46

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ISO9000 Certification and Innovation: an Empirical Analysis for Luxembourg**

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Abstract

The interest of policy-makers and academics for standards as tool for fostering innovation has considerably increased in the last decade. According to the current debate, standards can foster and hamper innovation at the same time. Addressing this debate, our research tests empirically whether the positive effects of ISO9000 on innovation overcome the negative effects.

In order to investigate more effectively the innovation in small companies and in the service sector, different definitions of innovations are implemented by considering both technological and non-technological innovation.

The main data source for the analysis is the Community Innovation Survey (CIS2006) for Luxembourg. These are complemented with information on certification taken from the list of ISO9000 certified companies provided by Mouvement Luxembourgeois pour la Qualité (MLQ).

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The opinions expressed here are those of the Authors and do not necessarily correspond to those of the Institutions of affiliation.

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2

The main result is that ISO9000 certification affects positively and significantly the probability of innovation when organizational and marketing innovation are included. The magnitude and significance of the impact are progressively reduced when considering more restrictive definitions of innovation. It appears that ISO9000 certification increases technical innovation capabilities of manufacturing companies and non-technical innovation capabilities of other service sectors. It seems as well that the effect of ISO9000 decreases with firms' size.

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"Innovation involves change in routines"
(Nelson and Winter, An evolutionary Theory of Economic Change 1982, pp 128)

"The Commission and the Council of the European Union have identified standardization as key instrument for improvements in order to foster innovation"

(Communication from the Commission, number 133, 2008)

1. Introduction

Innovation and standards are often perceived as antithetic because innovation is the realization of something new while standards are meant to hold things the same. However, recent works on innovation have emphasized the positive role that standards play in the commercial success of new goods and services (Swann 2000, Blind et al. 2004; Hesser et. al 2007; Egyedi and Blind 2008). Innovation, in a broad sense, is the destruction of previous standards and the settlement of the ones. However, this relationship is complex, not fully understood and the empirical studies are relatively few.

This study investigates empirically the impact of ISO9000 certification on innovation capabilities, defined as the probability to introduce an innovation. We distinguish between technological and non-technological innovation in order to investigate more effectively small companies and the service sector. The study considers different definitions of innovation based on two main criteria: R&D expenses and innovation type. The definitions are nested, from the most restrictive to the broadest definition which includes organizational and marketing innovation.

Standards can be classified according to various criteria and investigated according different perspectives: Network, Knowledge and Signalling (Riillo, 2009). A useful differentiation is between product and process standards. Product standards can both induce positive network effects -fostering innovation- and prevent the transaction from old to new technology –"lock-in" effect-.Process standards are less likely to induce network effects and their impact on innovation is less investigated in literature.

The focus of this research is a process standard -ISO9000- that is meant to support and assure quality management processes of companies, regardless their size or sector.

The analysis is performed on a unique dataset coming from two Luxembourgish databases. The main data source for the analysis is the Community Innovation Survey (CIS2006) for Luxembourg. These data are complemented with information on certification taken from the list of ISO9000 certified companies provided by Mouvement Luxembourgeois pour la Qualité (MLQ). The dataset includes small and large companies of manufacturing and service sector.

Results provide empirical evidences that ISO9000 has a positive effect on all type of innovations, but the impact is statistically significant at conventional levels only when marketing and organizational innovation (non-technical innovation) are included. Interestingly, it appears that ISO9000 certification increases technical innovation capabilities of manufacturing companies and non-technical innovation capabilities of service sector. It seems as well that the differential in innovation probability for certified and non-certified companies decreases as the employment level increases, indicating that the effect of ISO9000 decreases with firms' size.

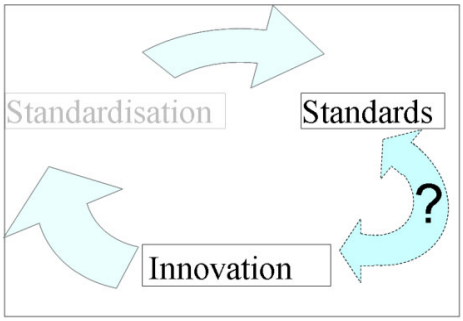
The paper is organized as follows. Section 2 summarizes the current literature on standard and innovation, defining the conceptual framework. Section 3 discusses the specificities of ISO9000 certification. Section 4 describes the data used in the empirical research and the variables. Section 5 presents the model and empirical results of the impact of ISO9000 on innovation. Section 6 is devoted to conclusions and further research directions.

2. Literature review

2.1 Conceptual framework

The goal of this study is to investigate the relation between standards and innovation in line with the conceptual framework described below and presented schematically in Figure 1. After the rise of innovation, a standardization phase could start to increase the market size and reduce the production cost (Utterback and Abernathy, 1975). The standardization process can be driven by market competition forces or by consensus in formal or informal committees at national or international level (David and Greenstein, 1990). At the end of the standardization phase, a standard is selected and the process can restart. The conceptual framework should not be static because the standards change dynamically and interact during time and market evolution (Kurihara, 2006; Egydi and Blind, 2008).

Figure 1: Conceptual framework



The relationship between standards and innovation is unclear (dotted line in Figure 1) and it is not completely explored (Riillo, 2009). Out of 18000 international standards, ISO9000 quality management standard was chosen for the investigation because it is world wide recognized and it is common among small and large companies, in manufacturing and service sector. Unfortunately, financial sector is excluded from the analysis because there were very few certified companies.

The next section provides an overview of the relationship between standards and innovation.

2.2 Standards

Standards can be defined as a limited set of solutions to recurrent problems (de Vries, 1997). There is some consensus on the ambiguous role of standards for innovation. Swann (2005) analysing UK data, recognizes that technical standards can foster and hinder innovation at the same time. If companies judge standards a source of valuable knowledge, then they perceive standards as barriers for innovation. In the same way, if companies consider standards useless for innovation, then they do not perceive standards as constraints for innovation (Swann, 2005). As shown in Table1, standards can be classified according to their economic function and the positive and negative effects on innovation. Moreover, the Table 1 presents the three main research trends identified in literature: "knowledge", "network" and "transactional cost" (Riillo, 2009) and the different effects of product and process standards.

Table 1: Effects of standards on innovation, adapted from Blind (2004, p. 28)

		Perspectives	Economic function	Positive effects	Negative effects
	Product standards	**"Networks"**	Compatibility Standards	• Existence of systems, innovation of modules without changing platforms	• Risk of monopoly • Impeding transition from old to new technology (lock in)
			Variety reducing	easier achievement of critical masses	• Reduction of variety
Process standards		**"Knowledge"**	Information/ measurement Standards	• Codified knowledge on state of technology Well recognized benchmark	
		Transactional/ signaling effect	Minimum Quality/Safety assurance	• Reducing information asymmetries • Greater probability of market acceptance of new products	• Exclusion of low quality low cost products from the market

"Network" perspective

Through compatibility, standards permit different devices to properly work in the same system and the reduction of variety allows economy of scale (Swann, 2000). The seminal works of David (1985) and Farrell and Soloner (1986) underline the risk of suboptimal efficiency and lock-in effect in absence of coordination and consensus on the standard. For instance, petroleum engines for vehicles cannot be replaced by hydrogen technology because there is no well spread distribution system, and there is no well spread distribution system because there are few hydrogen cars.

"Knowledge" perspective

Standard considered as codified information increase the stock of knowledge that is the basis for any innovation (Amesse and Cohendet, 2001). For instance, nanotechnology or biotechnology required common language, common measures and to develop further (DIN, 2000).

"Transactional cost" perspective

Asymmetric information damages commerce (Arkeloff, 1970) because traders need to control the qualities of a product every time before a transaction can be made (Den Butter 2007). Uncertainty about the quality can lead to a situation in which "bad drives out good" Gresham's Law (Swann, 2000). Acting as a market signal (Spence, 1973), certification against a standard can increase the trust between client and seller that is important for the diffusion of service innovation (Andersen, 1994; Terlaak and King, 2006). For instance, the energy efficiency label of appliances permits customers to easily recognize quality and companies can charge more for superior performances.

2.3 Innovation

Innovation literature is extensive and this section just includes some essential features to underline the importance of innovation for economic growth and to identify operative definitions of innovation that allow capturing the complexity of the phenomenon in manufacturing and service sector.

Since the seminal study of Solow (1956), several studies report that "technological change" accounts for large part of long term growth. The first models considered innovation as exogenously determined, but endogenous growth theory (Romer, 1986; Aghion and Havitt, 1998) explicitly accounts and explains technological progress and knowledge accumulation. The contribution of standards to innovation was fully recognized only with the seminal works of David (1985), Katz and Shapiro, (1985); Farrell and Soloner, (1986).

Schumpeter (1934, pp 66) 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 organization of any industry". Since then, a huge debate developed on innovation, its features and operational measurement (Fagerberg, 2004 for a review).

An important aspect of this debate is related with innovation in services. Service sector accounts for a great part of European GDP and it is even more important in Luxembourg. However, the innovative contribution of service sector could be difficult to quantify because service firms innovate differently than manufacturing firms and service innovation can be difficult to detect (Tether, 2005a).

Indeed, due to the difficulties in defining and gathering suitable quantitative information, several studies investigated only technological products and processes (TPP) innovation in manufacturing sector (Salazar and Holbrook, 2003). However, focusing on TPP alone can be misleading because it underestimates companies active in organizational, marketing and logistical methods, such as Wal-Mart or Dell Computers (Arundel and Hollanders, 2005). Indeed, including organizational and marketing innovation can lead to a different picture of innovation capabilities within individual countries (Parvan, 2009). The latest version of Oslo manual (2005) and the recent Community Innovation Surveys attempt to address many aspects of this debate on innovation (Bloch, 2007).

Other recent streams of research show that companies that usually do not perform formal R&D (i.e. small company and service sector) can effectively innovate introducing management improvement, organization and marketing innovation (Rammer at al., 2009).

Moreover, based on level of novelty of the firm's technical innovations and R&D efforts, Arundel and Hollanders (2005) deploy a classification of 4 "modes" of innovative firms (strategic and

intermittent innovators, technology modifier and adopter)

In order to address the debate on service innovation and R&D efforts, we implement alternative definitions of innovation aimed at capturing the complexity of the phenomena. In line with the work of Tether (2001) and Arundel and Hollander (2005), this study considers different definitions of innovation based on two main criteria: R&D expenses and innovation type as shown in Table 2.

As shown in Figure 2, the definitions are nested, from the most restrictive to the broadest definition.

Figure 2: Nested definitions of innovation

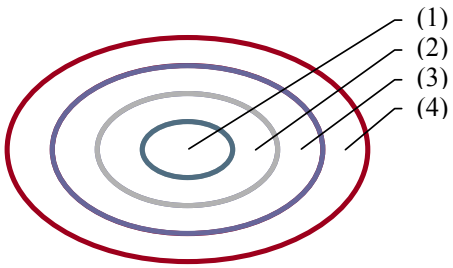


Table 2: Definitions of innovation

(1)	Product or process innovators with a positive expenditure in formal internal external R&D, new machinery and acquisition of external knowledge
(2)	Product or process innovators and a positive expenditure in formal internal external R&D, new machinery, acquisition of external knowledge
(3)	Product or process innovators
(4)	Product, process, organizational, marketing

In line with the different features of "innovation modes" (Arundel and Hollanders, 2005) different definitions permit to investigate more effectively innovation especially in small companies and in the service sector.

(1) The narrowest definition considers as innovators only product and process innovators with positive expenses in formal internal and external R&D, new machinery and acquisition of external knowledge ("narrow R&D"). This definition has already been used in innovation studies for Luxembourg, allowing therefore results comparison (Asikainen, 2008; Gomez-Ferreira 2010).

(2) The R&D expenses constraint is first relaxed by allowing also positive expenses in training, marketing and other expenses for innovation ("broad R&D"). The reason for doing so is to include all activities for process and product innovations that are particularly difficult to distinguish from R&D in the service sector (Oslo Manual 2005, p.97). Definition (2) includes all the companies that are innovative according to definition (1)

(3) Further generalization is then obtained by fully removing the constraint of positive R&D. The main reason for considering this third definition is that R&D does not include all the innovative activities "as there are other sources of technical change, such as learning by doing, which are not covered by this narrow definition" (Oslo manual p.22). This is particularly important since learning by doing receives considerable emphasis in ISO9000 literature. Moreover, in absence of a formal R&D department can be difficult for Small and Medium Enterprises (SMEs) to properly account for all the R&D expenses. Definition (3) includes definition (2) and (1)

(4) Finally, focusing only on product and process innovation may exclude other important non-technological aspects of innovation (Armbruster et al. 2008). Moreover, several of the objectives and effects of innovation are achieved with the combination of different types of innovation (Oslo Manual, 2005 pp108). Therefore, we include organisational and marketing innovators in the fourth definition. This definition (4) encompasses all types of innovation and suits better the innovative features of services and SMEs.

3. ISO9000

ISO9000 is a family of standards that are published and revised by the ISO Technical Committee ISO/TC 176, Quality management and quality assurance, and are considered an effective codification of Total Quality Management (TQM) principles (McAdam and Mckeown, 1999). TQM is a system of management concepts and approaches that aim to provide and improve products and services to satisfy customers' needs (Deming, 1986). ISO9000 certification is the first step (McAdam and Mckeown, 1999) and a "hard component" of TQM (Lopez-Mielgo et al. 2009).

The innovation objectives typical of TQM involve several aspect of innovation considered in the Oslo Manual. Cost reduction, facilitation of knowledge transfer, quality improvement and increase visibility of products are examples of TQM objectives that span across product, process, organization and marketing innovation.

However, the relationship between TQM and innovation is still debated in literature (see Prajogo and Sohal, 2001). Indeed there is a school of thought that underline that TQM and innovation pursue the same objectives (Lopez-Mielgo et. al., 2009) and the other school that emphasizes that the focus on incremental improvements ("exploitation") can prevent from "exploration" of new more radical innovation (Benner and Tushman , 2003).

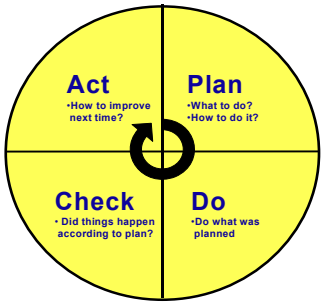
As shown in Table 3, the main idea of ISO9000 is the Plan-Do-Check-Act (PDCA) methodology that can be a useful tool to define, implement and control corrective actions and improvements. ISO9000 can raise efficiency and effectiveness of the operations, increase customer satisfaction and facilitate penetration in new market.

ISO9000 can be classified as a process standard but it is a particular type of standard because it lays down what requirements a quality system should meet, but does not dictate how they should be met. Moreover, ISO9000 is voluntary, meaning that a company has not legal obligation to respect the ISO9000 requirements. However, certification from accredited third party has the advantage to signal to the market the commitment to quality (Spence, 1973).

The validity of a certificate is generally three year, but maintenance auditing is performed on yearly basis. Moreover, the compliance with ISO9000 standards gives a presumption of conformity with the mandatory European quality assurance requirements (European Communities, 2000). Indeed, some products require CE marking to be freely trade in European Union. Certification to ISO9000 is one possible option to fulfill the CE marking requirements for management quality assurance.

ISO9000 standard does not rise network effect but is meant to provide codified knowledge valuable for innovation process (Prajogo and Hong, 2008) and signal quality of quality management (Terlaak and King, 2006) that can facilitate the penetration in the market of innovative products. Therefore, our study is in line with the "knowledge" and "Transactional cost" perspective.

Table 3: PDCA Plan-DO-Check-Act



"Plan"	Establish the objectives and processes necessary to deliver results in accordance with customer, statutory and regulatory requirements and the organization's policies;
"Do"	Implement the processes;
"Check"	Monitor and measure processes and product against policies, objectives and requirements and report the results;
"Act"	Take actions to continually improve process performance;"

Source: Adapted from ACQ web site (see references for full link)

The effect of ISO9000 on enterprise performance is debated in literature (see Dick, 2000 for a review). The effects of ISO9000 can be classified along two main categories: internal and external business dimensions (Sampaio et al., 2009). Internal dimensions affected by ISO9000 are related with the "knowledge" effect of the standard and includes organization, efficiency and quality of production process. Corbett et al. (2005) compare financial performance of ISO9000 companies against not certified but otherwise similar firms, reporting superior performance in terms of return on asset and sales. External dimensions are mainly related with the "minimum quality assurance" effect, including customers' pressures, legal requirements and marketing purposes. Terlaak and King (2006) adopt a signalling effect and report that growth performance of ISO9000 is superior to other companies even if ISO9000 have no impact on operational dimensions. Moreover, ISO9000 facilitates the codification of tacit knowledge and can increase the development of new knowledge (Bénézech et al., 2001; Penkovic and Galia 2009). However, some authors have a more critic position. Seddon, (1997) defines ISO9000 standard as an "economic disease" emphasizing that certification is "paper driven", increases paper work. Moreover, ISO9000 can induce uniform attitude and can reduce the "exploration" capability of the company (Benner and Tushman, 2002; Terziovsky and Guerrero-Cusumano 2009).

The evolutionary perspective, in particular the concept of "routine", offers interesting insights into the potential impact of ISO9000. Lazaric and Denis (2005) report the impact of ISO9000 adoption on "routinization" and memorization in the food industry. The study underlines that the implementation of ISO9000 offers the opportunity to improve the company performance.

Few large empirical studies have been performed on the relation on ISO9000 and innovation and they provide contradictory results. Pekovic and Galia (2009) investigating innovation capabilities of French manufacturing companies of minimum 40 employees identify a positive impact, while Terziovsky and Guerrero-Cusumano (2009) conclude that ISO 9000 has a negative impact on performance dimensions related to product innovation and positive effect on performances related to process innovation in Australian firms. The relation between innovation features and ISO9000 certification was investigated in German innovative service companies (Blind and Hipp, 2003). The study reports that financial companies are not certified and that the use of technology involving risks for security and health has an important impact for the propensity to be ISO9000 certified. The study concludes that a study on innovative and not innovative companies could better explain the relationship between ISO9000 certification and innovation.

Summarizing, ISO9000 can foster innovation and, at the same time, reduce opportunities for further improvements. The "net" effect of standards on innovation is still debated and empirical research in this field is relatively limited. ISO9000 incorporate valuable knowledge that can increase the "knowledge function" and support innovation process (Lopez-Mielgo, 2009). Moreover, the new product and service of certified company can easily meet the trust of customers (Terlaak and King, 2006). On the basis of the literature presented in the previous sections, the following hypothesis can be formulated and empirically verified:

Hypothesis 0 (H0): ISO9000 certified companies have the same innovation propensity than non-certified companies

The alternative hypothesis is therefore:

Hypothesis 1 (H1): ISO9000 certified companies have different innovation propensity than non-certified companies

4. Data and Variables

The research has been performed on a unique dataset obtained from two Luxembourgish data sources. One source of data is the Community Innovation Survey (CIS2006) and the other source is the exhaustive list of ISO9000 certificates from Mouvement Luxembourgeois pour la Qualité (MLQ).

The Community Innovation Surveys (CIS) are a series of surveys executed by national statistical offices throughout the European Union since 1992 according the definitions of Oslo manual. CIS collects data at firm level to investigate the innovation input, output and process. CIS2006 refers to the period 2004-2006, and includes enterprises with more than 10 employees in manufacturing and service sector. Each enterprise can be constituted by one or several legally distinct units.

MLQ is a public and private association to promote quality in Luxembourg that regularly updated the data on ISO certified companies. MLQ is the source of Luxembourgish data for international studies such as ISO world survey Data from MLQ are particularly reliable because of the regular updates and the small country size of Luxembourg.

The purpose of this study is to empirically investigate innovation at firm level. However, the ISO900 certificate can refer to distinct legal units. Therefore, for this study, an enterprise is considered certified if at least one legal unit belonging to it is certified. Moreover, as the CIS covers a period of 3 year, an enterprise is included in the group of certified companies if it is certified for at least one year between 2004 and 2006. Alternative certification periods, such as 2003-2005 and 2002-2004, were considered to address possible lag effects of ISO9000 certification (Corbett, 2005). The results, available upon request, are not substantially affected by the choice of the certification period.

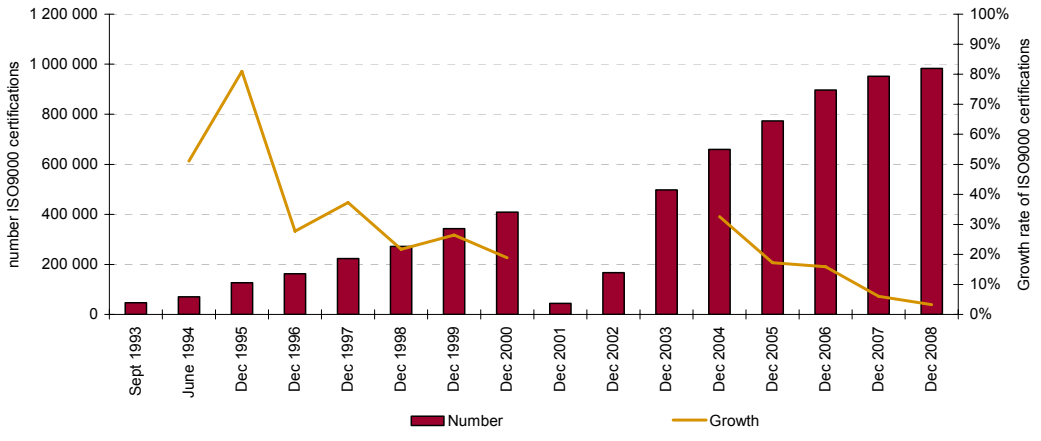
The next section presents first the dynamics of ISO9000 certification in Luxembourg and then the descriptive statistics of the dataset.

4.1 Dynamics of ISO9000 certification

ISO9000 is adopted worldwide and at the end of 2007 almost 1 000 000 company were certified. As shown in Figure 3 the number of certifications is constantly increasing starting from 1993. However, the growth rate slowed down between 2006 and 2007 suggesting that the certification market is reaching saturation (ISO survey 2007).

Until the year 2000, the certification was issued according to ISO9001:1994. After 2000, the survey recorded only certifications that were issued according the new version of the standard -the ISO9001:2000-. As certification is usually valid for three year, Figure 3 shows a gap between 2001 and 2004.

Figure 3: Number of world certification



Source: ISO Survey 2008, Authors' calculation

The effect of the shift from old to new version of ISO9000 is more evident in Figure 4 that reports separately ISO9000:1994 and ISO9000: 2000 certification for Luxembourg. Confronting Figure 3 and Figure 4 it can be concluded that the ISO9000 certification in Luxembourg is following a similar pattern of the certification in the world.

By reading Table 4 along the main diagonal, the number of certified firm increases over time, from 127 in 2002, to 237 in 2008. However, by reading the Table 4 by columns, it appears that companies certified in one year do not necessarily renew certification in the following years. For example among the 127 company certificate in 2002, 96 were again certified in 2003 and, of these, 79 were as well certified in 2003. In other words, only these 79 companies were certified for all three consecutive years 2002, 2003 and 2004. From the table, an intense dynamic of entry and exit in the pool of certified companies can be detected.

Table 4: Persistence during the time of ISO9000 certification

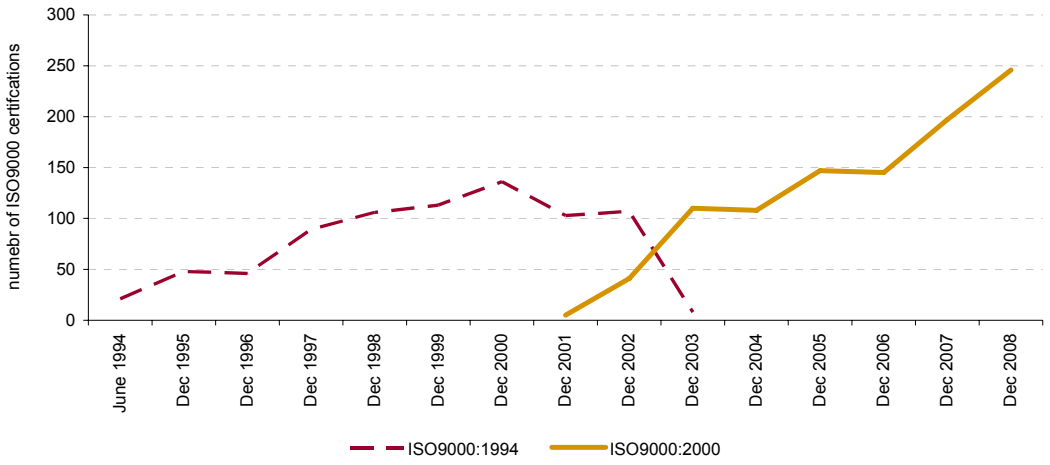
	2002	2003	2004	2005	2006	2007	2008
2002	127						
2003	96	169					
2004	79	128	170				
2005	44	67	89	153			
2006	42	64	86	145	184		
2007	41	62	84	143	180	196	
2008	36	55	77	127	147	156	237

Notes: Each cell represents the number of companies certified during the years reported in the corresponding row and column headings. For example, among the 127 companies certified in 2002, 36 were certified for all years from 2002 to 2008. (Source: MLQ authors' calculation)

As Table 4 suggests, there is a group of companies that persistently hold the certification for long period of time, while other companies loose the ISO9000. However, as the companies gaining certification are more numerous than the companies loosing it, the total number of ISO9000 companies increase over time.

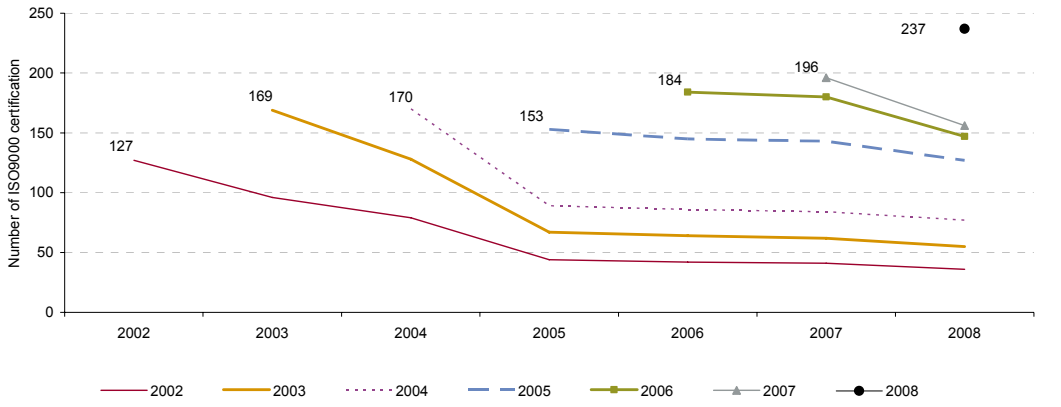
Figure 5 shows the persistence of certification for each year-line. The slope of the year-line indicates the ratio of companies certified in each year that do not renew certification in the following year. Starting from 2005, it appears that the number of certified companies stabilizes.

Figure 4: Diffusion of standards in Luxembourg



Source: ISO survey 2008 and MQL; Authors' calculation

Figure 5: ISO9000 certificate dynamics



Source: MLQ authors' calculation

4.2 Descriptive statistics

In this section are reported the essential features of descriptive statistics.

As already presented in the literature review, this study consider four nested definitions of innovation are summarised below.

(1) Product or process innovators and "narrow" R&D
(2) Product or process innovators and "broad" R&D

(3) Product or process innovators
(4) Product, process, organisational, marketing innovators

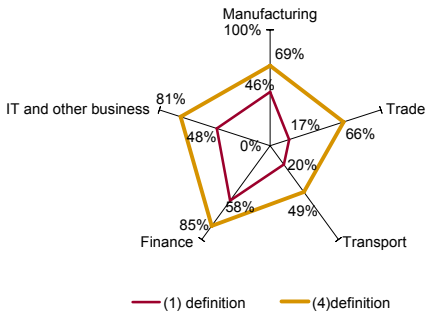
The Figures 6 and Figure 7 present the share of innovators according to the different definitions of innovation by sector and size. Additional descriptive statistics are reported in Annex.

Table 5: Innovation definition and sector

Definition	Manufacturing	Trade	Transport	Finance	IT and other business
					in %
(1)	46	17	20	58	48
(2)	48	36	24	65	59
(3)	49	36	26	65	59
(4)	69	66	49	85	81

Source: STATEC CIS2006 and MLQ authors' calculation

Figure 6: Innovation and sectors



Source: STATEC CIS2006 and MLQ authors' calculation

Service and manufacturing companies can have different attitude toward innovation. For example, manufacturing companies are more likely to rely on formal R&D than service companies (Tether 2005). Small service companies can compensate R&D gap taking advantage of ''softer'' forms of knowledge and technology, such as effective management system (Rammer, 2009). In order to offer an accurate picture of innovation, it is important to distinguish at least between service and manufacturing companies. Indeed, as highlighted by the evolutionary perspective, innovation patterns are contingent to specific market environment and can differ among sectors (Malerba *et al*, 2000).

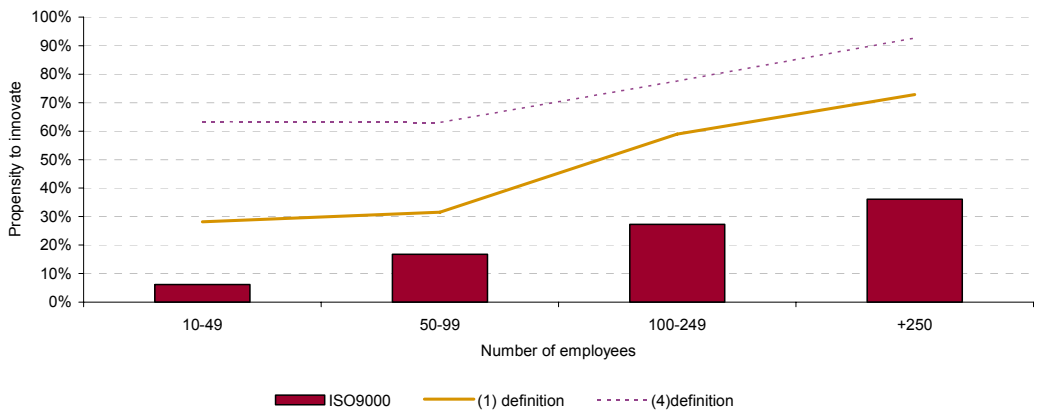
As shown in Table 5 and Figure 6, the propensity to certification varies among the different sectors of the economy. The most innovative sector is the financial sector, regardless of the definition of innovation adopted. Generalising the definition of innovation increases the innovation propensity, as one might expect, since the definitions are nested. In terms of magnitude, the increase in propensity is quite substantial, providing results consistent with Tether (2001, pp. 13) that reports increasing proportion of innovators for more generalized definitions of innovation.

Figure 6 shows that the percentage of innovative companies in the trade sector is 17% when adopting the most restrictive definition (1). However, when including organizational and marketing innovation of definition (4), the percentage increases of 48 percentage points, reaching 66%. For the manufacturing sector, the gain is only of 21 percentage points as the number of innovative firms increases from 48% of definition (1) to 69% of definition (4). As expected, this shows that organizational and marketing innovation is more relevant for services than for manufacturing. Very few financial companies are ISO9000 certified, probably because this sector is highly regulated and a minimum quality assurance standard like ISO900 offers no competitive advantage. This fact is consistent with the results of Blind and Hipp (2003). Therefore, the rest of the analysis is conducted excluding financial sector.

As shown in Figure 7, the size measured as number of employees is positively correlated to the percentage of innovators and to the percentage of ISO9000 certified companies. This remains true regardless of the definition.

However, smaller enterprises are more sensitive to different definitions of innovation, in line with the theory. The percentage of small innovative company increases from about 28% to 63% when moving from definition (1) to (4). For larger enterprises, the percentage increases only from 70% to 90%.

Figure 7: Certification and innovation by size



Source: STATEC CIS2006 and MLQ, authors' calculation

5. Model and estimation results

The study verify the impact of ISO9000 on the propensity to innovate, controlling for firms' characteristics (size, sectors, threats to market position and competitiveness factors) and other features whose relevance for innovation in the Luxembourgish economy has already been documented in previous studies (Asikainen, 2008; Gomez–Ferreira, 2010). The same set of endogenous variables is implemented for the four nested definition already presented in the literature section. Although different specifications may provide a better modelling for each definition, previous study on German CIS data found no statistically significant differences in the drivers of technological and non-technological innovation in a similar modelling setting (Schmidt and Rammer, 2007).In the logistic model presented in equation (1), - Inn- is a dichotomous dependent variable for innovative success while ISO9000 is an exogenous dichotomous variable indicating whether the company is certified or not. The logit regression states that L_{inn}, the natural logarithm of the odd ratio $\frac{P_{inn}}{1-P_{inn}}$, is linearly dependent of a vector X_{inn} of the characteristics of the single company (Gujarati, 2002 p 597). In formula:

$$L_{inn} = \ln\left(\frac{P_{inn}}{1-P_{inn}}\right) = \beta_0 + \beta_{iso9000} ISO9000 + \beta_{inn} Controls_{inn} + \varepsilon_{inn} \quad (1)$$

The main coefficient of interest is $\beta_{iso\,9000}$. The results of the model are presented in Table 6.

Table 6: Logit estimation results weighted sample

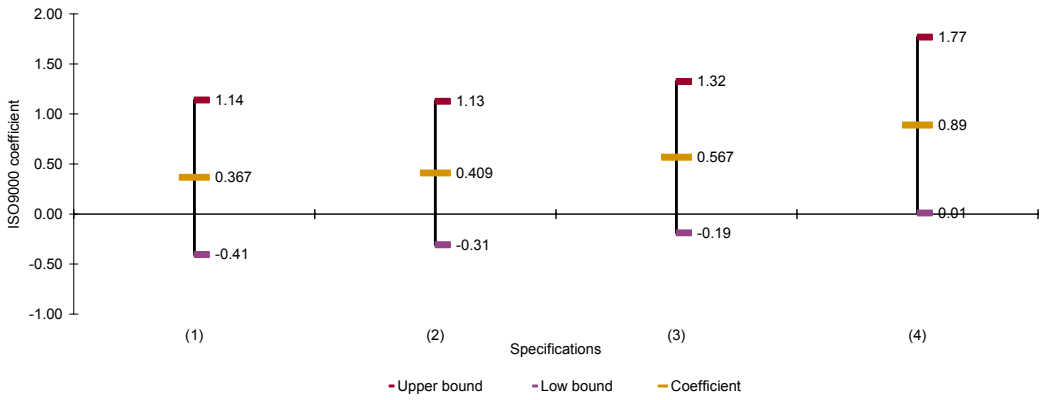
	Independent variables	*Product or process innovators "narrow" R&D*	*Product or process innovators "broad" R&D*	*Product or process innovators*	*Product, process, organisational, marketing innovators*
	Definition	-1	-2	-3	-4
	ISO9000	**0.367**	**0.409**	**0.567**	**0.888****
		(0.394)	(0.366)	(0.386)	(0.448)
Type of company	**Size** (ln employees)	**0.518*****	**0.363*****	**0.314*****	**0.217***
		(0.122)	(0.114)	(0.115)	(0.13)
	No group	**Baseline**	**Baseline**	**Baseline**	**Baseline**
	National group	**0.0557**	**0.152**	**0.145**	**0.53**
		(0.38)	(0.363)	(0.364)	(0.375)
	Foreign group	**0.425**	**0.917*****	**0.850*****	**0.887*****
		(0.298)	(0.291)	(0.285)	(0.317)
	Start up (< 5year)	**0.417**	**0.102**	**0.0549**	**0.266**
		(0.343)	(0.351)	(0.345)	(0.380)
Sectors	**Manufacturing**	**Baseline**	**Baseline**	**Baseline**	**Baseline**
	Trade	**-1.191*****	**-0.228**	**-0.307**	**0.0317**
		(0.383)	(0.344)	(0.343)	(0.376)
	Transport	**-1.227*****	**-1.111*****	**-1.038*****	**-0.842*****
		(0.306)	(0.298)	(0.294)	(0.289)
	IT and other services	**0.200**	**0.479**	**0.412**	**0.658***
		(0.342)	(0.342)	(0.340)	(0.373)
Threats	**Competitors**	**0.106**	**-0.284**	**-0.189**	**0.0778**
		(0.419)	(0.444)	(0.444)	(0.436)
	Costumers Demand	**0.00601**	**-0.0244**	**-0.145**	**0.488**
		(0.376)	(0.397)	(0.399)	(0.385)
Type of competition	**Price**	**-0.196**	**0.0317**	**0.11**	**0.0917**
		(0.281)	(0.275)	(0.273)	(0.280)
	Technology	**0.283**	**0.327**	**0.385**	**0.391**
		(0.261)	(0.254)	(0.252)	(0.277)
	Constant	**-2.307*****	**-1.572****	**-1.380****	**-1.023**
		(0.659)	(0.63)	(0.631)	(0.681)
Statistics	McKelvey & Zavoina's pseudo R2	0.400	0.364	0.343	0.365
	McFadden's Adj. R2	0.115	0.097	0.089	0.08
	Observations	1140	1140	1140	1140
	Innovators	368	464	474	745
	ISO9000 innovators	59	70	74	98

Weighted estimations, Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Source: STATEC CIS2006 and MLQ, authors' calculations

Looking at the main variable of interest $\beta_{iso\,9000}$, results show that the coefficient of ISO9000 is positive in all definition but not statistically significant for the first three models, where the H0 hypothesis cannot therefore be rejected at conventional levels. In other words, the impact of certification on innovation propensity, despite being positive, is not statistically significant. On the contrary, H0 is rejected in the fourth definition at 5% level. This means that when organizational and marketing innovations are included in the definition of innovation, a positive and significant impact of certification on innovation is detected. As Figure 8 shows, when relaxing the definition of innovation by moving from definition (1) to (4), the impact of certification increases monotonically in magnitude and the 95% confidence interval progressively shifts in the positive area.

Figure 8: 95% confidence intervals for ISO9000 coefficient



Source: STATEC CIS 2006 and MLQ, authors' calculation

In order to asses the impact of certification on innovation propensity, Table 7 reports the marginal effects of ISO9000 for all definitions In addition, 9 graphically presents the changes in probability for certified and non-certified in definition (4) for different employment levels. For the broadest definition (4), the changes in probability for certified and non-certified companies decreases as the employment level increases, holding all the control variables at their mean. Being ISO9000 certified increases the probability to be innovative of about 25 percentage points for small firms and of 15 percentage points for larger companies.

Table 7: Marginal effect of ISO9000

Defini- tions	(1)	(2)	(3)	(4)
Marginal effect ISO9000	**0.079**	**0.099**	**0.139**	**0.169****
	(0.089)	(0.091)	(0.096)	(0.071)

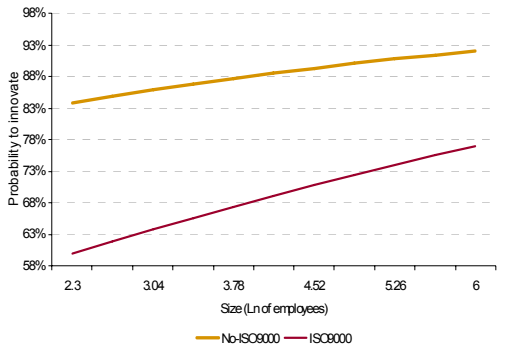
Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Marginal effect for dummy variable is the discrete change from 0 to 1

Marginal effect is calculated at sample mean.

Source: STATEC CIS2006 and MLQ, authors' calculation

Figure 9: Impact of marginal effect of ISO9000 on innovation probability for definition (4) according to size



Source: STATEC CIS2006 and MLQ, author's calculation

The Table 8 presents the result of a Logit regression for definition (1) and (4) splitting the sample in manufacturing and in other service companies. In definition (4), certification is not statistically significant for manufacturing sector and only marginally significant for services with p value of 0.133. Looking at the marginal effects reported in Table 9, the impact of ISO9000 certification gains statistical significance at 10% level for the average service sector company. Table 9 shows that acquiring the ISO9000 certification, the average manufacturing company would increase his technological innovation capabilities of 28.4 percentage points while the average service company would increase its innovation capabilities of 16.5 percentage points. It appears therefore that ISO9000 certification increases technical innovation capabilities of manufacturing companies and non-technical innovation capabilities of other service sector. Other definitions of certification present a similar but less strong pattern.

Table 8: Logit estimations

		Product or process innovators "narrow" R&D (1)		Product, process, organisational, marketing innovators (4)	
	Independent Variables / **Definition**	**Manufacturing**	**Service**	**Manufacturing**	**Service**
	ISO9000	**1.176****	**-0.059**	**0.71**	**0.844**
		(0.502)	(0.599)	(0.659)	(0.562)
	Size (ln employees)	**0.402****	**0.540*****	**0.330**	**0.146**
		(0.196)	(0.161)	(0.242)	(0.161)
Type of company	**No Group**	**Baseline**	**Baseline**	**Baseline**	**Baseline**
	National group	**-0.00113**	**0.0799**	**0.550**	**0.542**
		(0.506)	(0.53)	(0.577)	(0.472)
	Foreign group	**0.386**	**0.483**	**1.259****	**0.781****
		(0.508)	(0.367)	(0.503)	(0.370)
	Start up (< 5year)	**0.814**	**0.198**	**0.587**	**0.138**
		(0.536)	(0.448)	(0.608)	(0.463)
Sectors	**Trade**		**Baseline**		**Baseline**
	Transport		**-0.054**		**-0.836****
			(0.416)		(0.387)
	IT and other services		**1.469*****		**0.643**
			(0.431)		(0.450)
Threats	**Competitors**	**-0.513**	**0.319**	**0.0835**	**0.0615**
		(0.741)	(0.524)	(0.680)	(0.540)
	Consumers Demand	**0.202**	**-0.0594**	**0.821**	**0.380**
		(0.697)	(0.462)	(0.657)	(0.456)
Type of competition	**Price**	**0.178**	**-0.364**	**-0.0372**	**0.146**
		(0.437)	(0.348)	(0.500)	(0.338)
	Technology	**0.660***	**0.115**	**0.469**	**0.352**
		(0.383)	(0.338)	(0.461)	(0.337)
	Constant	**-2.023****	**-3.501*****	**-1.711***	**-0.65**
		(0.94)	(0.885)	(0.972)	(0.844)
Statistics	McKelvey & Zavoina's pseudo R2	0.314	0.401	0.344	0.394
	McFadden's Adj. R2	0.0844	0.0905	0.0759	0.0745
	Observations	310	830	310	830

Weighted estimations, Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Source: STATEC CIS2006 and MLQ, authors' calculations

Table 9: Marginal effect of ISO9000

Definitions	(1)		(4)	
Sectors	Manufacturing	Service	Manufacturing	Service
Marginal effects ISO9000	**0.284***** (0.109)	**-0.0106** (0.106)	**0.132** (0.105)	**0.165*** (0.0925)

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Marginal effect for dummy variable is the discrete change from 0 to 1.
Marginal effect is calculated at sample mean.

Source: STATEC CIS2006 and MLQ, authors' calculation

6. Conclusions, limitations and further developments

The debate about the relationship between standards and innovation is still open and consensus has not been achieved on many key issues.

This study empirically investigates the impact of ISO9000 standard on the propensity toward innovation.

Compared to previous empirical studies (Blind 2003, Pekovic and Galia, 2009; Terziovski and Guerrero-Cusumano 2009), the main originalities of this research are:

- representative data covering innovative and not-innovative firm with more than 10 employees in both manufacturing and services
- different definitions of innovations suitable to capture innovation in services

Indeed, the main result of this study is that ISO9000 certification affects positively and significantly the probability of innovation when organizational and marketing innovation are included, but not when the focus is restricted to technological innovation. The magnitude and significance of the impact are progressively reduced when considering more restrictive definitions of innovation. The impact of certification is stronger for smaller firms and reduces progressively as size increases, showing its links with firms' characteristics. If confirmed, this evidence highlights the relevance of the definition of innovation for evaluating the impact of certification. As CIS data are available for other countries, comparative studies could increase our understanding of the relationship between standards and innovation.

The results suggest that ISO9000 and other properly designed standards could be a tool for policy-makers aiming at increasing specific types of innovation. Open standards, as tool to foster innovation, can be really appealing to policy makers because standard based on consensus are less likely to interfere with competition. Companies with specific features in terms of size and sector can benefit more from ISO9000. It appears that ISO9000 certification increases technical innovation capabilities of manufacturing companies and non technical innovation capabilities of other service sector. Practitioners can better understand the features of firms for which the certification provide the best potential, also in terms of innovation.

In this study the ISO9000 was considered an exogenous determinant of innovation. However, it could be argued that "better" firms pursue simultaneously innovation and certification. As ISO9000 certification is voluntary, innovative firms can self-select the certification status. Another possible limitation is that ISO9000 certification can induce change in organization but not necessary organizational innovation. Therefore, potential endogenity issues require further refinement.

However, to verify potential endogenity issues and assess correctly the effect of ISO9000 on innovation, it is important to investigate what drives the decision of firms to be ISO9000 certified.

The evolution of certification remains puzzling. It appears that several companies attain and loose ISO9000 certification but clear motivations for this behaviour were not identified. What drives ISO9000 is an independent interesting research question and it is essential to address potential endogenity issues.

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Annex: Descriptive statistics

	All Obs.		No-ISO9000		ISO9000	
% of firms (weighted)		100%		92%		8%
# firms (weighted)		1432		1317		115
Dichotomous Dependent variables	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
National group (d)	0.14	0.35	0.13	0.34	0.26	0.44
Foreign group (d)	0.35	0.48	0.35	0.48	0.37	0.48
Start up (d)	0.14	0.35	0.15	0.36	0.04	0.19
Threats Competitors (d)	0.89	0.32	0.89	0.37	0.9	0.31
Costumers Demand (d)	0.88	0.32	0.88	0.33	0.93	0.26
Price competition (d)	0.63	0.48	0.62	0.48	0.74	0.44
Technology competition (d)	0.34	0.47	0.33	0.47	0.39	0.49
Definition (1)	0.38	0.49	0.36	0.48	0.52	0.5
Definition (2)	0.46	0.5	0.44	0.5	0.62	0.49
Definition (3)	0.47	0.5	0.45	0.5	0.65	0.48
Definition (4)	0.7	0.46	0.68	0.47	0.86	0.34

Innovation definitions:

(1) Product or process innovators and “narrow” R&D
(2) Product or process innovators and “broad” R&D
(3) Product or process innovators
(4) Product, process, organisational, marketing innovators