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Certification intensity level of the leading nations in ISO 9000 and ISO 14000 standards

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Abstract

Purpose – As the process of standardisation in all aspects of business management has accelerated in recent years in an environment characterised by economic globalisation and integration, two series of standards issued by the International Organisation for Standardisation (ISO) stand out: the ISO 9000 series, related to the implementation of quality systems; and the ISO 14000 series, related to the implementation of environmental management systems. The purpose of this paper is to analyse and compare the evolution of both standards in the leading countries in these certifications.

Design/methodology/approach – It is noteworthy that the same few nations consistently occupy the highest rankings in both the number of ISO 9000 and ISO 14000 series certifications. These countries are also those with highest growth rates in certifications. The present study examines these phenomena in terms of: a proposed new index for measuring the "certification intensity"; and a proposed model to analyse how standards are disseminated in a given country.

Findings – The leading nations in ISO 9000 and ISO 14000 series certifications have a common spreading pattern. All of them are increasing in both standards, not only in absolute number of certifications, but also in its certification intensity. On the other hand, the logistic curve is a good pattern to forecast the trend of these intensities.

Originality/value – The paper concludes with some forecasts and trends for the immediate future in the most successful countries. Some suggestions are also made for future research.

Keywords Standardization, Quality management, Environmental management, ISO 9000 series, Diffusion

Paper type Research paper

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1. Introduction

In recent years there has been a significant increase in the number of regulatory standards that have been proposed and implemented in a range of industries and business activities. This growth in standardisation has been driven by several factors, of which the most notable has been the significant expansion in economic globalisation and integration in the past two decades (Boiral, 2001; Mendel, 2001). Although there has been a general movement towards market liberalisation, the global economy continues to be governed by "rules", as evidenced by the proliferation of international standards (Nadvi and Wältring, 2002).

Standardisation can be defined in general terms as the establishment of order regarding various repetitive applications in industry, technology, science, and economics (Dale, 2002). Standardisation originally arose at the beginning of the twentieth century with the twin aims of limiting the diversity of components and promoting their inter-changeability—thus facilitating the economic production and maintenance of products and services. In theory, standardisation fosters international trade by eliminating obstacles arising from different national practices; however, if standards are not truly global, they can effectively become non-tariff barriers for international business relations by imposing additional requirements on the production of products and services (Krugman and Obstfeld, 2003; Blanco and Bustos, 2004).

The dissemination of effective international management standards would thus appear to be closely linked to the dynamics of the globalisation process itself. As outsourcing and relocation of business activities become increasingly adopted as cornerstones of a successful global business strategy, a certain degree of homogeneity in business management systems and processes is obviously desirable. However, in the absence of a global regulating authority, the task of designing, implementing, and enforcing standards has increasingly tended to be taken on by various non-government regional or global institutions (Brunsson and Jacobsson, 2000; Abbott and Snidal, 2001; Christmann and Taylor, 2006; Neumayer and Perkins, 2005; O'Rourke, 2006).

Two series of standards issued by the International Organisation for Standardisation (ISO) stand out among the proliferation of new standards as a result of their wide and successful dissemination:

(1) the ISO 9000 series, related to the implementation of quality systems; and

(2) the ISO 14000 series, related to the implementation of environmental management systems.

In the specialised literature there have been some attempts to approach how these standards have spread over the world. Corbett and Kirsch (2001, 2004) and Vastag (2003) have given some clues from the geographical point of view, but not from the dynamical view. They do not study the evolution of the standard from its appearance in a specific country until the present day. Saraiva and Duarte (2003) and Franceschini *et al.* (2004) enriched the debate by including this dynamic dimension. Later on, Marimon *et al.* (2006, 2009) and Casadesus *et al.* (2008) proposed new indicators to assess and analyse these disseminations. On the other hand, Albuquerque *et al.* (2007) analysed the global diffusion of the ISO 9000 and ISO 14000 series, using a diffusion model which includes several possible cross-country contagion effects; they found that the diffusion of ISO 9000 is driven primarily by geography and bilateral trade relations, whereas that of ISO 14000 is driven primarily by geography and cultural similarity.

Although it has not been underlined before in the literature, it is noteworthy that the same few nations consistently occupy the highest rankings in both the number of ISO 9000 and ISO 14000 series certifications. These nations are also those with highest growth rates in certifications. The present study examines these phenomena in terms of:

- a proposed new index for measuring the "implementation intensity" of certifications; and
- the logistic curve as a model of how new standards are disseminated in a given country.

2. Certification intensity of ISO 9000 and ISO 14000 implementation

According to the most recent data from the ISO, 951,482 firms in 175 countries are currently ISO 9001-certified and 154,572 firms in 148 countries are ISO 14001-certified (ISO, 2008). As shown in Tables I and II, China, Italy, Japan, and Spain consistently lead the ranking of certifications in both standards; indeed, during the past three years, these four countries have occupied the highest rankings with respect to both standards.

Apart from the absolute numbers of certifications in each country, the intensity of implementation of these standards can also be assessed in terms of the relationship between the number of certifications in each country and the GDP of that country (Marimon *et al.*, 2006; Casadesús *et al.*, 2008). However, because fluctuations in prices and currencies can make international comparisons of GDP problematical, the present study proposes a new indicator of "intensity of certifications" that utilises the internationally recognised measure of "purchasing power parity gross national income" (PPP GNI). The PPP GNI is calculated by considering gross national income (converted to international dollars) in terms of purchasing power parity. (An "international dollar" has the same purchasing power in terms of GNI as a US dollar has in the United States.)

Table III shows the "intensity of certifications" for 2002–2007, expressed in terms of this new indicator. For convenience, the indicators for ISO 9001 and ISO 14001 are referred to here as "i9" and "i14" respectively (in place of the "r9" and "r14" indicators used in Marimon *et al.*, 2006 and Casadesús *et al.*, 2008).

These indicies show that Italy is the country with the highest effort to spread ISO 9000 standard, above China and Spain, although China has a higher absolute number of certifications. Regarding to the effort to spread the ISO 14000 standard, Spain is above the other leading countries, although China and Japan have double the ISO 14000 certifications of Spain.

3. Diffusion model

The literature on the dissemination of management tools and systems is extensive (Rogers, 1995), as is the literature on the dissemination of innovations (both tangible and intangible) in general (Teece, 1980). In most cases, the adoption of innovations over time follows a sigmoid (S-shaped) curve that reflects three phases:

(1) an innovation is adopted at a low rate in its initial stages (producing a relatively "flat" curve);

(2) the rate of adoption then increases (producing a "steeper" curve); and

(3) the process reaches a saturation point (producing another relatively "flattening" of the curve) (Stoneman, 1995).

Table I. Ranking and number of world-wide ISO 9000 certifications (2002-2007)

	2002		2003		2004		2005		2006		2007	
China	1	75,755	1	96,715	1	132,926	1	143,823	1	162,259	1	210,773
Italy	2	61,212	2	64,120	2	84,485	2	98,028	2	105,799	2	115,539
Japan	6	33,964	3	55,916	4	48,989	3	53,771	3	80,518	3	73,176
Spain	7	28,690	6	33,125	5	40,972	4	47,445	4	57,552	4	65,112
Total sample		173,800		249,876		307,372		343067		406,128		464,600
Total world-wide		561,747		567,985		670,399		776608		897,866		951,486
Percentage		30.94		43.99		45.85		44.18		45.23		48.83

Source: Compiled from ISO (2003-2008) data

Table II.
Ranking and number of world-wide ISO 14000 certifications (2002-2007)

				2002		2003		2005		2006		2007
China	5	2,803	3	5,064	2	8,862	2	12,683	2	18,842	1	30,489
Italy	7	2,153	2	3,066	4	4,785	4	7,080	4	9,825	4	12,057
Japan	1	10,620	1	13,416	1	19,584	1	23,466	1	22,593	2	27,955
Spain	3	3,228	4	4,860	3	6,473	3	8,620	3	11,125	3	13,852
Total sample		18,804		26,406		39,704		51,849		62,385		84,353
Total world-wide		49,449		66,070		90,569		111,162		129,199		154,572
Percentage		38.03		39.97		43.84		46.64		48.29		54.57

Source: Compiled from ISO (2003-2008) data

With regard to the dissemination of the ISO 9000 and ISO 14000 series standards, Corbett and Kirsch (2001) proposed a regression model to analyse the number of ISO 14001 certificates in a given country in terms of its exporting capacity, its degree of commitment to the environment, and the number of ISO 9000 series certificates already issued in that country. The authors concluded that the number of ISO 9000 series certificates in a given country is related to the number of ISO 14001certificates issued in the same country. Although this is an interesting observation, the study was of a static nature and did not analyse how the dissemination of the two standards has occurred over time; nor did the study analyse dissemination of the standards within specific industry sectors (which, as the authors noted in the conclusions, would be an interesting analysis).

Other authors (Franceschini *et al.*, 2004; Marimon *et al.*, 2006, 2009; Casadesús *et al.*, 2008) have established that the so-called "logistic curve" (the most commonly occurring sigmoid curve) provides a good description of the dissemination of ISO 9000. The logistic curve was first applied by the nineteenth century Belgian mathematician, Verhulst, to account for the growth rate in the population of a given biological species – which is at a maximum when there are few individuals to compete for limited resources, but which decreases to zero once a certain saturation population is reached in terms of the available resources.

The logistic curve is expressed by the following equation:

$$N = \frac{N_0 K}{(K - N_0)e^{-r_0 t} + N_0}$$

in which:

- N represents the number of individuals (over time);
- N_0 represents the number of individuals at the starting point;
- K is the saturation level;
- r_0 is the initial growth rate; and
- t is independent variable (time).

The kernel of the model is the differential equation:

$$\frac{dN}{dt} = rN$$

	i9 (ISO 9000 intensity)[a]						i14 (ISO 14000 intensity)[a]					
	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007
China	20.76	23.47	28.40	26.84	26.30	29.76	0.77	1.23	1.89	2.37	3.05	4.30
Italy	40.27	41.31	53.26	60.54	62.44	65.18	1.41	1.98	3.02	4.37	5.80	6.80
Japan	9.78	15.66	12.96	13.57	19.19	16.55	3.06	3.76	5.18	5.92	5.38	6.32
Spain	29.30	32.22	37.47	40.78	45.38	47.07	3.30	4.73	5.92	7.41	8.77	10.01

Note: [a]Expressed in certifications per 1.00 E+09 current international $
Source: Compiled from ISO (2003-2008) data

Table III.
ISO 9000 and ISO 14000 intensity certification index (2002-2007)

The increase of a population is proportional to its size (N), where rate r (whose units are the inverse of time) represents the proportional increase of the population N in one unit of time, and it varies according to the expression:

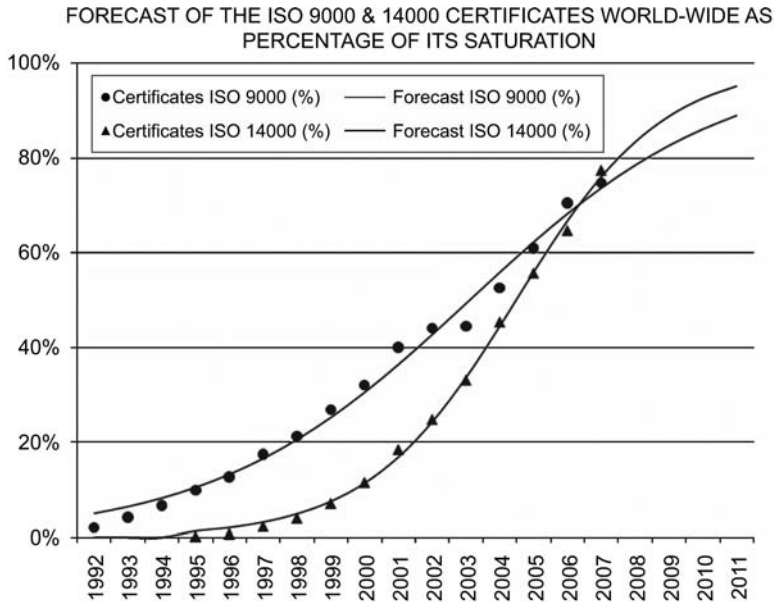
$$r = r_0\left(1 - \frac{N}{K}\right)$$

Marimon *et al.* (2006) established that the logistic model is also applicable to the ISO 14001 standard-based on the premise that an increase in the number of certificates for both standards is proportional to the number of existing certificates at a given time. Marimon *et al.* (2006) also noted that the dissemination of the ISO 14000 series was similar, in several economic sectors that the authors analysed. The authors thus concluded that the two standards are similar in terms of their dissemination. This is in accordance with the findings of Corbett and Kirsch (2001, 2004) and Vastag (2003), who had already established that the number of ISO 9000 series certifications in a given country is one of the factors that accounts for the number of new ISO 14001 certifications in that country.

Figure 1 shows the logistic curve that results from applying the above equation to the most reliable current worldwide data (ISO, 2008). (It should be noted in passing that that ISO 9000 and ISO 14000 series certificates are issued by local entities in each country, and that there is therefore no "official" database of certified companies.) The *Y*-axis shows the percentage of its saturation level (k) in both standards to enable the comparison of both evolutions. It is apparent from Figure 1 that the logistic curve fits the best-available certification data perfectly, with a fit of more than 99 per cent for "*R* squared" in both curves. It would seem that the implementation level for ISO 9001 is approximately 74.8 per cent and that for ISO 14001 is approximately 77.5 per cent. As Marimon *et al.* (2006) have noted, ISO 14001 has therefore experienced a somewhat faster growth than ISO 9001. This model forecasts that the 95 per cent saturation level on a worldwide scale would be 1,272,197 ISO 9001 certificates and 199,506 ISO 14001 certificates.

Figures 2 and 3 (for ISO 9000 series) and Figures 4 and 5 (ISO 14000 series) show individual analyses for the four countries (China, Italy, Japan, and Spain) that are on the top of the worldwide rankings for certifications. It can again be observed that the logistic curves fit the empirical data. Other patterns also render a high *R* squared, but the s-shaped curve is preferred. Following Teece (1980), this pattern is quite common in the dissemination of innovative technologies.

It can also be noted that the initial growth rate in the number of ISO 9000 series certifications has been similar in three of the four countries ($r_0 = 0.41$), with the exception of China (which had a somewhat higher index). The initial growth rate in ISO 14000 certifications has been much higher in all four countries (with the index in all cases exceeding 0.50). This information, together with the data in Tables I and II, clearly demonstrates that worldwide growth in ISO 14000 certification has been greater than that of ISO 9000 series; indeed, the initial growth rate in worldwide ISO 9000 certification was 0.26, while that of ISO 14000 certifications was 0.46. The ISO 14000 series certifications growth at the beginning of its life was almost twice the growth of the ISO 9000 series in its first years of existence. On the other hand, the ISO 14000 standards were published later than the ISO 9000 standards. The difference



Forecast of ISO certificates world-wide considering the logistic curve.

	ISO 9000			ISO 14000		
	DF	Sum Sq		DF	Sum Sq	
Regression	3	4.11 E12		3	7.00 E10	
Residual	13	1.26 E10		10	5.82 E7	
Uncorrected total	16	4.12 E12		13	7.01 E10	
(Corrected total)	15	1.36 E12		12	3.36 E10	
R-squared	0.991			0.998		
	Value	LL	UL	Value	LL	UL
N_0	64,402.57	43,258.96	85,546.18	2,553.82	1,684.90	3,422.73
K	1,272,196.60	982,934.84	1,561,458.35	199,505.73	176,721.89	222,289.57
r_0	0.26	0.21	0.317	0.46	0.41	0.51

LL: Lower limit of the 95% confidence interval
UL: Upper limit of the 95% confidence interval

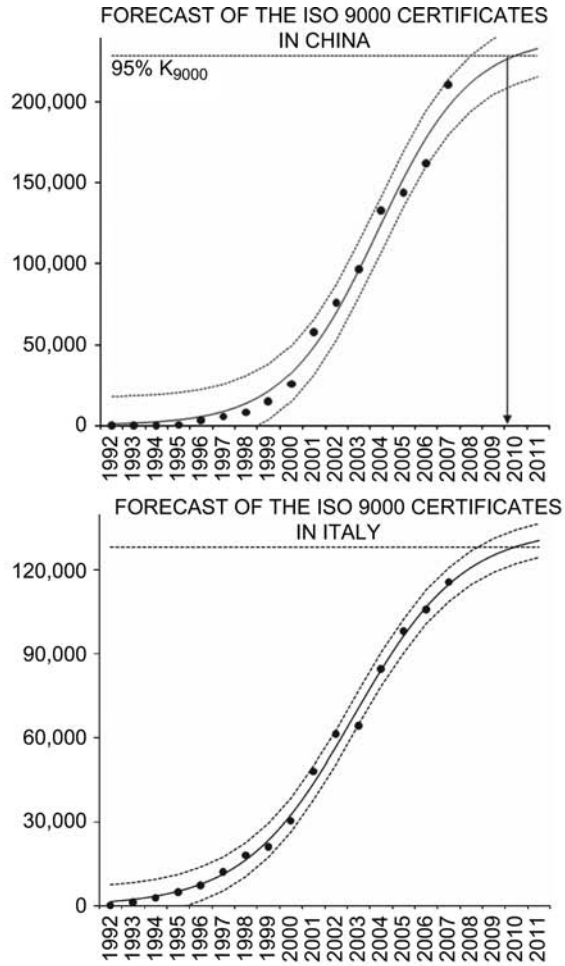
Source: Compiled from ISO (2008) data

Figure 1.
Logistic curves and forecast of certifications for ISO 9000 and ISO 14000 world-wide

between the initial growth rates explains why the percentage of ISO 14000 saturation is now above the percentage of ISO 9000, although it began some years later.

Here, a question arises: What are the causes that explain the gap between these different initial growths? The comparative study between the diffusion of ISO 9001 and ISO 14001 highlights the high rate of initial growth of ISO 14001 in comparison to the initial growth experienced by the ISO 9000 series. What are the causes that may explain this difference? It can be found in the analysis of the literature focused on the genesis of these two standards.

First, it must be borne in mind that the first phase of growth of the ISO 9000 series, in the late 1980s and early 1990s, was located mainly in the former European Community, particulalry in the UK, due to the experience of that country to BS 5750.

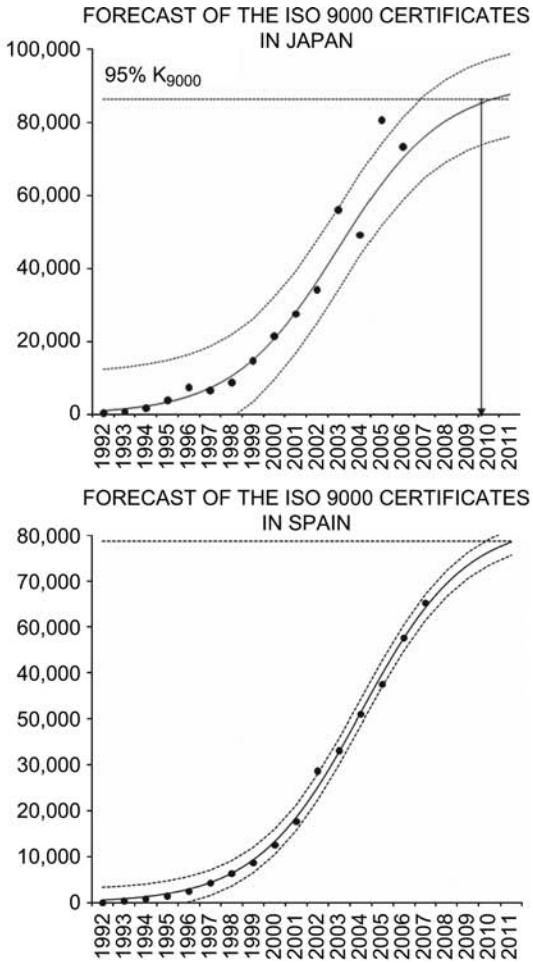


	China		Italy	
	Sum Sq	DF	Sum Sq	DF
Regression	1.28 E11	3	5.33 E10	3
Residual	8.20 E8	13	1.02 E8	13
Uncorrect total	1.28 E11	16	5.34 E10	16
(Corrected total)	7.34 E10	15	2.49 E10	15
R-squared	0.989		0.996	
	Value	Standard error	Value	Standard error
N_0	795.33	431.61	1,569.379	346.64
K	240,563.86	23,788.17	134,915.913	6,542.41
r_0	0.48	0.06	0.41	0.03

Figure 2.
Logistic curve and forecast of ISO 9000 certifications in China and Italy

Note: The dotted lines at both sides in the figures are the lower limit and upper limit of the 95% confidence interval. The 95% K_{9000} lines in the figures represent the 95% of the saturation level

Source: Compiled from ISO (2008) data

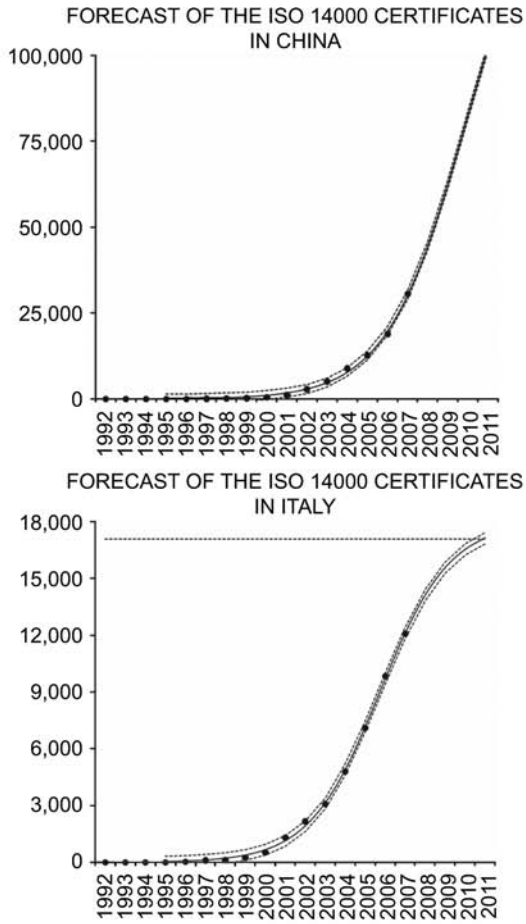


	Japan		Spain	
	Sum Sq	DF	Sum Sq	DF
Regression	2.26 E10	3	1.40 E10	3
Residual	3.58 E8	13	2.16 E7	13
Uncorrect total	2.30 E10	16	1.40 E10	16
(Corrected total)	1.10 E10	15	7.30 E9	15
R-squared	0.968		0.997	
	Value	Standard error	Value	Standard error
N_0	1,006.34	640.99	581.49	126,093
K	90,599.68	13,367.69	82,824.15	4,857.77
r_0	0.41	0.07	0.41	0.02

Note: The dotted lines at both sides in the figures are the lower limit and upper limit of the 95% confidence interval. The 95% K_{9000} lines in the figures represent the 95% of the saturation level

Source: Compiled from ISO (2008) data

Figure 3.
Logistic curve and forecast of ISO 9000 certifications in Japan and Spain

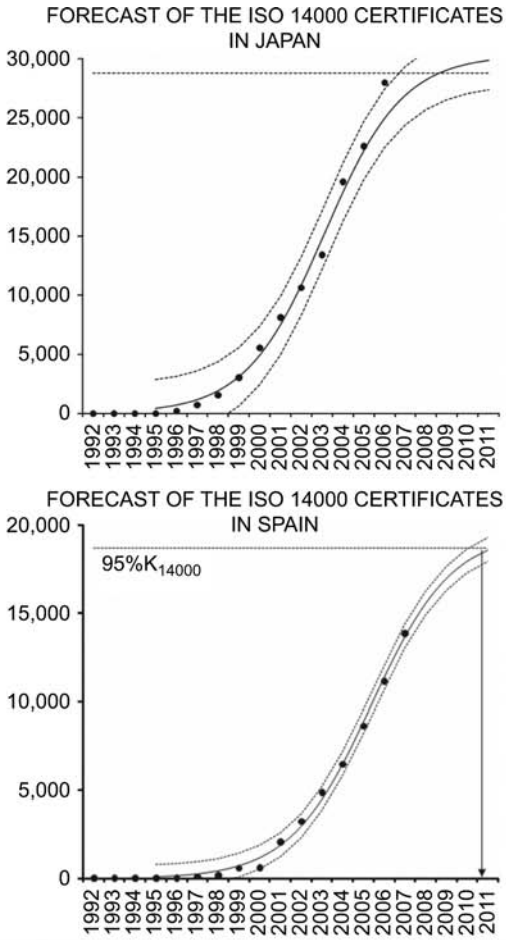


	China		Italy	
	Sum Sq	DF	Sum Sq	DF
Regression	1.56 E9	3	3.31 E8	3
Residual	3.25 E6	10	0.17 E6	10
Uncorrect total	1.56 E9	13	3.31 E8	13
(Corrected total)	1.06 E9	12	2.00 E8	12
R-squared	0.997		0.996	
	Value	Standard error	Value	Standard error
N_0	87.61	34.86	39.58	7.35
K	162,312.97	127,577.45	17,972.11	964.24
r_0	0.50	0.05	0.57	0.02

Note: The dotted lines at both sides in the figures are the lower limit and upper limit of the 95% confidence interval. The 95% K_{14000} lines in the figures represents the 95% of the saturation level

Source: Compiled from ISO (2008) data

Figure 4.
Logistic curve and forecast of ISO 14000 certifications in China and Italy



	Japan		Spain	
	Sum Sq	DF	Sum Sq	DF
Regression	2.61 E9	3	4.70 E8	3
Residual	1.24 E7	10	0.89 E6	10
Uncorrect total	2.63 E9	13	4.71 E8	13
(Corrected total)	1.19 E9	12	2.66 E8	12
R-squared	0.990		0.997	
	Value	Standard error	Value	Standard error
N_0	405.39	160.23	96.68	28.21
K	30,279.76	2,191.40	19,642.21	1,877.22
r_0	0.53	0.06	0.51	0.04

Note: The dotted lines at both sides in the figures are the lower limit and upper limit of the 95% confidence interval. The 95% K_{14000} lines in the figures represents the 95% of the saturation level

Source: Compiled from ISO (2008) data

Figure 5.
Logistic curve and forecast of ISO 14000 certifications in Japan and Spain

The European Commission promoted the adoption of this standard by the European companies when the harmonisation process was established to create the common European market in 1992 (Tsiotras and Gotzamani, 1996; Crowe *et al.*, 1998; Anderson *et al.*, 1999; Mendel, 2002). In this first phase, in the USA and in Japan the adoption of these standards was much less intensive, because these two trading blocs were then very critical towards the ISO 9000 series. Over the years, these two blocks assumed that firms exporting to the Europe would inevitably have to be certified, and so, some important institutional agencies in these countries promoted the adoption of ISO 9000, among others the US Departments of Defence and Energy, the Food and Drug Administration and the Federal Aviation Administration (Anderson *et al.*, 1999; Crowe *et al.*, 1998).

Second, the ISO 14000 standards were created in the mid-nineties, when there was an overall institutional framework prone to a green production and consumption paradigm. Actually, the creation of this standard coincides with the 1992 Rio Summit, a forum that asked ISO to create an EMS standard (Mendel, 2002). Although the process to establish the ISO 14000 standards was controversial (Haufler, 1999), once enacted there was a clear consensus to adopt it by the three major economic blocs of the time: the USA, whose administration was afraid that EMAS could become a technical barrier to free trade, in the same way that ISO 9000 had been in the 1980s; Japan, whose administration gave strong support for the spread of the ISO 14000; the third bloc – European Community – started with the advantage of having the largest number of certified companies according to the ISO 9000 series, a standard very similar in structure and procedure to ISO 14001.

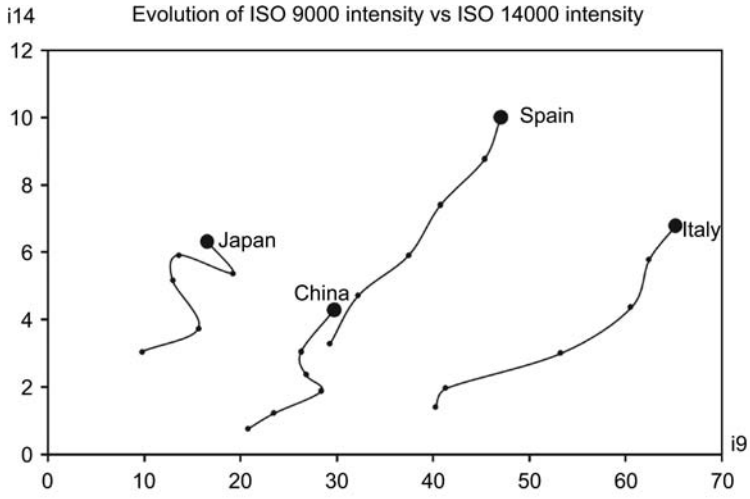
But the most important factor, in our view, is this third argument related to the endogenous nature of ISO 14001. This Standard was enacted in 1994, sheltered by the success of the ISO 9000 family of standards. Both Standards are very similar in terms of its methodology. Thus, the implementation of ISO 9000 series has clearly enabled the subsequent implementation of ISO 14001 (Montabone *et al.*, 2000; Corbett and Kirsch, 2001, 2004; Boiral, 2001, King and Lenox, 2001; Poksinska *et al.*, 2003).

4. Common features of growth in both standards

For the purpose of further analysis of the relationship between ISO 9000 certifications and ISO 14000 certifications, the "certification intensity" indicator (noted above) can be utilised. It has to be noted that the distribution of the countries on the diagram would be the same, taking directly the certificate numbers instead of the intensities. Nevertheless, the concept of intensities allows the analysis to readily compare different sized countries.

Figure 6 shows the certification intensity indices for both standards for China, Italy, Japan, and Spain. It is apparent that the certification intensity indices for these four countries are all generally rising. It is also apparent that the evolution of these standards is similar in Spain and Italy, although the former is making a greater effort with regard to ISO 14000, whereas the latter is focusing on ISO 9000. Japan and China also show a parallel trajectory, but both of these countries are at an earlier stage in the dissemination of the standards.

According to the classification proposed by Marimon *et al.* (2009), these four countries belong to the category of "expansionist behaviour". In contrast with this



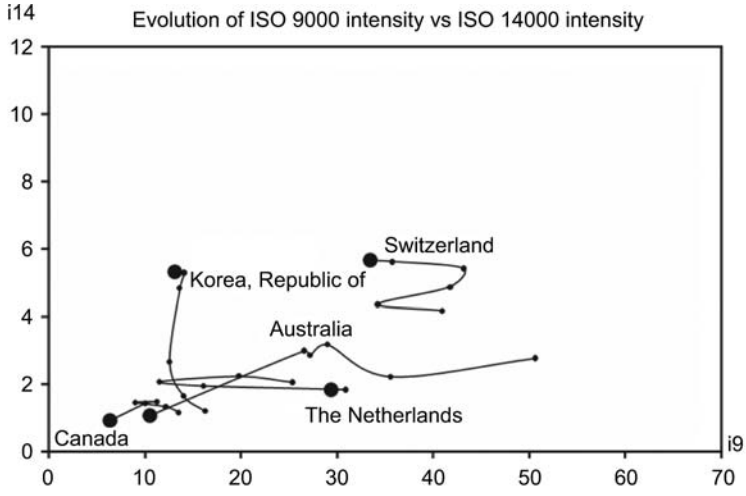
Note: The line of each county begins with the small dot (2002) and ends with the big dot (2007). The intermediate dots correspond to the consecutive years

Source: Compiled from ISO (2008) data

Figure 6.
Certification intensities of ISO 9000 and ISO 14000 (2002-2007) for China, Italy, Japan, and Spain

behaviour, Figure 7 shows the evolution of certification intensity indices for five other countries that have been less "expansionist".

It is apparent from Figure 7 that Switzerland shows an erratic evolution in terms of the intensity of ISO 9000 certification, but a slight steady growth in the intensity of ISO



Note: The line of each county begins with the small dot (2002) and ends with the big dot (2007). The intermediate dots correspond to the consecutive years

Source: Compiled from ISO (2008) data

Figure 7.
Certification intensities of ISO 9000 and ISO 14000 (2002-2007) for Australia, Canada, The Netherlands, Republic of Korea and Switzerland

14000 certifications. Australia and Canada show a decline in both indicators. The Netherlands graph ends almost at the point of departure; that is, its current situation is similar to the one it had in 2002. The Republic of Korea shows a big improvement with regard to the ISO 14000 standard; however, the other standard has declined slightly.

All of these analyses indicate that China, Italy, Japan, and Spain have a clear and consistent pattern. On the other hand, other countries follow different trends. All four demonstrate strong and sustained growth in both standards that is not seen in other countries. The question that arises is: Why is this so? Government policies that aim to promote both quality and environmental management, and an institutional positive attitude to the standards are likely to be two important factors (Heras *et al.*, 2008). Another possible explanation is the intensity of trade between these four nations and countries that also have a relatively high intensity of certifications (Potoski and Prakash, 2004; Neumayer and Perkins, 2005; Corbett and Kirsch, 2004). Potoski and Prakash (2009) have recently pointed out that ISO 9000 certification levels are associated with increases in countries' bilateral exports, particularly for developing countries' exports, which may be due to their more severe quality assurance challenges.

With regard to the governments of the four countries in question, Nadvi (2008) has contended that governments are increasing their influence in shaping the "rules of the game". Fryxell *et al.* (2004) claimed that the main drivers for certification in China were:

- ensuring regulatory compliance;
- enhancing the firm's reputation; and
- improving environmental performance.

Although these authors made no comment about the role of government in promoting the implementation of the ISO standards in China, other studies of China have noted the influence of public administration, especially with regard to ISO 14001 (Chan and Wong, 2006; Shin, 2005).

In Spain, some autonomous regions (such as the Basque Country and Catalonia) have initiated different policies from the rest of the country to encourage the implementations of the standards, with a remarkable success (Casadesus *et al.*, 2001; Heras *et al.*, 2008).

Italy has shown extraordinary growth in ISO 9000, but no specific studies have been conducted to explain this trend. The only relevant literature with regard to Italy is a forecast model of the growth (Franceschini, 2004). It is likely that the active role of some regional governments within Italy (e.g. Emilia-Romagna) could be an explanatory factor, as has been pointed out with regard to other standards (such as SA 8000) (Heras *et al.*, 2008).

Storz (2007) provided a possible explanation for China and Japan being somewhat less advanced than Italy and Spain in Figure 6. Because the ISO is dominated by European interests, Japan and China make relatively fewer proposals for international standards. As a result, European "prime movers" are setting the agenda for international standards, and "second movers" (such as China and Japan) suffer from information asymmetries.

Summarising, there are some common features in the spreading pattern of both standards in the four nations analysed. They are consistently at the top of the rankings, for both Standards, in recent years. The logistic curve explains well their

evolution with time. The intensity certification trends in both standards increase from 2002 to 2007: its lines evolve in parallel in Figure 6, generally towards the upper-right corner.

5. Conclusions

Four countries (China, Japan, Italy, and Spain) are consistently in the top ranking positions with regard to the number of ISO 9000 and 14000 series certifications. Moreover, these countries also demonstrate a commitment to the dissemination of ISO 9000 and ISO 14000 series standards, as reflected in their certification intensity indices. It would seem that a virtuous cycle has been established in these countries, whereby the more certifications they have, the greater is their certification intensity. This finding is in accordance with that of (Corbett and Kirsch, 2000, 2001).

It is also apparent that there is a positive relationship between growth in one standard and growth in the other. This finding is in accordance with that of Karapetrovic *et al.* (2006).

It would also seem that the prescriptive role of public administration plays an important role in extending the use of these standards. This finding is in accordance with that of Delmas (2002) and Potoski and Prakash (2004, 2009). It is also in accordance with the findings of Casadesus *et al.* (2001) and Heras *et al.* (2007, 2008), who have established that government support in the autonomous regions of Spain has facilitated the diffusion of both standards.

The findings of the present study require validation in subsequent studies. It is acknowledged that the conclusions of the present study are merely "working propositions", and more work is certainly required to establish their accuracy. However, the ideas put forward in this paper should be of interest to researchers who are working in this field in a variety of capacities (such as managers of multinational companies, accreditation and certification bodies, consultants, public-sector agencies, and so on).

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