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Diffusion of ISO 14001 environmental management system: global, regional and country-level analyses

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ABSTRACT

This paper explores the diffusion patterns of the ISO 14001 environmental management system worldwide. By using the data obtained from the ISO Survey of Certifications, the diffusion of ISO 14001 was investigated at global, regional, and country-specific levels. The results showed that both global and regional patterns resembled a typical logistic growth curve. The parameters of logistic curves were identified using nonlinear regression estimation, and the total number of ISO 14001 certificates issued was projected. At the country-specific level, correlation analysis was performed and three distinct groups were identified. The three groups resembled logistic growth curves with different growth rates. The spatial–temporal analysis showed that the diffusion of ISO 14001 was from west to east due to supply chain dynamics and change in the volume of total exports.

1. Introduction

Green production is a business strategy and an innovation that focuses on effectiveness and profitability through environmentally friendly design, procurement, production, and delivery processes. The ISO 14000 family of standards is designed to enable worldwide adoption of green production (ISO, 2012a,b) and covers various aspects of environmental management, assessment, and auditing at organizational, process, and product levels. In particular, the certification standard ISO 14001 has been widely adopted in a wide variety of organizations across the world since its creation in 1996.

ISO 14001 has been widely researched in different disciplines in the past twelve years (Albuquerque et al., 2007; Bansal and Bogner, 2002; Bansal and Hunter, 2003; Boiral, 2007; Corbett and Kirsch, 2001; Delmas, 2001, 2002; Gavronski et al., 2008; González-Benito and González-Benito, 2005; Heras-Saizarbitoria and Boiral, 2013; King et al., 2005; Lagodimos et al., 2007; Marimon et al., 2011; Morrow and Rondinelli, 2002; Nawrocka et al., 2009; Nishitani, 2010; Potoski and Prakash, 2004; Prakash and Potoski, 2006; Qi et al., 2011; To et al., 2012a; Viadiu et al., 2006; Vastag, 2004; Zeng et al., 2005). Some researchers focused on motivations for the standard's implementation (e.g. Bansal and Bogner, 2002; Bansal and Hunter, 2003; Boiral, 2007; Chan and Wong, 2006; Gavronski et al., 2008; González-Benito and González-Benito, 2005; Jiang and Bansal, 2003; Morrow and Rondinelli, 2002; Prajogo et al., 2012; Vastag, 2004), while others offered insights into the standard's potential benefits (e.g. Gavronski et al., 2008; Prajogo et al., 2012; Summers Raines, 2002; To et al., 2012b). One particular research area that has drawn a lot of attention is the diffusion of ISO 14001. A significant body of literature on this research area has been available, offering insights into 'how' ISO 14001 diffuses at the country level (Casadesus et al., 2008; Delmas, 2002; Lagodimos et al., 2007; Qi et al., 2011), regional level (Delmas, 2002), and global level (Albuquerque et al., 2007; Corbett and Kirsch, 2001; Nishitani, 2010; Viadiu et al., 2006). Recently, Heras-Saizarbitoria and Boiral (2013) have performed a meta-analysis of research articles published between 1995 and 2012 on meta-management standards including ISO 9001 and ISO 14001. They suggested that future research should be devoted to a number of areas including creation of meta-standards for global governance, international diffusion of meta-standards, motivations for and benefits of adoption of meta-standards, and difference in internationalization of meta-standards, among others.

The insights into the diffusion patterns of ISO 14001 at country, regional and global levels enable stakeholders of ISO 14001, including ISO Technical Committees, government accreditation agencies, and certification bodies, to tailor their promotion and marketing strategies to suit the characteristics of their target

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markets. On the other hand, they help researchers forecast the trend and development of ISO 14001 adoption at various levels, thereby facilitating worldwide sustainability development (Robèrt, 2000). This paper aims at (i) identifying the stages of ISO 14001 diffusion at global, regional, and country-specific levels, (ii) predicting the future growth of ISO 14001 certification at these levels, and (iii) exploring the spatial–temporal diffusion of ISO 14001 and the relationship between ISO 14001 diffusion and exports.

2. Literature review

2.1. ISO 14001 environmental management system

In 1987, the World Commission on the Environment and Development of the United Nations published the report "Our Common Future" in which sustainable development is defined as the principle of "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987; p.12). The report also calls for new insights into effective environmental management by means of, for example, decision support systems. When the United Nations hosted the Earth Summit in Rio de Janeiro in 1992, ISO collaborated with the International Electrotechnical Commission (IEC) on development of environmental standards (ISO, 2012a). A few months later, ISO and the IEC formed a technical committee TC207 to oversee the development of the environmental management system (Bansal and Bogner, 2002). The ISO 14001 environmental management system was launched in 1996 and updated in 2000 and 2004.

As stated in the ISO website (ISO, 2012b), an environmental management system that meets the requirements of ISO 14001:2004 has the following characteristics. It is a management system (or part of an overall system) that (i) identifies significant environmental aspects and controls the environmental impacts of an organization's activities, products or services; (ii) uses a systematic approach to setting and achieving environmental objectives and targets and demonstrating that the objectives and targets are achieved; and (ii) improves an organization's environmental performance continually. ISO suggests that the main aim of ISO 14001 provides a framework for a holistic, strategic approach for an organization for setting its environmental policy, plans, and actions. ISO 14001 is also applicable to all sizes and types of organizations.

Many researchers (Chan and Wong, 2006; Gavronski et al., 2008; Jiang and Bansal, 2003; Morrow and Rondinelli, 2002; Prajogo et al., 2012; Summers Raines, 2002; To et al., 2012a; Zeng et al., 2005) focused on motivations for and benefits of ISO 14001 certification, while (Bansal and Hunter, 2003; Nishitani, 2010; Potoski and Prakash, 2004; Prakash and Potoski, 2006) tried to explain why organizations in certain countries adopted this innovation. Potoski and Prakash (2004) and Prakash and Potoski (2006) reported that the adoption rate of ISO 14001 varied between countries. Analyzing raw data from 108 countries, they reported that the adoption rate tended to be higher in countries where trading partners adopted this innovation and consumers wanted mechanisms for identifying environmentally friendly firms (Prakash and Potoski, 2006). For the lack of diffusion studies of ISO 14001, Casadesus et al. (2008) used logistic functions to study the diffusion of ISO 14001 at the global level and in 13 selected countries with datasets from 1995 to 2005. Casadesus et al. (2008) reported that the global saturation level of ISO 14001 certificates was 64.6% in 2005 and forecast that the maximum number would be 160,000. They also argued that by 2008 the saturation level would reach 95% in most of the 13 selected countries, including Japan, China, and Spain (i.e. countries with the highest numbers of ISO 14001 certificates at that time). Unfortunately, Casadesus et al. (2008) underestimated the number of ISO14001 certificates in the global level as well as in country-specific levels quite significantly because of the lack of a sufficiently long time series of data – a problem that is not unusual in innovation diffusion studies (Gatignon et al., 1989). Lagodimos et al. (2007) focused on ISO 14001 certification in Greece and showed that ISO 14001 penetrated more effectively in the country's manufacturing sector than services and commerce sectors. Qi et al. (2011) studied the diffusion of ISO 14001 in China and found that signaling to foreign customers and community stakeholders had a positive effect on the diffusion. Marimon et al. (2011) analyzed the same subject and concluded that the diffusion among sectors tended to be homogenous. Despite the fact that many researchers recognized the importance of diffusion of ISO14000, studies investigating the details, the stages in particular, of ISO14000 diffusion at the global, regional, and country-specific levels are almost unavailable. Consequently, the first question of this study is as follows:

Question 1: What are the stages of ISO 14001 diffusion at the global, regional and country-specific levels?

2.2. Innovation diffusion

The diffusion of innovations has been studied by researchers over the past decades (Bass, 1969; Fisher and Pry, 1971; Katz et al., 1963; Rogers, 2003; Ryan and Gross, 1943). Rogers (2003) argued that an innovation, such as an idea or an organization practice perceived as new by other units of adoption, was communicated among members of a community while non-users might start adopting the innovation in the course of time. More specifically, the diffusion of an innovation normally followed an S-shaped curve with an initially slow rate of adoption, followed by a rapid rate of adoption, and leveled off at the saturation level. Bass (1969) borrowed the ideas from ecology and epidemiology and showed that the diffusion was governed by the following differential equation:

$$f(t) = \frac{\mathrm{d}F(t)}{\mathrm{d}t} = [p + q \times F(t)][1 - F(t)] \tag{1}$$

where $f(t)$ is the diffusion rate at time t, $F(t)$ the cumulative fraction of adopters at time t, p the coefficient of innovation and q the coefficient of imitation. By integrating $\mathrm{d}F(t)/\mathrm{d}t$ into Eq. (1) with respect to time, the S-shaped cumulative distribution of adopters is given as:

$$F(t) = \frac{1 - e^{-(p+q)t}}{1 + (q/p)e^{-(p+q)t}} \tag{2}$$

Fisher and Pry (1971) proposed a simple innovation/technology substitution model as:

$$\frac{\mathrm{d}F(t)}{\mathrm{d}t} = r \times F(t)[1 - F(t)] \tag{3}$$

where $F(t)$ is the fractional market share of the innovation at time t, and r is a constant of proportionality. The time scale t may be chosen such that $F(t_{\mathrm{mid}}) = 1/2$. By solving Eq. (3), the fractional market share of the innovation is obtained as follows:

$$F(t) = \frac{1}{1 + e^{-r(t - t_{\mathrm{mid}})}} \tag{4}$$

In terms of diffusion of ISO 14001, Eq. (4) is rewritten as

$$N(t) = \frac{N_{\mathrm{saturation}}}{1 + e^{-r(t - \mathrm{Year}_{\mathrm{mid}})}} \tag{5}$$

where $N(t)$ is the number of ISO 14001 certificates in a specific year t, $N_{\mathrm{saturation}}$ is the saturation level of ISO 14001, r is the growth rate, and $\mathrm{Year}_{\mathrm{mid}}$ is the year with the highest growth.