

The Diffusion of ISO 9000 and ISO 14001, Cross Sector Evidence from Eight OECD Countries

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Abstract

This paper examines the impact of industrial structure and performance, as well as of the configuration of industrial trade networks on the level of certification with ISO 9000 and ISO 14001, in manufacturing industries, in eight OECD countries. Taking into consideration the national and industrial fixed effects, we find that generally certification supports entry in international markets, by signalling conformity with international rules of control product quality and environmental impact, especially in domestically sourced, low labour productivity, and to a lesser extent in industries that put efforts in innovation. Moreover, the national and industrial trading relationships affect the levels of industrial certification. In particular, industrial trading relationships with British partners favour certification with both standards, with European partners support certification with ISO 14001, while those with German partners foster ISO 9000. Being part of EU market enhances certification with ISO 9000, but not of ISO 14001.

Introduction

From the 1980s, in a context in which outsourcing of production activities, globalisation of production and markets and more demanding customer bases were gaining relevance, voluntary process standards and certification schemes become important forms of industrial and trade coordination. Among others areas, voluntary process/ management standards have been used to address and signal management behaviours related to environment, personnel relations, health hazards, ethics, and social responsibility (Larsen and Häversjö, 2001; Terlaak, 2001). This paper focuses on the ISO management system standards—ISO 9000 and ISO 14001. ISO 9000 and ISO 14001 are among the most famous voluntary process standards in the literature, as they have been published by the International Standard Organisation (ISO) and they became the most widespread and popular ISO standards ever (ISO, 2001, 2005).

In particular, the adoption of these standards (certification) seems associated with strategies to access foreign markets as well as to tap organisational and managerial best-practices (Withers and Ebrahimpour, 2000; Guller et al., 2002; Terlaak and King, 2006). These standards have however diffused among actors with different objectives, levels of internationalisation and needs of control and management of their business activities, from public to private activities; from services to industrial activities, and from multinationals to small enterprises (ISO, 2005; King et al., 2005). Therefore, understanding the main

mechanisms that support the diffusion of voluntary management standards is increasingly important for firms and policy-makers, which aim at supporting national firms' competitiveness. Still, the literature is not consensual about the main driving forces of their diffusion.

Some authors argue that the diffusion of ISO 9000 and ISO 14001 are characterised by a bandwagon effect, because in some markets, non-adopters are increasingly at a relative disadvantage to their competitors (Larsen and Häversjö, 2001; Guller et al., 2002; Nelson et al. 2004; Casadesús and Karapetrovic, 2005). Others authors show instead how national institutions and policies play an important role in the development of appropriated infrastructures and in the diffusion of a national fashion on the utility of certification (i.e. on the building of awareness and need in firms) (Delmas, 2001). The role of national institutions and policies providing infrastructure, and technical and financial supports are especially stressed on studies on the diffusion of certification in developing countries.

Trying to measure the importance of different relational links, Guller et al. (2002) show that multinationals through inward foreign direct investment and the national cohesive trade relationships between countries explain the world diffusion of ISO 9000 between 1993 and 1998. Albuquerque et al. (2007) argue that cultural similarity was instead more important on the diffusion of ISO 14001 than bilateral trade relationships. Focusing instead on certification at firm level rather than at national level, some authors show that structure factors are also important, such as the size of the firm, the firms' export intensity, the firm's industrial activity and the level of certification in the industry explain adoption of certification (eg. Curkovic and Pagell, 1999; Blind and Hipp, 2003; Corbett, et al. 2003; King et al., 2005). Therefore, on the one hand cross-national mechanisms related to the national trading network on the other hand specific structural characteristics and performance of firms and their industries seem to influence the process of diffusion of ISO 9000 and ISO 14001. Studies on the diffusion of ISO 9000 and ISO 14001 have concentrated on firm level analysis of survey and case studies data or on country-level analysis of national aggregated panel data. The analysis of the structure, performance and relational characteristics on the industrial diffusion of ISO 9000 and ISO 14001 across countries has not been done yet.

This paper is an attempt to examine the impact of cross-industry and cross-national forces on the process of diffusion of certification. It focuses on the effect of the structure and performance characteristics of industries, as well as the configuration of industrial trade networks on the industrial level of certification with ISO 9000 and ISO 14001. In particular, the paper analysis the impact of the level of industrial openness to international markets, innovativeness and productivity, as well as of certain national and industrial trade relationships on the level of certification in 15 manufacturing industries, in eight varied OECD countries, for which relevant data was available.

Using negative binomial regressions and accounting for the national and industrial fixed effects, this paper shows that the diffusion of ISO 9000 and ISO 14001 is used to deal with specific industrial structure and performance characteristics. Moreover, national and industrial trade relationships affect the levels of industrial certification in one country. Consequently, certification reveals certain market strategies as well as certain positions on the industrial and national trade networks. Finally, country and industry fixed effects also play a role on the level of industrial certification.

ISO certification, industrial characteristics and trade networks

Users /Adopters of ISO 9000 and ISO 14001

Adoption of ISO 9000 and ISO 14001 seem to vary across firms with different sizes, industrial activities, foreign capital presence, and export propensity.

Firms with more than 50 employees are found to be more likely to adopt these standards, which might be related to both the high cost of certification and the presence of greater information asymmetries within the firm and between suppliers and customers (Ringe and Nussey, 1994; Blind and Hipp, 2003; Casadesús and Karapetrovic, 2005).

Moreover, foreign capital presence and large export propensity seem to be associated with certification (Terlaak and King, 2001; Corbett, 2004). Multinationals and supply-production chains, which tend to require their suppliers to conform with specific procedures, including with ISO management systems, may have been the most important channels for the diffusion of certification. The requirement of certification on suppliers and external partners is also a form that large buyers, multinationals, group of firms often use to strategically mobilise and capture knowledge, and control the performance of their suppliers as well as to assure compatibility of business processes (Larsen and Häversjö, 2001; Blind and Hipp, 2003; Pan, 2003). Indeed, several studies find that firms certify mainly to respond to customer and market pressures—to entry in global markets or to produce for supply-chains—as well as to avoid potential export barriers to enter in some foreign markets (Ringe and Nussey, 1994; Guller et al., 2002; Pan, 2003; Terziovski et al., 2003; King et al., 2005). In particular, ISO 9000 was incorporated into the European global assessment procedures of some products from non-EU countries (Withers and Ebrahimpour, 2000; Pan, 2003; Yeung and Mok, 2005).

Therefore, in the literature the process of diffusion of ISO certificates is often characterised as being led by a bandwagon effect. In some markets, non-certified firms are at a relative disadvantage to their competitors—i.e. non-adopters might face an inability to enter and compete in a specific market (Larsen and Häversjö, 2001; Guller et al., 2002; Casadesús and Karapetrovic, 2005). Indeed, an increase in certification of industrial competitors seems to influence positively the firms' decision to certify (King et al., 2005). Thus, certification can be viewed as a signalling device of firms' conformity to the international business rules, used by firms to maintain or increase their market share (Bénézech et al., 2001; Terlaak and King, 2001; Blind and Hipp, 2003; Pan, 2003). However, some authors suggest that the wide diffusion of certification needs also to account for the fact that certification requires firms to engage on the qualification of their suppliers and many firms meet this requirement by ordering their suppliers to be certified (Stevenson and Barnes, 2002; Corbett, 2004).

Despite not finding significant differences in the motivations for seeking ISO 9000 across industries (Corbett et al., 2003), the propensity to adopt ISO 9000 and ISO 14001 does not seem evenly distributed across sectors of activity (ISO, 2005). Moreover, the importance of these standards may be not the same in different industries. In particular, labour-intensive sectors (i.e. garments, footwear, food and other agrarian products), ISO 9000, ISO 14001, other private standards, and brands are used to support chain coordination, to reassure consumers of product characteristics, their behaviour about safety, and the ethical and environmental conditions and that of their suppliers around the world (Gereffi and Korzeniewicz, 1994). Indeed, in markets with high price competition, small price margins and homogeneous products, firms used to certify to sign market its “quality” and to foster improvements in cost-efficiency of their production (Blind and Hipp, 2003). Moreover, certification was found to be more likely among firms that hire low-qualified employees, a pattern that Blind and Hipp (2003) justify by the needs of managers to set performance standards to control low-skilled employees and to support flexibility and on-time production.

In technology and capital-intensive sectors (automobile, aircraft, computers and other capital and technology intensive industries) instead, the technology and product reliability seems to play a much important role than marketing; consequently product as well as management systems standards are expected to be more important than private ones or brands (Gereffi and Korzeniewicz, 1994). Indeed, certification was found to be more likely in firms that use communication, medical and environmental technologies, which according to Blind

and Hipp, 2003) seems associated with their higher and immediate health and safety risk. Still, other authors have argued that certification is often associated with internal efforts to improve the quality and conformity of products, the environmental and safety requirements of production, process efficiency and reduce costs (King et al., 2005). Thus, certification might as well be a sign of the firms' effort to innovate and improve efficiency. Indeed, in the presence of internal rigidities that constrain innovation, the likelihood of certification seems also to decrease (Blind and Hipp, 2003). An early study on ISO 9000 shows that high technology firms are the most satisfied with the certification (Vloeberghs and Bellens, 1996).

Hence, some cross-industry differences in the level of certification ISO 9000 and ISO 14001 may be explained in terms of industrial differences in export intensity, productivity, use of sophisticated technologies and firm size. Additionally, some of the cross-national levels of certification may be explained by differences in the structure and characteristics of national industries.

Trade networks

Researchers of social networks tend to emphasise the importance of networks as source of learning and diffusion of similar patterns of behaviour. They argue that because actors interact and share certain number of rules, there might be place for mutual influence. These relationships may have generated coercive isomorphism through contractual or authoritarian relationships. For example, "In 1994, Chrysler and GM mandated that their first tier suppliers be certified by the end of 1997. However, by the summer of 1997 only 2,791 locations certified, leaving roughly 7,000 uncertified. At that time, Chrysler and GM issued an ultimatum that suppliers become certified or cease doing business with them. Fifteen months later, 8,645 suppliers were registered" (Stevenson and Barnes, 2001:3). Most often firms' imitation tends instead to result from competitive pressure from competitors, as they expect to be penalised in the market if they did not imitate (Abramhamson and Rosenkopf, 1993; Ahuja, 2000; Nelson et al., 2004).

Therefore, the diffusion of ISO 9000 and ISO 14001 may have been a process of imitation which occurred across countries closely connected by trade relationships. For instance, ISO 9000 was initially adopted by firms in Europe and in countries with close links with the UK (ISO, 2001; Pan, 2003; Franceschini et al., 2004). The cohesive trade relationships between countries and foreign direct investment seem to have been crucial for the world diffusion of ISO 9000 (Guller et al., 2002). "The pressure exerted by downstream customers through global supply-chains on upstream firms in other countries" is considered by Corbett (2004:18) to be behind the great growth of ISO certificates worldwide. In this manner, firms exporting may also have imported management practices from that region back to their home country (Guller et al., 2002; Corbett, 2004). Hence, multinationals and governments through national trade and foreign investment policies significantly influenced the rate at which these practices were adopted. Therefore, firms' motivations for certification across countries are not so different (Bessède, 2000; EQF, 2002; Corbett et al., 2003; Pan, 2003).

This influence of trading networks on the diffusion of certification might however have been more important in the beginning of the diffusion process, as most of the existing evidence refers to that period. Moreover, the influence of trading networks might have been different for the diffusion of ISO 9000 and ISO 14001. Indeed, Albuquerque et al. (2007) argue that while bilateral trade relationships have been an important force on the international diffusion of ISO 9000 across countries, cultural similarity seems instead to have been more important on the diffusion of ISO 14001. In addition, the influence of trading networks on the diffusion of certificates might have been different for European and Non-European countries. In the literature, entry in international markets, mainly the EU market is often suggested as

main reason for certification by firms in non-EU countries (Withers and Ebrahimpour, 2000; Pan, 2003; Yeung and Mok, 2005). In Europe, diffusion of certification seems instead associated with an increased of the ability to charge higher prices or the quality of products (Aiginger, 2001).

In sum, this review of the literature suggests that firms may value differently the certification according to their industrial activity, technology intensity, international openness, and their trade partners. Still, national efforts to promote the diffusion of standards, to attract foreign direct investment and to join common market areas might as well explain cross-national differences in the level of industrial certification. In addition, the functioning of the national quality-technical network enforcing the certification rules might also create different national incentives for certification. Therefore, cross-country as well as cross-industry differences in the level of certification are expected. Industries have different structures and characteristics across countries, and firms' managerial attitude is very context specific. Moreover, national governments might have implemented quite different trade and foreign investment policies and given different emphasis to the diffusion of certification. The study of relative importance of structure, performance and relational characteristics of industries and countries on the diffusion on ISO 9000 and ISO 14001 has not been done yet. This paper is an attempt to do it.

Methodology and data

Data

This paper analyses the impact of industrial structural characteristics, as well as of trade relationships on the diffusion of ISO 9000 and ISO 14001, in 15 manufacturing industries in eight OECD countries. In particular, the objective is to analyse whether and how trade networks, as well as industrial performance (input and output) indicators explain the level of industrial diffusion of certification with ISO management system standards. We focused only on manufacturing industries due to the non-availability of information on the independent variables for services sectors across our sample of countries.

To address these issues, we use data from the ISO surveys on the total number of ISO 9000 and ISO 14001 certificates from 2001 to 2004, across 15 industrial sectors in eight OECD countries. In particular, we focus on Czech republic, Finland, Italy, Japan, Korea, Portugal, Spain and Switzerland. These countries were chosen based on the availability of data at industry level. Moreover, they represent a diverse group of countries in terms to size, level of income and being members or non members of European Union.

Industries are expected to have different characteristics across countries, in terms of exposure to international markets, efforts in innovation development, performance in terms of labour productivity, trading networks, as well as their relative importance on the national economy. In order to characterise the structure, performance and trade links of manufacturing industries in these countries, we use data from the OECD STAN and ANBERD dataset on the industrial Gross Domestic Product (GDP), Labour productivity, expenditures on Research and Development (R&D), amount of exports and imports. In addition, we collected data on the industrial share of trade (exports and imports) to the UK, Germany, to the US and to EU on the total industrial trade. Unfortunately, data on foreign direct investment at such lower level of desegregation is not available. Moreover, data on R&D expenditures is not available for Portugal and Switzerland.

On the strength of this data, we analyse the impact of industrial characteristics in terms of structure, performance and trade relationships on the observed level of industrial certification with ISO 9000 and ISO 14000 in the eight selected OECD countries. For this purpose, we use a negative binomial model, which allow relaxing the Poisson assumption of equal mean and variance because the dependent variables are overdispersed (Long and Freese,

2003). The dependent variables are the number of ISO 9000 and the number of ISO 14001 certification in 15 industries in eight countries from 2001 to 2004.

In particular, we compute two models. Model I takes into consideration the sector structural inherent characteristics such as relative size, openness to international markets, reliance on domestic or foreign suppliers, labour productivity, and formal efforts in innovation development. In this model, we consider the following independent variables: share of industrial GDP, labour productivity, share of export and imports on the industrial GDP, share of R&D on the industrial GDP. Moreover, this model takes into consideration the position of the country and industries on the trade network, as well as information on the preferred trade partners. In particular, it includes the share of industry trade (import-export) with the UK, Germany, US and EU on the total industry trade, as well as the dummy variable for countries that belong to the EU. Model II includes the same independent variables used in Model I as well as country and industry fixed effects in order to control for other sources of time-invariant unobserved heterogeneity across countries and industries.

Finally, we explore the forces explaining the industrial ratio of ISO 14001 to ISO 9000 certificates, by running an OLS regression on all the independent variables used in Model II.

In any country, the larger the size of the industry and the higher the export intensity of the sector, the more certificates a sector is expected to have. Moreover, the variable time is also expected to be significant and positively associated with the level of certification. Instead, the existing evidence does not allow us to make clear-cut expectation about the impact of imports on the level of industrial certification. On the one hand, industries that import intensively are expected to be more aware of management best-practices, and so to be more likely to be certified. Even that the adoption of best-practices from suppliers may also depend on the type of resources (i.e. strategic or basic inputs) on which industries are relying on. Moreover, a high import rate may reveal a high participation on international supply-chains, on which certification tends to prevail. On the other hand, firms, which rely more on domestic sources, are expected to feel a bigger incentive to certify to signal compliances with international business market rules. This hypothesis is increasingly reasonable as diffusion of certification is being resulting from adoption by late-adopters and laggards, which partly coincide with the publication of ISO 9000:2001.

Similarly, the existing evidence does not allow us to make clear-cut expectation about the impact of labour productivity on industrial certification. On the one hand, certified firms are expected to be more likely to achieve higher product conformity and higher control on energy and resources used, given their chosen technology, and consequently to reveal higher labour productivity. On the other hand, costs of certification, documentation and formality required in certified firms may sometimes lead to an increase of costs and consequently to lower labour productivity. Moreover, if national industries are price competitive, firms may not have many incentives to certify, as their price competitiveness already allows them to have large market shares. In particular, this last hypothesis is increasingly plausible as diffusion of certification is being resulting from adoption by late-adopters and laggards, which partly coincide with the publication of ISO 9000:2001.

In the same way, the impact of intensity of industrial investment in R&D is not easy to be anticipated. In R&D intensive industries, quality signing, product quality and conformity seem to be more diffused concerns. Consequently, certification is expected to be higher in less R&D intensive sectors. However, in R&D intensive industries product quality, technology capabilities and product differentiation might be more important than quality labels.

Furthermore, we expect that the more important is the UK as trade partner for industrial trade, the highest the level of industrial the diffusion of certification, especially with ISO 9000. ISO standards were based on national British standards, and diffusion there

occurred much earlier than in other countries. Given the long-tradition on developments and inclusion of industrial environmental concerns on laws and trade agreements to a certain extent alternative to ISO 14001, trade with Germany is not expected to favour the diffusion of ISO 14001. Given instead the absence of environmental concerns on the foreign and trade US policy in the last ten years, trade with the US is also expected to have a negative effect on the diffusion of ISO 14001. Finally, intensity of trade with EU is expected to increase the levels of industrial certification, as Europe represents 51.5% of world ISO 9000 certificates (49.2% of the world ISO14001 certificates) in 2001 and 48.9% in 2005 (43% of the world ISO14001 certificates). Still, this effect of industrial trading relationships with specific partners might be different for EU and for non-European countries.

Diffusion of ISO 9000 and ISO 14001 across countries and industries

National differences in the level of certification with ISO 9000 and ISO 14001 exist (ISO 2001, 2004, 2007). However, the ranking of countries with highest number of certificates has not been static. Until 2001, the UK was the country with the highest number of ISO 9000 certificates. France, instead, lagged behind in third place behind the UK and US until 1994, and fifth from 1997 to 1999 following the US, Germany and Italy. In December 2001, the UK is followed immediately by China, followed by Italy, Germany, and the US. Following the publication of ISO 9000:2000, there was a shift in the ranking of countries concerning the total number of ISO 9000 certificates. In December 2005, China and Italy were the leaders in the number of certificates, followed by Japan, Spain, UK, US and then Germany.

Contrary to ISO 9000 and despite the existence of a previous national standard, the British leadership in the number of ISO 14001 certificates was short. In 1997, Japan became the leader, and from 2001 the UK is no longer the European country with the highest number of ISO 14001 certificates, Germany took the European leadership. Some changes on the ranking of countries with more certifications were also observed from 2001 to 2005 even that fewer than the ones observed in the ranking of ISO 9000 certificates. In particular, Japan is still in 2005 the leader in ISO14001 certification. In 2005, Japan is followed by China, Spain, Italy and the UK. From 2001 to 2005, Germany lost its second place to occupy the eighth position, and Sweden lost its fourth place to occupy the eleventh.

The ratio of ISO 14001 to ISO 9000 certificates suggests the existence of three main groups of countries with different ranges of ISO 14001 to ISO 9000 ratios. The first group refers to Finland, Japan, Korea, Brazil, Spain, and Czech Republic that have about one ISO14001 certificate for five ISO 9000 certificates. These countries seem to have high environmental concerns diffused among their businesses. Opposite to this green-country group is the group composed by India, Italy, China, and Portugal for which the number of ISO 14001 certificates is less than one to ten.

Results from the ratio of ISO 14001 and ISO 9000 across industries suggest that cross-industrial differences on the business environmental concerns exist. In particular, nuclear fuel, and recycling show a higher number of ISO 14001 than ISO 9000, followed by water, gas and electricity supply, coke, mining, other social services, public administration and pharmaceuticals. This group shows a ratio of ISO 14001 to ISO 9000 certificates between one to two, and one to five. These industries are however, as we saw before, the least adopters of both certificates. The group of industries with lowest ISO 14001 to ISO 9000 certificates (1 to 50 to 1 to 12), include health and social work, education, engineering and other services, information technologies, financial intermediation, construction, concrete, leather and textiles. Except for building and other business services, the ten largest adopting industries are in the middle group with a ratio of ISO 14001 to ISO 9000 certificates between 1 to 6 and 1 to 11.

Concerning the industrial distribution of certificates, in 2005, the ten largest adopting

industries of 9000 are the same as the largest adopting industries of ISO 14001 certificates. They include construction, basic metals, electrical and optical equipment, and basic metals. These industries have been the largest adopters of certification since the late 1990s (ISO, 2001, 2005). Laggards are water, gas supply, publishing, shipbuilding, aerospace, wood products, publishing and nuclear fuels.

In sum, the number of ISO 9000 and ISO 14001 certificates are not similar across countries or industries. In the next section, we will analyse the relative importance of national and industries fixed effects and explore the importance of cross-country and cross-industries factors, such as openness to international trade, productivity, investment in R&D, or trade networks, in explaining the industrial level of certification.

Reasons for diffusion of certification in manufacturing

Table 1 – Results of the negative binomial estimation of the number of industrial ISO 9000 and ISO 14001 certificates

	ISO 9000		ISO 14001	
	Model1	Model 2	Model1	Model 2
year1	0.18*** (0.07)	0.14*** (0.03)	0.44*** (0.06)	0.36*** (0.05)
Sharegdp	24.66** (10.66)	1.50 (2.26)	6.54 (5.08)	0.13 (2.43)
Labprod	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)
export_p	-2.1*** (0.71)	0.65* (0.36)	-2.18*** (0.66)	1.81*** (0.50)
import_p	-0.49 (0.36)	-0.42** (0.20)	0.03 (0.31)	-0.95*** (0.26)
Rdgdg	2.63 (1.75)	3.77*** (0.79)	3.83** (1.53)	1.65 (1.17)
Eu	1.11*** (0.37)	1.99*** (0.36)	0.06 (0.38)	-1.19** (0.53)
trade_ge	3.22*** (0.92)	2.4*** (0.67)	1.38 (1.12)	0.03 (1.12)
trade_uk	7.65** (3.95)	5.29*** (1.54)	7.45** (3.39)	5.37** (2.21)
trade_us	-0.65 (0.91)	0.36 (0.42)	1.41** (0.71)	-0.01 (0.50)
trade_eu	-2.0*** (0.60)	0.19 (0.40)	-1.19** (0.62)	0.98* (0.57)
Country dummies		Significant		Significant
Industry dummies		Significant		Significant
Constant	6.63*** 0.67	1.37 0.52	3.99*** 0.43	1.54*** 0.53
Observations	321	321	306	306
Df	11	27	11	27
Wald test	115.90***	3961.78***	291.45***	1349.52***

Log likelihood	-2427.07	-2128.43	-1741.55	-1600.09
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In this section, we will analyse the impact of industrial structure and performance characteristics in terms of openness to international markets, productivity, location of suppliers, innovativeness, as well as of trading relationships on the level of certification of different manufacturing industries. Table 1 presents the results of the negative binomial models of the number of ISO 9000 certificates (first two columns), and the number of ISO 14001 certificates (last two columns).

ISO 9000

Model II, which considers country and industry country-effects, provides a somewhat different picture from the Model 1. Results suggest that industrial certification has increased over time, as the coefficient of variable time is significant and positive, *ceteris paribus*. The lower the labour productivity, the greater the number of certificates is the industry expected to have. Industries with greater share of trade with Germany and the UK have larger number of certificates. The relative size of the industry, and the share of trade with the EU are not anymore significantly explaining the number of ISO 9000 certificates. Moreover, industrial export and R&D intensity now positively and significantly explain the number of industrial certificates, while the industrial import intensity is significantly and negatively explaining the number of certificates.

Results of the Model II without the variable R&D intensity, which allow including observations from Portugal and Switzerland, are similar to these ones, except for some trade networking variables. Difference refer to the fact that the industrial share of trade with the UK and Germany become non significant, while the share of trade with EU becomes positive and significant. Moreover, the coefficient of EU countries becomes negative and significant. These differences are not explained by the drop of the R&D intensity as independent variable.

Our results suggest that despite the existence of industrial and countries fixed effects, some identifiable cross-country and cross-industries strategies that favour certification with ISO 9000. In particular, industrial certification with ISO 9000 seems enhanced and complementary to the industrial efforts to increase presence in international markets and innovativeness, as well as to overcome low levels of labour productivity. Moreover, certification is associated with strategies to supply domestically. Certification seems also, to a certain extent, to be fostered by the level of industrial penalisation for non-certification. Additionally, industrial trading networks and national trade location affects the level of industrial certification with ISO 9000. Trading with Germany and with the UK seems to provide incentives for certification. Countries within the EU reveal a higher propensity to ISO 9000 certifications than the third countries.

ISO 14000

Model II, which includes country and industry fixed-effects, provides a different picture from the Model I. Results suggest that certification with ISO 14001 increased over time, as the coefficient of variable time is significant and positive. The level of ISO 14001 certificates is expected to be higher among industries that trade highly with UK and with low labour productivity. Export intensity is supporting significantly the number of certificates, while import intensity is limiting certification. Moreover, intensity of trade with the EU is now significantly and positively affecting the level of industrial certification. However, the fact that a country belongs to the EU countries influences negatively the level of certification.

Results of Model II without the variable R&D intensity, including observations from Portugal and Switzerland, are similar except for trade with UK that becomes non significant. This does not seem to be related to the dropping of variable R&D intensity.

Ratio ISO 14000/ ISO 9000

Table 2 presents the results of the OLS regression on the ratio of ISO 14001 to ISO 9000 certificates.

Table 2 – Results of the OLS model of the ration of ISO 14001 to ISO 9000 certificates (Backward method)

	ratio ISO 9000 to ISO 14001 (with R&D intensity)	ratio ISO 9000 to ISO 14001 (without R&D intensity, including observations of Portugal and Switzerland)
year1	0.03 (0.02)	0.03 (0.02)
sharegdp		-1.18 (1.04)
labprod	0.00 (0.00)	0.002*** (0.00)
export_p	0.29* (0.16)	0.41** (0.18)
import_p		-0.16* (0.09)
Rdgdg	-1.04*** (0.41)	
Eu	-0.67*** (0.22)	-0.24** (0.11)
trade_ge	-0.47*** (0.46)	-0.48** (0.24)
trade_uk	1.65** (0.80)	0.68 (0.56)
trade_us	0.48*** (0.18)	0.21 (0.17)
trade_eu	0.49* (0.25)	0.23* (0.14)
Country		
Finland	0.60*** (0.11)	0.54*** (0.08)
Japan		0.49*** (0.09)
Industry		
Chemical	0.22** (0.10)	0.14* (0.08)
Other manuf.	0.31*** (0.11)	0.28*** (0.09)
Constant	-0.03 (0.22)	-0.14 (0.13)
Observation	305	355
F-test	F(15, 289) = 9.37***	F(14, 340) = 11.39***
R-squared	0.3273	0.3192
Adj R-squared	0.29	0.29

Root MSE	0.4445	0.42016
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Results suggest that the ratio of ISO 14001 to ISO 9000 is higher in industries with higher export intensity and lower R&D intensity. Trade with the UK has the highest positive impact on the ratio, followed trade with the EU and the US. Trade with Germany instead seems to be associated with a lower ratio. The ratio is higher for chemical and other manufacturing industries, *ceteris paribus*. European countries are more likely to have a lower ratio of ISO 40001 to ISO 9000 certificates, except Finland, *ceteris paribus*. Time does not explain differences in the ratio ISO 14001 to ISO 9000 across countries and industries.

We run the same model without variable R&D intensity to allow including observations for Portugal and Switzerland (Table 2, column 2). The coefficients of the variable labour productivity turns out positive and significant, while industrial import intensity turns out negative and significant. Moreover, trade with UK and US becomes non-significant.

Hence, our results suggest that certification with ISO 14001 is fostered by industrial management strategies to supply domestically, to increase export propensity and to overcome lower levels of labour productivity. Moreover, the industrial trade relationships also play a role. Trading with the UK, and to a lesser extent with EU provide incentives for certification with ISO 14001. Countries within the EU have fewer incentives for certification with ISO 14001 than the third countries to EU. Industrial and countries fixed effects also affect the level of industrial certification with ISO 14001.

Discussion

Our results suggest that there are some identifiable cross-country and cross-industries strategies that favour certification. The level of industrial certification with ISO 9000 and ISO 14001 seems associated with strategies to increase presence in international markets, to manage domestic supplies, as well as to overcome the market penalisation for not certifying and for presenting low levels of labour productivity. The level of industrial certification with ISO 9000 is also associated with R&D intensive production activities. Therefore, our results suggest that ISO 9000 and ISO 14001 can be seen as a management tool to expand presence in international markets by signalling control and conformity of quality and the sustainability of production of domestically supplied industries with low levels of labour productivity, but making some serious efforts towards innovation. This pattern of diffusion seems to reflect the fact that certification is reaching late-adopters and laggards, which aim at participating in global markets despite their lower productivity, at avoiding penalisation in their industry, and at tapping forms of improving their efficiency and innovative performance.

Moreover, our results suggest industrial trading networks and national trade location affects the level of industrial certification. Trading with the UK seems to create incentives for certification with both ISO 9000 and ISO 14001. Trading with Germany provides incentives for certification with ISO 9000, and trading with EU encourages certification with ISO 14001. Moreover, trade with the UK, and, to a lesser extent, with the EU and US is associated with an high ISO 14001 to ISO 9000 ratio, while trade with Germany is associated with a low ratio. Consequently, trading relationships also affect the levels of industrial certification in one country.

However this effect is not to be unique for EU and non-EU countries. Indeed, our results suggest that different countries have put different efforts towards the diffusion of certification with ISO 9000 and ISO 14000. In particular, non-EU countries seem to have put in place more efforts towards the adoption of ISO 14001 certification, while EU countries have put more efforts on the diffusion of ISO 9000. Hence, EU countries, except Finland are expect to have a lower ratio of ISO 14001 to ISO 9000. This might be related to the fact that

ISO 9000, which has been developed after the British BS5750 standard, has been until 2001 a mark of European business attitude. As seen in section 4, the UK has been the world leader until 2000, when the ISO 9000:2000 was published. Instead, Japan has been the world leader on ISO 14000 certification since 1997. Thus, the ratio ISO 14001 to ISO 9000 seems mainly disadvantageous to the traditional European business model, and favourable to the business attitude of Scandinavian, Japan, and to a lesser extent Korea and some developing countries.

Industrial fixed effects seem as well to play a role on the level of industrial certification. Compared to transport equipment industry, our reference category, basic metals, electrical and optical equipment, food industries, and machinery and transport have a much higher propensity to certification with both ISO 9000 and ISO 14001 than the other industries. Instead, pharmaceutical industry shows a significant negative propensity when compared to transport equipment industry. All the other industries show a higher propensity than transport equipment but not as high as the referred above. These results suggest that ISO 9000 and ISO 14001 may play different roles as co-ordination mechanism of business relationships, and eventually as source of enhancing product conformity and reliability, in different industrial manufacturing sectors.

In particular, ISO 14001 certification is relatively more important than ISO 9000 in industries with higher export and labour productivity and lower R&D intensity, consequently on capital intensive industries with slow technical change, as well as in industries that source-domestically. Additionally, the environmental concerns are particularly high in chemical and other manufacturing *ceteris paribus*, which seem to reveal the effect of final demand environmental concerns, and the importance of brands.

Conclusions

This paper has aimed at exploring the importance of structure and network dynamics in explaining innovation diffusion, focusing on the case of ISO 9000 and ISO 14001 certification. In particular, it analysed the impact of industrial openness to international markets, innovativeness and productivity, as well as of the configuration of industrial and national trade networks on the level of certification with ISO 9000 and ISO 14001, in 15 manufacturing industries, in eight OECD countries.

Our findings suggest that ISO 9000 and ISO 14001 supports entry in international markets by signalling compliance with international management rules for assurance of product quality and environmental impact of production, especially in domestically sourced industries and in industries with low labour productivity. ISO 9000 seems also to be a sign for efforts towards innovation. This pattern of diffusion seems to reflect the fact that adoption of ISO 9000 and ISO 14001 have extended to late adopters and laggards firms, industries and countries. In this sense, adoption is not anymore related to maintenance of performance advantages, but instead it is driven by the aim to access markets and to signal compliance with international rules of local production.

Besides these structural characteristics of industries, the national and the industrial specific configurations of the de networks also explain cross-industry and cross-industry differences in the levels of certification. In particular, the more British trading partners are important for an industry, the higher the level of industrial certification both with ISO 9000 and ISO 14001 is expected to be. Similarly, the more European trading partners are important, the higher the industrial level of ISO 14001 certification. Trading with German actors seems instead to favour certification with ISO 9000. In addition, being part of the EU market favours adoption of ISO 9000, but not adoption of ISO 14001.

Cross-country and cross-industry differences are also found on the relative role of ISO 9000 and ISO 14001. *Ceteris paribus* a management culture stressing environmental concerns seems particular important in Scandinavian countries, Japan, Korea, as well as chemical and

other manufacturing.

In sum, this paper contributes to the debate on the importance of structure and network positioning in explaining diffusion of ISO 9000 and ISO 14001 certification. The diffusion of ISO 9000 and ISO 14001 seems to depend on the network configurations, on the national and industrial context, however the inherent characteristics of actors also influence the firms' estimation of adoption benefits. The specific industrial and national management attitude might influence the relative importance of ISO 9000 and ISO 14001 certification in the 2000s. Still, the strategies underlying diffusion of both standards are similar: signalling conformity with international management rules of domestically-sourced production activities with low-productivity in order to be allowed in international markets. The only difference between ISO 9000 and ISO 14001 as management tool seems to refer to the fact that ISO 9000 may also be used as a tool to sign innovative efforts.

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