Title

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ABSTRACT

This paper analyzes the factors that explain the international diffusion of voluntary international management standards. We argue that to understand the diffusion of international standards we need to define a model that includes interactions between standards as well as interactions between standards and their institutional environment. We present two opposite views explaining how the previous diffusion of management standards facilitates or hampers the adoption of new management standards. We test a comprehensive model of diffusion of international environmental management standards within the chemical industry using a panel of 113 different countries during the period 2000 to 2003. Our results show that the previous experience of businesses in voluntary standards such as the Chemical Industry's Responsible Care program or ISO 9000, government commitment towards Environmental Management Systems Standards, and the level of activity of international non-governmental organizations in the country of adoption, impact positively on the adoption of ISO 14001 by chemical firms. Unlike previous studies that focused mostly on cross industry analyses, we do not find trade related factors significant while explaining adoption in the chemical industry. Our results differ, therefore from previous research and highlight the need to isolate industry effects to understand the diffusion of international standards.

Keywords: management standards; international diffusion of innovations; policy diffusion; chemical industry; Responsible Care; ISO 14001

INTRODUCTION

The last two decades have been marked by the development and diffusion of many industry voluntary environmental standards. Through these private or non-governmental regimes, firms commit voluntarily to improve their environmental management practices beyond compliance. These include, for example, the international environmental management standard ISO 14001, the Responsible Care standard for the chemical industry, the Sustainable Forestry Standard (SFI) and the Forest Sustainable Council Standard (FSC). While these standards bear some similarities, they also differ on important characteristics related to the type of actors who make the rules, the industries targeted, the content of the standard, how commitments are verified and whether compliance mechanisms exist. When trying to understand the factors that explain the diffusion of such a diverse set of standards, one wonders whether the same set of conditions independently explains their adoption or whether their development is interdependent. In other words does the initial adoption of some environmental standards trigger or hamper the adoption of other standards?

Scholars analyzing the factors that explain the international diffusion of voluntary environmental standards such as ISO 140041 have emphasized the role of national institutional environments and the role of forces related to trade (Christmann & Taylor, 2001, Corbett & Kirsch, 2001, Delmas, 2005, Kollman & Prakash, 2001). However, scholars have typically analyzed these standards independently through cross industry analyses and little is known about their interaction at the industry level. In this paper, we argue that environmental management standards should not be analyzed in isolation but in conjunction with other standards, because the initial adoption of some standards could explain the adoption of others.

There are two competing arguments to explain the interaction between environmental management standards. The first considers standards as exclusive of each other and competing with each other. Indeed, some scholars have explained the emergence of voluntary standards as a self-regulatory tool used by industry to hamper the creation of more stringent regulations or standards (King & Lenox, 2000, Prakash, 1999). For example, the Responsible Care program was initially set-up by the chemical industry to avoid potential regulations following the Bhopal accident (King & Lenox, 2000, Prakash, 1999). As another example, in the Forestry industry the SFI industry standard was launched by the AF&PA (forestry trade association) within two years of the FSC standard, and was established by a diverse group of stakeholders including representatives from environmental and social groups. Since 1995, the SFI standard, which was less stringent than the FSC standard has enrolled roughly eight times as many North American acres (136 million) in its certification scheme and more total acreage worldwide than the FSC has done in 10 years (Overdevest, 2004). Some researchers have cast doubts on the effectiveness of industry codes of conducts and whether these could be used as a protection against more stringent standards (King & Lenox, 2000). Are industry standards actually effective in hampering the adoption of more stringent initiatives? Is it more difficult for more ‘stringent’ standards to diffuse if less stringent standards are already established by the industry?

The alternative argument states that industry standards could provide information and learning opportunities for firms and could potentially pave the way for future and more stringent standards. The argument infers that with an increase in the number of adopters, uncertainties related to the risks and benefits of such voluntary practices will fade. Voluntary standards may become common practice and become the norm accepted by a broader range of firms.

Of course, the strength of each argument varies according to the specific characteristics of the standards and of their potential combination. Some standards may be similar and these similarities may make them compete with each other while other standards may complement each other. Additionally, these standards do not operate in an institutional vacuum. The characteristics of national governments and civil society should also mitigate the relationship between standards.

To understand the diffusion of international standards we need to define a comprehensive model that includes interactions between standards as well as interactions between standards and their institutional environment. In this paper we develop and test a model that explains the adoption of voluntary standards within an industry. We develop hypotheses related to interactions between standards, the role of support groups such as international NGOs and governments, and forces related to trade to explain the international diffusion of voluntary environmental standards.

Within the context of the chemical industry, we test whether the adoption of the international environmental management system ISO 14001 was favored or hampered by the adoption of other management quality, health, safety and environment standards namely Responsible Care, ISO 9000. Both ISO 9000 and ISO 14001 were designed by the International Organization for Standardization (ISO), an international non-governmental network of the national standards institutes of 156 countries. Responsible Care was developed by the chemical industry only. We also test whether the European Eco-Management & Audit Scheme (EMAS) issued by the European Commission to certify environmental management systems (EMSs) among European organizations has an impact on the adoption of ISO 14001. We test our hypotheses in 113 countries during the period 2000 to 2003.

Our results show that voluntary management standards in the chemical industry feed on rather than compete with each other. We find that the propensity of the industry to self-organize may facilitate the adoption of ISO 14001. Furthermore, we find that the adoption of ISO 14001 may be easier for companies that have adopted the international standard ISO 9000. In addition, we find some support for the hypothesis that governmental endorsement for voluntary environmental management standards in the form of the adoption of EMAS helps the diffusion of ISO 14001. Finally, our results show that the role of civil society in raising the level of concern toward environmental issues also helps explain diffusion of an international environmental management standard such as ISO 14001. We contribute to the literature on the diffusion of policy innovations by showing the cumulative effect of management standards and the importance of national institutional environments in facilitating the diffusion of international standards. Currently, there are active discussions in policy circles regarding whether environmental standards should be designed for specific industries or for organizations across industries. We contribute to this debate by showing that both approaches are complementary rather than in competition.

In the first part of the paper, we provide a review of the literature on the diffusion of international voluntary standards and describe the main characteristics of the voluntary standards that are the focus of our analysis. We subsequently develop hypotheses on the international diffusion of ISO 14001 based on three main mechanisms, namely cultural norms, support groups and trade ties. The third section of the paper is dedicated to the description of the different variables used to measure each of the factors influencing the adoption of the standard and the methodology to test the hypotheses. The last part of the paper includes the results of the statistical analysis and a concluding discussion.

LITERATURE REVIEW

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1995). The literature on policy diffusion is concerned with the chronological and geographic patterns of the adoption of a policy innovation across government units (Mossberger & Wolman, 2003). This literature has identified three main driving forces by which a policy occurs: the dynamics of the international system, national factors and the characteristics of the policy instrument (Tews, Busch, & Jorgens, 2003). Voluntary codes of conduct differ from traditional governmental policies because they are initiated by private actors rather than governments. Even though private governance mechanisms differ from policy processes, they do not operate in a political vacuum. The growing literature on the diffusion of international standards indicates that a complex interplay of factors influences the international spread of voluntary standards. Scholars have shown how the pattern of interactions between businesses and government within a country influences corporate decisions to adopt international standards (Delmas, 2002, Moon & De Leon, 2005, Potoski & Prakash, 2004). The main finding is that a less adversarial government stance towards a firm enhances the adoption of ISO 14001. Countries that have a long history of cooperation and trust between government and businesses can lower the uncertainty perception about their ISO 14001 investment and are likely to promote ISO 14001 (Moon & De Leon, 2005). The second important diffusion mechanism of international voluntary standards is related to the openness of the country to trade, where firms mimic the behavior of other firms adopting voluntary standards in other countries. For example, Kollman and Prakash found that trade linkages encourage ISO 14001 adoption if countries' major export markets have adopted this voluntary regulation (Kollman & Prakash, 2001).

While these studies emphasize the role of national institutional environments and openness to trade, little research has investigated how specific characteristics of a standard may impact its diffusion and how standards interact with each other. The only exception relates to the link between ISO 9000 the quality management standard and ISO 14001 which has been identified in several articles (Christmann and Taylor; 2001; Prakash and Potoski, 2006; Moon and Deleon, 2005). One of the reasons why little research exists on the interaction between ISO 14001 and other industry standards is that most of these studies use a cross industry approach. This approach can be explained by the fact that industry level information has been made available only recently by the International Organization for Standardization (ISO).

RESPONSIBLE CARE, ISO 14001, ISO 9000 AND EMAS

International voluntary management standards have been identified as private governance mechanisms established, monitored and enforced by private actors to govern their own conduct (Prakash, 2000). We describe below the characteristics of the four standards examined by this study. These standards can be distinguished based on who makes the rule, the content of the rule, how the commitment is verified and whether compliance mechanisms exist. First, some of these standards are designed by industry associations while others represent multi-stakeholders initiatives involving environmental NGOS and government or industry representatives. Second, some standards are industry specific while others are applicable to a wide range of industries. Third, some include third party verification while others do not. Finally, some include performance measurements while others focus on processes. Table 1 compares Responsible Care, ISO 14001, ISO 9000 and EMAS based on these main characteristics.

[Insert Table I about here]

Responsible Care

Responsible Care is an Environmental, Health and Safety (EHS) voluntary code of conduct within the chemical industry (Howard, Nash, & Ehrenfeld, 2000). It is developed, enforced and monitored by national chemical associations. The objective of the program was to regain public trust by demonstrating that chemical firms could be responsible corporate citizens who could self-regulate (King & Lenox, 2000). A related objective was to limit the significant negative externalities imposed on the whole chemical industry by accidents occurring in any firm (Prakash, 2000). The program was first developed in 1985 in Canada and in 1988 in the United States. Today 52 national chemical associations in different countries have joined the program (ICCA, 2005) (See Appendix I). National chemical trade associations can mandate or advise members to adopt Responsible Care. Members conduct self-evaluations annually and rate themselves on a scale and report their evaluation to the chemical association (Prakash, 2000).

ISO 14001

In 1996, ISO formally adopted the international environmental management standard ISO 14001, to implement and certify Environmental Management System (EMS). An EMS is one of the tools that an organization can use to implement an environmental policy. It consists of "a number of interrelated elements that function together to help a company manage, measure, and improve the environmental aspects of its operations" (Welford, 1996).

Unlike Responsible Care, ISO 14001 is designed to be adopted by any type of organization in any industrial sector. But the main difference between the Responsible Care program and ISO 14001 is that ISO 14001 can be third party certified.[1] Although organizations seeking ISO 14001 can self-declare, there are greater benefits with third party certification notably in reinforcing the credibility of certifications with customers, regulatory agencies, and the community. Because of third party certification, ISO 14001 can be more costly than Responsible Care. The costs of certification vary widely, depending on the size of the company, the nature of its operation, and the environmental system already in place. Estimates range from less than $50,000 for small firms to greater than $200,000 for larger firms (Watkins & Gutzwiller, 1999). These estimations involve the certification process only and do not take into account the cost of organizational changes that firms may have to carry out to attain the ISO 14001 standard. We therefore need to understand the circumstances under which a chemical company would be willing to incur the cost of adopting ISO 14001 in addition to Responsible Care.

ISO 9000

ISO 14001 was developed on the heels of the success of the international quality standard ISO 9000 which was initially issued in 1986. ISO 9000 is concerned with the steps taken by organizations to fulfill customers' quality requirements, applicable regulatory requirements, while aiming to enhance customer satisfaction, and achieve continual improvement of its performance in pursuit of these objectives (ISO, 2005). By December of 2003, more than half million facilities had adopted the standard. ISO 9000 and ISO 14001 bear similarities in their processes but they aim to improve different elements of an organization (quality versus the environmental impact of operations).

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[1] Responsible Care has evolved over time. After the period of our study, Responsible Care programs in some countries required a third party certification. We discuss this in the concluding section.

EMAS

In 1993, the European Commission adopted the Eco-Management and Audit Scheme (EMAS) Regulation, which established a voluntary system in which industrial sites could participate by implementing an EMS and pledge to achieve continual improvement in environmental performance (Kollman & Prakash, 2002).[2] Although voluntary, EMAS was established by the European Commission, an executive body composed of members of the European Union countries, rather than from industry or non governmental organizations. The standard requires not only third party certification but also companies to issue a public statement with information on their environmental performance.

These four standards represent a diverse set of standards which allows us to study the interactions between the various standards. What are the advantages of adopting only one standard as compared to adopting several standards? Would the advantages of one solution versus the other vary according to the national context? Previous analyses on the Responsible Care – ISO 14001 link based on the US context found that Responsible Care participants were less likely to get ISO 14001 certification (King, Lenox, & Terlaak, 2005). One explanation was that many chemical firms already had well functioning EMS such as Responsible Care and modifying their EMS to agree with ISO 14001 was perceived as an unnecessary cost (Prakash, 1999). These previous studies have focused exclusively on the US and it is unclear whether the results would hold in other national contexts. More evidence exists relating to the link between ISO 9000 and ISO 14001, although some of it is mixed. Some research shows that firms that adopt ISO 9000 are more likely to adopt ISO 14001(Darnall, 2003, Delmas, 2002, Moon & De

[2] EMAS became effective on April 10, 1995.

Leon, 2005, Potoski & Prakash, 2004) while other analyses have not found a consistent positive relationship between both standards (King, Lenox, & Terlaak, 2005).

ISO 14001 is particularly suited to studying the question of the interaction between standards for several reasons. First, it was issued 11 years after Responsible Care, 10 years after the ISO 9000 standard, and a couple of years after EMAS. Furthermore, ISO 14001 exhibits a number of features desirable for econometric identification. ISO 14001 was adopted in various countries over time and a great disparity exists in terms of adoption rates between specific countries. By December 2003, a total of 66,070 firms had adopted ISO 14001 in 113 countries. In the United States, the total number of ISO 14001 certificates was 3,553; while in Europe, the number of certificates was 31,997. With reference to the chemical sector, in 2003 there were 3,761 certificates worldwide. By December 2003, Japan already had 907 chemical facilities that were ISO 14001 certified, while the United States had only 135 (ISO, 2003). See Appendix II for a depiction of the number of ISO 14001 certificates by country in the chemical industry in 2003.

HYPOTHESIS DEVELOPMENT

The main finding of the diffusion theory is that, for most members of a social system, the innovation-decision depends heavily on the innovation-decisions of other members of the system (Rogers, 1995). It is well established that the introduction of an innovation may affect the diffusion process of another innovation, if the two are sufficiently related by function or application (Alpert, 1994). Two opposing views are related to the role of previous innovation on the likelihood of diffusion of additional innovations. The first view relates to arguments of path dependency where firms are locked-in with existing technologies and incur high coordination costs to switch to new ones. The second view relates to learning associated with the initial innovation that helps firms adopt subsequent innovations. Therefore, in some scenarios the previous adoption of specific innovations might help the subsequent diffusion of new ones. However, the opposite reality is also possible, where the co-existence of innovations is hampered by one dominant innovation that prevents others from diffusing.

What is the case for the cumulative diffusion of international management standards? The implementation of an EMS and the subsequent ISO 14001 certification can be considered as administrative innovations, rather than a technological innovation. A technological innovation is an idea for a new product, process or service while an administrative innovation pertains to the policies of recruitment, allocation of resources, and the structuring of tasks, authority and reward (Daft, 1978). Despite these differences, studies on administrative innovations show that their diffusion process has the same structure as the diffusion of technological innovations, i.e., a logistic function resulting in a S-shaped curve (Teece, 1980, Venkatraman, Loh, & Koh, 1994). We discuss below competing hypotheses on the role of the adoption of previous management standards on the adoption of later management standards.

Norms of exclusivity

The diffusion literature related to the impact of path dependency on the adoption of standards, highlights the difficulty that firms have in changing their technological trajectory once they have invested significantly in a standard (Bessen & Saloner, 1988, Katz & Shapiro, 1985). Firms with significant investments in alternative EMSs would find it less attractive to modify their existing EMS to fit the ISO 14001 standard (Prakash, 1999). This is particularly true if the new standard is associated with uncertainty related to its benefits and costs, something that is particularly relevant for an emerging standard such as ISO 14001. In addition, the adoption of ISO 14001 may be riskier than the adoption of Responsible Care. In the case of ISO 14001, the legal issue that can prevent some firms from considering the implementation of ISO 14001, is the potential discovery of regulatory violations that firms have not yet identified or resolved. ISO 14001 may lead to the discovery of non-compliance with applicable environmental regulations (Delmas, 2000). The identification of violations during the implementation phase or during self- or third party audits can lead to potential liabilities (Orts & Murray, 1997). As Responsible Care did not require environmental audits, the issue of potential liabilities did not arise. In addition, Responsible Care initially did not face the problem of path dependency since most chemical firms did not have established EMSs when Responsible Care was created(Prakash, 1999).

Norms are common practices whose value to an actor stems largely from their prevalence in a population (Elkins & Simmons, 2005). In the case of Responsible Care, firms may be subjected to norms of "exclusivity." As Potoski and Prakash have demonstrated, voluntary standards can be perceived as 'Clubs' where firms receive specific benefits because they belong to a specific community. Responsible Care and ISO 14001 are examples of club goods as one cannot price the discrete units of goodwill benefits generated by them. Firms will have incentives to pay membership fees only if such benefits are made excludable (Prakash, 1999). Can a firm belong to several clubs without endangering the reputation of their original club? If the norm within the industry is to participate in the "industry" standard, would memberships in multiple voluntary initiatives jeopardize the exclusivity of the industry 'club' membership? In that case, norms established by the industry could potentially work against multiple memberships. As Prakash stated: "the CMA needs to protect the brand equity of Responsible Care in the light of competition from initiatives such as ISO 14001 (…). If ISO 14000 become the de facto international standard, the chemical industry will lose its distinctive advantage vis-à-vis other industries in terms of claiming long-standing commitments to safer EHS practices" (Prakash, 2000)(p.202). Firms may be subjected to norms of exclusivity where they are discouraged to participate in competing standards. In light of these arguments we develop the following hypothesis related to the relationship between the adoption of Responsible Care and ISO 14001:

> Hypothesis 1. The greater the diffusion of Responsible Care in a particular country, the less the number of ISO 14001 certificates in the chemical industry within that country.

Norms and Learning

The opposite argument regarding the interaction between voluntary standards relates to how norms evolve with the initial adoption of a standard. First, firms that have prior EMS implementation experience may be less likely to be skeptical about ISO 14001 certification. This is especially true because of the initial uncertainty related to the benefits of the standard. Furthermore, it might be easier to certify with ISO 14001 if a firm has already implemented the Responsible Care program. Although a few exceptions exist, in most cases the environmental management aspect of the Responsible Care program will be equivalent to the ISO 14001 requirements. Indeed, in some countries such as Lithuania, Norway or India, national chemical associations support the adoption of the ISO 14001 standard within their member companies (ICCA, 2005). Responsible Care firms will incur lower costs to access the information required to implement the ISO 14001-based EMS than firms that have not implemented any type of EMS. In addition, experts in the chemical processing industry state that by upgrading an existing Responsible Care to comply with ISO 14001, a company can add depth, rigor and credibility to its existing programs (Gilbertsen & Kowalski, 2004). We therefore predict that:

> Hypothesis 2A. The greater the diffusion of Responsible Care in a particular country, the greater the number of ISO 14001 certificates in the chemical industry within that country.

The relationship between ISO 9000 and ISO 14001 is different from the one between Responsible Care and ISO 14001. ISO 9000 has become the norm for those organizations that aim to certify their quality management practices. ISO 14001 somehow complements the quality management system by establishing a similar system to manage environmental impact but addressing slightly different audiences. While ISO 9000 aims to improve quality and facilitate business objectives, ISO 14001 aims to improve environmental performance and facilitate relationships with not only market actors, but also non-market actors such as regulatory agencies and NGOs. There are clear economies of scope between both standards, and successful implementation of ISO 9000 facilitates the adoption of ISO 14001. In fact, because of the similarities between these standards and their implementation, consultants and certifiers of ISO 9000 also became consultants and certifiers of ISO 14001 (Mazurek, 2001). They had the opportunity to provide information about ISO 14001 certification during the process of advising their clients about ISO 9000. Therefore, in a country where a significant number of firms have adopted the ISO 9000 standard, it is likely that consultants and firms will have more knowledge about how to implement ISO 14001 than in a country where few ISO 9000 standards have been adopted. The role of these consultants and certifiers may be the key at the take-off phase of any innovation, when firms need help in understanding how to implement a management standard. Thus, we predict the following relationship between the quality standard ISO 9000 and the environmental standard ISO 14001:

> Hypothesis 2B. The greater the number of ISO 9000 certificates in the chemical industry within a country, the greater the number of ISO 14001 certificates in the chemical industry within that country.

Support groups: the role of government and civil society

Non-governmental initiatives such as international environmental standards do not operate in a cultural and institutional vacuum. Research has shown that voluntary initiatives operate under the shadow of the government and are facilitated by an active civil society (Delmas & Terlaak, 2001, Moon & De Leon, 2005). In addition to the influence that the previous adoption of management standards might have in the diffusion of ISO 14001, the position of other types of stakeholders such as the government and the civil society within each country towards international environmental issues and environmental voluntary management standards, could also shape the diffusion process.

The role of government

Scholars in institutional economics have analyzed how the interplay between government action and the structure of a nation's political institutions can shape the ability of a company to make private investments (Levy & Spiller, 1994). In particular, researchers note that policy uncertainty results in lower levels of investment and that even favorable government policies need to be credible if they are to facilitate investments (Henisz, 2000). The credibility and effectiveness of a government's commitment to a specific policy varies with its political and social institutions. Two examples of a government's commitment are the effectiveness of a nation's regulatory framework and the credibility of institutions that hold governments accountable for their actions (Henisz, 2000, Levy & Spiller, 1994, Lupia & McCubbins, 1998).

As firms are very dependent on the legal environment surrounding environmental protection, governmental commitment to both international policy issues and environmental protection is particularly important in explaining the diffusion of environmental management standards. As ISO 14001 is a management system that goes beyond existing command-and-control regulations, firms may view ISO 14001 as a tool to help their organizations comply with existing regulations and anticipate more stringent regulations. A government's commitment to the environment will therefore increase the perceived benefits of adopting ISO 14001. By contrast, uncertainty over the government commitment to environmental protection will result in fewer incentives for firms to invest in ISO 14001 efforts. Contexts of uncertainty regarding governmental commitment may lead to questioning the value of an unclear emerging standard than of a more mature standard that provides clearly identified benefits. We therefore hypothesize that:

> Hypothesis 3A. The higher the involvement of the country's government in international relations and environmental protection policies, the greater the number of ISO 14001 certificates in the chemical industry within that country.

In addition, the attitude of governments toward environmental management standards should play a role in helping their diffusion. Governments that are sympathetic to such standards will be able to provide incentives to firms seeking their adoption. For example, in Europe the European Commission paved the way to environmental management standards by adopting EMAS. EMAS was the first international EMS standard implemented in the world. It provided Europe with some experience in EMS standardization when ISO 14001 was put into place. Furthermore, EMAS, the European standard developed by the European Commission benefited from strong support by European authorities that promoted its diffusion into European firms. They also facilitated the development of a certification system with "verifiers" and consulting companies. These factors reduced the search and information costs for European firms. The two elements, experience and regulatory promotion of the standard facilitated the development of ISO 14001 in Europe by limiting transaction costs associated with the adoption of the standard and favoring the demand for ISO 14001 from stakeholders. Although EMAS continues to differ from ISO 14001 in its depth and demands with regard to commitment, transparency and environmental performance, the structure of the environmental management system is analogous to the structure of ISO 14001. ISO 14001 could become the first step to the adoption of a more stringent EMAS standard. Therefore we hypothesize that:

Hypothesis 3B. Countries implementing EMAS will experience a higher number of ISO 140001 certificates in the chemical industry.

The role of civil society

In addition to governments, other stakeholders, such as the community in the form of Non- Governmental Organizations (NGOs), may exert pressure on businesses to adopt certain practices and may assist in the diffusion of ideas among their member countries. Meyer et al (1997) have shown that the global spread of environmental discourse and organizations was especially stimulated by non-governmental actors such as the United Nations (Meyer, Frank, Hironaka, Schofer, & Tuma, 1997). NGOs have become sophisticated communicators and are perceived as instigators of change in the global marketplace. It has been shown that under increasing pressure from environmental and labor activists, multilateral organizations, and regulatory agencies in their home countries, multinational firms are adopting international environmental standard certification such as ISO 14001 (Gereffi, Garcia-Johnson, & Sasser, 2001).

ISO 14001 may help firms to respond to NGO environmental pressures by enabling them improve their environmental performance and communicate with NGOs. In turn, the degree of involvement of civil society in NGOs might be seen as another support group helping the diffusion process of ISO 14001. In their cross-sectional analysis of the international adoption of ISO 14001, Potoski and Prakash (2004) found that countries whose citizens join international

NGOs have more ISO 14001 certifications. Implementing an ISO 14001 EMS encourages companies to write their environmental statements, have people designated to respond to NGOs demands, and organize information within the firm so that it is easily accessible, documented and organized. Moreover, by having a system in place, it may be easier to disclose information to NGOs and the community when any problems or complaints arise. We thus expect that:

> Hypothesis 4. The higher the civil society activism in the form of involvement in International NGOs within a particular country, the greater the number of ISO 14001 certificates in the chemical industry within that country.

The role of trade ties

Economic and social linkages between firms across countries offer channels for the transfer of management practices across borders. Multinationals are widely recognized as key agents in the diffusion of practices across national borders, through the transmission of organizational techniques to subsidiaries and to other organizations in the host country (Arias & Guillen, 1998, Christmann & Taylor, 2001). Firms that export to countries where a high number of local firms have adopted a management standard may need to adopt the same standard to export to these countries or to trade with local firms there. Guler et al. (2002) have shown such behavior, which they call "cohesion in trade," for the case of ISO 9000. Prakash and Potoski have also shown that this behavior was significant in predicting the adoption of ISO 14001 across countries (Prakash & Potoski, 2006). Besides the influence that trade ties may have on ISO 14001 adoption rates, competitive bandwagon pressures may arise from a threat of lost competitive advantage. Firms may also adopt the same practices because not doing so would place them at a disadvantage relative to the competition and erode their edge in the market place. Guler et al. (2002) identified such behavior for the case of ISO 9000. According to this argument, firms competing with countries that have a higher adoption rate of ISO 14001 should mimic their competitors' behavior and adopt ISO 14001. We therefore expect:

Hypothesis 5. The higher the trade ties with countries that have been proactive in the adoption of ISO 14001, the greater the number of ISO 14001 certificates in the chemical industry within that country.

In conclusion, we expect that normative behavior related to the adoption of the Responsible Care, ISO 9000 and EMAS will impact the ISO 14001 adoption rates within the chemical sector. In addition, two other diffusion mechanisms related to national and international support groups and to trade ties will also shape the adoption rates. Our model of diffusion of environmental management standards is depicted in Figure 1.

[Insert Figure I about here]

DATA AND METHOD

We have compiled a panel dataset of the total number of ISO 14001 certified organizations within the chemical sector in 113 countries between 2000 and 2003. The dependent variable is the cumulative number of chemical facilities certified in each country for the period 2000-2003, as reported by the International Standardization Organization (ISO) in Geneva. The year 2000 was the first year that the ISO provided the number of certificates within a country by industry sector. Previously, ISO only recorded total number of ISO 14001 certificates by country. The reference month for the number of certificates was December of each year. We obtained measures for the independent variables from secondary databases. We measured all independent variables with a one-year lag.

Responsible Care. To account for the influence of the Responsible Care program on the diffusion of ISO 14001 in the chemical industry we created two variables. The first variable was created by taking the number of years that passed since a country's National Chemical Association (NCA) joined the Responsible Care program until the study year. The second set of variables differentiate between countries whose NCA requires all its members to join the Responsible Care program, countries whose NCA allows a voluntary decision to adopt Responsible Care and countries whose NCA does not participate in the program. The two binary variables included in the analysis are Required Responsible Care and Voluntary Responsible Care. Every year the International Council of Chemical Associations (ICCA) publishes a Responsible Care Status Report (ICCA, 2002). This report was used to collect some of the information to construct both variables. However, information for some of the countries was not available in the report. We contacted all 46 National Chemical Associations by e-mail and/or phone to collect the missing information.

ISO 9000 standard. We included a variable representing the number of chemical facilities with the ISO 9000 certification in the focal country, as reported by the International Standardization Organization to measure the existing experience with international process management standards. [3]

[3] We need to point out that information about the number of certifications for 1999 is not available from the ISO Survey. Therefore, for our first year of analysis, year 2000, we were unable to use a one-year lag information and we decided to use the 2000 information. For the remaining years we were able to use lagged ISO 9000 adoption rates. To ensure consistency in our results, we also ran the analysis for the 3-year period (2001-2003) and found the same significant results.

The role of the government. We use two variables to account for the role of the government in international and environmental matters and one variable representing the adoption of EMAS in Europe. First, we generated a measure that represents the **involvement of a country in international environmental treaties** related to the environmental impacts caused by the chemical industry. Several authors have used such variables to measure governmental commitments to environmental protection (Corbett & Kirsch, 2001, Frank, 1997). The EarthTrends Data Tables on Environmental Institutions and Governance from the World Resources Institute identify the main international environmental treaties and provide information on ratification dates (EarthTrends, 2003). This variable was calculated by taking the number of years that passed since a given nation ratified a given treaty. We focused on the three treaties related to the chemical industry: The Kyoto Protocol, the United Nations Framework Convention on Climate Change, and the Vienna Convention about Ozone. Countries that did not ratify a treaty were assigned zero. Countries with a higher score can thus be considered as first movers on the international environmental scene.

The second measure is a variable that accounts for the role of the government in international policy. We use the **number of Intergovernmental Organizations (IGOs) that a country's government has joined**. The Union of International Associations publishes the Yearbook of International Organizations annually (UIA, 2000-2003). They collect information about both International NGOs and Inter-Governmental Organizations (IGOs) by country. Previous researchers made use of the Yearbook to study different issues such as how social capital affects democracy (Paxton, 2002), the structure of the world culture (Boli & Thomas, 1997), the inequality of the world polity (Beckfield, 2003), the structure of the world environmental regime (Meyer, Frank, Hironaka, Schofer, & Tuma, 1997), and the adoption of the ISO 14001 standard across all industry sectors (Potoski & Prakash, 2004).

The third variable represents the presence of the **European Commission Eco-Management Audit Scheme (EMAS)** in a particular country and the impact it has on the adoption rates of ISO 14001 within the chemical industry. The variable EMAS which takes the value of one for those countries where EMAS had already started the diffusion process in each particular year.

The role of civil society. To measure the degree of pressure exerted by the civil society, we introduced a variable representing the number of International NGOs in each country. This variable is also gathered from the Yearbook of International Organizations. We use the number of international NGOs in each country as a proxy for the degree of the civil society involvement in international policy issues.

Cohesion in trade within the chemical industry. To approximate cohesion in trade, we adapted the measure developed by Guler et al. (2002), which captures how strongly a country is tied to other countries through trade and through the extent to which ISO certificates have already diffused in these countries. Unlike Guler et al., we used exports instead of total trade, as we expected the imitation effect to flow through export ties. Indeed, focal countries are more likely to be affected by the practices of their customers than by the rest of the world, as they must establish legitimacy to export to customers. . Formally, the cohesion in trade measure for country *i* at time *t* is:

$$\text{Cohesion in Trade}_{it} = \sum_{j} \text{ISO}_{jt-1} \times \left(\text{Exports}_{ij}/\text{Exports}_{i}\right)^{2}$$

where ISO_{jt-1} is the number of certificates for country *j* at time *t-1*, $Exports_{ij}$ is the exports from country *i* to country *j* in1999[4], and $Exports_i$ is country's total exports during the same period. The data on export ties between each pair of countries came from Feenstra(2004).

Competitive trade within the chemical industry. We measured competition in the network of world trade within the chemical industry by an adjusted structural equivalence measure. Structural equivalence for each country *i* as of year *t*, is measured by the Pearson rank correlation coefficient between the proportion of country *i*'s exports within the chemical industry, to all other countries (except *j*), and the proportion of country *j*'s exports to all other countries (except *i*), weighted by the sum of ISO 14001 certificates in the chemical industry in all other countries *j* as of year *t-1*. It is a first-order measure because it only takes into account direct ties between pairs of countries. Formally, for each country *i*, the competitive trade is:

$$\text{Competitive Trade}_{it} = \sum_{\text{j}} \text{ISO Chem}_{\text{jt}-1} \times corr\left(\text{Exports}_{\text{i}}/\text{Exports}_{\text{j}}\right)$$

where ISO_{jt-1} is the number of ISO 14001 certificates in the chemical industry for country *j* at time *t-1*, corr ($Exports_i$, $Exports_j$) is the Pearson correlation coefficient between the percentage of country *i*'s exports with all other countries an the percentage of country *j*'s exports with all other countries for 1999.

Size of the national chemical industry. To control for the extent of adoption in a country at any given time, it would be ideal to compare the number of certifications within the chemical industry with the maximum number of potential certifications, e.g., the number of chemical establishments, but this information does not exist for most of the countries included in

[4] The year 1999 is the last year that World Trade Flows includes data on Exports.

this study. We tried to solve this problem using two alternate control variables. The first alternative is to deflate certification counts using GDP and population. GDP has been used as a deflator (Corbett & Kirsch, 2001, Guler, Guillen, & Macpherson, 2002), but it does not represent the actual number of firms that could potentially be certified. The second alternative is to use the number of chemical establishments by country available at the Industrial Statistics Database created by the United Nations Industrial Development Organization (UNIDO). Although this second alternative is our ideal measure, this database only contains information for 51 out of our 113 countries. We thus used the GDP per capita measure in most of our regression models.

Foreign Direct Investment. We also control for the impact of the presence of foreign multinationals with a variable that represents the value of inward foreign direct investment (FDI) as percentage of Gross Domestic Product (GDP). This measure was obtained from the World Bank's Development Indicators Database for the years 1999-2002.

Level of ISO 14001 diffusion within the country. Finally we control for the level of ISO 14001 diffusion in each country by including the number of years since the first ISO 4001 certificate was awarded in that particular country. This variable allows us to establish control between early and late ISO 14001 adopters. Table 2 summarizes the descriptive statistics and correlation coefficients of all our variables.

[Insert Table II about here]

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Estimation

Our dependent variable, which represents the cumulative number of ISO 14001 certificates in the chemical industry per country, has two characteristics: it is a count variable, and it includes observations clustered at zero and observations far in the right tail of the distribution (see Appendix II). Because of these characteristics, our dependent variable has a variance higher than its mean and is thus over-dispersed. Poisson regression is specifically designed for count dependent variables. Unfortunately, it assumes that the mean and variance of event counts are equal (Greene, 2003). When individual counts are more dispersed than the Poisson model, the negative binomial model can be used, because a random term reflecting unexplained between-subject differences is included in the regression model (Gardner, Mulvery, & Shaw, 1995). Therefore, we ran a negative regression model with random effects[5] using a panel dataset. The test of the inclusion of random effects is highly significant in our full model (χ^2= 270.80, p=0.000), indicating that unobserved firm effects exist. The panel negative binomial model that we used is represented by the following equation:

$$\ln \lambda_{it} = \beta' \mathrm{X}_{it} + \mu_i + \varepsilon_{it}$$

where X is a vector of characteristics of the country *i* at time *t*, μ_i is a group specific random element, similar to ε_{it} except that for each group, there is only a single draw that enters the regression identically in each period. We ran the model using the *xtnbreg* command in the Stata 7 statistical software (Stata, 2001).

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[5] We use the random effect model because a fixed effect model would disregard all countries without any ISO 14001 certificates within the chemical sector by 2003.

RESULTS

Table 3 summarizes the test results of the direct effects of the different explanatory variables on the adoption of ISO 14001 within the chemical industry using six different models. In the first three models we use GDP as the measure of industry size. In Models 4 to 6 we use the number of chemical establishments instead of GDP as a control for the size of the sector but, due to the large number of missing values, the number of observations dropped from 357 to only 104 and the number of countries from 103 to only 51.[6]

Due to collinearity issues, we use different measures of the effect of Responsible Care in separate models. In Models 1 and 4 we use the two binary variables to control for the presence of required and voluntary Responsible Care while in Models 2 and 5 we use the number of years since Responsible Care was adopted by the country's national chemical association. Last, we add two additional models, 3 and 6, in which we exclude the variable International NGOs[7] to show that even though this variable is highly correlated with some of the other independent variables, our results do not vary when it is included in the first two models.

[Insert Table III about here]

Hypotheses 1 and 2A predict opposite effects of the experience with the National Chemical Association's Responsible Care program on the diffusion of ISO 14001 within the chemical sector. We use different measures to test for the impact of Responsible Care

[6] See Appendix II for a list of countries included in each model.

[7] We calculate the variance inflation factor for the linear regression. The results show that the variable International NGOs is highly correlated with some of the independent variables. Hence, we exclude this variable from our analysis in Models 3 and 6 to ensure that our results are consistent.

experience. We find that both variables, the number of years since National Chemical Association (NCA) of a particular country joined the Responsible Care ($p<0.01$ in Model 3 and $p<0.05$ in Models 2, 5 and 6), and whether Responsible Care is required to join a particular NCA are positive and significant ($p<0.01$ in Models 1 and 4). Our results support our hypothesis 2A, which predicts a positive relationship between the experience with Responsible Care and the likelihood of adopting ISO 14001.

Hypothesis 2B predicts a positive effect of the number of ISO 9000 certifications in the chemical industry on ISO 14001 adoption. All our models test for the impact of ISO 9000, and the variable is positive and significant ($p<0.01$), supporting our second hypothesis.

To understand the magnitude of these effects we calculate incidence-rate ratios. These ratios indicate, for example, that an additional year in the Responsible Care program increases the expected number of ISO 14001 chemical facilities in a particular country by a factor of 1.08, that is, 8% when other variables are held constant. Hence, for a country with 12 chemical facilities with ISO 14001, if they had an additional year in Responsible Care the expected number of ISO 14001 was 13. The effect that Responsible Care membership requirements have on the adoption of ISO 14001 among chemical facilities is much stronger. In those countries where the National Chemical Association asks for Responsible Care as a membership requirement, the number of ISO 14001 certified facilities increases by a factor of 3.23, or 323%. Similarly, in the case of the European EMAS in Model 4, in those countries where EMAS is present, the number of ISO 14001 certified facilities increases by a factor of 2.60, or 260%.

Hypothesis 3A predicts that the role of a particular government in international policy issues and the credibility of its governmental commitment to the environment will positively influence the adoption of ISO 14001 by chemical firms. We test these effects using two measures: a variable representing the involvement in international environmental treaties concerning the chemical sector and a variable representing the number of Intergovernmental organizations that a particular government belongs to. Our results do not show support for the role that the government might play on the decision to adopt ISO 14001 in the chemical industry. Even though we find some significant results in two models, these disappear when other independent and control variables are included. The level of governmental commitment towards the environment does not seem to impact the early diffusion of ISO 14001 in the chemical industry. One explanation for this result could be that such variables impacted the adoption of ISO 14001 indirectly by influencing the initiation of the Responsible Care program which in turned facilitated the diffusion of ISO 14001.

Hypothesis 3B predicts a positive effect of the implementation of EMAS within a country on ISO 14001 adoption. The variable EMAS, controlling for the presence of the European standard for Environmental Management System, is not significant in the first three models. However, the same variable is positive and significant ($p<0.05$) in the last three models. It may not be surprising that the effect of EMAS is not significant in the models representing all the countries of our sample since EMAS is only implemented in Europe. The last three models include a smaller subset of countries (51) in which the presence of EMAS has a positive effect on ISO 14001 adoption rates within the chemical industry.

Hypothesis 4 states that the level of community activism and involvement in international policy issues measured by the number of international NGOs will enhance the adoption of ISO 14001 in the chemical sector. The results in models 1 and 2 support our hypothesis since the variable representing the number of international NGOs is positive and significant ($p<0.05$). Therefore, the level of community activism and its involvement in international NGOs in a particular country favors the adoption of ISO 14001 within the chemical industry. The same variable is not significant when we use Chemical Establishments as the control variable for industry size.

Hypothesis 5 states that trade ties with countries that have been proactive in the adoption of ISO 14001 will impact the adoption of ISO 14001 in the focal country. Contrary to what one would expect, the cohesion in the trade variable is not shown to be significant, indicating that at the early stages of ISO 14001 adoption in the chemical sector, the trade ties between countries do not impact the diffusion rates of the standard. With regard to the competitive trade variable, the variable does not show any significant effect on adoption either, which indicates that the competitor's behavior towards ISO 14001 does not influence its diffusion in the chemical sector. These results differ from previous findings where cohesion in trade was found to explain the international diffusion of ISO 9000 and ISO 14001 (Guler, Guillen, & Macpherson, 2002). As mentioned earlier these studies were across industries and did not include specific industry effects. Industry level variation is expected due to different levels of export-dependence and pollution intensity. So it is possible that the role of bilateral trade would be a less important driver of the adoption of ISO 14001 in the chemical industry than in other industries. For example, studies have shown that the role of supplier relationships are important in the automotive industry with the US Big Three automotive manufacturers (Ford, General Motors, and Chrysler) requesting their suppliers to adopt ISO 14001 (Delmas & Montiel, 2007). Some of the results of earlier studies may be driven by the weight of industries for which trade ties play an important role in the diffusion of environmental standards.

The variable representing foreign direct investment (FDI) is negative and significant; indicating that high levels of investment are associated with low levels of adoption of the standard among chemical firms. Countries with a high level of FDI are generally countries with low level of development. It is therefore not surprising that the sign of the FDI variable is the opposite of the GDP per capita variable which exerts a significant and positive effect on the number of ISO 14001 certificates. Multinationals may therefore not bring sufficient pressure to promote the diffusion of ISO 14001 in developing countries.

Finally, the variable representing the number of years since ISO 14001 entered a country is positively significant in the first three models, indicating that countries that are the early adopters of ISO 14001 are also more likely to see high numbers of adoptions within the chemical sector. As we noted, other trend variables such as the number of years of existence of the Responsible Care program in the country also showed significant positives. This result shows an acceleration of the phenomenon of adoption over the years.

DISCUSSION AND CONCLUSION

Most authors recognize the fact that voluntary environmental standards do not operate in isolation, but within the context of larger cultures or national regulations. However, very few acknowledge that they also operate in concert with other private or semi-private environmental governance mechanisms.

We started our paper by recognizing the competing hypotheses provided by the diffusion literature concerning the impact of existing standards on the likelihood of success of a new standard. Firms could be subjected to norms of exclusivity where they are discouraged to participate in competing standards. Alternatively, firms could learn from the initial adoption of the industry standard and be aware of the benefits of voluntary standards which become more the norm than the exception. Our findings show support for the latter explanation. We find that in the early stages of diffusion of an international environmental standard, previous adoption of other standards will shape the adoption of the latter. In particular, we find that in the case of the international environmental standard ISO 14001 in the chemical industry, the previous adoption of both the National Chemical Association's Responsible Care program, the quality standard ISO 9000 and the European EMAS standard enhanced the diffusion of ISO 14001. We find that regardless of their characteristics, all these standards enhance the diffusion of ISO 14001. We therefore conclude that environmental management standards feed on each other and that previous standards accelerate the adoption rates of subsequent ones. In the chemical context, firms that had already joined the Responsible Care program reinforce their environment, health and safety management system by also pursuing ISO 14001 certification. These results are consistent with previous findings about the impact of trade association membership in the decision to adopt new voluntary programs. Rivera (2004) found that trade association membership impacted the decision to adopt the Certification for Sustainable Tourism (an environmental voluntary program for the tourism industry) among the Costa Rican hotel industry (Rivera, 2004). We find that previous adoption of the Responsible Care program, which is promoted and managed by chemical trade associations in the different countries, impacts the decision to adopt a second voluntary program, the international voluntary standard ISO 14001.

In addition, we have argued that other institutional factors may drive the diffusion of a new industry standard within a particular sector. We predict that institutional pressure from governments and the civil society enhances the adoption of ISO 14001 within the chemical industry. We find some support to the argument that the adoption of voluntary but 'governmental' environmental management system standards can help the diffusion of ISO 14001. In the early stages of ISO 14001 diffusion, we also find that other institutional pressures can drive the chemical sector to adopt the standard such as pressures from civil society in the form of Non-Governmental Organizations (NGOs). It is well known how the chemical sector has been targeted by the civil society due to its well-documented impacts on the environment (OECD, 2001). Chemical companies might adopt ISO 14001 to send a signal of good environmental behavior to NGOs who might have been skeptical about the effectiveness of the Responsible Care Program.

Our study provides a bridge between the literature on the international diffusion of non-governmental standards and the policy diffusion literature. We show the cumulative effect of management standards in specific institutional settings, notably when non-market actors such as NGOs are involved in pressurizing firms to adopt a new standard. We test a comprehensive set of factors to explain the diffusion of ISO 14001 and find that previous standards and NGOs play a major role in the diffusion of ISO 14001 in the chemical industry. While the policy diffusion literature has highlighted the importance of policy characteristics in predicting policy diffusion, the literature on the diffusion on non-governmental standards had paid less attention to the characteristics of international voluntary standards, probably because of the lack of existing data at the industry level. We show that this factor should not be forgotten as it is a major influence, at least in the chemical industry.

Unlike previous studies we do not find a significant role for government commitment in international environmental affairs or trade ties for the chemical industry adopting voluntary standards. Regarding the role of governments, our results show that more specific commitment to environmental management standard explains better the adoption of further standards rather than general commitment towards the environment. This is consistent with previous studies that showed the importance of a non-adversarial institutional environment to facilitate the adoption of

ISO 14001 (Kollman & Prakash, 2001Delmas, 2005, Moon & Deleon, 2005). In addition, it is possible that government efforts may impact indirectly on ISO 14001 through the adoption of Responsible Care. Regarding the role of trade ties, it is possible that national trade associations in the chemical industry play a more important role than forces related to bilateral trade to explain the diffusion of voluntary standards. Previous studies may not have identified industry specificities in that regard because they aggregated industry effects.

Our analysis is not without limitations. We first need to point out that our purpose is to analyze chemical companies' adoption strategy toward the new ISO 14001 standard considering that two other voluntary standards, ISO 9000 and Responsible Care were already diffused in some of the countries of analysis. Some of the institutional factors that explain the adoption of ISO 14001 might also have explained the previous adoption of the ISO 9000 and/or Responsible Care standards. However, because these previous standards were issued more than 10 years prior to ISO 14001, and because of data limitations (for example there is no data on the initial number of adoption per country for ISO 9000) it is not possible to test the factors that explain the initial adoption of these older standards. Furthermore, we want to state that additional factors such as quality customer requirements for ISO 9000 and industrial accidents and fatalities for Responsible Care might have explained the previous adoption of these standards. However, it is not the purpose of our study to determine the factors that drove companies to adopt Responsible Care in the first place.

Further research should investigate whether adoption decisions in the future, when the standard is better established, will differ from our findings. The World Trade Organization has been encouraging companies to adopt ISO 14001 as a means of preventing barriers to international trade and this will most likely impact future adoption rates of the standard. Other industry sectors with different characteristics should also be analyzed to compare the diffusion of management practices between different industries. In addition, future analyses will need to study the current strategies undertaken by some countries to integrate some of these industry standards. For instance, in the United States, the American Chemical Council (ACC) has recently designed a combined Responsible Care- ISO 14001 certification program called RC-14001 (Chemical Week, 5/17/2002:51). It will be interesting to observe whether or not other industries will follow the ACC initiative and design similar programs to simplify the adoption of both standards in specific countries and whether this has an impact on adoption rates. We identified links between the Responsible Care standard and ISO 14001 in terms of how one standard can influence the diffusion of the other. However, we did not investigate how the standards influence each other in terms of their content. Both ISO 14001 and Responsible care are continuously evolving over time. Further research should analyze how standards influence the content of each other.

Our research has important policy implications. Industry codes of conduct have been sometimes criticized as being developed by industries to protect themselves from more stringent standards (King & Lenox, 2000, Overdevest, 2004). Our research shows that this may not always be the case and that industry standards can pave the way for the next generation of standards that are more rigorous. Trade associations play an important role in fostering collective action behavior. Our results indicate that policy makers could build on the coordination abilities of trade associations to facilitate the diffusion of voluntary standards. We suggest that it is possible to envisage incremental approaches, where firms start initially with 'easier' standards, learn about these and subsequently move to more stringent standards. Some researchers have argued that voluntary codes covering a wider gamut of industries may be preferable to industry level codes because generalized codes reduce stakeholders' transaction costs of monitoring as well as facilitating an inter-industry comparison (Prakash, 2000). Our research shows that "generalist" codes of conducts such as ISO 14001 should not be opposed to industry codes such as Responsible Care as both could co-exist.

In summary, voluntary environmental standards should not be treated as alternative to one another but rather as complementary to each other. Few studies have examined how combinations of voluntary standards or combinations of voluntary standards with public ordering could be integrated into an optimal regulatory mix (Gunningham, Grabosky, & Sinclair, 1998). We need more studies that show how the design of complementary combinations of policy instruments tailored to particular environmental goals and circumstances will be more effective in improving the environment. Such studies would help to connect the emerging literature on the diffusion of environmental management standards to the literature on policy diffusion.

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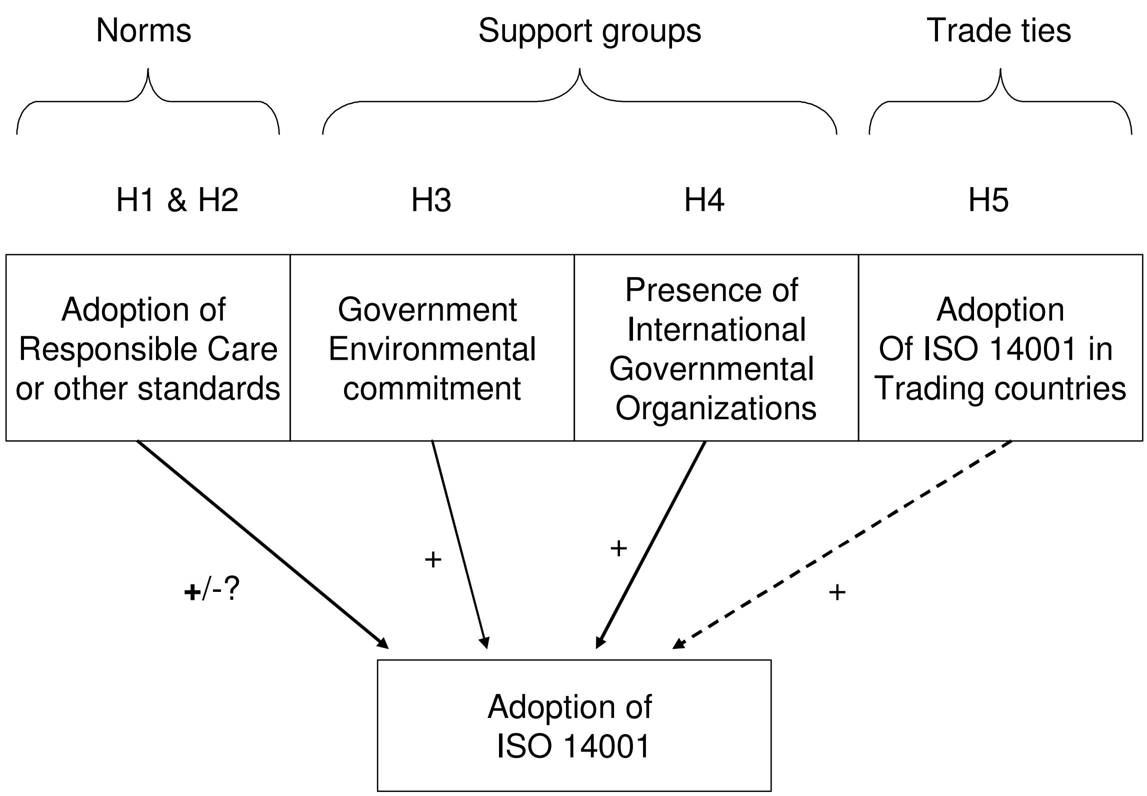
FIGURE I

FACTORS RELATED TO THE INTERNATIONAL DIFFUSION OF ISO 14001 IN THE CHEMICAL INDUSTRY



______ denotes hypothetical relationships that are confirmed or partly confirmed by our empirical analysis

------- denotes hypothetical relationships that are not confirmed by our empirical analysis

TABLE I

COMPARISON OF ISO 14001, ISO 9000,

THE RESPONSIBLE CARE PROGRAM and EMAS

VOLUNTARY PROGRAM	RESPONSIBLE CARE	ISO	ISO 9000	EMAS
Date of publication	1996	1987	1985 in Canada	1993 in Europe
Who makes the rule	Industry	NGOS, national standard organizations and industry	NGOS, national standard organizations and industry	European Commission
What is the content of the standard	Environmental, Health & Safety management system	Environmental Management System (EMS)	Quality Management System	Environmental Management System (EMS) and performance assessment
How is the commitment verified/compliance mechanisms	Trade association	Third party certification	Third party certification	Third party certification
Audience	Chemical Industry	Multi industry	Multi industry	Multi industry

TABLE II. DESCRIPTIVE STATISTICS AND CORRELATIONS

	Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	ISO 14001 in Chemical	27.29	95.23	1													
2	Required Responsible Care	0.33	0.47	0.23	1												
3	Voluntary Responsible Care	0.13	0.33	0.11	-0.27	1											
4	Years in Responsible Care	3.39	4.38	0.38	0.47	0.57	1										
5	ISO 9000 in Chemical	2.80	2.30	0.43	0.43	0.41	0.72	1									
6	EMAS	0.16	0.36	0.21	0.37	0.16	0.50	0.38	1								
7	Years in ISO 14001	2.82	2.25	0.33	0.52	0.31	0.71	0.73	0.45	1							
8	International NGOs	6.84	0.83	0.33	0.52	0.38	0.75	0.80	0.59	0.73	1						
9	International Chemical Treaties	16.06	4.82	0.23	0.10	0.21	0.38	0.39	0.20	0.43	0.43	1					
10	InterGovernmental Organizations	3.90	0.26	0.26	0.40	0.20	0.49	0.54	0.60	0.49	0.71	0.30	1				
11	Cohesion in Trade	3.77	1.26	-0.15	-0.35	-0.13	-0.29	-0.41	-0.34	-0.18	-0.48	0.05	-0.44	1			
12	Competitive Trade	6.13	1.11	0.15	0.19	0.21	0.34	0.43	0.25	0.42	0.47	0.20	0.32	-0.09	1		
13	FDI	0.72	1.29	-0.12	0.09	0.19	0.21	0.06	0.23	0.04	0.19	-0.00	0.12	-0.06	0.03	1	
14	GDP x capita	8.81	1.03	0.30	0.39	0.34	0.65	0.61	0.54	0.64	0.70	0.28	0.42	-0.31	0.47	0.18	1
15	Chemical Establishments	6.12	1.66	0.38	0.33	0.24	0.48	0.59	0.21	0.41	0.59	0.54	0.48	-0.44	-.036	-0.14	0.34

|coefficients| >0.12 are significant at the p<0.01

TABLE III. NEGATIVE BINOMIAL OF THE NUMBER OF CHEMICAL ISO 14001 CERTIFICATIONS

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	GDP as control for size of the industry			Chemical Establishments as control for size of industry		
Required Responsible Care	1.17**			1.47**		
	(0.32)			(0.49)		
Voluntary Responsible Care	0.39			0.62		
	(0.37)			(0.58)		
Years in Responsible Care		0.08*	0.11**		0.12*	0.12*
		(0.04)	(0.03)		(0.05)	(0.05)
ISO 9000 in Chemical	0.36**	0.31**	0.36**	0.35**	0.28**	0.28**
	(0.07)	(0.07)	(0.06)	(0.09)	(0.09)	(0.09)
EMAS	-0.42	-0.37	-0.20	0.98*	0.96*	0.95*
	(0.29)	(0.29)	(0.28)	(0.41)	(0.40)	(0.38)
Years in ISO 14001	0.12+	0.16*	0.18**	-0.01	-0.00	-0.00
	(0.06)	(0.06)	(0.06)	(0.14)	(0.12)	(0.12)
International NGOs	0.66*	0.74*		-0.03	-0.02	
	(0.34)	(0.32)		(0.49)	(0.49)	
International Chemical Treaties	0.00	-0.02	-0.02	0.08*	0.04	0.04
	(0.03)	(0.03)	(0.02)	(0.04)	(0.03)	(0.03)
Intergovernmental Organizations	0.41	0.49	0.69+	-0.17	0.11	0.10
	(0.40)	(0.36)	(0.36)	(0.59)	(0.55)	(0.53)
Cohesion in Trade	0.10	0.01	-0.08	0.02	-0.11	-0.11
	(0.11)	(0.10)	(0.09)	(0.19)	(0.18)	(0.16)
Competitive Trade	0.10	0.09	0.11+	0.10	0.26	0.25
	(0.06)	(0.06)	(0.06)	(0.33)	(0.34)	(0.29)
FDI	-0.10*	-0.11*	-0.10*	-0.17+	-0.22*	-0.22*
	(0.05)	(0.05)	(0.05)	(0.09)	(0.09)	(0.09)
GDP x capita	0.32+	0.23	0.35*			
	(0.17)	(0.16)	(0.15)			
Chemical Establishments				0.21*	0.16	0.16
				(0.10)	(0.10)	(0.10)
Constant	-11.80**	-10.89**	-7.91**	-3.99	-4.44	-4.52
	(2.50)	(2.53)	(2.12)	(3.47)	(3.28)	(2.88)
Observations	357	357	357	104	104	104
Number of id	113	113	113	51	51	51
Log likelihood	-811.53	-819.07	-821.86	-317.21	-321.49	-321.50

Standard errors in parentheses **p<0.01, *p<0.05, +p<0.1

APPENDIX I

RESPONSIBLE CARE MEMBER COUNTRIES AND YEAR OF ADOPTION

Country	**Adoption year**	**Country**	**Adoption year**
Argentina	1992	Lithuania	2002
Australia	1989	Malaysia	1994
Austria	1992	Mexico	1991
Belgium	1991	Morocco	1998
Brazil	1992	Netherlands	1990
Bulgaria	2002	New Zealand	1991
Canada	1985	Norway	1993
Chile	1994	Peru	1996
Colombia	1994	Philippines	1996
Czech Rep.	1994	Poland	1992
Denmark	1995	Portugal	1993
Ecuador	1999	Singapore	1990
Estonia	2002	Slovak Rep.	1996
Finland	1992	Slovenia	2002
France	1990	South Africa	1994
Germany	1991	South Korea	1999
Greece	1995	Spain	1993
Hong Kong	1992	Sweden	1991
Hungary	1992	Switzerland	1992
India	1993	Taiwan	1997
Indonesia	1997	Thailand	1996
Ireland	1992	Turkey	1993
Israel	2001	United Kingdom	1989
Italy	1992	United States	1985
Japan	1990	Uruguay	1998
Latvia	2002	Venezuela	2002

APPENDIX II

COUNTRIES INCLUDED IN THE STUDY (2003 Data)

Country	# ISO 14001 (2003)	# ISO Chemical (2003)	Country	# ISO 14001 (2003)	# ISO Chemical (2003)
Albania*	0	0	Lithuania*	72	1
Algeria	0	0	Malaysia	370	17
Angola	0	0	Mauritius	1	0
Argentina	286	5	Mexico*	406	19
Austria*	500	21	Morocco	6	1
Azerbaijan*	5	0	Mozambique	0	0
Bahrain	3	0	Nepal	1	0
Bangladesh	4	0	Nicaragua	0	0
Belarus	4	0	Niger	2	0
Bolivia	7	0	Nigeria	8	2
Brazil*	1008	54	Norway*	350	6
Bulgaria*	17	2	Oman*	2	1
Cambodia	1	0	Pakistan	26	1
Cameroon	1	0	Panama*	2	0
Canada*	1274	36	Papua New Guinea	1	0
Chile	99	6	Peru	31	0
China*	5064	0	Philippines*	174	2
Colombia*	135	12	Poland*	555	8
Cote d'Ivoire	0	0	Portugal*	248	16
Czech Republic*	519	32	Romania*	96	9
Denmark*	486	5	Russian Federation*	48	6
Ecuador*	1	0	Senegal*	0	0
Egypt, Arab Rep.	195	20	Seychelles	1	0
El Salvador	0	0	Sierra Leone	0	0
Estonia*	74	1	Singapore*	523	21
Fiji	1	0	Slovak Republic	165	14
Finland*	1128	57	Slovenia	205	0
France*	2344	128	South Africa	378	34
Gabon	0	0	Spain*	4860	216
Georgia*	0	0	Sri Lanka	11	0
Germany*	4144	778	Sudan	0	0
Ghana	0	0	Sweden*	3404	29
Greece	126	8	Syrian Arab Republic*	34	1
Guatemala	1	0	Tajikistan	0	0
Honduras	6	0	Tanzania	0	0
Hungary*	770	37	Thailand*	736	75
Iceland	3	0	Togo	0	0
India*	879	97	Trinidad and Tobago	9	0
Iran, Islamic Rep.*	88	0	Tunisia	18	2
Ireland	218	10	Turkey*	240	14
Israel*	163	29	Turkmenistan	1	0
Italy*	3066	204	Uganda	3	0
Jamaica	1	0	Ukraine	7	1
Japan*	13416	907	United Kingdom*	5460	117
Jordan*	39	13	United States	3553	135
Kazakhstan	4	0	Uruguay	32	8
Kenya	1	0	Uzbekistan	0	0
Korea, Rep.*	1495	166	Venezuela*	20	0
Kuwait	0	0	Vietnam	56	14
Kyrgyz Rep.*	0	0	Yemen, Rep.	0	0
Latvia*	3	0	Zambia	0	0

*Countries included in Models 4 to 6