Does the organisation determine action to eliminate the causes of potential non-conformities in order to prevent their occurrence?
Are preventive actions appropriate to the effects of the potential problems?
Is a documented procedure established to define requirements for:
Determining potential non-conformities and their causes?
Evaluating the need for action to prevent occurrence of nonconformities?
Determining and implementing action needed?
Records of results of actions taken (4.2.4)?
Reviewing preventive action taken?

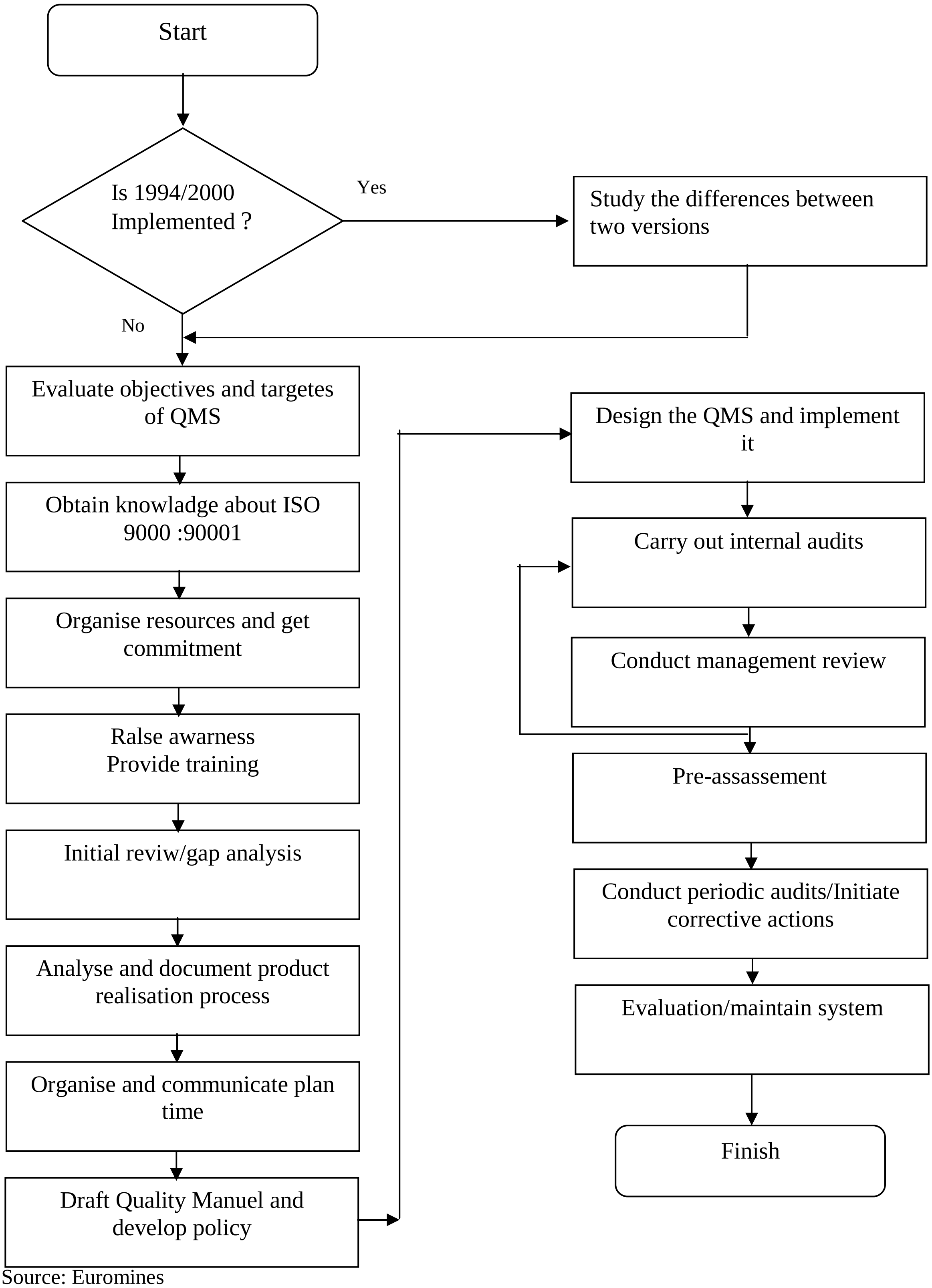
Source: Euromines

Appendix 1.3: ISO 9000 family standards

Standard/ document	Title
ISO 9000:2005	Quality management systems – Fundamentals and vocabulary
ISO 9001:2008	Quality management systems – Requirements
ISO 9004:2000	Quality management systems – Guidelines for performance improvements
ISO 10001:2007	Quality management – Customer satisfaction – Guidelines for codes of conduct for organisations
ISO 10002:2004	Quality management – Customer satisfaction – Guidelines for complaints handling in organisations
ISO 10003:2007	Quality management – Customer satisfaction – Guidelines for dispute resolution external to the organisation
ISO 10005:2005	Quality management – Guidelines for quality plans
ISO 10006:2003	Quality management – Guidelines for quality management in projects
ISO 10007:2003	Quality management – Guidelines for configuration management
ISO 10012:2003	Measurement management systems – Requirements for measurement processes and measuring equipment
ISO/TR 10013:2001	Guidelines for quality management system documentation
ISO 10014:2006	Quality management – Guidelines for realising financial and economic benefits
ISO 10015:1999	Quality management – Guidelines for training
ISO/TR 10017:2003	Guidance on statistical techniques for ISO 9001:2000
ISO 10019:2005	Guidelines for the selection of quality management system consultants and use of their services
ISO/TS 16949:2002	Quality management systems – Particular requirements for the application of ISO 9001:2000 for automotive production and relevant service part organisations
ISO 19011:2002	Guidelines for quality and/or environmental management systems auditing

Source: Selection and use of ISO 9000 family standards (2009)

Appendix 1.4: The ISO 9000 implementation process flow chart



Source: Euromines

Appendix 1.5: French government surveys on technological and organisational change: ancestors the COI survey

Background

The French government surveys organisation topics since the middle of the 1980s'. Traditionally, the Ministry of labor has two domains of competence: work ("travail") and employment ("emploi"). The first has to do with industrial legislation, the second with labor market regulations. Surveys on organisation originated from the "work" department. Interest in work organisation came from the need to complement the information gathered through the national surveys on working conditions.

A first labor force survey was designed in 1987, under the acronym TOTTO ("enquête sur les Techniques et l'Organisation du Travail auprès des Travailleurs Occupés"), by a team under the direction of Michel Gollac. Its aim was to better understand how working conditions were related with work (task and technology) and worker (gender, age, social origin) characteristics. The TOTTO survey has been conducted again in 1993. At the same time, the Ministry of labor launched a new business survey inspired by the British Workplace and Industrial Relations Survey (REPONSE survey), in order to improve knowledge about industrial relations in French firms. The conception of the REPONSE survey has been coordinated by Thomas Coutrot and Anna Malan.

At the end of the 1980's, the Ministry of industry designed, a system of annual surveys aiming at measuring the innovative behavior of firms. This took place in the context of the public debate on the productivity paradox. At the beginning of the 90s, most OECD countries had data bases on R&D expenditures built according to the Frascati manual and they were implementing their innovation surveys along the lines of the OSLO manual. In 1991, Ministry of Industry conducted a first innovation survey. In 1993, a smaller survey on organisational change (the survey on "organisational change in production") was conducted to better understand the relations between technological innovation and organisational innovation. The design of this survey has been directed by Nathalie Greenan and Dominique Guellec.

1) The "TOTTO" surveys (INSEE, 1987; DARES, 1993)

The "TOTTO" ("enquête sur les Techniques et l'Organisation du Travail auprès des Travailleurs Occupés") survey has been financed and conducted by the National Institute of Statistics and Economic Studies (INSEE) in1987, financed by the Ministry of labor (DARES) and conducted by INSEE in 1993. Researchers from the fields of ergonomic, industrial medicine, psychology, sociology and economics contributed to the design of the questionnaire. Both in 1987 and in 1993, the survey *was a supplement to the annual labour force survey and a sample of about 20 000 occupied workers from all industries were interviewed.*

Workers were asked about their perception of the way they work. The main topics of the questionnaire are the nature of tasks performed, timetables, hierarchical relation, autonomy, communication, work rhythm, deadlines and technology use. Information was gathered through face-to-face interviews of about 45 minutes, completed at the workers' home.

Workers also gave the name and address of their establishment, which allows to trace the firm identification number. This number is used in all the official surveys conducted at the firm level and in data files of government origin. Thus, matched employer/employee data sets can be generated from this type of surveys.

2) The "REPONSE" survey (DARES, 1993)

Financed by the Ministry of labour (DARES), this survey aims at measuring the social climate and the state of industrial relations. Researchers in economics and industrial relations, statisticians and firm representatives participated in the design of the questionnaire. Firm and trade union representatives of about 3000 establishments of firms over 50 employees from all industries were interviewed.

The employer was asked about social climate within the firms and about participatory devices ("pratiques participatives"): negotiation with trade union representatives, incentive strategy, conflicts, employee involvement schemes, technological and organisational innovations. Questions on technology and organisation were asked to better understand the context of information sharing and to measure whether these topics were discussed directly or indirectly (through trade unions) with employees. A set of questions on the same topics(sometimes the same questions) were asked to trade union representatives, allowing to measure some the convergence or divergence in points of view. This survey has been carried out once again in 1998.

3) The survey on organisational change in production (SESSI, 1993)

Financed by the Ministry of industry (SESSI), the aim of this survey was to measure aspects of the firm's behaviour that could influence its capacity to innovate and its competitivity. The group of experts that participated in the design of the questionnaire was mainly composed of economists. 2600 manufacturing firms over 50 employees were interviewed.

The focus of the questionnaire is on the organisation of the production department of the firm and on the use of advanced manufacturing technologies. The main topics are the objectives of organisational change, technology use, sharing of responsibilities for operating activities on the shop-floor between operators, the supervisors and specialists, timetables, teamwork, change in competencies, quality norms, changes in formal relations between departments, impacts of organisational change on various indicators. As this survey was a postal survey, this questionnaire is a very short one (two pages), with mainly qualitative questions addressed to the production manager of the firm.

Whereas in the TOTTO survey, questions aim at measuring the main characteristics of jobs in terms of organisation and technology use, in this firm level survey, most questions are on changes on a 5 years period. As a matter of fact, this is an output of the discussions about the design of both questionnaires. For the TOTTO survey, the group of experts felt that workers had to be asked some very simple questions about their everyday work, trying to formulate questions in the most "objective way". At the firm level, the interviewed person is expected to give an answer concerning the whole firm or part of it. Here, the "pilot" group felt that it was easier to respond about the change that occurred within the firm during a given period of time than about the state at a given date. In a way, it is assumed that their is much more heterogeneity within the firm in the state of organisation than in organisational changes.

Source: Greenan and Mairesse (2001)

Appendix 1.6: Pearson correlation coefficients

	QUALITY ADOPTERS	SMALL	SMEDIUM	MEDIUM	BIG	GROUP	EXPORT	CUSTOMER	QUALITY IMPROVEMENT	COST	NEW
QUALITY ADOPTERS	1.00	-	-	-	-	-	-	-	-	-	-
SMALL	0.28	1.00	-	-	-	-	-	-	-	-	-
SMEDIUM	0.03	-0.51	1.00								
MEDIUM	-0.15	-0.31	-0.31	1.00							
BIG	-0.25	-0.31	-0.32	-0.19	1.00	-	-	-	-	-	-
GROUP	-0.27	-0.34	0.01	0.19	0.24	1.00	-		-	-	
EXPORT	-0.23	-0.16	-0.05	0.11	0.17	0.20	1.00	-	-	-	-
CUSTOMER	-0.28	-0.16	-0.00	0.01	0.13	0.15	0.10	1.00	-	-	-
QUALITY IMPROVEMENT	-0.08	-0.04	-0.00	0.03	0.03	0.03	0.04	0.10	1.00	-	-
COST	-0.14	-0.14	0.01	0.06	0.10	0.14	0.09	0.09	0.16	1.00	-
NEW	0.07	-0.09	-0.02	0.05	0.10	0.19	0.12	0.08	0.14	0.09	1.00

Source: Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample 8 352 firms.

Appendix 1.7: Determinants of Quality Standards (manufacturing and services sectors)

	NEW ADOPTERS vs EARLY ADOPTERS	
Variables	Estimate	z-value
Intercept	0.19***	4.84
SMEDIUM	-0.03*	-1.90
MEDIUM	-0.07***	-4.19
BIG	-0.08***	-5.29
GROUP	-0.00	-0.06
EXPORT	-0.05***	-4.50
CUSTOMER	-0.01	-1.41
QUALITY IMPROVEMENT	0.02	0.75
COST	-0.02	-1.22
NEW	-0.01	-0.41
Adjusted McFadden R2	0.08	
SC	2983.988	
SC(Intercept only)	2998.389	
Likelihood ratio	164.7302	
Number of observations	4237	
Number of firms in each category:		
Early Adopters	3758	
New Adopters	479	

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.
Sector reference: TRANSPORT.

Chapter II

The Description and Determinants of Environmental Standards: A Comparison between ISO 14001 and Responsible Care [8]

SECTION 1- INTRODUCTION

SECTION 2- DESCRIPTION AND DIFFUSION OF THE ISO 14000 STANDARDS

SECTION 3- RELATED LITERATURE AND HYPOTHESES

SECTION 4- DATA AND MODEL SPECIFICATION

4.1 The database and variables

4.2 Descriptive Statistics

4.3 The Empirical Model

SECTION 5- RESULTS AND DISCUSSION

SECTION 6- CONCLUDING REMARKS

APPENDICES CHAPTER II

[8] This chapter is a developed version of the article "Chemical Firms' Registration for the Responsible Care Program and the ISO 14001 Standard: A Comparative Approach" (with Gilles Grolleau and Naoufel Mzoughi) which is published in *Economics Bulletin*, 12, 29 (2007):1-13.

1. Introduction

Due to several environmental catastrophes (*e.g.* Seveso in 1976; Three Mile Islands in 1979; Bhopal in 1986; Chernobyl in 1986) and the perceived risks associated with its activities, the chemical sector has been exposed to an increasing pressure to improve the management of its environmental impacts. In response to these pressures, the Canadian Chemical Producers' Association (CCPA) designed the Responsible Care program in 1985 to cope with environmental issues and restore public confidence in chemical sector. This program has been diffused to several countries. This unilateral voluntary initiative encourages firms to adopt beyond-compliance policies and commit themselves to continually enhance their health, safety and environmental performances. Moreover, firms commit themselves to more openness in communication about their activities and their achievements. By acting in a responsible way, the chemical sector expects to earn public trust and maintain its 'social license' to continue its operations in a safe and profitable way and with due care for the interests of future generations. While there is a common basis, the Responsible Care program is adapted to domestic conditions by different national chemical industry associations. The program has gained credibility by threatening non-adopting firms that they would be excluded from the chemical association. Moreover, the self-monitoring procedure has evolved in a number of countries towards third party verification (Prakash, 1999).

More recently, another system, the ISO 14001 standard was adopted by several thousand chemical firms worldwide with a similar objective. Contrary to the Responsible Care program that was designed *by* and *for* the chemical industry, the ISO 14001 standard can be adopted by all kinds of organisations, regardless of their activity or location. This standard does not replace technical requirements embodied in statutes or regulations nor does it prescribe standards of performance for organisations. Instead, it requires that an organisation implements a set of practices and procedures which, when implemented together, result in an environmental management system (EMS). Actually, the ISO 14000 series guides firms in the creation of environmental policy by helping managers to define environmental objectives and examine the environmental impact of products, services and processes. The Responsible Care program and the ISO 14001 standard are both voluntary approaches, which share the goal of implementing environmental management systems. Nonetheless, these approaches also differ on several issues (Table 2.1).

Table 2.1: Characterisation of the Responsible Care program and ISO 14001 standard

Characteristics	Responsible Care	ISO 14001
Date of creation	1985	1996
Designer	CMA	ISO
Adopters	Firms of the chemical sector	Any firm worldwide
Verification	Variable with an evolution to third party assessment	Auto-assessment or third-party certification
Cost of implementation	+	++

Source: Prakash (1999)

While there is a growing literature on EMSs approaches (*e.g.* Henriques et Sadorsky, 1996; Prakash, 1999; Nakamura *et al.*, 2001; Anton *et al.*, 2004) such as, the 33/50 Program, Responsible Care Programs, Eco-Management and Audit Scheme (EMAS)[9] and 14000 standard, the empirical evidence regarding the determinants of EMSs registration in the chemical sector is relatively scarce. More precisely, a part of paper by Delmas and Montiel (2008), where authors analyse the factors that explain the international diffusion of voluntary international standards in chemical sector, we are not aware of any other research that deals with the subject.

The aim of this chapter is to fill this gap by identifying the factors that drive chemical companies to adopt either RC or ISO 14001, in a comparative approach. Moreover, compared to other empirical studies performed on other sectors, we investigate the effects of new variables such as previous environmental accidents and information disclosure requirements. The remainder of this chapter is as follows. In the next section, we define ISO 14000 standard as one of the most widespread standard for environmental improvement and we discuss the figures concerning its diffusion. In the third section, we provide a theoretical rationale for EMS certification and formulate hypotheses. The fourth section presents the data and the methods used. Section five discusses the results. Section six is devoted to conclusive remarks.

[9] The brief description of the 33/50 Program, Responsible Care Programs, Eco-Management and Audit Scheme (EMAS) is presented in Appendix 2.1.

2. Description and diffusion of the ISO 14000 standards

Following the success of the ISO 9000 standard, the ISO launched the ISO 14000 environmental management system standard in 1996 as a framework for ensuring that risks, liabilities and impacts are properly identified, minimised and managed (Darnall *et al.*, 2000). ISO 14000 builds on ISO 9000 and it uses the process management principles of the 9000 series as a foundation, adding environmental policy and environmental safety elements. In fact, the ISO 14000 standards are based on the same approach that managers have successfully used to identify and eliminate quality defects with ISO 9000, which help to identify and correct process defects that result in pollution (Delmas, 2003). In this sense, the standard is established on the principle of the Deming's 'Plan-Do-Check-Act' cycle which includes: environmental policy, planning, implementation and operation, checking and corrective action, and management review. The implementation process of ISO 14000 standards is presented in Appendix 2.2.

In the same vein as the ISO 9000 standard, one of the key attractions of the ISO 14000 standard is its flexibility coupled with its universal applicability. Therefore, the number of certfied firm is impressive (in comparison to other environmental approaches), with more than 150 000 certified firms at the end of 2007 (ISO, 2007).

The first edition of the ISO 14000 series was a set of guidelines for developing systems and practices divided into six sections, each containing one or more standards. Table 2.2 includes these six sections.

Table 2.2: The first edition of the ISO 14000

Section	Standards
Environmental Management Systems	ISO standards 14001 and 14004
Environmental Performance Evaluation	ISO standards 14014, 14015 and 14031
Environmental Auditing	ISO standards from 14010 to14014
Life Cycle Assessment	ISO standards from 14040 to 14043
Environmental Labeling	ISO standards from14020 to 14025
Environmental Aspects in Product Standards	ISO standard 14060

Source: The ISO family of International Standards (2009)

A second edition of ISO 14000 was published in 2004, updating the standard. With respect to a firm's control and influence, the ISO 14001:2004 standard does not add any new requirements.[10] It only reaffirms that the organisation has the discretion to define the scope of the EMS and identify which environmental aspects may provide control and influence. The new version has developed the 19011:2002 standard for environmental management standard auditing, which replaces previous standards from the ISO 14010 series.[11]

Similarly to the ISO 9000 registration process, firms that have developed, implemented and documented an environmental management system according to ISO 14001 guidelines can apply for an official third party audit that may justify the award of ISO 14001 certification. The main objectives of the audit are to validate the system compliance and implementation and also to determine the system effectiveness. As we stressed in the previous chapter, the firm has to undertake a regular audit inspection which usually occurs once or twice a year and their environmental management system must be re-certified every three years.

Advantages of the ISO 14000 implementation

A great amount of literature has emphasised the benefits associated with ISO 14000 implementation. The benefits of ISO 14000 could be summarised as: increased market share, improved working climate, improved customer satisfaction, improved efficiency of operations and processes, and cost reduction *(e.g.* Zutshi and Sohal, 2004; Holt, 1998).

Disadvantages of the ISO 14000 implementation

Similarly to ISO 9000 implementation, ISO 14000 adoption requires strict time and cost management to successfully develop, implement and obtain certification for EMS. The different types of costs that are associated with ISO 14000 certification are: training, documentation, process modification, registration fee, design of EMS, organisational adoption and legal consequences *(e.g.* Zutshi and Sohal, 2004).

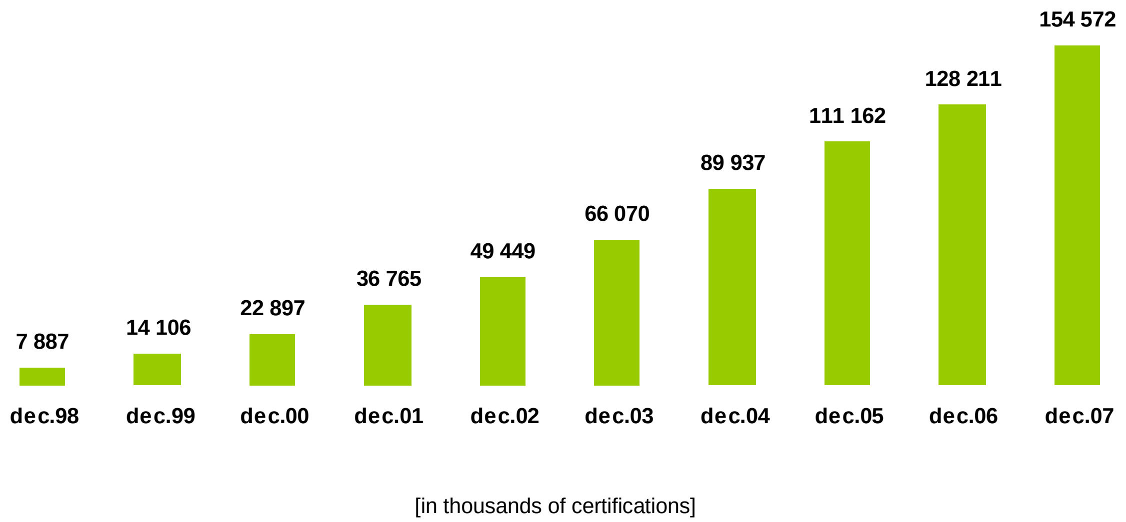
[10] The list of ISO 14001:2004 requirements is presented in Appendix 2.3.
[11] The current list of standards is presented in Appendix 2.4.

Moreover, Delmas (2000) argues that "design costs of ISO 14001 standard" are a more important constraint than are the "registration costs" and the "annual cost of maintaining an ISO 14001.

The diffusion of the ISO 14000 in the world

By the end of 2007, ISO listed 154 572 ISO 14001 certificates in 148 countries or an increase of 26 361 certificates in one year (Figure 2.1). Therefore, we may conclude that at the global level certification recorded a growth of 21% in 2007 (vs 16% in 2006 or more than 17 000 additional certificates between the end of 2005 and the end of 2006). After a slight slow-down of growth in 2006, ISO 14001 recorded significant progress in 2007 at the world level.

Figure 2.1: ISO14001 certification in the world

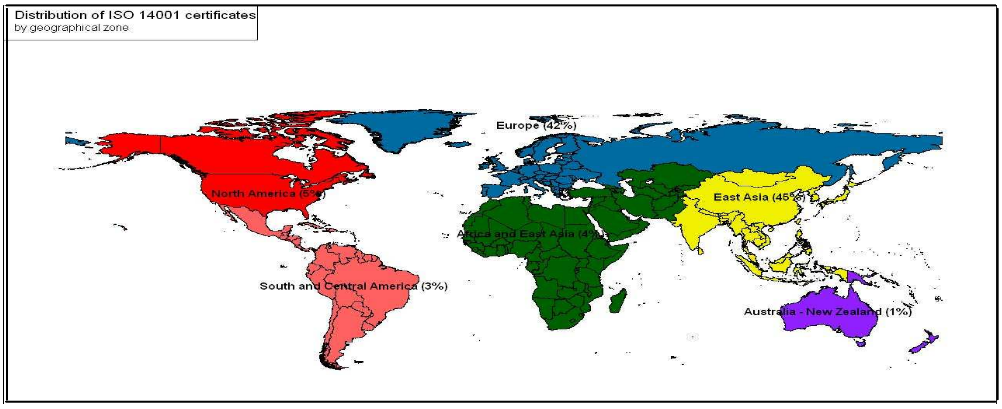


Source: The ISO Survey of Certifications 2007 (17th Cycle)

Furthermore, Figure 2.2 shows that European and Far East countries account for 87% of the ISO 14001 certificates in the world. For the first time, the Far East is in front of Europe and has become the geographical zone with the greatest number of ISO 14001 certificates, with more than 45% of the market share. It gains 4 points as compared to the end of 2006, thanks to a significant growth of 34%. On the other hand, Europe has lost 2 points despite a growth of 16% in 2007.

As for ISO 9001, North America and Australia-New Zealand reduce their number of ISO 14001 certifications by 2 points. The proportions of other geographical zones stay unchanged.

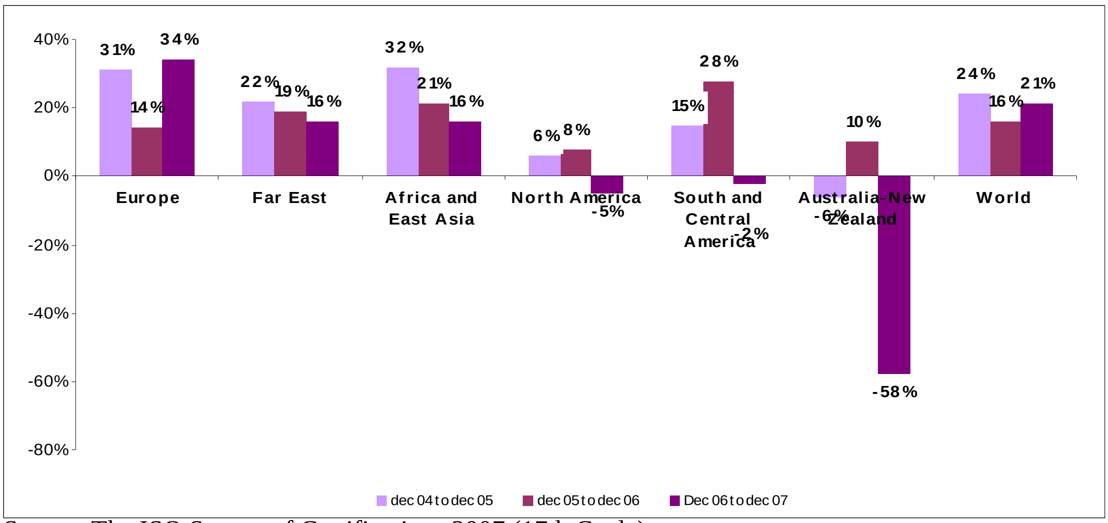
Figure 2.2: Distribution of ISO 14001 certificates by geographical zone on the 31st December 2007



Source: The ISO Survey of Certifications 2007 (17th Cycle)

From Figure 2.3, we remark that European countries register an increase of more than 9 000 certificates during 2007. The growth of Africa and East Asia is in decline compared to the previous years. Other regions suffered from a decrease of their certificates, with a significant drop for Australia-New Zealand in 2007. The Far East recorded a very significant growth in 2007 (+34%); more than 18 000 additional certificates in one year. China, alone, explains more than one half of this increase.

Figure 2.3: Evolution of the ISO 14001 growth level in the world

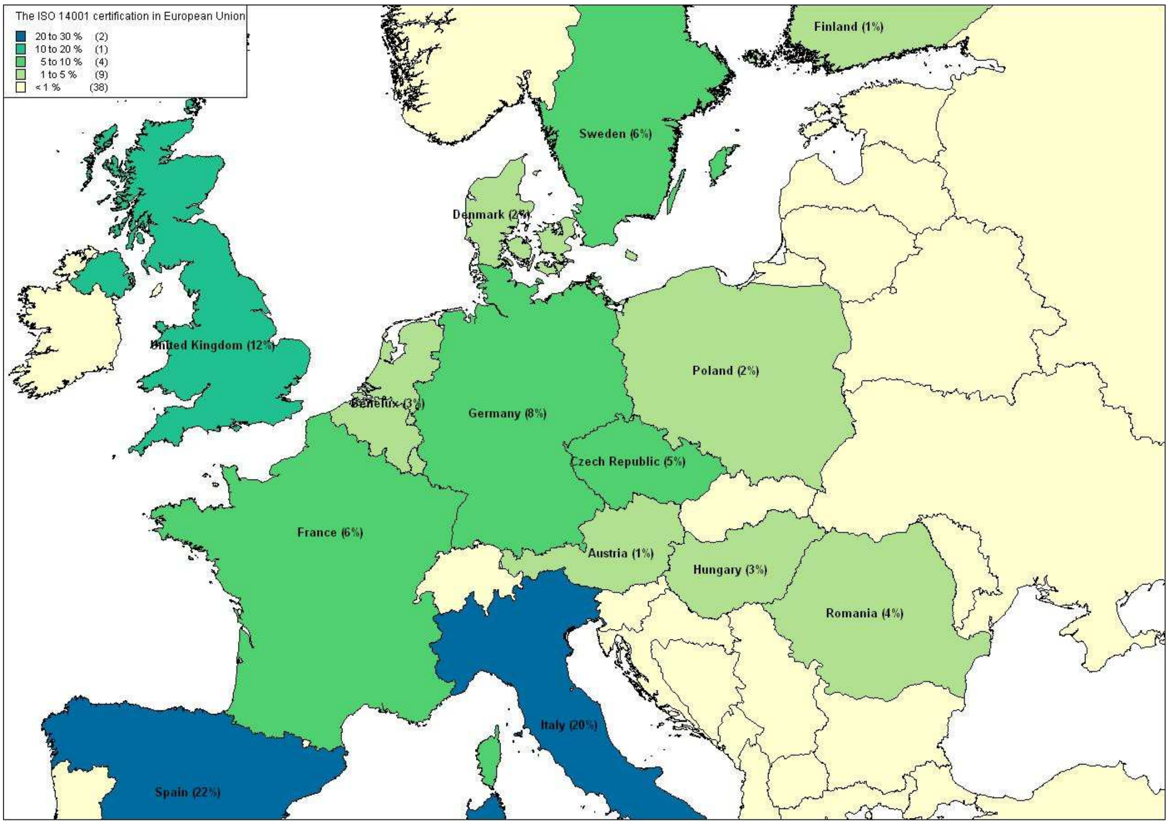


Source: The ISO Survey of Certifications 2007 (17th Cycle)

Members of the European Union make up 39% of the ISO 14001 certificates at the world level (Figure 2.4). This represents 1 point less compared to the previous year.

The classification of the EU countries suffers no global change, but the distance continues to increase between Spain, Italy and the rest of the European countries. Spain and Italy are, as previously, at the top of EU countries for ISO 14001 certification and each of them gains 2 points of market share as compared with 2006. The positions of the United Kingdom and France stay unchanged while Germany and Sweden lost 2 points. Other countries such as Czech Republic, Romania and Hungary continue their progress and gained 1 point of the EU market share.

Figure 2.4: The ISO 14001 certification in the European Union

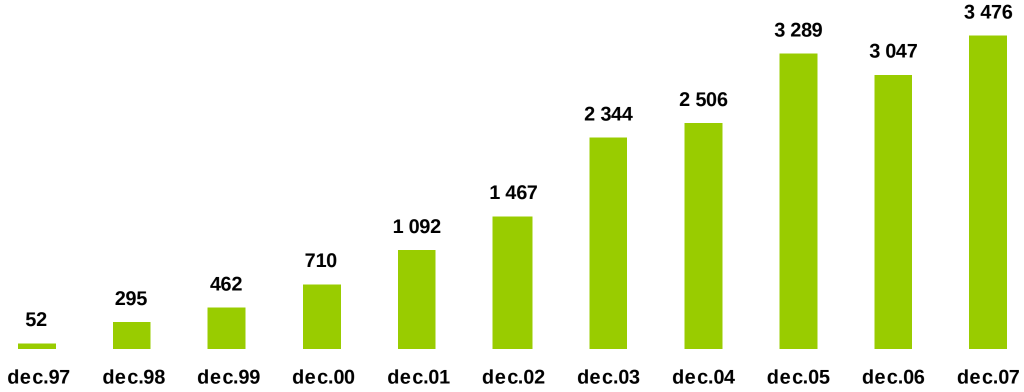


Source: The ISO Survey of Certifications 2007 (17th Cycle)

Figure 2.5 presents the distribution of the ISO 14001 certification in France. With 3 476 certificates, the ISO 14001 standard represents the most adopted environmental management system in France.

Moreover, the number of certifications continues to increase in France: the ISO reported an increase of 14% in 2007 as compared to the previous year.

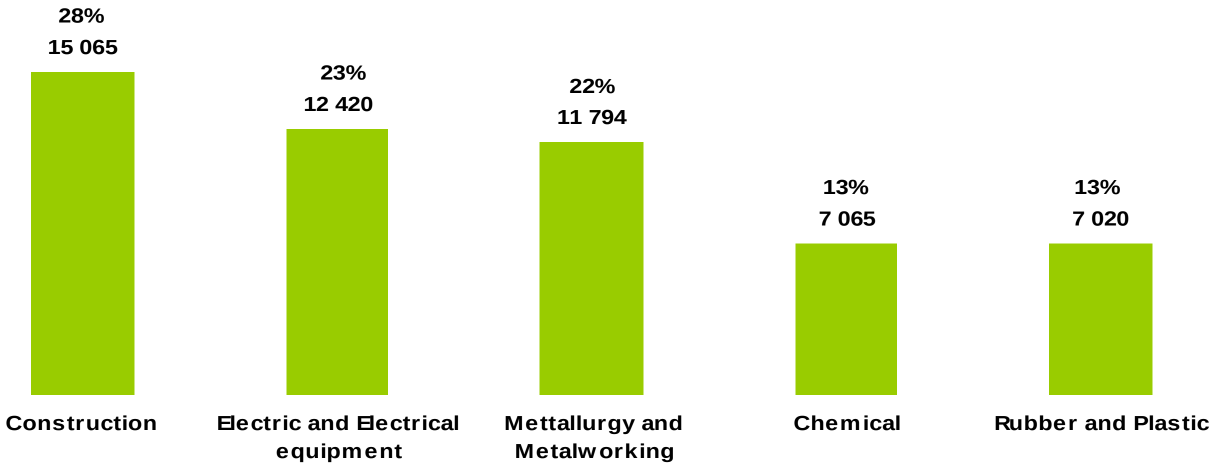
Figure 2.5: ISO 14001 certification in France



Source: The ISO Survey of Certifications 2007 (17th Cycle)

Once again, construction, electronic and electrical equipment, metallurgy and metalworking, chemical, and rubber and plastics sectors represent 45% of the ISO 14001 certificates around the world (Figure 2.6).

Figure 2.6: The ISO 14001 certification per sector of activity



Source: The ISO Survey of Certifications 2007 (17th Cycle)

For the first time, the construction sector is placed on top of the ISO 14001 certified sectors due to a superior growth at the world level. Therefore, we may say that the construction sector "dethrones" the sector of electronic and electrical equipment fabrication that records a lower than average growth. The metallurgy and metalworking, and chemical sectors stay on the 3rd and the 4th position, with growth rates which are equal to the world average. The sector of rubber and plastics takes the last position in the top 5 sectors.

Finally, service sectors represent 29% of the ISO 14001 certificates around the world at the end of 2007, compared to 71% in the manufacturing sectors.

3. Related literature and conceptual framework

From an economic viewpoint, the firm's decision to certify an EMS can be explored in the context of a discrete choice model, where the rational manager chooses the alternative (either Responsible Care or ISO 14001 or no EMS at all) that maximises the net expected benefits. Noteworthy, the net expected benefits will also depend on firm's characteristics (Grolleau and Thomas, 2007). In this sense, as it is indicated by Grolleau and Thomas (2007), it is important to check whether firm's characteristics have positive impact on EMS adoption.

Most empirical studies devoted to EMS adoption are mainly multi-sectoral analyses and use a binary-choice model to explain a discrete voluntary decision by a vector of variables corresponding to the expected predictors. Based on a literature review, we formulate several hypotheses regarding the predictors of EMS certification by chemical firms.

Main activities of the firm

Environmental regulations and their costs differ among sub-sectors due to their different types and levels of pollution. Because each sector has different polluting potentials, the magnitude of pressure from stakeholders concerning the environment may be different. The firms in more regulated and monitored sub-sectors are more likely to integrate environmental management into their overall management system, since the costs associated with non-compliance tend to be significantly higher.

It is also believed that firms that belong to highly polluting sub-sectors will face more difficulties in trying to develop a more comprehensive EMS than a less polluting firm, due to their sub-sectors characteristics (Ruiz-Tagle, 2006; Grolleau *et al.*, 2007). In line with these authors, we contend that EMSs are about more than 'pollution' in the ordinary sense and encompass a wide range of aspects relating to sustainable production, workers' health and safety and ethical issues. As this chapter concentrates on chemical firms, we formulate the following hypothesis:

H1: The probability of registering for a certified EMS increases for firms belonging to chemical sub-sectors which are more polluting and more risky, ceteris paribus. Because Responsible Care has been directly conceived by and for the chemical sector and is more likely to fit sector specificities, we assume that the sub-sector effect is likely to play a more important role in registering for Responsible Care.

Company size

Arora and Cason (1995) argue that the company size has a positive effect on voluntarism. Similarly to QMS implementation, EMS implementation and certification require significant amounts of financial, managerial and qualified human resources, larger firms are more likely to adopt an EMS. The fixed cost gives an advantage to big firms since those firms can spread it over a greater number of produced units. Furthermore, economies of scale and 'learning by doing' may also give an advantage to larger firms. In addition, larger firms are more visible and more subject to various pressures that may encourage them to adopt a formal EMS. Most empirical studies (Nakamura *et al.*, 2001; King and Lenox, 2001; Welch *et al.*, 2002) found that the probability of adopting an EMS increases with the firm size. Consequently, we hypothesize:

H2: The probability of registering for a formal EMS increases with the firm size, ceteris paribus. Because the adoption cost of Responsible Care is frequently considered as lower than that of ISO 14001, we contend that the size effect is stronger for ISO 14001 than for Responsible Care.

Previous experience with similar mechanisms

In a 'new institutional economics' perspective, norms may have an impact on the cost of EMS certification (Grolleau *et al.*, 2007). In a context where there is a lot of information, resources and skills on how to implement a similar or related process standard, such as ISO 9000, there will probably also be information and skills available on how to implement an

EMS (King and Lenox, 2001; Delmas, 2003). Firms that have previous experience with similar standards are expected to incur lower additional costs (*e.g.* through the overlap of documentation requirements) because of learning by doing and scale economies. Moreover, integrated systems allowing joint implementation and certification of two or more standards also reduce the marginal cost of a certified EMS (Bansal and Hunter, 2003; Nakamura *et al.*, 2001). As we indicated previously, ISO 9000 and ISO 14000 standards have very similar structure. Consequently, prior certification with standards having a similar architecture is likely to reduce the overall cost of EMS certification. Empirical studies corroborate this contention. We therefore hypothesise:

H3: The probability of registering for a certified EMS increases with firm experience with other process standards, ceteris paribus.

Disclosure requirement

Several countries have introduced in their regulatory arsenal a mandatory disclosure of information related to environmental performances of companies, such as the Toxic Release Inventory (TRI) (Antweiler and Harrison, 2003). In France, the regulatory act so-called ‘Nouvelles Régulations Economiques’ (New Economic Regulations) requires that companies listed on the stock market provide an environmental report each year.

The ‘Nouvelles Régulations Economiques’ divides social reporting into three categories: human resources (including employment indicators, remuneration, equity, and diversity); community (including the impact on and engagement with local populations and stakeholders); and labor standards (including respect for and promotion of International Labour Organisation conventions). According to Tietenberg (1998), the conceptual economic foundation for disclosure policies is the Coase Theorem which asserts that socially optimal risk sharing can be obtained if all stakeholders can negotiate at a very low cost. Removing or at least attenuating information asymmetries, which constitute an impediment to private bargaining may enable to reach a Pareto-optimal outcome.

Thanks to publicly available information on the environmental performances of the companies, various stakeholders may give an advantage to companies with good environmental performances. This mandatory requirement and the impact it can have, especially on the valuation of the firms in the stock market may push firms to adopt a formal EMS in order to demonstrate to their stakeholders their credible commitment to environmental management (Jiang and Bansal, 2003; Hibiki *et al.*, 2003). Consequently, we formulate the following hypothesis:

H4: The mandatory disclosure requirements imposed by gouverment increase the probability that a firm registers for an EMS, ceteris paribus. Because, the ISO 14001 standard is considered to be more stringent and credible than Responsible Care, we contend that the disclosure requirements would have a stronger impact for registration to the former.

Customers' location

Firms' environmental performance is frequently unobservable, especially to customers located in areas which are institutionally, geographically and culturally different. Hence, foreign customers may demand more visible commitment to environmental protection because they may have less opportunity to monitor the performance of a company or less knowledge about its actions. In a signaling or screening rationale, firms that have distant customers are more likely to prove their environmental commitment (Arrow, 1963; Spence, 1973) through institutional devices like ISO 14001 and Responsible Care. In this sense, customers usually use international standards as a tool to screen and select foreign suppliers. (Delmas and Montiel, 2009). The ISO 14001 certification may prove the ability of the supplier to satisfy environmental expectations of customers and make public unobservable attributes, especially in contexts when customers may be vulnerable to reputation externalities (Boiral, 2006). King and Lenox (2001) showed that the distance to customers had a significant positive impact on firms' decisions to adopt a certified ISO 14001 standard. Moreover, anecdotal evidence shows that some EMSs are *de facto* passports to make business with foreign companies (Terlaak and King, 2006). In fact, in order to obtain a "title" for "preferred supplier", firms need to improve information flow by showing their commitment to environmental improvement (Delmas and Montiel, 2009). Several empirical studies, such as Corbett and Kirsch (1999) and Bansal and Hunter (2003), confirmed the significant role played by exports in firms' decisions to register for a certified EMS. Indeed, export markets in eco-sensitive countries like Germany and Austria may have a strong impact (relative to less eco-insensitive countries) on the decision to adopt EMS certification (Chang and Kristiansen, 2006). Additionally, customers in these countries demand that not only their domestic but also their foreign suppliers adopt EMS certification. Hence, it is important to mention that customers of different countries have different priorities and ideas with regard to the environment and its management (Neumayer and Perkins, 2004; Nishitani, 2007). Thus, distinguishing between export destinations seems to be an important issue in EMS certification. Related to these arguments, we formulate the following hypotheses:

H5a: The probability of registering for a certified EMS increases with the distance to customers, ceteris paribus.

H5b: The probability of registering for a certified EMS increases as customers are located in foreign countries, ceteris paribus. Because of its international and generic aspect, and third party verification, we contend that export considerations are likely to have a higher impact on ISO 14001 certification compared to Responsible Care.

H5c: The probability of registering for a certified EMS increases as the customer's hosting country is sensitive to environmental issues, ceteris paribus.

Environmental performance

Regulatory influence theory postulates that firms are willing to invest in voluntary action because voluntarism provides the firm greater ability to influence or manipulate the regulatory system. Actually, firms may commit in environmental voluntary initiatives to reduce or transfer direct and indirect regulatory pressure (Maxwell and Decker, 1998). More precisely, Maxwell and Decker (2006) show that if a firm voluntarily makes an observable investment in pollution control that lowers its marginal cost of abatement, then it is optimal for the regulator to monitor the firm less frequently. Furthermore, the authors provide the model evidence that confirms the fact that if a firm makes an observable, irreversible environmental investment, prior to the regulator's allocation of inspection resources, then the regulator will reduce subsequent inspection efforts at that firm. In this sense, Welch *et al.*, (2002) argue that firms experiencing stronger regulatory pressure are more likely to adopt an environmental management system. Moreover, "through their commitment to improve the natural environment and their threat of issuing more stringent regulations [or improving the enforcement of existing regulation], governments can send a clear signal to firms that environmental concerns will be taken seriously in the future" (Delmas, 2003, p. 12).

Additionally, firms whose reputations have suffered from environmental accidents are more sensitive to environmental issues (Delmas and Toffel, 2008). According to Yiridoe and Marett (2004, p. 58), "the primary objective of the ISO 14001 EMS standard is to enhance and continuously improve compliance with environmental laws and regulations, and the environmental stewardship policies of organisations". Finally, several empirical studies have proved that regulatory pressure is a significant determinant of EMSs certifications (Grolleau *et al.*, 2007; Delmas and Toffel, 2008; Delmas and Montiel, 2009).

H6: The probability of registering for a certified EMS increases with the firm's willigness to improve environmental performance, ceteris paribus. Given the higher external pressure, we contend that firms that have experienced environmental accidents or problems and/or face higher environmental risks are more likely to register for a certified EMS.

4. Data and model specification

4.1 The database and variables

In January 2005, survey questionnaires[12] were sent to the exhaustive list of French chemical firms or production units (N=720) as published annually in '*Info Chimie Magazine*'.[13] The latter contains all the chemical firms, their addresses, the names of the CEO, the names of the environmental managers and some firms' key characteristics. Out of 720 firms surveyed, 86 responded with usable data (with a response rate of 12 %).

The dependent variables, denoted *ISO14* and *RC*, are binary variables equal to 1 if the firm is registered for the ISO 14001 standard and Responsible Care, respectively. The number of registered firms is 40 for ISO 14001 and 41 for Responsible Care. The proportion of certified firms in the sample (about 50%) is considerably higher than the proportion of certified firms in the whole firm population. Certified firms are over-represented in the sample of respondents, since certified firms were more willing to answer the questionnaire (26% of the companies inside the chemical industry in France are ISO 14001 standards certified, COI, 2006).[14]

[12] The questionnaire borrows several elements from surveys used in prior studies.
[13] Info Chimie Magazine, 2004, n°457, Juillet/Août, Spécial usines chimiques.
[14] Changement Organisationnel et Informatisation (COI), 2006, www. enquetecoi.net.

To test hypotheses H1 to H6 we used ten dummy explanatory variables as follows. To test H1 (main activities of the firm), we asked the surveyed firms to indicate what their main activities are. Four sub-sectors commonly used in the French nomenclature[15] are considered: basic chemistry including both inorganic and organic chemistry, fine chemistry, speciality chemistry and pharmaceuticals. Among 86 firms who responded to our survey 47 are from basic chemistry industry, 24 from fine chemistry industry, 27 are from speciality chemistry industry, 7 are from pharmaceuticals, and 5 are from the category 'others'. Specific companies can participate in several sub-sectors. Due to a small number of responses, we can not compute for each sub-sector specific discrepancy in the behaviour of chemical firms regarding certification. Thus, we investigate whether belonging to those sub-sectors generally considered as more polluting, *i.e.* inorganic and organic chemistry (*BASIC*), increases the probability of EMS certification. The other sub-sectors constitute the reference group.

For H2 (size of production unit), we use the variable *SIZE* equal to 1 if the firm has more than 100 employees in its production unit.

To operationalise H3 (experience with other standards) we use ISO 9000 certification as a proxy (*ISO9*).

To test H4 (disclosure requirements) we use the variable *STOCK* equal to 1 if the company is publicly traded. Indeed, as mentioned above, firms operating on stock markets are subject to the 'New Economic Regulations' act and thus are asked to provide a publicly available environmental report.

To test H5a (distance to customers), we create the variable *DISTANCE* that takes the value of 1 if the distance to main customers is more than 250 km. The effect of exports on the registration for a certified EMS (H5b) is measured by the variable *EXPORT* that takes the value of 1 when the company makes more than 10% of its turnover in foreign countries. To test H5c (region of export), we use the variable *REGION* that is equal to 1 if the main region of exports is North Europe, North America or Japan.

[15] See the website of the Chemical Industry Union (UIC) : http://www.uic.fr/us/indus01.htm

To test H6 (environmental performance), three variables are used: *SEVESO*, *ENVPROB* and *RISKS*. *SEVESO* is equal to 1 if the company is classified SEVESO I or SEVESO II or both. SEVESO I (1982) and SEVESO II (1996) are European directives intended for industrial companies where dangerous substances are present in quantities exceeding the thresholds in the directives. SEVESO I aimed at controlling major-accident hazards of industrial activities in the member states of the European Community. In France, the SEVESO I was implemented without major modifications of the existing law. This Directive was replaced by Directive 96/82/EC, called the Seveso II-Directive, on the control of major accident hazards. The Seveso II Directive is a legislative document that all the members of the EU must fulfil through implementation of national legislation. We contend that firms which are subject to these directives are more likely to register for a certified EMS. *ENVPROB* is equal to 1 if the firm declared that it has experienced an environmental problem in the last ten years. Finally, the variable *RISKS* is equal to 1 if the firm anticipates high future environmental risks. Firms were asked to weight the importance of environmental risks on a ten-point scale from 1 to 10, where 10 indicates that the environmental risks are very high. The variables used in estimation are indicated in Table 2.3. No problem of multicolinearity has been detected (Appendix 2.5).

Table 2.3: Definition of variables and sample statistics

Variable	Definition
ISO14	The firm is certified with ISO 14001 standard Dummy variable (=1 if yes)
RC	The firm is registered for Responsible Care program Dummy variable (=1 if yes)
BASIC (H1)	The firm's main activity is basic chemistry Dummy variable (=1 if yes)
SIZE (H2)	The firm has more than 100 employees in production unity Dummy variable (=1 if yes)
ISO9 (H3)	The firm is certified with ISO 9000 standard Dummy variable (=1 if yes)
STOCK(H4)	The firm is on the stock market Dummy variable (=1 if yes)
DISTANCE (H5a)	The firm's distance to customers > 250 km Dummy variable (=1 if yes)
EXPORT (H5b)	The firm's turnover abroad >10% of total sale Dummy variable (=1 if yes)
REGION (H5c)	The firm's region of export North Europe, North America or Japan Dummy variable (=1 if yes)
SEVESO (H6)	The firm has SEVESO I or SEVESO II or both Dummy variable (=1 if yes)
ENVPROB (H6)	The firm had environmental problems in last 10 years Dummy variable (=1 if yes)
RISKS (H6)	The importance of risk generates by firm's activity is higher than 5 on the scale from 1 to 10 (very low to very high) Dummy variable (=1 if yes)

Number of observations: 86.

4.2 Descriptive Statistics

From the Table 2.4 we can see that more than a half of firms in both categories of environmental approaches belong to more polluting sectors (55% and 59%, respectively). Consequently, those firms adopt environmental practices in order to improve their environmental performance. As expected, there are more ISO 14001 certified firms (58%) that belong to category of large firms comparing to firms that have Responsible Care (44%). Hence, this may support the notion that small firms do not have enough resources to become ISO 14001 certified. Surprisingly, both types of environmental management adopters have very high percentage of firms (around 75%) that are ISO 9001 certified. In fact, as we disused previously, we expected that since ISO 9001 and ISO 14001 standards have similar structure and philosophy, there will be higher percentage of ISO 14001 registered firms that are also ISO 9001 registered. Furthermore, one can remark that higher percentage of firms that are on the stock market have ISO 14001 certification.

Table 2.4: Descriptive Statistics

Variables	ISO 14001	Responsible Care
BASIC	55%	59%
SIZE	58%(a)	44%
ISO9	75%	76%
STOCK	35%	29%
DISTANCE	73%	68%
EXPORT	68%	68%
REGION	40%	100%
SEVESO	53%	56%
ENVPROB	20%	10%
RISKS	53%	56%
Total	**53%**	**47%**

Lecture: (a) 58 % of ISO 14001 registered firms have more than 100 employees in production unity.

Once again, the findings induce that if the distance from customer is superior to 250 km, firm will prefer to adopt ISO 14001 certification rather than Responsible Care. On the other side, if a firm makes its business abroad, generally it chooses between two environmental approaches without significant difference. Interestingly, if the main region of firm's exports is North Europe, North America or Japan, a firm will be more sensible to adopt Responsible Care comparing to ISO 14000 standard. Concerning the variable *SEVESO*, we can remark that both categories of adopters have approximately the same number of firms. In addition, if firm has experienced an environmental problem in the last ten years it will rather implement ISO 14001 than Responsible Care. Finally, firm that anticipates high future environmental risks choose among those two approaches without any difference.

4.3 The Empirical Model

For each EMS, *i.e.* ISO 14001 standard and Responsible Care, we use a linear model for the underlying latent variable driving certification:

$$Y_i^* = \alpha + \sum_{i=1}^{10} \beta_i X_i + \mu_i, \quad i = 1, 2, ..., N. \qquad (1)$$

where X_i represents the vector of variables for ISO 14001 and Responsible Care certification (*BASIC*, *SIZE*, *ISO9*, *STOCK*, *DISTANCE*, *EXPORT*, *REGION*, *SEVESO*, *ENVPROB*, *RISKS*); $\beta_1 - \beta_{10}$ are slope coefficients to be estimated and α and μ are the intercept and the disturbance term, respectively. The interpretation of the latent variable in this kind of model is typically that of an overall net gain (or profit) originating from certification (that is, the perceived difference between profit under certification and profit without certification). Of course, profit here has to be taken in a very broad sense. When this latent variable is positive, certification gains outweigh losses due to certification. The model of firms' certification choice is stated as a discrete-choice model, with the dummy variables indicating certification, *ISO14* and *RC*, as the dependent variables Y_i :

$$\begin{aligned} Y_i &= 1 \quad \textit{if} \quad Y_i^* > 0, \\ Y_i &= 0 \quad \textit{otherwise.} \end{aligned} \qquad (2)$$

We specified logistic distributions for μ and maximised the log-likelihood of the logit models (Greene, 2003) to estimate models' parameters up to a positive constant.[16]

5. Results and discussion

Logit estimation results are presented in Table 2.5. The main result from our estimation is that determinants for EMS certification differ among the two systems. While ISO 14001 registration is driven by the company size, the previous experience with process standards, the disclosure requirements and customers' location, registration for Responsible Care is mainly driven by environmental factors, *i.e.* environmental regulations, problems and risks.

The hypothesis that sub-sector characteristics could have a differential impact on the decision to be EMS-certified (H1) is not supported. This may be explained by the fact that in

[16] Unfortunately, due to the low number of observations (86), we could not use a multinomial logit model.

the chemical industry the ‘reputational’ spillover effects are relatively high making all the industry incriminated in the case of an environmental crisis (Rees, 1994). Nevertheless, additional studies with more usable data are required to better understand the possible effects of sub-sectors.

The second hypothesis which states that the probability of EMS registration increases with the company size *ceteris paribus* is supported for ISO 14001 standard only. Our findings are consistent with previous studies. For instance, investigating the drivers of EMS certification in the agrofood industry, Grolleau *et al.*, (2007) show that the probability of certification increases with the firm size. According to these authors, ‘EMS promoters might be able to increase certification by encouraging large certified firms to require that their (smaller) suppliers become certified’. Our result gives an additional empirical content to this argument. Furthermore, the insignificant effect of firm size for Responsible Care could be due to the fact that Responsible Care does not require third-party certification. Hence, firms do not need significant amount of financial resources for certification that are usually available only for larger firms.

The hypothesis that the experience with other standards increases the probability of EMS registration *ceteris paribus* (H3) is supported for ISO 14001 since the variable ISO9 is significant and positive. As we expected voluntary environmental certification is not an isolated act, but rather fits more or less with the pre-existing framework (Rogers, 1995). Encouraging certification of a voluntary approach that fits a pre-existing system of voluntary standards reduces the opportunity costs for potential adopters. Furthermore as suggested by Grolleau *et al.*, (2007) ISO14001 promoters may prefer modifying the pre-existing system incrementally, rather than directly imposing a radical change. Concerning the finding related to Responsible Care, a possible explanation of this result could be due to different architectures of ISO 9000 and Responsible Care.

The hypothesis that information disclosure requirements increase the probability of EMS certification, *ceteris paribus* (H4) is supported for ISO 14001 certification. As mentioned above, stockholders would prefer adoption of ISO 14001 because of Responsible Care ‘credibility lack’. Actually, it could be that stakeholders trust more in third-party certification such as ISO 14001. In addition, firms that have adopted Responsible Care before the creation of the ISO 14001 standard and are satisfied with its environmental outcome could have less interest in registering for the former.

The results related to hypotheses H5a, H5b and H5c are quite interesting. The distance to customers (H5a) is almost significant for ISO 14001 standard, but the sign of the parameter is negative. This counterintuitive result could be explained by the fact that, in general, consumers of chemical products could pay more attention to their near surroundings than those areas that are far from them. Nevertheless, we can not give a clear-cut conclusion and more research is needed to confirm or not this possible explanation. The hypothesis that the probability of EMS registration increases with exportation *ceteris paribus* (H5b) is not supported. This result could be explained by the fact that the French legislation on pollution may benefit from a good image abroad, making EMS registration less useful for exports. Moreover, as argued by Prakash (1999) firms that export substantial proportions of their outputs on the EU market are more likely to adopt ISO 14000 than firms that do not significantly depend on the EU markets, since for the EU market, ISO 14000 may soon become necessary for market access.

The hypothesis H6 stating that the probability of registering for a certified EMS increases with the firm's exposure to regulatory pressure, *ceteris paribus* is supported for Responsible Care registration. Environmental performance through SEVESO is a significant determinant for EMS certification. Nevertheless, the parameter associated with past environmental problems is negative. This negative sign could be explained by the fact that some firms have already a bad image due to environmental problems. Thus, although, Responsible Care was created after a series of environmental catastrophes, firms could estimate that registration with Responsible Care is unlikely to reconstruct a good public image. The variable *ENVPROB* is significant but has a negative sign. Evidence exists that it is less costly for organisations with better environmental performance to acquire environmental management systems and certify with ISO 14001. Thus, the negative sign could be explained by the fact that companies that faced environmental problems will avoid certification because it is too costly for them to meet EMS requirements (King and Lenox, 2001). Finally, our estimation shows a positive effect of future risks on Responsible Care registration.

Table 2.5: Determinants of ISO 14001/Responsible Care registration

	ISO 14001		Responsible Care	
Variables	Estimate	z-value	Estimate	z-value
Intercept	-2.25***	-3.38	-1.60***	2.03
BASIC	0.85	1.34	0.89	1.42
SIZE	2.28***	3.51	0.07	0.68
ISO9	1.13*	1.67	0.97	1.46
STOCK	2.35***	2.99	0.81	0.99
DISTANCE	-1.15	-1.59	-1.11*	-1.68
EXPORT	-0.73	-0.91	0.95	1.08
REGION	1.52*	1.70	-0.58	-0.78
SEVESO	0.98	1.18	1.09*	1.74
ENVPROB	0.99	0.96	-1.73**	-2.06
RISKS	-0.23	-0.31	1.27**	1.97
Max Rescaled R2	0.46		0.41	
-2 log L	82.35		87.63	
-2 log L (Intercept only)	118.80		119.03	
Likelihood ratio	36.44		31.40	
Percent concordant	84.2		82.1	
Number of observations	86		86	
Number of certified firms	40		41	

(*), (**) and (***) stand for parameter significance at the 10, 5 and 1 percent level respectively.

6. Concluding remarks

We examined empirically the determinants of registration for ISO 14001 standard or Responsible Care program by the French chemical industries. Although the aims of these two environmental management systems are similar, the factors that influence their adoption are quite different. Indeed, our findings suggest that the firm size and signaling unobservable attributes to distant customers are significant determinants of the ISO 14001 certification, while environmental factors play a significant role in Responsible Care registration. Thus, a company can choose one of these two EMSs depending on its strategy and business aim. A company that has a higher turnover in foreign countries would rather implement the ISO 14001 standard.

Because the firm size is likely to play a more important role for ISO 14001 certification as compared to Responsible Care, it seems more feasible for small firms to be Responsible Care registered. Given the different nature of determinants for the two systems, the *a priori* high costs of a double certification can be an obstacle for firms that search for the environmental outcome while signaling their environmental efforts. For instance, firms that are ISO 14001 certified seem more sensitive to information disclosure requirements. Thus, it may be necessary to increase the credibility of Responsible Care program among stakeholders to allow firms that are registered with it to signal their outcome without having to incur additional costs to be ISO 14001 certified. Thanks to our results, policymakers willing to promote a given EMS may adopt better tailored policies. A natural extension to our contribution is to examine the determinants of joint certification (*i.e.* ISO 14001 and Responsible Care) by some firms which could add a valuable contribution to these issues. In fact, as indicated by Delams and Montiel (2008) voluntary environmental standards should not be treated as alternatives to one another but rather as mutually complementary. ISO 14001 should not be opposed to Responsible Care since both of them could co-exist within the same firm. The authors find that previous adoption of the Responsible Care program impacts positively on the decision of a firm to adopt a second voluntary program, such as the ISO 14001 standard. Furthermore, it could be interesting to provide comparative analysis as to which of these two environmental approaches, Responsible Care or ISO 14001 standard, best improves environmental and economic performance of the firm.

APPENDICES CHAPTER II

Appendix 2.1: The brief description of the main Environmental Programs

Appendix 2.2: The list ISO 14001:2004 requirements

Appendix 2.3: The list current standards

Appendix 2.4: The ISO 14000 implementation process flow chart

Appendix 2.5: Pearson correlation coefficients

Appendix 2.1: THE BRIEF DESCRIPTION OF THE MAIN ENVIRONMENTAL PROGRAMS

The 33/50 Program was initiated in 1991 by the Environmental Protection Agency's (EPA) as a first voluntary pollution prevention program. Its goal was to reduce the aggregate releases of 17 chemicals reported to the Toxics Release Inventory (TRI) by 33% by 1992 and by 50% by 1995, relative to the emissions reported in 1988. The 17 chemicals were selected on the basis of their high volume of industrial production, high releases and off-site transfers relative to total production, possibility for substitution and other forms of prevention, and their toxicity and potential harm to human health. The 33/50 Program is part of a broad group of EPA activities designed to encourage pollution prevention as the best means of achieving reductions in toxic chemical releases and transfers. All firms that enrolled in the 33/50 Program received Certificates of Appreciation signed by the Administrator. Furthermore, the EPA provides assistance to firms as part of the program by conducting regional pollution prevention workshops. In addition, the EPA has published a training guide (Pollution Prevention Resources and Training Opportunities) and Waste Minimisation Opportunity Manuel and developed a series of bibliographic reports with details on pollution prevention and recycling techniques. The progress of program can be tracked through publicly available Toxics Release Inventory Data.

Responsible Care is the chemical industry's global voluntary initiative under which firms, through their national associations, work together to continuously improve their health, safety and environmental performance and to communicate with stakeholders about their products and processes. Responsible Care is a voluntary code of conduct developed, monitored and enforced by the Chemical Manufacturers Association (CMA). The program was first lunched in 1985 in Canada and in 1988 in the United States. The Responsible Care campaign was initiated as a response to the adverse publicity and concern of the Bhopal disaster. By 2009, the chemical industries in 53 countries have adopted versions of Responsible Care programs. Three categories of actors have subscribed to Responsible Care: CMA members; partner companies, particularly those in the transportation sector and partner associations such as the state chemical industry councils and the national associations of firms that deal with chemicals.

The Eco-Management and Audit Scheme (EMAS) is a management tool for firms and other organisations to evaluate, report and improve their environmental performance. Its aim is to encourage different actors on the market to take responsibility for their environmental matters and to decrease harmful environmental impacts in a self regulatory and voluntary way. Eco-Management and Audit Scheme (EMAS) followed the development of BS 7750. EMAS was adopted by the European Union (EU) in 1993, but it became effective in 1995. The Eco-Management and Audit Scheme (EMAS) is similar to ISO 14001 in its components and requirements (Sulzer, 1999). EMAS was revised in 2001 (Regulation EC 761/2001) and now can be applied across entire organisations. Nevertheless, important distinctions between the two standards remain. Unlike ISO 14001, EMAS requires organisations to produce an environmental statement; it is more rigorous in mandating reductions in environmental impacts to levels not exceeding those corresponding to economically viable applications of best available technology; and it requires organisations to make much more information publicly available, thereby enhancing a facility's transparency.

Appendix 2.2: ISO 14001:2004 REQUIREMENTS

4. Environmental Management System
4.1 General requirements
Has the organisation established, documented, implemented, maintained and continually improved an EMS?
Is there a minimum of 3 months objective evidence to conclude the system is fully implemented and monitored for effectiveness?

4. 2 Environmental policy
Is there an environmental policy, which is identified as such and documented?
does the policy include commitment to:
Continual improvement?
Prevention of pollution?
Compliance with applicable legislative and regulatory requirements?
Other requirements to which the organisation subscribes?
Is it appropriate to the nature, scale and environmental impacts of its activities, products and services?
Does it provide a framework for setting and reviewing environmental objectives and targets?
Is there a practice or procedure to communicate it to all the employees, existing and new and consistently followed?
Did top management approve the current version when it was issued?
Is there a practice or procedure to make it available to the public and is it consistently followed?
Is the procedure periodically reviewed and revised so as to keep it up-to-date?
Is the policy communicated to all employees and other people working there, on behalf of the organisation?

4.3 Planning
4.3.1 Environmental aspects
Is there a procedure to identify environmental aspects of its activities, procedures and services that it can control and influence?
Does it provide determination as to which identified environmental aspects have or can have significant environmental impacts?
Is it ensured that the aspects relating to the significant impacts are considered in setting environmental objectives?
Is the procedure implemented and consistently followed?
Is the procedure periodically reviewed and revised?

4.3.2 Legal and other requirements
Is there a procedure to identify and have access to all:
Government statutory requirements?
Regulatory requirements?
Other legal requirements such as permits, consent order etc?
Other requirements to which is subscribed such as industrial standards, corporate requirements, contracts, customer requirements, agency orders and voluntary initiatives to which is committed?
Does the management and employees have reasonable access to the requirements identified under it?
Is the procedure implemented and consistently followed?
Is the procedure periodically reviewed and revised so as to keep it up-to-date?
Is ensured that the legal and other requirements are taken into account in establishing, implementing

and maintaining the EMS?

4.3.3 Objectives, targets and programme(s)
Are there established, implemented and maintained documented environmental objectives and targets?
Are they at relevant functions and levels?
Are the objectives and targets measurable with the environmental policy, including the commitments to prevention of pollution?
Does the organisation take into account the legal and other requirements to which it subscribes and its significant environmental aspects?
Does the organisation establish, implement and maintain a programme for achieving its objectives and targets?
Does this include the designation of responsibility for achieving objectives and targets at relevant levels?
And does this include the time frame by which they are to be achieved?

4.4 Implementation and operation
4.4.1Resources,roles, responsibility and authority
In each of the environmental functional areas, are the roles, responsibilities and authorities:
Established and implemented?
Maintained and improved?
Documented and communicated?
Understood?
Does management consistently provide resources essential to the implementation and control of the EMS?
Technology?
Do resources include human resources and specialised skills?
Financial resources?
Has top management appointed a specific Management Representative who has defined roles, responsibilities and the authority for:
Ensuring ISO 14001 EMS requirements are established, implemented and maintained?
Reporting on the performance of the EMS to top management for review and as a basis for improvement of the EMS?

4.4.2 Competence, training and awareness
Can the organisation ensure that any person performing tasks on its behalf that have the potential to cause a significant environmental impact is identified by the organisation?
Are the competent on the basis of training, appropriate education or experience?
Are the records of these training/experience and competence retained?
Does the organisation identify training needs associated with its EMS and environmental aspects?
Is there a procedure established, implemented and maintained to make person working for it or on its behalf aware of:
The importance of conformance with its environmental policy and procedures and with the requirements of its management system?
The significant environmental impacts, actual and potential, of their work activities and the environmental benefits of improved personal performance?
Their role and responsibilities in achieving conformance with its environmental policy and procedures and with the requirements of the EMS, including emergency preparedness and response requirements?

The potential consequences of departure from specified environmental related operating procedures?

4.4.3 Communication
Has the organisation established, implemented and maintained an environmental communications procedure relating to its environmental aspects and its EMS that provide for:
Internal communications between various levels and functions of the organisation?
Receiving, documenting and responding to relevant communications from external interested parties?
Is the procedure implemented and consistently followed?
Is it periodically reviewed and revised where needed so to keep it up-to-date?

4.4.4 Documentation
Does the EMS documentation include:
The environmental policy, objectives and targets?
A description of the scope of the EMS
A description of the main elements of the EMS and their interaction and reference to related documents.
Documents, including records, determined by the organisation to be necessary to ensure effective planning, operation and control of processes that relate to environmental aspects?

4.4.5 Control of documents
Is there an established, implemented and maintained procedure for controlling all EMS documents required by ISO 14001 and other requirements relating to the system?
Has the organisation a procedure established, implemented and maintained to:
Approve documents for adequacy prior to issue? Review and update as necessary and re-approve documents?
Ensure that changes and the current revision status of documents are identified?
Ensure that relevant versions of applicable documents are available at points of use?
Ensure that documents remain legible and ready identifiable?
Ensure that documents of external origin determined by the organisation to be necessary for planning and operating of the EMS are identified and their distribution controlled?
Prevent the unintended use of obsolete documents and apply suitable identification to them if they are retained for any purpose?

4.4.6 Operation control
Has the organisation identified those operations and activities that are associated with its identified significant environmental aspects consistent with its environmental policy, objectives and targets, in order to ensure that they are carried out under specified conditions by;
Establishing, implementing and maintaining documented procedures to control the situations where their absence could lead to deviations from the environmental policy and objectives and targets?
Stipulating operating criteria in the procedures?
Establishing, implementing and maintaining procedures related to the identified significant environmental aspects of goods and services used by the organisation and communicating applicable procedures and requirements to suppliers, including contractors?

4.4.7 Emergency preparedness and response
Has the organisation established, implemented and maintained procedures to:
Identify potential for accidents that can have an impact on the environment?

And how it will respond to them?
Does the organisation respond to actual emergency situations and accidents and prevent or mitigate associated adverse environmental impacts?
Does the organisation periodically review and, where necessary, revise its emergency preparedness and response procedures, in particular, after the occurrence of accidents or emergency situations?
Does the organisation test such procedures where practicable?

4.5. Checking
4.5.1 Monitoring and measurement
Has the organisation established implemented and maintained procedures to monitor and measure on a regular basis the key characteristics of its operations and activities that can have a significant impact on the environment?
Do the procedures include requirements for:
Information to monitor performance? Applicable operational controls? Conformance with the defined objectives and targets?
Conformity with the organisation s environmental objectives and targets?
Does the organisation ensure that calibrated or verified monitoring and measurement equipment is used and maintained?
And are the associated records retained?

4.5.2 Evolution of compliance
Are there established, implemented and maintained procedures for periodically evaluating compliance with applicable legal requirements?
Are there records of the results of these periodic evaluations?
Does the organisation evaluate compliance with other requirements to which it subscribes?

4.5.3 Nonconformity, corrective actions
Are there established, implemented and maintained procedures for dealing with actual and potential nonconformities and for taking corrective action and preventive action?
Are the procedures defining requirements for:
Identifying and correcting nonconformities and taking actions to mitigate their environmental impacts?
Investigating nonconformities, determining their cause and taking actions in order to avoid their recurrence?
Evaluating the need for actions to prevent nonconformities and implementing appropriate actions designed to avoid their occurrence?
Recording the results of corrective actions and preventive actions?
Reviewing the effectiveness of corrective actions and preventive actions taken?

4.5.4 Control of records
Does the organisation establish and maintain records as necessary to demonstrate conformity to the requirements of its EMS and of ISO 14001?
Are the results achieved?
Does the organisation establish, implement and maintain a procedure for the identification, storage, protection and retrieval, retention and the disposal of records?

4.5.5 Internal audit
Does the organisation ensure that internal audits of the EMS are conducted on planned intervals to:

Determine whether the EMS conforms to planned arrangements for environmental management including the requirements of ISO14001?
Determine whether the EMS has been properly implemented and is maintained?
Does the organisation ensure that internal audits of the EMS are conducted on planned intervals to provide information on the results of audits to management?
Are audit programmes planned, established, implemented and maintained by the organisation?
Are they taking into consideration the environmental importance of the operations concerned and the results of previous audits?
Are the audit procedures established, implemented and maintained that address:
The responsibility and requirements for planning and conducting audits, reporting results and retaining associated records?
The determination of audit criteria, scope, frequency and methods?
Do the selection of auditors and the conduct of audits ensure objectivity and the impartiality of the audit process?

4.6 Management review
Does top management review the organisation s EMS at planned intervals to ensure its continuing suitability, adequacy and effectiveness?
Do reviews include assessing opportunities for improvement and the need for changes to the EMS, including the environmental policy and the environmental objectives and targets?
Does input to management reviews include:
Results of internal audits and evaluations of compliance with legal requirements and with other requirements to which the organisation subscribes?
Communications from external interested parties, including complaints?
The environmental performance of the organisation?
The extent to which objectives and targets have been met?
Status of corrective and preventive actions?
Follow-up actions from previous management reviews?
Changing circumstances, including developments in legal and other requirements related to its environmental aspects?
Recommendations for improvement?
Do the outputs from management reviews include any decisions and actions related to possible changes to environmental policy, objectives, targets, and other elements of the EMS consistent with the commitment to continual improvement?

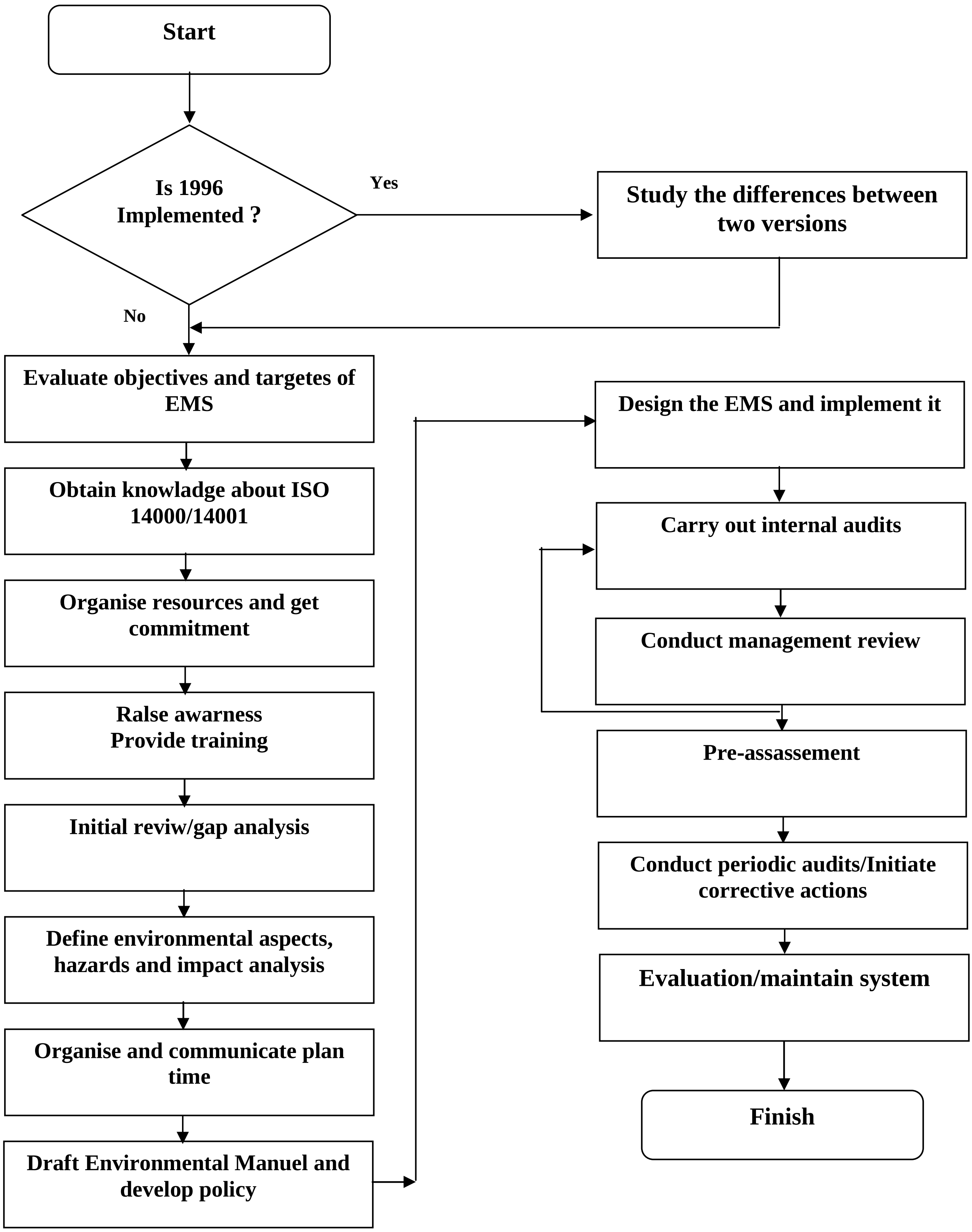
Source: Euromines

Appendix 2.3: ISO 14000 family standards

Standard/ document	Title
ISO 14001:1996	Environmental management systems –Specification with guidance for use
ISO 14001:2004	Environmental management systems – Requirements with guidance for use
ISO 14004:2004	Environmental management systems – General guidelines on principles, systems and support techniques
ISO/CD 14005	Environmental management systems –Guidelines for a staged implementation of an environmental management system, including the use of environmental performance evaluation
ISO 14015:2001	Environmental management –Environmental assessment of sites and organisations (EASO)
ISO 14031:1999	Environmental management – Environmental performance evaluation – Guidelines
ISO/TR 14032:1999	Environmental management – Examples of environmental performance evaluation (EPE)
ISO 14040:2006	Environmental management –Life cycle assessment – Principles and framework
ISO 14044:2006	Environmental management – Life cycle assessment – Requirements and guidelines
ISO/TR 14047:2003	Environmental management –Life cycle impact assessment – Examples of application of ISO 14042
ISO/TR 14049:2000	Environmental management –Life cycle assessment– Examples of application of ISO 14041 to goal and scope definition and inventory analysis
ISO 14050:2002	Environmental management – Vocabulary
ISO/DIS 14050	Environmental management –Vocabulary
ISO/TR 14062:2002	Environmental management – Integrating environmental aspects into product design and development
ISO 14063:2006	Environmental management –Environmental communication –Guidelines and examples
ISO 19011:2002	Guidelines for quality and/or environmental management systems auditing
ISO/WD 26000	Guidance on social responsibility Guidance on social responsibility

Source: Selection and use of ISO 14000 family standards (2009)

Appendix 2.4: The ISO 14000 implementation process flow chart



Source: Euromines

Appendix 2.5: Pearson correlation coefficients

	ISO14	RC	BASIC	SIZE	ISO9	STOCK	DISTANCE	EXPORT	REGION	SEVESO	ENVPROB	RISK
ISO14	1.00	-	-	-	-	-	-	-	-	-	-	-
RC	0.23	1.00	-	-	-	-	-	-	-	-	-	-
BASIC	0.11	0.18	1.00	-	-	-	-	-	-	-	-	-
SIZE	0.44	0.18	-0.03	1.00	-	-	-	-	-	-	-	-
ISO9	0.26	0.27	0.15	0.28	1.00	-	-	-	-	-	-	-
STOCK	0.29	0.16	-0.01	0.08	0.02	1.00	-	-	-	-	-	-
DISTANCE	0.01	-0.08	0.19	0.18	0.15	0.02	1.00	-	-	-	-	-
EXPORT	0.07	0.09	0.15	0.14	0.35	-0.01	0.40	1.00	-	-	-	-
REGION	0.03	-0.19	0.04	-0.03	-0.07	-0.19	0.22	0.39	1.00	-	-	-
SEVESO	0.27	0.35	0.09	0.38	0.13	0.10	0.06	0.04	-0.23	1.00	-	-
ENVPROB	0.09	-0.17	0.01	0.01	0.09	-0.01	0.20	0.20	0.17	0.04	1.00	-
RISK	0.25	0.32	0.07	0.36	0.20	0.14	0.08	0.01	-0.00	0.43	0.16	1.00

Number of observations: 86.

Part II
The Effect of Quality and Environmental Management Tools on Firm Performance

Chapter 3: Do Quality and Environmental Standards Improve Firms' Business Performance?

Chapter 4: From Quality to Innovation: Evidence from two Employer Surveys

Chapter 5: Green Not (only) for Profit: An Empirical Examination of the Effect of Environmental Standards on Employees' Recruitment

Chapter 6: ISO 9000 Standard as a Club Good: Network Effect Evidence

Introduction of the second part

Globalisation of production and markets, severe international competition, the improvement of information flows and the rapid transfer of technology are among the factors that have increased the dynamism of the competitive environment to which firms must respond. The new competitive challenges demand that firms accurately understand market demands, in order that they may better satisfy their customers' needs and continuously anticipate changes in market rules in order to assure their long-term survival. In order to achieve those objectives, it is argued that firms confer increasingly great importance on the adoption of management practices. The main principle of management practices is that firms can attain higher performance while remaining cost competitive by inducing structural changes and by encouraging employee empowerment.

However, despite the expectation that performance improvement will be the result of the implementation of management practices, empirical research presents equivocal findings. While some research demonstrates that the adoption of management practices led to business advantages (*e.g.* Huselid, 1995; Black and Lynch, 2001), other research has not found similar linkages (*e.g.* Cappelli and Neumark, 2001; Staw and Epstein, 2000). One possible reason for these contradictory results could be the broad variety of indicators of the management practices examined across those research papers. This PhD dissertation will overcome the above problem by exclusively focussing on the effect of quality and environmental management practices on firm performance. **Part II** of this PhD dissertation examines whether and how quality and environmental management practices impact on a series of indicators of French firm performance.

The objective of **chapter 3** is to provide an empirical analysis that is likely to inform managers and policymakers as to whether Quality and Environmental Standards may be compatible with objectives other than quality and environmental improvement considerations, respectively. Therefore, we will examine the impact of Quality (QS) and Environmental

Standards (ES) on two key business performance indicators of French firms: the firm's turnover and the firm's profit. Moreover, based on the fact that quality and environmental organisational structures are complementary, this chapter will also provide an empirical answer to the question of whether a firm gains greater business performance improvements from complementarities (synergies), as the result of combining the adoption of Quality and Environmental standards, as compared to a situation when only one of these standards is implemented.

It has been found that the rapid development and diffusion of new technologies has forced firms to be more innovative (Encaoua *et al.*, 2000; Kleinknecht and Mohnen, 2002). And in many firms, barriers to innovation are difficult to overcome without implementing quality practices. Such findings support the argument that quality practices, in both their human and technological dimensions, help to create an environment and culture that supports innovation. Moreover, quality systems allow for better customer orientation, employee involvement, improved leadership, better access to tools, regular meetings and better team spirit, all of which improve innovation performance. **Chapter 4** of this dissertation evaluates the impact of quality on innovation performance. We will analyse different areas of innovation using nine innovation indicators. Additionally, we use three original Quality Levels, based on either ISO certification or additional or complementary certification and we will consider the network of relationships between the firm and its external environment.

An increasing body of work argues that the use of comprehensive employee human resource management (HRM) policies, such as recruitment and selection procedures, may provide a direct and economically significant contribution to firm performance (*e.g.* Huselid, 1995). The assumption behind this is that a more effective organisation of HRM policies is a source of sustained competitive advantage. The aim of **chapter 5** is not to investigate the effect of HRM policies on firm performance but to evaluate whether recruitment (one of the key HRM policies) is enhanced when a firm has adopted Environmental Standards. Such an enhancement would imply that Environmental Standards deliver more than simply environmental benefits and that firms can strategically use these standards to generate win-win opportunities.

Finally, **chapter 6** aims to demonstrate empirically that ISO standards act as a Club Good. There are various studies that consider ISO standards as a Club Good (*e.g.* Potoski and

Prakash , 2005), but to the best of our knowledge, there is no analysis of ISO standards in the context of a network in which firms are either certified or not certified and in which the ties (between the firms) represent an economic relationship. From our point of view, an approach that analyses such a network is important because the production of Public Goods fundamentally induces a network of relationships between different participants. In our case, the advantage of network analysis is that it makes the empirical analysis of ISO as a Club Good more definitive. Indeed, we will try to show that firm productivity varies according to a firm's relative position in a network (*i.e.* a network effect) in order to support the argument that the ISO standard is a Club Good.

Chapter III

Do Quality and Environmental Standards Improve French Firms' Business Performance? [17]

[17] This section is a developed version of the article "Do Quality and Environmental-Related Standards Improve French Firms' Business Performance?" (with Gilles Grolleau and Naoufel Mzoughi) which is submitted.

1. Introduction

Quality and environmental standards have been identified as important factors contributing to the ability of firms to maintain competitive advantage. The significant recognition of these standards has been attributed in great part to their capacity to assure the firm's survival and to effectively align an organisation's key business processes. Hence, during the last two decades, quality and environmental standards have proliferated worldwide what is confirmed by the number of certificates delivered at the end of 2007 for the two 'famous' standards, ISO 9000 and ISO 14000 standards. They have reached more than 950 000 certificates for the former and more than 150 000 for the later (for more details see **chapters 1 and 2**).[18]As we explained previously, a quality standard (QS) is an organisational process involving changes in the fundamental behavior and applied routine of employees that ensures that the quality of goods and services provided by an organisation meets customers' demands and regulatory requirements. An environmental standard (ES) requires that an organisation implements a set of environmental practices and procedures which ensure that risks, liabilities and impacts are properly identified, minimised and managed (Darnall *et al.*, 2000).

The relationship between quality and environmental standards, and economic performance has received an increased attention over the last few years (*e.g.* Benner and Veloso, 2008; Porter and Van Der Linde, 1995). From a theoretical perspective, QS are likely to increase firms' competitiveness by lowering defect rates, reducing cost of quality and increasing productivity, on-time delivery and customer satisfaction. Similarly, organisations implementing an ES are likely to gain competitive advantage by detecting and eliminating inefficiencies in resource use. Porter and Van Der Linde (1995) provide several theoretical rationales and anecdotal evidence (case studies) of how environmental constraints encouraged firms to use resources more efficiently, which resulted in productivity improvement. For instance, properly designed environmental standards can trigger innovations that lower the total cost of a product or improve its value by using inputs more efficiently, eliminating the need for hazardous, hard-to-handle materials and removing unneeded activities. Ultimately, this enhanced *resource productivity* makes companies more competitive. However, it should

[18] The ISO Survey of Certifications 2007 (17th Cycle)

be noticed that several scholars suggest that QS/ES implementation is costly, and as such, decreases firms' competitiveness (Konar and Cohen, 2001; Corbett *et al.*, 2005).

Therefore, the issue of whether QS and ES have a positive or negative impact on business performance (and the level of this influence) is far from being resolved. In **chapter 3,** we empirically investigate the effect of QS and ES on business performance of French firms. Additionally, France is one of leading European countries regarding QS/ES adoption. With 22 981 firms (respectively 3 476) registered according to the ISO 9000 (respectively ISO 14001) standard, French firms rank the fifth (respectively the sixth), behind Italy, Spain, Germany and UK (respectively Italy, Spain, Germany, UK and Sweden).[19] While adding empirical content to the previous literature, providing such an empirical analysis is likely to inform managers and policymakers on whether QS (respectively ES) may be compatible with objectives other than quality (respectively environmental) improvement considerations.

The value added of this chapter is fourfold. First, we study the impact of both quality and environmental standards on firm's business performance. Second, based on the fact that is important to analyse a firm's management practices "not in isolation, but as part of a coherent incentive system" (*e.g.* Kandel and Lazear, 1992; Milgrom and Roberts, 1995), we examine whether quality and environmental standards are more likely to increase business performance when implemented together than when only one of these standards is implemented. Third, we use a cross-sectional database and a larger sample compared to several previous studies. Fourth, we correct bias selection using the matching method.

The remainder of this chapter is organised as follows. Section 2 presents the literature review. The data, the econometric methods used and the main results are provided in section 3. Section 4 concludes and suggests policy implications and future directions.

[19] Source: The ISO Survey of Certifications 2007 (17th Cycle)

2. Literature review

2.1 The impact of quality standards on firm performance

Based on a review of the literature, Benner and Veloso (2008) distinguish two possible sources of performance improvements from ISO 9000 quality management standards. Firstly, the authors argue that performance improvement is expected to arise from improved operational efficiencies that translate directly into cost reductions. Cost reductions are obtained by improved documentation, standardised procedures, learning-by-doing and elimination of defect-free products. For instance, a study by Deloitte and Touche and CEEM Information Services found that the 620 respondents in their survey of ISO 9000 registered firms reported annual cost savings ranging from $25 000 to $600 000, with an average annual savings of $179 000 (Quality Systems Update 1993). A second expected source of performance improvement from adopting ISO 9000 standard comes from increases in revenue as ISO 9000 certified firms are able to access new markets or customers. In order to empirically test their previous arguments, Benner and Veloso (2008) utilise US longitudinal panel data from 650 firms in the automotive supplier industry and conclude that early adopters of ISO 9000 standard have increased their return on assets (ROA), return on sales (ROS) and Tobin's *q*.

Furthermore, Lo *et al.*, (2008) analyse data from 695 US listed manufacturing firms in North America and confirm that being ISO 9000 certified significantly improved the time-based efficiency of a firm's operations. More precisely, firms shortened the number of inventory days (*i.e.* the time required to convert raw materials into products) by 3.68 days one year after ISO 9000 implementation. Moreover, the authors find that ISO 9000 certified firms continued to perform better in terms of attaining a shorter operating cycle by 8.75 days (8.29% shorter) three years after they obtained certification. Hence, they conclude that ISO 9000 adoption improves the material and cash flows in manufacturing supply chains. The performance of shortened account receivable days also suggests that ISO 9000 certified firms could offer better customer service and higher product quality.

Terlaak and King (2006) examined 19 713 US facilities from 232 different manufacturing industries (SIC codes 2011-3999) and state that adoption of ISO 9000 increases sales.

Using US event-study methods from 7 238 manufacturing firms covering the period from 1987 to 1997, Corbett *et al.*, (2005) test whether ISO 9000 certification leads to productivity improvements, market benefits and improved financial performance. The results obtained suggest that a firm's decision to seek its first ISO 9000 certification was indeed followed by significant improvements in firm performance measured by return on assets, return on sales and Tobin's *q* sales, cost of goods divided by sales and sales divided by assets. Additionally, the authors conclude that three years after certification, the certified firms do display significantly improved performance.

Naveh and Marcus's study (2005) investigates the effects of implementing the international standard ISO 9000 on measures of business and operating performance using a survey of 1 150 quality managers in 924 organisations. Based on the literature and a case study, they identified two stages in implementing ISO 9000-(1) Installation, which has two dimensions: (a) external coordination and (b) integration; and (2) Usage, which also has two dimensions: (a) in daily practice and (b) as a catalyst for change. Their analysis indicated that while the installation stage was necessary to successfully implement ISO 9000, organisations achieved a distinct operating advantage from ISO standard when they used it in daily practice. However, they conclude that while implementing the ISO 9000 standard led to improved operating performance, this outcome did not necessarily or automatically yield better business performance.

Exploring the association between ISO 9000 certification and financial performance at the organisational level, Sharma (2005) uses three dimensions of financial performance including operating efficiency, growth in sales and overall financial performance. These dimensions of performance are measured using profit margin, growth in sales and earnings per share, respectively. Based on data for a sample of 70 companies listed on the Singapore Stock Exchange over a 6-year period, the results of the study are consistent with the hypothesized effects, showing that ISO 9000 certification is positively associated with firm's financial performance. In particular, the results show that the extent of improvement is driven largely by operating efficiencies and the authors propose that firms can benefit most from ISO 9000 certification if they are also genuinely interested in the quality philosophy by improving their internal business processes.

Terziovski *et al.,* (2003) also find that the quality audit process for ISO 9000 contributes to improved business performance, using data collected in a cross-sectional study undertaken in Australia. Those organisations that pursue certification willingly and positively across a broad spread of objectives are more likely to report improved organisational performance.

Benner and Tushman (2002) explore the impact of process management activities, such as the ISO 9000 standard, on technological innovation performance exploring 20 year longitudinal data in the paint and photography industries. Drawing on research in organisational evolution and learning, they show that these practices enhance incremental innovation at the expense of exploratory innovation because they reduce variance in organisational routines and influence the selection of innovations. In both industries, ISO 9000 standards were associated with an increase in both exploitative innovations that built on existing firm knowledge and an increase in exploitative innovation's share of total innovations. Significantly, the individual element found to contribute most to business performance was customer focus.

Furthermore, Anderson *et al.,* (1999) find that exports to Europe and elsewhere increase U.S. firms' likelihood of seeking ISO 9000. Observing a sample of 63 electronic firms, Simmons and White (1999) argue that the average profitability of an ISO 9000 registered firm is higher than the average profitability of a non-ISO 9000 registered firm.

On the other hand, comparing the implementation of ISO 9000/1994 and ISO 9001/2000, Martínez-Costa *et al.,* (2009) evaluate their impact on firm performance with a sample of 713 Spanish industrial firms. Based on the mean and covariance structural (MACS) analyses, the authors conclude that ISO 9001/2000 certified companies do not perform noticeably better than ISO 9000/1994 or non-certified companies, which suggests that the ISO standard has no impact on firm performance. These findings are confirmed by a similar study. Indeed, Martinez-Costa *et al.,* (2008) found that ISO 9000 certification in Spanish manufacturing firms (N=700) has little or no explanatory power of the firms' productivity or return on assets.

Surveying 204 firms from a wide range of industries between 1999 and 2002, McGuire and Dilts (2007) found no significant effect of ISO 9000 on the stock market valuation.

In the same vein, documenting stock price performance for a sample of Spanish companies, Martinez-Costa and Martinez-Lorente (2003) applied the methodology of event studies to investigate whether the market interprets the quality registration of a company as a signal of its better future performance. After applying parametric and non-parametric tests, they do not find evidence to affirm that the market values positively ISO 9000 registration.

Examining 800 firms divided into three samples: "certified", "not yet certified" and "non-certified" over a period of five years (1995-2000), Heras *et al.,* (2002) have analysed the differences in their sales growth and profitability. They find no evidence to support any causal link between ISO 9000 registration and improvements.

Lima *et al.,* (2000) examined data from 129 Brazilian firms in the manufacturing industry on five return indicators (operating income on total assets, net income on total assets, sales to total assets, operating income to sales and net income to sales) and state that no differential levels of performance can be detected between certified and non-certified firms. Furthermore, this result is sustained even when the authors compare sub-groups characterised by type of certification (9001 or 9002) or by year of certification.

Analysing manufacturing companies in Australia (N=962) and New Zealand (N=379), Terziovski *et al.,* (1997) have evaluated the impact of ISO 9000 certification on firms' organisational performance, using the following indicators: customers' satisfaction, employees' moral, cost of quality, delivery in full on time, defects rates, warranty costs, productivity, cash flow, employee growth, market share growth, sales growth, export growth and innovation. They found that only cash flow significantly increases with certification. This supports the view that on average ISO 9000 certification has little or no explanatory power on organisational performance.

2.2 The impact of environmental standards on firm performance

As regards the impact of environmental standards on business performance, previous empirical studies are scarcer and also offer mixed results. These mixed results highlight the complex nature of the link between environmental and business performance (Corbett and Klassen, 2006). For instance, using survey data from more than 1 000 manufacturing facilities in Canada, Germany, Hungary and United States, Darnall *et al.*, (2008) present empirical evidence inducing that facilities which adopt more comprehensive environmental management systems can improve profitability and growth.

Drawing on data provided by a survey of North American managers, which details their attitudes toward EMS and ISO 14001, the study of Melnyk *et al.*, (2003) assesses the effects of having a formal but uncertified EMS compared to having a formal, certified system. The results strongly demonstrate that firms in possession of a formal EMS perceive that it has a positive impact on many dimensions of operational performance. The results also show that firms that have gone through EMS certification experience a greater impact on performance than firms that have not certified their EMS.

In a study of U.S. based multinational firms, Dowell *et al.*, (2000) argue that firms adopting a single stringent global environmental standard have much higher market values, as measured by Tobin's *q*, than firms defaulting to less stringent or poorly enforced host country standards.

After controlling for variables traditionally thought to explain firm level financial performance, Konar and Cohen (2001) underline that bad environmental performance - measured by the aggregate pounds of toxic chemicals emitted per dollar revenue of the firm and the number of environmental lawsuits pending against the firm - has a significant negative effect on the market value for US publicly traded firms (N=321).

Khanna and Damon's research (1999) shows that firms' participation to the voluntary program 33/50 has a negative impact on their current return on investment, but a positive effect on long-term profitability. Their evidence is based on examination of 12 463 facilities in the US chemical industry.

Russo and Fouts (1997) posit that environmental performance and economic performance are positively linked. They tested the hypothesis on a sample of 243 firms over a two year period. Using independently developed environmental ratings (based on compliance records, abatement expenditures, support for environmental NGOs, etc), the authors' results indicate that "it pays to be green", confirming that environmental performance influences a firm's economic performance as measured by return on assets.

Working with 127 firms from the Standard and Poor's 500 list of corporations (S&P 500), Klassen and McLaughlin (1996) prove that environmental systems have a positive impact on financial performance measured by stock prices.

Hart and Ahuja (1996) claim that that efforts to reduce emissions through pollution prevention have a positive impact on both operational and financial performance. They suggest that efforts associated with pollution prevention benefits operating performance (return on sale and return on assets) in the following year, whereas it takes about two years for financial performance improvement (return on equity, ROE) to feed through.

In contrast to the above arguments, the traditional economic view suggests that any environmental improvement made by a firm transfers costs previously incurred by society back to the firm (McGuire *et al.,* 1988). Hence, it is suggested that compliance with environmental regulations incurs significant costs, which reduces a firm's capacity to compete. In addition, this traditional view responds to the claims made by the supporters of 'the Porter Hypothesis' by arguing that although cost savings can easily be obtained with a number of simple prevention measures, the most ambitious prevention measures may involve costs that exceed the savings to be derived from them.

In this vein, using a panel data set covering 37 plants over the period 1997-2003 in Quebec's pulp and paper industry, Barla (2007) shows rather disappointing evidence for the effectiveness of ISO 14001. While discharges of biological oxygen demand emissions slightly decline following certification, the author does not find any significant change in total suspended solids emissions or in the quantity of rejected process water.

The study of Link and Naveh (2006) sought to determine if the environmental management standard ISO 14001 helps organisations reduce the negative impact their business activities may have on the environment, and as a result, also improves their business performance. Analysis of 40 firms did not reveal any support for the hypothesis that achieving improvement in environmental performance as result of ISO 14001 implementation leads to better business performance.

Moreover, Cormier *et al.,* (2005) investigate the impact of environmental reporting on the relationship between a firm's earnings and its stock market value. To assess how country-specific contexts may affect the impact of environmental reporting, they focus on firms from Canada, France and Germany, three countries that employ different reporting and governance regimes. Results suggest that decisions to report environmental information have a moderating impact on the stock market valuation of a German firm's earnings. In contrast, environmental reporting does not significantly influence the stock market valuation of the earnings of Canadian and French firms.

Similarly, using an event study methodology on a sample of 71 announcements of corporate environmental initiatives, Gilley *et al.,* (2000) investigate the influence of environmental initiatives on firms' anticipated economic performance. The authors propose that, due to the potential positive effects of these initiatives on firm performance (through increases in reputation), shareholders will react positively to announced environmental initiatives. Contrary to their hypothesis, they found no overall effect of announced environmental initiatives on stock returns.

Studying European, North American and Japanese transnational corporations operating in the US, Levy (1995) finds no evidence concerning a relationship between reductions in TRI emissions and changes in returns on assets or sales, or in the growth rate of sales.

2.3 Complementarities, quality and environmental standards

Based on the literature review on Quality and Environmental Management standards, one may conclude that those two standards have common implementation practices such as leadership, training and permanent self-assessment, and improvement. Therefore, firms that have previous experience with one of those two standards are expected to incur lower additional costs (*e.g.* through the overlap of documentation requirements, avoiding duplication of effort, the alignment of goals, processes and resources, the reduction in the costs of internal and external audits, and the availability of joint training and improved communication between all organisational levels) because of learning by doing and scale economies (Grolleau *et al.,* 2007). On the other side, although these organisational schemes have a similar architecture, quality standards aim to improve quality and firms business objectives, whereas environmental standards aim to improve environmental performance and firm relationships with not only market actors, but also non-market actors (Delmas and Montiel, 2008). Furthermore, ES include some complementary aspects leading to good operations which are not included in QS (Corbett and Kirsch, 2001). For instance, key benefits of adopting ISO 14001 by the multinational Dole Food Co. Inc. included strong employee motivation and loyalty, reduced absenteeism and improved workforce productivity.[20]

Therefore, having both quality and environmental practices creates a complementary effect which implies that the magnitude of the performance effect of two or more management practices is larger than the sum of the marginal effects from adopting only one practice (Ichniowski *et al.,* 1997) because of the synergistic effects of bundling practices together. Actually, Milgrom and Roberts (1995) define complementarities as the relationship between two or more activities entailing that "doing more of any one of them increases the returns to doing more of the others". In this sense, complemetarity theory suggests that firms are likely to combine a consistent set of practices and that the returns to such a full configuration of activities are greater than the sum of the individual returns (Whittington and Others, 1999).

However, there is a gap in the literature concerning complementary effect of both quality and environmental standards on firm performance.

2.4 Hypotheses development

In this chapter, we intend to analyse the effects of QS and ES on business performance. Following the above arguments we explore the two following hypotheses:

[20] Anonymous, 2001, Dole Reports Motivation, Health and Safety, and Productivity Benefits from ISO 14001, ISO Management Systems –The International Review of ISO 9000 and ISO 14000, December, 56-58 (http://www.staratel.com/iso/ISO/ISO900014000/articles/pdf/casestudy_2-01.pdf).

H1: Quality and environmental standards improve a firm's business performance, ceteris paribus.

Based on the fact that the adoption of individual management practices may be expected to influence business performance positively, the adoption of two or more complementary practices could be expected to affect business performance much more strongly. Consequently, we hypothesize that:

H2: Because of their complementarity effect, quality and environmental standards are more likely to increase business performance when implemented together than when only one of these standards is implemented, ceteris paribus.

3. Empirical Analysis

3.1 The database

The data used in this chapter is extracted from the French Organisational Changes and Computerisation survey (Changement Organisationnel et Informatisation, COI) from 2006, which is explained in detail in **chapter 1**. [21] While the survey questionnaire was not originally designed to investigate our question, it offers an unexpected opportunity to investigate on a large number of firms whether being registered for quality or environment standards contributes to successful improvement of firms' business performance. The statistical analysis of this chapter uses a data set of up to 10 100 observations in 11 sectors of activity. The definition of variables used for descriptive statistics and estimation is presented in Table 3.1.

[21] More details about the design and scope of this survey are available on www.enquetecoi.net. Survey COI-TIC 2006-INSEE-CEE/Treatments CEE.

Table 3.1: Definition of variables

Variable	**Definition**
Dependent variables	
TURNOVER	Logarithm of turnover per employee Continuous variable
PROFIT	Logarithm of profit per employee Continuous variable
Independent variables	
QS	Firm registration for ISO 9000, EAFQ, etc. Dummy variable (=1 if registered in 2006)
ES	Firm registration for ISO 14000, organic labeling or fair trade Dummy variable (=1 if registered in 2006)
QSES	Firm registration for both a QS and ES Dummy variable (=1 if registered in 2006; =0 if registered for only one kind of standard)
SIZE	Size of the firm SMALL (20 TO 49 employees) SMEDIUM (50 TO 199 employees) MEDIUM (200 TO 499 employees) BIG (more than 500 employees)
GROUP	Belonging to a group Dummy variable (=1 if yes)
NETWORK	Belonging to a network of firms Dummy variable (=1 if yes)
EXPORT	Share of firm exportation by turnover (Continuous variable)
RELOCATION	Relocation abroad of a part of the business Dummy variable (=1 if yes)
CUSTOMER1	Customer's demands for product and service certificates (French NF label, QUALICERT, etc) Dummy variable (=1 if yes)
CUSTOMER2	Customer's demands for a contract to assure delivery timeless Dummy variable (=1 if yes)
ACTIVITY	The main activity of the firm 11 dummy variables (=1 if agrifood, consumption goods, cars and equipments, intermediate goods, energy, construction, commercial, transport, financial and real-estate activities, services for firms and services for individuals, respectively)

The sectors are considered according to the French nomenclature.
Source: Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample 10 100 firms.

Noteworthy, our two dependent variables, namely *TURNOVER* and *PROFIT,* present firm business performance indicators.

Descriptive Statistics

We remark from Table 3.2 that the characteristics of quality and environmental registered firms are generally similar. Concerning firm size we notice that higher percentage of big firms firms are also environmentally registered (34%) whilst “only” 19% of quality registered firms belong to the same size category.

Furthermore, 43 % (respectively 31%) of firms in the category *SMALL* adopt quality standards (respectively environmental standards). The evidence indicates that a slightly lower proportion of quality registered firms are a part of a larger concern (65%) compared to those that are environmentally registered (71%).

Contrary to previous findings, we may conclude that a higher percentage of firms that are quality registered (89%) belong to a network as compared to environmentally registered firms (85%).

Interestingly, 89% of firms in our sample implement both quality and environmental standards. Furthermore, we may notice that environmentally-oriented firms have a slightly higher level of exports than quality-oriented firms. When we look at the variable *RELOCATION*, we may conclude that firms that adopt quality or environmental standards do not relocate their business abroad to a great extent. More precisely only 6% (respectively 10%) of quality (respectively environmentally) registered firms relocate their business abroad.

We observe that both types of firms (quality and environmental adopters) are very concerned about customer demand for product and service quality certificates such as French NF label (Eco-label), QUALICERT, etc. Actually about 70% of quality and environmental adopters provide their customers with quality certificates. Therefore, this finding may imply that significant number of customers are more likely to consider that the supplier’s quality will influence their quality in the global supply chain.

On the other hand, only around 20% of quality and environmental certificated firms are concerned about customer demand for a contract that assures on-time delivery.

Table 3.2: Descriptive Statistics

	QUALITY STANDARDS	ENVIRONMENTAL STANDARDS
	Company's Size	
SMALL	43% (a)	31%
SMEDIUM	26%	21%
MEDIUM	12%	14%
BIG	19%	34%
	Corporate status	
GROUP	65%	71%
NETWORK	89%	85%
	Previous experience	
QS/ES	87%	
	Mean export by firm's turnover	
EXPORT	0.13	0.18
	Relocation	
RELOCATION	6%	10%
	Customer's demands	
CUSTOMER1	70%	71%
CUSTOMER2	22%	17%
Total	**60%**	**29%**

Source: Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample 10 100 firms, weighted by the number of employees.
Lecture: (a) 43% of "Quality Adopters" are firms that belong to category of small firms.

3.2 Estimation strategy

To measure business performance, we use two continuous variables: the firm's turnover (denoted TURNOVER) and profit (denoted PROFIT) in 2006. To test the above-mentioned hypotheses, we use the binary variables denoted QS, ES and QSES. QS is equal to 1 if the firm was registered according to a quality standard such as the ISO 9001 standard and French quality standard EAQF in 2006. ES is equal to 1 if the firm was registered according to ISO 14001 standard, organic labeling or fair trade, in 2006.[22] QSES is equal to 1 if the firm had both a quality and environmental standards in 2006 and 0 if it was registered according to only one of them.

[22] Unfortunately, we cannot distinguish between these standards, since they were put together under the same name in the survey. Threfore, we cannot estimate the specific effects of each program.

Our attempt to verify empirically our two hypotheses raises a problem because we would like to know the difference between a firm's performance with and without the QS/ES. Evidently, we can not observe both outcomes for the same firm at the same time. Taking the mean outcome of non-participants (*e.g.* non-QS/ES adopters) as an approximation is not advisable, since participants and non-participants usually differ even in the absence of treatment (*e.g.* quality standard).

Moreover, firms that adopt QS/ES or both of them can make the object of a non-random selection process as it may depend on a firm's individual characteristics (*e.g.* size, sector, etc). This induces a selection bias. Actually, we suppose that a firm adopting QS/ES or both standards has a particular need or it is subjected to specific conditions which can explain implementation of these standards.

Consequently, adoption of QS/ES or both standards is not necessarily independent of firm's business performance. To circumvent the selection bias, we estimate evaluation models with matching estimators. To address this problem, we use a propensity score matching method. It was initially developed by Rubin (1974) in order to study the efficiency of medical treatments, but empirical examples can be found in very diverse fields of study. It applies for all situations where one has a treatment, a group of treated individuals and a group of untreated individuals. Its basic idea is to find in a large group of non-participants those individuals who are similar to the participants in all relevant pre-treatment characteristics X . That being done, differences in outcomes between this well selected and thus adequate control group and actual participants can be attributed to the programme.

Let us note T, a binary variable indicating if the individual received or not a treatment (T=1 if the individual is treated, T=0 if not). In our case, the treatment will be quality or environmental standards certification or having both standards. We will consider three models of comparison:

- *In Model 1*, T = 1 if the firm is QS registered and T = 0 if the firm is not QS registered (neither ES).
- *In Model 1*, T = 1 if the firm is ES registered and T = 0 if the firm is not ES registered (neither QS).

- *In Model 3*, T = 1 if the firm has both QS and ES and T = 0 if the firm has only one standard, QS or ES.

In order to perform our econometric strategy and correct for selection bias, we will create three samples. For instance, in the *Model 1*, we will eliminate firms that have environmental standards or both quality and environmental standards. Hence, we will work with a sample in which we compare firms that are only QS registered and firms that have no other type of standards (QS, ES or both of them).

The efficiency of the treatment is measured via business performance indicators: logarithm of turnover per employee and logarithm of profit per employee, noted as $BUSINESS$. Thus each firm has two potential results: $BUSINESS_0$ (if T=0) and $BUSINESS_1$ (if T=1).

However, as we note previously, if firms are quality or environmentally certified, we can only observe their business performance in this case and not in the case of absence of quality or environmentally certification. In other words, in practice, only the results of the current quality or environmentally situation are observable for each firm and business outcomes that would have resulted from different strategies need to be estimated. This is precisely what propensity matching methods are intended to do.

Following Rubin (1974), the difference between the impact of a firm with QS/ES/QES and what the impact would be if a firm did not have QS/ES/QES is noted $C = BUSINESS_1 - BUSINESS_0$. The individual treatment effect is unobservable, and consequently its distribution is not identifiable. If the property of independence is respected $(BUSINESS_0, BUSINESS_1) \perp T$, there would be no selection bias.

Thus three quantities are of interest to us: $C = E\left[BUSINESS_1 - BUSINESS_0\right]$ is the average treatment effect over the whole population, $C_1 = E\left[BUSINESS_1 - BUSINESS_0 \middle| T = 1\right]$ is the average treatment effect over treated firms and $C_0 = E\left[BUSINESS_1 - BUSINESS_0 \middle| T = 0\right]$ is the average treatment effect over non-treated firms. For each dependent variable, we will estimate the quantities C , C_1 and C_0 . Our discussion will be focused on the average treatment effect over treated firms.

Moreover, in order to estimate the treatment effect of quality or environmental standards inside the firm, we have to construct for each treated firm a counterfactual from firms in the non treated population. The results of Rosenbaum and Rubin (1983) help in constructing a group of counterfactual firms with a propensity score. The propensity score constitutes a one-dimensional summary of a set of observable characteristics and it predicts the probability of being exposed to the treatment.

The counterfactual group could, for instance, be composed of firms that are identical to the treated firm, with respect to the set of observable background characteristics such as size, industry, features of the firm's strategy and external constraints. The procedure was extensively studied by Heckman and his co-authors in a series of papers where the matching principle is extended through *kernel* or *nearest neighbour* techniques to provide a non parametric estimate of the treatment effect given the value of the propensity score (Heckman *et al.,* 1997, 1998).

We will use a non parametric *Kernel* matching estimator that use weighted averages of all individuals in the control group to construct the counterfactual outcome.

Thus, one major advantage of these approaches is the lower variance which is achieved because more information is used. Weighting depends on the distance between each individual from the control group and the participant observation for which the counterfactual is estimated. The estimated intercept provides an estimate of the counterfactual mean. In our case, the business performance outcome of this counterfactual firm is a weighted average of the outcome of the comparison group members.

More precisely, for a given firm, the weighting coefficients used to construct the counterfactual firm depend on the distance between the firm's score and the score of each firm of the comparison group. Kernel matching estimator takes the following form:

$$C=\frac{1}{N_1}\sum_{i\in I_1}\left\{y_i-\sum_{j\in I_0}\frac{K\left[\left(P(X_j)-P(X_i)\right)/h\right]}{\sum_{j\in I_0}K\left[\left(P(X_j)-P(X_i)\right)/h\right]}y_j\right\} \tag{1}$$

where N_1 presents the number of treated, K is the kernel function, h is the estimation bandwidth, I_1 is the sample of treated and I_0 is the sample of non-treated, $P(X)$ are values estimated by propensity score. The literature shows that the choice of kernel has, generally, no influence on results (DiNardo and Tobias, 2001), among different *kernel function*, we use the function G by Epanechnikov:

$$G\left(\left(\mathrm{P}\left(\mathrm{X_j}\right)\text{-}\mathrm{P}\left(\mathrm{X_i}\right)\right)/h_j\right)=3/4\left(1-\left(\left(\mathrm{P}\left(\mathrm{X_j}\right)\text{-}\mathrm{P}\left(\mathrm{X_i}\right)\right)/h_j\right)^2\right) \quad \text{if} \quad \left|\left(P(X_j)-P(X_i)\right)/h_j\right|\le 1 \text{and}$$

$$G\left(\left(\mathrm{P}\left(\mathrm{X_j}\right)\text{-}\mathrm{P}\left(\mathrm{X_i}\right)\right)/h_j\right)=0 \text{ otherwise.}$$

Contrary, the choice of the bandwidth parameter is seen as very important (Silverman, 1986; Pagan and Ullah, 1999; Caliendo and Kopeinig, 2008). High bandwidth-values yield a smoother estimated density function, therefore leading to a better fit and a decreasing variance between the estimated and the true underlying density function.

On the other hand, underlying features may be smoothed away by a large bandwidth leading to a biased estimate. The bandwidth choice is therefore a compromise between a small variance and an unbiased estimate of the true density function. In this chapter we use, Silverman's bandwidth that is defined in the following way: $h_j = 1{,}364 * 15^{1/5} * \sigma_{S_j} * n_j^{-1/5}$ where σ_{S_j} represents the standard error of the propensity score for the control group and n_j the number of firms inside the control group.

In order to confirm that our results are not too much sensible on the choice of bandwidth value, we implement specific test of robustness establishing different values on bandwidth value, in our case between 0.01 and 0.457. For example, whatever the value of estimated bandwidth, variable *QS* has always positive and significant impact (significant at 1%) on the logarithm of turnover per employee.

In order to construct the counterfactuals, we estimate a Logit model of being QS or ES registered (*H1*) and QES registered (*H2*), and derive the corresponding propensity score (PS). Important to mention, Logit and Probit models usually yield similar results.

3.3 Determinants of the QS, ES and QES

As it is indicated previously, in the first step of PS-matching, we estimate the probability that a firm adopts a quality or environmental standard or both. Noteworthy, we work on the three different samples. In the first sample, we compare firms that have quality standards versus firms that do not have quality standards but also do not have environmental or both quality and environmental standards.

In second sample we compare firms that have adopted environmental standards with firms that do not have any other type of standards (quality, environmental standards or both). Finally, in the third sample we compare firms that have both quality and environmental standards with firms that have only one standard, quality or environmental standard.

We use the following background characteristics: main activity of the firm, firm size, belonging to a group or a network, export, relocation and customers' demands. A justification for introducing these variables could be found in previous literature devoted to the adoption of quality and environmental standards (*e.g.* Nakamura *et al.*, 2001; Terlaak and King, 2006; Grolleau *et al.*, 2007; Prakash, 2008).

Logit estimation results are presented in Tables 3.3, 3.4 and 3.5 together with goodness-of-fit measures (Maximum-Likelihood estimation). Several versions of the model have been estimated to investigate the robustness of results to the omission of some variables. The main results remain unchanged. No problem of multicolinearity has been detected (Appendix 3.3).

The first group of variables that we have utilised is the sector of activity. We have used 11 sectors of activity and as a reference the sector of intermediate goods. As suggested by the literature, we found that the probability of quality or environmental standards adoption depends on sector of activity. For instance, firms in the construction sector are more likely to adopt quality standards, while belonging to the energy sector increases the probability of environmental standards adoption and also the adoption of both standards.

The variables *SIZE* and *RELOCATION* are significant for the three models, which is consistent with previous studies (Grolleau *et al.*, 2007; Terlaak and King, 2006; Grolleau and Mzoughi, 2005). Based on the fact that quality and environmental standards implementation demands significant investment costs, big firms are in an advantageous position, since they can spread these costs over more units of output.

Several factors can explain why relocation affects the adoption of quality and environmental standards. For example, achieving scale economies by applying the same standard across all production units and not needing to relocate in less quality-oriented or pollution havens can drive firms to adopt quality or environmental standards (Grolleau and Mzoughi, 2005). Belonging to a group (*GROUP*) has a positive impact on firms that have both quality and environmental standards or firms that have only a quality standard.

As we note in **chapter 1**, firms that are part of a group more easily share better information and bear less risk in adopting management practices, which in turn may reduce the costs of searching for necessary quality or environmental information. Furthermore, we find similar results as Grolleau and Thomas (2007) concerning the effect of the firm's corporate structure on adoption of the environmental standards.

Actually, the variable *GROUP* has no influence on the environmental standards implementation. Interestingly, the variable *NETWORK* is not significant for the first and third models, but has a negative effect on adoption of environmental standards. This could be explained by the fact that firms that belong to a network are in a less advantageous position concerning the time needed for implementation.

Moreover, firms exporting a part of their products abroad would adopt both quality and environmental standards or only a quality standard. Hence, from a signaling perspective, quality and environmental standards may provide information on the general capability of a supplier to meet the quality and environmental expectations of the customer, and make unobservable characteristics public.

Surprisingly, the variable *EXPORT* has no impact on environmental standards adoption. A possible explanation of this result is that foreign customers consider French firms to be as effective as their domestic producers in terms of quality and environmental issues, making ES/QS playing a weaker role as a market signals.

The variable *CUSTOMER1* has a positive effect on quality standards adoption, decreases the probability of adopting both quality and environmental standards, but has no effect on environmental standards adoption. This result can be explained by the fact that, for quality standards, the main requirements are defined by customers themselves.

Finally, the variable *CUSTOMER2* has a positive and significant impact on adoption of environmental standards only. These results should be considered with some precaution, since we had to eliminate a great number of firms in order to compare firms that have only environmental standards *versus* those with no standard at all.

Table 3.3: Determinants of choosing Quality Standards

		QS	
Variables		Estimate	z-value
Intercept		-1.93	-12.52
SIZE	SMEDIUM	0.42***	5.32
	MEDIUM	0.99***	10.56
	BIG	1.20***	14.53
GROUP		0.54***	8.56
NETWORK		-0.11	-1.20
EXPORT		0.37***	5.79
RELOCATION		-0.08	-0.58
CUSTOMER1		2.11***	20.48
CUSTOMER2		0.92***	9.16
AGRIFOOD		-0.43***	-3.19
CONSUMPTION GOODS		-1.55***	-11.69
CARS AND EQUIPMENTS		0.17	1.30
ENERGY		0.64	1.27
CONSTRUCTION		0.25*	1.93
COMMERCIAL		-0.89***	-8.04
TRANSPORT		-1.05***	-8.81
FINANCIAL AND REAL-ESTATE ACTIVITIES		-0.44**	-2.05
SERVICES FOR FIRMS		-0.83***	-7.88
SERVICES FOR INDIVIDUALS		-1.51***	-8.44
Max Rescaled R2		0.34	
-2 log L		7838.999	
-2 log L (Intercept only)		9981.009	
Likelihood ratio		2142.0104	
Percent concordant		79.9	
Number of observations		7 217	
Number of registered firms		3 401	

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.
Sector reference: INTERMEDIATE GOODS.

Table 3.4: Determinants of choosing Environmental Standards

		ES	
Variables		Estimate	z-value
Intercept		-2.20***	-6.31
SIZE	SMEDIUM	0.07	0.30
	MEDIUM	0.56**	2.29
	BIG	0.88***	4.26
GROUP		0.05	0.33
NETWORK		-0.82***	-4.64
EXPORT		-0.19	-1.12
RELOCATION		1.21***	4.65
CUSTOMER1		0.26	1.22
CUSTOMER2		-0.33**	-1.78
AGRIFOOD		0.51	1.48
CONSUMPTION GOODS		-0.41	-1.24
CARS AND EQUIPMENTS		-14.87	-0.89
ENERGY		1.96***	2.25
CONSTRUCTION		-2.59***	-2.49
COMMERCIAL		-0.24	-0.79
TRANSPORT		-0.94***	-2.42
FINANCIAL AND REAL-ESTATE ACTIVITIES		-0.53	-1.04
SERVICES FOR FIRMS		-0.97***	-2.85
SERVICES FOR INDIVIDUALS		-0.32	-0.88
Max Rescaled R2		0.11	
-2 log L		1612.952	
-2 log L (Intercept only)		1782.844	
Likelihood ratio		169.8921	
Percent concordant		73.4	
Number of observations		4 049	
Number of registered firms		233	

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.
Sector reference: INTERMEDIATE GOODS.

Table 3.5: Determinants of choosing both, Quality and Environmental standards

		QSES	
Variables		Estimate	z-value
Intercept		-0.98***	-5.24
SIZE	SMEDIUM	0.05	0.40
	MEDIUM	0.54***	4.41
	BIG	1.43***	12.94
GROUP		0.30***	3.69
NETWORK		0.03	0.25
EXPORT		0.40***	5.35
RELOCATION		0.40***	4.05
CUSTOMER1		-0.28**	-2.18
CUSTOMER2		-1.08***	-8.00
AGRIFOOD		-0.51***	-4.72
CONSUMPTION GOODS		-0.79***	-5.62
CARS AND EQUIPMENTS		0.02	0.19
ENERGY		1.77***	6.89
CONSTRUCTION		-0.32***	-2.62
COMMERCIAL		-0.67***	-5.82
TRANSPORT		-1.19***	-8.55
FINANCIAL AND REAL-ESTATE ACTIVITIES		-1.04***	-3.36
SERVICES FOR FIRMS		-1.12***	-10.71
SERVICES FOR INDIVIDUALS		-0.35*	-1.73
Max Rescaled R2		0.26	
-2 log L		7218.836	
-2 log L (Intercept only)		8556.755	
Likelihood ratio		1337.9194	
Percent concordant		75.3	
Number of observations		6 284	
Number of registered firms		2 650	

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.
Sector reference: INTERMEDIATE GOODS.

3.6 Discussion of the results

In the second step of PS-matching, we compute the so-called ‘causal’ estimator of the effect of both practices on the business performance. As it is common, we introduce only significant variables in the second step. PS-matching estimates are presented in Table 3.6.

Looking at the results (Table 3.6), it can be seen that the implementation of effective QS and ES may improve firm business performance, although some aspects of performance may be improved more than others. The findings provide empirical evidence that quality and environmental standards improve firm turnover but have no effect on profit, which partly supports hypothesis H1. Actually, we may conclude that adoption of quality standards increases firm turnover by 6% while implementation of environmental standards improves firm turnover by 18%. Hence, the evidence supports our view that quality and environmental standards influence different performance variables to differing extents.

Furthermore, hypothesis H2 is also supported, since the two dependent variables, that is, *TURNOVER* and *PROFIT*, are positive and significant (Table 3.6). In other words, having both standards is more beneficial to the firm, in terms of turnover and profit increase, than having only one kind of standard. More precisely, these results suggest that by adopting both quality and environmental standards, firms raise their turnover per employee by 15%. In the same vein, having both standards improves profit per employee by 21%.

Therefore, separate and joint quality and environmental certification exert a heterogeneous influence in terms of intensity and direction. This leads us to the conclusion that in order for firms to achieve maximum impact across different business performance measures they have to adopt both quality and environmental standards.

Finally, in order to appreciate the importance of the selection bias we can compare the results to the naïve estimates (Table 3.6, last column).

In general, the figures obtained from naïve estimates are often higher than those obtained from the PS-matching results. For example, the mean difference in terms of logarithm of profit per employee between Quality Adopters and Non Adopters is 0.27 (significant at 1%) while this difference is not significant for PS estimator.

Table 3.6: PS-matching estimates – QS/ES/QES Impacts on Business Performance (a)

	Global	**Treated**	**Non-treated**	**Difference of Mean (b)**
	Logarithm of turnover per employee			
QS	0.09***	0.06**	0.12***	0.10***
ES	0.20***	0.18***	0.20***	0.35***
QSES	0.14***	0.15***	0.14***	0.29***
	Logarithm of profit per employee			
QS	-0.01	0.01	0.02	0.12***
ES	0.04	0.11	0.04	0.32***
QSES	0.24***	0.21***	0.26***	0.52***

Bootstrapped standard errors
The regression integrates 11 indexes of industries (reference: INTERMEDIA GOODS).
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively.
(a) The supports are available in Appendix 3.2.
(b) The supports are available in Appendix 3.1.

4. Concluding remarks

Using a propensity score matching method, this chapter offers a refined analysis of the link between QS/ES and business performance among French firms. First, we have shown that quality and environmental standards contribute to the improvement of French firms' business performance, by increasing their turnover but not profit. This result offers additional empirical support to the theoretical arguments stating that QS/ES may allow adopting firms to enhance their competitiveness. Moreover, the results are also complementary to previous literature on QS/ES adoption (see Halkos and Evangelinos, 2002 and references therein) according to which increasing business performance and competitiveness considerations are important drivers of QS/ES registration and can explain the large diffusion of such standards. Our findings support, to some extent, the predictions of the 'extended' Porter hypothesis (Porter and Van Der Linde, 1995) -which predicts that well-crafted environmental voluntary approaches may increase both environmental and economic performance – and extends it to quality considerations. The evidances are consistent with the positive effects attributed to ISO 14001 on the management of human resources found by several case studies in French firms (Phanuel, 2001; Berger-Douce, 2002). Indeed, our estimation results suggest that managers, regulators and promoters of QS (respectively ES) may consider the implementation of such standards as a win-win strategy, that is, not only as a tool of quality (respectively environmental) improvement, but also a leverage to increase firms' business performance and hence competitiveness.

Second, we have shown that quality and environmental standards are more likely to improve business performance when implemented together than when only one of these standards is implemented. As we indicated previously, the findings reveal that an increase in a firm's turnover and profit of 15% and 21%, respectively, resulting from the adoption of both quality and environmental standards. This result points out the synergy between ES and QS. In line with previous economic literature (*e.g.* Milgrom and Roberts, 1995), this result suggests that complementarity among different organisational innovations can lead to better business performance. Additionally, in terms of profit and turnover increase, firms could have vested interest in implementing both standards that have public attributes and those which are mainly privately-oriented. From the public authorities' point of view, it would be also more effective to encourage and help firms to implement both quality and environmental standards in order to increase the competitiveness of their fellow firms.

Nevertheless, although we have offered empirical evidence to the positive effect of QS/ES on firms' business performance, we have not identified the mechanisms by which business performance is enhanced, that is, whether firms increase their turnover and profits because of efficiency gains, better human resource management, etc. The identification of such mechanisms could add fruitful result to our contribution. Moreover, investigating additional dimensions of business performance other than turnover and profit, and assessing whether the positive effects are sustainable constitute interesting extensions. Furthermore, we have considered firms that were yet registered according to QS and ES in 2006, regardless of the date of registration and have tested our hypothesis on French firms only. Taking into account these temporal considerations and considering an international setting may also constitute a challenging extension for future research and provide a way to examine these associations more rigorously in terms of causes.

APPENDICES CHAPTER III

Appendix 3.1: Mean of Business Performance

Appendix 3.2: Supports of the PS-matching estimates

Appendix 3.3: Pearson correlation coefficients

Appendix 3.1: Mean of Business Performance

	QUALITY STANDARDS	ENVIRONMENTAL STANDARDS	QUALITY/ ENVIRONMENTAL STANDARDS
LOGARITHM OF TURNOVER PER EMPLOYEE	5.05	5.31	5.35
LOGARITHM OF PROFIT PER EMPLOYEE	1.31	1.75	1.84

Source: Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample 10 100 firms

Appendix 3.2: Supports of the PS-matching estimates

Table A: Quality registered firms vs Non Quality registered firms

Characteristics	*Logarithm of turnover per employee*
MIN	6288.00
MAX	6724.00
MEAN	6465.38
	Logarithm of profit per employee
MIN	6200.00
MAX	6672.00
MEAN	6459.38

Source: Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample 10 100 firms.
The standard deviation of the treatment effect is computed using bootstrap with 150 simulations.[23]

Table B: Environmentally registered firms vs Non Environmentally registered firms

Characteristics	*Logarithm of turnover per employee*
MIN	2513.00
MAX	4038.00
MEAN	3558.05
	Logarithm of profit per employee
MIN	2498.00
MAX	4006.00
MEAN	3522.23

Source: Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample 10 100 firms.
The standard deviation of the treatment effect is computed using bootstrap with 150 simulations.

Table C: Quality and Environmentally registered firms vs Quality or Environmentally registered firms

Characteristics	*Logarithm of turnover per employee*
MIN	4814.00
MAX	5995.00
MEAN	5377.27
	Logarithm of profit per employee
MIN	4774.00
MAX	5947.00
MEAN	5362.70

Source: Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample 10 100 firms.
The standard deviation of the treatment effect is computed using bootstrap with 150 simulations.

[23] Usually in the literature the standard deviation of the treatment effect is computed using bootstrap with 100 simulations

Appendix 3.3: Pearson correlation coefficients

	TURNOVER	PROFIT	ES	QS	SMALL	MEDIUM	SMEDIUM	BIG	GROUP	NETWORK	EXPORT	RELOCATION	CUSTOMER1	CUSTOMER1
TURNOVER	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-
PROFIT	0.55	1.00	-	-	-	-	-	-	-	-	-	-	-	-
QS	0.11	0.10	1.00	-	-	-	-	-	-	-	-	-	-	-
ES	0.18	0.16	0.41	1.00	-	-	-	-	-	-	-	-	-	-
SMALL	-0.09	-0.06	-0.21	-0.26	1.00	-	-	-	-	-	-	-	-	-
SMEDIUM	-0.05	-0.06	-0.18	-0.12	-0.26	1.00	-	-			-	-	-	-
MEDIUM	0.03	-0.01	-0.02	0.06	-0.21	-0.22	1.00	-	-	-	-	-	-	-
BIG	0.09	0.11	0.33	0.27	-0.44	-0.46	-0.37	1.00	-	-	-	-	-	-
GROUP	0.20	0.17	0.22	0.27	-0.36	-0.13	0.09	0.33	1.00	-	-	-	-	-
NETWORK	-0.07	0.06	0.09	0.20	-0.08	-0.08	0.05	0.10	0.14	1.00	-	-	-	-
EXPORT	0.19	0.20	0.24	0.28	-0.21	-0.10	0.04	0.23	0.20	0.23	1.00	-	-	-
RELOCATION	0.06	0.05	0.15	0.10	-0.09	-0.04	0.00	0.11	0.10	0.08	0.22	1.00	-	-
CUSTOMER1	-0.03	-0.02	0.25	0.43	-0.14	-0.05	0.06	0.11	0.19	0.27	0.26	0.11	1.00	-
CUSTOMER2	0.00	0.02	-0.21	-0.24	0.12	0.07	-0.03	-0.13	0.12	-0.02	-0.09	-0.05	-0.72	1.00

Source: Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample 10 100 firms.

Chapter IV

From Quality to Innovation:

Evidence from two French Employer Surveys[24]

[24] This section is a developed version of the article "From quality to innovation: Evidence from two French Employer Surveys" (with Fabrice Galia) which is published in *Technovation*, 29, 12 (2009): 829-842.

1. Introduction

Developments in technology over the last ten years have drastically changed the characteristics of business. A great increase in market competition has accelerated the globalisation of international companies and changed business requirements. Many firms have responded to these changes by using quality-based strategies (Foley *et al.*, 1997) that can drive firms to make significant improvements in profitability, productivity and competitiveness (Deming, 1986). In parallel to becoming quality-oriented, firms have also been urged to become more innovative (Encaoua *et al.*, 2000; Kleinknecht and Mohnen, 2001).

Although, Winter (1994) stresses the indispensability of quality management in the struggle for competitive survival, the new market demands that a firm be both quality efficient and innovative (March, 1991; Tushman and O'Reilly, 1997). Therefore, innovation is now unavoidable for firms which want to develop and maintain a competitive advantage and/or gain entry into new markets (Brown and Eisenhardt, 1995; OECD, 1997). Moreover, Désiage *et al.*, (2009) show that firms that are oriented to innovation improvement are more likely to survive than others. Both quality and innovation performances are increasingly high-profile activities for all kinds of firms and are usually associated with gaining a competitive advantage.

In many firms barriers to innovation are difficult to overcome without implementing quality practices. In that sense, quality in its human and technical dimensions can help create an environment and culture that supports innovation. More precisely, quality dimensions such as customer focus, employee training and team work can facilitate innovation improvement. Furthermore, there are many common aspects to quality practices and innovation performance (Prajogo and Sohal, 2001).

This relationship between quality and innovation highlights that the objectives of innovation should conform to the objectives of quality since both quality and innovation performance can be considered as organisational dynamic capabilities based on learning, improvement and change.

Abrunhosa and Moura E Sà (2008) argue that the relationship between quality practices and innovation is complex and depends on the specific elements taken into account in each case. Indeed, the literature presents conflicting arguments concerning the impact of quality on innovation. One set of arguments supports a positive relationship between quality and innovation, implying that firms implementing quality systems also improve their innovation performance (Prajogo and Sohal, 2004; Abrunhosa and Moura E Sà, 2008; Prajogo and Hong, 2008). The opposite set of arguments claims that quality will hinder firms from being innovative due to several inherent factors that are not congruent with the aim of innovation (Kanter, 1983; Flynn, 1994; Glynn, 1996). From this literature, we can summarise that the impact of quality on innovation depends both on the specific quality system under consideration and the type of innovation.

Up to date, studies have usually been focused either on the Total Quality Management system (TQM) or quality in general at the firm level, while only a few studies have investigated ISO 9000 certification as a quality reference. In fact, to the best of our knowledge, no study has previously investigated the wide network of relationships between the firm and its external environment when studying the quality-innovation relationship. Furthermore, various dimensions of innovation can be distinguished (product, process, incremental, radical, technological, non-technological); however many studies did not specify which dimensions of innovation they had considered when analysing the impact of quality (Singh and Smith, 2004).

The central question of **chapter 4** is whether quality has a positive effect on innovation. Moreover, this chapter contributes to an improved understanding of the quality-innovation relationship in three ways. Firstly, in contrast to previous research, this chapter presents three different Quality Levels, based on either ISO 9000 certification or systems additional to ISO 9000 and also deals with networks of relationships between the firm and its external environment. Secondly, the chapter distinguishes between nine indicators of innovation performance. Finally, we have corrected for bias selection using the matching method.

The design of the chapter is as follows. Section 2 defines innovation performance and reviews the literature relating the impact of quality on innovation. In Section 3, we develop the data, the hypothesis, the econometric methods used and the main results. Section 4 is devoted to concluding remarks, policy implications and research limitations and future research directions.

2. Literature review

2.1 Innovation performance: definitions and key principles

Before discussing the literature on the impact of quality on innovation, we only define innovation, since ISO 9000 standard is presented already in **chapter 1**.

Innovation is widely acknowledged as key to economic development, since it potentially leads to productivity and competitive gains. There are various definitions of innovation. Joseph Schumpeter is often thought of as the first economist to draw attention to the importance of innovation. Schumpeter (1934) defined innovation as: “The introduction of new goods (…), new methods of production (…), the opening of new markets (…), the conquest of new sources of supply (…) and the carrying out of a new organisation of any industry”. Furthermore, OECD (1996), defined innovation as “implementing new ideas that create value” which refers to the various types of innovation such as product development, the deployment of new process technologies, and management practices. The European Commission defines innovation as “the renewal and enlargement of the range of products and services and the associated markets; the establishment of new methods of production, supply and distribution; the introduction of changes in management, work organisation and the working conditions and skills of the workforce”.

The review of the literature indicates that the measurement of innovation is likely to be difficult due to the broad nature of innovation activities. However, one method of trying to assess innovation is to make the distinction between *output* of innovation activity and the *input* into innovation activity (Rogers, 1998). Generally, the key output of innovation activity is the firm’s success which may be defined as profits, market share, productivity, etc. Moreover, the literature defines some alternative measure of innovation output: the number of new improved products or processes introduced, percentage of sales from new or improved products or processes, intellectual property (IP) statistics such as patents, trade markets, designs, etc. Concerning inputs into innovation activity, Oslo Manuel (2005) indicates that

R&D represents the basic input indicator (OECD, 2005). The Frascati Manuel, produced by the OECD (1993), defines R&D as "Research and experimental development (R&D) comprises of creative work undertaken on a systematic basis in order to increase the stock of knowledge including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications".

Firms can engage in innovation for a number of reasons. Their objectives may involve products, markets, efficiency, quality or the ability to learn and to implement changes. In this sense, Schumpeter (1934) argues that the concept of innovation, along with credit and profit maximisation, plays driving force of firm's economic development. Hence, identifying firms' motives for innovation and their importance is of help in examining the forces that drive innovation activities (OECD, 2005). Hence, many studies have been devoted to the determinants of innovation and research and development (R&D). The most frequently examined factors are size and type of the firm, industrial sectors, group membership, technological opportunities, market share, information source, degree of competition and the capacity for appropriation of the innovation benefit (Crépon *et al.*, 1998; Encaoua *et al.*, 2000; Kleinknecht and Mohnen, 2001). Then, the literature distinguishes three dimensions enhancing innovation, such as: factor conditions (human resources, basic research infrastructure, information infrastructure and the supply of capital risk), supporting environment (competition, innovation incentives, presence of clusters, and local suppliers) and demand conditions (sophisticated customers, anticipated needs). However, an approach which empirically studies the relationship between quality management systems and different innovation indicators has been marginalised.

It is important to mention that innovation activities can also be hampered by a number of factors, such as high costs or lack of demand, factors specific to an enterprise, such as lack of skilled personnel or knowledge and legal factors, such as regulations or tax rules (OECD, 2005).

2.2 The impact of quality systems on innovation performance

As we mentioned previously, studies have usually analysed the impact of either Total Quality Management system (TQM) or quality in general on innovation performance.

Unfortunately, due to data limitations we will use ISO 9000 as our reference for quality management.

Furthermore, using ISO 9000 certification as a reference for quality has advantages compared to TQM (Benner and Tushman, 2002). The ISO 9000 program's focus is on ensuring that organisations create consistent, stable processes through process documentation and adherence, which assures the delivery of quality products or services. Furthermore, TQM programs include many features that are defined in different ways by researchers and in comparison to ISO 9000 certification, it is unclear which practices organisations adopt and specifically, whether the adopted practices involve mapping, improving and adhering to processes.

However, the literature review mainly focuses on how the Total Quality Management system (TQM) or quality in general impacts on innovation performance, which will help us to better understand the relationship between ISO 9000 certification and innovation performance.

A review of the literature suggests that there are conflicting arguments concerning the impact of quality systems on innovation performance. The arguments for a positive impact of quality on innovation performance could be based on the similarities of the determinants of both quality and innovation, especially the internal determinants (for a review of the literature see Perdomo-Ortiz *et al.*, 2006). Claims that support a positive relationship between quality management and innovation suggest that companies embracing quality in their system and culture will provide a fertile environment for innovation because quality embodies principles that are congruent with innovation (Mahesh, 1993; Roffe, 1999). As Zairi (1994) remarked, TQM has "given organisations the impetus and commitment required for establishing climates of never-ending innovation or innovativeness". Perdomo-Ortiz *et al.*, (2006) empirically examine the relationship of the broader concepts of TQM and business innovation capability (BIC) for 102 firms in sectors that produce machinery and instruments for measurement, analysis and control. They argue that TQM can favour the development of BIC.

Moreover, the authors conclude that although all the dimensions of TQM are related to business innovation capability, three of them stand out as particularly significant: process management, product design and human resource management. Using empirical data gathered from 194 middle/senior managers in Australian firms, Prajogo and Sohal (2004) analyse the effects of TQM on product innovation concluding that two dimensions of TQM, leadership and people management, have a significant influence in this domain. Measuring TQM practices by the six criteria of the Malcolm Baldridge National Quality Award (leadership, strategic planning, customer focus, information and analysis, people management and process management), Prajogo and Hong (2008) show that TQM makes a significant contribution to R&D performance in terms of product quality and product innovation in 130 R&D divisions of Korean manufacturing firms.

Furthermore, Santos-Vijande and Alvarez-Gonzalez's (2007) empirical findings confirm that TQM strongly influences technical and administrative innovation regardless of the market turbulence in which the firm operates. The authors argue that the implementation of TQM via its impact on people management is actively involved in offering the employees a real role in the management of the organisation, which may influence the firm's basic beliefs and values related to innovation performance.

In the same sense, Hoang *et al.*, (2006) conclude that TQM practices, in general, support innovation performance. Their findings indicate that TQM significantly and positively impacts on the level of newness innovation and especially the number of new products and services commercialised. The author's results show that three constructs, leadership and people management (including top management commitment, employee involvement, and employee empowerment), process and strategic management (including process management, information and analysis systems and strategic management) and open organisation have a positive impact on the innovation performance of the companies surveyed in Vietnam. However, findings suggest that education and training, while showing a positive effect on the number of new products and services, had a negative relationship with the level of overall newness. Moreover, authors did not find any evidence for the impact of customer focus (as an important aspect of TQM) on the firm's product and service innovation performance.

Similarly, a study by Abrunhosa and Moura E Sà (2008) on Portuguese footwear firms finds that TQM principles such as communication, supportive people management practices and teamwork have a positive association with the adoption of technological innovation. On the other hand, they conclude that not all TQM principles will improve innovation performance (autonomy and consultation).

In the same vein, Benner and Tushman (2002) suggest that as ISO 9000 certification reduces variance in organisational routines, they influence the selection of innovations. In the paint and photography industry, they find that the extent of process management activities in a firm are associated with an increase in both exploitative innovations that built on existing firm knowledge and an increase in exploitative innovation's share of total innovations. As the authors indicate, exploration and exploitation have been characterised as fundamentally different search modes. While exploitation involves improvements in existing components and architectures that are built on the existing technological trajectory, exploratory innovation involves a shift to a different technological trajectory.

After controlling for unobservable individual heterogeneity and time effects, Lopez-Mielgo *et al.*, (2009) confirm the positive link between innovation capabilities and quality management.

In contrast to the above arguments, several authors reject the positive impact of quality management systems on innovation for the reason that they possess principles that could hinder innovation. While standardisation is necessary for conformance and error reduction, it could result in rigidity from the innovation point of view (Kanter, 1983; Glynn, 1996). Moreover, standardisation could drive a reduction in ambiguity in the design of tasks, which makes innovation difficult. Furthermore, it leads to lower flexibility and openness to change as a result of the "adhesion" that is generated to repeated behaviour (Prajogo and Sohal, 2004). The problem solving method taught by TQM emphasises the use of data, indeed one of the most famous terms used in TQM literature is "management by fact". This term strongly promotes the idea of rational thinking supported by a set of data, tools and techniques. In this sense, Glynn (1996) suggests that in situations where a problem is familiar, prior experience may lead to the direct retrieval of the prior solution-as in the case of routinised problem solving. This means that if workers are allowed to deal only with routine operational problems, then it would be unlikely that they would produce innovative solutions since workers rely on already learned behaviors that disable creativity.

Furthermore, Flynn (1994) argues that rapid product innovation and quality improvement can not be simultaneously achieved. This implies that in specific situations (when industry and market conditions are taken into consideration) firms have to prioritise quality over innovation or vice versa. However, the authors argue that specific types of organisational infrastructure that may provide an environment which best supports fast product innovation, combined with high quality.

Moreover, using a survey of 418 Australian manufacturing organisations, results by Singh and Smith (2004) indicate that there is insufficient statistical evidence to suggest that TQM is related to innovation. The authors underline that the model presented in this study reflects a rather simplistic linear relationship between TQM constructs and innovation. They conclude that TQM constructs and innovation are related in a more complex way.

We propose that as innovation is a result of a combination of different activities, such as research and development, process development, design, marketing, organisational restructuring, resource management and employee development, it is likely be supported by quality systems such as ISO 9000 that enhance the possibilities for such combination.

2.3 Hypotheses development

In this chapter we aim to study the positive effects of quality systems on innovation performance. Following the above we formulate the following hypothesis:

H1: Firms with ISO 9000 certification will improve their innovation performance.

Furthermore, we want to verify the claim that improvement of innovation performance varies according to the Quality Level that already exists inside a firm. We want to provide an empirical answer to the question of whether a firm’s position within the quality hierarchy is positively correlated with innovation performance. Consequently, we formulate the following hypothesis:

H2: Different levels of quality differentially improve innovation performance.

3. Empirical Analysis

3.1 The database

The research presented here is based on two microeconomic databases, the French Organisational Changes and Computerisation in 1997 (Changement Organisationnel et Informatisation, COI) and the Community Innovation Surveys (CIS3, 1998-2000). The COI database is explained in detail in **chapter 1**.

The Community Innovation Survey is the result of a significant increase in the importance given to innovation issues at the EU level and of associated efforts made to provide a rich set of information about input/output indicators of innovation activity at a firm level. The background for the CIS project is a set of mostly independent surveys on innovation carried out in the 1980s. The experience from these surveys resulted in the Oslo Manual (1992) drawn up by the OECD and revised in 1996. The manual has provided a specific set of guidelines for the design and actual implementation of national surveys aimed at covering a wide range of dimensions of innovation activities. The Oslo Manual puts into practice most of the recent advances in our understanding of the nature and organisation of innovation activities within the firms and in the economic system as a whole. Although the Oslo Manual is specifically intended to investigate innovation at the level of individual firms, it also provides specific guidelines to measure the existence and strength of systemic technological interactions between firms and the broader innovation system in which they operate (OECD, 1992, 1996).

In 1993 Eurostat co-ordinated a Community Innovation Survey which involved thirteen countries using a harmonised questionnaire, designed according to the guidelines contained in the Oslo Manual. In each country a stratified random sample of firms operating both in the manufacturing and in the service sectors was selected. Similar surveys were run in many other countries, including non-OECD and developing countries. In total, over 50 countries have carried out at least one innovation survey. Up to now there exist five waves of CIS (CIS1 for 1990-1992, CIS2 for 1994-1996, CIS3 for 1998-2000, CIS4 for 2002-2004, CIS5 for 2006). Multiple rounds of innovation surveys exist also in most other EU countries. Some countries had initiated their own surveys prior to CIS1 (such as France, Germany, Italy, the Netherlands, Norway and Sweden).

The innovation surveys assemble data on innovators and non-innovators, where "innovators" are defined as enterprises that have over the last three years introduced, have tried to introduce or are still in the process of introducing a new product or a new process, where "new" is defined as substantially improved or completely new, and where a distinction is made between products new to the firm (but not necessarily new to the market) and products new to the firm and to the market. In these surveys, firms are asked to give information about the inputs, the outputs and the behavioral and organisational dimensions of their innovative activities. Some of these data are quantitative, some are dichotomous (yes/no responses) and some are polychotomous, categorically ordered data, measured on a Likert scale. CIS data have been used in over 60 recent academic articles, mainly in economics (for prominent contributions using CIS data see Mairesse and Mohnen, 2002).

For the empirical purposes of this chapter, we use the French CIS3 survey, carried out by SESSI (Ministry of Economics, Finances and Industry) over the period 1998-2000. Manufacturing firms, with at least 20 employees, answer questions primarily concerned with the nature of technological innovations, innovation performance, the supervision of these innovations (*i.e.* innovation projects), the internal and external sources of R&D, the objectives of technological innovation, the principal sources of information, cooperation to achieve innovation, and finally the obstacles to innovation projects.

Merging these two surveys (COI and CIS) by the firm identification number (SIREN) we get an original database which provides detailed information on firms' characteristics, quality systems and innovation performance. It is important to mention that these two surveys are mandatory for all firms. The merger of these data sets provides a sample of 1 146 manufacturing firms with at least 20 employees. The variables used for estimation and descriptive statistics are indicated in Table 4.1. No problem of multicolinearity has been detected (Appendix 4.1).

Table 4.1: Definition of variables

Variable	**Definition**
Dependent variables	
NEW OR IMPROVED PRODUCTS (for the firm)	During 1998-2000, the firm introduced into the market a new or significantly improved products (goods or services) for the firm Dummy variable (=1 if yes)
TURNOVER DUE TO NEW OR IMPROVED PRODUCTS	Estimation how turnover in 2000 was distributed between new or significantly improved products (goods or services) introduced during the period 1998–2000 (Continuous variable)
NEW OR IMPROVED PRODUCTS (on the market)	During 1998-2000, the firm introduced into the market a new or significantly improved products (goods or services) for the firm's market Dummy variable (=1 if yes)
SHARE OF NEW OR IMPROVED PRODUCTS (to the market)	Estimation of new or significantly improved products (goods or services) not only new for the enterprise, but also new for firm's market contribution in total turnover in 2000 (Continuous variable)
NEW OR IMPROVED PROCESS (for the firm)	During 1998-2000, the firm introduced into the market a new or significantly improved production processes including methods of supplying services and ways of delivering products Dummy variable (=1 if yes)
TECHNOLLOGICALLY NEW PROCESS	During 1998-2000, the firm introduced any technologically new or modified (with combination of new technologies) production processes Dummy variable (=1 if yes)
NEW PROCESS (non-technological)	During 1998-2000, the firm introduced a new (or modified) production process (non-technological) Dummy variable (=1 if yes)
INNOVATION EXPENDITURE	Total innovation expenditure in 2000. (Continuous variable)
INNOVATION PROJECTS	Number of studied or realised innovation projects per year is more than 1 Dummy variable (=1 if yes)
Independent variables	
ISO 9000 in 1994	The firm is certified with ISO 9001, ISO 9002, EAQF in 1994 Dummy variable (=1 if yes)
ISO 9000 in 1997	The firm is certified with ISO 9001, ISO 9002, EAQF in 1997 Dummy variable (=1 if yes)
ISO 9000 SUPPLIERS	The suppliers is certified with ISO 9000 standard Dummy variable (=1 if yes)
OTHER CERTIFICATION	The firm has other system of certification or measure of total quality Dummy variable (=1 if yes)
ACTIVITY	The main activity of the firm: 11 dummy variables (=leather and wearing; edition, printing and reproduction; pharmaceutical industry, manufacture of soap, perfumes and care products; home equipment; car industry; naval construction, rail road materials/manufacture electric and electronic equipment; manufacture of mechanical equipment; manufacture of paper and wood/chemistry, rubber and plastic; manufacture of metal transformation; manufacture of electric components; electronic components; textile and mineral)
SIZE	SMALL (20 TO 199 employees)

	BIG (more than 200 employees)
COST	Cost Reduction strong or very strong strategic importance for the firm Dummy variable (=1 if yes)
NEW PROCEDURE	Implementation of new procedure for products strong or very strong strategic importance for the firm Dummy variable (=1 if yes)
COMPETITIVE PRESSURE	Competitive pressure influences the choice of firm's organisation and computerisation Dummy variable (=1 if yes)
UNCERTAINTY ON THE MARKET	Uncertainty on the market influences the choice of firm's organisation and computerisation Dummy variable (=1 if yes)
CLEINTS CONDITIONED	Clients conditioned influences the choice of firm's organisation and computerisation Dummy variable (=1 if yes)
SUPPLIERS CONDITIONED	Suppliers conditioned influences the choice of firm's organisation and computerisation Dummy variable (=1 if yes)
STOCKHOLDERS CONDITIONED	Stockholders conditioned influences the choice of firm's organisation and computerisation Dummy variable (=1 if yes)

The sectors are considered according to the French nomenclature.
Source: Survey COI 1997 merges to the CIS3.

3.2 Measuring quality and innovation

As we said above, we use ISO 9000 certification[25] as a quality reference. Even if we claim that ISO 9000 certification is a multidimensional practice, our research will not estimate how each dimension of ISO 9000 individually impacts on innovation performance. Hence, our findings will provide a more general conclusion as to how ISO 9000 certification, in its entirety, impacts on innovation performance.

A new feature of this chapter is that three original measures of Quality Level are created. The relationship between firms and their substitute or additional system to ISO 9000 will determine the Quality Level established inside the firm. The focus on openness and interaction in studies of innovation suggests that the network of relationships between the firm and its external environment can play an important role in performance evaluation. Actually, supplier involvement and collaboration has been seen as necessary to improve supply chain effectiveness and a firm's competitiveness. So, dealing with a quality certified supplier while non-certified improves a firm's signals concerning quality improvement

[25] Under this variable it is included ISO 9001, ISO 9002, EAQF. Unfortunately, we can not distinguish between these standards, since in the survey they were put together under the same name, so ISO 9000 is a reference for this variable. Threfore, we cannot estimate the specific effects of each program.

(Terlaak, 2001). Moreover, having additional systems of certification or total quality may improve a firm's performance even further. The argument could be based on the concept of complementarity since it is argued that the returns of a management practice can be substantially higher when it is combined with other management practices rather than introduced alone (*e.g.* Milgrom and Roberts, 1995).

The first category of firms is called firms with Top Quality Level and it includes firms that have ISO 9000 certification, where suppliers are also certified or have other systems of certification or total quality. Furthermore, in this group we include firms that are ISO certified and also have other systems of certification or total quality. The third possibility for the group of Top Quality Level is that firms are certified and their suppliers are also certified, but they do not have another system of certification or total quality. This group presents the highest Quality Level on the hierarchy since the access to quality-oriented partners may have considerable economic benefits, measured by rates of growth, profitability or survival (*e.g.* Podolny, 1993). Participating in these networks offers opportunities and creates skills necessary for trading knowledge about quality and innovation improvement (Eriksson and Jacoby, 2003). We consider that being a Top quality firm demands at least ISO certification and another type of quality support (certified suppliers and/or other type of system of certification).

The second category is called Medium Quality Level and it includes firms that are not ISO certified but which have another system of certification or total quality and their suppliers have ISO certification. In this category we include also firms that have only either ISO certification or another system of certification or total quality or whose suppliers are ISO certified. Being a Medium Quality Level firm implies at least one linkage, internal or external, to quality system. Ties to quality-oriented partners might be valuable because they provide significant knowledge of quality issues, which may significantly improve a firm's outcomes. Network ties have also been postulated as providing access to complementary assets as well as access to external legitimacy and status similar to that provided by legitimating institutions (*e.g.* Baum and Oliver, 1991). Therefore, a firm's network ties to quality registered firms may influence its capabilities as well as others' perceptions of its capabilities.

The third category named Low Quality Level includes firms that are not ISO certified, do not have any other system of certification or total quality and whose suppliers also do not have ISO certification. Having no internal or external linkage that facilitates the flow of quality knowledge among partners induces the status of a Low Quality Level firm.

This categorisation allows us to empirically construct the different levels of quality to understand their effect on the improvement of innovation performance.

Innovation performance is conceptualised by three aspects: product innovation, process innovation and innovation activities. We use nine indicators of innovation performance: five dichotomous indicators of innovation, and four continuous indicators which are provided by the third Community Innovation Survey. Product innovation presents the introduction of a new product (service) on the market or the significant improvement of one product (service) that will meet customer demand. Under this category we will analyse four variables: a new or improved product for the firm, turnover due to new or improved products, new or improved products on the market and share of new or improved products on the market. The approach called process innovation combines the adoption of a process view of the business with the application of innovation to key processes. We distinguish three types of process innovation that represent our dependent variables: process innovation in general, technologically new processes, and new processes (non-technological). Furthermore, the third category of innovation (called innovation activities) includes two variables: total innovation expenditure and number of innovation projects.

3.3 Propensity Score Estimates-estimation strategy

Nevertheless, being registered according to ISO 9000 standard or belonging to a superior quality level may not be randomly determined, and may depend on a firm's individual characteristics. In other words, a firm may choose to register because of a particular need or specific conditions, which can induce a selection bias. To avoid such a bias, we estimate evaluation models with matching estimators (Rubin, 1974) which is explained in details in **chapter 3**. Let us note T a binary variable equal to 1 if the firm received a treatment, *i.e.* ISO 9000 certification or belongs to a superior quality level. The efficiency of the treatment is measured through the result y_i. Thus each firm, has two potential results: y_0 (if

T = 0) and y_1 (if T= 1). y_0 and y_1 are never observed simultaneously, since a firm either is treated, or untreated, but never both at the same time. In other words, only the real situation of the firm, noted Y, is observed: $Y = y_1 T + y_0(1-T)$. Let us note T, a binary variable indicating if the individual received or not a treatment (T=1 if the individual is treated, T=0 if not). Hence, we will consider four models of comparison:

- *In Model 1*, T = 1 if the firm is ISO 9000 certified and T = 0 if the firm is not ISO 9000 certified.
- *In Model 2*, T = 1 if the firm belongs to a Top Quality Level and T = 0 if the firm belong to Medium Quality Level.
- *In Model 3*, T = 1 if the firm belongs to a Top Quality Level and T = 0 if the firm belong to Low Quality Level.
- *In Model4 T* = 1 if the firm belongs to a Medium Quality Level and T = 0 if the firm belongs to Low Quality Level.

Let us note y innovation indicators (product innovation, process innovation or innovation activities) and evaluate the effect of each treatment on y. Thus, three quantities are interesting: $\mathrm{C}=\mathrm{E}\left[\mathrm{y}_1 - y_0\right]$ is the average treatment effect over the whole population; $\mathrm{C}_1=\mathrm{E}\left[\mathrm{y}_1 - y_0 | \mathrm{T}=1\right]$ is the average treatment effect over treated firms; and $\mathrm{C}_0=\mathrm{E}\left[\mathrm{y}_1 - y_0 | \mathrm{T}=0\right]$ is the average treatment effect over non-treated firms. If property of independence is respected $(\mathrm{y}_1, y_0) \perp \mathrm{T}$, there would be no selection bias. In the majority of cases, the property of independence is not valid. A solution would be to compare the product innovation, process innovation or innovation activities of each firm that received the treatment with the product innovation, process innovation or innovation activities of an identical counterfactual who did not receive the treatment. To identify statistically the counterfactual, a useful approach consists in building a counterfactual population for which the distribution of a number of observable characteristics (X – matching variables) is the same as for the group receiving the treatment. Consequently, the property of independence is respected conditionally to observed matching criteria $(y_0, y_1) \perp \mathrm{T} | \mathrm{X}$. When many matching criteria must be taken into account, finding a counterfactual can be problematic. Rosenbaum and Rubin (1983) solved this problem by showing that conditional independence with the X

variables was equivalent to the independence compared to the propensity score (PS). The propensity score constitutes a one-dimension summary of the matching variables and it estimates the probability of being exposed to the treatment, conditionally to these variables. As in the previous chapter, we use the kernel estimator proposed by Heckman *et al.*, (1997; 1998). For the computation of the kernel estimator for the treated, each non-treated firm takes part in the construction of the counterfactual of the treated firm. The weight of the non-treated in the constitution of the counterfactual is given according to the distance between their score and the score of a treated firm. In order to calculate the standard error for the kernel estimator, we implement a bootstrap technique.

As in **chapter 3**, we perform specific test of robustness in order to confirm that our results are not too sensible on the choice of bandwidth value. Actually, we establish different values on bandwidth value between 0,01 and 0,457. For instance, whatever the value of estimated bandwidth, ISO 9000 has always positive and significant impact (significant at 1%) on the new or improved products for the firm. Like in **chapter 3**, for the binary treatment case, where we estimate the probability of ISO adoption vs non-ISO adoption, Logit and Probit models usually yield similar results. For the purposes of this chapter, in order to construct the counterfactuals, we estimate a Logit model of being ISO 9000 certified (*H1*) and derive the corresponding propensity score (PS). We also estimate three Logit models of choosing one Quality Level among Top, Medium or Low (*H2*). Following Bonjour *et al.,* (2001) and Lechner (2000) we will use three binomial models rather than a multinomial model. As Lechner (2000) indicates, there is little difference in their relative performance but he suggests that the binomial models present marginally more accurate results. Noteworthy, only variables that influence simultaneously the participation decision and the outcome variable should be included.

3.4 Descriptive Statistics

Tables 4.2 and 4.3 provide descriptive statistics for ISO 9000 certification and three Quality Levels. From Table 4.2, we can notice that six firms out of ten are ISO 9000 certified. Furthermore, the construction of three Quality Levels is presented in the same table. The distribution of each category of Quality levels is: 61%, 22%, and 17% for the Top Quality Levels firms, Medium Quality Levels firms and Low Quality Levels firms, respectively.

Table 4.2: Distribution of ISO 9000 certification and three categories of Quality Levels

Type of Quality Level	ISO 9000 CERTIFIED FIRMS	ISO 9000 CERTIFIED SUPPLIERS	OTHER SYSTEM OF CERTIFICATION OR TOTAL QUALITY	Total
TOP QUALITY LEVEL	yes	yes	yes	61%
	yes	no	yes	
	yes	yes	no	
MEDIUM QUALITY LEVEL	yes	no	no	22%
	no	yes	yes	
	no	yes	no	
	no	no	yes	
LOW QUALITY LEVEL	no	no	no	17%
Total	64%	76%	45%	

Source: Survey COI 1997 merges to the CIS3, sample 1 146 companies, not weighted by the number of employees.

Table 4.3 provides the ISO 9000 certified and the three Quality Levels firms' descriptive statistics according to their background characteristics such as size, features of the firm's strategy and external constraints.

Table 4.3: Descriptive Statistics

	ISO 9000 CERTIFICATION	TOP QUALITY LEVEL	MEDIUM QUALITY LEVEL	LOW QUALITY LEVEL
	Company's Size			
SMALL	22%(a)	21%	43%	68%
BIG	78%	79%	57%	32%
	Features of the company's strategy			
COST REDUCTION	94%	95%	87%	80%
NEW PROCEDURE	56%	57%	48%	43%
	External market's constraints			
COMPETITIVE PRESSURE	81%	82%	76%	69%
UNCERTAINITY ON THE	59%	59%	61%	54%

MARKET				
CLIENTS CONDITIONED	78%	79%	74%	65%
SUPPLIERS CONDITIONED	16%	17%	19%	21%
STOCKHOLDERSCONDITIONED	37%	37%	28%	15%
Total	**64%**	**61%**	**22%**	**17%**

Source: Survey COI 1997 merges to the CIS3, sample 1 146 companies, not weighted by the number of employees.
Lecture: (a) 22% of "ISO 9000 Adopters" are companies that have between 20 to 49 employees (the category-small firm).

3.5 Determinants of the ISO adoption and Quality Levels

As explained above, the first part of PS-estimates is defining the determinants of being ISO certified (*H1*) or belonging to one of the Quality Levels (*H2*) using background characteristics such as size, sector of activity, features of the firm's strategy and external constraints (Table 4.4).

The first group of variables that we have used includes a firm's size and sector of activity. Our results are consistent with those in **Chapter 1**. Bigger firms seem more able to be ISO 9000 certified or to operate at a superior Quality Level for several reasons such as the availability of financial resources and technical competences, or their higher sensitivity to their environmental image. We can note that company size is positive and significant for the four logistic regressions.

We have used eleven sectors of activities and we define as a reference the sector of textile and mineral industries. As in the literature, we find that the probability of being ISO certified is stronger in some industries, like the electrical and electronic equipment, metal, construction and mechanical equipment industries. Similar results are obtained for our three Quality Level categories which highlights that specific sectors of activity tend to be more sensitive to quality systems than others.

Concerning the features of the company's strategy, we can see from Table 4.4 that for our four logistic regressions, when the coefficients associated with cost reduction and implementation of a new production procedure are significant, they are also positive. In other words, when cost reduction and new procedures are important or very important for the company's strategy, they will increase the company's probability of being quality certified.

When comparing Medium Quality Level firms to Low Quality Level firms, there is no variable that plays such a part in the decision to belong to Medium Quality Level firms.

Considering the five external market constraints, one can remark that for all four estimated regressions, the variables of competitive pressure, uncertainty on the market and suppliers - conditions seem to play no role in determining the firm’s probability to be ISO certified or to be in one Quality Level.

Clients’ conditions have an important positive impact on choosing between Top and Low Quality Level firms and between Medium and Low Quality Level firms. When we look at the variable stockholders-conditions the associated coefficients, when significant, are positive.

This tells us that when stockholders’ conditions are an important external constraint, firms will adopt quality systems. Surprisingly, all five external market constraints have no influence on whether a firm operates at Top rather than Medium Quality Level.

Table 4.4: Determinants of choosing the ISO 9000 certification and Quality Level

	(H1) ISO Certified Firms vs ISO Non Certified firms (ref)	(H2) Top Quality Level vs Medium Quality Level (ref)	(H2) Top Quality Level vs Low Quality Level (ref)	(H2) Medium Quality Level vs Low Quality Level (ref)
Intercept	-1.96***	-1.10**	-2.99***	-1.49***
	Size of the company			
Big	1.56***	1.09***	2.50***	1.28***
	Features of the company’s strategy			
Cost reduction	0.49**	0.48	0.55	0.36
New procedure	0.25	0.27*	0.58**	0.03
	External market's constraints			
Competitive pressure	0.07	0.11	0.22	0.20
Uncertainty on the market	-0.00	-0.03	0.39	0.07
Clients conditioned	0.15	-0.03	0.75**	0.47*
Suppliers conditioned	-0.13	-0.06	-0.21	-0.14
Stockholders conditioned	0.40**	0.26	0.68**	0.38
	Sector of Activity			
Industry of leather and wearing	-1.91***	-1.14*	-2.69***	-1.29**
Industry of edition, printing and reproduction	-1.87***	-0.99*	-2.80***	-1.24**
Pharmaceutical industry, manufacture of soap, perfumes and care products	-0.45	-0.76**	1.05*	1.38***
Industry of home equipment	-0.06	-0.12	0.28	0.18
Car industry	1.82***	1.75***	2.11***	0.59
Naval construction, railroad materials/ manufacture of electric and electronic equipment	-1.52***	1.16***	2.90***	1.26**
Manufacture of mechanical equipment	1.31***	1.01***	1.98***	1.11***
Manufacture of paper and wood/chemistry, rubber and plastic	1.14***	0.93***	1.68***	0.67**
Manufacture of metal transformation/ Manufacture of electric components	2.09***	1.69***	2.99***	1.47***
Manufacture of carburant/ electricity, gas and water supply	0.82**	0.98**	1.44**	0.23
Max-rescaled r-square	0.40	0.23	0.60	0.31
Number of firms	1 146	952	899	441

Source: Survey COI 1997 merges to the CIS3.
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively.

3.6 Discussion of the results

We will first introduce the PS-matching results and then compare these results with so-called naïve results (the differences in the sample means), revealing some selection effects. The main results of PS matching, as we indicated previously, are related to the treatment of treated estimators.

The findings provide empirical evidence (Table 4.5) that ISO 9000 certification significantly and positively contributes to seven out of nine indicators of innovation performance. More precisely, correlation between ISO 9000 and innovation is positive and significant concerning products (*NEW OR IMPROVED PRODUCTS FOR THE FIRM, TURNOVER DUE TO NEW OR IMPROVED PRODUCTS, NEW OR IMPROVED PRODUCTS ON THE MARKET AND SHARE OF NEW OR IMPROVED PRODUCTS TO THE MARKET),* processes *(TECHNOLOGICALLY NEW PROCESS*) and innovation activities (*TOTAL INNOVATION EXPENDITURE AND NUMBER OF INNOVATION PROJECTS*).

Moreover, it is in its precise form that ISO 9000 certification seems to be positively associated with innovation performance. Therefore, the hypothesis that the firms that adopt ISO 9000 certification will improve their innovation performance (*H1*) is supported for specific innovation indicators.

Furthermore, the comparison of the results of the naïve estimates (Table 4.5, last column) with the results of the PS-matching provides evidence that results are different. Indeed in general, the figures of the naïve estimates are different (and higher) than those of the PS-matching results revealing some selection effects. For example, the mean difference in terms of new or improved products for the firm between ISO Adopters and Non Adopters is 0.27 (significant at 1%) while this difference is only 0.12 (significant at 1%) for PS estimator.

It can be seen from Tables 4.6, 4.7 and 4.8 that the likelihood of being innovators can be ranked as follows: Top Quality Level firms, Medium Quality Level firms and Low Quality Level firms. More precisely, the results indicate that Top Quality Level firms are more innovative than those of Medium Quality Level and that Medium Quality Level firms are more innovative than those of Low Quality Level. For managers, this implies a need to focus more on quality improvement systems in order to improve their firm's innovation performance.

From Table 4.6, we can conclude that for Top Quality Level firms, quality systems have a positive impact on product innovation (*NEW OR IMPROVED PRODUCTS FOR THE FIRM, TURNOVER DUE TO NEW OR IMPROVED PRODUCTS, NEW OR IMPROVED PRODUCTS ON THE MARKET AND SHARE OF NEW OR IMPROVED PRODUCTS TO THE MARKET*), process innovation (*NEW OR IMPROVED PROCESSES AND TECHNOLOGICALLY NEW PROCESS*) and innovation activities (*TOTAL INNOVATION EXPENDITURE*).

Therefore, being a Top Quality Level firm impacts positively on seven out of nine indicators of innovation performance. Furthermore, we can conclude that being a Top or Medium Quality Level firm has a similar impact on the number of innovation projects.

From Table 4.7, findings suggest that there is no difference in impact between Top and Low Quality Level firms on Turnover due to new or improved products and all three categories of innovation process. However, Top Quality Level firms improve significantly and positively in five out of nine innovation performance indicators.

More precisely, belonging to this category has an impact on product innovation (*NEW OR IMPROVED PRODUCTS FOR THE FIRM, NEW OR IMPROVED PRODUCTS ON THE MARKET AND SHARE OF NEW OR IMPROVED PRODUCTS TO THE MARKET*) and innovation activities (*TOTAL INNOVATION EXPENDITURE AND NUMBER OF INNOVATION PROJECTS*).

The last Table 4.8 provides the conclusion that there is some difference between the effects on the innovation of firms when comparing Medium and Low Quality Level firms. Firms with a Medium Quality Level see a positive impact on four out of nine areas of innovation, product innovation (*NEW OR IMPROVED PRODUCTS OF THE FIRM AND NEW OR IMPROVED PRODUCTS ON THE MARKET*) and innovation activities (*TOTAL INNOVATION EXPENDITURE AND NUMBER OF INNOVATION PROJECTS*). Furthermore, we can conclude that even though Medium Quality Level firms do not have a well established quality system, the quality signals that they receive via additional or substitute or indirect certification (via suppliers) could enhance innovation performance. These results confirm that substitution or external linkages with firms with well-established quality systems can help to improve innovation performance.

Therefore, the evidence generally supports hypothesis *H2* stating that different levels of quality have a differentiated impact on innovation performance.

From the findings above we can conclude that alternative quality systems improve innovation performance in a manner similar to the improvements seen with the ISO 9000 standard. The positive impact of quality systems on product innovation could be explained by the principle of customer satisfaction.

It is well known that quality-oriented firms focus on customer satisfaction, which implies obtaining information about both the current needs of customers and the future needs of existing customers and taking into account the full range of environmental forces that will help the development of new products (Santos-Vijande and Alvarez-Gonzalez, 2007).

However our results also demonstrated that specific innovation indicators (New process (non-technological)) cannot be improved by the implementation of quality standards. Similar results are obtained by Santos-Vijande and Alvarez-Gonzalez (2007), who did not find any direct effect of TQM on technical innovation.

We can conclude that technical innovations require a different model of practices or a different organisational structure under the ISO 9000 standard. In other words, quality systems have to be integrated with other organisational resources to influence greater technological innovation.

Table 4.5: PS-matching estimates – ISO 9000 Impacts on Innovation Performance (H1)

(a)

	Global	Treated	Non-treated	Difference of Mean (b)
	Effect on Product (ISO Certified Firms vs ISO Non Certified Firms)			
NEW OR IMPROVED PRODUCTS FOR THE FIRM	013***	0.12***	0.12***	0.27***
TURNOVER DUE TO NEW OR IMPROVED PRODUCTS	0.03***	0.03***	0.02**	0.05***
NEW OR IMPROVED PRODUCTS ON THE MARKET	0.12***	0.13***	0.10**	0.21
SHARE OF NEW OR IMPROVED PRODUCTS TO THE MARKET	0.03***	0.02**	0.03**	0.03
	Effect on Processes (ISO Certified Firms vs ISO Non Certified Firms)			
NEW OR IMPROVED PROCESSES FOR THE FIRM	0.06	0.05	0.06	0.19***
TECHNOLOGICALLY NEW PROCESS	0.10**	0.10**	0.08**	0.15***
NEW PROCESS (NON-TECHNOLOGICAL)	-0.01	-0.02	-0.01	0.05***
	Effect on Innovation Activities (ISO Certified Firms vs ISO Non Certified Firms)			
TOTAL INNOVATION EXPENDITURE (LOGARITHM)	0.27**	0.31**	0.21*	0.39***
NUMBER OF INNOVATION PROJECTS	0.09**	0.09*	0.10**	0.25***

Bootstrapped standard errors
Source: Survey COI 1997 merges to the CIS3, sample 1 146 companies.
The regression integrates 11 indexes of industries that correspond to NAF 36 (reference: textile and mineral industries).
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively.
(a) The supports are available in Appendix 4.3.
(b) The supports are available in Appendix 4.2.

Table 4.6: PS-matching estimates - The difference between Top and Medium Quality Level impact on Innovation performance (H2) (a)

	Global	**Treated**	**Non-treated**	**Difference of Mean (b)**
	Effect on Product (Top Quality Level vs Medium Quality Level)			
NEW OR IMPROVED PRODUCTS FOR THE FIRM	0.09**	0.09**	0.08*	0.17***
TURNOVER DUE TO NEW OR IMPROVED PRODUCTS	0.04***	0.04***	0.03**	0.04***
NEW OR IMPROVED PRODUCTS ON THE MARKET	0.08**	0.09**	0.07*	0.15***
SHARE OF NEW OR IMPROVED PRODUCTS TO THE MARKET	0.03***	0.03***	0.03***	0.03***
	Effect on Processes (Top Quality Level vs Medium Quality Level)			
NEW OR IMPROVED PROCESSES FOR THE FIRM	0.08*	0.08*	0.09**	0.14***
TECHNOLOGICALLY NEW PROCESS	0.12**	0.11**	0.13***	0.21***
NEW PROCESS (NON-TECHNOLOGICAL)	-0.00	0.00	-0.00	0.04
	Effect on Innovation Activities (Top Quality Level vs Medium Quality Level)			
TOTAL INNOVATION EXPENDITURE (LOGARITHM)	0.23**	0.25**	0.20*	0.20*
NUMBER OF INNOVATION PROJECTS	0.05	0.5	0.05	0.13***

Bootstrapped standard errors
Source: Survey COI 1997 merges to the CIS3, sample 952 companies.
The regression integrates 11 indexes of industries that correspond to NAF 36 (reference: textile and mineral industries).
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively.
(a) The supports are available in Appendix 4.3.
(b) The supports are available in Appendix 4.2.

Table 4.7: PS-matching estimates - The difference between Top and Low Quality Level impact on Innovation performance (H2) (a)

	Global	Treated	Non-treated	Difference of Mean (b)
	Effect on Product (Top Quality Level vs Low Quality Level)			
NEW OR IMPROVED PRODUCTS FOR THE FIRM	0.19***	0.19***	0.19***	0.41***
TURNOVER DUE TO NEW OR IMPROVED PRODUCTS	0.02	0.02	0.03	0.06**
NEW OR IMPROVED PRODUCTS ON THE MARKET	0.16**	0.17**	0.12**	0.31***
SHARE OF NEW OR IMPROVED PRODUCTS TO THE MARKET	0.03**	0.03**	0.03**	0.04**
	Effect on Processes (Top Quality Level vs Low Quality Level)			
NEW OR IMPROVED PROCESSES FOR THE FIRM	0.09	0.11	0.05	0.24**
TECHNOLOGICALLY NEW PROCESS	0.06	0.08	0.04	0.24
NEW PROCESS (NON-TECHNOLOGICAL)	-0.02	-0.02	-0.03	0.09
	Effect on Innovation Activities (Top Quality Level vs Low Quality Level)			
TOTAL INNOVATION EXPENDITURE (LOGARITHM)	0.63***	0.70***	0.45**	0.65***
NUMBER OF INNOVATION PROJECTS	0.15**	0.15**	0.15**	0.37***

Bootstrapped standard errors.
Source: Survey COI 1997 merges to the CIS3, sample 899 companies.
The regression integrates 11 indexes of industries that correspond to NAF 36 (reference: textile and mineral industries).
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively.
(a) The supports are available in Appendix 4.3.
(b) The supports are available in Appendix 4.2.

Table 4.8: PS-matching estimates - The difference between Medium and Low Quality Level impact on Innovation performance (H2) (a)

	Global	Treated	Non-treated	Difference of Mean (b)
	Effect on Product (Medium Quality Level vs Low Quality Level)			
NEW OR IMPROVED PRODUCTS FOR THE FIRM	0.18***	0.19***	0.18***	0.24***
TURNOVER DUE TO NEW OR IMPROVED PRODUCTS	0.02	0.02	0.02	0.02**
NEW OR IMPROVED PRODUCTS ON THE MARKET	0.11**	0.10**	0.11**	0.16***
SHARE OF NEW OR IMPROVED PRODUCTS TO THE MARKET	0.01	0.01	0.01	0.01**
	Effect on process (Medium Quality Level vs Low Quality Level)			
NEW OR IMPROVED PROCESSES FOR THE FIRM	0.02	0.02	0.02	0.10**
TECHNOLOGICALLY NEW PROCESS	-0.01	-0.02	-0.00	0.03
NEW PROCESS (NON-TECHNOLOGICAL)	-0.02	-0.01	-0.01	0.04
	Effect on Innovation Activities (Medium Quality Level vs Low Quality Level)			
TOTAL INNOVATION EXPENDITURE (LOGARITHM)	0.26**	0.31**	0.21*	0.45***
NUMBER OF INNOVATION PROJECTS	0.16**	0.16**	0.15**	0.24***

Bootstrapped standard errors

Source: Survey COI 1997 merges to the CIS3, sample 441 companies.

The regression integrates 11 indexes of industries that correspond to NAF 36 (reference: textile andmineral industries).

Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively.

(a) The supports are available in Appendix 4.3.

(b) The supports are available in Appendix 4.2.

4. Conclusion

The **chapter 4** provides empirical findings that support the notion that quality practices improve innovation performance. This approach is based on the argument that quality practices, in both their human and technological dimensions, help to create an environment and culture that support innovation. Moreover, quality systems allow for better customer orientation, employee involvement, improved leadership, better access to tools, regular meetings and better team spirit, all of which will improve innovation performance.

This chapter adds to the growing body of literature concerning the impact of quality on innovation performance in three unique ways. Firstly, we have used three different Quality Levels, based on either ISO certification or additional certification and considered the network of relationships between the firm and its external environment. Secondly, we have analysed different innovation areas using nine innovation indicators. Finally, using propensity score methodology we have corrected for bias selection.

Our empirical evidence is consistent with the first hypothesis stating that there is a positive and significant relationship between ISO 9000 certification and innovation performance. However, it seems that there are specific fields of innovation where a quality system has no significant effect. Moreover, our results suggest that the impact of quality systems on innovation varies according to the type of innovation examined. This suggests that in order for quality systems to achieve maximum impact across the full range of innovation practices they have to be integrated with other organisational resources existing within a firm.

Concerning the second hypothesis, our findings demonstrate that there is a positive and significant relationship between Quality Levels and innovation performance for specific areas of innovation. This is particularly true when we compare and contrast Top and Medium Quality Level, and Top and Low Quality Level. Furthermore, four innovation indicators can be positively influenced by Medium Quality Level firms as compared to the impact obtained by Low Quality Level firms. This indicates that firms can utilise additional or substitute certification or even access indirect certification (via suppliers) in order to make a positive impact on specific innovation areas. Importantly, these results imply that Medium Quality Level firms can still make a positive impact on innovation whilst avoiding the costly processes of direct ISO 9000 certification. In other words, by switching to only one position up on the quality hierarchy (*i.e.* becoming Medium Quality Level), firms can improve their innovation performance. However, those firms that want to pursue a high level of innovation performance must have the capability to fully manage quality requirements.

4.1 Managerial Implication

Several managerial implications may be derived from this chapter. First, the evidences suggest that firms that want to establish source of longer term competitiveness such as innovation (Perdomo-Ortiz *et al.*, 2006), could achieve this objective through ISO 9000 implementation. However, the findings indicate that specific innovation indicators can not be improved by ISO 9000 adoption (new or improved processes and non-technological new process). This may itself depend on the way that certification is implemented and the firm's strategy is defined. Therefore managers should implement ISO 9000's practices (customer focus, leadership, involvement of people, process approach, system approach to management, continual improvement, factual approach to decision making) to suit each firm's unique strategic direction and performance especially as regards innovation.

Second, the involvement of all actors dealing with a firm is essential, including also the commitment of suppliers. The implication of our findings is that being ISO certified reinforces a firm's innovation performance especially when suppliers are also ISO certified (Top quality level firms). In other words, managers have to build strong links with ISO certified suppliers. This implies that companies should pay attention not only to their own certification, but also to the quality certification of their suppliers.

Third, our results confirm that firms can benefit from a quality effect indirectly or through substitute certification. Specifically, firms without ISO certification can deal with ISO certified suppliers in order to benefit from quality management experience and in this way improve their own innovation performance. The contribution could be especially significant for managers of small firms. A costly process of ISO certification presents an obstacle for small firms in adopting certification. Hence some firms may try to obtain substitute or indirect, through their suppliers, certification, to gain advantage of ISO certification, but at the same time try to avoid the difficult and costly process of ISO certification. However, for managers, it is important to understand that an internal well established quality management system is a prerequisite for excellent innovation performance, and a substitute or indirect certification (through suppliers) is not sufficient for significant innovation performance improvement.

Fourth, as proposed by Lopez-Mielgo *et al.*, (2009) quality and innovation departments should cooperate in order to ease quality and innovation improvement.

4.2 Research limitations and future directions

This chapter has some limitations that can be overcome in future researches. Among others, the limitations that may be encountered are of three types.

Firstly, future work should explore equivalent questions in multiple industries and countries. While the manufacturing industry is suitable for studying how quality systems impact innovation performance, our evidence is not applicable to other industries. Furthermore, future empirical analysis of the issue could be based in other countries, especially if we consider that there are cultural differences concerning quality practices. These would provide further insights that would assist in generalising the findings. Secondly, there is a problem of temporary limitations. The implementation of any type of tool, system or program related to quality tends to pay off in the long run, according to academic literature. Hence, the age of certification should affect the overall performance of the firm. Therefore, it is important to conduct analysis to see whether early adopters of quality practices have better impact on innovation performance than new ones. Finally, different quality dimensions may impact differently on innovation performance (Abrunhosa and Moura E Sà, 2008; Prajogo and Sohal, 2004; Prajogo and Hong 2008). We can extend our research by examining how different dimensions of ISO 9000 impact on different innovation indicators. Providing a detailed analysis of the impact of ISO 9000's dimensions on innovation, the findings could enable policy-makers to better formulate and effectively apply regulations governing innovation improvement within firms.

APPENDICES CHAPTER IV

Appendix 4.1: Pearson correlation coefficients

Appendix 4.2: Mean of Innovation Performance

Appendix 4.3: Supports of the PS-matching estimates

Appendix 4.1: Pearson correlation coefficients

	NEW OR IMPROVED PRODUCTS	TURNOVER DUE TO NEW OR IMPROVED PRODUCTS	NEW OR IMPROVED PRODUCTS	SHARE OF NEW OR IMPROVED PRODUCTS	NEW OR IMPROVED PROCESS	TECHNOLLOGICALLY NEW PROCESS	INNOVATION EXPENDITURE	INNOVATION PROJECTS	ISO 9000 in 1994	ISO 9000 in 1997	ISO 9000 SUPPLIERS	OTHER CERTIFICATION	SMALL	BIG	COST	NEW PROCEDURE	COMPETITIVE PRESSURE	UNCERTAINTY	CLEINTS CONDITIONED	SUPPLIERS CONDITIONED	STOCKHOLDERS CONDITIONED
NEW OR IMPROVED PRODUCTS	1.00																				
TURNOVER DUE TO NEW OR IMPROVED PRODUCTS	0.55	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEW OR IMPROVED PRODUCTS	0.67	0.47	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHARE OF NEW OR IMPROVED PRODUCTS	0.38	0.78	0.57	1.00	-	-	-	-	-	-	-	-	-								
NEW OR IMPROVED PROCESS	0.48	0.30	0.42	0.26	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TECHNOLLOGICALLY NEW PROCESS	0.39	0.26	0.42	0.29	0.73	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEW PROCESS	0.21	0.11	0.15	0.32	0.50	0.01	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INNOVATION EXPENDITURE	0.34	0.30	0.31	0.05	0.30	0.24	0.10	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-
INNOVATION PROJECTS	0.64	0.36	0.48	0.25	0.49	0.37	0.26	0.32	1.00	-	-	-	-	-	-	-	-	-	-	-	-
ISO 9000 in 1994	0.09	0.04	0.06	0.24	0.03	0.04	0.02	0.03	0.05	1.00	-	-	-	-	-	-	-	-	-	-	-
ISO 9000 in 1997	0.26	0.17	0.21	0.03	0.18	0.16	0.08	0.13	0.23	0.40	1.00	-	-	-	-	-	-	-	-	-	-
ISO 9000 SUPPLIERS	0.26	0.16	0.19	0.15	0.17	0.12	0.09	0.18	0.22	0.21	0.57	1.00	-	-	-	-	-	-	-	-	-
OTHER CERTIFICATION	0.16	0.11	0.15	0.13	0.11	0.11	0.06	0.16	0.16	-0.05	0.14	0.29	1.00	-	-	-	-	-	-	-	-
SMALL	-0.32	-0.16	-0.24	0.11	-0.26	-0.21	-0.13	-0.08	-0.29	0.05	-0.34	-0.32	-0.24	1.00	-	-	-	-	-	-	-
BIG	0.32	0.07	0.24	-0.10	0.26	0.21	0.13	0.08	0.29	0.08	0.34	0.32	0.24	-0.01	-	-	-	-	-	-	-
COST	0.09	0.03	0.06	0.04	0.13	0.09	0.05	0.01	0.09	0.02	0.17	0.18	0.06	-0.18	1.00	-	-	-	-	-	-
NEW PROCEDURE	0.04	0.06	0.04	0.03	0.09	0.07	0.04	0.06	0.05	0.01	0.09	0.10	0.08	-0.02	0.18	1.00	-	-	-	-	-
COMPETITIVE PRESSURE	0.06	0.03	0.04	0.02	0.02	-0.01	-0.01	-0.02	0.06	-0.02	0.09	0.11	0.05	-0.08	0.02	0.07	1.00	-	-	-	-
UNCERTAINTY	0.00	-0.03	-0.01	0.03	-0.01	-0.04	0.00	-0.03	-0.05	0.01	-0.00	0.02	-0.01	0.07	0.08	0.05	0.27	1.00			
CLEINTS CONDITIONED	-0.01	-0.01	-0.02	-0.03	0.02	0.03	-0.01	-0.02	0.00	0.00	0.09	0.10	0.08	-0.03	-0.07	0.11	0.16	0.09	1.00	-	-
SUPPLIERS CONDITIONED	-0.02	0.01	-0.03	0.01	-0.02	-0.01	-0.02	0.02	-0.04	0.00	-0.05	-0.01	-0.02	0.13	0.03	-0.00	0.08	0.12	0.18	1.00	-
STOCKHOLDERS CONDITIONED	0.08	0.07	0.08	0.09	0.07	0.03	0.11	0.06	0.09	0.03	0.15	0.14	0.11	-0.19	0.18	0.03	0.05	0.04	0.06	0.05	1.00

Source: Survey COI 1997 merges to the CIS3.

Appendix 4.2: Mean of Business Performance

	ISO 9000 CERTIFIED FIRMS	ISO 9000 NON CERTIFIED FIRMS	TOP QUALITY LEVEL	MEDIUM QUALITY LEVEL	LOW QUALITY LEVEL
NEW OR IMPROVED PRODUCTS FOR THE FIRM	0.68	0.41	0.69	0.52	0.28
TURNOVER DUE TO NEW OR IMPROVED PRODUCTS	0.11	0.06	0.11	0.07	0.05
NEW OR IMPROVED PRODUCTS ON THE MARKET	0.46	0.25	0.47	0.32	0.16
SHARE OF NEW OR IMPROVED PRODUCTS TO THE MARKET	0.06	0.03	0.06	0.03	0.02
NEW OR IMPROVED PROCESSES FOR THE FIRM	0.49	0.30	0.49	0.35	0.25
TECHNOLOGICALLY NEW PROCESS	0.33	0.18	0.40	0.19	0.16
NEW PROCESS (NON-TECHNOLOGICAL)	0.17	0.12	0.18	0.14	0.09
TOTAL INNOVATION EXPENDITURE	0.89	0.50	0.90	0.70	0.25
NUMBER OF INNOVATION PROJECTS	0.62	0.37	0.62	0.49	0.25

Source: Survey COI 1997 merges to the CIS3, sample 1 146 companies.

Appendix 4.3: Supports of the PS-matching estimates

Table A: ISO 9000 Certified Firms vs ISO Non Certified Firms

Characteristics	*New or improved products for the firm*
MIN	774
MAX	1 094
MEAN	944.05
	Turnover due to new or improved products
MIN	813
MAX	1 084
MEAN	950.50
	New or improved products on the market
MIN	767
MAX	1 088
MEAN	940.81
	Share of new or improved products to the market
MIN	821
MAX	1 129
MEAN	943.32
	New or improved processes for the firm
MIN	777
MAX	1 065
MEAN	947.83
	Technologically new process
MIN	817
MAX	1 113
MEAN	946.37
	New process (non-technological)
MIN	752
MAX	1 105
MEAN	942.35
	Logarithm of total innovation expenditure
MIN	788
MAX	1 096
MEAN	958.67
	Number of innovation projects
MIN	814
MAX	1 083
MEAN	958.54

Survey COI 1997 merges to the CIS3, sample 1 146 companies.
The standard deviation of the treatment effect is computed using bootstrap with 150 simulations

Table B: Top Quality Level vs Medium Quality Level

	New or improved products for the firm
MIN	857
MAX	1 104
MEAN	999.37
	Turnover due to new or improved
MIN	832
MAX	1 106
MEAN	998.85
	New or improved products on the market
MIN	852
MAX	1 105
MEAN	994.84
	Share of new or improved products to the market
MIN	865
MAX	1 112
MEAN	996.65
	New or improved processes for the firm
MIN	776
MAX	1 117
MEAN	1 008.14
	Technologically new process
MIN	903
MAX	1 115
MEAN	1 017.57
	New process (non-technological)
MIN	871
MAX	1 097
MEAN	1 005.65
	Logarithm of total innovation expenditure
MIN	823
MAX	1 115
MEAN	996.02
	Number of innovation projects
MIN	835
MAX	1 112
MEAN	1 002.49

Survey COI 1997 merges to the CIS3, sample 952 companies.
The standard deviation of the treatment effect is computed using bootstrap with 150 simulations.[26]

[26] Usually in the literature the standard deviation of the treatment effect is computed using bootstrap with 100 simulations

Table C: Top Quality Level vs Low Quality Level

	New or improved products for the firm
MIN	442
MAX	987
MEAN	618.18
	Turnover due to new or improved products
MIN	456
MAX	842
MEAN	623.17
	New or improved products on the market
MIN	445
MAX	860
MEAN	622.61
	Share of new or improved products to the market
MIN	434
MAX	976
MEAN	617.67
	New or improved processes for the firm
MIN	462
MAX	993
MEAN	634.47
	Technologically new process
MIN	464
MAX	984
MEAN	632.95
	New process (non-technological)
MIN	578
MAX	1 011
MEAN	814.44
	Logarithm of total innovation expenditure
MIN	412
MAX	949
MEAN	629.37
	Number of innovation projects
MIN	432
MAX	954
MEAN	620.81

Survey: COI 1997 merges to the CIS3, sample 899 companies.
The standard deviation of the treatment effect is computed using bootstrap with 150 simulations

Table D: Medium Quality Level vs Low Quality Level

	New or improved products for the firm
MIN	451
MAX	1 146
MEAN	898.27
	Turnover due to new or improved products
MIN	735
MAX	1 146
MEAN	896.93
	New or improved products on the market
MIN	735
MAX	1 146
MEAN	896.93
	Share of new or improved products to the market
MIN	396
MAX	1 146
MEAN	894.10
	New or improved processes for the firm
MIN	656
MAX	1 146
MEAN	893.60
	Technologically new process
MIN	523
MAX	1 146
MEAN	1 146
	New process (non-technological)
MIN	396
MAX	1 146
MEAN	880.71
	Logarithm of total innovation expenditure
MIN	439
MAX	1 146
MEAN	883.28
	Number of innovation projects
MIN	455
MAX	1 146
MEAN	894.33

Survey: COI 1997 merges to the CIS3, sample 441 companies.
The standard deviation of the treatment effect is computed using bootstrap with 150 simulations

Chapter V

Green Not (only) for Profit: An Empirical Examination of the Effect of Environmental Standards on Employees' Recruitment[27]

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[27] This section is a developed version of the article "Green Not (only) for Profit: An Empirical Examination of the Effect of Environmental-Related Standards on Employees' Recruitment" (with Gilles Grolleau and Naoufel Mzoughi) which is accepted for revision in Resource and Energy Economics.

1. Introduction

The way in which a firm manages its human resources is widely recognised as a source of competitive advantage (*e.g.* Pfeffer, 1994). This argument suggests that the use of Human Resource (HR) practices, including comprehensive employee recruitment and selection procedures, incentive compensation and performance management systems, and extensive employee involvement and training, can improve the knowledge, skills and abilities of a firm's current and potential employees, increase their motivation, reduce shirking, and enhance the retention of quality employees while encouraging non-performers to leave the firm (*e.g.* Huselid, 1995). Accordingly, it is important for a firm to adopt human resource practices that will make the best use of its employees.

Owing to the increasing importance of human resource practices to the competitive advantage of firms, the literature has increasingly paid attention to the relationship between HR practices and firm performance. For instance, using a unique international data set from a 1989-1990 survey of 62 automotive assembly plants, MacDuffie (1995) examines the impacts of HR practices, measured by hiring, compensation, status barriers and training, on firm performance. The author concludes that utilisation of these practices leads to productivity improvements. Delaney and Huselid's (1996) results, based on 590 for-profit and non-profit firms from the Nationals Survey, confirm positive associations between human resource practices, such as training and staffing selectivity, and firm performance measures. Furthermore, Ichniowski *et al.*, (1997) investigate the productivity effect of HR practices using data from a sample of 36 steel production lines owned by 17 companies and find that lines using a set of HR practices (such as incentive pay, teams, flexible job assignments, employment security and training) achieve substantially higher levels of productivity than do lines with the more traditional approach. Examining the relationship between Human Resource Management (HRM) practices and the performance of 101 foreign-owned subsidiaries in Russia, Fey and Bjorkman (2001) provide support for the assertion that investments in HRM practices can substantially assist a firm in improving overall performance. In a recent study, Jones *et al.*, (2010) analyse the impact of HR practices on firm performance using a panel data. Their findings indicate that appropriate utilisation of human resource practices enhances productivity.

Generally, the literature review confirms that adoption of well-established HR practices is associated with improved firm performance. Hence, **chapter 5** is not concerned with the empirical analysis of HR practices and firm performance. Rather, it analyses if firm's environmental responsibility makes a firm more attractive to good job seekers. We explore whether the adoption of environmental standards (ES) enhances specific HR practices such as employee recruitment. Such an enhancement would imply that environmental standards deliver more than simply environmental benefits and that firms can strategically use these standards to generate win-win opportunities. In this sense, ES acts as a sophisticated selection tool designed to screen out all but the very best potential employees. Therefore, environmental standards improve firm performance indirectly, via the improvement of employee recruitment, a factor which is found to be positively related to firm performance (*e.g.* Huselid, 1995).

The specific contributions of this chapter are as follows. First, the present research is, to the best of our knowledge, the first that empirically analyses whether the environmental standards can deliver benefits beyond environmental considerations using employee recruitment as a measure for firm performance. The rationale for a positive relationship is based on the fact that a firm's pro-environmental stance is helpful in attracting good applicants, which could be translated into improved performance. Second, it uses databases which provide rich information on firm characteristics. Third, we correct for the potential endogeneity of environmental standards variables employing a bivariate probit model.

The remainder of this chapter is organised as follows. In section 2 we present a literature review. Section 3 presents the data and model specification. The results are provided and discussed in section 4. Section 5 concludes and suggests policy and managerial implications.

2. Literature review

2.1 Employee's perception of environmental standards

In a well-known contribution, the Nobel laureate in economics Milton Friedman (1970) argued that 'there is one and only one social responsibility of business - to use its resources and engage in activities designed to increase its profits so long as it stays within the rules of the game'. Nevertheless, the empirical evidence shows that numerous firms exhibit their voluntary social responsibility commitments. This evidence is notably reflected in the sizeable economics literature devoted to the adoption of voluntary environmental approaches (see **chapter 2**). Interestingly, even Friedman conceded that 'it may well be in the long run interest of a corporation that is a major employer in a small community to devote resources to providing amenities to that community or to improving its government. That may *make it easier to attract desirable employees* (emphasis added by the authors), it may reduce the wage bill or lessen losses from pilferage and sabotage or have other worthwhile effects.'

As we noted in **chapter 3**, in line with the Porter hypothesis, several scholars have emphasised possible economic and environmental benefits resulting from well-crafted voluntary initiatives (Porter and Van Der Linde, 1995; Hart, 1997; Reinhardt, 2000). In a recent survey, Ambec and Lanoie (2008) listed seven channels through which environmental standards may raise the benefits of firms or cut their costs: better access to markets, possibility for differentiation of products, commercialisation of pollution-control technology, savings on regulatory, material energy and services, capital, and labor costs. Among economic benefits, a relatively neglected area is *whether and how* environmental standards improve human resource management. In fact, meeting environmental requirements not only allows a firm to display high levels of environmental conduct but it also may provide, indirectly, various sources of competitive advantage such as improved training, better motivated work forces, the ability to attract desired employees, etc. For example, the multinational corporation, Dole Food Co. Inc. reported that 'key benefits (of adopting Environmental Management Systems) include strong employee motivation and loyalty which translates into reduced absenteeism and improved productivity.[28] In the same vein, Grolleau *et al.*, (2007, see also Darnall *et al.*, 2000) showed that ISO 14001 registration among French agrofood firms was mainly driven by the desire to improve human resource management. Moreover, the authors argue that by implementing environmental approaches, employees may feel better about themselves since they are a part of a project aiming at generating public benefits rather than simply a project oriented towards private benefits. In fact, this kind of participation may provide employees with tangible proof of the firm's real (rather than cosmetic) commitment to supporting a socially responsible project. Based on a case study, Phanuel (2001) confirms that ISO 14001 adoption increased managerial efficiency. Similarly,

[28] Anonymous, 2001, Dole Reports Motivation, Health and Safety, and Productivity Benefits from ISO 14001. ISO Management Systems—*The International Review of ISO 9000 and ISO 14000*, December, 56-58.

Halkos and Evangelinos (2002) argue that an improved motivation of employees is positively associated with EMS implementation. Findings by Diller (1997) suggest that adoption of ISO 14001 certification promotes, among other things, the efficient use of human resources. Kosasih and Shobirin (1995) demonstrate that use of Environmental Management Systems will help a firm in finding optimum solutions in order to avoid the excessive use of human and other resources. Exploring 156 companies, Lewin (1991) confirms that employee morale was up to three times higher in companies that were actively involved in volunteer programs.

The literature review has examined the impact of environmental standards on different management areas, such as marketing, production and finance, but little is known about the dynamics of the interactions between human resource dimensions and environmental standards inside a firm. Moreover, a positive relationship between a firm's environmental responsibility and HR dimensions may be translated into improved firm performance.

Among the several dimensions of human resource management likely to be affected by the adoption of environmental standards, recruitment is an obvious candidate. We presume that a firm's environmental reputation does not only attract customers, but also enables firms to attract high quality employees.

2.2 Recruitment objectives

Firms have always been concerned with attracting the right employees (*e.g.* Schneider, 1987). Boudreau and Rynes (1985) suggest that the ability of a firm to manage information that will increase applicant interest about the firm is key to the economic utility of recruitment efforts. Actually, recruitment is given prominence as the first stage in building an organisation by attracting and choosing the most appropriate candidates. The primary objectives of recruitment are the number and the quality of applicants attracted by the firm (Turban and Cable, 2003).

Incompatibility between the individual and the firm can impede the achievement of necessary performance levels (Lado and Wilson, 1994), while an advanced recruitment process can bring to the firm employees who match the abilities of existing employees and fit into the existing interpersonal structure (Fernadez, 1992). A good fit is an important aspect, because of its relationship with organisational outcomes such as effective socialisation, organisational commitment, job performance and turnover.

Noteworthy, evidence proves that the recruitment process is positively associated with firm performance (*e.g.* Terprstra and Rozell, 1993).

2.3 The relationship between environmental responsibility and recruitment

Attracting top candidates may be easier for firms known for environmental stewardship compared to non-environmentally friendly firms. Indeed, because job choices are made under conditions of limited information, an environmental standard may provide information on the general capability of a firm to meet environmental expectations and make unobservable characteristics public (Spence, 1973; Grolleau *et al.,* 2007). In the early stages of the job selection process, the environmental signals are important because good candidates may be more attracted if they perceive positive signals about the firm (Rynes *et al.,* 1991). In this sense, Brekke and Nyborg (2008) demonstrate that firms may be able to use their 'green' profile as a screening device to attract more productive workers. Furthermore McKinsey (1991, quoted by Gladwin, 1993) surveyed 403 senior executives from around the world and found that 68% of them think that 'organisations with a poor environmental record will find it increasingly difficult to recruit and retain high caliber employees'. Improvement of safety conditions through environmental standards is also likely to attract employees. In this sense, Stigler (1962) suggests that firms that develop reputations for attending to employee welfare may attract better applicants.

Moreover, Judge and Bretz (1992) indicate that while pay, promotional opportunities and the type of work are important predictors of job choice intentions, they are less important than general firm values. Additionally, Crifo and Diaye (2010) demonstrate that non monetary incentives (fringe benefits, status, identity or self-image) play an important role in a firm's employment policy. When making job choice decisions, job seekers compare their values to those they perceive to be held by the firms that are signaling their values. They require complete and accurate organisational information to match their needs properly with organisational offerings (Wanous, 1992). Therefore, environmental standards give potential recruits more information on a firm's business orientation which should allow them to self-select into a firm that fits with their personal values. In this sense, several authors argue that people prefer working for companies they regard as ethical and responsible, in firms that fit the image they would like to give to themselves (Frank, 2003). For instance, assuming that individual's utility increases with their altruistic behavior, Frank (2003, see also Brekke and Nyborg, 2008) contends that if the wages in two companies are the same, there would be an excess supply of applicants to the socially responsible company. In equilibrium, the less altruistic jobs are expected to offer a compensating wage premium. Therefore, altruistic individuals are likely to accept lower wages, and thus allow the firm to balance the cost of its socially responsible operations. Frank's (2003) survey results show that 88 percent of socially concerned respondents would prefer a job for the American Cancer Society rather than for Camel Cigarettes with an average compensating wage premium of about $ 24 000 per year. In this sense, Dechant and Altman (1994) argue that employee perceptions of a firm's environmental behaviour and whether it fits their values profile affects their willingness to work for that firm. Based on the statement of the Division Director of Environmental Affairs for the Dexter Corporation, the authors suggest that college graduates are looking for more than just a pay check; rather they are interested in a firm with which they could identify morally and philosophically. Similarly, a study of the Asia Environmental Office of Sony International showed that introduction of an Environmental Management System had a positive effect on staff recruitment, helping to attract capable employees (Chan, 1997).

Several empirical research examine job seekers' perceptions of the importance of corporate social performance (CSP) and environmental responsibility. For instance, Zappalà (2004) argues that corporate community involvement policies can have a positive effect on a range of employee processes and outcomes that are directly associated with HRM, such as employee motivation, morale, commitment, recruitment, retention, development and teamwork. Backhaus *et al.*,'s (2002) study suggests that CSP is an important attribute for job seekers. Accordingly, firms may find it effective to incorporate CSP information into their recruitment efforts. In addition, the authors hypothesize differences in the effects of CSP dimensions on the ratings of employer attractiveness and find that environment, community relations and diversity dimensions have the largest effects on firm attractiveness ratings. Drawing on social identity theory and signalling theory, Turban and Greening (1997; 2000) argue that corporate social performance may provide a competitive advantage in attracting good job applicants. The authors underline that signalling theory proposes that a firm's CSP sends signals to prospective job applicants about what it would be like to work for a firm. Moreover, social identity theory recommends that job applicants have higher self-images when working for socially responsive firms over their less responsive counterparts. Their findings imply that prospective job applicants are more likely to pursue jobs with socially responsible firms than with firms that have poor social performance reputations. Investigating the effects of an organisation's CSP on its perceived attractiveness as an employer among different job-seeking groups, Schmidt-Albinger and Freeman (2000) conclude that CSP is positively related to employer attractiveness for job seekers. Extending previous research, their findings suggest that an organisation's CSP becomes increasingly important when that organisation seeks to attract highly educated applicants with a high level of job choice. Examining the effect of a pro-environmental stance on the recruiting efforts of a fictitious firm (N=303), Bauer and Aiman-Smith's evidence (1996) supports the idea that a proactive firm stance on the environment would be positively related to perceived firm attractiveness, intentions to pursue employment with that company and acceptance of a job offer.

A related argument, that support positive relationship between environmental standards and employee's recruitment, can be found in the conceptual framework proposed by Margolis (1982), where individuals have two utility functions, one motivated by egoistic considerations and the other motivated by altruistic considerations. Their behavior depends therefore on the trade-off between these two functions. Environmental standards by their nature call for the altruistic utility function. Indeed, individuals would prefer socially responsible companies to reduce their cognitive dissonance, *i.e.* attenuate the possible intrinsic conflict between their employees' preferences (such as earning a high wage) and their citizens' preferences (such as clean environment). Moreover, from the firm's viewpoint, the individual's behavior or aspirations in a given domain (for example, protecting the environment) could be an indicator of his behavior in another domain (for example, working harder which in turn increases profitability) (Porter and Kramer, 2006).

Consequently, we test whether *ceteris paribus* environmental standards improve companies' recruitment.[29]

[29] One can argue that if the less altruistic jobs are expected to offer a compensating wage premium, while altruistic individuals are likely to accept lower wages, and if the wage reflects this sufficiently, less altruistic jobs with higher wages are indifferent to altruistic jobs with lower wages to the employees. If environmental standards improve companies' recruitment process, this can indicate that the wage does not sufficiently adjust to difference in between less altruistic jobs and altruistic jobs. The wage adjustment can be imperfect notably because intrinsic motivations cannot always be translated into monetary tradeoffs (Frey, 1994).

3. Empirical Analysis

3.1 The database

The data is extracted from the French Organisational Changes and Computerisation's (COI, 2006) survey[30] which is explained in detail in **chapter 1**. As we indicated previously, the original dataset included a representative sample of 13 790 private firms located in France from all industries except agriculture, forestry and fishing. Firms were asked to fill in a self-administrated questionnaire concerning the utilisation of information technologies and work organisational practices in 2006 and changes that have occurred since 2003.

Firms were also interviewed on the economic goals of organisational change and the economic context in which those decisions were made. The question about recruitment was stated as follows: 'Do you have difficulties in recruiting?' Two categories of employees are distinguished: (1) professional employees other than computer specialists, and (2) non-professional employees. For each category of employees, the surveyed firms had to answer either on a 4-point scale, ranging from 'no difficulties' to 'very high difficulties' or choose 'no recruitment'.

Because two variables, namely the average wage and exports, were not available in the COI database, it was merged with two other French databases. The first set of data is called the Annual Statement of Social Data (Déclarations Annuelles de Données Sociales, DADS) which is used to obtain information about wages. It contains administrative documents filled in by employers and reported to the Social Security and Tax Agencies. Some DADS information has been collected every year since 1950; the current system was first used for the declarations relating to 1993. The DADS processing system permits researchers to have a kind of ongoing census of employee wages, number of days worked during the course of each year, qualifications, occupation, duration of employment, etc. The results are usually available 15 months after the end of the reporting year.

To obtain information about firm's export level we use the Annual Enterprise Survey (Enquête Annuelle d'Entreprises, EAE).

[30] More details about the design and scope of this survey are available on www.enquetecoi.net. : Survey COI-TIC 2006-INSEE-CEE/Treatments CEE.

The final dataset includes 10 840 observations. The definitions of variables used for descriptive statistics and in estimation are presented in Table 5.1. No problem of multicolinearity has been detected (Appendix 5.1).

Table 5.1: Definition of variables

Variable	**Definition**
Dependent variables	
PROFESSIONAL EMPLOYEES	Problems in recruitment of professional employees Dummy variable (=1 if no or weak)
NON PROFESSIONAL EMPLOYEES	Problems in recruitment of non-professional employees Dummy variable (=1 if no or weak)
Independent variables	
ES	Registered for ISO 14000, organic labeling or fair trade Dummy variable (=1 if registered in 2006)
ACTIVITY	The main activity of the firm 11 dummy variables (=1 if agrifood, consumption goods, cars and equipments, intermediate goods, energy, construction, commercial, transport, financial and real-estate activities, services for firms and services for individuals, respectively)[a]
SIZE	SMALL (20 TO 199 employees) MEDIUM (200 TO 499 employees) BIG (more than 500 employees)
GROUP	Belonging to a group Dummy variable (=1 if yes)
NETWORK	Belonging to a network Dummy variable (=1 if yes)
WAGE	Logarithm of average wage within a firm (Continuous variable)
QS 2003	Registered with ISO 9000, EAQF, etc Dummy variable (=1 if certified in 2003)
QS 2006	Registered with ISO 9000, EAQF, etc Dummy variable (=1 if certified in 2006)
RELOCATION	Relocation abroad of a part of the business Dummy variable (=1 if yes)
EXPORT	Share of firm exportation by turnover (Continuous variable)
PUBLIC SERVICES	The firm uses public services for recruitment Dummy variable (=1 if yes)
TEMPING AGENCY	The firm uses temping agency for recruitment Dummy variable (=1 if yes)
PRO_NETWORK	The firm uses professional network for recruitment Dummy variable (=1 if yes)
REC_INTERNET	The firm uses its own internet website for recruitment Dummy variable (=1 if yes)
WEB	The firm uses employment websites for recruitment Dummy variable (=1 if yes)

The sectors are considered according to the French nomenclature.
Source: COI and DADS, sample 10 840 firms.

Descriptive Statistics

Table 5.2 provides information on environmentally registered firms. Moreover, we distinguish here between firms that adopted ES in 2003 and 2006, in order to understand whether those characteristics change over time.

Table 5.2: Descriptive Statistics

	ES in 2003	ES in 2006
	Company's Size	
SMALL	79%(a)	78%
MEDIUM	11%	12%
BIG	10%	10%
	Corporate status	
GROUP	59%	58%
NETWORK	77%	78%
	Previous experience	
QS in 2003	87%	72%
QS in 2006	82%	82%
	Mean export by firm's turnover	
EXPORT	0.13	0.13
	Relocation	
RELOCATION	8%	7%
	Wage	
WAGE	9.71	9.71
Total	**9%**	**12%**

Source: Survey COI and DADS, 2006, sample 10 840 firms, weighted by the number of employees.
Lecture: (a) 79% of "ES in 2003" are firms that belong to category of small firms.

Concerning firm size, we found similar results between the two types of ES adopters. Around 80% of firms certified with environmental standards belong to the category of small firms, whilst around 10% of those firms belong to the category of big firms. Furthermore, we arrive at the same conclusion when we look at variables that present a firm's corporate status. The evidence indicates that approximately 60% of both types of environmentally certified firms are part of a group while around 80% of those firms belong to a network. Interestingly, firms that adopted ES in 2003 implemented more quality standards in 2003 (87%) than firms that adopted ES in 2006 (72%). On the other hand, we obtain the same results for both types of environmentally certified firms concerning the adoption of quality standards in 2006

(82%). To make signs of commitment to environmental actions more visible to their foreign customers, firms adopt environmental standards. Our results demonstrate that both types of environmentally registered firms have the same level of exports. Furthermore, firms that have implemented environmental standards in 2003 relocate their business slightly more (7%) than firms that adopted ES in 2006 (6%). Finally, the findings indicate that the mean of avarage firm's wage is the same for the two types of environmental adopters.

3.2 Estimation strategy

The dependent variables, denoted *PROFESSIONAL EMPLOYEES* and *NON-PROFESSIONAL EMPLOYEES*, are binary variables equal to 1 if the firm has no or weak problems of recruiting professional and non-professional employees, respectively. To test the main hypothesis of this chapter, that is, environmental standards improve companies' recruitment *ceteris paribus*, we use the variable denoted *ES*, which is a binary variable equal to 1 if the firm was registered according to one of the following standards, *i.e.* ISO 14001 standard, organic labeling, fair trade, etc in 2006.[31]

Several factors that are likely to influence the recruitment serve as control variables. First, the ease of recruitment is likely to vary across sectors. Some sectors are more attractive than others for a variety of reasons such as better wages and better working conditions compared to a similar position in another sector. Some sectors can also benefit from the fact that job seekers prefer working for companies they regard as corresponding to their values and expectations. The sector effect is tested using the variable *ACTIVITY*.[32] According to the French Nomenclature, we consider 11 sectors: agrifood, consumption goods, cars and equipments, intermediate goods, energy, construction, commercial, transport, financial and real-estate activities, services for firms and services for individuals. The sector of service for individuals plays as reference category.

Second, the firm size is likely to influence the recruitment of employees. Among other advantages, bigger firms frequently have more financial resources, more human resources, have access to various recruiting channels and can offer better promotion opportunities or

[31] Unfortunately, we cannot distinguish between those standards, since they were put together under the same name in the survey. Threfore, we cannot estimate the specific effects of each program.
[32] We do not formulate predictions regarding which sectors experience more or less difficulties in recruiting employees. Despite its interest, this issue is beyond the scope of this chapter.

services, resulting in being more attractive to job seekers, compared to smaller firms (Atkinson and Storey, 1994). The effect of firm size, broadly considered, is tested through the variables *SIZE* (number of employees), *GROUP* (belonging to a group) and *NETWORK* (belonging to a business network such as a franchise network).

Third, wages offered by firms (*WAGE*) may have an impact on recruitment. Higher wages are likely to attract more candidates. According to Phelps (1968), when firms are confronted with a difficulty to fulfil jobs they may respond by offering higher wages compared to wages paid elsewhere, in order to encourage potential candidates to choose their company.

Fourth, firms registered for the quality standard might experience fewer difficulties in recruiting employees. The quality standard can deliver benefits likely to motivate potential employees such as increased participation in decision-making procedures and improved job satisfaction. Consequently, if potential employees are only sensitive to the effects resulting from these organisational improvements and insensitive to the environmental effects, then the adoption of an environmental standard in addition to a quality standard will not improve the recruitment process. This effect is tested using two variables: *QS 2003* (registration according to the standard ISO 9001, EAQF, etc in 2003) and *QS 2006* (registration according to the standard ISO 9001, EAQF, etc in 2006). These variables allow to take into account potential correlation within firms between environmental and organisational issues.

Fifth, firms that relocate abroad a part of their business may hold many attractive characteristics for productive job-seekers. For instance, these firms may be bigger, possibly being able to offer both more varied and more prestigious career opportunities. They may be also able to offer the possibility of working abroad, which may also be attractive for some job-seekers. This effect is tested using the variable *RELOCATION* which captures whether the firm has an office or plant abroad.

Finally, it is argued that informal recruitment methods (*e.g.* personal networks) produce fewer difficulties in employee recruitment than formal methods (*e.g*. newspaper advertisements, employment agencies, both public and private, etc). Two theoretical perspectives could explain these arguments. One perspective suggests that potential candidates who are informally recruited through referrals have a better person-job fit than those who are recruited formally (Ullman, 1966). Extensive personal observations of the potential applicant are used to make a person-job fit assessment and to screen applicants. In contrast, recruiters have less information about potential candidates recruited through formal sources. In this situation, person-job fit is generally assessed by a short job interview. The validity and reliability of the job interview has been questioned (Arvey and Campion, 1982) because recruiters are able to collect only a small sample of information about the job applicant's personal attributes. Secondly, Taylor and Schmidt (1983) suggest that informal recruitment sources are more effective than formal recruitment sources because informally recruited employees have more opportunities to gather accurate information about the job's attributes. Unfortunately, our base provides only examples of formal recruitment through the variables *PUBLIC SERVICES*, *TEMPING AGENCY*, *PRO_NETWORK*, *REC_INTERNET* and *WEB*.

Noteworthy, the same unobservable factors may have an impact on both employees' recruitment and the firm's likelihood to register for environmental standards. Actually, if we use directly ES in order to explain employee's recruitment, we risk to obtain biased results. In term of econometrics, it means that the variable *ES* is endogenous. Previous studies (*e.g.* Arora and Cason, 1995; Nakamura *et al.*, 2001; Grolleau *et al.*, 2007; Arimura *et al.*, 2008) show that the firm size, quality standards and the main activity of a firm are positively related to participation in environmental standards such as ISO 14001. Grolleau and Mzoughi (2005) argue that achieving scale economies by applying the same standard in all production units regardless of the location can drive firms to adopt environmental standards.

Hence, this potential unobserved heterogeneity will result in the correlated error terms of variables that present recruitment and environmental standards. Thus, we apply a bivariate probit model in order to correct for endogeneity of the variable *ES* (Greene, 2003). Our model is formulated as a system of two latent-variable equations with normally distributed and correlated disturbances: one for a firm's ES adoption decision and a second for the recruitment decision. Moreover, Maddala (1983) argues that this is a specific case of the bivariate probit model, denoted by Greene (2003) as a recursive model. The bivariate probit model relies on a simultaneous estimation approach in which the factors that determine a firm's environmental registration are estimated simultaneously with the factors that determine recruitment. The two equations are jointly estimated using maximum likelihood.

Our observed variables, Y_1 and Y_2, corresponding respectively to environmental standards and recruitment are defined by:

$$\begin{aligned} &Y_1 = 1 \quad if \quad Y_1^* > 0, \\ &Y_1 = 0 \quad otherwise. \end{aligned} \qquad (1)$$

$$\begin{aligned} &Y_2 = 1 \quad if \quad Y_2^* > 0, \\ &Y_2 = 0 \quad otherwise. \end{aligned} \qquad (2)$$

Y_1^* and Y_2^* are latent variables influencing the probability of registration with environmental standards and employees' recruitment, respectively. We consider the following bivariate probit model:

$$\begin{cases} Y_1^* = \alpha_1 + \beta_1 X_1 + \delta Z_1 + \mu_1 \\ Y_{2k}^* = \alpha_2 + \beta_2 X_2 + \gamma Y_1 + \mu_2 \\ E[\mu_1] = E[\mu_2] = 0 \\ Var[\mu_1] = Var[\mu_2] = 1 \\ Cov[\mu_1, \mu_2] = \rho \end{cases} \qquad (3)$$

where X_1 is a vector of exogenous variables including a constant firm's characteristics (*ACTIVITY*, *SIZE*, *GROUP*, *NETWORK*, *QS 2003*, *QS 2006* and *RELOCATION*). X_2 includes the variables *ACTIVITY*, *SIZE*, *GROUP*, *NETWORK*, *WAGE*, *QS 2003*, *QS 2006*, *RELOCATION*, *PUBLIC SERVICES*, *TEMPING AGENCY*, *PRO_NETWORK*, *REC_INTERNET* and *WEB*.

β_1, β_2, δ and γ are slope coefficients to be estimated. α_1, α_2, μ_1 and μ_2 are the intercepts and disturbance terms for the two equations, respectively. *k* distinguishes between professional and non-professional employees.

rho is the correlation between the error terms in the recruitment and environmental standards equations. Residuals of the equations above follow a normal bivariate normal distribution (BVN) with zero means and a covariance matrix that writes, after normalisations to 1 of the diagonal elements, as follows:

$$\begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} \rightarrow N(0,\Sigma), \text{ where } \Sigma = \begin{pmatrix} 1 & \rho_{12} \\ \rho_{12} & 1 \end{pmatrix}$$

A Wald test of the significance of *rho* is a direct test of the endogeneity of Y_1 and Y_2 (Wooldridge, 2002). When *rho* is statistically different from zero, that is, the probability that a relationship exists between environmental standards and recruitment, simultaneous estimation procedures are essential to appropriate estimation.

The vector of variables Z_1 represents the instrumental variable which usually guarantees the identification of the model and helps to estimate correlation coefficients (Maddala, 1983). Indeed, in order to identify the bivariate probit, we generally need an additional variable that will explain the probability of environmental standards but not relevant to explain recruitment. The difficulty here is that we can expect very similar factors to influence both the probability of ES adoption and recruitment. Since a formal econometric test that could indicate the correct specification of the model is not available, any argument as to why specific variables are expected to influence one equation and not the other has to be of a substantive, theoretical nature. However, Wilde (2000) has clarified the matter and has shown that identification by functional form is necessary in the absence of exclusion restrictions. More precisely, the author states that in recursive bivariate probit models, it is sufficient that each equation includes one exogenous regressor to achieve identification. Nevertheless, the common practice is to impose restrictions whenever it is possible to improve the identification of the model. In this chapter, we use the share of exports by turnover (*EXPORT*) as an instrumental variable.[33]Signaling or screening rationales (Spence, 1973) can explain why exportation affects adoption of environmental standards. Firms that have distant customers are more likely to prove their environmental commitment through institutional devices like environmentally standards because firms' environmental performance is frequently unobservable, especially to customers located in areas which are institutionally, geographically and culturally different. In other words, environmental standards may prove the ability of the supplier to meet environmental expectations of customers and make public

[33] Since the variable *EXPORT* is continuous, it may seem that it is more likely to capture firm size than export *per se*. To check this issue, we tested a model using exports as a dummy variable. The results remained unchanged.

unobservable attributes (Grolleau *et al.*, 2007). However, we do not expect *a priori* an effect of exports on employees' recruitment. Moreover, even if a potential effect exists it can be captured by the variable *WAGE*, used as a control variable. Indeed, since the contribution of Bernard and Jensen (1995), some empirical studies showed that average wages in exporting firms are higher than in non-exporting firms from the same industry and region (for a recent review of the literature, see Schank *et al.*, 2007). Moreover, there is no evidence that support positive correlation between export and employee's recruitment.

Noteworthy, using BVN to indicate the distribution function of the bivariate standard normal distribution with correlation *rho*, we obtain the four basic probabilities of this bivariate probit model, which are:

$$
\begin{aligned}
&Prob[Y_1=1,Y_2=1]=BVN(\beta_1X_1,\beta_2X_2+\delta,\rho)\\
&Prob[Y_1=1,Y_2=0]=BVN(-\beta_1X_1,\beta_2X_2,-\rho)\\
&Prob[Y_1=0,Y_2=1]=BVN(\beta_1X_1-\beta_2X_2,-\delta,-\rho)\\
&Prob[Y_1=0,Y_2=0]=BVN(\beta_1X_1,-\beta_2X_2,-\rho)
\end{aligned}
\tag{4}
$$

Thus, the expected value for Y_1, given the vectors X_1 and X_2 is:

$$
\begin{aligned}
&E(Y_1\mid X_1,X_2)=Prob[Y_2=1]E(Y_1\mid Y_2=1,X_1,X_2)+Prob[Y_2=0]E(Y_1\mid Y_2=0,X_1,X_2)\\
&=Prob[Y_2=1]Prob[Y_1=1\mid Y_2=1,X_1,X_2]\\
&+Prob[Y_2=0]Prob[Y_1=1\mid Y_2=0,X_1,X_2]\\
&=Prob[Y_1=1,Y_2=1]+Prob[Y_1=0,Y_2=0]\\
&=BVN(\beta_1X_1,\beta_2X_2+\delta,\rho)+BVN(-\beta_1X_1,\beta_2X_2,-\rho)
\end{aligned}
\tag{5}
$$

4. Results and discussion

Bivariate probit estimation results are presented in Tables 5.3 and 5.4, together with goodness-of-fit measures (Maximum-Likelihood estimation). We also report average treatment effects for the variable *ES*. The average treatment effect is the average difference between the probability that a firm improves its recruitment when it is registered for an environmental standard and the probability that it improves its recruitment when it is not registered for an environmental standard. Hence, the average treatment effect equals:

$$\frac{1}{N}\sum_{i=1}^{N}\left[\Phi(\alpha_2 + X_{2i}\beta_2 + \gamma) - \Phi(\alpha_2 + X_{2i}\beta_2)\right] \qquad (6)$$

In both models *rho* is significantly different from 0. This means that the variable of environmental standards is endogenous and it confirms the interest in using the bivariate probit model. Several versions of the model have been estimated to investigate the robustness of results to the omission of some variables. The main results remain unchanged.

We first present the estimation results regarding the factors that may influence firms to adopt environmental standards. The results are similar for both models, that is, for professional and non-professional employees. As expected, the variables *SIZE, QS 2003, QS 2006* and *RELOCATION* are significant. Belonging to a network was found to have a negative impact on environmental standards adoption. Belonging to a group positively influences the adoption of environmental standards for both models what confirms results form **chapter 3**. Two sectors, that is, intermediate goods and energy, are more sensitive to the registration of environmental standards. Finally, as expected our instrumental variable is positive and significant for both models.

The main hypothesis of **chapter 5**, that is, environmental standards have an impact on recruitment, is confirmed for professional and non-professional employees. This result is consistent with that of several studies (*e.g.* Grolleau *et al.*, 2007) which showed that improvement of human resource management is one of the major drivers of environmental management systems registration. Interestingly, average treatment effects show that the hypothesis is relatively more supported for non-professional employees than professional ones. Firms with environmental standards are 79 percent (respectively 47 percent) more likely to improve recruitment of non-professional employees (respectively professional employees) compared to firms without environmental standards. Based on the fact that non-professional employees are most affected by environmental damages, we can understand the interest of non-professional employees towards working in environmentally registered firms. Moreover, the result for professional staff is consistent with several studies stating that well-educated individuals are more likely to exhibit environmentally friendly preferences (*e.g.* Torgler and Garcia-Valinas, 2007). This result can indicate to registered firms to more publicise their environment commitment in circles of well-educated people rather than adopting a 'one-size-fits-all' approach.

Our analysis provides also information about other determinants of recruitment. The results are generally similar for both models. The variables *SIZE, GROUP, NETWORK* and *WAGE* are significant, as expected. In other words, big firms, firms who belong to a group or a network, and firms who offer higher wages have fewer problems in recruiting employees. However, it is important to mention that big firms have no influance on recruitment of non-professionals. The variables *QS 2003* and *QS 2006* are significant when considering professional and non-professional employees, but their signs are negative. This result can be explained by the divergence between promises and real impacts of adopting a quality standard. Several authors (*e.g.* Lasfargues, 1994) argue that ISO 9001 rarely delivers the expected benefits and the adoption process reduces employees' autonomy and flexibility, impedes creativity because of formal procedures, is red tape generating and time-consuming and frequently constitutes a source of stress at the workplace, especially at audit times. If job seekers are informed about these presumed real effects of quality standards, they may be less interested to apply to firms where the standard is implemented. The variable *RELOCATION* has a significant impact on recruitment of non-professional employees only. This result may be explained by the fact that we do not take into account destinations neither the reasons of relocation. For instance, if a firm relocates a part of its business in order to lower wage rates, which are an often quoted reason for relocating labor-intensive divisions, it might experience a difficulty to attract professional employees. As expected, variables that present formal way of recruitment when significant they are negative what indicate that they increase the difficulties of recruitment. Finally, when considering non-professional employees, the variable *ACTIVITY* is significant for 3 sectors: consumption goods, services for firms and services for individuals. This result can be explained by the fact that usually in those sectors employers use more 'word-of-mouth' (that is, informal) recruitment methods –via relatives, friends, current employees and people already known as workers at other firms (*e.g.* suppliers/competitors) (Goodman *et al.*, 1998). An implication of this result could be that sectors/firms seeking highly professional employees are more likely to benefit from adopting environmental standards than the others, notably in terms of facilitated recruitment.

Table 5.3: Bivariate probit estimates of the effect of environmental standards on recruitment of professional employees

		ES		PROFESSIONAL EMPLOYEES	
Variables		Estimate	z-value	Estimate	z-value
Intercept		-1.62***	-17.76	-1.85***	-5.84
ES		-	-	0.69***	4.49
SIZE	MEDIUM	0.19***	3.89	0.22***	5.41
	BIG	0.60***	13.62	0.27***	5.02
GROUP		0.08*	1.89	0.17***	5.71
NETWORK		-0.32***	-5.99	0.19***	4.71
WAGE		-	-	0.21***	6.01
QS 2003		0.19***	2.90	-0.11*	-1.90
QS 2006		0.94***	13.47	-0.15***	-2.46
RELOCATION		0.23***	3.59	0.08	1.29
EXPORT		0.53***	6.63	-	-
PUBLIC SERVICES		-	-	-0.21***	-6.22
TEMPING AGENCY		-	-	-0.14***	-4.06
PRO_NETWORK		-	-	-0.09***	-2.59
REC_INTERNET		-	-	-0.00	-0.14
WEB		-	-	-0.01	-0.47
AGRIFOOD		0.15	1.43	-0.06	-0.75
CONSUMPTION GOODS		-0.03	-0.31	-0.09	-1.08
CARS AND EQUIPMENTS		-0.06	-0.59	-0.43***	-5.44
INTERMEDIATE GOODS		0.17*	1.71	-0.38***	-5.19
ENERGY		0.96***	5.10	-0.34*	-1.95
CONSTRUCTION		-0.01	-0.12	-0.94***	-11.45
COMMERCIAL		0.04	0.49	-0.13**	-2.07
TRANSPORT		-0.33***	-2.97	-0.06	-0.86
FINANCIAL AND REAL-ESTATE ACTIVITIES		-0.09	-0.57	-0.07	-0.65
SERVICES FOR FIRMS		-0.40***	-4.03	-0.01	-0.15

Likelihood ratio	-9501.907
WaldChi2(36)	2387.24
Rho	-0.34***
Wald test of rho=0 Chi2(1)	12.64***
Number of observations	9 348
Number of registered firms	1 675
Marginal effects of the variable *STANDARD*	0.27
Average treatment effects of the variable *STANDARD*	0.47***

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.
Sector reference: SERVICES FOR INDIVIDUALS.

Table 5.4: Bivariate probit estimates of the effect of environmental standards on recruitment of non-professional employees

		ES		NON-PROFESSIONAL EMPLOYEES	
Variables		Estimate	z-value	Estimate	z-value
Intercept		-1.58***	-17.78	-2.63***	-6.95
ES		-	-	0.96***	4.35
SIZE	MEDIUM	0.17***	3.38	0.17***	3.15
	BIG	0.58***	12.57	0.06	0.83
GROUP		0.04	0.92	0.14***	3.87
NETWORK		-0.33***	-6.02	0.11**	2.27
WAGE		-	-	0.34***	7.97
QS 2003		0.19***	2.88	-0.12*	-1.70
QS 2006		0.96***	13.27	-0.17*	-1.91
RELOCATION		0.21***	2.99	0.14*	1.65
EXPORT		0.48***	5.83	-	-
PUBLIC SERVICES		-	-	-0.09**	2.26
TEMPING AGENCY		-	-	-0.03	-0.70
PRO_NETWORK		-	-	-0.01	-0.16
REC_INTERNET		-	-	-0.02	-0.50
WEB		-	-	-0.01	-0.37
AGRIFOOD		0.13	1.21	0.02	0.19
CONSUMPTION GOODS		0.01	0.05	0.27***	2.80
CARS AND EQUIPMENTS		-0.01	-0.09	0.10	1.07
INTERMEDIATE GOODS		0.16*	1.66	-0.05	-0.67
ENERGY		0.92***	4.61	-0.19	-0.82
CONSTRUCTION		-0.06	-0.58	-0.26***	-3.03
COMMERCIAL		0.07	0.82	0.09	1.29
TRANSPORT		-0.35***	-3.13	0.02	0.28
FINANCIAL AND REAL-ESTATE ACTIVITIES		-0.06	-0.35	0.37***	2.74
SERVICES FOR FIRMS		-0.34***	-3.48	0.21**	2.75

Likelihood ratio	-7281.99
WaldChi2(36)	2139.33
Rho	-0.53***
Wald test of rho=0 Chi2(1)	9.91***
Number of observations	8 503
Number of registered firms	1 542
Marginal effects of the variable *STANDARD*	0.20
Average treatment effects of the variable *STANDARD*	0.79***

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.
Sector reference: SERVICES FOR INDIVIDUALS.

5. Conclusion

Many firms now realise the importance of attracting and retaining high quality employees as a necessary component of their competitive advantage (*e.g*. Turban and Greening, 1997; 2000). In **chapter 5,** we examine whether a firm's environmental responsibility makes it more attractive to high quality job seekers. If so this would show that adoption of environmental standards may indirectly improve a firm's performance via the recruitment process.

In fact, the key question addressed in this chapter is whether firms as well as "doing the right thing may also do well by doing good" (Schmidt-Albinger and Freeman, 2000). Our empirical investigation shows that environmental standards can deliver benefits beyond environmental considerations such as contributing to successful recruitment. Additionally, it confirms previous findings suggesting that a firm's environmental responsibility is an important attribute to job seekers considering potential employers (*e.g.* Greening and Turban, 2000). Hence, companies that are proactive in preserving and protecting the environment obtain positive benefits from communicating those values to potential recruits. In a market where obtaining good employees continues to become more critical to a firm's ability to compete, the implication of these findings is significant.

Policymakers and supporters of voluntary standards can emphasise this benefit in order to encourage firms to adopt these initiatives. This finding suggests new ways of achieving the Porter hypothesis promises. The adoption of environmental standards helps firms indirectly via the recruitment of high quality employees to improve business performance (*e.g.* Huselid, 1995). Moreover, since the recruitment process demands a significant amount of financial resources as well as time, environmental standards adoption could be seen as a cost-effective way to attract qualified workers.

Our main result opens a new door for a refined and broader assessment of the effects of environmental voluntary approaches. A promising issue is to investigate *how* and *the ways by which* environmental standards affect other dimensions of human resource management. These various dimensions are likely to interact (*e.g.* recruitment, employees' morale) and resulting tradeoffs deserve more academic attention (Frank, 2003). In addition, the effect of environmental standards should be further examined taking into account the temporal dimension, by verifying whether employees 'reward' differently long-term and short-term commitment to environmental issues. Moreover, the literature argues that particular dimensions of corporate social performance are specifically important to determining the advantages gained by the ability to attract highly qualified employees (Schmidt-Albinger and Freeman, 2000). Hence, it would be interesting to provide an analysis examining the impact of different environmental dimensions on a firm's attractiveness to employees.

APPENDICES CHAPTER V

Appendix 5.1: Pearson correlation coefficients

Appendix 5.1: Pearson correlation coefficients

	PROFESSIONAL EMPLOYEES	NON PROFESSIONAL EMPLOYEES	ES	SMALL	MEDIUM	BIG	GROUP	NETWORK	ISO9 2003	ISO9 2006	WAGE	RELOCATION	EXPORT	PUBLIC SERVICES	TEMPING AGENCY	PRO_NETWORK	REC_INTERNET	WEB
PROFESSIONAL EMPLOYEES	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NON PROFESSIONAL EMPLOYEES	0.36	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES	0.05	0.06	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SMALL	-0.16	-0.13	-0.25	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MEDIUM	0.07	0.07	0.07	-0.63	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-
BIG	0.13	0.10	0.25	-0.65	-0.18	1.00	-	-	-	-	-	-	-	-	-	-	-	-
GROUP	0.12	0.08	0.16	0.32	0.17	0.24	1.00	-	-	-	-	-	-	-	-	-	-	-
NETWORK	0.04	0.02	0.02	-0.11	0.14	0.08	0.12	1.00	-	-	-	-	-	-	-	-	-	-
ISO9 2003	0.02	0.02	0.35	-0.29	0.13	0.23	0.24	0.13	1.00	-	-	-	-	-	-	-	-	-
ISO9 2006	0.02	0.02	0.37	-0.28	0.13	0.22	0.25	0.13	0.88	1.00	-	-	-	-	-	-	-	-
WAGE	0.08	0.08	0.12	-0.11	0.07	0.07	0.20	0.25	0.20	0.20	1.00	-	-	-	-	-	-	-
RELOCATION	0.04	0.04	0.12	-0.13	0.07	0.10	0.12	0.08	0.11	0.10	0.11	1.00	-	-	-	-	-	-
EXPORT	0.07	0.07	0.18	-0.19	-0.01	0.25	0.10	0.05	0.13	0.11	0.14	0.09	1.00	-	-	-	-	-
PUBLIC SERVICES	0.01	0.09	0.04	-0.09	0.06	0.06	0.04	-0.04	0.03	0.05	-0.11	-0.03	-0.03	1.00	-	-	-	-
TEMPING AGENCY	0.04	0.12	0.10	-0.20	0.12	0.14	0.20	0.10	0.18	0.19	0.21	0.04	0.12	0.20	1.00	-	-	-
PRO_NETWORK	0.06	0.09	0.05	-0.12	0.06	0.09	0.11	0.00	0.08	0.09	0.07	-0.02	-0.00	0.21	0.21	1.00	-	-
REC_INTERNET	0.10	0.06	0.14	-0.35	0.14	0.30	0.26	0.01	0.17	0.17	0.10	0.07	0.04	0.14	0.15	0.20	1.00	-
WEB	0.09	0.07	0.11	-0.30	0.15	0.23	0.24	0.08	0.15	0.16	0.13	0.06	0.09	0.19	0.18	0.20	0.46	1.00

Source: COI and DADS, sample 10 840 firms.

Chapter VI

ISO 9000 Standard as a Club Good: Network Effect Evidence[34]

[34] This chapter is a developed version of the article "ISO 9000 Standard as a Club Good: Network Effect Evidence from the French Employer Survey" (with Marc-Arthur Diaye and Nathalie Greenan).

1. Introduction

Traditional standards were considered by economists as public goods (Berg, 1989), *i.e.* goods whose benefits are available to everyone and from which no one can be excluded and therefore no one can fully appropriate the benefits. However, with the appearance of private organisations providing standardisation, traditional standards have been replaced by new standards that are characterised by transparency, flexibility, etc. Consequently, in the literature it is argued that standards become quasi-public goods, somewhere in between the public and the private dichotomy (Antonelli, 1994). In fact, in economics, distinctions are no longer understood to be drawn simply between the public and the private goods. More precisely, the goods are rather classified according to two attributes, the degree to which they are rivalrous and the degree to which they are excludable (Sandler and Tschirdart, 1980; see also Figure 6.1 below). Using these criteria, economics distinguishes four types of goods: private goods, common goods, public goods and club goods.

Table 6.1: Types of economic goods

	Excludable	Non-excludable
Rivalrous	**Private goods**	**Common goods (Common-pool resources)**
Non- rivalrous	**Club goods**	**Public goods**

It is well-known in the literature that voluntary standards like *ISO* can be conceptualised as Club Good (Potoski and Prakash, 2005; Kollman and Prakash, 2002; Prakash, 1999), since they derive mutual benefits from sharing production costs, member's characteristics and excludable benefits (Sandler and Tschirdart, 1997). Economists generally define clubs as voluntary groups in which two or more individuals cooperate in order to create a common shared good. Together, rivalrousness and excludability denote the utility derived from the creation of an exhaustible good that is at the same time also protected from consumption by outsiders to the group who did not contribute to its creation.

However, to the best of our knowledge, there is no empirical examination that will support the notion that ISO standard may be considered as a Club Good. Hence, the purpose of this chapter is to provide empirical evidence that ISO standard could be conceptualised as a Club Goods.

The remainder of the chapter is organised as follows: the next sub-section presents the review of the literature that supports the notion that ISO standard is a Club Good; section 3 develops the main issue of the chapter; section 4 presents the data sets, variables and some descriptive statistics; section 5 introduces our econometric analysis and result, finally section 6 concludes.

1.1 ISO standard as Club Goods: Literature review

We provide here an overview of the arguments existing in the literature implying that ISO standards are Club Goods.

Examining different aspects of Environmental Management Standards such as ISO 14001 and EMAS, Potoski and Prakash (2005) argue that these standards should be conceptualised as Club Goods since it is impossible to price the discrete units of goodwill benefits that they generate. The membership fees that firms pay to become ISO certified represents the cost of implementing and hiring a third party auditor. However, firms will only be motivated to adopt the ISO standards, and therefore to pay these membership fees, if the excludable benefits of certification outweigh the costs.

In this sense, it is important that key stakeholders can distinguish between firms that have an ISO standard approved by a third party and those that do not, in order to produce the excludability of the goodwill benefits. Therefore, certification reduces the transaction costs for various external actors to distinguish members from non-members. The reputation of ISO clubs provides valuable information about the activities of members because many activities of firms are unobservable to most external actors.

Club membership could also have monetary benefits. For instance, sales increase because products were produced respecting quality or environmental issues. To summarise, as indicated by Potoski and Prakash (2005), excludable benefits of ISO membership represent a credible signal of a firm's activities.

2. Methodology

2.1 The network analysis

In order to provide empirical evidence that the ISO standard is a Club Good, we will use network analysis. Network effects could be defined as changes in the benefit that an actor derives from a good, when the number of other actors consuming the same good increases. For instance, positive network effects create the ISO language that facilitates firm performance inside and outside the network.

From our point of view, an approach in terms of network is important because the production of Public Goods fundamentally induces a network of relationships between different participants. In fact, the social network perspective is based on the idea that the structure of social interactions among members enhances or constrains access to valued resources (Brass, 1984; Ibarra, 1993). In the same vein, the literature emphasises the importance of cooperation and networking in achieving higher performance and profitability (*e.g.* Gulati *et al.*, 2000).

We can not analyse directely whether the ISO certification could be conceptualised as a Club Good. However, this hypothesis can be tested indirectly via the analyse of ISO's network effect. Therefore, in this chapter, we want to show empirically that the net monetary gain of a firm varies according to its relative position in the ISO network (network effect).

The rationale for our approach is that the costly process of ISO certification, as an obstacle for many firms, influences firms to choose between different positions inside the network. Network theory proposes that networks spanning social divides are associated with performance related outcomes (Burt, 1992). Accordingly, some firms may try to be indirectly certified, through their suppliers, to gain advantage of ISO certification, but at the same time they try to avoid the difficult and costly process of ISO certification.

The first step, in order to perform network analysis of the ISO standard as a Club Good is to distinguish different types of firms (available from databases utilised in this chapter). The first category of firms called Direct Complete Adopters includes companies that have ISO 9000 certification and whose suppliers are also ISO 9000 certified. The second category named Direct Non Complete Adopters, contains those firms that are certified with

ISO 9000 although their suppliers are not. The third category called Indirect Adopters includes firms which are not ISO certified but their suppliers have ISO certification. The fourth category named Non Adopters includes firms that are not ISO certified and their suppliers also do not have ISO certification.

This categorisation allows us to empirically construct a network of relationships between firms (certified/non certified) being Direct Complete Adopters, Direct Non Complete Adopters, Indirect Adopters or Non Adopters therefore represents in some sense the position of the firms inside the network.

2.2 Network Structure

A network is considered as a collection of nodes (the members of the network) and ties (relationships between members in terms of diffusion of quality improvement information). The structure of network linkages provides opportunities and imposes constraints on the actions of participants. In fact, as indicated by Jackson (2005), individuals are assumed to form or maintain relationships that they find advantageous and avoid or remove themselves from relationships that are not advantageous. This choice perspective suggests that the structure and the properties of networks are based on cost and benefits analysis.

In considering performance related outcomes, network research is generally focused on the structure and hierarchy inside networks (Granovetter, 1973; Burt, 1992; Sparrowe *et al.*, 2001; Salancik, 1995). The extent to which an actor is connected to others in a network is seen as a structural property associated with positive outcomes such as power (Brass, 1984), influence in decision making (Friedkin, 1993), innovation (Ibarra, 1993) or disadvantages such as organisational exit (Krackhardt and Porter, 1986). In this sense, a tie's value is characterised by its incremental effect on the network's structure (Burt, 2000). Consequently, specific ties might yield better information access than others. For example, people with networks rich in structural holes are more likely to be promoted early, enjoy greater career mobility and adapt to changing environments more successfully (*e.g.* Burt, 1992).

2.3 Relative position inside the network

In the ISO network, being certified is a positive signal concerning quality improvement (Terlaak and King, 2006), and having a supplier as a certified firm amplifies this positive signal. Firms seeking to improve their performance are increasingly concerned about the performance of other firms upstream in their supply chain (Delmas and Montiel, 2009). In fact, ISO 9000 has become an international standard that serves as a key selection criterion for supplier selection (Lo *et al.,* 2008). A high level of involvement between firm and suppliers is an important characteristic of many successful businesses since more than half the value of a firm's product is purchased from suppliers (Levine, 1995). In the same vein, Baiman *et al.,* (2000) argue that the quality of a firm's product depends not only on the firm's actions but those of its suppliers. Hence, the firm's objective is to establish a good relationship with its suppliers in order to assure continuous improvement of its performance. Supplier quality management must become an integral part of achieving consistent total product quality (Trent and Monczka, 1999). In this sense, many firms work closely with their suppliers to create competitive advantages in cost and cycle time reduction, on-time delivery and access to product and process technology (Trent and Monczka, 1999). Consequently, numerous firms have demanded that their suppliers become quality certified (Anderson *et al.,* 1999). For instance, in the US, large companies like General Electrics, Du Pont and Eastman Kodak demand that their suppliers become certified.

On the other hand, for a certified firm to have a non-certified firm as a supplier, reduces the positive signals stemming from quality improvement. However, having a certified firm as a supplier, while being non-certified, improves signals regarding quality improvement. In fact, the concept of "supplier partnering" which involves close cooperation between firms and their suppliers (Pagel, 1999), allows non-certified plants to learn about best quality management practices from their certified supply chain partners (Terlaak, 2001).

As a consequence, being certified or not, and having certified suppliers or not will determine firm's position inside the ISO network. The fact that both actors in the relationship (firms and suppliers) of Direct Complete Adopters[35] are members of the ISO Club allows

[35] Direct Complete Adopters include companies that have ISO 9000 certification and their suppliers are also ISO 9000 certified; Direct Non Complete Adopters contain firms that are certified with ISO 9000 certification but their suppliers are not; Indirect Adopters include firms which are not ISO 9000 certified but their suppliers have

firms to improve their knowledge about the best quality management practices. Moreover, even if we do not find both actors in the relationship of Direct Non Complete Adopters as members of the ISO Club, the firm's certification permits this group to still have a good knowledge about quality practices and therefore to keep a strong position inside the ISO Club. In the case of Indirect Adopters, we may say that although the principal beneficiary of ISO advantages (firm) does not directly belong to the ISO Club, firms in this group indirectly benefit from ISO advantages through its suppliers which are certified (indirect membership). We define this relationship as a fairly weak in term of quality knowledge. Finally, firms which belong to the Non Adopters category are not members of the ISO Club, so the knowledge about quality practices is very weak.

According to the relationship between firms and suppliers (and their knowledge about quality practices), we can classify firms in four categories: Direct Complete Adopters are at the top of the classification, followed by Direct Non Complete Adopters, then Indirect Adopters and finally, Non Adopters, respectively.

2.4 Main Question: Hierarchical Positioning by Cost-Benefit Analysis

Hierarchy is an important characteristic of ties since it may increase the value of information acquired through a network. Social resource theory suggests that actors in higher status positions have advantageous resources such as wealth, prestige, power, better access to others, better information flow, etc. (Lin, 1999; DeGraaf and Flap, 1988; Marsden and Hurlbert, 1988). Moreover, having ties to such actors may also be beneficial.

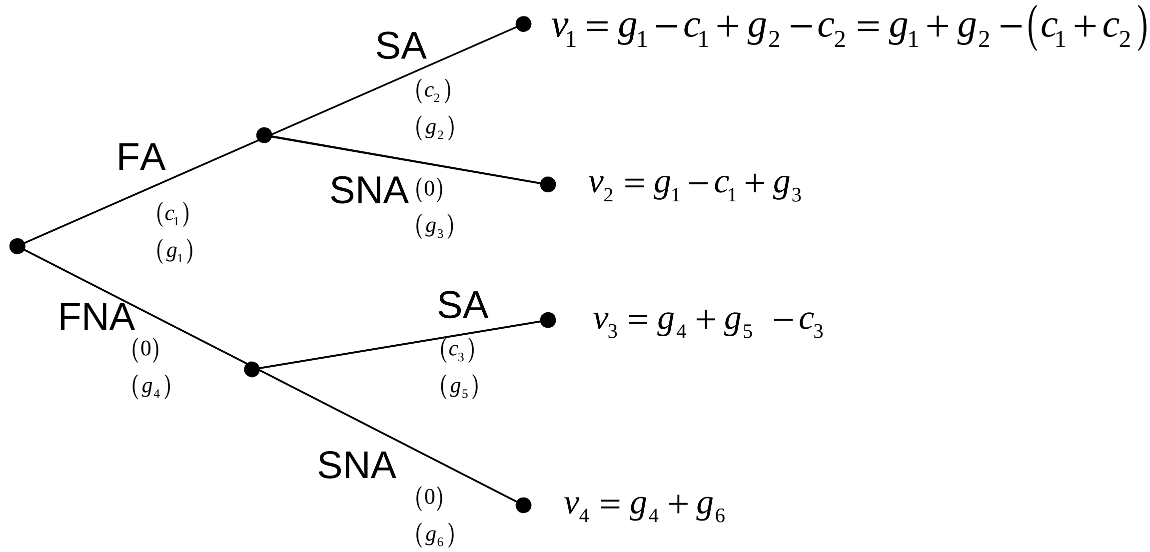
Hence, the objective of this research is to respond empirically to following question:

Whether the hierarchy inside the ISO network imply a similar hierarchy in terms of monetary gains?

In order to understand the logic of this question, we state the following Figure 6.1.

ISO 9000 certification; and Non Adopters include firms that are not ISO certified and their suppliers do not have ISO 9000 certification.

Figure 6.1: Net monetary gains of the ISO adopters and Non adopters



where:

- FA, FNA, SA and SNA respectively mean "ISO Adopter Firms", "non ISO Adopter Firms", "ISO Adopter Suppliers" and "non ISO Adopter Supplier".

- c_1*,* c_2*, and* c_3 *are respectively the cost of ISO certification, the additional cost of having suppliers that are certified with ISO when the company is certified with ISO and the additional cost of having suppliers that are certified with ISO when the company is not ISO certified.*

- $g_1 + g_2$ *is the gain of a company that is certified with ISO when its suppliers are also certified with ISO.*

- $g_1 + g_3$ *is the gain of a company that is certified with ISO when its suppliers are not certified with ISO.*

- $g_4 + g_5$ *is the gain of a company that is not certified with ISO when its suppliers are certified with ISO.*

- $g_4 + g_6$ *is the gain of a company that is not certified with ISO when its suppliers are not certified with ISO.*[36]

- v_j*,* $j \in \{1, 2, 3, 4\}$*, is the net monetary gain that a company could receive or not from the implementation/non-implementation of the ISO certification.*

[36] Of course, it seems reasonable to state that $g_1 > g_4$, $g_2 > g_3 > g_5 > g_6$ and $c_1 > c_3 > c_2$.

Obviously, v_1, v_2, v_3, v_4 are respectively the values of Direct Complete Adopter firms, Direct Non Complete Adopter firms, Indirect Adopter firms and Non Adopters firms. [37]

The main remark from Figure 6.1 is that Indirect Adopters do not act as "free riders" in this network because they pay additional costs of having certified suppliers. Furthermore, we may consider that the decision of a firm to become a Direct Complete Adopter, Direct Non Complete Adopter, Indirect Adopter or Non Adopter is usually optimal. As a consequence, the ordering inside the ISO network does not necessarily imply a similar ordering in terms of monetary gains $v_1 > v_2 > v_3 > v_4$. If we take four different firms which are respectively Direct Complete Adopter, Direct Non Complete Adopter, Indirect Adopter and Non Adopter, it is *a priori* impossible to say whether the net monetary gains for the Direct Complete Adopter firm (v_1) are higher than the net monetary gains for the Direct Non Complete Adopter firm (v_2) which are higher than the net monetary gains for the Indirect Adopter firm (v_3) which are higher than the net monetary gains for the Non Adopter firm(v_4). Hence the question of the relationship between the ordering inside the ISO network and the ordering in terms of monetary gains is not trivial.

3. Econometric Strategy

In this chapter we want to provide an empirical answer to the question whether the ordering inside the ISO network (the position inside the network) is positively correlated with the ordering in terms of net monetary gains (v_j).

If the answer to this question is positive, it demonstrates the real existence of the network effect and it also shows that the application of our analysis using the concept of ISO as a Club Good is pertinent.

From an empirical standpoint, we will either look at the ordering $v_1 > v_2 > v_3 > v_4$ or at the ordering $v_{1-2} > v_3 > v_4$ where v_{1-2} is the net monetary gains of Direct Complete Adopters

[37] The notation could be confusing, indeed roughly speaking, we have to put an index to v_j. For instance v_j^k where $j \in \{1, 2, 3, 4\}$, and $k \in$ {Direct Complete Adopters, Direct Non Complete Adopters, Indirect Adopters and Non Adopters}.

and Direct Non Complete Adopters considered as one category.[38] More precisely, v represents firm's gain (in our case firm's productivity).

Let y be the economic performance variable, in our case defined as firm's productivity. y_i is therefore the productivity variable of firm i. y_i can be written as: $y_i = Z_{1i} + Z_{2i}$ (1), where Z_{1i} is the productivity due to all other factors but the position inside the ISO network, and Z_{2i} is the productivity due to the position inside the ISO network.

Let: $Z_{1i} = \beta_0 + \beta_1 X_{1i} + \ldots + \beta_p X_{pi} + u_{1i}$ (2), where the $X_1, \ldots, X_p$ are variables which explained Z_1.

and $Z_{2i} = v_1\chi_{1i} + v_2\chi_{2i} + v_3\chi_{3i} + v_4\chi_{4i} + u_{2i}$ (3) if we look at the ordering $v_1 > v_2 > v_3 > v_4$

or $Z_{2i} = v_{1\_2}\chi_{1\_2i} + v_3\chi_{3i} + v_4\chi_{4i} + \chi_{2i}$ (4), if we look at the ordering $v_{1-2} > v_3 > v_4$.

Of course, the $\chi_{1i}, \chi_{1\_2i}, \chi_{2i}, \chi_{3i}$ are the characteristic functions which equal to 1 if the firm i belongs to the corresponding category and 0 if otherwise and u_{1i}, u_{2i} are error terms.

Testing $v_1 > v_2 > v_3 > v_4$ in the model

$y_i = \beta_0 + \beta_1 X_{1i} + \ldots + \beta_p X_{pi} + v_1\chi_{1i} + v_2\chi_{2i} + v_3\chi_{3i} + v_4\chi_{4i} + \varepsilon_{i.}$ (5),

is equivalent to testing $0 > v'_2 > v'_3 > v'_4$ in the model

$y_i = g_0 + \beta_1 X_{1i} + \ldots + \beta_p X_{pi} + v'_2\chi_{2i} + v'_3\chi_{3i} + v'_4\chi_{4i} + \varepsilon_i$ (6).

Likewise testing $v_{1-2} > v_3 > v_4$ in the model

$y_i = \beta_0 + \beta_1 X_{1i} + \ldots + \beta_p X_{pi} + v_{1\_2}\chi_{1\_2i} + v_3\chi_{3i} + v_4\chi_{4i} + \varepsilon_i$ (7)

is equivalent to testing $0 > v'_3 > v'_4$ in the model

$y_i = g_0 + \beta_1 X_{1i} + \ldots + \beta_p X_{pi} + v'_3\chi_{3i} + v'_4\chi_{4i} + \varepsilon_i$ (8).

However, this model considers ISO 9000 adopters as exogenous. More precisely, the position inside the ISO certification network may not be random as it may depend on firms' individual characteristics and a firm's choice. Some unobserved characteristics that influence

[38] We consider this case (in which we do not directly compare the Direct Non Complete Adopters with the other categories) because as shown by the descriptive statistics (see section 4.3.1), the category of Direct Non Complete Adopters includes very few firms (only 183) when we use the COI database in 1997.

the choice of a particular position inside ISO network could also influence firm's productivity. Furthermore, given the participation decision, firms have to decide among four ISO 9000 categories. For instance, costs and benefits effect are correlated with firm's productivity, the decision to choose among ISO adopters is endogenous, leading to biased estimates. Moreover, several empirical researches have demonstrated that ignoring the potential bias endogeneity of measures of management practices leads to downward biased estimates of these practices on firm performance (*e.g.* Ichniowski and Shaw, 1995). Hence, the switching regression model controls for the endogenous effect by estimating simultaneously the selection equation and the productivity equations, for two regimes: superior or inferior position inside ISO network.

The switching model structure is defined by two states: state 1 and state 0, corresponding respectively to a specific type of ISO adopters (for instance state 1 may correspond to Direct Complete Adopters and state 0 to Indirect Adopters; likewise concerning Direct Complete Adopters vs Non Adopters; Indirect Adopters vs Non Adopters; Direct Complete Adopters and Direct Non Complete Adopter vs Indirect Adopters; Direct Complete Adopters and Direct Non Complete Adopter vs Non Adopters).

Hence, the model is composed of the following system of three equations that are estimated simultaneously:

$$log(y_{1i}) = \beta'_1 X_i + \varepsilon_{1i} \tag{9}$$

$$log(y_{0i}) = \beta'_0 X_i + \varepsilon_{oi} \tag{10}$$

$$ISO_i^* = \gamma' M_i + Z_i + \mu_i > 0 \tag{11}$$

Equations (9) and (10) are the structural equations that describe the productivity of firms in the alternative regimes. More precisely, as we define previously, y_{1i} and y_{0i} represent respectively the productivity of firm i in state 1 and state 0. Furthermore, X_i is a vector of explanatory variables (features of the company's strategy, external market's constraints, logarithm of the capital per employee, logarithm of the labour, etc), β'_1 and β'_0 are vectors of slope coefficients to be estimated. Finally ε_1 and ε_0 are the disturbance terms for the two equations respectively, with null means and variances equal to σ_1^2 and σ_0^2.

Equation (11) is the selection equation that determines a firm's "propensity" of belonging in one of ISO's categories that depends on differences between monetary gains associated with each category (being Direct Complete Adopters, Direct Non Complete Adopters, Indirect Adopters or Non Adopters). More precisely, $ISO*_i$ is the monetary gain for the firm i of belonging to one of the ISO categories and a firm i will choose one of the categories if its monetary gain of belonging to this category is strictly positive. In equation (11), M_i is a vector of explanatory factors of being in one of the ISO categories and μ is an error term which follows a normal law with mean and variance respectively equal to zero and one.

Here ISO_i^* is a latent variable measuring the tendency or the firm's likelihood of being in the first or the second regime and it has following form:

$$\begin{aligned} &ISO_i = 1 \quad if \quad ISO_i^* > 0 \\ &ISO_i = 0 \quad otherwise. \end{aligned} \tag{12}$$

Noteworthy, it is well known that this type of models are sensitive to the distributional assumption and the specification of the both the first step switching equation and the productivity equations. Hence, in order to reduce this sensitivity, we need to have an additional variable that influences firm's position choice inside the ISO network but does not to influence productivity. In fact, to achieve the identification of the selection equation, we need one variable that influences firm's choice to choose among ISO adopters but may be excluded from the productivity equations (*i.e.* at least one variable in M which is not in X). To achieve this identification, we include the vector Z_i containing: whether a firm has a full time quality manager or outsource manager for quality. The inclusion of those variables may be justified by argument that an administrational unit (such as the quality unit) indicates a closer proximity to institutionalised norms, thus increasing the perceived need to comply with those norms (Beck and Walgenbach, 2005). Moreover, Beck and Walgenbach (2005) find that having a larger proportion of administrative staff, *i.e*. concerning quality issue, improves and promotes better possibility of implementing ISO 9000. Statistically the instrumental variable is not significant determinants of productivity. Furthermore, to our knowledge, there is no empirical or theoretical evidence regarding the direct relationship between those variables and firm's productivity

Finally, we observe $log(y_{1i})$ if $ISO_i = 1$ and $log(y_{0i})$ if $ISO_i = 0$, with Σ the variance-covariance matrix which can be written:

$$\Sigma = \begin{pmatrix} \sigma_1^2 & \rho_{10} & \rho_{1\mu} \\ \rho_{10} & \sigma_0^2 & \rho_{0\mu} \\ \rho_{1\mu} & \rho_{0\mu} & 1 \end{pmatrix}$$

Besides, the variance-covariance matrix Σ can be estimated in one step. In order to test for the endogeneity of the switching model, the parameters of interest are the covariances of the error term of each productivity equation with the error terms of the selection equation. If these covariances are different from zero, then the selection process is not exogenous, and the estimation of the productivity equations by Ordinary Least Squares (OLS) would produce inconsistent estimators of the parameters of the model. The covariance between the error terms of the selection equation and firm's productivity equations informs us about the adequacy of using the switching model to describe the selection process. Actually, we have endogeneity if $\rho_{1\mu}$ or $\rho_{0\mu}$ are significantly different from zero, *i.e.* if the errors of the productivity equations and the error of the choice equation are correlated. ρ_{10} is not defined since the two regimes are never observed simultaneously.

Switching models are then based on the analysis of three variables but each of them is partly observed (Maddala, 1983). The selection variable, ISO^*_i, is not directly observed but only through a dummy ISO_i.

Moreover, the probability of observing y_{1i} or y_{0i} depends on the outcome of the selection variable ISO_i. The expected productivity, conditionally on being state 1 can be calculated as follows,

$$E\left[\log(y_{1i}) \middle| \; ISO_i = 1\right] = \beta_1 ' X_i + \sigma_1 \rho_{1\mu} \frac{\phi(\gamma ' M_i)}{1 - \Phi(\gamma ' M_i)} \tag{13}$$

In the same way, the expected productivity, conditionally on being in state 0 is given by

$$E\left[\log(y_{0i})\middle|\ ISO_i = 0\right] = \beta_0{}' X_i + \sigma_0 \rho_{0\mu} \frac{-\phi(\gamma' M_i)}{\Phi(\gamma' M_i)} \tag{14}$$

The model is estimated by the method of Maximum Likelihood. Although we do not observe the tendency of a firm being in one or the other productivity regime, we know that if $ISO_i = 1$ the firm's productivity is determined by equation (9), and if $ISO_i = 0$, the firm's productivity is determined by equation (10). The likelihood function for each observation is thus given by:

$$\begin{aligned}\log L = \sum_{i=1}^{n} & prob(ISO_i = 1) f\left[\log(y_{1i})\middle|\ ISO_i = 1\right] \\ & prob(ISO_i = 0) f\left[\log(y_{0i})\middle|\ ISO_i = 0\right],\end{aligned} \tag{15}$$

with

$$prob(ISO_i = 1) = \Phi(\gamma' M_i)$$

$$prob(ISO_i = 0) = 1 - \Phi(\gamma' M_i)$$

$$\begin{aligned} f\left[\log(y_{1i})\middle|\ ISO_i = 1\right] &= \left[\Phi(\gamma' M_i)\right]^{-1} \sigma_1^{-1} \phi\left\{\sigma_1^{-1}\left[\log(y_{1i)} - \beta_1' X_{1i}\right]\right\} \\ & \text{x}\Phi\left\{\left(1 - \frac{\rho_{1\mu}^2}{\sigma_1^2}\right)^{-1/2}\left[\gamma' M_i - \frac{\rho_{1\mu}}{\sigma_1^2}\left(\log\left(y_{1i}\right) - \beta_1' X_{1i}\right)\right]\right\}\end{aligned} \tag{16}$$

$$\begin{aligned} f\left[\log(y_{1i})\middle|\ ISO_i = 0\right] &= \left[\Phi(\gamma' M_i)\right]^{-1} \sigma_1^{-1} \phi\left\{\sigma_0^{-1}\left[\log(y_{0i)} - \beta_0' X_{0i}\right]\right\} \\ & \text{x}\Phi\left\{\left(1 - \frac{\rho_{0\mu}^2}{\sigma_0^2}\right)^{-1/2}\left[\gamma' M_i - \frac{\rho_{0\mu}}{\sigma_0^2}\left(\log\left(y_{0i}\right) - \beta_0' X_{0i}\right)\right]\right\}\end{aligned} \tag{17}$$

The maximisation of the log likelihood permits us to define the following parameters:

a) γ' is the vector of coefficients of the factors explaining the choice of the position inside the ISO network.

b) $\beta_1^{'}$ *and* $\beta_0^{'}$ are the vectors of coefficients of the factors explaining productivity, conditioned on utilisation of superior or inferior position inside the ISO network, respectively.

c) $\rho_{1\mu}$ *and* $\rho_{0\mu}$ are the correlation terms between the ISO category's choice equation and productivity equations.

d) σ_1^2 *and* σ_0^2 are the productivity variances in the two states.

Finally, we implicitly use a Cobb-Douglas production function written in value added form in which the ISO standard is a production factor. Actually, our productivity variable is the logarithm of value added per employee $\log(y/L)$.

Among our explanatory variables, we have $\log(K/L)$, the logarithm of capital per employee, the logarithm of number of employees $\log(L)$ and of course the ISO 9000 categories.

4. The database and the variables

4.1 The database

The research presented here is based on the French Organisational Changes and Computerisation (Changement Organisationnel et Informatisation, COI) survey which is explained in detail in **chapter 1.** Moreover, in order to take into account temporal considerations of the ISO network analysis, we use two editions of the database. First, we present the results using the database in 1997 and then, we compare them to those obtained using the database from 2006.

Furthermore, to obtain information about firm's performance (*e.g.* export, value added) in 1997, we use the Annual Enterprise Survey (Enquête Annuelle d'Entreprises, EAE). The Annual Enterprise Survey is the main source of structural statistics. It supplies many estimates needed for preparing the national accounts. The EAE is an annual, exhaustive, obligatory survey conducted by the French Ministry of Industry. The survey covers six broad sectors of economic activity: manufacturing and other goods-producing industries; food (including beverages and tobacco); construction and public works; transportation; wholesale/retail trade and services. Each of these sectors is under the responsibility of a separate surveying entity. The surveys on wholesale/retail trade and services are managed by INSEE. The four others are managed by the statistical offices of the government ministries. The survey field is defined on the basis of the firm’s principal activity, number of employees and legal category. The survey sample is selected from a sub-set of the overall sampling frame every December. The survey universe contains about 1.8 million enterprises; the sample, about 190 000 enterprises. The sample comprises two groups: (1) an “exhaustive” group of 80 000 enterprises that are surveyed each year without sampling, and (2) a sampled group. Each year, one-half of the sampled group is replaced.

The objective of the survey is to collect basic data on the structure of surveyed firms. The survey provides us with exhaustive information on the firms’ activities, structural characteristics, number of units and location of their main office.

The questionnaire includes a “change of structure” box, composed of “change-of structure lines”. These lines actually correspond to the elementary operations of the enterprise surveyed. The firm responds by indicating whether it has been involved in a restructuring in the accounting period considered. On the lines provided, the firm reports information on structural change, such as the links between enterprises, tangible assets divested, date of effect, implementation date and so on. The EAE therefore supplies very full information on elementary operations. By contrast, there is no overall view of the restructuring, since all the elementary operations recorded exclusively involve the firm surveyed.

Moreover, we lose the “type of event” component for the enterprises cited in these operations other than for the enterprise surveyed. In particular, we do not know the fate of these enterprises after restructuring, nor about their existence prior to the change, nor the type of restructuring involved.

Employing the databases from 1997, our empirical analysis is restricted to the manufacturing sectors and we work with a sample of 4 577 firms which have at least 20 employees. On the other hand, the new edition of COI database allows us to overcome sectoral limitation, since it encompasses a broader range of sectors. Here, we work on a sample of 10 628 firms also with more than 20 employees.

4.2 The variables definition

4.2.1 The variables definition -COI and EAE from 1997

Table 6.2: Definition of variables

Variable	**Definition**
Dependent variables	
PRODUCTIVITY **(a)**	Logarithm of Value Added per employee (Continuous variable)
Independent variables	
DIRECT COMPLETE ADOPTERS	The firm is registered for ISO 9001, ISO 9002, EAQF. and the supplier is registered by ISO certification Dummy variable (=1 if firm and supplier- yes)
DIRECT NON COMPLETE ADOPTERS	The firm is registered for ISO 9000, EAQF, etc and the supplier is not registered by quality standards or ISO certification Dummy variable (=1 if firm-yes and supplier-no)
INDIRECT ADOPTERS	The firm is not registered for ISO 9000, EAQF, etc and the supplier is registered by quality standards or ISO certification Dummy variable (=1 if firm-no and supplier-yes)
NON ADOPTERS	The firm is not registered for ISO 9000, EAQF, etc and the supplier is not registered by quality standards or ISO certification Dummy variable (=1 if firm-no and supplier-no)
ACTIVITY	The main activity of the firm: 17 dummy variables (=1 agro-food; wearing, leather and shoes; edition, printing and reproduction; soap, perfumes and care and pharmaceutical industry; household equipments; automobiles; naval, aeronautical and railroad materials; boilers, metallic tank, mechanical equipments and machines for general utilisation; machines for agro-culture, machines-tools of others specific machines and weapon and munitions; electric and electronic equipments; wood and paper; artificial fiber; synthetic products and plastic materials; mineral, organic and parchemical products; metallurgies and transformation of materials; and electric and electronic components; textile)
SIZE	SMALL (20 TO 49 employees) MEDIUM (50 TO 199 employees) BIG (more than 200 employees)
QUALDEP	The firm has quality department in 1994 Dummy variable (=1 if yes)
QUALEXT	The firm has quality department in 1994 Dummy variable (=1 if yes)
OTHER CERTIFICATION	Registered for type of certification measure or total quality management Dummy variable (=1 if registered in 1994)
EXPORT	Share of firm exportation by turnover (Continuous variable)
QUALITY IMPROVEMENT	Quality strong or very strong strategic importance for product Dummy variable (=1 if yes)
COST	Cost Reduction strong or very strong strategic importance Dummy variable (=1 if yes)
NEW PROCEDURE	Implementation of new procedure for products strong or very strong strategic importance

	Dummy variable (=1 if yes)
COMPETITIVE PRESSURE	Competitive pressure influences the choice of firm's organisation and computerisation Dummy variable (=1 if yes)
UNCERTAINTY ON THE MARKET	Uncertainty on the market influences the choice of firm's organisation and computerisation Dummy variable (=1 if yes)
CLEINTS CONDITIONED	Clients conditioned influences the choice of firm's organisation and computerisation Dummy variable (=1 if yes)
SUPPLIERS CONDITIONED	Suppliers conditioned influences the choice of firm's organisation and computerisation Dummy variable (=1 if yes)
STOCKHOLDERS CONDITIONED	Stockholders conditioned influences the choice of firm's organisation and computerisation Dummy variable (=1 if yes)
LABOUR	Logarithm of labour (Continuous variable)
CAPITAL	Logarithm of capital per employee (Continuous variable)

The sectors are considered according to the French nomenclature.
Source: Survey COI 1997 mergers to EAE 1997.
(a) As we indicated previously, we use a Cobb-Douglas production function written in value added form in which the ISO standard is a production factor., $\log(K/L)$ is the logarithm of capital per employee and $\log(L)$ is the logarithm of number of employees.

First, we will present construction of the variable using the two databases from 1997. The variables used for estimation and descriptive statistics are indicated in Table 6.2. Using our four categories of ISO adopters (Direct Complete Adopters, Direct Non Complete Adopters, Indirect Adopters, and Non Adopters), we construct five dummies of ISO adopters and for each of them we evaluate the impact on productivity.[39] It is important to mention that we are not in the measure to compare directly the Direct Non Complete Adopters with the other categories for sub-representatively problems. [40]

To resume, we consider five models:

- *In Model 1, the dummy variable is 1 if the firm is* a Direct Complete Adopter and is 0 if the firm is an Indirect Adopter.
- *In Model 2, the dummy variable is 1 if the firm is* a Direct Complete Adopter and is 0 if the firm is a Non Adopter.

[39] Under this variable it is included ISO 9001, ISO 9002, EAQF. Unfortunately, we cannot distinguish between these standards, since in the survey they were put together under the same name, so QS is a reference for this variable. Threfore, we cannot estimate the specific effects of each program.
[40] See section 4.3.1.

- *In Model 3, the dummy variable is 1 if the firm is* an Indirect Adopter and is 0 if the firm is a Non Adopter.
- *In Model 4, the dummy variable is 1 if the firm is* a Direct Complete Adopter or a Direct Non Complete Adopter and is 0 if the firm is an Indirect Adopter.
- *In Model 5, the dummy variable is 1 if the firm is* a Direct Complete Adopter or a Direct Non Complete Adopter and is 0 if the firm is a Non Adopter.

For instance, when we compare Direct Complete Adopters to Indirect Adopters, y_1 will be the logarithm of the productivity per employee of Direct Complete Adopter firms and y_0 will be the logarithm of the productivity per employee of Indirect Adopter firms.

4.2.2 The variables definition - COI from 2006

Even that the questionnaires of two editions of COI database are not identical, we have a possibility to create the four ISO categories, but also to benefit from some additional variables that are not presented in the version of 1997. The variables used for estimation are indicated in Table 6.3.

As in the previous case, we use four categories of adopters, Direct Complete Adopters, Direct Non Complete Adopters, Indirect Adopters, and Non Adopters, in order to create six dummies of adopters in order to analyse their impact on firm's productivity. Noteworthy, the new edition of COI database permits us to examine separately the effect of Direct Non Complete Adopters from Direct Complete Adopters since the number of Direct Non Complete Adopters is sufficient, in this case, to perform our empirical model.

Table 6.3: Definition of variables

Variable	**Definition**
Dependent variables	
PRODUCTIVITY **(a)**	Logarithm of Value Added per employee (Continuous variable)
Independent variables	
DIRECT COMPLETE ADOPTERS	The firm is registered for ISO 9000, EAQF, etc and the supplier is registered by quality standards or quality control procedure Dummy variable (=1 if firm and supplier- yes)
DIRECT NON COMPLETE ADOPTERS	The firm is registered for ISO 9000, EAQF, etc and the supplier is not registered by quality standards or quality control procedure Dummy variable (=1 if firm-yes and supplier-no)
INDIRECT ADOPTERS	The firm is not registered for ISO 9000, EAQF, etc and the supplier is registered by quality standards or quality control procedure Dummy variable (=1 if firm-no and supplier-yes)
NON ADOPTERS	The firm is not registered for ISO 9000, EAQF, etc and the supplier is not registered by quality standards or quality control procedure Dummy variable (=1 if firm-no and supplier-no)
ACTIVITY	The main activity of the firm: 9 dummy variables (=1 agro-food; consumption goods; cars and equipments; intermediate goods; energy; construction; commercial; transport; financial and real-estate activities; services for firms; and services for individuals respectively)
SIZE	SMALL (20 TO 49 employees) MEDIUM (50 TO 199 employees) BIG (more than 200 employees)
QUALDEP	The firm has quality department in 2003. Dummy variable (=1 if yes)
QUALEXT	The firm has quality department in 2003. Dummy variable (=1 if yes)
ES	Certified with ISO 14000, organic food labeling or fair trade Dummy variable (=1 if certified in 2006)
EXPORT	Share of firm exportation by turnover (Continuous variable)
QUALITY IMPROVEMENT	Quality strong or very strong strategic importance for product Dummy variable (=1 if yes)
COST	Cost Reduction strong or very strong strategic importance Dummy variable (=1 if yes)
TECH IMPROVEMENT	Technological improvement strong or very strong strategic importance Dummy variable (=1 if yes)
STANDARDISATION	Standardisation strong or very strong strategic importance Dummy variable (=1 if yes)
SHORTENING DEADLINES	Shortening deadlines strong or very strong strategic importance Dummy variable (=1 if yes)
COMPETITIVE PRICE	Competitive price strong or very strong strategic importance Dummy variable (=1 if yes)
COMPETITIVE PRESSURE	Competitive pressure influences strong or very strong the choice of firm's organisation and computerisation Dummy variable (=1 if yes)
UNCERTAINTY ON THE MARKET	Uncertainty on the market influences strong or very strong the choice of firm's organisation and computerisation Dummy variable (=1 if yes)
CLIENTS CONDITIONED	Three main clients make up 50% of the firm's turnover

	Dummy variable (=1 if yes)
SUPPLIERS CONDITIONED	Three main suppliers make up 50% of the firm's purchase Dummy variable (=1 if yes)
LABOUR	Logarithm of labour (Continuous variable)
CAPITAL	Logarithm of capital per employee (Continuous variable)
LABELLING	Under customer policy firm uses labeling goods and services with specific clients Dummy variable (=1 if yes)
FIXED DEADLINES	Under customer policy firm uses contract to assure delivery timeless Dummy variable (=1 if yes)
CONTACT-CALL CENTERS	Under customer policy firm uses contact or call centers Dummy variable (=1 if yes)

The sectors are considered according to the French nomenclature.
Source: Survey COI-TIC 2006-INSEE-CEE/Treatments CEE.
(a) As we indicated previously, we use a Cobb-Douglas production function written in value added form in which the ISO standard is a production factor., $\log(K/L)$ is the logarithm of capital per employee and $\log(L)$ is the logarithm of number of employees.

Generally those six dummies are similar as in previous edition of the COI survey:

- *In Model 1', the dummy variable is 1 if the firm is* a Direct Complete Adopter and is 0 if the firm is a Direct Non Complete Adopter.
- *In Model 2', the dummy variable is 1 if the firm is* a Direct Complete Adopter and is 0 if the firm is an Indirect Adopter.
- *In Model 3', the dummy variable is 1 if the firm is* a Direct Complete Adopter and is 0 if the firm is a Non Adopter.
- *In Model 4', the dummy variable is 1 if the firm is* a Direct Non Complete Adopter and is 0 if the firm is an Indirect Adopter.
- *In Model 5', the dummy variable is 1 if the firm is* a Direct Non Complete Adopter and is 0 if the firm is a Non Adopter.
- *In Model 6', the dummy variable is 1 if the firm is* an Indirect Adopter and is 0 if the firm is a Non Adopter.

For instance, as in previous case, when we compare Direct Complete Adopters to Direct Non Complete Adopters, y_1 will be the logarithm of the productivity per employee of Direct Complete Adopter firms and y_0 will be the logarithm of the productivity per employee of Direct Non Complete Adopter firms.

4.3 Descriptive Statistics

4.3.1 Descriptive Statistics - COI and EAE from 1997

Firm distribution for each category of adopters (Direct Complete Adopters, Direct Non Complete Adopters, Indirect Adopters, Non Adopters) is respectively 1 949 firms, 183 firms, 960 firms and 1 485 firms.

From the Table 6.4, we can see that the proportion of uncertified firms that have certified suppliers is significant: 22% firms (from a total of 64% non certified companies) are part of this group or approximately 40% of non certified companies. In comparison, only 4% of companies certified with ISO (from a total of 36% certified companies) have suppliers that are not certified with ISO, which suggests that ISO certified companies avoided having relationships with suppliers that are not certified with ISO. This suggests, as we expected, that being certified (*i.e.* inside the network) gives a positive signal concerning quality information and having as a supplier a certified firm amplifies this positive signal.

Our data suggests several important first-order differences between the four types of ISO firms. In particular, we can observe that there are more firms that are certified with ISO since 1994 under the category Direct Non Complete Adopters than Direct Complete Adopters.

We notice that there is a positive correlation between the company size and the position inside the network so that the highest percentage of larger firms make up Direct Complete Adopters (23%), whilst the highest percentage of smaller companies belong to Non Adopters (4%). Furthermore, although the full time quality manager is present in each category of adopters, the percentage of concentration is positively related to the group position inside the network, with the highest percentage being present in the category of Direct Complete Adopters (74%). Interestingly, there exists a small percentage of companies (in each category) that utilise quality services from outsource managers. Investment in the quality standards can at the same time be a function of improvement of the company's competence and can also make a positive signal on the market, especially for companies that export abroad. Companies might view ISO certification as an export requirement, especially if they operate a majority of their business abroad (Terlaak and King, 2006).

The international marketing aspects of the ISO 9000 certification have been regarded as one of the most important reasons to seek certification. We notice that the percentage of export is positively correlated with the position inside the network, the highest export being for the category of Direct Complete Adopters which descends in the following pattern: Direct Complete Adopters > Direct Non Complete Adopters > Indirect Adopters > Non Adopters.

Table 6.4: Descriptive Statistics

	Direct Complete Adopters	Direct Non Complete Adopters	Indirect Adopters	Non Adopters
	Year of ISO Certification			
1994	38%	47%	0%	0%
	Company's Size			
SMALL	39% (a)	54%	62%	69%
MEDIUM	38%	34%	30%	27%
BIG	23%	12%	8%	4%
	Quality department in 1997			
FULL TIME QUALITY MANAGER	74%	56%	43%	21%
	Quality outsourcing in 1997			
OUTSOURCE QUALITY MANAGER	18%	22%	14%	6%
	Previous certification			
OTHER CERTIFICATION	15%	12%	25%	8%
	Mean export by firm's turnover			
EXPORT	0.22	0.19	0.17	0.16
Total	**32%**	**4%**	**22%**	**42%**

Source: Survey COI 1997 and EAE 1997, sample of 4 577 firms, weighted by the number of employees.
Lecture: (a) 39% of "Direct Complete Adopters" are companies that have between 20 to 49 employees (the category-small firm).

Finally, we observe that firms which are not ISO certified do not tend to substitute ISO certification for another type of certification (QA, ISO 14000, QS …). On the other hand, as we can see from Table 6.4, 15% of Direct Complete Adopters have other types of certification or total quality management. In contrast, only 8% of Non Adopters have another kind of certification. It seems therefore that there is no strategy of substitution among Non Adopter companies relating to the quality issue. Other kinds of adopters such as Direct Complete

Adopters may view the ISO certification as being complementary to other kinds of certifications.

Interestingly, the category Indirect Adopters has the highest percentage of firms (25%) that have other types of certification or total quality management. A possible reason for this is that Indirect Adopters firms want through previous experience with similar standards to lower additional costs of ISO 9000 implementation (*e.g.* through the overlap of documentation requirements) because of learning by doing and scale economies.

4.3.2 Descriptive Statistics - COI from 2006

From the second edition of the COI database, we obtain a distribution of firms within each category of adopters (Direct Complete Adopters, Direct Non Complete Adopters, Indirect Adopters, Non Adopters), that is 3 548 firms, 1 324 firms, 2 376 firms and 3 020 firms, respectively. Similarly, as in the previous table, Table 6.5 shows that the proportion of uncertified firms that have certified suppliers is significant: 23% firms (from a total of 52% non certified firms). Furthermore, 13% of firms certified with ISO (from a total of 48% certified companies) have suppliers that are not certified with the ISO standard. Interestingly, comparing Tables 6.4 and 6.5, we may notice that the distribution of Direct Complete and Indirect Adopters seems to stay approximately the same (35% vs 32% and 23% vs 22%, respectively). On the other side, we find a 9 points increase of the firms belonging to the category of Direct Non Complete Adopters, while there is a decrease of 13 points of the firms inside the category Non Adopters. This could indicate that managers understand the importance of the certification that enables a firm to become “at least” part of Direct Non Complete Adopters. Concerning the year of ISO certification, there are more companies that are certified with ISO since 2003 under the category Direct Complete Adopters than Direct Non Complete Adopters, which is contrary to findings from 1997.

Furthermore, as for the previous findings, our results support the idea that there is a positive correlation between firm size and its position within the network showing that the big firms dominate the group of Direct Complete Adopters (51%), while small firms dominate the category of Non Adopters (72%). Even though full time quality managers and outsourced quality managers are present in each category of adopters, the highest percentages are focused in the categories of Direct Complete and Direct Non Complete Adopters (40% and 41%, respectively). Furthermore, in a context where there is a lot of information, resources and skills on how to implement a similar or related process standard, *e.g.* ISO 14000, it is more likely that there will also be information and skills available on how to implement an ISO 9000 standard (Grolleau *et al.*, 2007).

Table 6.5: Descriptive Statistics

	Direct Complete Adopters	Direct Non Complete Adopters	Indirect Adopters	Non Adopters
	Year of ISO Certification			
2003	69%	29%	0%	0%
	Company's Size			
SMALL	22% (a)	11%	66%	72%
MEDIUM	34%	14%	27%	24%
BIG	51%	11%	7%	4%
	Quality department in 2003			
FULL TIME QUALITY MANAGER	40%	13%	25%	22%
	Quality outsourcing in 2003			
OUTSOURCE QUALITY MANAGER	41%	14%	24%	21%
	Similar certification			
ENVIRONMENTAL CERTIFICATION	65%	17%	10%	8%
	Mean export by firm's turnover			
EXPORT	0.13	0.07	0.06	0.05
Total	**35%**	**13%**	**23%**	**29%**

Source: Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample of 10 268 firms, weighted by the number of employees.
Lecture: (a) 22% of "Direct Complete Adopters" are companies that have between 20-49 employees (the category-small firms).

Firms that have previous experience with similar mechanisms are expected to incur lower costs (*e.g.* through the overlap of documentation requirements) because of learning by doing and economies of scale. Therefore, from Table 6.5 we remark that 65% of Direct Complete Adopters have environmental certificates. Conversely, only 8% of Non Adopters are environmentally registered. ISO certifications may prove the ability of the firm to satisfy the quality expectations of customers and make otherwise unobservable attributes publicly visible (Grolleau *et al.*, 2007).

As for the results from the previous edition of the COI, we observe that the percentage of exports is positively correlated with the position of a firm within the network. The highest level of exports are from firms belonging to the category of Direct Complete Adopters, which descend in the following order: Direct Complete Adopters > Direct Non Complete Adopters > Indirect Adopters > Non Adopters.

5. Estimates Results

5.1 Estimates Results - COI and EAE from 1997

Firstly, we present the switching endeogenous results obtained for the 1997 analysis.

Table 6.6 (determinants of ISO categories), Table 6.7 (determinants of firm's productivity of superior position inside the ISO network) and Table 6.8 (determinants of productivity of superior inferior inside ISO network) report results from the estimates of the Model 1, Model 2 and Model 3. The results obtained from the estimates of Model 4 and Model 5 are presented in Table 6.10 (determinants of ISO categories), Table 6.11 (determinants of productivity of superior position inside ISO network) and Table 6.12 (determinants of productivity of superior inferior inside the ISO network). No problem of multicolinearity has been detected (Appendix 6.1). From Table 6.8 and Table 6.12, we can note that the correlation structure of the error terms between selection equations (choice of ISO 9000 adopters) and productivity equations ($\rho_{0\mu}$ and $\rho_{1\mu}$) are significantly different from zero (at least one of them). These figures tell us that there is evidence of a non-random selection on ISO adoption and hence, the variables that present ISO adopters are endogenous. This confirms the implementation of our econometric model.

The estimation results regarding the factors that may impact on adoption of different ISO 9000 categories are presented in Table 6.6 and Table 6.10. The estimation of the selection equation includes all variables which will later be also included in the estimation of the productivity equations. Additionally, as we indicated previously, two instrumental variables that explain the ISO 9000 categories, but have no impact on productivity, are included in order to identify correctly the model.

The first group of variables that we have utilised is the sector of activity. We have used 17 sectors of different firm's activities and as a reference the sector of textile industry. As in the literature, we found that the probability to be ISO certified is higher in specific industries such as the manufacture of mechanical equipment, machines for general utilisation, electric and electronic equipment, etc.

Concerning the features of the company's strategy, we can see from Table 6.6 and Table 6.10 that for our five regressions and for the three variables (presenting quality improvement, cost reduction and new procedures), the coefficients, when significant, are positive. When quality improvement, cost reduction and new procedures are important or very important for the firm's strategy, they will increase the company's probability of being ISO certified and to become a Direct Complete Adopter (compared to being a Non Adopter). It is interesting to note that when comparing Direct Complete Adopters to Indirect Adopters, only the new procedure plays a role in the decision of the firm to become a Direct Complete Adopter. When comparing Indirect Adopters to Non Adopters, only the quality improvement indicator plays a role (at a 5% level of significance) in the decision of the firm to become an Indirect Adopter.

Concerning the external market's constraints, one can remark that the uncertainty on the market seems to play no role in determining the firm's probability to become ISO certified or the firm's position inside the ISO network. Indeed, this variable is not significant in all four regressions (out of five). It is only significant (only at a 10% level) when comparing Direct Complete Adopters + Direct Non Complete Adopters with Indirect Adopters. It could therefore be interpreted that the market uncertainty increases the probability that a non ISO certified firms opt to have ISO certified firms via suppliers. If we look at the other variables (presenting, competitive pressure, clients-conditioned, suppliers-conditioned and stockholders-conditioned), the coefficients, when significant, are positive. For instance, the clients' conditions are significant (at a 1% level) for all three regressions (out of five). This tells us that when clients' conditions are an important external constraint, firms will adopt ISO certification either directly or indirectly through their suppliers. The same explanation can be used in the case of stockholders whereby companies are more driven to become ISO certified by stockholders' conditions. Another interesting result is that only the firms in the category of Direct Complete Adopters vs Non Adopters are more cautious about the conditions imposed by suppliers. Finally, it is quite surprising that the competitive pressure on the market is significant (at a 10% level) only when comparing Indirect Adopters with Non Adopters. This result implies that the competitive pressures increase both the probability that a non-certified firm wants to have a certified firm as a supplier and the probability that a certified firm wants be a supplier of a non-certified firm.

Having other types of certification or total quality management has positive effect only when we compare Indirect Adopters vs Non Adopters. On the other hand, when we compare Direct Complete Adopters vs Indirect Adopters or Direct Complete Adopters +Direct Non Complete Adopters vs Indirect Adopters, other type of certification or total quality management will impact adoption negatively. It is important to mention again that variables presenting quality department and outsourcing are included as the determinants of ISO categories and are left over in the productivity equations. Hence, they are our instruments. We can notice that having full time quality manager impacts positively the ISO 9000 adoption for all five regressions. Furthermore, outsource quality manager has a positive impact on the ISO 9000 adoption, indeed as we can see the variable is positive and significant for four regressions (out of five).

Finally, the logarithm of capital per employee and the logarithm per labour have a positive impact on the ISO 9000 categories. As we can see, the logarithm of capital per employee is positive and significant for four regressions. Moreover, we found the same results as in the literature relating to the effects of the number of employees on the adoption of ISO certification (Anderson *et al.*, 1999; Terlaak and King, 2006). Generally, firm size mainly determines the firm's possibility (in the sense of financial resources) to choose one of the categories of ISO adopters. The second stage results define factors that may impact on the logarithm of value added per employee for ISO adopters of superior level inside the network (Tables 6.7 and 6.11). The first group of variables that we have utilised is the sector of activity as in the previous stage. The findings indicate that the majority of sectors have a positive and significant impact on the dependent variable.Concerning the features of the company's strategy, we can see from Tables 6.7 and 6.11 that for our five regressions, only cost reduction is significant, but with a negative sign. This indicates that when cost reduction is an important or a very important company strategy, it impacts negatively the value added. Concerning the external market's constraints, we notice that for our four regressions only competitive pressure and uncertainty on the market impact the value added, but negatively. Concerning the other types of certification or total quality management, it seems that it impacts negatively the logarithm of the value added per employee (for firms belonging to superior position inside ISO network). Indeed, this variable is negative for two regressions (out of five).

Finally, the logarithm of capital per employee and the logarithm of the labour have positive and significant impact on the logarithm of the value added per employee for ISO adopters of superior level inside the network, for four regressions.The third stage results define factors that may impact on the logarithm of the value added per employee for ISO adopters of inferior level inside the network. Concerning the variable sector of activity, as we can see from the Tables 6.10 and 6.12, results are similar as in the second stage.Concerning variables of features of the company's strategy, we notice that only quality improvement has a positive and significant impact on the choice of ISO adopters for thee regressions. Furthermore, as in the previous regime, the cost reduction when significant is negative, for instance, when comparing Direct Complete Adopters vs Non Adopters, Indirect Adopters vs Non Adopters and Direct Complete Adopters +Direct Non Adopters vs Non Adopters. The new process has a negative impact on the logarithm of the value added per employee for ISO adopters of inferior level inside the network when comparing Direct Complete Adopters vs Non Adopters and Direct Adopters +Non Adopters vs Non Adopters.

Concerning the external market's constraints, we can see from Tables 6.8 and 6.12 that the coefficients, when significant, are negative. Thus, we can conclude that competitive pressure has a negative impact on our dependent variable for four regressions. Similarly, the uncertainty on the market also has a negative impact for three regressions. Furthermore, the findings suggest that client's condition has a negative impact when we compare Direct Complete Adopters vs Non Adopters and Direct Complete Adopters+Direct Non Adopters vs Non Adopters.Having other types of certification or total quality management has a positive effect when we compare Direct Complete Adopters vs Indirect Adopters and Direct Complete Adopters +Direct Non Complete Adopters vs Indirect Adopters. Contrary, this variable impacts negatively the logarithm of the value added per employee (for firms belonging to inferior position inside the ISO 9000 network) when we compare Indirect Adopters vs Non Adopters.

Finally, the logarithm of the capital per employee is positive for all five regressions. However, the partial elasticity for capital is slightly higher for specific regressions in the regime with superior position inside the ISO network. On other hand, the logarithm of the labor is significant and negative for all five regressions.Furthermore, we compare observed and predicted productivity's mean of our five ISO dummies (Table 6.9 and Table 6.13). Switching models ensure us to predict productivity, conditionally on the position inside the ISO network. For doing this, we use equations (9) and (10). With this method, the predicted productivity includes correlation parameters between the ISO adopter's position equation and productivity equations. This endogenous bias correction allowed by switching regressions leads us to following conclusions.[41] The comparison between Direct Complete Adopters and Indirect Adopters shows positive results concerning the effects on productivity (Table 6.9). This result confirms the prediction given by the graphic in Figure 6.1: Indirect Adopters have a link that permits them to enter into the ISO Club and thus differentiate themselves from Non Adopters. One can also remark that the coefficients of significance in Models 1 and 2 are same to those in Models 4 and 5 despite the fact that Direct Complete Adopters and Direct Non Complete Adopters have been merged. This leads us to conclude that Direct Non Complete Adopters are in a more advantageous position inside the network as compared to Indirect Adopters or Non Adopters. Moreover, since both actors (firm and suppliers) within Direct Complete Adopters are certified, it permits this group to have the highest impact on productivity. Furthermore, although the suppliers of Direct Non Complete Adopters are not certified, firm certification still gives them the possibility to have a high impact as evidenced by their second position inside the network's hierarchy.

The case of Indirect Adopters proves that firms can also indirectly profit form the ISO certification (via suppliers) and that firms inside this group differ from Non Adopters. Indeed, Indirect Adopters take up the third position in regards to the strength of impact effects, while Non Adopters occupy the lowest position. We also observed that the difference for our dependent variable (productivity) between firms within Indirect Adopters and Non Adopters shows that Indirect Adopter firms gain from ISO certification via their certified suppliers. In Model 5, merging Direct Complete Adopters with Direct Non Complete Adopters decrease the predicted value (when it is compared with Non Adopters). This could mean that the ISO certified firms dealing with the non ISO certified suppliers have some negative signals on the market.However, our results indicate that the productivity of Direct Complete Adopter firms is higher than the one of Direct Non Complete Adopter firms which is higher than the one of

[41] A classical test for the equality of predicted productivity shows that the difference of productivity is statistically significant.

Indirect Adopter firms which is higher than the one of Non Adopter firms. Therefore, we may conclude that the position inside the ISO hierarchy is positively associated to the firm's performance. Nevertheless, before presenting overall conclusion, we will discuss the results obtained using the databases from 2006.

Table 6.6: Switching regression (part 1)

Equation 1: Determinants of choosing one of the ISO categories

	Direct Complete Adopters vs Indirect Adopters (ref) (a)	Direct Complete Adopters vs Non Adopters (ref)	Indirect Adopters vs Non Adopters (ref)
Intercept	-2.35***	-4.40***	-2.34***
	Features of the company's strategy		
Quality Improvement	-0.00	0.22***	0.17**
Cost Reduction	0.05	0.09	0.08
New Process	0.13**	0.15***	0.02
	External market's constraints		
Competitive Pressure	0.00	0.05	0.14**
Uncertainty On The Market	-0.08	-0.05	0.04
Clients Conditioned	0.08	0.28***	0.16***
Suppliers Conditioned	-0.03	0.11*	0.12*
Stockholders Conditioned	0.02	0.18**	0.06
	Other type of certification or total quality management		
Other Type Of Certification	-0.39***	-0.02	0.54***
	Quality department and outsourcing in 1994		
Full Time Quality Manager	0.31***	0.62***	0.23***
Outsource Quality Manager	0.30***	0.38***	0.06
	Capital and Labor		
Logarithm Of The Capital Per Employee	0.22***	0.20***	0.03
Logarithm Of The Labor	0.28***	0.51***	0.21***
	Sector of Activity		
Agro-Food Industry	-0.19	0.35***	0.61***
Industry Of Wearing, Leather And Shoes	-0.67***	-0.87*	-0.25**
Industry Of Edition, Printing And Reproduction	-0.14	-0.32*	-0.06
Manufacture Of Soap, Perfumes And Care Products And Pharmaceutical Industry	-0.73***	0.41**	0.94***
Manufacture Of Household Equipments	-0.11	0.16	0.34**
Manufacture Of Automobiles	0.78***	1.22***	0.50*
Manufacture Of Naval, Aeronautical And Railroad Materials	0.24	1.13***	0.96***
Manufacture Of Boilers, Manufacture Of Metallic Tank, Mechanical Equipment And Machines For General Utilisation	0.62***	1.14***	0.71***
Manufacture Of Machines For Agro-Culture, Machines- OF Others Specific Machines And	0.19	0.74***	0.72***

Weapon And Munitions			
Manufacture Of Electric And Electronic Equipment	0.87***	0.42***	0.72***
Extractives Industries/ Manufacture Of Glass And Other Product Glass And Ceramic Products And Construction Equipments	0.22	0.22	0.13
Manufacture Of Wood And Paper	0.19	0.48***	0.35**
Industry Of Artificial Fiber, Synthetic Products And Plastic Materials	0.72***	1.13***	0.53***
Industry Of Mineral, Organic And Parchemical Products	0.54***	1.09***	0.41**
Metallurgies And Transformation Of Materials	0.92***	1.42***	0.73***
Manufacture Of Electric And Electronic Components	0.91***	1.57***	0.84***

(a) The reference category is Indirect Adopters while dependent variable is Direct Complete Adopters.

Table 6.7: Switching regression (part 2)

Equation 2: Determinants of the logarithm of the value added per employee (superior position inside ISO network)

	Direct Complete Adopters vs Indirect Adopters (ref) (a)	Direct Complete Adopters vs Non Adopters (ref)	Indirect Adopters vs Non Adopters (ref)
Intercept	2.63***	2.99***	3.03***
	Features of the company's strategy		
Quality Improvement	0.03	0.03	-0.00
Cost Reduction	-0.07**	-0.08**	0.00
New Process	0.02	0.01	-0.02
	External market's constraints		
Competitive Pressure	-0.05*	-0.05**	-0.09**
Uncertainty On The Market	-0.05**	-0.05**	-0.02
Clients Conditioned	-0.00	-0.01	-0.04
Suppliers Conditioned	-0.02	-0.01	-0.04
Stockholders Conditioned	0.02	0.02	0.01
	Other type of certification or total quality management		
Other Type Of Certification	-0.06***	-0.02	0.03
	Quality department and outsourcing in 1994		
Full Time Quality Manager	-	-	-
Outsource Quality Manager	-	-	-
	Capital and Labor		
Logarithm Of The Capital Per Employee	0.18***	0.16***	0.15***
Logarithm Of The Labor	0.05***	0.02***	0.01
	Sector of Activity		
Agro-Food Industry	0.19**	0.21***	0.10
Industry Of Wearing, Leather And Shoes	-0.07	0.01	-0.07
Industry Of Edition, Printing And Reproduction	0.21**	0.23**	0.35***
Manufacture Of Soap, Perfumes And Care Products And Pharmaceutical Industry	0.42***	0.50**	0.94***
Manufacture Of Household Equipments	0.08	0.09	0.15*
Manufacture Of Automobiles	0.23***	0.17**	0.15
Manufacture Of Naval, Aeronautical And Railroad Materials	0.26***	0.24***	0.20***
Manufacture Of Boilers, Manufacture Of Metallic Tank, Mechanical Equipment And Machines For General Utilisation	0.28***	0.22***	0.24***
Manufacture Of Machines For Agro-Culture, Machines-Tools Of Others Specific Machines And Weapon And Munitions	0.34***	0.32***	0.36***
Manufacture Of Electric And Electronic	0.43***	0.36***	0.36***

Equipment			
Extractives Industries/ Manufacture Of Glass And Other Product Glass And Ceramic Products And Construction Equipments	0.24***	0.22***	0.21***
Manufacture Of Wood And Paper	0.21***	0.18***	0.09
Industry Of Artificial Fiber , Synthetic Products And Plastic Materials	0.23***	0.16**	0.12
Industry Of Mineral, Organic And Parchemical Products	0.65***	0.60***	0.81***
Metallurgies And Transformation Of Materials	0.20***	0.12**	0.08
Manufacture Of Electric And Electronic Components	0.25***	0.17***	0.11

(a) The reference category is Indirect Adopters while dependent variable is Direct Complete Adopters.

Table 6.8: Switching regression (part 3)

Equation 3: Determinants of the logarithm of the value added per employee (inferior position inside ISO network)

	Direct Complete Adopters vs Indirect Adopters (ref) (a)	Direct Complete Adopters vs Non Adopters (ref)	Indirect Adopters vs Non Adopters (ref)
Constant	3.13***	3.13***	3.03***
	Features of the company's strategy		
Quality Improvement	-0.01	0.09***	0.08**
Cost Reduction	0.00	-0.07**	-0.08**
New Process	-0.04	-0.04*	-0.03
	External market's constraints		
Competitive Pressure	-0.08*	-0.05*	-0.07**
Uncertainty On The Market	0.00	-0.07**	-0.07***
Clients Conditioned	-0.05	-0.07***	-0.07**
Suppliers Conditioned	-0.02	-0.02	-0.03
Stockholders Conditioned	-0.01	-0.00	-0.01
	Other type of certification or total quality management		
Other Type Of Certification	0.11***	-0.05	-0.16***
	Quality department and outsourcing in 1994		
Full Time Quality Manager	-	-	-
Outsource Quality Manager	-	-	-
	Capital and Labor		
Logarithm Of The Capital Per Employee	0.12***	0.17***	0.18***
Logarithm Of The Labor	-0.05***	-0.05***	-0.04**
	Sector of Activity		
Agro-Food Industry	0.15*	0.14**	0.08
Industry Of Wearing, Leather And Shoes	0.04	0.02	0.02
Industry Of Edition, Printing And Reproduction	0.40***	0.57***	0.56***
Manufacture Of Soap, Perfumes And Care Products And Pharmaceutical Industry	1.08***	0.55***	0.41***
Manufacture Of Household Equipments	0.21**	0.10	0.07
Manufacture Of Automobiles	0.01	0.18	0.22**
Manufacture Of Naval, Aeronautical And Railroad Materials	0.18*	-0.08	-0.14
Manufacture Of Boilers, Manufacture Of Metallic Tank, Mechanical Equipment And Machines For General Utilisation	0.15*	0.31***	0.30***
Manufacture Of Machines For Agro-Culture, Machines-Tools Of Others	0.37***	0.22**	0.17**

Specific Machines And Weapon And Munitions						
Manufacture Of Electric And Electronic Equipment	0.22***		0.29***		0.31***	
Extractives Industries/ Manufacture Of Glass And Other Product Glass And Ceramic Products And Construction Equipments	0.18*		0.19***		0.21***	
Manufacture Of Wood And Paper	0.07		0.04		0.04	
Industry Of Artificial Fiber, Synthetic Products And Plastic Materials	-0.01		0.07		0.10	
Industry Of Mineral, Organic And Parchemical Products	0.62***		0.42***		0.48***	
Metallurgies And Transformation Of Materials	-0.07		0.14*		0.17***	
Manufacture Of Electric And Electronic Components	-0.04		-0.01		0.02	
$\sigma_j^2\,(j=0,1)$	0.51	0.44	0.45	0.43	0.49	0.45
$\rho_{j\mu}^2\,(j=0,1)$	-0.62***	0.45***	-0.39**	0.02	-0.63***	-0.06

Source: Survey COI 1997 merges to the EAE 1997, sample of 2 909, 3 434 and 2 445 companies, respectively.

Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively

(a) The reference category is Indirect Adopters while dependent variable is Direct Complete Adopters.

Table 6.9: Observed and predicted productivity

Model 1 (b)	**Direct Complete Adopters**		**Indirect Adopters**	
	Observed Productivity	*Predicted Productivity (a)*	*Observed Productivity*	*Predicted Productivity (a)*
Means	3.82	3.84	3.66	3.41
SD	0.49	0.24	0.56	0.24

Model 2 (c)	**Direct Complete Adopters**		**Non Adopters**	
	Observed Productivity	*Predicted Productivity*	*Observed Productivity*	*Predicted Productivity*
Means	3.82	3.84	3.56	3.64
SD	0.49	0.25	0.54	0.26

Model 3 (d)	**Indirect Adopters**		**Non Adopters**	
	Observed Productivity	*Predicted Productivity*	*Observed Productivity*	*Predicted Productivity*
Means	3.66	3.69	3.56	3.64
SD	0.56	0.32	0.54	0.30

Source: Survey COI 1997 merges to the EAE 1997, sample of 2 909, 3 434 and 2 445 companies, respectively.
(a) : Lecture: The predicted productivity comes from the switching model
(b) In Model 1, the dummy variable is 1 if the firm is a Direct Complete Adopter and is 0 if the firm is an Indirect Adopter.
(c) In Model 2, the dummy variable is 1 if the firm is a Direct Complete Adopter and is 0 if the firm is a Non Adopter.
(d) In Model 3, the dummy variable is 1 if the firm is an Indirect Adopter and is 0 if the firm is a Non Adopter.

Table 6.10: Switching regression (part 1)

Equation 1: Determinants of choosing one of the ISO categories

	Direct Complete and Direct Non Complete Adopters vs Indirect Adopters (ref) (a)	Direct Complete and Direct Non Complete Adopters vs Non Adopters (ref)
Constant	-1.98***	-4.02***
	Features of the company's strategy	
Quality Improvement	-0.04	0.18**
Cost Reduction	0.03	0.07
New Process	0.12**	0.12**
	External market's constraints	
Competitive Pressure	0.02	0.08
Uncertainty On The Market	-0.10*	-0.07
Clients Conditioned	0.03	0.23***
Suppliers Conditioned	-0.06	0.07
Stockholders Conditioned	0.04	0.19***
	Other type of certification or total quality management	
Other Type Of Certification	-0.38***	0.01
	Quality department and outsourcing in 1994	
Full Time Quality Manager	0.28***	0.58***
Outsource Quality Manager	0.27***	0.40***
	Capital and Labor	
Logarithm Of The Capital Per Employee	0.20***	0.19***
Logarithm Of The Labor	0.28***	0.48***
	Sector of Activity	
Agro-Food Industry	-0.16	0.37***
Industry Of Wearing, Leather And Shoes	-0.51**	-0.74***
Industry Of Edition, Printing And Reproduction	-0.11	-0.28*
Manufacture Of Soap, Perfumes And Care Products And Pharmaceutical Industry	-0.75***	0.36**
Manufacture Of Household Equipments	-0.07	0.20
Manufacture Of Automobiles	0.73***	1.17***
Manufacture Of Naval, Aeronautical And Railroad Materials	0.17	1.05***
Manufacture Of Boilers, Manufacture Of Metallic Tank, Mechanical Equipment And Machines For General Utilisation	0.56***	1.08***
Manufacture Of Machines For Agro-Culture, Machines-Tools Of Others Specific Machines And Weapon And Munitions	0.19	0.72***
Manufacture Of Electric And Electronic Equipment	0.77***	1.31***
Extractives Industries/ Manufacture Of Glass And Other Product Glass And Ceramic Products And Construction	0.18	0.16***

Equipments		
Manufacture Of Wood And Paper	0.14	0.42***
Industry Of Artificial Fiber , Synthetic Products And Plastic Materials	0.70***	1.12***
Industry Of Mineral, Organic And Parchemical Products	0.48***	1..00***
Metallurgies And Transformation Of Materials	0.85***	1.36***
Manufacture Of Electric And Electronic Components	0.81***	1.47***

(a) The reference category is Indirect Adopters while dependent variable is Direct Complete Adopters and Direct Non Complete Adopters.

Table 6.11: Switching regression (part 2) Equation 2: Determinants of the logarithm of the value added per employee (superior position inside ISO network)

	Direct Complete and Direct Non Complete Adopters vs Indirect Adopters (ref) (a)	Direct Complete and Direct Non Complete Adopters vs Non Adopters (ref)
Intercept	2.64***	2.95***
	Features of the company's strategy	
Quality Improvement	0.01	0.02
Cost Reduction	-0.08**	-0.09**
New Process	0.02	0.01
	External market's constraints	
Competitive Pressure	-0.05*	-0.06**
Uncertainty On The Market	-0.06**	-0.06***
Clients Conditioned-S	0.01	0.00
Suppliers Conditioned	-0.01	0.00
Stockholders Conditioned	0.02	0.02
	Other type of certification or total quality management	
Other Type Of Certification	-0.06**	-0.02
	Quality department and outsourcing in 1994	
Full Time Quality Manager	-	-
Outsource Quality Manager	-	-
	Capital and Labor	
Logarithm Of The Capital Per Employee	0.18***	0.17***
Logarithm Of The Labor	0.05***	0.03***
	Sector of Activity	
Agro-Food Industry	0.20***	0.21***
Industry Of Wearing, Leather And Shoes	0.02	0.09
Industry Of Edition, Printing And Reproduction	0.20**	0.21**
Manufacture Of Soap, Perfumes And Care Products And Pharmaceutical Industry	0.40***	0.47***
Manufacture Of Household Equipments	0.11	0.12
Manufacture Of Automobiles	0.21***	0.16**
Manufacture Of Naval, Aeronautical And Railroad Materials	0.25***	0.24***
Manufacture Of Boilers, Manufacture Of Metallic Tank, Mechanical Equipment And Machines For General Utilisation	0.26***	0.21***
manufacture of machines for agro-culture, machines-tools of others specific machines and weapon and munitions	0.36***	0.34***
Manufacture of electric and electronic	0.42***	0.35***

equipment		
Extractives industries/ Manufacture of glass and other product glass and ceramic products and construction equipments	0.22***	0.20***
Manufacture wood and paper	0.19***	0.17**
Industry of artificial fiber, synthetic products and plastic materials	0.23***	0.16**
Industry of mineral, organic and parchemical products	0.61***	0.56***
Metallurgies and transformation of materials	0.19***	0.11*
Manufacture of electric and electronic components	0.24***	0.17***

(a) The reference category is Indirect Adopters while dependent variable is Direct Complete Adopters and Direct Non Complete Adopters.

Table 6.12: Switching regression (part 3)

Equation 3: Determinants of the logarithm of the value added per employee (inferior position inside ISO network)

	Direct Complete and Direct Non Complete Adopters vs Indirect Adopters (ref) (a)	Direct Complete and Direct Non Complete Adopters vs Non Adopters (ref)
Constant	3.07***	3.17***
	Features of the company's strategy	
Quality Improvement	-0.00	0.09***
Cost Reduction	0.00	-0.07**
New Process	-0.04	-0.04*
	External market's constraints	
Competitive Pressure	-0.08**	-0.06*
Uncertainty On The Market	0.01	-0.06**
Clients Conditioned	-0.04	-0.07***
Suppliers Conditioned	-0.02	-0.02
Stockholders Conditioned	-0.02	-0.01
	Other type of certification or total quality management	
Other Type Of Certification	0.12***	-0.06
	Quality department and outsourcing in 1994	
Full Time Quality Manager	-	-
Outsource Quality Manager	-	-
	Capital and Labor	
Logarithm Of The Capital Per Employee	0.12***	0.16***
Logarithm Of The Labor	-0.05***	-0.06***
	Sector of Activity	
Agro-Food Industry	0.15**	0.13***
Industry Of Wearing, Leather And Shoes	0.02	0.03
Industry Of Edition, Printing And Reproduction	0.39***	0.58***
Manufacture Of Soap, Perfumes And Care Products And Pharmaceutical Industry	1.10***	0.54***
Manufacture Of Household Equipments	0.20**	0.09
Manufacture Of Automobiles	0.02	0.16*
Manufacture Of Naval, Aeronautical And Railroad Materials	0.19**	-0.10
Manufacture Of Boilers, Manufacture Of Metallic Tank, Mechanical Equipment And Machines For General Utilisation	0.16**	0.28***
Manufacture Of Machines For Agro-Culture, Machines-Tools Of Others Specific Machines And Weapon And Munitions	0.37***	0.20***

Manufacture Of Electric And Electronic Equipment	0.23***		0.27***	
Extractives Industries/ Manufacture Of Glass And Other Product Glass And Ceramic Products And Construction Equipments	0.19**		0.20***	
Manufacture Wood And Paper	0.08		0.04	
Industry Of Artificial Fiber, Synthetic Products And Plastic Materials	-0.01		0.05	
Industry Of Mineral, Organic And Parchemical Products	0.62***		0.41***	
Metallurgies And Transformation Of Materials	-0.06		0.11	
Manufacture Of Electric And Electronic Components	-0.04		-0.04	
$\sigma_j^2\,(j=0,1)$	0.45	0.52	0.46	0.43
$\rho_{j\mu}^2\,(j=0,1)$	-0.64 ***	0.46***	-0.46***	0.01

Source: Survey COI 1997 merges to the EAE 1997, sample of 3 092 and 3 617 companies, respectively.
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively
(a) The reference category is Indirect Adopters while dependent variable is Direct Complete Adopters and Direct Non Complete Adopters.

Table 6.13: Observed and predicted productivity

Model 4 (b)	**Direct Complete +Direct Non Complete Adopters**		**Indirect Adopters**	
	Observed Productivity	*Predicted Productivity (a)*	*Observed Productivity*	*Predicted Productivity (a)*
Means	3.82	3.84	3.66	3.41
SD	0.50	0.25	0.56	0.24

Model 5 (c)	**Direct Complete +Direct Non Complete Adopters**		**Non Adopters**	
	Observed Productivity	*Predicted Productivity*	*Observed Productivity*	*Predicted Productivity*
Means	3.82	3.84	3.56	3.66
SD	0.50	0.25	0.54	0.25

Source: Survey COI 1997 merges to the EAE 1997, sample of 3 092 and 3 617 companies, respectively.
(a) : Lecture: The predicted productivity comes from the switching model.
(b) In Model 4, the dummy variable is 1 if the firm is a Direct Complete Adopter or a Direct Non Complete Adopter and is 0 if the firm is an Indirect Adopter.
(c) In Model 5, the dummy variable is 1 if the firm is a Direct Complete Adopter or a Direct Non Complete Adopter and is 0 if the firm is a Non Adopter.

5.2 Estimates Results- COI from 2006

Tables 6.14 and 6.18 (the determinants of ISO categories), Tables 6.15 and 6.19 (the determinants of productivity for the superior position inside the ISO network) and Tables 6.16 and 6.20 (the determinants of productivity for the superior inferior position inside the ISO network) report results from the estimates obtained using the 2006 database. No problem of multicolinearity has been detected (Appendix 6.2).

From Table 6.16 and Table 6.20, we can note that the correlation coefficients between selection equations (choice of the ISO 9000 adopters) and productivity equations ($\rho_{0\mu}$ and $\rho_{1\mu}$) are significantly different from zero, (at least one of them). Hence, as in previous case, those results induce that the ISO 9000 adopters are endogenous and that our econometric model is appropriate.

The estimation results regarding the factors that may impact the adoption of different ISO 9000 categories are presented in Table 6.14 and Table 6.18. Generally results are similar to those obtained using the databases from 1997.

The first group of variables that we have utilised is the sector of activity. We have used 11 sectors of company's activities, the reference is the sector of intermediate goods. As we mentioned previously, the new edition of the COI database permits to control for additional sectorial variables (a part of manufacturing sectors). Like in the literature, we find that the probability that firms adopt one of ISO categories is sensible to the sector of activity. For instance, belonging to the car sector and to the equipment sector increases the probability of ISO adoption.

Concerning the features of the company's strategy, we remark from Table 6.14 and Table 6.18 that quality improvement represents a positive and significant determinant for Model 1', Model 2', Model 3', Model 5' and Model 6', while it is ineffective for Model 4'. [42] Furthermore, cost reduction is not significant for the five models, except the one where we compare Direct Non Complete vs Non Adoptres. In this case, cost reduction has a positive and significant impact. Generally, when technological improvement is important or very important for the firm's strategy, it increases the firm's probability to belong to a superior ISO category (for Model 1', Model 2', Model 3', Model 5'). Interestingly, the standardisation of work procedures and methods stays ineffective on the adoption of ISO certification. Improvement and/or maintenance of skills in the company impacts negatively firm's choice to become Directly Complete Adopters, when comparing to Direct Non Complete Adopters, or Directly Complete, when comparing to Indirect Adopters or Direct Non Complete when comparing to Indirect Adopters, while it impacts positively firm's choice to become Direct Non Complete Adopters, when comparing to Non Adopters, or Indirect Adopters, when comparing to Non Adopters. Possibility to shorten deadlines impacts negatively Model 1', while we obtain a positive impact on Model 3' and Model 6'. Finally, competitive price influences only one model. In fact, in Model 3', competitive prices impacts negatively the adoption of Direct Complete Adopters (comparing to Non Adopters).

[42] The Models are defined in the section 4.2.2.

Concerning external market's constraints, one can remark that the competitive pressure impacts positively the adoption of Direct Complete Adopters (when they are compared to Direct Non Complete Adopters) and Direct Non Complete Adopters (when they are compared to Indirect Adopters). On the other side, the same variable decreases the probability for a firm to choose Direct Complete Adopters when they are compared to Indirect Adopters. Further, we can notice that uncertainty on the market has a positive impact only for Model 3' and Model 4', in the rest of the models, this variable seems to be ineffective. If we look at the suppliers' condition, the coefficients, when significant, are positive. Hence, we may conclude that the suppliers' condition increases firm's probability to belong to Model 2' or Model 3'. Surprisingly, the client's condition has no influence for all six regressions.

As expected, having environmental standards has a positive and significant impact for all six models, which confirms our presumption that integrated systems allowing a joint implementation and certification of two or more standards may reduce the cost of the ISO 9000 implementation.

As in previous case, having a full time quality management and an outsource quality manager are considered as the instruments. We can notice that having a full time quality manager impacts positively the ISO 9000 adoption for five regressions (out of six). Furthermore, outsource quality manager has a positive impact on the ISO 9000 adoption for all six regressions.

Concerning the relation with clients, the results differ among variables that characterise this category. Hence, using labeling for goods and services has no impact on Model 1', Model 2' and Model 3', while it affects positively the rest of the models. Generally, delivering or supplying goods or services in fixed deadlines influences positively the adoption of only one of the ISO categories. Having contact or call center for clients has no impact on Models 1' and 2', but it impacts positively Model 3', Model 5' and Model 6' and it has a negative influence on Model 4'.

Finally, the logarithm of capital per employee or the logarithm per labour has a positive impact on the ISO adoption, which confirms the results of previous edition.

As in previous case, the second stage results define factors that may impact the logarithm of the value added per employee for ISO adopters of superior level inside the network (Tables 6.15 and 6.19). The first group of variables that we have utilised is the sector of activity as in previous stage. The results are similar with those from COI in 1997, indicating that the majority of sectors have a positive and significant effect on the dependent variable.Concerning the features of the company's strategy, we may conclude that results are generally very similar among models. Hence, quality improvement, technological improvement and shortening deadlines improve firm's value added, while improvement and/or maintenance of skills and competitive price impact it negatively. Concerning the external market's constraints findings induce that competitive pressure impacts negatively our dependent variable in Model 4' and Model 5'. In the same sense, we notice that for our four regressions uncertainty on the market affects negatively added value. Supplier's conditions are significant only for two models, but since the sign is negative we conclude that it influences negatively our dependent variable. Once again, the added value is negatively influenced by client's conditions.Concerning the environmental registration, it seems that it has a negative impact on the logarithm of the value added per employee.Concerning the relation with clients, we can remark that, generally, only the possibility to deliver or to supply goods or services in a fixed deadline improves the value added for all six regressions.

Finally, the logarithm of capital per employee and the logarithm of the labour have positive and significant impact on the logarithm of the value added per employee for ISO adopters of superior level inside the network. More precisely, the logarithm of capital per employee is significant for the six regressions, while the logarithm of the labour is significant only for two regressions.

The third stage results define factors that may impact on the logarithm of the value added per employee for ISO adopters of inferior level inside the network. Concerning the sector of activity, as we can see from the Tables 6.16 and 6.20 results are similar as for the second stage. Concerning variables of features of the company's strategy, we notice that quality improvement has a positive and significant impact on the value added only for one regression; cost reduction is positive and significant for two regressions; technological improvement influences positively the value added in the six regressions; standardisation has not effect at all; improvement and/or maintenance of the skill in the company has a negative impact for four regressions; shortening deadlines has a positive impact on the value added for only one regression and finally, competitive price influences negatively for all six regressions. Concerning the external market's constraints, we can see from Table 6.16 and Table 6.20 that the coefficients, when significant, are negative, as in the previous results from the previous databases edition. We remark that competitive pressure has a negative impact on our dependent variable for four regressions. In the same vein, the uncertainty on the market also has a negative impact for three regressions. Furthermore, supplier's condition has a negative impact for all six models, while client's condition rests insignificant. Being registered for environmental standards has a negative effect when we compare Direct Complete Adopters vs Indirect Adopters, Direct Complete Adopters vs Direct Non Complete Adopters and Direct Non Complete Adopters vs Indirect Adopters.

Concerning the relation with clients, we may conclude that using labeling goods and services influences negatively our dependent variable for five regressions. Contrary, delivering or supplying goods or services in fixed deadlines will improve the value added in all six models. Having contact or call service for clients induces mitigated results. In fact, the findings indicate that this variable impacts negatively the value added when we compare Direct Complete Adopters vs Direct Non Complete Adopters and Indirect Adopters vs Non Adopters, while it will impact positively added value when we compare Direct Complete Adopters vs Indirect Adopters.

Finally, as in the previous case, the logarithm of the capital per employee is positive for all six regressions. On other hand, the logarithm of the labor is significant and negative for all five out of six regressions.As for the results of COI database in 1997, we compare observed and predicted productivity's means for our six ISO dummies (Tables 6.17 and 6.21). The results obtained from the comparison between Direct Complete Adopters and Direct Non Complete Adopters (Table 6.17) support, as in a previous case, our prediction given by the graphic in Figure 6.1. Actually, being certified and dealing with a certified firm amplifies the positive signal while, dealing with a non-certified firm when certified decrease the positive signal. The results are going into the same direction when we compare Direct Complete Adopters and Indirect Adopters and Direct Complete Adopters and Non Adopters. Hence, we may conclude that being a certified firm while having certified suppliers permits to have the highest impact on productivity. Therefore, this confirms that firms that belong to the category of Direct Complete Adopters are leaders in the ISO network hierarchy.Furthermore, using the new editions of databases we are in measure to evaluate the direct effect of Direct Non Complete Adopters. With our findings, we may conclude that Direct Non Complete Adopters are in a more profitable position inside the network comparing to Indirect Adopters or Non Adopters. Even that the suppliers of Direct Non Complete Adopters are not certified, the firms' direct certification is enough "strong" to have a superior impact on productivity comparing to Indirect and Non Adopters. Hence, they are situated on the second position inside the ISO network hierarchy.As in the previous case, the findings associated to Indirect Adopters prove again that firms can indirectly profit form the ISO certification (via suppliers), what makes them different from Non Adopters. Consequently, Indirect Adopters are placed on the third position inside the network.

Finally, as Non Adopters are not part of the ISO network, directly or indirectly, they can not receive a positive signal which could influence their position in the network hierarchy. Not surprisingly, they are situated on the last position. Based on the findings of both database editions (1997 and 2006), we may conclude that there is a positive relationship between the hierarchy in the network and the impact on productivity. Hence, the productivity of Direct Complete Adopter firms is higher than those of Direct Non Complete Adopter firms which is higher than those of Indirect Adopter firms which is higher than those of Non Adopter firms. These findings suggest that being a certified firm amplifies a positive effect on the productivity of firms. In addition, owing to the network effect, a non-certified firm dealing with certified suppliers (Indirect Adopters) can also improve its productivity. Finally, the results of this network analysis confirm empirically that the ISO standard could be conceptualised as a Club Good.

Table 6.14: Switching regression (part 1)

Equation 1: Determinants of choosing one of the ISO categorie

	Direct Complete Adopters vs Direct Non Complete Adopters (ref) (a)	Direct Complete Adopters vs Indirect Adopters (ref)	Direct Complete Adopters vs Non Adopters (ref)
Intercept	-0.77***	-1.69***	-3.19***
	Features of the company's strategy		
Quality Improvement	-0.03	-0.01	0.26**
Cost Reduction	0.09	0.07	0.12*
Technological Improvement	0.08*	0.03	0.08
Standardisation Of Work Procedures And Methods	0.08*	0.09*	0.17***
Improvement And/Or Maintenance Of Skills In The Company	0.02	-0.11***	-0.01
Shortening Deadlines	-0.01	-0.08*	0.09*
Competitive Price	-0.06	0.06	-0.14**
	External market's constraints		
Competitive Pressure	0.08*	-0.07*	0.02
Uncertainty On The Market	-0.06	0.02	-0.02
Supplier Conditioned	0.03	0.08*	0.25***
Clients Conditioned	0.05	0.07	0.06
	Quality department and outsourcing in 2003		
Full Time Quality Manager	0.22***	0.14***	0.30***
Outsource Quality Manager	0.13***	0.19***	0.27***
	Previous experience		
ES	0.23***	1.04***	1.17***
	Relation with Clients		
Using Labelling Goods And Services-Yes	0.04	0.74***	0.86***
Deliver Or Supply Goods Or Services In A Fixed Deadline-Yes	0.31***	0.27***	0.44***
Contact Or call centre for clients-yes	0.70***	0.53***	1.21***
	Capital and Labor		
Logarithm Of The Capital Per Employee	0.04***	0.07***	0.11***
Logarithm Of The Labor	0.06***	0.19***	0.25***
	Sector of Activity		
Agro-Food Industry	0.16*	-0.30***	-0.00
Consumption Goods	-0.14	-0.95***	-0.68***
Cars And Equipments	0.26***	0.18***	0.24***
Energy	-0.46***	-0.18	-0.47
Construction	0.01	-0.06	0.23***
Commercial	-0.32***	-0.65***	-0.58***
Transport	-0.42***	-0.46***	-0.79***
Financial And Real-Estate Activities	-0.20	-1.11***	-0.92***
Services For Firms	-0.47***	-0.38***	-0.60***
Services For Individuals	0.50***	-0.83***	-0.46***

(a) The reference category is Indirect Adopters while dependent variable is Direct Complete Adopters.

Table 6.15:Switching regression (part 2)

Equation 2: Determinants of the logarithm of the value added per employee (superior position inside ISO network)

	Direct Complete Adopters vs Indirect Adopters (ref) (a)	Direct Complete Adopters vs Non Adopters (ref)	Direct Complete Adopters vs Non Adopters (ref)
Intercept	2.92***	2.86***	2.87***
	Features of the company's strategy		
Quality Improvement	0.21***	0.21***	0.21***
Cost Reduction	-0.01	-0.01	-0.01
Technological Improvement	0.13***	0.13***	0.13***
Standardisation Of Work Procedures And Methods	-0.00	-0.00	-0.00
Improvement And/Or Maintenance Of Skills In The Company	-0.05***	-0.05***	-0.05***
Shortening Deadlines	0.05***	0.05***	0.05***
Competitive Price	-0.14***	-0.14***	-0.14***
	External market's constraints		
Competitive Pressure	-0.02	-0.01	0.01
Uncertainty On The Market	-0.06***	-0.06***	-0.06***
Supplier Conditioned	-0.02	-0.02	-0.02
Cleints Conditioned	-0.03*	-0.03*	-0.03*
	Quality department and outsourcing in 2003		
Full Time Quality Manager	-	-	-
Outsource Quality Manager	-	-	-
	Previous experience		
ES	0.03*	0.05**	0.04**
	Relation with Clients		
Using Labelling Goods And Services	-0.01	0.00	-0.00
Deliver Or Supply Goods Or Services In A Fixed Deadline	0.05*	0.05**	0.05***
Contact Or Call Centre For Clients	0.03	0.04	0.04*
	Capital and Labor		
Logarithm Of The Capital Per Employee	0.20***	0.20***	0.20***
Logarithm Of The Labor	0.01	0.01*	0.01*
	Sector of Activity		
Agro-Food Industry	-0.05*	-0.06*	-0.05*
Consumption Goods	0.12***	0.10***	0.11***
Cars And Equipments	0.10**	0.10***	0.10***
Energy	0.48***	0.48***	0.48***
Construction	0.16***	0.16***	0.16***
Commercial	0.09***	0.08***	0.09***
Transport	0.00	-0.00	-0.01
Financial And Real-Estate Activities	0.39***	0.37***	0.39***
Services For Firms	0.21***	0.20***	0.20***
Services For Individuals	-0.23***	-0.26***	-0.24***

(a) The reference category is Indirect Adopters while dependent variable is Direct Complete Adopters.

Table 6.16:Switching regression (part 3)

Equation 3: Determinants of the logarithm of the value added per employee (inferior position inside ISO network)

	Direct Complete Adopters vs Indirect Adopters (ref) (a)		Direct Complete Adopters vs Non Adopters (ref)		Direct Complete Adopters vs Non Adopters (ref)	
Intercept	3.08***		3.21***		3.15***	
	Features of the company's strategy					
Quality Improvement	-0.03		0.05		0.09*	
Cost Reduction	-0.02		0.06*		-0.02	
Technological Improvement	0.13***		0.12***		0.10***	
Standardisation Of Work Procedures And Methods	0.03		-0.03		-0.02	
Improvement And/Or Maintenance Of Skills In The Company	-0.05*		-0.03		-0.04*	
Shortening Deadlines	0.06**		0.03		0.01	
Competitive Price	-0.09**		-0.19***		-0.08**	
	External market's constraints					
Competitive Pressure	-0.10***		-0.02		-0.10***	
Uncertainty On The Market	-0.01		-0.08***		-0.03	
Supplier Conditioned	-0.06*		-0.08***		-0.06***	
Cleints Conditioned	-0.05		0.02		-0.02	
	Quality department and outsourcing in 2003					
Full Time Quality Manager	-		-		-	
Outsource Quality Manager	-		-		-	
	Previous experience					
ES	-0.08***		-0.17***		-0.07	
	Relation with clients					
Using Labelling Goods And Services	-0.04		-0.11***		-0.15***	
Deliver Or Supply Goods Or Services In A Fixed Deadline	0.06*		0.07**		0.14***	
Contact Or Call Centre For Clients	-0.08*		-0.03		-0.07	
	Capital and Labor					
Logarithm Of The Capital Per Employee	0.21***		0.18***		0.20***	
Logarithm Of The Labor	-0.01		-0.05***		-0.05***	
	Sector of Activity					
Agro-Food Industry	-0.12*		-0.04		-0.04	
Consumption Goods	-0.05		0.28***		0.26***	
Cars And Equipments	0.11*		0.14***		0.14***	
Energy	0.27**		0.88***		0.23	
Construction	0.13**		0.21***		0.24***	
Commercial	0.06		0.15***		0.11***	
Transport	0.06		0.09		0.07	
Financial And Real-Estate Activities	0.26***		0.69***		0.49***	
Services For Firms	0.39***		0.41***		0.47***	
Services For Individuals	-0.22*		0.04		0.10*	
$\sigma_j^2\left(j=0,1\right)$	0.48	0.51	0.48	0.61	0.48	0.59
$\rho_{j\mu}^2\left(j=0,1\right)$	0.03	-0.29***	0.11	-0.35***	0.08	-0.18***

Source: COI-TIC 2006-INSEE-CEE/Treatments CEE, sample of 4 872, 5 924 and 6 568 companies, respectively.
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively
(a) The reference category is Indirect Adopters while dependent variable is Direct Complete Adopters.

Table 6.17: Observed and predicted productivity

Model 1' (b)	**Direct Complete Adopters**		**Direct Non Complete Adopters**	
	Observed Productivity	*Predicted Productivity (a)*	*Observed Productivity*	*Predicted Productivity (a)*
Means	3.94	3.93	3.88	3.84
SD	0.57	0.31	0.61	0.33

Model 2' (c)	**Direct Complete Adopters**		**Indirect Adopters**	
	Observed Productivity	*Predicted Productivity (a)*	*Observed Productivity*	*Predicted Productivity (a)*
Means	3.94	3.93	3.79	3.75
SD	0.57	0.31	0.68	0.35

Model 3' (d)	**Direct Complete Adopters**		**Non Adopters**	
	Observed Productivity	*Predicted Productivity*	*Observed Productivity*	*Predicted Productivity*
Means	3.94	3.93	3.73	3.72
SD	0.57	0.31	0.70	0.34

Source: COI-TIC 2006-INSEE-CEE/Treatments CEE, sample of 4 872, 5 924 and 6 568, respectively.
(a) Lecture: The predicted productivity comes from the switching model
(b) In Model 1', the dummy variable is 1 if the firm is a Direct Complete Adopter and is 0 if the firm is a Direct Non Complete Adopter.
(c) In Model 2', the dummy variable is 1 if the firm is a Direct Complete Adopter and is 0 if the firm is an Indirect Adopter.
(d) In Model 3', the dummy variable is 1 if the firm is a Direct Complete Adopter and is 0 if the firm is a Non Adopter.

Table 6.18: Switching regression (part 1)

Equation 1: Determinants of choosing one of the ISO categories

	Direct Non Complete Adopters vs Indirect Adopters (ref) (a)	Direct Non Complete Adopters vs Non Adopters (ref)	Indirect Adopters vs Non Adopters (ref)
Intercept	-1.06***	-2..62***	-1.75***
	Features of the company's strategy		
Quality Improvement	0.03	0.24*	0.18*
Cost Reduction	-0.10	-0.03	0.13***
Technological Improvement	0.09*	0.14***	0.01
Standardisation Of Work Procedures And Methods	0.04	0.10**	0.07*
Improvement And/Or Maintenance Of Skills In The Company	-0.15***	0.10*	0.09***
Shortening Deadlines	-0.04	-0.03	0.09***
Competitive Price	0.10	-0.07	-0.04
	External market's constraints		
Competitive Pressure	0.11***	-0.04	0.05
Uncertainty On The Market	0.08*	0.08*	0.01
Supplier Conditioned	-0.05	0.20***	0.28***
Cleints Conditioned	-0.01	0.01	8.18e-06
	Quality department and outsourcing in 2003		
Full Time Quality Manager	-0.03	0.16***	0.16***
Outsource Quality Manager	0.06*	0.19***	0.10***
	Previous experiences		
ES	0.79***	0.88***	0.26***
	Relation with clients		
Using Labelling Goods And Services	0.75***	0.93***	0.15***
Deliver Or Supply Goods Or Services In A Fixed Deadline	-0.00	0.20***	0.19***
Contact Or Call Centre For Clients	-0.13***	0.61***	0.75***
	Capital and Labor		
Logarithm Of The Capital Per Employee	0.03*	0.06***	0.05***
Logarithm Of The Labor	0.13***	0.21***	0.10***
	Sector of Activity		
Agro-Food Industry	-0.49***	-0.20	0.33***
Consumption Goods	-0.79**	-0.62***	0.18**
Cars And Equipments	-0.15	-0.15	0.09
Energy	-0.56	0.16	-0.66
Construction	-0.04	0.16	0.20***
Commercial	-0.36***	-0.31***	0.02
Transport	-0.02	-0.41***	0.36***
Financial And Real-Estate Activities	-0.98***	-0.76***	0.23*
Services For Firms	-0.09	-0.25***	-0.27***
Services For Individuals	-1.32***	-0.98***	0.40***

(a) The reference category is Indirect Adopters while dependent variable is Direct Non Complete Adopters.

Table 6.19: Switching regression (part 2)

Equation 2: Determinants of the logarithm of the value added per employee (superior position inside ISO network)

	Direct Non Complete Adopters vs Indirect Adopters (ref) (a)	Direct Non Complete Adopters vs Non Adopters (ref)	Indirect Adopters vs Non Adopters (ref)
Intercept	2.93***	3.10***	3.02***
	Features of the company's strategy		
Quality Improvement	-0.03	-0.03	0.06
Cost Reduction	-0.02	-0.01	0.07*
Technological Improvement	0.13***	0.13***	0.13***
Standardisation Of Work Procedures And Methods	0.04	0.04	-0.01
Improvement And/Or Maintenance Of Skills In The Company	-0.06***	-0.05*	-0.04*
Shortening Deadlines	0.06*	0.07*	0.03
Competitive Price	-0.10***	-0.11***	-0.19***
	External market's constraints		
Competitive Pressure	-0.10***	-0.10***	-0.03
Uncertainty On The Market	-0.01	-0.01	-0.08***
Supplier	-0.06*	-0.05	-0.07***
Cleints	-0.04	-0.04	0.03
	Quality department and outsourcing in 2003		
Full Time Quality Manager	-	-	-
Outsource Quality Manager	-	-	-
	Previous experiences		
ES	0.00	-0.05	-0.01
	Relation with clients		
Using Labelling Goods And Services-Yes	0.03	0.03	-0.01
Deliver Or Supply Goods Or Services In A Fixed Deadline-Yes	0.09***	0.09***	0.11***
Contact Or Call Centre For Clients-Yes	-0.02	-0.01	0.08
	Capital and Labor		
Logarithm Of The Capital Per Employee	0.22***	0.22***	0.19***
Logarithm Of The Labor	0.01	0.00	-0.02
	Sector of Activity		
Agro-Food Industry	-0.15*	-0.11	-0.06
Consumption Goods	-0.14	-0.07	0.18***
Cars And Equipments	0.13*	0.14**	0.17***
Energy	0.24*	0.22*	0.82***
Construction	0.12*	0.12**	0.21***
Commercial	-0.01	0.02	0.06
Transport	0.01	0.01	0.00
Financial And Real-Estate Activities	0.16	0.23*	0.58***
Services For Firms	0.35***	0.34***	0.34***
Services For Individuals	-0.29***	-0.17	-0.04

(a) The reference category is Indirect Adopters while dependent variable is Direct Non Complete Adopters.

Table 6.20: Switching regression (part 3)

Equation 3: Determinants of the logarithm of the value added per employee (inferior position inside ISO network)

	Direct Non Complete Adopters vs Indirect Adopters (ref) (a)	**Direct Non Complete Adopters vs Non Adopters (ref)**	**Indirect Adopters vs Non Adopters (ref)**
Intercept	3.13***	3.14***	3.13***
	Features of the company's strategy		
Quality Improvement	0.04	0.08*	0.08*
Cost Reduction	0.08**	-0.02	-0.03
Technological Improvement	0.11***	0.09***	0.10***
Standardisation Of Work Procedures And Methods	-0.02	-0.02	-0.02
Improvement And/Or Maintenance Of Skills In The	-0.03	-0.04*	-0.05**
Shortening Deadlines	0.02	0.01	0.01
Competitive Price	-0.19***	-0.09***	-0.09***
	External market's constraints		
Competitive Pressure-	-0.02	-0.10***	-0.10***
Uncertainty On The Market	-0.09***	-0.04*	-0.04
Supplier	-0.08***	-0.06***	-0.07***
Cleints	-0.03	-0.02	-0.02
	Quality department and outsourcing in 2003		
Full Time Quality Manager	-	-	-
Outsource Quality Manager-	-	-	-
	Previous experiences		
ES	-0.15***	-0.06	-0.02
	Relation with clients		
Using Labelling Goods And Services	-0.12***	-0.17***	-0.11***
Deliver Or Supply Goods Or Services In A Fixed Deadline	0.10***	0.14***	0.14***
Contact Or Call Centre For Clients	0.05*	-0.04	-0.07*
	Capital and Labor		
Logarithm Of The Capital Per Employee	0.18***	0.20***	0.20***
Logarithm Of The Labor	-0.04***	-0.05***	-0.05***
	Sector of Activity		
Agro-Food Industry	-0.01	-0.03	-0.07
Consumption Goods	0.26***	0.26***	0.22***
Cars And Equipments	0.19***	0.16***	0.14***
Energy	0.73***	0.19	0.25
Construction	0.21***	0.24***	0.23***
Commercial	0.11***	0.10***	0.08*
Transport	0.03	0.06	0.06
Financial And Real-Estate Activities	0.67***	0.49***	0.43***
Services For Firms	0.34***	0.46***	0.46***
services for individuals	0.07	0.12*	0.05
$\sigma_j^2\,(j=0,1)$	0.51 0.62	0.50 0.59	0.59 0.60
$\rho_{j\mu}^2\,(j=0,1)$	0.26*** -0.43***	0.02 -0.22***	0.15 -0.23***

Source: COI-TIC 2006-INSEE-CEE/Treatments CEE, sample of 3 700, 4 344 and 5 396 companies, respectively.
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively
(a) The reference category is Indirect Adopters while dependent variable is Direct Non Complete Adopters.

Table 6.21: Observed and predicted productivity

Model 4' (b)	**Direct Non Complete Adopters**		**Indirect Adopters**	
	Observed Productivity	*Predicted Productivity (a)*	*Observed Productivity*	*Predicted Productivity (a)*
Means	3.88	3.87	3.80	3.61
SD	0.61	0.35	0.68	0.38
Model 5' (c)	**Direct Non Complete Adopters**		**Non Adopters**	
	Observed Productivity	*Predicted Productivity (a)*	*Observed Productivity*	*Predicted Productivity (a)*
Means	3.88	3.87	3.73	3.78
SD	0.61	0.35	0.69	0.37
Model 6 (d)	**Indirect Adopters**		**Non Adopters**	
	Observed Productivity	*Predicted Productivity (a)*	*Observed Productivity*	*Predicted Productivity (a)*
Means	3.80	3.79	3.73	3.60
SD	0.69	0.35	0.69	0.34

Source: COI-TIC 2006-INSEE-CEE/Treatments CEE, sample of 3 700, 4 344 and 5 396 companies, respectively.
(a) Lecture: The predicted productivity comes from the switching model.
(b) In Model 4', the dummy variable is 1 if the firm is a Direct Non Complete Adopter and is 0 if the firm is an Indirect Adopter.
(c) In Model 5', the dummy variable is 1 if the firm is a Direct Non Complete Adopter and is 0 if the firm is a Non Adopter.
(d) In Model 6', the dummy variable is 1 if the firm is an Indirect Adopter and is 0 if the firm is a Non Adopter.

6. Conclusions

The existing empirical literature dealing with ISO 9000 standards mainly evaluates the effect of these standards on firm performance (see **chapter 3** and **chapter 4**). Rather than simply investigating whether the ISO standard impacts positively or negatively on the productivity of firms, **chapter 6** tries to extend previous research by providing an empirical answer to the question of whether there is a positive correlation between a firm's hierarchical position in the ISO network and the impact on productivity. The main contribution of this chapter is the provision, through network analysis, of empirical evidence demonstrating that ISO norms can be seen as Club Goods. For this purpose, we have assembled datasets that aggregate different characteristics of firms and indicators of performance, covering two different years (1997 and 2006). We controlled for the potential endogeneity of ISO 9000 variables using an endogenous switching model. Our findings demonstrate that there is a positive and significant relationship between the hierarchical position in the ISO network and the impact on productivity. More precisely, our results are highlighted using two editions of our databases (COI and EAE in 1997 and COI and EAE in 2006). Moreover, the COI database from 2006 permits us to overcome some important limits of previous results (which used the databases from 1997). The fact that our sample in 1997 is restricted only to manufacturing firms, would have limited our conclusion of a relationship between ISO network and productivity in rest of the economy. The new edition of our databases allows us to draw general conclusions, since it encompasses a wider range of sectors. Hence, we may argue that the productivity of Direct Complete Adopter firms is higher than that of Direct Non Complete Adopter firms which are higher than those of Indirect Adopter firms which are higher than those of Non Adopter firms.

The evidence we accumulated indicates that adopting the ISO 9000 standard *per se* does not raise productivity to the same degree as when firms also deal with suppliers that are quality certified. It is this combination that seems to matter most for productivity.

Moreover, we show that firms which are not ISO certified will, if they have ISO certified firms as suppliers, profit from this network, generating a positive signal on the market through their certified suppliers. Hence, cooperation among firms and suppliers permits Indirect Adopters to benefit from supplier knowledge and therefore improves their performance as compared to Non Adopters. Therefore, these findings imply that Indirect Adopters can enhance firm performance whilst avoiding the costly processes of direct ISO 9000 certification. As we said previously, the contribution could be especially significant for small firms since indirect certification (via suppliers) may permits to those firms to gain advantage of ISO certification, but at the same time avoid the difficult and costly process of ISO certification. This shows that a key objective for these firms is to establish a good relationship with suppliers in order to assure continuous improvement of their performance.

Strong relationships with supplier will lead to faster development and performance improvement.

Even though the objective of this chapter is not to evaluate the impact of ISO certification on firms' economic performance, given that we have identified a statistically and economically significant effect of certification for Direct Complete Adopters and Direct Non Complete Adopters on productivity, we may also conclude that the ISO 9000 standard is positively associated with productivity improvement. Interestingly, the evidence of this chapter suggests that having multiple affiliations or participating in more than one network improves productivity more significantly than having only one affiliation (Eriksson and Jacoby, 2003). From a theoretical perspective, our findings underline the importance of network relationships in the process of performance improvement. Network ties to firms that belong to the ISO club play an important role in productivity improvement for firms. Participating in these networks offers opportunities and creates skills necessary for better productivity. Having multiple ties generates large amounts of information, including new information that competitors may not possess (Podolny and Baron, 1997).

Further research on this issue should be extended including literature on supply chain relationships. Moreover, it will be interesting to provide an analysis that contains international setting since the implementation of management practices depends also on a country's institutional framework (Godard, 2004). Some countries may implement those practices following "involvement way" rather than "intensification way" which may explain different findings across countries. Finally, in order to generalise better our conclusion supporting a positive correlation between hierarchical position in the ISO network and the impact on firm performance, it will also be interesting to examine additional indicators of firm performance other than productivity. The choice of performance measures matters since they mediate the relation between the firm's probability of choosing to become one of the categories of ISO adopters and firm performance

APPENDICES CHAPTER VI

Appendix 6.1: Pearson correlation coefficients - COI from 1997

Appendix 6.2: Pearson correlation coefficients - COI from 200

Appendix 6.1: Pearson correlation coefficients - COI from 1997

	PRODUCTIVITY	ISO 9000	ISO 9000 SUPPLIERS	QUALDEP	QUALEXT	OTHER CERTIFICATIO N	EXPORT	QUALITY	COST	NEW PROCEDURE	COMPETITIVE PRESSURE	UNCERTAINTY ON THE MARKET	CLIENTS CONDITIONED	SUPPLIERS CONDITIONED	STOCKHOLDER S CONDITIONED	LABOUR	CAPITAL
PRODUCTIVITY	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ISO 9000	0.17	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ISO 9000 SUPPLIERS	0.10	0.33	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QUALDEP	0.07	0.28	0.17	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-
QUALEXT	0.04	0.23	0.15	0.37	1.00	-	-	-	-	-	-	-	-	-	-	-	-
OTHER CERTIFICATION	0.12	0.35	0.22	0.15	0.15	1.00	-	-	-	-	-	-	-	-	-	-	-
EXPORT	0.09	0.09	0.09	0.04	0.05	0.11	1.00	-	-	-	-	-	-	-	-	-	-
QUALITY IMPROVEMENT	0.05	0.09	0.11	0.07	0.06	0.01	0.02	1.00	-	-	-	-	-	-	-	-	-
COST	0.05	0.11	0.15	0.11	0.08	0.05	0.01	0.14	1.00	-	-	-	-	-	-	-	-
NEW PROCEDURE	0.08	0.12	0.06	0.04	0.12	0.09	0.00	0.14	0.11	1.00	-	-	-	-	-	-	-
COMPETITIVE PRESSURE	-0.03	-0.00	0.01	0.00	0.02	0.00	-0.00	0.03	0.12	0.01	1.00	-	-	-	-	-	-
UNCERTAINTY ON THE MARKET	-0.03	0.02	0.01	0.01	0.00	0.01	0.00	0.05	0.09	0.06	0.23	1.00	-	-	-	-	-
CLIENTS CONDITIONED	-0.02	0.15	0.09	0.07	0.02	0.05	-0.00	0.01	0.01	0.03	0.05	0.06	1.00	-	-	-	-
SUPPLIERS CONDITIONED	-0.04	-0.04	0.08	-0.03	-0.03	-0.01	-0.00	-0.01	-0.00	-0.00	0.04	0.02	0.01	1.00	-	-	-
STOCKHOLDERS CONDITIONED	-0.07	-0.02	0.08	-0.04	-0.04	-0.03	-0.00	-0.02	-0.04	-0.03	0.03	0.00	0.00	0.01	1.00	-	-
LABOUR	0.14	0.38	0.22	0.36	0.22	0.32	0.17	0.05	0.21	0.15	-0.05	-0.02	0.03	0.02	0.12	1.00	-
CAPITAL	0.52	0.15	0.15	0.24	0.15	0.20	0.10	0.08	0.14	0.12	-0.03	-0.01	0.05	0.01	0.09	-0.01	1.00

Source: Survey COI 1997 mergers to EAE 1997.

Appendix 6.1: Pearson correlation coefficients - COI from 2006

	PRODUCTIVITY	ISO 9000	ISO 9000 SUPPLIERS	QUALDEP	QUALEXT	ES	EXPORT	QUALITY IMPROVEMENT	COST	TECH IMPROVEMENT	STANDARDI SATION	SHORTENING DEADLINES	COMPETITIVE PRICE	COMPETITIVE PRESSURE	UNCERTAINTY ON THE MARKET	CLIENTS CONDITIONED	SUPPLIERS CONDITIONED	LABOUR	CAPITAL	LABELLING	FIXED DEADLINES	CONTACT-CALL CENTERS
PRODUCTIVITY	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ISO 9000	0.12	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ISO 9000 SUPPLIERS	0.08	0.29	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QUALDEP	0.14	0.26	0.21	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QUALEXT	0.11	0.21	0.16	0.40	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES	0.10	0.38	0.20	0.18	0.15	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EXPORT	0.07	0.05	0.04	0.05	0.05	0.09	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QUALITY IMPROVEMENT	0.03	0.07	0.07	0.08	0.06	0.03	0.01	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COST	0.03	0.10	0.11	0.11	0.08	0.06	0.02	0.14	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-
TECH IMPROVEMENT	0.14	0.10	0.07	0.14	0.12	0.07	0.02	0.14	0.14	1.00	-	-	-	-	-	-	-	-	-	-	-	-
STANDARDISATION	0.04	0.13	0.11	0.15	0.11	0.09	0.03	0.11	0.17	0.23	1.00	-	-	-	-	-	-	-	-	-	-	-
SHORTENING DEADLINES	0.05	0.08	0.09	0.08	0.06	0.03	0.02	0.10	0.32	0.15	0.16	1.00	-	-	-	-	-	-	-	-	-	-
COMPETITIVE PRICE	-0.06	0.07	0.05	0.05	0.04	0.05	0.01	0.24	0.26	0.07	0.12	0.12	1.00	-	-	-	-	-	-	-	-	-
COMPETITIVE PRESSURE	-0.06	-0.01	0.02	-0.00	0.02	0.01	-0.01	0.03	0.06	0.00	0.04	0.07	0.08	1.00	-	-	-	-	-	-	-	-
UNCERTAINTY ON THE MARKET	-0.06	0.04	0.04	0.03	0.03	0.03	0.02	0.05	0.11	0.04	0.06	0.09	0.08	0.26	1.00	-	-	-	-	-	-	-
CLIENTS CONDITIONED	-0.00	0.12	0.11	0.05	0.02	0.07	-0.00	0.01	0.03	0.01	0.03	0.03	0.02	0.02	0.04	1.00	-	-	-	-	-	-
SUPPLIERS CONDITIONED	-0.08	-0.02	0.02	-0.06	-0.03	-0.02	-0.02	0.01	-0.01	-0.01	-0.01	0.02	0.01	0.03	0.02	0.01	1.00	-	-	-	-	-
LABOUR	0.10	0.32	0.20	0.33	0.22	0.28	0.16	0.05	0.14	0.12	0.16	0.15	0.06	-0.03	0.00	0.00	-0.16	1.00	-	-	-	-
CAPITAL	0.45	0.13	0.13	0.18	0.15	0.18	0.07	0.08	0.08	0.09	0.03	0.13	0.01	-0.01	0.01	-0.00	-0.04	0.12	1.00	-	-	-
LABELLING	0.03	0.40	0.19	0.17	0.14	0.22	0.05	0.10	0.05	0.05	0.09	0.10	0.06	-0.01	-0.00	0.01	0.01	0.19	0.03	1.00	-	-
FIXED DEADLINES	0.10	0.30	0.22	0.20	0.13	0.15	0.03	0.02	0.09	0.10	0.12	0.03	0.08	0.02	0.06	0.12	0.02	0.18	0.01	0.26	1.00	-
CONTACT-CALL CENTERS	0.04	0.40	0.38	0.18	0.11	0.20	0.02	0.08	0.08	0.06	0.11	0.02	0.07	0.00	0.09	0.30	-0.02	0.18	0.01	0.24	0.32	1.00

Source: Survey COI 2006 mergers to EAE 2006.

Part III
The Effect of Quality and Environmental Management Tools on Employee Outcomes

Introduction of the third part

The adoption of quality and environmental approaches leads to reorganisation of the workplace followed by job rotation, learning across tasks, teamwork, decentralisation of responsibility, worker participation in decision making, etc. The impact of these changes on firm performance has been studied extensively. Relatively less is known about their effects on worker outcomes, and, in particular, the impact of environmental approaches on employees. In order to fill this gap, **Part III** of this PhD dissertation aims to analyse whether and how quality and environmental management approaches impact on different indicators of employee outcomes.

An increasing number of firms have changed their work organisation adopting quality and environmental practices that have been recognised as "win-win" tools that bring significant benefits to employers. On the other hand, a limited number of theoretical and empirical studies suggest contradictory evidence for the impact of these practices on working conditions. This subject is of great importance, especially as work-related health problems have greatly increased since the 1990s (Askenazy and Caroli, 2010). Using French matched employer-employee data, **chapter 7** aims to contribute to greater understanding of the effects of quality and environmental practices on working conditions as measured by employee accidents at work. Furthermore, using an additional database on the working conditions of French employees, we distinguish between working accidents that lead to sick leave and those that do not, and estimate the effect of quality practices on these two measures. Overall, our findings suggest new directions for a reconsideration and broader assessment of quality and environmental practices.

The implementation of environmental standards can be facilitated by attracting and motivating workers characterised by their pro-social motivation. Therefore, we might expect that employees choosing to work for firms that have registered for environmental standards would be more likely to have a positive appraisal of their job in terms of social utility, to make a better evaluation of their employment relationship, to be more actively involved in their job, and to donate more effort to the employer in comparison with other workers. Using a French employer-employee survey, **chapter 8** examines the impact of environmental standards on employee well-being at work (measured by employee feelings of usefulness to others and employee feelings that his work is fairly valued) and job involvement (measured by an employee's self reported level of involvement and non compensation for overtime work). This analysis is of particular significance as employee welfare contributes to the improvement of firm performance.

Chapter VII

Quality and Environmental Practices: The Tools for Improving Working Conditions? [43]

[43] This section is a developed version of the article "Quality and Environmental Practices: The Tools for Improving Working Conditions?" which is submitted.

1. Introduction

The increase in global competition and rapid economic developments pushed firms to reconsider their work organisation. A growing area of research focuses on new organisational structures that introduce work practices such as training and learning across tasks, teamwork, decentralisation of responsibility, worker participation in decision making, etc. In response to market demands for a new system of organisation and in order to maintain competitive advantage, many firms adopted quality and environmental standards. As we precise previously, a management system standard represents a set of requirements that a management system must meet to receive certification of compliance, usually from a third-party auditor. A quality standard (QS) is an approach to ensure continuous improvement of the quality of goods and services delivered by the participation of employees at all levels and in all functions of a firm. An environmental standard (ES) consists of a number of interrelated elements that function together to ensure that risks, liabilities and impacts are properly identified, minimised and managed (Darnall *et al.*, 2000). For a successful implementation of quality techniques and tools, the most important factors are human aspects (*e.g.* training, education, involvement, etc). There should be a thorough understanding of quality standards by management and all levels of employees. For this purpose, employees need efficient information flow systems, good team work, and a high level of commitment, education and training that will allow them to identify and solve problems, to improve work methods and to take quality and environmental responsibilities.

Quality or environmental practices have been praised as a tool for improving a firm's business performance (*e.g*. Terlaak and King, 2006; Khanna and Damon, 1999). This body of evidence shows that quality and environmental standards matter for both firms and employees. However, relatively less is known about the effects of these practices on employees. Moreover, the limited literature that does exist proposes two competing views concerning the impact of management practices on employees. One group of researchers supports a mutual gain perspective, arguing that both firms and employees may benefit from the implementation of new management practices. In addition to the mutual-gain view, Freeman and Kleiner (2000) go one step further, suggesting that gains to firms are in fact likely to be modest and employees are able to obtain most of the benefits. From an employee-perspective, these management practices have been seen as a way to offer higher income, more interesting work, greater autonomy and greater employment security (Kalmi and Kauhanen, 2008; Appelbaum *et al.*, 2000). On the other hand, the critical view argued that adoption of these management practices increases job intensity and job strain as well as decreasing job security and wages (*e.g.* Brenner *et al.*, 2004; Ramsay *et al.*, 2000).

In **chapter 7** we will focus on working conditions as a major issue for employees. The rationale for link between quality and environmental standards, and employees working conditions could be based on the fact that the adoption of these standards induces work re-organisation (characterised by job rotation, self-responsible teams, multi-tasking, a greater involvement of employees in decision-making, etc) which may affect employee working conditions. Moreover, the subject is of great importance, especially if we consider that work-related health problems have greatly increased since the 1990s (Askenazy and Caroli, 2010).

Existing analyses concerning the effect of management practices on working conditions lead to ambiguous results (*e.g.* Levine and Toffel, 2009; Florida and Davidson, 2001; Askenazy and Caroli, 2010; Brenner *et al.*, 2004). Indeed, while some research demonstrates that management practices improve working conditions by the identification and elimination of potentially hazardous practices, development of a formal corrective action process and the institutionalisation of routine audits and management reviews (Naveh and Erez, 2006), other research has found that flexible organisational practices such as quality circles, total quality management (TQM), and self-directed work teams reduce control and increase work intensification which increases human costs in terms of worker health and safety degeneration (Brenner *et al.*, 2004). Moreover, Levi (1983) argues that a majority of occupational accidents and disease are associated with unhealthy working environments resulting from workplace toxins, unsafe work practices and poorly engineered tools and machines.

The aim of **chapter 7** is to contribute to an improved analysis of the impact of quality and environmental standards on employee working conditions as measured by employee accidents at work. The originality of this research is fourfold. First, we follow Askenazy and Caroli's analysis (2010) relating the impact of quality norms, job rotation and information communication technologies (ICT) on working conditions using a French database for the year 1998. In fact, they find that employees involved in quality norms and job rotation face working conditions that are significantly worse than those of employees not involved. However, the authors argue that the implementation of new work practices, over time, could induce some learning which could, in turn, generate a long-term improvement of working conditions. Hence, we will offer an empirical answer to the above argument using a similar database from 2006.

Second, this chapter distinguishes between two indicators for management practices, quality and environmental standards. To the best of our knowledge, there is no direct evidence to allow any conclusion to be drawn concerning the impact of environmental standards on working accidents.

The third contribution of our research comes from the utilisation of the Organisational Changes and Computerisation survey (COI, 2006) which provides a representative sample of French firms with more than 20 employees. The database provides employee and firm characteristics for a large sample (N=12 959 observations). Moreover, in order to distinguish between working accidents that lead to sick leave and those that do not, we utilise an additional database on working conditions. Hence we will offer an empirically grounded response to the question of whether and how quality practices impact on these two types of accidents at work.

Finally, we correct for the endogeneity of quality and environmental practices variables using trivariate probit models (when we use the database on working conditions, we employ a bivariate probit model to correct for the endogeneity of quality practices variables).

The remainder of this chapter is organised as follows. Section 2 reviews the literature related to the impact of management practices on working conditions. Section 3 presents the data and model specification. The results are provided and discussed in section 4. Section 5 concludes and suggests future directions of research as well as policy implications.

2. Literature review

2.1 High Performance Workplace Practices and working conditions

Barling *et al.*, (2003) distinguish several factors that support a positive relationship between High Performance Workplace Practices (HPWPs) and occupational safety; these factors could easily be applied to the analysis of quality and environmental approaches. The authors argue that training has an important role in preventing accidents and improving safety. Based on the fact that training is an important factor in the adoption of both quality and environmental approaches, we may suggest that these approaches have the 'potential' to improve working conditions. Furthermore, greater autonomy and participation in decision making (also associated with the adoption of quality and environmental approaches) may lead to better decisions about safety. Similarly, greater job autonomy allows individuals over time to focus not just on fault remediation, but also on fault prevention, which significantly impacts on safety in the longer term (Wall *et al.*, 1992).

However, Barker (1993) argues that the introduction of HPWP replaces the traditional mode of worker supervision by making workers monitor each other, which creates a more stressful form of control. In the same sense, Berggren (1993) underlines that while employees may gain discretion in work methods induced by new management practices they may lose control of the pace of their work, thereby becoming exposed to increased work stresses and health hazards.

2.2 Quality and Environmental Practices and working conditions

As previously noted, a review of the literature provides a contradictory picture concerning the link between quality practices and employees' working conditions. Indeed, as argued by Askenazy (2001), new work practices and quality of working life are at the same time complementary, separate and antithetical. The author explains that those practices increase the interest of one's work and may contain quality of work life procedures that will increase employee motivation. In contrast, those practices can increase the pace of work and can be incompatible with safety aspects.

The argument for a positive impact of quality on working conditions could be based on the fact that new work organisation allows managers to identify and eliminate hazardous practices and to add safety precautions by fostering greater attention to detail (Naveh and Erez, 2006). Indeed, as suggested by Toffel (2000), departments charged with managing quality sometimes also manage health and safety. Moreover, quality and safety procedures address problems with a common source, generally relating to failures in the production process. Quality practices address dimensions such as continuous improvement and control of hazards should guarantee better quality and a safer workplace environment (Askenazy, 2001). It is also argued that quality practices make work more diversified and potentially more interesting (Askenazy and Caroli, 2010) which increases alertness and hence reduces the risk of workplace accidents. Supporting this view, using a large US database, Levine and Toffel (2009) provide empirical evidence that injury rates declined after ISO 9001 certification. Furthermore, Naveh and Marcus (2007) identify 40 ISO 9000 certified US tracking firms and compare their safety performance before and after ISO certification. They conclude that the safety performance of the quality certified carriers was significantly better after certification than before and it was also significantly better than that of non-certified carriers. Using longitudinal data for 200 Swiss firms, Ramaciotti and Perriard (1999) provide evidence that the rate of occupational injuries was initially lower in firms which subsequently implemented the ISO 9000 standard. Noteworthy, Organ and Greene (1981) conducted a path analysis of 247 engineers and scientists and concluded that standardisation provides needed guidance and clarifies responsibilities, thereby decreasing stress and uncertainty and helping employees to feel and perform better.

However, other research surveys find negative effects on working conditions resulting from new management practices implementation. Investigating the impact of new work practices such as quality norms, job rotation, collective discussions on work organisation and working time flexibility on working conditions in different French sectors, Askenazy and Caroli (2010) found that workers involved in new practices such as quality norms and job rotation face working conditions that are significantly worse than those of workers in non innovative work practices. Using a French database on working conditions, Colombier *et al.*, (2007) show that specific types of Information and Communication Technologies (ICT) are source of employees stress. Additionally, seeking to address the impact on working conditions of lean production implementation in the UK (the sample contains 1391 workers), Conti *et al.,* (2006) found that 8 tested practices of lean production (such as work pace/intensity, resource removal, working longer than desired hours, cycle time, doing work of absent workers, feeling of blame for defects, ergonomic difficulty, lack of adequate tools) are negatively related to stress. Combining a US establishment-level survey data on new working practices with data on the rates of cumulative trauma disorders (CTDs) in the same establishments, Brenner *et al.*, (2004) and Farris and Brenner (2001) offer evidence that new work practices (*e.g.* quality circle, work teams, just-in time-production) are positively and statistically significantly associated with CTD rates across establishments. Investigating 26

US sectors from a panel data, Askenazy (2001) concludes that the adoption of Total Quality Management (TQM), job rotation and autonomous work teams seems to be correlated to a dramatic increase in occupational injuries and illnesses. Similarly, Ramsay *et al.,* (2000) suggest that new management practices are positively related to job strain. In the same vein, Adler *et al.*, (1997) found that the implementation of the Toyota Production System's quality principles provoked a dramatic rise in CTDs. However, the authors further argued that encouraging employees to focus on continuous improvement could help to reduce injury rates. Analysing 6 Swedish furniture manufacturers, Karltun *et al.*, (1998) argue that the ISO 9000 standard has negative effects on working conditions that include increased stress and more strenuous work.

Even though these studies provide evocative findings, the majority of them are not in the mesure to control for a very detailed set of workers and job characteristics to properly isolate the effect of quality standards on the accidents at work.

In this chapter, we provide empirical evidence to answer the questions of *whether and how* quality practices impact on employee working accidents in France.

To the best of our knowledge, there exist a small number of papers that relate employees working conditions to environmental standards. For instance, using panel data of German manufacturing firms, Askildsen *et al.*, (2006) indicate that firms with high absenteeism have a higher probability of investing in down-the-line technology (*e.g.* filter and purification technology for environmental pollution prevention) and waste management/ recycling.

These results support the notions that health related problems within firms are linked with problems of local environmental pollution and could be eliminated by environmental standards adoption. In Florida and Davidson's (2001) study of 62 high-adopting firms of Environmental Management System (EMS) and pollution prevention practices in Pennsylvania, the authors found that these firms reported major sources of in-plant improvement, including among others, employee health and safety. Similar results are reported by Quazi *et al.,* (2001). In fact, they concluded that one of the main motives for ISO 14001 implementation is the assurance of employee welfare. Moreover, Ambec and Lanoie (2008) argue that better environmental performance can reduce the cost of labour by reducing the cost of illness, absenteeism and turnover. Significantly, voluntary environmental initiatives contribute to increased employee' morale, motivations and well-being (Grolleau *et al.,* 2007; Darnall *et al.,* 2000; Frank, 1996).

Although a positive correlation is found, it is very difficult to provide a direct conclusion concerning the relationship between environmental standards and employee working conditions. Thus, this chapter will fill this gap by identifying *whether and how* environmental practices impact on employee working accidents.

3. Empirical Analysis

3.1 The databases

The findings of this chapter is based on two databases, Organisational Changes and Computerisation's (COI) 2006 survey[44] and the Labor Force Survey (Enquête Emploi, EE) and a complementary survey which is about working conditions and organisation (Enquête Conditions de Travail, CT, 2005).

The first data is COI that is a matched employer/employee dataset on organisational change and computerisation (explained in detail in **chapter 1**). Here, we work with a sample of 12 959 employees.

The second part of this chapter is based on the Labor Force Survey (Enquête Emploi, EE) and a complementary survey which is about working conditions and organisation (Enquête Conditions de Travail, CT). The Labor Force Survey is an annual survey of individuals conducted by the French National Statistical Agency (INSEE) in March of every year (with the exception of the year 1999 when the survey was undertaken in January). This survey is a source of a declarative nature. The EE is a 1/300 sample of the French population based on a three year rotating panel. A large sample of about 150 000 individuals aged 15 or more, in 75 000 households are interviewed for three subsequent years. Yet a short panel length is created by the fact that the EE provides a large, nationally representative sample for every year. Nationally panel-based transition probabilities can be constructed from every year

[44] More details about the design and scope of this survey are available on www.enquetecoi.net. : Survey COI-TIC 2006-INSEE-CEE/Treatments CEE.

since 1984. Another attractive feature of the EE is that it contains individual specific information about demographic characteristics (*e.g.* age, sex, marital status, number of children in the household, etc), level of education and labor market characteristics (*e.g.* labor force participation status, employment status, net monthly salary in the main job, number of hours worked in the main job during the week before the interview, industry, type of occupation, etc) and the region of residence. In addition, from 1990, the survey includes a question asking for the employee's status 12 months earlier.

French Surveys on working conditions are carried out by the DARES (The Statistics Department of the Ministry of Labour). The first National survey on working conditions was carried out in 1978, and it was renewed in 1984, 1991, 1998 and 2005. Each survey was conducted on a sample of around 20 000 people, and was based on the questioning of employees regarding their perceptions of their work. At first it was focused on physical work, but the survey was later enriched and redirected towards dealing with the organisation of work and its psychological aspects.

Merging these two surveys we get an original database which provides detailed information on workers' characteristics, workplace organisation, workers' positions and working conditions. We work on a sample of 9 186 individuals.

It should be noted that while the COI survey provides both information on employer and employee characteristics, the working conditions database is mainly oriented to employee characteristics.

3.2 The variables definition

3.2.1 The variables definition -COI 2006

First, we will present construction of the variable using COI 2006 survey. The variables used for estimation and descriptive statistics are indicated in Table 7.1.[45]

[45] No problem of multicolinearity has been detected. However, because of the table's length we do not report Pearson correlation coefficients for these variables.

Table 7.1: Definition of variables

Variable	**Definition**
Dependent variables	
ACCIDENT	Having one or more accidents at work Dummy variable (=1 if yes)
Independent variables	
QS	Registered for ISO 9000, EAQF (Supplier Quality capability evaluation), etc. Dummy variable (=1 if certified in 2006)
ES	Registered for ISO 14000, organic labeling fair trade Dummy variable (=1 if registered in 2006)
SIZE	SMALL (20 TO 49 employees) MSMALL(49 TO 199 employees) MEDIUM (200 TO 499 employees) BIG (more than 500 employees) ***(ref)***
EXPORT	Share of firm exportation by turnover (Continuous variable)
QAL	Quality strong or very strong strategic importance for product, service and performance Dummy variable (=1 if yes)
JIT	The firm utilises just-in-time Dummy variable (=1 if certified in 2006)
TEAM	The firm utilises autonomous work groups or teams Dummy variable (=1 if certified in 2006)
SEX	The employee is a man Dummy variable (=1 if yes)
AGE	Employee is: AG1 (15 TO 29 years old) AG2(30 TO 49 years old) ***(ref)*** AG3 (50 years old or more)
COUPLE	The employee lives in couple Dummy variable (=1 if yes)
EDUCATION	Employee has: EDU1 (Grand Ecole, PhD, Master or University degree) EDU2 (two years of superior education) EDU3 (preparation for specialised high school degree) EDU4 (High School degree) EDU5 (technical or lower general secondary degree) ***(ref)*** EDU6 (primary school degree)
SENIORITY	SEN1 (1 TO 3 years) SEN2 (3 TO 5 years) SEN3 (5 TO 10 years) SEN4 (10 years or more) ***(ref)***
OCCUPATION	Employee is: OCC1 (management) OCC2 (middle-management) OCC3 (white color workers) ***(ref)*** OCC4 (blue color workers)
ASSOC	The employee participates in sport, culture or social association ASSOC_1 (if employee participates) NOASSOC (if does not participate) ASSOC_2 (there is no association) ***(ref)***
QUAL_FORMA	The employee attended a training for quality control

	Dummy variable (=1 if yes)
PTIME	The employee has a part time job Dummy variable (=1 if yes)
WHOURS	Working hours (Continuous variable)
NIGHT	The employee works at night (between 0h and 5h) frequently or occasionally Dummy variable (=1 if yes)
SUNDAY	The employee works on Sunday (between 0h and 24h) frequently or occasionally Dummy variable (=1 if yes)
COMPUTER	The employee uses computer for work purposes Dummy variable (=1 if yes)
INTERNET	The employee uses internet for work purposes Dummy variable (=1 if yes)
CONSEC	The employee's mistake can provoke direct dangerous consequences for his security Dummy variable (=1 if yes)
CONNEG	The employee's mistake can provoke direct consequences on the other employees Dummy variable (=1 if yes)
UNCLEAR	The employee has not been clearly explained what he must do in his job Dummy variable (=1 if yes)
REPEATE	The employee realises different tasks everyday or every week Dummy variable (=1 if almost never or never)
OBJECTIVE	The employee has to reach precise objectives Dummy variable (=1 if yes)
HOW	The employee receives precise instruction how should he realise his task Dummy variable (=1 if yes)
STRESS	The employee feels unable to cope with his work or overloaded every day or at least once a week Dummy variable (=1 if yes)
INCIDENT	The employee has to deal with incidents alone Dummy variable (=1 if)
INTERRUP	The employee can interrupt his work for a moment if he wishes Dummy variable (=1 if yes)
HELPCHEF	The employee will be helped by his chef if he is overloaded with work Dummy variable (=1 if yes)
HELPCOL	The employee will be helped by his colleagues if he is overloaded with work Dummy variable (=1 if yes)
AMEL	The employee or his colleagues recently made suggestions to improve their job position, procedures, machines Dummy variable (=1 if yes)
ACTIVITY	The main activity of the firm 11 dummy variables (=1 if agrifood, consumption goods, cars and equipments, intermediate goods, energy, construction, commercial, transport, financial and real-estate activities, services for firms and services for individuals, respectively)[a]

The sectors are considered according to the French nomenclature.
Source: Survey COI 2006.

3.2.2 The variables definition – EE and Working Condition surveys

The variables from Working Conditions survey, used for estimation and descriptive statistics are indicated in Table 7.2.[46]

Table 7.2: Definition of variables

Variable	**Definition**
Dependent variables	
ACCIDENT1	Working accidents without a sick leave Dummy variable (=1 if yes)
ACCIDENT2	Working accidents with a sick leave Dummy variable (=1 if yes)
Independent variables	
QUALPROCED	Employee has to respect quality strict procedures Dummy variable (=1 if yes)
SIZE	SMALL (1 TO 49 employees) ***(ref)*** SMEDIUM (50 TO 199 employees) MEDIUM (200 TO 499 employees) BMEDIUM (500 TO 999 employees) BIG (1000 employees or more)
SEXE	Employee is a man. Dummy variable (=1 if yes)
AGE	Employee is: AG1 (15 TO 29 years old) AG2(30 TO 49 years old) ***(ref)*** AG3 (50 years old or more)
COUPLE	Employee is single Dummy variable (=1 if yes)
EDUCATION	Employee has: EDU1 (no diploma) EDU2 (lower general secondary degree) EDU3 (specialised high school degree, high school degree or technical degree) ***(ref)*** EDU4 (2 years of University degree) EDU5 (superior degree)
SENIORITY	SEN1 (less than 1 year) SEN2 (1 TO 5 years) SEN3 (5 TO 10 years) SEN4 (10 years or more) ***(ref)***
OCCUPATION	Employee is: OCC1 (farmer, craft worker or self-employed craftsman) OCC2(managers or intellectually superior personnel) OCC3 (middle-management) OCC4 (white collar workers) ***(ref)*** OCC5 (blue collar workers)
WHOURS	Working hours (continuous variable)
FULL TIME	Employee has a full time job

[46] No problem of multicolinearity has been detected. However, because of the table's length we do not report Pearson correlation coefficients for these variables.

	Dummy variable (=1 if yes)
COMPUTER	Employee uses computer during the work Dummy variable (=1 if yes)
INTERNET	Employee uses internet during the work Dummy variable (=1 if yes)
HURRY	Employee has to hurry up either all the time or often Dummy variable (=1 if yes)
BUSY	Employee has to often change task unexpectedly in order to complete another one Dummy variable (=1 if yes)
INTERRUPT	Employee can interrupt his work Dummy variable (=1 if yes)
REPEATE	Employee has to repeat constantly same actions and operations Dummy variable (=1 if yes)
RISKQUAL	Employee feels that his mistakes may have consequences on the quality of the product Dummy variable (=1 if yes)
RISKFIN	Employee feels that his mistakes may have financial consequences for the firm Dummy variable (=1 if yes)
RISKDANG	Employee feels that his mistakes may have consequences for his or someone else security Dummy variable (=1 if yes)
TENSIONCOLL	Employee feels tensions in the relationships with colleagues Dummy variable (=1 if yes)
TENSIONHIERA	Employee feels tensions in the relationships with hierarchical superiors Dummy variable (=1 if yes)
ISOLATE	Employee works always or often out of the work premises Dummy variable (=1 if yes)
PAUSE	Employee has at least 48h consecutive break during the week Dummy variable (=1 if yes)
MEAL	Employee has meal break Dummy variable (=1 if yes)
IMPOSSIB	Employee can not arrive to respect always or often quality and time delivery at the same time Dummy variable (=1 if yes)
ACTIVITY	The main activity of the firm 11 dummy variables (=1 if agrifood, consumption goods, cars and equipments goods, intermediate goods, energy, construction, commercial, transport, financial and real-estate activities, services for firms, services for individuals, respectively)

The sectors are considered according to the French nomenclature.
Source: EE and working conditions surveys.

3.3 Descriptive Statistics

3.3.1 Descriptive Statistics -COI 2006

Table 7.3 provides a comparative analysis of the characteristics of quality and environmental registered firms. Based on the overall findings, one may conclude that generally the characteristics of firms adopting quality or environmental approaches are similar. Concerning firm size, we remark that QS firms make up 20% of big firms while ES firms make up 35% of the same size category. Furthermore, 57 % (respectively 42%) of firms in the category *SMALL* adopt quality standards (respectively environmental standards). As was the case in previous chapters, we notice that a high percentage (89%) of firms adopt both quality and environmental approaches. When we observe the implementation of just-in-time and team group practices, one may conclude that ES firms have an advantage. In fact, comparing ES and QS registered firms we can see that ES firms have a higher percentage of just-in-time and team work practices implementation (47% and 63%, respectively) as compared to QS firms (34% and 49%, respectively). Based on the evidence below, we argue that both quality and environmental-oriented firms are very interested in quality improvement. The findings obtained confirm our previous results that quality and environmental approaches provide a significant customer signal, especially for customers located abroad. Finally, we obtain quite disappointing results concerning quality training. More precisely, only 37 % (respectively 40%) of QS (respectively ES) firms provide their employees with quality-focused training.

Table 7.3: Descriptive Statistics

	QUALITY STANDARDS	ENVIRONMENTAL STANDARDS
	Company's Size	
SMALL	57% (a)	42%
SMEDIUM	17%	15%
MEDIUM	6%	8%
BIG	20%	35%
	Previous experience	
QS/ES	87%	
JIT	34%	47%
TEAM	49%	63%
	Quality Improvement	
QAL	98%	98%
	Mean export by firm's turnover	
EXPORT	0.13	0.19
	Training	
QUAL_FORMA	37%	40%
Total	**47%**	**16%**

Source Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample 12 959 firms, weighted by the number of employees.
Lecture: (a) 57% of "Quality Adopters" are firms that belong to category of small firms.

3.3.2 Descriptive Statistics – EE and Working Condition surveys

Table 7.4 indicates that employees that follow strict quality procedures work mostly in the category of big firms. Not surprisingly, 68% of employees that use these practices are men. It is argued that quality practices are usually associated with harder work tasks which are usually "reserved" for men. Furthermore, a majority of employees that work in a quality-oriented environment are between 30 and 49 years old. We can remark from the table that a high percentage (57%) of employees that work with quality practices have to hurry up either often or all the time. Moreover, this type of employee has to often change task unexpectedly in order to complete another one. Based on the evidence, we may conclude that, usually, employees that are quality-oriented respect quality issues and delivery time. Moreover, we can suggest that a majority of employees (64%) that have to follow strict quality procedures do not repeat the same actions and operations constantly or often. Hence, working under quality practices is likely to be more interesting. A majority of employees that use quality practices in their work activities feel that their mistakes may have quality and financial consequences (around 75%). Furthermore, 47% of those employees feel that their mistakes may have consequences on their own or someone else's security.

Table 7.4: Descriptive Statistics

	QUALITY PRACTICES
	Company's Size
SMALL	29% (a)
SMEDIUM	15%
MEDIUM	10%
BMEDIUM	7%
BIG	39%
	Gender
MAN	68%
	Age
AG1	21%
AG2	59%
AG3	20%
	Work characteristics
HURRY	57%
BUSY	66%
IMPOSSIB	14%
REPEATE	36%
	Risk
RISKQUAL	77%
RISKFIN	74%
RISKDANG	47%
Total	**57%**

Source: EE and Working Conditions surveys, sample 9 186 employees.
Lecture: (a) 29% of employees that use quality practices are work in firms that belong to category of small firms.

3.4 Estimation strategy

3.4.1 Estimation strategy - COI 2006

A correlation between, on one side, employees' likelihood to work in quality or environmentally registered firms, and on the other side, working conditions, might be attributed to common observed or unobserved characteristics. Failure to account for this endogeneity would lead to single-equation estimates of the effect of quality or environmental approaches on working accidents, and therefore produce biased results. In order to correct for the potential endogeneity of the variables of quality and environmental practices, we apply a trivariate probit model (Greene, 2003). This model forms a system of three probit models that have endogenous dummy explanatory variables. It relies on a simultaneous estimation approach in which the factors that determine quality and environmental standards are estimated simultaneously with the factors that explain the probability of working accidents. In this way, the probability of working accidents is supposed to be affected by the likelihood of employees working in quality and environmental registered firms. The three equations are jointly estimated for each explanatory variable using maximum likelihood.

We denote, Y_1 and Y_2, our binary variables that equal to 1 if the employee is working for a firm which uses a quality or an environmental standard, in 2006, respectively.[47] The dependent variable denoted Y_3, is a binary variable which equals to 1 if the individual has at least one accident at work. They are defined as follows:

$$\begin{aligned} &Y_1 = 1 \quad if \quad Y_1^* > 0, \\ &Y_1 = 0 \quad otherwise. \end{aligned} \qquad (1)$$

$$\begin{aligned} &Y_2 = 1 \quad if \quad Y_2^* > 0, \\ &Y_2 = 0 \quad otherwise. \end{aligned} \qquad (2)$$

$$\begin{aligned} &Y_3 = 1 \quad if \quad Y_3^* > 0, \\ &Y_3 = 0 \quad otherwise. \end{aligned} \qquad (3)$$

Y_1^* and Y_2^* are latent variables influencing the probability that the worker is employed in a firm that uses quality and environmental standards, respectively, and Y_3^* presents the probability of the worker facing a working accident. We consider the following trivariate probit model:

$$\begin{cases} Y_1^* = \alpha_1 + \beta_1 X_1 + \delta_1 Z_1 + \mu_1 \\ Y_2^* = \alpha_2 + \beta_2 X_2 + \delta_2 Z_2 + \mu_2 \\ Y_3^* = \alpha_3 + \beta_3 X_3 + \gamma_1 Y_1 + \gamma_2 Y_2 + \mu_3 \end{cases} \qquad (4)$$

[47] The variable *QS* includes: ISO 9001, EAQF, etc; The variable *ES* includes: ISO 14001 standard, organic labeling or fair trade. Unfortunately, we cannot distinguish between those standards, since they were put together under the same name in the survey. Threfore, we cannot estimate the specific effects of each program.

where X_1 and X_2 are the vectors of exogenous variables including firm (*SIZE, ACTIVITY*, *JIT* and *TEAM***)** and employee characteristics (*SEX*, *AGE*, *EDUCATION*, *SENIORITY, OCCUPATION* and *QUAL_FORMATION*). The variable describing the firm's characteristics are usually used in the literature as the determinants for quality and environmental practices adoption (Prakash, 2008; Grolleau *et al.*, 2007; Terlaak and King, 2006) and individuals' attitudes towards quality and environmental issues (Askenazy and Caroli, 2010; Torgler and Garcia-Valinas, 2007).

The vectors of variables Z_1 and Z_2 represent the vectors of instrumental variables that guarantee the identification of the model and help to estimate correlation coefficients (Maddala, 1983). Indeed, in this type of model (as we can see in **chapter 5** and **6**), in order to identify the trivariate probit, we need additional variables that explain the probability of adopting management practices (quality and environmental standards) but are not correlated to the error term of the working accidents equation. Furthermore, as we can see from **chapter 5**, Wilde (2000) argues that in this type of model, in order to achieve identification, it is sufficient that each equation includes one varying exogenous regressor. However, it is still good practice to exclude some variables from the equations. There is no comprehensive method that would give precise predictions about the choice of instrumental variables. Nevertheless, based on the literature review, we propose the following variables that are expected to influence quality or environmental standards adoption but that have no impact on working accidents.

For quality standards the vector Z_1 includes the firm's preference that quality is strong or very strong strategic importance (*QAL*) and level of exports (*EXPORT*), while for environmental standards Z_2 includes the worker's preference to invest himself in the firm's social life via membership in sport, cultural or social association (*ASSOC*) and level of exports (*EXPORT*).

Several rationales can explain why those variables affect corresponding management practices. Since quality practices ensure work method continuity and final quality output (Wealleans, 2000), firms that consider quality improvement (*QAL*) as an important or a very important strategic priority are highly motivated to adopt these practices. More precisely, firms that follow quality operations and procedures are in the best position to influence the quality of their goods and services. The underlying assumption is that if work processes were chaotic, the products and services that are produced would not have acceptable levels of quality (Prakash, 2008). The variable *EXPORT* is chosen due to the argument that a firm's quality or environmental performance is usually unobservable, especially to customers located in areas which are institutionally, geographically and culturally different. Hence, from a signalling perspective, quality or environmental standards can provide information on the general capability of a firm to meet the quality or environmental expectations of customers and thus make unobservable characteristics more public (Spence, 1973; Grolleau *et al.*, 2007). Therefore, internationally recognised certification may play a strong role in signalling unobservable characteristics and generating customer trust (Zucker, 1986). Furthermore, we consider that taking part in social activities (*ASSOC*) is seen as a proxy of social interest. Hence, pro-social motivation would predict that employees are attracted to environmentally responsible firms (see **chapter 5**). Statistically the instrumental variables have no influence on working accidents. Important to mention, up to our knowledge, there is no empirical or theoretical evidence that support positive relationship between those variables and working conditions.

In order to identify the direct effects of quality and environmentally practices on employee working conditions, our analysis controls for different variables that are usually expected to have an impact on employee's working conditions (*e.g.* International Labour Organisation (ILO), 1998; Askenazy and Caroli, 2010).

Hence, X_3 includes three sets of variables: firm characteristics (*SIZE, ACTIVITY*, *JIT* and *TEAM)*, socio-demographic characteristics (*SEXE, AGE, COUPLE* and *EDUCATION*) and job characteristics (*SENIORITY, OCCUPATION, QUAL_FORMATION, PTIME, WHOURS, NIGHT, SUNDAY, COMPUTER, INTERNET, CONSEC, CONNEG, UNCLEAR, REPETION, OBJECTIVE, HOW, STRESS, INCIDENT, INTERRUP, HELPCHE, HELPCOL* and *AMEL*).

$\beta_1, \beta_2, \beta_3, \gamma_1, \gamma_2$, δ_1 and δ_2 are slope coefficients to be estimated.

Finally, $\alpha_1, \alpha_2, \alpha_3$, μ_1, μ_2 and μ_3 are the intercepts and the disturbance terms for the three equations, respectively.

Residuals of these three equations follow a normal trivariate law with zero means and a covariance matrix that can be written, after normalisations to 1 of the diagonal elements, as follows:

$$\begin{pmatrix} \mu_1 \\ \mu_2 \\ \mu_3 \end{pmatrix} \rightarrow N(0,\Sigma) \text{, where } \Sigma = \begin{pmatrix} 1 & \rho_{12} & \rho_{13} \\ \rho_{12} & 1 & \rho_{23} \\ \rho_{13} & \rho_{23} & 1 \end{pmatrix}$$

When estimating a trivariate probit model, three coefficients of correlation between the disturbance terms are produced (they are denoted ρ_{12}, ρ_{13}, ρ_{23}). These three correlation coefficients represent the extent to which unobserved covariates jointly determine the outcomes of interest and account for unobserved correlation among outcomes. ρ_{12} represents the correlation coefficient between the error terms of the risk of working accidents and quality standards equations; ρ_{13} represents the correlation coefficient between the error terms of the risk of working accidents and environmental standards equations; ρ_{23} represents the correlation coefficient between the error terms of the quality and environmental standards equations. Further more, if $\rho_{12} \neq 0$ and $\rho_{13} \neq 0$, this means that the variables quality and environmental related are endogenous to the risk of accident probability. The conditions $\rho_{12} = 0$ and $\rho_{13} = 0$ can be tested using likelihood ratio (LR) tests, which are appropriate when testing for exogeneity in the simultaneous estimation of bivariate probit models (Fabbri *et al.*, 2004). A similar reasoning is used here in the trivariate case.

The estimation is made by maximum likelihood and we use the GHK (Geweke-Hajivassiliou-Keane) simulator (for the writing of the likelihood and of the GHK simulator see Greene, 2003). The model is tested by implementing the Stata programs developed by Terracol (2002).

3.4.2 Estimation strategy – EE and Working Conditions surveys

Using working conditions survey we create two dependent variables denoted *ACCIDENT1* and *ACCIDENT2* that are binary variable which equals to 1 if the individual has working accidents without or with sick leave, respectively. To understand whether quality strict procedures reduces or not employees' working accidents *ceteris paribus*, we use the variable denoted *QUALPROCED* which is binary variable that equals to 1 if employees have to follow quality procedures.

The relationship between quality practices and working accidents is examined on the basis of a bivariate probit model that explores the idea that an employee's choice to work with quality practices may be correlated to the risk of working accidents, since the same observable and unobservable factors may impact on both, employee choices to follow strict quality procedures and working accidents. The model is explained in detail in **chapter 5**.

We denote Y_1 our observed variable corresponding to the fact that the employee follows quality strict procedures while while Y_{2k} corresponds to working accidents. They are defined as follows:

$$\begin{aligned} &Y_1 = 1 \quad \textit{if} \quad Y_1^* > 0, \\ &Y_1 = 0 \quad \textit{otherwise.} \end{aligned} \qquad (1)$$

$$\begin{aligned} &Y_{2k} = 1 \quad \textit{if} \quad Y_{2k}^* > 0, \\ &Y_{2k} = 0 \quad \textit{otherwise.} \end{aligned} \qquad (2)$$

Y_1^* are latent variables influencing the probability of adoption of quality strict procedures and Y_2^* corresponds to employee's working accidents, where *k* distinguishes between working accidents without and with a sick leave. We consider the following bivariate probit model:

$$\begin{cases} Y_1^* = \alpha_1 + \beta_1 X_1 + \delta Z_1 + \mu_1 \\ Y_2^* = \alpha_2 + \beta_2 X_2 + \gamma Y_1 + \mu_2 \end{cases} \qquad (3)$$

where X_1 is a vector of exogenous variables including firm (*SIZE* and *ACTIVITY),* socio-demographic *(SEX, AGE, EDUCATION, SENIORITY* and *OCCUPATION*) and job characteristics *(HURRY, BUSY, INTERRUPT, REPETE, RISQUAL, RISKFIN, RISKDANG, TENSIONCOLL* and *TENSIONHIERA).* The choice of variables (determinants of quality practices adoption and individual attitudes towards management practices) is based on the same literature review as in the previous instance when we used the COI 2006 survey (*e.g.* Prakash, 2008; Terlaak and King, 2006; Torgler and Garcia-Valinas, 2007; Askenazy and Caroli, 2010).

The vector of variables Z_1 variable is used for the model to be well-identified (Maddala, 1983). Indeed, as we can see in previous case as well as in **chapter 5**, we need the additional variables that will explain the probability of following quality strict procedures but not correlated to the error term of the working accidents equation.

Z_1 is represented by the variable *IMPOSSIB*. In fact, several rationales can explain why the variable *IMPOSSIB* affects quality strict procedures. The quality standard is based on the classical management practices of 'plan, organise, lead and control', which are intended to integrate quality concerns into the firm's daily routine (Boiral, 2003). Hence, according to Withers *et al.*, (1997) firms with solid operations and processes operating under quality approaches are in the best position to improve the quality of their final outputs. What more, timeliness of delivery is also found to be a significant outcome of quality management (Anderson *et al.*, 1999). As in the previous case, statistical examination confirms that our instrumental variable is not significantly correlated to the risk of working accidents. Additionally, the literature review provides no evidence to support a relationship between this variable and working accidents.

X_2 includes three sets of variables: firm (*SIZE* and *ACTIVITY)*, socio-demographic characteristics (*SEXE, AGE, COUPLE* and *EDUCATION*) and job's characteristics (*SENIORITY, OCCUPATION, WORKING TIME, COMPUTER, INTERNET, HURRY, BUSY, INTERRUPT, REPETE, RISQUAL, RISKFIN, RISKDANG, TENSIONCOLL, TENSIONHIERA, ISOLATE, PAUSE* and *MEAL).* Once again, the selection of variables is motivated by the literature presented in the previous case (*e.g.* International Labour Organisation (ILO), 1998; Askenazy and Caroli, 2010).

$\beta_1, \beta_2,$ γ and δ are slope coefficients to be estimated.

Finally, $\alpha_1, \alpha_2,$ μ_1 and μ_2 are the intercepts and the disturbance terms for the two equations, respectively.

Residuals of these two equations follow a normal bivariate law with zero means and a covariance matrix that can be written, after normalisations to 1 of the diagonal elements, as follows:

$$\begin{pmatrix}\mu_1\\ \mu_2\end{pmatrix} \rightarrow N(0,\Sigma), \text{ where } \Sigma = \begin{pmatrix}1 & \rho_{12}\\ \rho_{12} & 1\end{pmatrix}$$

As we precise in **chapter 5**, in estimating the interrelationship, a bivariate probit model produces an estimation of *'rho'*, the correlation coefficient between the disturbance terms. When *rho* is statistically different from zero, there is a probability that a set of common unobserved factors influence quality practices and employee's accidents at work, in other words, this means that the variable quality practices is endogenous. We test the significance of *rho* with a Wald chi-square statistic.

4. Estimates Results

4.1 Estimates Results-COI 2006

Trivariate probit estimation results are presented in Table 7.5, together with goodness-of-fit measures (Maximum-Likelihood estimation).

The estimated coefficients of ρ_{12}, ρ_{13}, ρ_{23} are statistically significant in all cases (see Table 7.5). This confirms the interest in using a trivariate probit model. For instance, the correlation coefficient between the error terms of the risk of working accidents and quality standards equations (ρ_{12}) is significantly different from zero at the 1% level of significance. This indicates that the unobserved variables influencing the probability of having working accidents are negatively correlated with the unobserved characteristics affecting the implementation of quality standards inside the firm. The other two correlation coefficients *(ρ_{13} and ρ_{23})* are significantly and positively different from 0.

Workers choice equation

The estimation results regarding the factors that may impact employee choice to work in quality and environmentally registered firms are presented in Table 7.5. The first group of variables that we have used includes firm size, sector of activity, just-in-time (JIT) and autonomous work groups or teams. As regards firm size, we found the same results as in previous chapters, which confirms that firm size mainly determines the likelihood of a firm adopting quality or environmental approaches. We have used eleven sectors of activities and we defined as a reference the sector of intermediate goods. Consistently with the previous findings, we may argue that the probability of adopting quality practices is stronger in some industries, like the car and equipment industries and the energy sector. Furthermore, the probability of being environmentally certified is positively significant only for the energy sector. As expected, just-in-time and autonomous work groups or teams increase the probability of quality and environmental standards adoption. In fact, there are many similarities between quality and environmental requirements and just-in-time and autonomous work groups or teams principals what may be transformed into advantages during the implementation of quality and environmental standards.

Examining socio-demographic characteristics, we notice that male workers have a greater preference to work in quality certified firms but do not have any significant preference to work in an environmentally registered firm. These findings are supported by previous studies (*e.g.* Torgler and Garcia-Valinas, 2007). The results revel that employees between 15 and 29 years old are against quality standards adoption while the variable *AGE* stays ineffective on environmental standards implementation. Interestingly, the adoption of quality standards is driven up more by workers that obtained an undergraduate, Masters or PhD degree than workers that only have a primary or specialised high school degree. This could be explained by the fact that highly educated employees usually have high responsibility positions where quality practices implementation could be very helpful. Concerning environmental standards, we notice that employees with high school degree are often resistant to its implementation.

Looking at job characteristics, one can remark that seniority has no impact on the employee's choice to work for quality certified firms, but it decreases the employee's propensity to work in an environmentally registered firm (in the case of workers between 3 to 5 years of seniority). Furthermore, middle managers are not in favor of quality standards adoption as compared to white collar workers (the reference category). Other occupational categories have no impact on quality standards implementation. Being part of senior management impacts negatively on the adoption of environmental standards. Not surprisingly, attending quality training has a positive effect on the adoption of the two practices. Finally, as expected, our instrumental variables have a significant impact on the adoption of both quality and environmental approaches.

Working accidents equation

The estimated effects of quality and environmental standards on working conditions are reported in Table 7.5 (third column). The findings concerning quality practices suggest that these practices increase the risk of working accidents. Therefore, we conceive that characteristics of quality practice such as high rates of repetition, the increased pace of work (alongside the increase of employee responsibility for quality), job rotation and increased monitoring may worsen employee safety (Askenazy, 2001; Brenner *et al.*, 2004). On the other hand, environmental standards reduce the risk of working accidents. Hence, we suppose that environmental standards implementation leading to pollution reduction, reduction of contact with hazardous materials, air emissions decrease, bad odours, noise reduction, etc entails an improvement in the health and safety conditions of employees. The differing effects of quality and environmental standards on working conditions could be explained by two phenomena. First, even though environmental standards share many common traits with quality standards, environmental standards also include specific complementary aspects that lead to good operations, which are not included in quality standards (Corbett and Kirsch, 2001). Second, in quality practices, the major system requirements are defined by customers. The situation for environmental practices is not so straightforward. In fact, even if environmental practices s are focused on customers, there are many additional stakeholders (such as employees) to be considered as well (Delmas, 2001).

Our analysis also provides the results of other determinants of working accidents (Table 7.5). Thus, we can check whether our findings are consistent with what is usually found in the literature regarding the impact of firm characteristics (*SIZE, ACTIVITY*, *JIT* and *TEAM)*, socio-demographic characteristics (*SEXE*, *AGE*, *COUPLE* and *EDUCATION*) and job characteristics (*SENIORITY*, *OCCUPATION*, *QUAL_FORMATION*, *PTIME, WHOURS, NIGHT*, *SUNDAY, COMPUTER*, *INTERNET*, *CONSEC*, *CONNEG*, *UNCLEAR*, *REPETION*, *OBJECTIVE*, *HOW*, *STRESS*, *INCIDENT*, *INTERRUP*, *HELPCHE*, *HELPCOL* and *AMEL*) on working accidents (*e.g.* ILO, 1998; Askenazy and Caroli, 2010).

First, the size of the firm in which a worker is employed has a positive impact on working accidents. The findings are contrary to our presumption that bigger firms have more financial resources to implement appropriate organisational practices that will prevent accidents. The results indicate that only one sector of activity has any influence on working accidents. More precisely, working in the sector of transportation, will decrease the risk of working accidents. We observe that the variable *JIT* impacts positively on the risk of working accidents. Our results confirm previous findings arguing that just-in-time systems contribute to increasing the number of trauma disorders through increased repetition and work intensification (Putz-Anderson, 1988). On the other hand, the use of autonomous work groups or teams does not have any influence on working accidents.

We presume that as men often occupy more physically demanding work places than women, being a man will have a negative impact on working accidents. However, our results show that being a man has no effect on the risk of working accidents. Concerning variable *AGE*, we note that older employees have a lower probability of working accidents than the younger ones. Furthermore, the findings imply that the variable *COUPLE* has a negative and significant impact, what suggests that being part of a couple reduces working accidents. A possible explanation could be that a married person usually chooses jobs with lower risks of accidents.

As expected, education reduces the probability of accidents. Regarding educational levels though, we can notice that the estimated coefficient is positively correlated with an increase of educational level. Having had preparation for a specialised high school degree rather than a technical secondary education does reduce the risk of working accidents, while a PhD or Masters degree, reduces even more this probability. We found support for our findings in Galizzi and Zagorsky's research (2009), which reports that people injured at work are often individuals with relatively little education.

Seniority is positively associated with working accidents. In fact, for the all three categories, the variable *SENIORITY* is significant and positive. Not surprisingly, blue collar workers bear more risk of working accidents than middle-management workers. Being a part of senior or middle management decreases the probability of working accidents, while being a blue collar worker increases this probability.

Even though we expected that attending quality training will decrease the risk of working accidents, the evidence suggests that quality training has no significance for the rates of working accidents.

Furthermore, having a part-time job has no effect on working accidents. The same conclusion is obtained for the variable *WHOURS*. On the other hand, working during the night will increase the risk of working accidents, while working on Sundays has no effect.

As expected, we found that using a computer at work reduces working accidents, while using the internet has no impact.

The employee's feeling that his/her mistakes can provoke direct dangerous consequences for his/her security has a positive impact on the risk of the working accidents, while their feeling that his/her mistake can provoke direct dangerous consequences for the other employees is not significant.

Unsurprisingly, receiving an unclear job description has a positive and significant impact on working accidents. Ambiguity limits the extent to which employees fully understand what is required in their job, and will increase working accidents (Hemingway and Smith, 1999). Repetitive movements at work may cause a range of accidents since in this case employees engage in risk-seeking behaviour (Fisher, 1993). However, our results indicate that carrying out a range of different tasks at work increases the risk of accidents. This surprising finding could be explained by the idea that changing tasks gives no time for employees to learn how to deal adequately with specific tasks. In fact, it reduces the possibility for workers to improve safety through work routines and learning-by-doing. In addition, obliging employees to reach precise objectives increases the probability of working accidents. If an employee receives precise instructions how he/she should carry out his/her task, he/she has a greater chance of having accidents at work. This unexpected result could be explained by the idea that employees prefer to organise their work on their own rather than receiving instruction.

Another factor driving up the risk of accidents is the amount of work employees have to deal with. More precisely, our results indicate that if an employee feels unable to cope with his/her work or he/she is overloaded, it increases the likelihood of working accidents. A simple explanation is that employees under pressure have less concentration or are less careful to avoid possible accidents. Interestingly, when employees have to deal with incidents alone or when they can interrupt their work have no effect on the probability of work accidents. Similarly, receiving help from superiors or collogues has no impact on risk of accidents. Finally, contrary to our presumption, the possibility for employees to make suggestions in order to improve their job position, procedures and machines, enhances the risk of working accidents.

Table 7.5: Trivariate probit estimates of the effect of quality and environmental standards on working accidents

		QS		**ES**		**ACCIDENTS**	
Variables		Estimate	z-value	Estimate	z-value	Estimate	z-value
Intercept		-0.47***	-5.52***	-0.97***	-16.00	-1.67***	-14.47
QS		-	-	-	-	0.29***	6.09
ES		-	-	-	-	-0.77***	-9.44
SIZE	MEDIUM	0.34***	9.15	0.12***	2.71	0.07	1.44
	BMEDIUM	0.65***	13.82	0.53***	10.73	0.00	0.06
	BIG	0.83***	27.06	0.74***	22.70	0.12***	2.74
EXPORT		1.60e-07*	1.70	6.13e-07***	6.83	-	-
QAL		0.46***	6.67	-	-	-	-
JIT		0.21***	7.37	0.35***	12.59	0.11***	3.28
TEAM		0.38***	14.40	0.36***	13.27	-0.02	-0.54
SEXE		0.09***	3.30	-0.03	-0.83	-0.00	-0.02
AGE	AG1	-0.11***	2.85	-0.04	-1.02	0.13***	2.69
	AG3	0.03	1.07	0.02	0.72	-0.10***	-2.23
COUPLE		-	-	-	-	-0.08***	-2.36
EDUCATION	EDU1	0.11***	2.29	0.07	1.38	-0.16***	-2.49
	EDU2	0.05	1.36	0.01	0.29	-0.18***	-3.29
	EDU3	0.13***	2.75	0.00	0.04	-0.12**	-2.09
	EDU4	-0.01	-0.21	-0.08*	-1.60	-0.08	-1.26
	EDU6	0.07	1.23	0.04	0.63	0.06	0.87
SENIORITY	SEN1	0.01	0.32	-0.07	-1.38	0.14***	2.52
	SEN2	-0.02	-0.48	-0.11***	-2.44	0.12***	2.28
	SEN3	-0.04	1.26	-0.05	-1.48	0.15***	3.83
OCCUPATION	OCC1	-0.05	-1.13	-0.11**	-1.98	-0.29***	-3.79
	OCC2	-0.17***	-4.27	-0.06	-1.46	-0.12***	-2.11
	OCC4	0.01	0.36	-0.03	-0.63	0.18***	3.35
ASSOC	ASSOC_1	-	-	0.07*	1.65	-	-
	NOASSOC	-	-	-0.12***	-4.28	-	-
QUAL_FORMATION		0.36***	13.41	0.18***	6.74	-0.02	-0.55
PTIME		-	-	-	-	-0.10	-0.93
WHOURS		-	-	-	-	0.00	1.46

NIGHT	-	-	-	-	0.11***	2.79
SUNDAY	-	-	-	-	0.05	1.14
COMPUTER	-	-	-	-	-0.17***	-4.22
INTERNET	-	-	-	-	-0.03	-0.75
CONSEC	-	-	-	-	0.20***	3.97
CONNEG	-	-	-	-	0.07	1.45
UNCLEAR	-	-	-	-	0.09***	2.66
REPEAT	-	-	-	-	0.10***	3.07
OBJECTIVE	-	-	-	-	0.06*	1.91
HOW	-	-	-	-	0.01	0.36
STRESS	-	-	-	-	0.10***	3.04
INCIDENT	-	-	-	-	0.03	0.89
INTERRUP	-	-	-	-	0.01	0.36
HELPCHEF	-	-	-	-	-0.03	-0.93
HELPCOL	-	-	-	-	0.02	0.63
AMEL	-	-	-	-	0.08***	2.51
AGRIFOOD	-0.28***	-4.86	-0.24***	-4.51	-0.08	-1.18
CONSUMPTION GOODS	-1.13***	-19.83	-0.69***	-11.74	-0.04	-0.59
CARS AND EQUIPMENTS	0.08	1.42	-0.14***	-3.18	0.04	0.66
ENERGY	0.08***	4.88	1.14***	9.85	-0.00	-0.01
CONSTRUCTION	0.10*	1.64	-0.13***	-2.26	-0.11	-1.54
COMMERCIAL	-0.09***	-18.89	-0.48***	-10.29	0.05	0.81
TRANSPORT	-0.78***	-14.5	-0.77***	-12.21	-0.28***	-3.77
FINANCIAL AND REAL-ESTATE ACTIVITIES	-1.13***	-11.52	-0.78***	-6.23	-0.16	-1.10
SERVICES FOR FIRMS	-0.58***	-12.26	-0.68***	-13.84	-0.08	-1.20
SERVICES FOR INDIVIDUALS	-1.13***	-15.38	-0.60***	-7.27	0.13	1.43

Likelihood ratio	-15678.05
WaldChi2(116)	6193.15
Correlation of residuals accidents/QS Rho13	-0.05***
Correlation of residuals accidents/ES Rho23	0.38***
Correlation of residuals QS/ES Rho23	0.57***
LR test of rho12=rho13=rho=23=0	1015.1407
Number of observations	12 959
Number of workers in QS registered firms	7 747
Number of workers in ES registered firms	3 690

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively
Sector reference: INTERMEDIATE GOODS.

4.2 Estimates Results-EE and Working Conditions surveys

Tables 7.6 and 7.7 provide results based on a bivariate probit model.

Since *rho*, the present relation between quality practices and working accidents without sick leave, is significantly different from 0 (Table 7.6), we may confirm our interest in using the bivariate probit model. On the contrary, the insignificant *rho* of employee accidents at work with sick leave model indicates that the quality practices variable is not endogenous.

Therefore, a simple univariate probit, with *rho* being constrained to equal 0, would give unbiased results. However, the implementation of the bivariate probit was nevertheless necessary because it shows the exogeneity of this variable (Table 7.7).

Workers choice equation

The estimation results regarding the factors that may impact on a worker's probability of working in a quality-oriented environment are presented in Tables 7.6 and 7.7. The overall results are similar for the two models as well as with results obtained from using a COI 2006 survey. As in the previous case, the first group of variables that we have used includes firm size and sector of activity.

The results are consistent with previous findings for both variables; the firm's size mainly determines its likelihood of introducing quality practices, and the implementation of quality practices varies among different sectors.

With regard to socio-demographic characteristics, we confirm, once again, that men are more likely to work under quality approaches. Contrary to previous findings, the variable *AGE* is not significant for the two models. Surprisingly, only employees with no diploma and those that have a higher degree have a negative tendency towards the adoption of quality control procedures.

Concerning job characteristics, we may conclude that employees between 1 and 5 years of seniority have a decreased propensity for the implementation of quality procedures. Furthermore, as compared to white collar workers (the reference category), workers in all other occupational categories prefer the adoption of quality control procedures.

Employees that have to hurry their work all the time or have to change task inexpertly in order to complete another, have an increased propensity towards quality standards adoption. In contrast, having the possibility of interrupting one's work has no affect on the adoption of quality practices. Moreover, employees that constantly repeat the same actions and operations are more likely to implement quality practices. This finding could be explained by the fact that working with quality practices allows employees to complete more varied work tasks.

Concerning employee mistakes that can provoke consequences on product quality, firm and security, we conclude that all these variables positively influence the likelihood of adopting quality procedures.

Finally, while employees that feel tension in their relationships with colleagues have no influence on the adoption of quality procedures, employees that feel tension in their relationship with their hierarchical superior will prefer to work in an environment with quality control procedures.

Working accidents equations

The estimated effects of quality strict procedures on working accidents are reported in Tables 7.6 and 7.7. The findings concerning quality strict procedures have different outcomes for working conditions when we distinguish between working accidents that do and do not lead to sick leave.

While quality strict procedures increase the risk of working accidents that do not lead to sick leave, they have no effect on working accidents that lead to sick leave. Hence, our previous results are confirmed, since we may conclude that work intensification imposed by the adoption of quality practices impacts negatively on employee safety (Brenner *et al.*, 2004). However, the accidents that employees experience from the utilisation of these procedures are not serious enough to lead to sick leave. Finally, our results are consistent with those obtained by Askenazy and Caroli (2010) what induces that even though new work practices could lead to some learning over time, they will not be useful for the improvement of working conditions.

As in the previous case, our analysis also provides the results of examining other determinants of working accidents in order to verify whether the results are at least partially attributable to job characteristics (Tables 7.6 and 7.7).

Generally, the results are similar for both models. One may argue firm size has no impact on working accidents (working accidents that do and do not lead to sick leave), except that medium sized firms experience more accidents that lead to sick leave. Interestingly, our results indicate that the sector of activity has no impact on working accidents that lead to sick leave, while working in the sectors of consumer goods, construction, commercial, transport, financial and real-estate activities, services for firms, and services for individuals reduces the risk of working accidents that do not lead to sick leave.

Furthermore, men have a higher risk of experiencing working accidents that lead to sick leave. This can be explained by the fact that men usually occupy more dangerous work places than women. Our results are consistent with previous results that state that older employees have fewer working accidents that lead to sick leave.

The variable *AGE* stays insignificant for working accidents that do not lead to sick leave. The evidence indicates that the variable *COUPLE* is negative, but not significant, for working accidents that lead to sick leave while being single increases the risk of working accidents that do not lead to sick leave.

Having a superior degree rather than a specialised high school degree, high school degree or technical degree impacts negatively on the risk of working accidents. However, since the variable *EDUCATION* stays insignificant, we conclude that education has no impact on working accidents.

Moreover, the findings indicate that workers of 1 to 5 years of seniority bear more risk of working accidents than workers with more than 10 years of seniority. As expected, blue collar workers bear more risks of working accidents than middle-management workers. On the other hand, being a manager or part of the intellectually superior personnel decreases the probability of working accidents.

Variable *WHOURS* indicates that, while working hours has no impact on minor accidents, they increase the probability of serious ones. Furthermore, having a full-time job has no effect on working accidents.

Consistently with previous results, the utilisation of a computer at work will reduce the probability of working accidents but those with sick leave, while using the internet has no effect on both models. Having to hurry work all the time has no influence on working accidents. Employees that have to change their task in order to complete another one increase their risk of having working accidents that do not lead to sick leave. Having the possibility of interrupting one's work has no effect on accidents at work. In the same sense, constant repetition of the same actions and operations has no effect on working accidents.

Interestingly, when an employee feels that his mistakes can provoke consequences for the quality of the product, he/she faces less risk of accidents at work that lead to sick leave. A simple explanation could be that employees are more attentive during work in order to achieve product quality, and at the same time they avoid accidents. On the other hand, while an employee's feeling that his mistakes can provoke consequences for the firm has no impact on accidents, an employee's feeling that his mistakes can provoke consequences for security increases the risk of both types of working accidents, which is confirmed by previous results.

Employees that feel tensions in their relationships with colleagues and hierarchical superiors have more risk of minor accidents. On the other hand, while employees that feel tension in the relationship with colleagues face a greater risk of accidents that lead to sick leave, employees that feel tensions in the relationship with their hierarchical superior face no greater risk of accidents that lead to sick leave. Another factor driving up the risk of accidents without a sick leave occurs when employees who work always or often outside of work premises.

Finally, having at least a 48h consecutive break during the week or having a meal break will decrease the probability of experiencing a working accident that leads to sick leave.

Specific differences between the findings based on COI 2006, and EE and working conditions surveys could be explained by several factors. Firstly, quality is defined differently in two surveys (quality standards and quality strict procedures). Secondly, EE and working conditions surveys distinguish between two types of accidents. Moreover, the COI database is oriented towards both firm and employee characteristics, while when using EE and working conditions surveys we have only two firm characteristics (size and sector).

Table 7.6: Bivariate probit estimates of the effect of quality procedure on working accidents without sick leave

		QUALITY PROCDEURE		ACCIDENT1	
Variables		Estimate	z-value	Estimate	z-value
Intercept		-0.73***	-9.44	-2.57***	-13.56
QUALPROCED		-	-	0.34***	2.85
SIZE	SMEDIUM	0.32***	7.13	0.07	0.88
	MEDIUM	0.50***	9.45	0.19**	2.01
	BMEDIUM	0.53***	8.25	0.04	0.74
	BIG	0.58***	15.93	0.07	0.96
MAN		0.11***	3.32	0.04	0.52
AGE	AG1	-0.00	-0.10	0.03	0.34
	AG3	0.02	0.49	-0.09	-1.16
COUPLE		-	-	0.12*	1.85
EDUCATION	EDU1	-0.20***	-4.99	-0.09	-1.24
	EDU2	0.05	0.93	-0.03	-0.31
	EDU4	0.01	0.23	-0.03	-0.37
	EDU5	-0.12***	-2.20	-0.09*	-0.69
SENIORITY	SEN1	0.00	0.09	0.02	0.21
	SEN2	-0.09***	-2.38	0.12*	1.65
	SEN3	-0.01	-0.29	-0.01	-0.08
OCCUPATION	OCC1	0.32***	3.59	0.01	0.05
	OCC2	0.15***	2.61	-0.36***	-2.32
	OCC3	0.26***	5.81	-0.02	-0.22
	OCC5	0.24***	5.23	0.20***	2.14
WORKING HOURS		-	-	0.01	0.63
FULL TIME		-	-	-0.10	-1.14
COMPUTER		-	-	0.10	1.47
INTERNET		-	-	-0.11	-1.49
HURRY		0.07**	2.22	0.10*	1.76
BUSY		0.22***	7.39	0.20***	3.20
INTERRUPT		-0.01	-0.18	0.03	0.47
REPETE		0.27***	8.00	0.09	1.40
RISKQUAL		0.32***	9.06	-0.08	-1.00
RISKFIN		0.23***	6.58	-0.03	-0.38
RISKDANG		0.23***	6.87	0.19***	2.85
TENSIONCOLL		0.03	0.91	0.15***	2.34
TENSIONHIERA		0.09**	2.42	0.21***	3.15
ISOLATE		-	-	0.22***	3.14
PAUSE		-	-	-0.09	-1.20
MEAL		-	-	-0.00	-0.01
IMPOSSIB		0.09***	2.10	-	-
AGRIFOOD		0.12	1.48	-0.09	-0.68
CONSUMPTION GOODS		-0.40***	-5.31	0.10	0.74
CARS AND EQUIPMENTS		0.09	1.33	-0.03	-0.30
ENERGY		0.17	1.28	0.07	0.33

CONSTRUCTION	-0.25***	-3.78	0.10	0.92
COMMERCIAL	-0.50***	-8.52	0.11	1.16
TRANSPORT	-0.53***	-7.69	0.07	0.33
FINANCIAL AND REAL-ESTATE ACTIVITIES	-0.62***	-8.86	-0.04	-0.25
SERVICES FOR FIRMS	-0.44***	-7.94	0.03	0.30
SERVICES FOR INDIVIDUALS	-0.41***	-5.62	0.08	0.67
Number of workers that follow quality strict procedure			5 201	
rho			-0.16***	
Wald test of rho=0			5.61***	

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively
Sector reference: INTERMEDIATE GOODS.

Table 7.7: Bivariate probit estimates of the effect of quality procedure on working accidents with sick leave

		QUALITY PROCDEURE		ACCIDENT2	
Variables		Estimate	z-value	Estimate	z-value
Intercept		-0.73***	-9.44	-2.17***	-12.38
QUALPROCED		-	-	0.31	1.45
SIZE	0.32***	7.12	0.02	0.29	0.88
	0.50***	9.45	-0.13	-1.30	2.01
	0.53***	8.28	-0.08	-0.61	0.74
	0.58***	15.92	-0.08	-1.05	0.96
MAN		0.11***	3.32	0.14***	2.13
AGE	-0.00	-0.08	0.10	1.44	0.34
	0.02	0.50	-0.12*	-1.68	-1.16
COUPLE		-	-	-0.02	-0.43
EDUCATION	-0.20***	-4.99	0.08	1.35	-1.24
	0.05	0.92	0.03	0.28	-0.31
	0.01	0.22	-0.13	-1.29	-0.37
	-0.12***	-2.23	-0.19	-1.30	-0.69
SENIORITY	0.01	0.07	0.08	0.85	0.21
	-0.09***	-2.37	0.19***	2.83	1.65
	-0.01	-0.26	0.11	1.55	-0.08
OCCUPATION	0.32***	3.60	-0.24	-1.26	0.05
	0.15***	2.62	-0.68***	-3.49	-2.32
	0.26***	5.80	-0.01	-0.06	-0.22
	0.24***	5.23	0.21***	2.15	2.14
WORKING HOURS		-	-	0.01***	2.27
FULL TIME		-	-	0.11	1.14
COMPUTER		-	-	-0.19***	-2.78
INTERNET		-	-	-0.13	-1.57

HURRY	0.06***	2.20	0.06	1.12
BUSY	0.22***	7.38	0.08	1.39
INTERRUPT	-0.01	-0.17	0.00	0.08
REPETE	0.27***	7.98	0.08	1.51
RISKQUAL	0.32***	9.05	-0.16***	-2.37
RISKFIN	0.23***	6.61	0.01	0.13
RISKDANG	0.23***	6.87	0.28***	4.49
TENSIONCOLL	0.03	0.92	0.31***	5.36
TENSIONHIERA	0.09***	2.42	-0.03	-0.50
ISOLATE	-	-	0.02	0.25
PAUSE	-	-	-0.22***	-3.32
MEAL	-	-	-0.14*	-1.84
IMPOSSIB	0.09***	2.09	-	-
AGRIFOOD	0.12	1.47	-0.10	-0.68
CONSUMPTION GOODS	-0.40***	-5.29	0.08	0.57
CARS AND EQUIPMENTS	0.09	1.38	0.17	1.52
ENERGY	0.17	1.27	-0.76**	-2.06
CONSTRUCTION	-0.25***	-3.79	-0.04	-0.33
COMMERCIAL	-0.50***	-8.91	0.03	0.26
TRANSPORT	-0.53***	-7.69	-0.02	-0.20
FINANCIAL AND REAL-ESTATE ACTIVITIES	-0.62***	-8.86	-0.32*	-1.71
SERVICES FOR FIRMS	-0.44***	-7.95	-0.00	-0.04
SERVICES FOR INDIVIDUALS	-0.41***	-5.62	0.14	1.11
Number of workers that follow quality strict procedure	5 201			
rho	-0.12			
Wald test of rho=0	0.89			

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively
Sector reference: INTERMEDIATE GOODS.

5. Conclusions

On the one hand, an increasing number of firms have changed their work organisation adopting quality and environmental approaches that have been recognised as “win-win” tools that bring significant benefits to firms through increased efficiency, productivity and business performance. On the other hand, a limited number of theoretical and empirical studies suggest contradictory evidence for the impact of these practices on working conditions.

Using French matched employer-employee data, we have been able to shed new light on the effects of quality and environmentally practices on employee working accidents.

Overall, our findings suggest new directions for a reconsideration and broader assessment of quality and environmental practices. Moreover they are of conceptual, methodological, and practical significance.

The estimation results show that quality practices increase the risk of employee's accidents. Therefore, it is necessary for a firm to integrate a set of safety approaches with quality practices in order to foresee and prevent potential working accidents. We show that quality practices increase the risk of working accidents in general although they are ineffective on working accidents that lead to sick leave. This suggests that the accidents that employees experience because of quality strict procedures are rather minor in nature rather than requiring sick leave.

Moreover, the effect of quality practices on working conditions may also depend on the way in which quality practices are implemented. Hence, managers have to assure that such practices are designed and implemented with employee participation (Poksinska, 2007). Similarly, in order that employees benefit from quality practices implementation, the firm has to be managed as a stakeholder institution where workers have strong representation and co-determination rights (Godard, 2004).

Furthermore, based on the survey results, it can be concluded that environmental standards contribute significantly to the improvement of working conditions by reducing the risk of accidents. In view of the fact that working accidents are costly for firms, environmental standards could be a driver for cost reductions which will lead to improved business performance. This is a significant finding for managers who are hesitant about implementing environmental standards because they are skeptical about its benefits.

Limitations and Future Research

This chapter has some limitations that should be taken into account in further research. Firstly, future empirical analysis on the subject should verify whether the implementation of quality practices encourages employees to signal more often accidents at work. Secondly, future research is needed to explore equivalent questions in an international setting, especially if we consider that there are cultural differences concerning quality and environmental practices. This would allow one to test more directly the hypothesis that institutional environment shapes the outcomes of quality and environmental practices adoption for employees. Thirdly, there is some need to expand the measurement of working conditions. Proposing more indicators for working conditions will be helpful to understand better which area of work is affected or not by the new ways of work organisation. Fourthly, the literature indicates that different quality dimensions may impact differently on firm performance (see, **chapter 4**). We can extend our research by examining how different dimensions of quality standards impact on working conditions. Providing a detailed analysis of the impact of various aspects of quality practices on working conditions could enable policy-makers to improve aspects that currently have a negative impact and improve the overall impact of quality practices on working conditions. Finally, our research also misses individual heterogeneity in participation in quality and environmental standards. Some studies have shown that not all employee groups use quality and environmental standards equally.

Chapter VIII

How Green is my Firm?

Worker Well-Being and Job Involvement in Environmentally Certified Firms[48]

SECTION 1- INTRODUCTION

SECTION 2- LITERATURE REVIEW

SECTION 3 – EMPIRICAL ANALYSIS

3.1 The database

3.2 Descriptive Statistics

3.3 Estimation Strategy

SECTION 4 – DISCUSSION OF THE RESULTS

SECTION 5 – CONCLUSION

[48] This section is a developed version of the article "How Green is my Firm? Worker Well-Being and Job Involvement in Environmentally-Related Certified Firms" (with Joseph Lanfranchi).

1. Introduction

In post-industrial societies, firms need both a legal right and a 'social license' to operate. Therefore, in addition to the well-known profit maximisation goal, entrepreneurs may invest in social responsibility - the firm's commitment to implement procedures and policies devoted to improve the well-being of employees, customers and any institution representative of the local community (Turban and Greening, 1997). Firms have to integrate economic, social and environmental concerns into their business strategies, their management tools and their activities, going beyond compliance and investing more into human, social and environmental capital. Indeed, meeting the requirements demanded by these 'social licensors' could be achieved through the adoption of environmental standards since these will lead the firms to conduct business in a more ethical and socially responsible manner.

A growing body of literature has been concerned with the motivation for environmental standards adoption (*e.g.* Grolleau *et al.*, 2007; Ambec and Lanoie, 2008) and their impacts on firm performance (*e.g.* Khanna and Damon, 1999; Darnall *et al.*, 2008). However, as yet, an important but apparently neglected issue concerns whether or how those standards impact on employee outcomes. This is significant subject since it is argued that resources and capabilities associated with employees are crucial for the success of the firm. Therefore, the aim of **chapter 8** is to fill this gap in the literature by examining how the use of environmental standards impacts on worker well-being and job involvement. Evidence of such a relationship would be of importance for firms since a number of positive outcomes are related to worker well-being and job involvement such as improved labour productivity, reduced absenteeism, lower turnover rates, etc.

One rationale for suggesting there is a positive impact of environmental standards on well-being and job involvement can be traced in Brekke and Nyborg's model (2008) showing that workers who exhibit preferences that depend positively on the level of social welfare are ready to make a form of labour donation to environmentally responsible employers. This labour donation could take the form of a lower reservation wage or a higher level of effort. Hence, one of the driving forces inducing firms to invest in environmental activities can be found in the desire to screen pro-socially motivated applicants in order to improve motivation and job involvement. Green entrepreneurs would therefore expect that an advantage in labour productivity is likely to compensate for the costs of environmentally devoted investments.

Moreover, several authors have cited improved employee goodwill (such as a decrease of labour problems) as an important outcome of social responsibility (*e.g.* Soloman and Hansen, 1985).

A second explanation derives from the moral prejudice that employees may face if their employer undertakes business policies that will damage its social reputation. Indeed, according to Social Identity Theory, individuals evaluate their self-images by comparing the main features of the social group they belong to with the characteristics of other groups. Therefore, employees of firms which commit themselves toward a better environmental performance should experience higher job satisfaction as they benefit from their employers' good reputation and image in the community.

Finally, induced work re-organisation due to environmental standards adoption may provide different working opportunities for employees such as participation in decision-making, more autonomy, enhancement of their skills and improvement in leadership opportunities, which may all lead to improvement of their well-being and job involvement. Additionally, the implementation of environmental practices has positive effects on workers' physical security (see **chapter 7**) and therefore workers' welfare. In fact, employer commitment to environmental improvements can be associated with a better attention to safety practices as well as a decrease of environmental incidents, which is expected to also reduce the exposure of workers to dangerous materials.

In all cases, employers may therefore expect that implementing an environmental standard is likely to lead to a reduction in labour costs. In fact, employee well-being at work or job satisfaction and job involvement have been regularly associated with effort and productivity. Thus, low job satisfaction is associated with higher rates of absenteeism (Drago and Wooden, 1992), higher rates of quitting (Clark, 2001) and lower levels of work effort, including counter productive behaviour (Mangione and Quinn, 1975), and performance (Iaffaldano and Muchinsky, 1985). Similarly, job involvement, defined as the extent to which an employee identifies with his job and actively participates in it, has also been identified as improving firm performance by several means such as an increase of employee effort and performance (Diefendorff *et al.*, 2002) and reduction of employee turnover (Rabinowitz and Hall, 1977).

As stated by Ambec and Lanoie (2008), it would be useful to provide direct empirical evidence of the association of labour cost reductions with the implementation of environmental standards. If we cannot provide such a direct test, the first originality of our contribution is to assess the likelihood of such an association. Hence, we investigate the effect of working in an environmentally oriented firm on likely predictors of labour productivity. The second point of interest of our study comes from the utilisation of the Organisational Changes and Computerisation survey (Changement Organisationnel et Informatisation, COI, 2006) which provides a representative sample of French firms with more than 20 employees. As we said previously, in the COI survey both employers and employees are interviewed, the former about firm practices, technological and organisational changes and the latter about the working conditions, the content of their jobs, and their attitudes and opinions. Importantly, this large employer-employee database provides employer information about the adoption of environmental standards together with various measures of employee evaluations of the work organisation and job characteristics. Therefore, we are able to control for a very detailed set of workers and job characteristics to properly isolate the effect of environmental standards on well-being and job involvement. Finally, the utilisation of French data has the further advantage of providing an analysis of organisations outside the extensively studied US and UK cases. Furthermore, the growing sense of concern about the environment in the French society has been recently exposed by the results of the last 2009 European Polls where French voters elected the highest number of green members in the EU Parliament.

This chapter is structured as follows. Section 2 reviews the literature on the link between environmental standards and the attitudes of workers. Section 3 presents the data and model specification. The results are provided and discussed in section 4. Section 5 concludes and suggests future directions and policy implications.

2. Literature review: Environmental standards and employee attitudes at work

In this section, we will review how previous theoretical and empirical literature explains the link between the implementation of environmental standards and workforce attitudes such as well-being and job involvement.

As we indicate in previous chapters, an Environmental Management System (EMS) is a management structure that provides firms with a framework to minimise their environmental impact, ensure compliance with environmental laws and regulation, and reduce wasteful uses of natural resources. EMS could be integrated in a firm's daily operation via different environmental standards (*e.g.* ISO 14001, EMAS, Responsible Care, etc). Furthermore, it is expected that the management structure under EMS will help firms to improve their operating structures, to substitute their regulated inputs with unregulated (and perhaps less harmful) ones, to eliminate some of their processes and waste streams, to modify their supplier relationships, and implement other changes (Darnall *et al.*, 2000).

In fact, the implementation of environmental approaches represents a significant organisational change within a firm. It can be defined as a self-motivated effort at internalising environmental externalities by adopting management practices that will enable the firm to make continuous improvements in production methods and environmental performance (Khanna and Anton, 2002). However, such a change may imply considerable investments and one rational question would be: is it profitable to invest in such environmental standards?

The Porter hypothesis offers a positive answer to this question stating that the different types of returns obtained from environmental innovations may compensate their implementation costs (see **chapter 3** and **5**). A recent survey by Ambec and Lanoie (2008) listed seven channels through which environmental standards may provide benefits to firms or cut their costs, these being better access to markets, greater possibilities for differentiation of products, commercialisation of pollution-control technology on the one hand and savings on regulatory costs, material energy and services, capital and labour costs. Of particular interest for our research is the effect of working in an environmentally firm on likely predictors of labour productivity and costs such as employee well-being at work and job involvement. It is argued by some researchers that firms may actually benefit from socially and environmental responsible actions in terms of employee morale and productivity (Moskowitz, 1972; Parket and Eibert, 1975).

The positive impact of environmental standards on such employee outcomes may be rationalised by at least two lines of argument. The first postulates that environmental standards implementation will help to attract and motivate workers characterised by pro-social values. The second identifies indirect effects on employee outcomes caused by changes in work organisation and improvements in working conditions due to environmental standards adoption. The following discussion will develop the two perspectives, respectively.

To achieve workforce understanding of and commitment to environmental issues, firm managers need to find strong motivational factors. Generally, the intrinsic motives that are likely to encourage employees have an ideological character. Hence, pro-social motivation, defined as an individual's aspiration to have a positive impact on the well-being of other people and groups within society, may be a strong device to improve work commitment. For this reason, environmental voluntary initiatives may improve human resources management if the firm succeeds in attracting and motivating workers who share these values. For instance, Grolleau *et al.,* (2007) showed that ISO 14001 registration among French agrofood firms was mainly driven by the desire to improve human resource management.

Our main theoretical reference for rationalising this intuitive argument is the model by Brekke and Nyborg (2008) showing that when workers have preferences that depend positively on the well-being of others, they are ready to self select themselves to work in "green firms" and then to work harder for environmentally responsible employers. Consequently, the benefits from efficient recruitment of pro-socially motivated workers may out-weight the costs of environmental investments.

Analogously with Brekke and Nyborg's model (2008), the Labour Donation Theory may help us to confirm a positive link between environmental responsibility and employee's motivation. Originally, the theory was put forward to explain how non-profit organisations which offer goods and services aimed at generating social benefits may succeed at recruiting workers ready to accept lower wages than the ones they could obtain in the profit sector (Preston, 1989). It further argues that non-profit employees are intrinsically motivated employees. The theory postulates that goals, management practices and alleged values of productive organisations help not only to attract but also to motivate individuals that prefer to work for employers devoted to socially desirable objectives. Moreover, labour donation can take the form of a specific level of involvement in the firm's activity. Where employers cannot perfectly control the effort level of their workforce, pro-social motivation would ensure that workers are more likely to work hard. Empirical evidence has shown that non-profit and public sector workers are more likely to accept lower wages (Narcy, 2009), donate their labour, measured by unpaid overtime (Gregg et *al.,* 2008), be less absent (Lanfranchi and Narcy, 2007) and declare themselves significantly more satisfied at work (Benz, 2005; Lanfranchi and Narcy, 2008). Accordingly, this type of motivation based on individual values may generate benefits both for employees in terms of well-being at work and employers in terms of increased productivity.

Moreover, individuals may also engage themselves in the activities of any social group whenever these are evaluated positively in society. According to Social Identity Theory, an individual assesses his social identity on the basis of his adherence to various organisations, including the firm he works for. However, these firms gain reputations in the society through competition, comparison and judgments. Therefore, since reputation reflects a firm's social status and provides information about how well the firm is perceived relative to its competitors, the reputation of the firm reflects on its employees. Individual identification with the organisation is then the process through which such evaluations are transformed into an evaluation of the individual's own personality. Therefore, employee attitudes should be favourably influenced by a positive perception in society of the social performance of their employers. Moreover, employees' estimates of the reactions of external environment to the firm in which they work influence both their job satisfaction and their intentions to leave the firm. If firm's attributes are perceived as attractive by employees, they will identify strongly with the firm and strong identification may translate into co-operative and citizenship-type behaviours (Dutton *et al.,* 1994). Similarly, Hess *et al.,* (2002) argue that organisational involvement in social causes generally enhances an organisation's reputation, which leads to a positive impact on employee work attitudes. A positive corporate identity may create an emotional association between employees and firm, resulting in enhanced labour productivity. Hence, improved environmental performance may positively influence employee well-being and job involvement while negative reputations would result in negative employee attitudes.

Moreover, it is argued that firm's social actions provide employees with critical information to judge the firm's fairness (Aguilera *et al.,* 2007). The literature review on the subject has demonstrated that employees' perceptions of the fairness of firm's actions have a strong impact on their attitudes about and actions toward the firm (Colquitt *et al.,* 2001). Employees who perceive a great level of fairness are committed, trusting, loyal, hard-working and are good citizens at work. Contrary, when a great level of injustice is perceived, employees are likely to organise sabotage and revenge (Aquino *et al.,* 2001). Therefore, we presume that adoption of environmental standards will improve employee's well-being and job involvement since employees see an environmental responsible organisation as a fair organisation.

Firm's ethical behavior may have an impact on job satisfaction. Example of such relationship can be found in Vitell and Davis' research (1990) indicating strong dissatisfaction of employees when they face unethical behavior in their firm.

Some sparse evidence seems to confirm the concerns of the workforce for the social benefits generated by their employers' activity. Hence, the largest increase in the employee values at work, recorded in the International Social Survey Programme in 1989, 1997 and 2005, is registered for the two following items: "my work allows helping other people" and "my work is useful to society" (Clark, 2009). In addition, in a study of recent graduates from Cornell University, Frank (1996) indicates that personal values affect the choice of employers and the level of reservation wages. The author's survey results show that 88 percent of the sampled graduates would prefer a job for the American Cancer Society rather than for Camel Cigarettes with an average compensating wage premium of about $ 24.000 per year, confirming that individuals are likely to accept lower wages, and thus allow the firm to balance the cost of its socially responsible operations. In same sense, Forbes reported a study done by Students for Responsible Business which found that more than half of 2 100 MBA student respondents indicated they would accept a lower salary to work for a socially responsible company (Dolan, 1997). Also, Turban and Greening (1997) show a positive correlation between ratings of a firm's Corporate Social Responsibility and its degree of attractiveness for workers. More in line with the precise topic of our study, empirical results of **chapter 5** show that when French firms have adopted environmental standards, they experience fewer difficulties in recruiting both professional and non-professional employees.

The second perspective is related to the fact that adoption of environmental standards may trigger other changes in the work organisation and indirectly influence employee outcomes. In fact, the adoption of environmental standards, just like the use of high performance work practices, may induce work re-organisations that provide workers with opportunities to participate in decision-making, to be more autonomous, to enhance their skills, to improve leadership opportunities, etc. Those new opportunities could be further associated with improvement of overall job satisfaction. For instance, Appelbaum *et al.*,

(2000) argue that the opportunity to participate in decision-making leads to the creation of trust between workers and supervisors and to intrinsic rewards. Trust and intrinsic rewards are in turn positively associated with higher commitment, job satisfaction and lower stress. In the same vein, Bauer (2004) suggests that greater autonomy for employees in the performance of their tasks is positively related to employee's job satisfaction.

However, working re-organisation may have conflicting effects on employee well being, since it may be often associated with higher demands within the job and therefore with intensification of labour effort that may have negative consequences on employee outcomes (*e.g.* Green and McIntosh, 2001).

In addition to these job design effects, there may be other indirect effects of environmental standards on overall job satisfaction through their impact on working conditions. The employee's welfare-safety link is strongly supported in the empirical literature. It was argued that work accidents, injuries, and bad working conditions result in decreased morale, organisational commitment and job satisfaction (Michael *et al.*, 2005). Therefore as environmental standards entail an improvement in the health and safety conditions of employees through pollution improvement, reduction of contacts with hazardous materials, diminution of bad odours, noise etc, one may expect that these standards will generate positive effects on worker job satisfaction (see **chapter 7**).

Finally, if we are not aware of any academic study of the link between environmental standards and employee well-being and job involvement, recent private firm surveys seem to confirm the benefits of environmental investments in terms of employee well-being and job involvement.

More precisely, a survey of US firms by the Hudson Institute conducted in 2000 concluded that employees who believe that they work in a socially responsible environment are six times more likely to be loyal than those workers who believe that their organisation is not socially responsible and behaves in an unethical manner. Another study by the Kenexa Research Institute stressed that employees working at firms with environmental and social programs are more satisfied with their job and management and stay longer at their jobs than peers in firms with minimal or no corporate responsibility programs.[49] In the same vein, the multinational corporation, Dole Food Co. Inc. reported that 'key benefits (of adopting environmental management systems) include strong employee motivation and loyalty which translates into reduced absenteeism and improved productivity.[50]

3. Empirical Analysis

3.1 The database

The data is extracted from the French Organisational Changes and Computerisation in 2006 (Changement Organisationnel et Informatisation, COI). [51] This survey was created by researchers and statisticians from INSEE (National Institute for Statistics and Economic Studies), DARES (Ministry of Labour) and CEE (Center for Labour Studies). This collaboration gathered a great deal of knowledge and expertise, which has made it possible to put together questionnaires for public administration, private firms and their workforce (for more details see **chapter 1**).

Furthermore, to obtain information about worker compensation, the COI survey has been merged with another French administrative database, Annual Statement of Social Data (Déclarations Annuelles de Données Sociales, DADS), containing information on employee compensation (for more details see **chapter 5**). Direct information on net wages is however unavailable and each individual worker is linked with the value of the percentile of the country-wide wage distribution he belongs to.

Finally, after further deletion of firms and employees that did not answer all the relevant information for our study, we are left with 11 600 usable observations.

The variables used for descriptive statistics and estimation are indicated in Table 8.1.[52]

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[49] Working for the Earth: Green Companies and Green Jobs Attract Employees, Social Funds, www.socialfunds.com/news/article.cgi/article2389.html, October 9, 2007

[50] Anonymous, 2001, Dole Reports Motivation, Health and Safety, and Productivity Benefits from ISO 14001. ISO Management Systems—*The International Review of ISO 9000 and ISO 14000*, December, 56-58.

[51] More details about the design and scope of this survey are available on www.enquetecoi.net. : Survey COI-TIC 2006-INSEE-CEE/Treatments CEE.

[52] No problem of multicolinearity has been detected. However, because of the table's length we do not report Pearson correlation coefficients for these variables.

Table 8.1: Definition of variables

Variable	**Definition**
Dependent variables	
USEFUL	The employee's work is useful for others Dummy variable (=1 if yes)
RECOGNITION	The employee's work is fairly valued Dummy variable (=1 if yes)
INVOLVEMENT	The employee is involved in his work Dummy variable (=1 if employee is very involved)
COMPENSATION	The employee is compensated for supplementary work hours Dummy variable (=1 if yes)
Independent variables	
ES	Registered for ISO 14000, organic labeling or fair trade Dummy variable (=1 if registered in 2006)
QS	Registered for ISO 9000, EAQF (Supplier Quality capability evaluation), etc. Dummy variable (=1 if certified in 2006)
JIT	The firm utilises just-in-time. Dummy variable (=1 if certified in 2006)
TEAM	The firm utilises autonomous work groups or teams. Dummy variable (=1 if certified in 2006)
STAND	The strategic importance of the standardisation of processes and working methods is : STAND1 (very important) ***(ref)*** STAND2 (important) STAND3 (quite important) STAND4 (not important)
SIZE	SMALL (20 TO 49 employees) SMEDIUM (49 TO 199 employees) MEDIUM (200 TO 499 employees) BIG (more than 500 employees) ***(ref)***
EXPORT	Share of firm exportation by turnover (Continuous variable)
SEX	The employee is a women Dummy variable (=1 if yes)
AGE	Age (Continuous variable)
AGESQ	Age Squared (Continuous variable)
SINGLE	The employee lives alone Dummy variable (=1 if yes)
EDUCATION	Employee has: EDU1 (primary or lower secondary degree) EDU2 (technical degree) ***(ref)*** EDU3 (general secondary or preparation for specialised secondary degree) EDU4 (superior-fist cycle degree) EDU5 (superior-first or second cycle degree,

	grande école, école de commerce, etc)
SENIORITY	SEN1 (1 TO 3 years) ***(ref)*** SEN2 (3 TO 5 years) SEN3 (5 TO 10 years) SEN4 (10 years or more)
OCCUPATION	Employee is: OCC1 (management) OCC2 (middle-management) OCC3 (white collar workers) OCC4 (blue collar workers) ***(ref)***
ASSOC	The employee participates in sport, culture or social association ASSOC_1 (if employee participates) NOASSOC (if does not participate) ASSOC_2 (there is no association) ***(ref)***
PARTIME	The employee has a part time job Dummy variable (=1 if yes)
CONTROL	The employee's work is controlled: CONTROL1 (if controlled constantly) CONTROL2 (if controlled at least once a day) CONTROL3 (if controlled at least once a week) CONTROL4 (if controlled at least once a month) CONTROL5 (if controlled for occasionally, rarely or never) ***(ref)***
HDETER	Working times are defined: HD1 (if defined by firm without possibility of modification) HD2 (possibility of choice between different working hours) HD3 (if defined by employee) ***(ref)***
INCIDENT	The employee has to deal with incidents alone Dummy variable (=1 if)
INTERRUP	The employee cannot interrupt his work for a moment if he wishes Dummy variable (=1 if yes)
QUALIFICATION1	The employee thinks that he lacks specific skills to do his job correctly Dummy variable (=1 if yes)
QUALIFICATION2	The employee does not use all his skills in his job Dummy variable (=1 if yes)
STRESS	The employee feels unable to cope with his work or overloaded every day or at least once a week or at least once a month Dummy variable (=1 if yes)
OBJECTIVE	The employee has to reach precise targets Dummy variable (=1 if yes)
HOW	The employee receives precise instruction how should he realise his task Dummy variable (=1 if yes)
REPETITION	The employee almost never or never realises different tasks Dummy variable (=1 if almost never or never)
CONSEC	The employee's mistake can provoke direct dangerous consequences for his or others' security

	Dummy variable (=1 if yes)
CONFIR	The employee's mistake can provoke negative consequences for firm (*e.g.* financial consequences, negative image, loss of clients) Dummy variable (=1 if yes)
UNCLEAR	The employee has not been clearly explained what he must do in his job Dummy variable (=1 if yes)
HELCHEF	The employee will be helped by his superior if he is overloaded with work Dummy variable (=1 if yes)
HELPCOL	The employee will be helped by his colleagues if he is overloaded with work Dummy variable (=1 if yes)
FAMILIAR	The employee uses the familiar "tu" when speaking to his superior Dummy variable (=1 if yes)
WAGE	Net Hourly Wage (Continuous variable)
ACTIVITY (for space reasons, we do not report sample statistics for these variables)	The main activity of the firm: 9 industry dummy variables (consumption goods, intermediate goods and energy, equipment goods, trade, construction, financial and real-estate activities, agro-alimentary industry, services for firms and media, transport respectively)

The sectors are considered according to the French nomenclature.
Source: Survey COI 2006 merges to the DADS.

The measures of employee attitudes

Well-being at work and job involvement are usually defined as employees attitudes towards or evaluations of a specific object- the job. In the previous literature, these concepts have been measured using single indicators and/or multiple items scale. Since the survey we use was not originally designed to study in detail these dimensions, we will focus on distinct binary indicators of worker well-being and job involvement. Several rationales may support our choice.

Warr (2007) defines well-being at work as people's feelings about themselves in relation to their job. He argues that well-being at work can be assessed in a two dimensions framework where the first dimension captures the feelings of pleasure at work and the second the feelings of arousal. Therefore, well-being can be seen and measured as a composite construct. However, most of the studies have chosen to synthesise well-being at work with a single job satisfaction indicator usually constructed from the answer to the following question: "All in all, how satisfied would you say you are with your job?". We follow this measurement strategy and propose two indicators of global and partial well being at work.

According to Locke (1976), job satisfaction is a self-reported state of mind resulting from the appraisal of one's job. Most importantly, it reflects a comparison between the amounts of rewards employees receive and the amount they believe they should receive (Robbins, 1997). Therefore, our first binary dependent variable *RECOGNITION* captures such a comparison as it takes the value 1 if the employee thinks his work is fairly valued when he makes a balance of what he brings to the company and the benefits he gets back. Our second binary variable *USEFUL* is intended to measure one other aspect of well-being at work, that is the sense of usefulness of the worker's job. This binary variable takes the value 1 if the employee thinks that his work is useful for others.

Job involvement, originally defined by Lodahl and Kejner (1965) as the "degree to which a person is psychologically identified with his work", has frequently been measured on a constructed scale from a list of items (six in the original scale by Lodahl and Kejner). As we cannot construct a classic job involvement scale, we have chosen to capture two psychological and behavioural dimensions of job involvement using two binary variables *IMPLICATION* and *COMPENSATION* that are equal to 1 if the employee states he is heavily involved a lot in his job and if the employee is compensated for supplementary work hours, respectively. Accepting compensation-free supplementary hours can be seen as a kind of labour donation, a conduct that we interpret as a strong sign of job involvement. As we have noticed in the above section, environmental or ethical standardisation may help firms to screen pro-socially motivated workers ready to donate labour. Besides, the large investment costs associated with the implementation of such standards act as a commitment on the part of the firm not to divert the employee donations of effort towards increasing its profits at the expense of social objectives. Therefore, certification acts as a signal of credible commitment and helps to screen and motivate pro-socially motivated workers.

The measure of environmental standards

To understand whether environmental standards impact on employee well-being and job involvement *ceteris paribus*, we use the variable denoted *ES*, which is a binary variable equal to 1 if the firm was registered according to one of the following standards, *i.e.*, ISO

14001 standard, organic labelling or fair trade, etc in 2006. Unfortunately, we cannot distinguish between these three standards, since they were put together under the same question in the survey.

3.2 Descriptive Statistics

Table 8.2 provides us comparative analysis between firm that have adopted environmental standards in 2003 and 2006. Generally, we may conclude that there is no significant difference between those two types of adopters. Concerning firm size, we notice that the highest percentages of large firms are also Environmental Adopters (around 35%).

Moreover, the results indicate that the percentage of Environmental Adopters in large firms decrease by 2% in three years. As expected high percentage of Environmental Adopters implement also quality standards. What more, Environmental Adopters continue to adopt quality standards since the percentage of quality standards adoption increases by 2% in three years. In same sense, adoption of just in time and team practices is also present among Environmental Adopters. Around 60% of Environmental Adopters consider standardisation of processes and working methods as important strategic orientation. Once again, we may confirm that firm export orientation is significant driver of environmental standards adoption.

Table 8.2: Descriptive Statistics

	ENVIRONMENTAL STANDARDS in 2003	ENVIRONMENTAL STANDARDS in 2006
	Company's Size	
SMALL	30% (a)	30%
SMEDIUM	20%	20%
MEDIUM	13%	15%
BIG	37%	35%
	Previous experience	
QS	85%	87%
JIT	48%	47%
TEAM	63%	63%
STAND1	18%	17%
STAND2	61%	60%
STAND3	19%	21%
SRAND4	2%	2%
	Mean export by firm's turnover	
EXPORT	0.20	0.19
	Worker's characteristics	
MAN	65%	66%
AGE	41	41
EDU1	13%	13%
EDU2	17%	17%
EDU3	44%	43%
EDU4	16%	17%
EDU5	10%	10%
OCC1	9%	10%
OCC2	23%	23%
OCC3	21%	20%
OCC4	47%	47%
ASSOC_1	9%	9%
NOASSOC	34%	33%
ASSOC_2	57%	58%
Total	**12%**	**16%**

Source Survey COI-TIC 2006-INSEE-CEE/Treatments CEE, sample 11 600 firms, weighted by the number of employees.
Lecture: (a) 30% of "Environmental Adopters in 2003" are firms that belong to category of small firms.

Concerning employee's characteristics, we can see that majority of employees, in environmental firms are men (around 66%). Furthermore, average age of workers employed in environmentally oriented firms is 41. When we look at employee's education and occupation, we may conclude that around 43% of employees (majority) that work in 'green' firm have secondary degree while the majority of those employees are blue collar workers. Finally, 9% of 'green' workers participate in sport, culture or social association.

3.3 Estimation strategy

Since, the same unobservable factors may impact, on one hand on the likelihood of employees working in an environmental registered firm and on the other hand on employee well-being and job involvement, we apply a bivariate probit model in order to correct for endogeneity (Greene, 2003). As is explained in **chapter 5**, the model relies on a simultaneous estimation approach in which the factors that determine the probability of working in a firm which uses an environmental standard are estimated simultaneously with the factors that explain the probability that the employee declares a high level of well-being and job involvement.

We denote Y_1 our observed binary variable corresponding to the fact that the worker is employed in a firm using an environmental standard while Y_{2k} corresponds to employee well-being (*USEFU*L and *RECOGNITION)* and job involvement (*IMPLICATION* and *COMPENSATION)*. They are defined as follows:

$$\begin{aligned} Y_1 &= 1 \quad if \quad Y_1^* > 0, \\ Y_1 &= 0 \quad otherwise. \end{aligned} \qquad (1)$$

$$\begin{aligned} Y_{2k} &= 1 \quad if \quad Y_{2k}^* > 0, \\ Y_{2k} &= 0 \quad otherwise. \end{aligned} \qquad (2)$$

Y_1^* and Y_{2k}^* are latent variables measuring the unobserved gains for the employee working for a firm which uses an environmental standard and the unobserved levels of employee's well-being and job involvement, respectively, where *k* distinguishes between *USEFU*L, *RECOGNITION*, *IMPLICATION* and *COMPENSATION.* We consider the following bivariate probit model:

$$\begin{cases} Y_1^* = \alpha_1 + \beta_1 X_1 + \delta Z_1 + \mu_1 \\ Y_{2k}^* = \alpha_2 + \beta_2 X_2 + \gamma Y_1 + \mu_2 \end{cases} \qquad (3)$$

where X_1 is a vector of exogenous variables including:

- firm characteristics: registration for quality standard like ISO 9000 (*QUALITY*), use of just-in-time production methods (*JIT*), autonomous work groups (*TEAM*), degree of standardisation of processes or working methods (*STAND1-STAND4)*, dummies for the size (*SMALL*, *SMEDIUM*, *MEDIUM* and *LARGE*) and industry of the firm;
- socio-demographic characteristics: gender (*SEX*), age and age squared (*AGE* and *AGESQ*), level of education (*EDU1-EDU5)*, occupations (*OCC1-OCC4)*.

As we can see in **chapter 7**, these sets of variables are usually used in the literature as the determinants of environmental standards adoption (Grolleau *et al.*, 2007) and individuals' attitudes towards environmental issues (Torgler and Garcia-Valinas, 2007).

The vector of variables Z_1 represents the set of instrumental variables which usually guarantees the identification of the model and helps to estimate correlation coefficients (Maddala, 1983). There are two main requirements for Z_1 being an instrumental variable:

1) The instrument must be correlated with the endogenous explanatory variable Y_1, conditional on the other covariates.
2) The instrument should not be correlated with the error term μ_2 in the equation explaining Y_{2k}.

Note that the above requirements for our set of instrumental variables being valid are purely statistical. Therefore, it does not matter whether the instrumental variables reflect decisions at firm or individual level.

In relation to our model, we require an instrumental variable that will explain the probability of working for a firm with registered environmental standards but not correlated to the employee's well-being and job involvement. Although Wilde (2000) states that in recursive bivariate probit models it is sufficient that each equation includes one varying exogenous regressor to achieve identification, our model includes three variables that can play the role of instruments. In the worker choice equation we included two dummy variables intended to measure to what extent the workers have chosen to put a lot of themselves into the firm's social life. The first dummy *ASSOC1* measures if the worker joined a sport, cultural or social association within the firm, the second *NOASSOC* identifies that the worker does not join such an association and the reference group consists of workers employed in firms without any such association. If the worker chooses to take part in the activity of an association within the firm, we assume that this behaviour can be seen as an indication of his taste for social interactions. The third instrumental variable measures the share of firm's exports in its turnover (*EXPORT*). In fact, a firm's environmental performance is frequently unobservable, especially to customers located in areas which are institutionally, geographically and culturally different. From a signalling perspective, firms that have distant customers are more likely to prove their environmental commitment through institutional devices like environmentally standards (Spence, 1973). Therefore, this type of certification may prove the ability of the supplier to satisfy environmental expectations of customers and make public unobservable attributes (Grolleau *et al.,* 2007). Even if it is not a proper test for instrumental variable validity, it is worth noting that none of our proposed instrumental variables appears to be a significant determinant of employee's well-being and job involvement in a single equation probit model.

In order to identify the proper effects of working in environmentally firms on employee's well-being and job involvement, our econometric model includes a robust set of firm, individual and job-specific controls. Hence, X_2 includes:

- firm' characteristics: the variables are identical to the ones included in the choice equation.
- workers' socio-demographic characteristics: we further control for marital status (*SINGLE*) and seniority of the worker (*SEN1-SEN4).*
- job characteristics: part-time job (*PARTIME*), intensity of supervision (*CONTROL1-CONTROL5*), self-determination of working times (*HD1-HD3*), latitude to deal with incidents (*INCIDENT*), to interrupt the work at will (*INTERRUP*), skill utilisation (*QUALIFICATION1*) lack of required skills (*QUALIFICATION2*), workload (*STRESS*), normative demands in terms of targets (*OBJECTIVE*), precise instructions for task compliance (*HOW*), task variety (*REPETITION*), safety consequences of worker mistakes (*CONSEC*), other consequences of worker mistakes (*CONNEG*), negative consequences for the firm of worker mistakes (*CONFIR*), information about

required behaviour (*UNCLEAR*), net hourly wage (*WAGE*), help from colleagues and supervisor in case of overload (*HELPCOL* and *HELPCHEF*).

The logic for the choice of this set of variables is based on the previous literature on well being at work. More precisely, the choice of workers' socio-demographic characteristics followed from Frey and Stutzer's (2002) work on employee happiness and well-being. Concerning job characteristics, one can presume that jobs differ in the level to which they are characterised by each feature and that those variations explain the differences in observed well-being. Therefore, Warr (1999) classified those job features in ten categories. Within our dataset, we found control variables for eight of these categories (the classification is detailed in the results section).

β_1, β_2, γ and δ are slope coefficients while α_1, α_2, μ_1 and μ_2 are the intercepts and the disturbance terms for the two equations, respectively. This set of coefficients is estimated using Maximum Likelihood method.

Residuals of these two equations follow a normal bivariate law with zero means and a covariance matrix that can be written, after normalisations to 1 of the diagonal elements, as follows:

$$\begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} \rightarrow N(0, \Sigma), \text{ where } \Sigma = \begin{pmatrix} 1 & \rho_{12} \\ \rho_{12} & 1 \end{pmatrix}$$

As we explain previously (see **chapter 5** and **7**), in estimating the interrelationship, a bivariate probit model produces an estimation of *'rho'*, the correlation coefficient between the disturbance terms.

When *rho* is statistically different from zero, there is a probability that a set of common unobserved factors influences environmental standards and employee well-being and job involvement, in other words, this means that the variable environmental standards is endogenous. We test the significance of *rho* with a Wald chi-square statistic.

4. Results and discussion

Bivariate probit estimation results are presented in Tables 8.3, 8.4, 8.5 and 8.6 together with goodness-of-fit measures.

Workers choice equation

In the models of employee well-being and compensation for supplementary working hours, *rho* is significantly different from 0. As indicated previously, we may conclude that the variable of environmental standards is endogenous and it confirms the interest in using the bivariate probit model. On the contrary, the insignificant *rho* of the employee's involvement model indicates that the environmental standards variable is not endogenous. Therefore, a simple univariate probit model, with *rho* being constrained to equal 0, would give unbiased results. However, the implementation of the bivariate probit model was nevertheless necessary to check for the exogeneity of this variable.

We first present the estimation results regarding the factors that may impact on the fact that the worker is employed in a firm that adopted environmental standards. Generally, the results are similar for all the four models.

Among firm characteristics, the use of quality standards, just-in-time production and autonomous work teams or groups have a positive and significant impact on the adoption of environmentally standards. As it is explained previously experiences with similar processes and standards helped the organisations to incur lower additional costs because of "learning-by-doing" (*e.g.* through the overlap of documentation) and scale economies (Grolleau *et al.*, 2007). Not surprisingly, if standardisation of production processes and working methods is not a strategically important issue for a firm, this impacts negatively on the likelihood of implementation of environmentally standards. Once again we confirm that the firm's size mainly influences its likelihood, in terms of financial resources, of adopting environmental practices (*e.g.* Grolleau *et al.*, 2007). We can note that all firm size indicators are negative and significant for the four models. This implies that the larger the firm the more likely it is to adopt environmental standards. We have also controlled for nine sectors of activities and we defined as a reference the sector of trade. As in the literature, we find that the probability of adopting environmental practices is stronger in some industries, notably the sectors of equipment and intermediate goods and energy.

In term of worker socio-demographic characteristics, we notice that female workers have a greater preference towards working for environmentally certified firms. In fact, our results confirm previous findings showing that women have greater environmental concerns than men (*e.g.* Torgler and Garcia-Valinas, 2007). Moreover, while Nord *et al.,* (1998) show a strong relationship between age and environmental concern, our findings indicate no impact of age on an employee's choice to work for "green" firms. Contrary to our expectation that a higher degree of education leads to higher environmental preferences, since well informed individuals are more aware of environmental problems, the level of education appears to have no effect on the likelihood of an individual working for an environmentally certified firm. Finally, white collar employees are more likely to work for firms that have adopted environmental standards than blue collar ones. The other occupational categories have no effect on the probability of working for environmental certified firms.

Finally, we can notice that our instrumental variables have the expected effect. When employees choose not to join a sport, cultural or social association existing in the firm, they are also less likely to work for a firm which adopted an environmental standard. The reluctance to engage in social activity within the firm is interpreted as a proxy of lower pro-social motivation. Second, as anticipated, the higher the level of firm exports the more likely it is to implement environmental.

Well-being and job involvement equations

The main goal of our study is to assess the effect of environmental standards on employee attitudes. The next four equations give contrasted results.

The estimated effects of environmental standards on employee well-being and job involvement are reported in Tables 8.3, 8.4, 8.5 and 8.6. The outcomes are similar when we look at the effect of environmental standards on employee feelings of usefulness in their job and employee feelings of being fairly valued. More precisely, we find that environmental standards impact positively on employee well-being. In fact, employees will often try to work in a firm with whom they can identify regarding environmental and social issues. Hence, this strong identification is often translated into satisfied employees. From this perspective, we can argue that environmental standards improve intrinsic employee motivation, co-workers' behaviour and working conditions.

Furthermore, the argument that environmental standards improve job involvement is supported only partially, since the evidence indicates that environmental standards have no impact on employee implication. On the other hand, the negative impact on compensation indicates that employee willingness to donate some supplementary effort is related to their environmental concerns. This finding can be interpreted as a form of labour donation in terms of supplementary work effort.

Additionally, in order to measure the qualitative importance of the implementation of environmental standards, we report its marginal and average treatment effects (Table 8.7). In our case the average treatment effect is the average difference between the probability that an employee will report positive well-being and job involvement if he works in an environmentally registered firm and if he works in a non environmentally registered firm. Hence, the average treatment effect equals:

$$\frac{1}{N}\sum_{i=1}^{N}\left[\Phi(\alpha_2 + X_{2i}\beta_2 + \gamma) - \Phi(\alpha_2 + X_{2i}\beta_2)\right] \tag{4}$$

The findings indicate that workers employed in an environmentally certified firm have a respectively eight and twelve percentage points higher probability of feeling useful and being fairly treated in their jobs than workers employed in a non environmentally certified firm. Furthermore, while the use of environmental standards does not have any influence on employee's job involvement, it appears to decrease by seventeen percentage points the likelihood that employees obtain compensation for supplementary working hours. Once again, one should consider that these findings are obtained while controlling for an extensive set of variables describing the organisational choices within the firm, the individual characteristics and a large set of job variables controlling for job content, the extent of autonomy and discretion given to the employee, his opportunity to use his skills, the variety of the tasks, his physical security and pay.

In addition, our analysis also demonstrated the effects of other characteristics that determine employee well-being and job involvement (Tables 8.3, 8.4, 8.5 and 8.6). First, in terms of firm characteristics, the utilisation of quality standards, just-in-time and autonomous work teams or groups generally has a negative influence on employee well-being and job involvement. This could be explained by the fact that the adoption of these practices is known to lead to work intensification (*e.g.* Delbridge *et al.*, 1992; Askenazy and Caroli, 2010) but without any additional "award" that would compensate for it. Interestingly, the results reveal that standardisation is the only factor that has an impact on employee's involvement. More precisely, if standardisation does not represent an important strategic issue for a firm, this will improve employee involvement. Furthermore, employees experience higher job satisfaction in smaller firms (Clark, 1997). Moreover, the differences between structural characteristics of the work environment are probably the source of cross-sector variations concerning the impact on employee well-being and job involvement.

Concerning socio-demographic characteristics, we first notice that being a woman decreases employee's well-being, which is contrary to Clark's (1997) argument that women have lower expectations about labour market outcomes and so they are more easily satisfied. On the other hand, our results indicate that women are more involved in their jobs and that they are ready to work supplementary hours without additional compensation. These findings could be explained by the fact that there has been a significant increase in the labour force participation of women and that they now obtain better conditions, better workplace and promotion opportunities. In contrast to the U-shaped relationship between age and employee job satisfaction found in previous studies, our results suggest that age has no effect on employee well-being. Age is found as a factor that impacts positively on employee implication but has no effect on compensation for supplementary working hours. Marital status has no significant impact on employee well-being nor on job involvement. Usually we find in the literature that higher level of education is associated negatively with job satisfaction (Clark, 1997) or has no effect on job involvement (Sekaran and Mowday, 1981). However, we obtain different results. First, our results show that the worker's feeling of job usefulness and especially of being fairly valued seems to increase with his level of education. Second, the likelihood of being compensated for overtime hours decreases with educational levels. The results indicate also that seniority has a significant influence only on two dependent variables, namely the employee's feeling of being fairly valued and employee involvement. Not surprisingly, in terms of employee occupation, being in a higher level of occupational group is found to be positively and significantly associated with employee well-being. Similar evidence is found for employee involvement at work. In France, white collar workers are customarily seen as being paid for a task and not for a specific duration of work. It is therefore not surprising to find out that employees in a higher occupational category are less likely to receive compensation for additional work.

Having a part-time job appears to have a positive impact on an employee's feeling that his work is fairly valued, while it seems to have no impact on employee usefulness and compensation for supplementary working hours. On the other hand, having a part time job seems to decrease employee invovlement with work, probably because those employees tend to have lower pay (Rothstein, 1996), fewer benefits (Belous, 1989), if any, and engage in fewer organisational citizenship behaviors (Stamper and Van Dyne, 2001).

We now turn to the effects of variables that measure job characteristics. Following Warr (1999), we will review these effects along the following eight key features of the job.

Opportunity for personal control

Being controlled constantly or at least once a day has a negative impact on employees well-being and employee involvement, as it is known that employees value autonomy and prefer to organise their work alone. If an employee cannot organise his own working time, this decreases his feeling that his work is fairly valued, together with his job involvement. On the contrary, it has a positive impact on his compensation for supplementary working hours. Also in line with the view that employee discretion is positively related to job satisfaction, we found that the employees who are given the opportunity to deal with incidents alone more often perceive their job as useful and are actively involved in their job. Finally, the employee's well-being is found to decrease when he is not allowed to interrupt his work at will.

Opportunity for skill use

When an employee reports that he does not use all his skills in his job, our findings indicate that he is less likely to feel fairly valued. In addition, having specific qualifications that are not utilised also decreases employee involvement. Those results are supported by

Johnson and Johnson (2000) suggesting that perceived over-qualification has a negative effect on job satisfaction.

Externally generated goals

Furthermore, if the employee feels overloaded at least once a month or more frequently, he is found to be more likely to report that his job is useful to others and that he is very involved. In fact, this result may be explained by the idea that when workers are given power and responsibility in the job, it may be difficult to cope with but it is also intrinsically rewarding. Moreover, our results also show that these workers usually consider themselves as unfairly treated when they tally what they bring to the firm and the benefits they receive in exchange. Furthermore, if an employee is given a precise objective to achieve, our results show that it decreases his feeling that his job is fairly valued, while it improves his level of involvement. However, receiving precise instructions for the execution of a task has a negative impact on employee usefulness and employee implication. This surprising result could be explained by the fact that employees prefer to organise their work on their own rather to receive restrictive instructions.

Variety

It has been frequently observed in the job satisfaction literature that when jobs are challenging in nature, workers feel happier at work. In the same vein, our results show that the employee's obligation to repeat always the same actions or operations will drive him to feel useless and not fairly valued.

Environmental clarity

An employee's feeling that his mistake can provoke direct dangerous consequences for his own security or that of others, has a positive and significant impact only on job usefulness and compensation for supplementary working hours. Similar results (for models of employee usefulness, job involvement and compensation for supplementary working hours) are obtained for the effect of the variable representing an employee's feeling that his mistake can provoke other direct negative consequences (*e.g.* sanction, loss of wage, dismissal) on himself. Furthermore, an employee's feeling that his mistake can provoke direct negative consequences, such as loss of performance bonus, jobs shed, consequences on colleagues' work quality, on the client, on other employees, plays negatively only on recognition. Finally, we remark on the positive effect of the employee's feeling that his mistake can provoke negative consequences for firm (*e.g.* financial consequences, negative image, loss of clients) on usefulness and job involvement. Our results also suggest that a lack of supportive supervision may appear as a negative trait in the job. So, when employees are not given clear instructions about what must be done in their jobs, it has a negative impact on employee well-being and job involvement.

Supportive supervision

Being helped by superiors or colleagues will improve employee well-being and job involvement.

Opportunity for interpersonal contact

Similarly, having a close relationship with his supervisor improves an employee's usefulness and job involvement.

Availability of money

Finally, we confirm the expected results that wage level is positively associated with employee well-being and his involvement in his job.

Table 8.3: Bivariate probit estimates of the effect of environmental standards on employee's job usefulness

		ES		USEFUL	
Variables		Estimate	z-value	Estimate	z-value
Intercept		-1.28***	-5.39	0.52*	1.75
ES		-	-	0.59**	2.29
QS		1.09***	27.46	-0.09	-0.94
JIT		0.30***	9.55	-0.01	-0.32
TEAM		0.26***	8.25	-0.10**	-2.51
STAND	STAND1	-0.05	-1.36	-0.02	-0.46
	STAND3	-0.09*	-1.94	0.03	0.56
	STAND4	-0.34***	-2.63	-0.10	-0.86
SIZE	SMALL	-0.64***	-13.19	0.06	0.86
	SMEDIUM	-0.66***	-15.01	0.17**	2.40
	MEDIUM	-0.42***	-10.37	0.10	1.59
EXPORT		0.44***	6.71	-	-
SEXE		0.06*	1.69	-0.11***	-2.59
AGE		-0.01	-0.61	0.01	1.13
AGESQ		0.001	0.77	-0.001	-0.68
SINGLE		-	-	-0.03	-0.82
EDUCATION	EDU1	-0.04	-0.86	-0.14***	-2.74
	EDU3	-0.06	-1.37	0.01	0.30
	EDU4	-0.03	-0.71	0.12**	2.08
	EDU5	-0.01	-0.04	0.07	0.95
SENIORITY	SEN2	-	-	-0.02	-0.28
	SEN3	-	-	-0.06	-1.13
	SEN4	-	-	-0.06	-1.45
OCCUPATION	OCC1	-0.05	-0.87	0.13	1.50
	OCC2	0.02	0.52	0.18***	3.33
	OCC3	0.22***	4.35	0.10*	1.83
ASSOC	ASSOC_1	0.12**	2.54	-	-
	NOASSOC	-0.17***	-4.94	-	-
PARTIME		-	-	0.01	0.22
CONTROL	CONTROL1	-	-	-0.07*	-1.68
	CONTROL2	-	-	-0.10**	-2.04

	CONTROL3	-	-	0.001	0.06
	CONTROL4	-	-	0.05	0.74
HDETER	HD1	-	-	-0.04	-0.60
	HD2	-	-	-0.03	-0.48
INCIDENT		-		0.07***	2.24
INTERRUP		-		-0.10***	-2.37
QUALIFICATION1		-	-	0.10***	2.84
QUALIFICATION2		-	-	-0.05	-1.40
STRESS		-	-	0.14***	4.23
OBJECTIVE		-	-	0.02	0.62
HOW		-	-	-0.22***	-5.19
REPETITION		-	-	-0.19***	-5.19
CONSEC		-	-	0.07*	1.83
CONNEG		-	-	-0.01	-0.20
CONFIR		-	-	0.11***	2.71
UNCLEAR		-	-	-0.11***	-3.07
HELPCHEF		-	-	0.12***	3.48
HELPCOL		-	-	0.08**	2.09
FAMILIAR		-	-	0.08***	2.34
WAGE		-	-	0.01***	3.02
CONSUMPTION GOODS		-0.09	-1.34	-0.03	-0.41
INTERMEDIATE GOODS AND ENERGY		0.37***	7.16	-0.19***	-2.85
EQUIPMENT GOODS		0.18***	3.17	-0.14*	-1.88
CONSTRUCTION		0.14**	2.16	0.30***	3.35
FINANCIAL AND REAL-ESTATE ACTIVITIES		-0.13	-1.39	0.15	1.49
AGRO-ALIMENTARY INDUSTRY		0.03	0.42	-0.19***	-2.78
SERVICES FOR FIRMS AND MEDIA		-0.44***	-7.54	0.17***	2.64
TRANSPORT		-0.36***	-4.88	0.23***	3.10

Likelihood ratio	-8389.22
WaldChi2(36)	3259.28***
Rho	-0.37**
Wald test of rho=0 Chi2(1)	4.64**
Number of observations	11 600
Number of workers in registered firms	3 304

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.
Sector reference: TRADE.

Table 8.4: Bivariate probit estimates of the effect of environmental standards on employee's feeling that his work is fairly valued

		ES		RECOGNITION	
Variables		Estimate	z-value	Estimate	z-value
Intercept		-1.26***	-5.30	-0.25	-1.11
ES		-	-	0.30**	2.27
QS		1.09***	27.42	-0.06	-1.48
JIT		0.29***	9.40	-0.05*	-1.67
TEAM		0.26***	8.26	-0.02	-0.74
STAND	STAND2	-0.05	-1.33	0.01	0.11
	STAND3	-0.09*	-1.90	-0.04	-1.06
	STAND4	-0.33***	-2.57	-0.03	-0.38
SIZE	SMALL	-0.64***	-13.05	0.14***	3.13
	SMEDIUM	-0.66***	-14.78	0.04	0.97
	MEDIUM	-0.43***	-10.49	-0.01	-0.09
EXPORT		0.45***	6.93	-	-
SEXE		0.06*	1.64	-0.20***	-6.46
AGE		-0.007	-0.64	0.01	1.21
AGESQ		0.001	0.80	-0.0001	-0.84
SINGLE		-	-	-0.03	-1.14
EDUCATION	EDU1	-0.03	-0.70	-0.01	-0.12
	EDU3	-0.06	-1.44	-0.04	-1.24
	EDU4	-0.04	-0.76	0.08**	2.09
	EDU5	-0.01	-0.09	0.07	1.32
SENIORITY	SEN2	-	-	0.27***	5.72
	SEN3	-	-	0.22***	5.09
	SEN4	-	-	0.06*	1.93
OCCUPATION	OCC1	-0.06	-0.94	0.44***	7.89
	OCC2	0.02	0.52	0.20***	5.15
	OCC3	0.21***	4.23	-0.00	-0.03
ASSOC	ASSOC_1	0.12**	2.45	-	-
	NOASSOC	-0.17***	-4.99	-	-
CONTROL	CONTROL1	-	-	-0.14***	-4.03
	CONTROL2	-	-	-0.03	-0.68
	CONTROL3	-	-	-0.04	-0.99

	CONTROL4	-	-	-0.04	-0.80
HDETER	HD1	-	-	-0.21***	-4.94
	HD2	-	-	-0.13***	-3.08
PARTIME		-	-	0.04	0.83
CONSEC		-	-	-0.03	-1.04
CONNEG		-	-	-0.13	-4.58
CONFIR		-	-	-0.01	-0.04
UNCLEAR		-	-	-0.23***	-8.50
REPETITION		-	-	0.01	0.47
OBJECTIVE		-	-	-0.07***	-2.59
HOW		-	-	0.06*	1.77
STRESS		-	-	-0.18***	-7.08
FAMILIAR		-	-	0.04	1.38
INCIDENT		-	-	-0.03	-1.12
INTERRUP		-	-	-0.08**	-2.33
QUALIFICATION1		-	-	-0.07***	-2.87
QUALIFICATION2		-	-	-0.42***	-16.45
HELPCHEF		-	-	0.26***	9.99
HELPCOL		-	-	0.09***	2.91
WAGE		-	-	0.01***	4.01
CONSUMPTION GOODS		-0.10	-1.39	0.08	1.40
INTERMEDIATE GOODS AND ENERGY		0.36***	7.04	0.02	0.35
EQUIPMENT GOODS		0.18***	3.03	0.00	0.02
CONSTRUCTION		0.13**	1.97	0.12**	2.10
FINANCIAL AND REAL-ESTATE ACTIVITIES		-0.12	-1.36	0.08	1.02
AGRO-ALIMENTARY INDUSTRY		0.03	0.50	0.08	1.54
SERVICES FOR FIRMS AND MEDIA		-0.45***	-7.60	-0.02	-0.45
TRANSPORT		-0.36***	-4.92	0.22***	4.15
Likelihood ratio			-12273.11		
WaldChi2(85)			3748.88***		
Rho			-0.14*		
Wald test of rho=0 Chi2(1)			3.14*		
Number of observations			11 601		
Number of workers in registered firms			3 304		

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.
Sector reference: TRADE.

Table 8.5: Bivariate probit estimates of the effect of environmental standards on employee's job involvement

		ES		IMPLICATION	
Variables		Estimate	z-value	Estimate	z-value
Intercept		-1.35***	-5.41	-0.32	-1.37
ES		-	-	0.19	1.24
QS		1.11***	27.62	-0.09*	-1.77
JIT		0.29***	9.48	0.01	0.04
TEAM		0.26***	8.38	-0.01	-0.33
STAND	STAND2	-0.05	-1.34	0.02	0.43
	STAND3	-0.09*	-1.93	0.03	0.74
	STAND4	-0.33***	-2.59	0.18*	1.88
SIZE	SMALL	-0.64***	-13.00	0.06	1.17
	SMEDIUM	-0.66***	-14.96	0.08*	1.7
	MEDIUM	-0.43***	-10.49	0.03	0.73
EXPORT		0.44***	6.76	-	-
SEXE		0.06*	1.67	0.13***	3.98
AGE		-0.01	-0.69	0.02**	2.07
AGESQ		0.00	0.85	-0.0002	-1.54
SINGLE		-	-	-0.04	-1.35
EDUCATION	EDU1	-0.03	-0.67	0.01	0.30
	EDU3	-0.06	-1.44	0.05	1.31
	EDU4	-0.03	-0.70	0.07*	1.73
	EDU5	-0.01	-0.04	0.03	0.45
SENIORITY	SEN2	-	-	0.11**	2.28
	SEN3	-	-	0.16***	3.50
	SEN4	-	-	0.06*	1.71
OCCUPATION	OCC1	-0.06	-0.96	0.51***	8.35
	OCC2	0.02	0.51	0.32***	7.94
	OCC3	0.21***	4.19	0.16***	3.77
ASSOC	ASSOC_1	0.12***	2.50	-	-
	NOASSOC	-0.16***	-4.87	-	-
CONTROL	CONTROL1	-	-	-0.03	-0.80
	CONTROL2	-	-	-0.09***	-2.22
	CONTROL3	-	-	-0.02	-0.37

	CONTROL4	-	-	-0.02	-0.43
HDETER	HD1	-	-	-0.29***	-6.05
	HD2	-	-	-0.21***	-4.07
PARTIME		-	-	-0.33***	-6.81
CONSEC		-	-	0.01	0.36
CONNEG				0.03	1.15
CONFIR				0.07**	2.37
UNCLEAR				-0.04*	-1.27
REPETITION				-0.22***	-7.38
OBJECTIVE				0.17***	6.22
HOW				-0.21***	-6.69
STRESS				0.21***	7.98
FAMILIAR				0.10***	3.71
INCIDENT				0.10***	3.89
INTERRUP				-0.05	-1.45
QUALIFICATION1				0.01	0.24
QUALIFICATION2				-0.15***	-5.61
HELPCHEF				0.15***	5.40
HELPCOL				0.01	0.22
WAGE				0.003*	1.84
CONSUMPTION GOODS		-0.10	-1.38	0.00	0.09
INTERMEDIATE GOODS AND ENERGY		0.36***	7.09	-0.01	-0.23
EQUIPMENT GOODS		0.18***	3.12	-0.03	-0.58
CONSTRUCTION		0.13**	2.08	0.12***	2.00
FINANCIAL AND REAL-ESTATE ACTIVITIES		-0.12	-1.34	-0.09	-1.31
AGRO-ALIMENTARY INDUSTRY		0.03	0.45	0.04	0.78
SERVICES FOR FIRMS AND MEDIA		-0.44***	-7.57	-0.05	-1.16
TRANSPORT		-0.36***	-4.89	0.11*	1.96
Likelihood ratio			-11579.20		
WaldChi2(36)			3701.22***		
Rho			-0.11		
Wald test of rho=0 Chi2(1)			1.40		
Number of observations			11 600		
Number of workers in registered firms			3 304		

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.
Sector reference: TRADE.

Table 8.6: Bivariate probit estimates of the effect of environmental standards on whether individuals are compensated for supplementary working hours

		ES		COMPENSATION	
Variables		Estimate	z-value	Estimate	z-value
Intercept		-1.27***	-5.36	-0.04	-0.19
ES		-	-	-0.43***	-3.00
QS		1.09***	27.45	0.03	0.64
JIT		0.29***	9.41	0.11***	3.69
TEAM		0.25***	8.20	-0.01	-0.53
STAND	STAND2	-0.04	-1.17	-0.03	-1.02
	STAND3	-0.09*	-1.91	-0.06	-1.54
	STAND4	-0.34***	-2.64	0.02	0.22
SIZE	SMALL	-0.65***	-13.19	-0.04	-0.98
	SMEDIUM	-0.67***	-15.12	-0.06	-1.28
	MEDIUM	-0.43***	-10.61	-0.02	-0.52
EXPORT		0.44***	6.75	-	-
SEXE		0.06*	1.65	-0.08***	-2.51
AGE		-0.01	-0.63	0.01	0.67
AGESQ		0.0001	0.78	-0.0002	-1.36
SINGLE		-	-	-0.02	-0.72
EDUCATION	EDU1	-0.03	-0.67	-0.11***	-2.74
	EDU3	-0.06	-1.41	-0.03	-0.74
	EDU4	-0.03	-0.59	-0.07*	-1.88
	EDU5	-0.002	-0.04	-0.16***	-3.08
SENIORITY	SEN2	-	-	-0.06	-1.35
	SEN3	-	-	-0.04	-0.92
	SEN4	-	-	-0.01	-0.17
OCCUPATION	OCC1	-0.05	-0.88	-0.56***	-10.13
	OCC2	0.02	0.45	-0.16***	-4.45
	OCC3	0.21***	4.27	-0.05***	-1.16
ASSOC	ASSOC_1	0.11***	2.20	-	-
	NOASSOC	-0.16***	-4.87	-	-
CONTROL	CONTROL1	-	-	0.03	0.82
	CONTROL2	-	-	0.01	0.39
	CONTROL3	-	-	-0.01	-0.26

	CONTROL4	-	-	-0.01	-0.30
HDETER	HD1	-	-	0.15***	3.64
	HD2	-	-	0.29***	6.54
PARTIME		-	-	0.05	1.11
CONSEC		-	-	0.11***	3.92
CONNEG		-	-	-0.004	-0.14
CONFIR		-	-	0.06**	2.03
UNCLEAR		-	-	-0.11***	-4.30
REPETITION		-	-	-0.12***	-4.22
OBJECTIVE		-	-	-0.002	-0.10
HOW		-	-	-0.12***	-3.83
STRESS		-	-	0.08***	3.18
FAMILIAR		-	-	-0.02	-0.79
INCIDENT		-	-	0.07***	2.72
INTERRUP		-	-	0.04	1.33
QUALIFICATION1		-	-	0.09***	3.67
QUALIFICATION2		-	-	-0.01	-0.42
HELPCHEF		-	-	0.10***	4.06
HELPCOL		-	-	0.16***	5.54
WAGE		-	-	0.02	1.47
CONSUMPTION GOODS		-0.10	-1.39	0.01	0.11
INTERMEDIATE GOODS AND ENERGY		0.37***	7.21	0.00	0.10
EQUIPMENT GOODS		0.19***	3.27	0.14***	2.69
CONSTRUCTION		0.13**	2.05	0.05	0.89
FINANCIAL AND REAL-ESTATE ACTIVITIES		-0.13	-1.39	-0.22	3.29
AGRO-ALIMENTARY INDUSTRY		0.03	0.54	0.12***	2.26
SERVICES FOR FIRMS AND MEDIA		-0.44***	-7.50	-0.09**	-2.04
TRANSPORT		-0.36***	-4.87	0.06	1.20
Likelihood ratio			-12582.56		
WaldChi2(36)			3436.59***		
Rho			0.25***		
Wald test of rho=0 Chi2(1)			7.54***		
Number of observations			11 600		
Number of workers in registered firms			3 304		

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.
Sector reference: TRADE.

Table 8.7: Marginal and average treatment effects of the variable *ES*

	Marginal Effect		**Average Treatment Effect**	
	Estimates	**z**	**Estimates**	**Z**
USEFUL	0.077**	2.45	0.081**	2.24
RECOGNITION	0.116**	2.27	0.107**	2.35
IMPLICATION	0.063	1.28	0.059	1.26
COMPENSATION	-0.173***	-3.07	-0.162***	-3.00

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively. The marginal effect is computed using the mfx command in Stata, the respective standard errors being evaluated with the delta method. The average treatment effect is computed using bootstrap with 500 simulations.

5. Conclusion

More and more private firms make considerable voluntary investments in environmentally standards. One of the rationales for its implementation is that firms may anticipate savings on production costs and more specifically on labour costs. However, the previous evidence about this assumption was rather indirect with some indication that firms may improve recruitment and motivation of the workforce.

In order to fill a gap in the literature, this chapter attempts to investigate the effect of environmental practices on two specific dimensions of human resource management. More precisely, using an employer-employee dataset representative of the French private firms with more than 20 employees, we created two dimensions of employee's well-being, measured by employee feelings of being useful for others and employee feelings that his job is fairly valued, and job involvement, measured by employee implication and the absence of compensation for supplementary work hours. The estimation results unambiguously show that environmental practices are associated with higher employee well-being. Hence, employees working for firms that are certified for an environmental standard are found to report greater feelings of usefulness about their job and declare that they are more often fairly valued in their jobs. However, findings relating to job involvement suggest that while employees do not claim to be significantly more involved in their job, "green workers" are more likely, *ceteris paribus*, to work uncompensated for supplementary work hours than "non green workers".

One implication of these results is that policy makers can emphasise the likelihood of private benefits in terms of workforce motivation. In fact, the market equilibrium might cancel out the costs of environmental standards adoption, since the employer's view holds that satisfying employee interests will result in an improvement of the firm's financial and economic performance (Freeman, 1984; Porter and Van Der Linde, 1995). Hence, we can argue that the costs of having environmental standards may be compensated by benefits regarding employee outcomes. Additionally, because employee well-being and job involvement is known to be related to a number of positive outcomes (improved labour productivity, reduced absenteeism, lower turnover rates, etc) the results confirm, once again, that environmental standards can be seen as a tool for achieving competitive advantage through raising employee dedication and loyalty, and thus increasing productivity.

However, our study is only a first step towards a complete assessment of the labour productivity gains of environmental standards. Future research should develop supplemental indicators in order to assess the effects of environmental practices on absenteeism, health and safety issues and quits. Such inquiry could shed new light on issues that might improve overall firm's business performance. In addition, it will be important to provide a direct empirical evidence of association of labor cost reductions with the implementation of environmental standards. Another research avenue would be to study if the benefits from standardisation beyond environmental performance may really last in the long run and help green firms to survive in competitive markets. Furthermore, firms may also integrate environmental standards in differing degrees. In fact, specific firms may just do the minimum in order to obtain the standard. For these firms, the adoption of the standard never goes beyond paperwork. In contrast, other firms may actively integrate standards into every aspect of their business, involving employees in the implementation of the standard (for comprehensive review see, Boiral, 2007). Hence, being able to distinguish firms according to the degree to which they have integrated environmental standards will allow us to understand how much the degree of integration influences both firm and employee outcomes.

General Conclusion

This PhD dissertation aims to contribute to both theoretical and empirical literature concerned with two leading management systems that have as their target zero defects or waste, namely Quality (*e.g.* ISO 9000 standards) and Environmental (*e.g.* ISO 14000 standards) Management approaches, respectively. A Quality Management (QM) approach represents a holistic management philosophy that aims at reaching higher quality values in order to meet the expectations of increasingly demanding customers. An Environmental Management (EM) approach consists of a number of interrelated elements that function together to help a firm implement an environmental policy for the purpose of reducing environmental impact and minimising the firm's effects on the natural environment (Delmas, 2002). In many ways, Quality and Environmental Management systems are conceptually similar (*e.g.* structure, cost/benefit strategy and customer-orientation). Moreover, Environmental Management is based on the same core principles of Quality Management (Florida and Davison, 2001; Corbett and Klassen, 2006). The systematic approach of Quality and Environmental Management emphasises the importance of understanding and managing the dynamics of all functions within a firm. Hence adoption of these approaches often induces organisational changes associated with modifications to the firm's culture, structure, work environment and processes. Consequently, their adoption matters to both firms and employees.

Quality and Environmental approaches have emerged as key organisational practices that help firms worldwide to achieve a competitive edge by both improving the firm's quality and environmental performance and raising its level of efficiency. As a result, they have been widely adopted around the world. The most popular of these approaches is the ISO 9000 Quality Management Systems standard, which had been adopted by more than 900, 000 organisations by the end of 2007, and the ISO 14000 Environmental Management Systems standard, which had more than 100 000 certifications worldwide by the end of 2007. Given that the empirical analysis of this PhD dissertation is based on French firms, it is important to mention that France is one of the leading European countries regarding the implementation of Quality and Environmental Management approaches. For instance, with 22 981 firms registered with ISO 9000 and 3 476 firms certified for ISO 14000 standards, French firms rank 5th (behind Italy, Spain, Germany and UK) and 6th (behind Italy, Spain, Germany, UK and Sweden) among European countries for the highest level of adoption of ISO 9000 and ISO14000 standards, respectively (The ISO Survey of Certifications, 2007).

The overall purpose of the present research is conceptualised into three main areas relating to quality and environmental approaches as follows: (1) the determinants of standards adoption, (2) the impact of standards on firm outcomes, and (3) the impact of standards on employee outcomes. These three areas represent the three main parts of this PhD thesis. The advantage of carrying out multi-aspect analysis of quality and environmental standards adoption is that it allows us to gain a deeper knowledge of the relevant economic activities within a firm that are associated with the implementation of quality and environmental standards. While each of the three parts of this PhD dissertation focuses on a different aspect of the analysis, we can draw patterns and make links between all three of them, thus contributing to a richer understanding of these management approaches.

Somewhat surprisingly, economic investigation into the determinants of adoption of the above approaches is, to the best of our knowledge, still lacking. The aim of this research is to provide an improved knowledge of the organisational behaviour of firms as it relates to quality and environmental standards adoption. Hence, in an attempt to bridge the gap in the literature, **Part I** of this PhD dissertation, discusses the factors which motivate firms to adopt quality and environmental approaches. Moreover, two chapters focus particularly on describing ISO 9000 and ISO 14000 standards since they are both considered as the most widespread management approaches for quality and environmental improvement, respectively.

Currently, there is no general scholarly agreement regarding the effects of quality and environmental approaches on firm performance. Some positive views have argued that quality and environmental approaches are fundamentally based on resource productivity which leads to improved firm performance (Terlaak and King, 2006; Porter and Van Der Linde, 1995). However, other findings have suggested that the implementation of these standards is far too costly, and as such, decreases the competitiveness of adopting firms (Konar and Cohen, 2001; Corbett *et al.*, 2005). The purpose of **Part II** of this PhD dissertation is to provide a clearer understanding of the relationship between the adoption of these approaches, and firm performance. Moreover, each of the four chapters in **Part II** of this thesis uses a different set of indicators of firm performance. This is important, since focusing on just a few outcomes could potentially yield misleading results as to the overall impact of quality and environmental approaches on firm performance.

It has been argued that changes resulting from the implementation of management practices, such as Quality and Environmental Management standards, are more directed towards improving firm performance rather than employee welfare (Appelbaum, 2002). The issue of how employees perceive these changes therefore remains particularly uncertain. Moreover, there is only a limited body of literature that analyses how quality and environmental approaches influence employee outcomes: even this has generally focused solely on the effect of quality approaches on employee welfare. In addition, empirical results reporting the effects of quality practices on employee outcomes have been somewhat conflicting, and the existing literature is thus far from in agreement (Levine and Toffel, 2009; Askenazy and Caroli, 2010). Some authors have argued that employers gain from quality practices at the expense of employees, while others maintain that both employer and employee are better off in a quality-oriented workplace. Hence, **Part III** (comprising two chapters) of this PhD dissertation attempts to contribute to the existing literature by examining the impact of Quality and Environmental Management approaches on employee outcomes. Importantly, the analysis covers a range of outcomes since these management practices may have different effects on different employee outcomes.

The overall findings of this PhD dissertation are derived through the application of various statistical and econometric tools to a number of French employer and employee databases. In each chapter, we have used the most appropriate econometric strategy that can best control for-identified biases (selection bias and endogeneity bias). Owing to the original databases used in this thesis, we are able to examine the impact of quality and environmental approaches on various indicators of firm and employee outcomes. This allows us to identify whether specific firm or employee performance measures are more likely to be influenced by these approaches. Moreover, management approaches may have differing impacts within different national frameworks. Indeed, the majority of empirical studies on the subject, to the best of our knowledge, only concern the experience in Anglo-Saxon countries. Hence, there is a great need for analyses to be conducted in the French institutional context as quality and environmental approaches may have different effects in France as compared to Anglo-Saxon countries.

The discussion below summarises the main findings and their policy implications. Finally, we also consider some of the limitations of this project, and suggest directions for future research based on our present results.

Main findings and policy implications

The aims of **chapter 1** are twofold. Firstly, we seek to understand which factors contribute to the adoption of quality standards. Secondly, this chapter aims to empirically identify the similarities and differences in the motivations for quality registration between the manufacturing and service sectors, and between Early and New Adopters (based on the year of certification).

Our findings suggest that firm characteristics, such as size, corporate status and previous experience with similar standards, positively influence the adoption of Quality Standards in both sectors. Moreover, indicators of external features as measured by export performance and customer satisfaction, also play a significant role in quality registration across both the manufacturing and service sectors. On the other hand, the determinants of quality adoption in the manufacturing and service sectors differ mainly when considering the features of a firm's internal strategy, such as the importance of quality improvement and cost reduction. More precisely, while quality improvement strategy plays a significant role in quality standards adoption in service firms, it is an insignificant determinant of quality standards implementation in manufacturing firms. On the other hand, cost reduction strategy impacts positively on a firm's likelihood of adopting quality standards in the manufacturing sector, but has no influence in the service sector. Furthermore, our findings indicate that motivations for the implementation of quality practices vary between Early and New Adopters, particularly when we examine export levels and cost reduction levels between these two categories of adopters. Generally, we find that these two characteristics are significant for Early Adopters, whilst they are insignificant for New Adopters. Therefore, our results confirm the previous assumptions that Early Adopters are motivated to adopt quality standards by the need to improve efficiency, which can also be achieved by increasing export and cost reduction levels.

The results of this chapter have significant implications for policymakers. By empirically analyzing the incentives for quality registration in both the manufacturing and service sectors, these results enable policymakers to more precisely target their policies according to the needs of each sector, rather than simply use a 'one-size-fits-all' approach. Additionally, this research suggests further areas of improvement in quality standards for both the manufacturing and service sectors. More specifically, our findings show that to increase the level of adoption of quality standards might be best achieved by focusing on quality improvement strategy in the service sector while focusing more on the associated opportunities for cost reduction in the manufacturing sector.

In **chapter 2**, our analysis of the determinants of the adoption of both ISO 14000 standards and the Responsible Care program by the French chemical firms suggests that although the goals of these two Environmental Management Systems (EMS~~s~~) are similar, the factors that influence their adoption are quite different. Indeed, empirical analysis demonstrates that features such as firm size and signaling unobservable attributes to distant customers are considerable factors behind ISO 14000 certification, while environmental factors play a more significant role in the Responsible Care program registration. The evidence suggests the strategy and business aims of a firm determine which EMS it adopts.

Based on the empirical evidence obtained, we conclude that a firm with a high turnover in foreign countries is more likely to implement the ISO 14000 standard than a firm with less international business. As a result, it may be necessary to increase the credibility of the Responsible Care program among international stakeholders in order to allow firms that are registered with it to signal unobservable characteristics to distant customers without having to incur additional costs by having to also invest in ISO 14000 certification. Furthermore, since–the larger firm size is an important factor behind a firm adopting ISO 14000 certification rather than Responsible Care program, it seems that it may be easier for smaller firms to adopt the Responsible Care program. Our results may help policymakers to adopt better tailored policies in order to promote a particular EMS.

Chapter 3 presents a detailed analysis of the relationship between quality and environmental management standards and firm performance. The obtained results support, to some extent, the predictions of the 'extended' Porter hypothesis (Porter and Van Der Linde, 1995) and make it possible to extend it to quality considerations. Moreover, we show that quality and environmental standards positively influence firm turnover, while having no impact on firm profits. These findings thus have important implications for managers, regulators and promoters. Indeed, the adoption of QMS and EMS may be considered to be a ‘win-win strategy’, not only because it is a powerful tool for quality and environmental improvement, but also because it can be a source of performance improvement.

Additionally, we provide evidence that quality and environmental standards are more likely to improve firm performance when implemented together than when implemented alone. Adopting both standards improves two measures of firm performance: profit and turnover. This underlines the synergy between EMS and QMS confirming that complementarity between different organisational innovations can lead to better firm performance (Milgrom and Roberts, 1995). Hence, managers should encourage their firms to implement both quality and environmental standards in order to improve their overall competitiveness.

Chapter 4 provides empirical findings that support the first hypothesis stating that there is a positive and significant relationship between ISO 9000 standards and innovation performance (as measured by new or improved products for the firm, turnover due to new or improved products, new or improved products on the market, share of new or improved products on the market, new technological processes, total innovation expenditure and number of innovation projects). However, it appears that there are specific areas of innovation (as measured by new or improved processes and non-technological new processes) where quality standards have no impact at all.

In order to test the second hypothesis (that different levels of quality differentially improve innovation performance), we created three quality levels based on either ISO 9000 certification or the use of other quality systems whilst also taking account of the networks of relationships between the firm and its external environment. The first category of firms is called ‘Top Quality Level’ and it includes firms that have ISO 9000 certification and whose suppliers are also ISO 9000 certified or have other systems of certification or total quality. Furthermore, in this group we include firms that are ISO 9000 certified and also have other systems of certification or total quality. The third type of firm included in the Top Quality Level are those firms who have ISO 9000 certification and whose suppliers are also ISO 9000 certified, but where neither party has another system of certification or total quality. The second category of firms is called 'Medium Quality Level' and it includes firms that are not ISO 9000 certified but which have another system of certification or total quality and whose suppliers do have ISO 9000 certification. In this category we also include firms that only have either ISO 9000 certification or another system of certification or total quality, or, if they have neither of these, their suppliers are ISO 9000 certified. The third category named 'Low Quality Level' includes firms that are not ISO 9000 certified, do not have any other system of certification or total quality and whose suppliers also do not have ISO 9000 certification. Our empirical evidence is consistent with the second hypothesis. This is strongly confirmed when we compare firms of Top and Medium Quality Level, and firms of Top and Low Quality Level. Comparing firms of Medium and Low Quality Level, the results are confirmed for four out of nine innovation indicators (new or improved products of the firm, new or improved products on the market, total innovation expenditure and number of innovation projects).

Several major implications can be drawn from this chapter. Firstly, the findings indicate that firms may obtain a source of long-term competitiveness such as innovation (Perdomo-Ortiz *et al.*, 2006) through ISO 9000 implementation. Nevertheless, based on the evidence obtained, we conclude that specific innovation measures can not be improved simply by ISO 9000 adoption. Improvement seems to depend on the manner in which certification is implemented and on the firm's general strategy. Hence, managers ought to implement ISO 9000 standards in a manner consistent with the firm's unique strategy, with a special focus on innovation performance. Secondly, our results confirm that the quality-orientation of the actors (*e.g*. suppliers) with whom the firm is dealing is fundamental. In other words, firms need to pay attention not only to their own certification with quality standards, but also to the quality certification of their suppliers. Thirdly, our results show that firms can benefit from a quality effect on innovation indirectly or through substitute certification. In particular, firms without ISO 9000 certification that deal with ISO 9000 certified suppliers can benefit from improvement of their own innovation performance. This is especially significant for managers of small firms since they can avoid the costly process of ISO 9000 certification but still improve their own innovation performance by indirect means. Nevertheless, managers ought to understand that an internal well-established quality management system is necessary for the maximum innovation improvement. Finally, firms need to establish strong cooperation between quality and innovation departments in order to facilitate the improvement of innovation performance via the implementation of quality standards (Lopez-Mielgo *et al.*, 2009).

In **chapter 5**, we provide evidence which demonstrates that environmental standards can deliver benefits beyond merely environmental considerations, such as contributing to successful recruitment. We show that the implementation of environmental standards improves the recruitment of both professional and non-professional employees.

Our analysis suggests new ways of achieving the Porter 'win-win' hypothesis, and will therefore help policymakers and supporters of environmental standards to better motivate firms to adopt these initiatives. We confirm that the adoption of environmental standards may help firms to indirectly improve their performance, contributing to more successful recruitment. Moreover, since recruitment is a costly process in terms of financial resources as well as time management, environmental standards may be a cost-effective tool for attracting more qualified workers.

The main contribution of **chapter 6** is to provide empirical network analysis supporting the proposition that ISO standards may be considered as a Club Good. In so doing, we analyse the impact of a firm's hierarchical position within the ISO 9000 network on firm productivity. The ISO 9000 network consist of four types of ISO 9000 adopters; Direct Complete Adopters (firms that have ISO 9000 certification and whose suppliers are also ISO 9000 certified); Direct Non–Complete Adopters (firms that are certified with ISO 9000 although their suppliers are not); Indirect Adopters (firms that are not ISO 9000 certified but whose suppliers have ISO 9000 certification) and Non Adopters (firms that are not ISO 9000 certified and whose suppliers also do not have ISO 9000 certification).

We found that the productivity of Direct Complete Adopter firms is higher than that of Direct Non Complete Adopter firms, which is itself higher than that of Indirect Adopter firms, which is finally higher than that of Non Adopter firms. Consequently, we conclude that ISO 9000 standards can be conceptualised as a Club Good. Additionally, these findings further demonstrate that the ISO 9000 standard has a positive effect on firm productivity.

Our results confirm that firms that are not ISO 9000 certified will, if they have ISO 9000 certified firms as suppliers, profit from this network, generating a positive signal on the market via their certified suppliers. Hence, we may conclude that a quality-based relationship between firms and suppliers allows Indirect Adopters to benefit from suppliers with regards to their performance improvement.

Considering our findings, policymakers may need to point out that a quality-based relationship between firms and their suppliers is a significant factor for firm performance improvement. Moreover, the evidence provided in this chapter suggests that firms having multiple ties within the network improve their productivity more significantly than firms having only one network link. This underlines the importance of the network relationships in the process of firm performance improvement.

Chapter 7 attempts to understand the effects of quality and environmental practices on employee accidents occurring at work.

Our results show that quality standards increase the overall risk of employee accidents at work, although they have no impact accidents at work that lead to sick leave. These findings show that it is necessary for managers to apply a set of safety approaches when implementing quality practices. Consistent with our results, Poksinska (2007) argues that the effect of quality practices on working conditions may depend on the ways by which quality practices are implemented. Therefore, the author concludes that managers have to ensure that such practices are designed and implemented with employee participation.

On the other hand, our results suggest that environmental standards significantly enhance working conditions via accident reduction. Based on the fact that accidents at work are costly, environmental standards could therefore be seen as a tool for cost reduction, thus indirectly contributing to performance improvement of a firm. This is a significant finding for managers, especially those who are hesitant about implementing environmental standards, due to their skeptical attitudes towards the potential benefits of such an adoption.

Chapter 8 investigates the effects of environmental practices on two specific aspects of human resource management, namely, employee well-being and job involvement. Our evidence shows that environmental practices seem to positively improve employee well-being. More precisely, employees working for firms that are certified for an environmental standard report greater feelings of usefulness at their job and declare that they are more often fairly valued in their jobs. Interestingly, evidence also suggests that while employees of environmental certified firms do not claim to be significantly more involved in their job, they are more likely, *ceteris paribus*, to work uncompensated for additional working hours than employees working for non-environmentally certified firms.

Therefore, policymakers need to highlight the employee benefits that can be obtained from the adoption of environmental standards. Indeed, market equilibrium might balance out the costs of adopting environmental standards, since employers generally accept the view that satisfying employee interests will result in an improvement of the firm's overall performance (Freeman, 1984; Porter and Van Der Linde, 1995).

Limitations and Future directions of research

This research opens up a wide area for future research and presents numerous ideas that require further exploration and development.

Two main directions for future research are suggested by this discussion. Firstly, because our data concentrates on the French institutional framework, it is unclear to which extent our findings can be generalized across other national contexts. Hence, future research may consider the same issues analysed in this PhD dissertation, but taking into account different international settings. Secondly, a majority of the studies we have presented face temporal limitations. The incentives for and effects of quality and environmental approaches tend to change over time (Delmas, 2003). Therefore, it is important to conduct future analysis to see whether the impact or determinants of quality and environmental approaches depend on the year of implementation.

With regards to **chapter 1**, which confirms that the determinants of quality standards differ between the manufacturing and service sectors, the natural extension of this work would be to investigate whether Quality Management Standards impact differently on firm performance between the manufacturing and service sectors. Based on the fact that voluntary environmental standards should not be treated as alternatives to one another but rather as mutually complementary (Delmas and Montiel 2008), an obvious further direction of **chapter 2** would be to examine the determinants of joint certification (*e.g.* ISO 14000 and Responsible Care program). Future research should also provide comparative analysis of whether or not these two environmental approaches, Responsible Care program and the ISO 14000 standard, improve environmental and firm performance to the same extent.

Concerning **Parts II** and **III**, several lines of future research could be followed. Firstly, future research should identify the mechanisms by which firm or employee performance become enhanced following quality or environmental approaches adoption. Moreover, based on the fact that different aspects of quality or environmental approaches may impact differently on firm and employee performance (Abrunhosa and Moura E Sà, 2008; Schmidt-Albinger and Freeman, 2000), it would be worth investigating the patterns and character of these potential differences on different indicators of performance.

It is argued that some firms may only perform the minimum in order to obtain quality or environmental standards, while other firms may actively integrate standards into every aspect of their business (for a comprehensive review see, Boiral, 2007). As a potential future study, one could investigate whether the degree of integration matters when examining the impact of quality and environmental approaches on employee and firm outcomes. Secondly, investigating the effects of quality and environmental approaches on additional aspects of firm (*e.g*. returns on sales, returns on assets and returns on equity) and employee (*e.g*. labour productivity, wage and employee morale) performance would be a significant extension of this research.

Furthermore, some specific avenues for future research only apply to **chapter 4**. Since **Chapter 4** is mainly focused on a particular industry (manufacturing), it is not specific to which extent its findings can be generalized. Therefore, it would be of great interest to explore equivalent issues in multiple industries.

Despite limitations that one would hope to overcome in future research, we believe that we, nevertheless, provide significant findings that will substantially advance the understanding in the field of quality and environmental approaches.

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Table of contents

Tables and Figures

Les Déterminants et les Effets des Normes de Qualité et d'Environnement : Analyses Microéconométriques à partir de Données Françaises d'Entreprises et de Salariés

Résumé

Ces dernières décennies ont vu l'émergence et le développement de plusieurs pratiques managériales ayant rapport à la qualité et à l'environnement. Néanmoins, l'analyse des raisons de l'adoption de ces pratiques managériales par les entreprises et de leurs effets sur les entreprises et les salariés a été assez peu étudiée par les économistes. Cette thèse contribue à la littérature empirique sur les pratiques managériales liées à la qualité et à l'environnement dans les entreprises en France. Elle est construite autour de trois thèmes majeurs : (1) l'analyse des déterminants d'adoption de ces pratiques managériales, (2) l'étude de leur impact sur des indicateurs de performance d'entreprises et (3) l'étude de leur impact sur des mesures liées aux salariés. La thèse s'articule autour de ces trois axes de recherche en trois parties.

Dans la **première partie de la thèse**, nous présentons les pratiques managériales de qualité et d'environnement, en se concentrant plus particulièrement sur les normes de qualité ISO 9000 et les normes environnementales ISO 14000. Nous étudions les déterminants de l'adoption des ces normes de qualité et d'environnement. Nous montrons dans un premier temps que les déterminants de l'adoption des normes de qualité sont différents dans les secteurs de l'industrie et des services, plus précisément du point de vue de la stratégie interne de ces entreprises (amélioration de la qualité, réduction des coûts et innovation). En revanche, certaines caractéristiques d'entreprises (taille, appartenance à un groupe financier, expérience avec d'autres normes) et des caractéristiques décrivant la stratégie externe des entreprises (niveau d'exportation et satisfaction des clients) ont le même effet dans l'adoption de ces normes dans les deux secteurs. Dans un second temps, nous analysons les déterminants de l'adoption de la norme ISO 14001 et de l'Engagement de Progrès dans des entreprises de l'industrie chimique. Nous montrons que les deux systèmes analysés ont des déterminants différents : d'un côté, les principaux déterminants de l'adoption de la norme ISO 14001 sont la taille de l'entreprise, l'expérience avec d'autres normes, obligations d'information et la localisation géographique des clients et d'un autre côté, les principaux déterminants de l'Engagement de Progrès sont la pression réglementaire, avoir rencontré des problèmes environnementaux dans le passé et prévoir des risques environnementaux futurs.

Dans la **deuxième partie de la thèse**, nous analysons si les normes de qualité et d'environnement conduisent les entreprises à de meilleures performances, en utilisant une palette riche d'indicateurs de performance d'entreprises. Nous montrons que les normes de qualité ont un impact positif sur le chiffre d'affaires et certains indicateurs de performance d'innovation et de productivité. En revanche, elle n'ont pas d'effet sur le profit et sur d'autres mesures de performance d'innovation. Concernant les normes environnementales, nous montrons qu'elles améliorent le chiffre d'affaires et les pratiques de recrutement des personnels qualifiés et des personnels non qualifiés, mais n'ont pas d'impact sur le profit des entreprises. Enfin, notre investigation montre que le fait de mettre en place simultanément des normes de qualité et d'environnement améliore plus fortement les performances des entreprises par rapport à l'adoption séparée de ces normes.

La **troisième partie de la thèse** étudie les effets des normes de qualité et d'environnement sur des mesures liées aux salariés. Les normes de qualité augmentent les risques d'accident, mais n'ont pas d'effet sur les accidents de travail entraînant un arrêt. Concernant les normes environnementales, nous montrons qu'elles améliorent significativement les conditions de travail à travers la diminution des accidents. De plus, les salariés qui travaillent dans des entreprises qui adoptent des normes environnementales considèrent que leur travail est davantage utile pour la société et ils ressentent une meilleure reconnaissance de leur travail. Ainsi, les normes environnementales augmentent le sentiment de bien-être des salariés. Nous montrons également que les salariés travaillant dans des entreprises ayant adopté des normes environnementales ne se déclarent pas plus impliqués dans leur travail et pourtant font davantage d'heures supplémentaires non rémunérées que les salariés d'entreprises n'ayant pas pris d'engagements similaires en matière de protection de l'environnement.

Mots clés : normes managériales de qualité, normes managériales d'environnement, déterminants, indicateurs de performance d'entreprises, indicateurs liés aux salariés.

Motives and Effects of Quality and Environmental Standards: Micro-econometric Analyses of French Firms and Employees

Abstract

The scope and magnitude of changes occurring in business today has led to great interest in and widespread adoption of Quality and Environmental Management approaches. However, despite their prevalence, efforts at understanding the motives for their adoption, as well as their effects on firm and employee outcomes, are still in their infancy. This PhD dissertation provides useful theoretical and empirical contributions to three research topics dealing with Quality and Environmental Management approaches in the French institutional framework: (1) the determinants of their adoption, (2) their impact on firm outcomes and (3) their impact on employee outcomes. These three aspects make up the three parts of this PhD thesis.

In **part I**, we define and characterise quality and environmental approaches with a special focus on ISO 9000 Quality Management standards and ISO 14000 Environmental Management standards. Furthermore, we empirically examine the determinants of quality and environmental standards adoption. Our findings reveal that the determinants of quality standards significantly differ between manufacturing and service firms, particularly when we examine features of the internal strategy of those firms (quality improvement, cost reduction and innovation). However, we have also obtained evidence which indicates that the characteristics of firms (firm size, corporate status and previous experience with similar standards) and features of their external strategy (export levels and customer satisfaction) play a significant role in quality standards adoption across both the manufacturing and service sectors. Moreover, we empirically investigate the determinants of chemical firms' registration for the ISO 14001 standard or the Responsible Care program. We show that most determinants are different for the two systems analysed: while firm size, previous experience with similar standards, information disclosure requirements and customer location are major determinants of ISO 14001 standard registration, regulatory pressure, past environmental problems and future risks are the main drivers of Responsible Care registration.

In **part II**, we empirically investigate whether quality and environmental standards are related to better firm performance using various sets of performance measures. The evidence indicates that quality standards positively influence turnover and specific indicators of innovation performance and productivity, but have no impact on profit and some other innovation performance measures. Based on our empirical findings, we conclude that while environmental standards improve turnover and recruitment of both professional and non professional employees, they have no effect on profit. Moreover, the research shows that implementing both quality and environmental standards is likely to better enhance firm outcomes than implementing only one standard.

Part III is focused on the effect of quality and environmental standards on employee outcomes. The estimation results show that quality standards increase the risk of employee accidents although more specifically they are ineffective on working accidents that lead to sick leave. On the other hand, our results lead to the conclusion that environmental standards add significantly to the enhancement of working conditions, via the reduction of accidents. Furthermore, the obtained evidence shows that environmental standards seem to improve employee well-being. More precisely, employees working for firms that are certified for an environmental standard report greater feelings of usefulness about their job and declare that they are more often fairly valued in their jobs. The evidence also shows that employees working for environmentally certified firms do not claim to be significantly more involved in their job but they are more likely, *ceteris paribus*, to work uncompensated for supplementary work hours than "non green workers".

Keywords: quality management standards; environmental management standards; determinants; firm outcomes; employee outcomes.