LSE Research Online

Eric Neumayer and Richard Perkins

What explains the uneven take-up of ISO 14001 at the global level?: a panel-data analysis

Article (Accepted version)
(Refereed)

Original citation:
Neumayer, Eric and Perkins, Richard (2004) What explains the uneven take-up of ISO 14001 at the global level?: a panel-data analysis. Environment and planning A, 36 (5). pp. 823-839. ISSN 0308-518X
DOI: 10.1068/a36144

© 2004 Pion

This version available at: http://eprints.lse.ac.uk/16269/
Available in LSE Research Online: September 2012

LSE has developed LSE Research Online so that users may access research output of the School. Copyright © and Moral Rights for the papers on this site are retained by the individual authors and/or other copyright owners. Users may download and/or print one copy of any article(s) in LSE Research Online to facilitate their private study or for non-commercial research. You may not engage in further distribution of the material or use it for any profit-making activities or any commercial gain. You may freely distribute the URL (http://eprints.lse.ac.uk) of the LSE Research Online website.

This document is the author's final manuscript accepted version of the journal article, incorporating any revisions agreed during the peer review process. Some differences between this version and the published version may remain. You are advised to consult the publisher's version if you wish to cite from it.

http://eprints.lse.ac.uk

What explains the uneven take-up of ISO 14001 at the global level? A panel data analysis

Published in:

Environment and Planning A 36 (5), 2004, pp. 823-839

Eric Neumayer

Department of Geography and Environment, London School of Economics and Political Science, Houghton Street, London WC2A 2AE, England, e.neumayer@lse.ac.uk

Richard Perkins

Department of Geography, University of Plymouth, 8-11 Kirkby Place, Plymouth PL4 8AA, England, richard.perkins@plymouth.ac.uk

What explains the uneven take-up of ISO 14001 at the global level? A panel data analysis

Abstract.

Since its release in the mid-1990s, close to 37,000 facilities have been certified to ISO 14001, the international, voluntary standard for environmental management systems. Yet, despite claims that the standard can be readily adapted to very different corporate and geographic settings, its take-up has been highly geographically variable. This paper contributes to a growing body of work concerned with explaining the uneven diffusion of ISO 14001 at the global level. Drawing from the existing theoretical and empirical literature we develop a series of hypotheses about how various economic, market and regulatory factors influence the national count of ISO 14001 certifications. These hypotheses are then tested using econometric estimation techniques using data for a panel of 142 developed and developing countries. We find that per capita ISO 14001 counts are positively correlated with income per capita, stock of foreign direct investment, exports of goods and services to Europe and Japan, and pressure from civil society. Conversely, productivity and levels of state intervention are negatively correlated. The paper finishes by offering a number of recommendations to policy-makers concerned with accelerating the diffusion of voluntary environmental standards.

Introduction

One of the most significant trends in corporate environmental governance since the early-1980s has been the rapid growth of self-regulatory initiatives (Rondinelli & Berry, 2000; Gunningham & Sinclair, 2002; Paton, 2002). These comprise a variety of approaches and instruments whereby firms set and enforce rules and standards of permissible behaviour on a voluntary basis, rather than in response to formal regulatory requirements (Segerson & Li, 1999; Haufler, 2001). Yet, arguably the most visible example of self-regulation has been ISO 14001, an international, voluntary standard for environmental management promoted by the Geneva-based International Organization for Standardization (ISO).

In common with many other self-regulatory codes adopted by corporations over the past two decades the origins of ISO 14001 are deeply rooted in the process of globalisation. It was primarily conceived to facilitate trade and investment by replacing numerous and often conflicting national standards for environmental management with a single international one (Davy, 1997; Quazi et al, 2001; Melnyk et al, 2003). Moreover, in defining a framework for environmental improvement flexible enough to be adapted to very different national and corporate conditions, the architects of ISO 14001 hoped that the standard would appeal to firms in both developed and developing countries (Rondinelli & Vastag, 2000; Wilson, 2002).[1]

Yet, despite its alleged global credentials, it is clear that implementation of ISO 14001 has been highly geographically uneven. In absolute numbers, uptake has been

[1] The term "firm" is used broadly here to denote all private- and public-sector entities, ranging from manufacturing units to administrative buildings, capable of acquiring ISO 14001 certification.

greatest in Japan, followed by a number of leading European countries, the US and Australia. A number of late industrialising economies in East and Southeast Asia have also been rapidly implementing the standard in recent years. Elsewhere, however, uptake has been comparatively low (Matouq, 2000; Steger, 2000). In per capita terms, the Scandinavian countries, Switzerland, Singapore, Australia, Japan and some other European countries top the list.

What explains the wide variation in the take-up of ISO 14001? Previous insights into this question have mostly come from comparative analyses of certification counts in Europe and the US (Prakash, 1999; Delmas, 2002; Kollman & Prakash, 2002). These studies have been instrumental in highlighting the role played by different features of the national institutional environment in promoting and/or inhibiting the take-up of ISO 14001. Based on qualitative evidence from a handful of developed economies, however, question marks remain over the generalisability of their findings. This points to the need for multiple country, quantitative research. Yet, the only study of this kind is itself problematic (Corbett & Kirsch, 2001), relying on a handful of dubious proxy variables and omitting a large number of developing countries from the sample.

This paper responds to the gap in the existing literature by undertaking a more systematic and broad-based analysis of international variations in the uptake of ISO 14001. Drawing from recent theoretical and empirical literature on industry self-regulation and environmental management systems (EMS) we develop a series of hypotheses about the relationship between ISO 14001 certification counts and various characteristics of the national institutional environment. These hypotheses are then tested quantitatively for a panel of 142 countries using a set of measurable proxies.

Briefly, our results suggest that take-up of ISO 14001 has been influenced by both supply-side and demand-side factors. The per capita certification count is positively correlated with income per capita, the export of goods and services to Europe and Japan, the presence of foreign direct investment and pressure from civil society. Conversely, productivity and state intervention are negatively correlated with per capita certification counts.

The rest of the paper is organised as follows. First, we provide a brief introduction to ISO 14001 and review previous studies that have sought to explain cross-country variations in take-up of the standard. Hypotheses are developed in the next section. We then describe the data and methods used in the study, followed by results and a broader discussion of the implications of our research.

The nature and origins of ISO 14001

According to Steger (2000, p.24), an environmental management system (EMS) can be defined as, '…a transparent, systematic process known corporate-wide, with the purpose of prescribing and implementing environmental goals, policies, and responsibilities, as well as regular auditing of its elements.' The origins of systems for managing firms' environmental impacts can be traced back to the 1970s (Krut & Gleckman, 1998). Yet it was not until the following decade that widespread interest in EMS emerged. This was closely bound-up with a broader shift towards self-regulation whereby firms, subject to ever greater levels of public scrutiny, began to adopt voluntary codes of conduct in order to demonstrate their environmental commitment (Clapp, 2001; Hoffman, 2001; Stewart, 2001; King et al., 2002). The first EMS were unilateral, firm-level initiatives. Since the early-1990s, however, a number of “standardised” environmental management systems have been developed by various national (e.g., the British Standards Institute’s 7750) and regional bodies (e.g., the European Union’s Eco-Management and Audit Scheme) (Starkey, 1996).

ISO 14001 continues this trend toward standardisation at the international level. It was developed by the International Organization for Standardization (ISO), a Swiss-based non-governmental organisation set-up in 1946. Traditionally, the ISO restricted its activities to writing technical standards for products in order to expedite trade and technology transfer (Clapp, 2001). However, beginning in the late-1980s, it began writing standards for management processes and procedures. Following the success of its first procedural standard, the ISO 9000 series for quality management, the ISO initiated steps to introduce a parallel set of standards for environmental management. The result was the ISO 14000 series which aims to provide a comprehensive framework for systematically improving environmental performance that can be accepted and implemented by organisations worldwide (Quazi et al, 2001).

ISO 14000 consists of two types of standard. The first, and the centrepiece of the series, is the ISO 14001 procedural standard. A number of facilities certified themselves to draft versions of ISO 14001 prior to its official release in September 1996 (ISO, 2002). ISO 14001 sets out the minimum requirements of an effective environmental management system. These comprise main five elements: (1) an environmental policy; (2) an assessment of the organisation’s environmental effects and compliance with legal and other requirements; (3) a management system defining the responsibilities, procedures and controls required to achieve the organisation’s environmental policy; (4) periodic audits and reviews of the environmental management system to ensure continuous improvement; and (5) a public statement declaring that ISO 14001 is being implemented (Krut & Gleckman, 1998, pp.10-12).

Accompanying ISO 14001 is a set of guidance standards intended to provide assistance to managers in various aspects of environmental management. Several of these provide guidelines for evaluating an organisation's environmental performance and management system, e.g., ISO 14010/11/12 (Environmental Auditing). Others, meanwhile, are process and product evaluation standards which, as their name suggests, focus on the analysis and evaluation of product and process characteristics, e.g., ISO 14020 (Environmental Labelling) (Melnyk et al, 2003).

ISO 14001 is the only certifiable standard in the 14000 series. Firms that comply with its requirements have two choices: declare themselves in compliance; or use a registered auditor to verify that the organisation's operations conform to the documented environmental management system (Rondinelli & Vastag, 2000; Mendel, 2002). In practice, self-certification carries only limited credibility, with the result that many firms prefer third party accreditation.

ISO 14001 has come in for considerable criticism since its release in 1996. Much of this has centred on the fact that the standard does not require certified facilities to reduce their environmental impacts or set specific performance targets. Instead, it merely calls on firms to commit themselves to legal compliance, a condition that critics believe is unlikely to evoke significant investments in environmental improvement (Roht-Arriaza, 1997; Krut & Gleckman, 1998; Clapp, 2001; Bansal & Bogner, 2002). Supporters, however, claim that such criticism is misplaced. They argue that it is precisely the standard's flexibility that makes it a useful tool to address environmental issues in very different corporate and geographic settings.

What is clear is that, much like ISO 9000 before it, ISO 14001 has proved popular with firms. In the six-year period 1995-2001 the number of certified facilities grew from 257 to 36,765. Yet, as shown in Tables 1 and 2, uptake of the standard has been geographically uneven. So far, certification activity has been greatest in Europe and, to a lesser extent, the Far East. Elsewhere, however, enthusiasm for ISO 14001 has been comparatively low. In fact, only ten countries account for nearly 70 per cent of world certifications, seven of which are member states of the European Union.

< Insert tables 1 and 2 about here >

Review and critique of the existing literature

What accounts for the uneven diffusion of ISO 14001 worldwide? This question has recently been addressed by two bodies of literature. Drawing heavily from institutional theory the first group of studies have taken a largely qualitative approach (Prakash, 1999; Delmas, 2002; Kollman & Prakash, 2002; Milstein et al, 2002). Their starting point is the belief that firms will only implement ISO 14001 where the apparent benefits more than offset the costs and, moreover, that these costs and revenues are in turn shaped by the broader institutional environment in which firms operate.

Following this approach, the very different certification counts in Europe and the US are explained in terms of distinctive demand and supply-side characteristics of their national institutional environments. Thus, Kollman & Prakash (2002) and Delmas (2002) point to the pivotal role played by the British Standards Institute (BSI) in promoting ISO 14001 in the UK, and how the absence of an equivalent body has hindered similar take-up of the standard in the US. They also draw a contrast between Germany, where certified firms have often received "relief" from regulatory agencies, and the US, whose more adversarial and legalistic tradition has prohibited similar concessions from being granted to ISO 14001 compliant facilities. The result, these scholars argue, is that the economic incentives for implementing the standard have been far lower. Going further, Delmas describes how, unlike the US, many European countries had prior experience of formal EMS (e.g., EMAS). This lowered the subsequent costs of implementing and certifying ISO 14001 and contributed to its greater popularity.

The second approach taken in the literature is quantitative and has sought to identify the determinants of ISO 14001 adoption using data from a far larger sample of countries. It is represented by a single study, Corbett & Kirsch (2001), who use a regression model to estimate the influence of four variables for a sample of 63 developed and developing countries in 1998. The authors find statistically significant and positive relationships between ISO 14001 counts and export propensity, "environmentality" and, most strongly of all, ISO 9000 counts. Curiously, however, their estimations suggest that the level of development, proxied by income per capita, does not have a statistically significant effect.

The above works have done much to increase our understanding of various demand- and supply-side variables implicated in the uneven diffusion of the ISO 14001 environmental management standard across the globe. Neither, however, is without substantial drawbacks. Based exclusively on qualitative analysis and evidence from a handful of developed economies recent institutionalist accounts can be criticised for their lack of generalisability.

Corbett & Kirsch's (2001) study overcomes some of these shortcomings in that it uses quantitative techniques in a larger sample of developed and developing countries. Yet, it too, is not without its weaknesses. Partly as a result of data limitations the study only investigates a few variables. Moreover, several of these rely on proxies which, at best, are weakly rooted in the actual concepts the authors purport to measure. For example, Corbett & Kirsch (2001) use a count of international environmental treaties ratified by each country as a proxy for "environmental attitude" or "environmentality". It is far from clear, however, that ratification of international environmental treaties ("environmentality") is a satisfactory measure of "…the extent to which firms in a given country are predisposed to care about environmental issues, whether due to government regulations or incentives, pressure from consumers, employees, NGOs…or for other reasons" (p. 334). Recent conceptual approaches argue that it is precisely the failure of public law and regulation to reflect wider societal demands for environmental protection that underpin the emergence and diffusion of self-regulatory codes. Similarly, relying on a measure of aggregate exports to GDP ratio to capture supply chain pressures for certification in foreign markets has only limited appeal, since reports strongly indicate that these requirements are only currently important in Europe and Japan (Roht-Arriaza, 1997; Tanner, 1998).

More generally, although Corbett & Kirsch include the majority of countries with ISO 14001 certifications in their sample (N=63), they omit all the ones that do not. Selecting a sample on such a criterion leads to well-known selection bias in the estimations. Indeed, given that many of the excluded countries are developing ones, we suspect that it could go some way in explaining the surprising result that per capita income has no statistically significant effect on certification counts.

This paper seeks to overcome several of the weaknesses inherent in previous work. With a view to generating more generalisable findings than existing qualitative contributions we use econometric estimation techniques. Yet, going beyond Corbett & Kirsch, our study features a much larger sample (N=142) that is only constrained by the availability of data for our explanatory variables. Additionally, we test for the influence of a larger number of demand- and supply-side variables, using measures more firmly rooted in the actual decision of firms to implement and certify ISO 14001. Finally, in contrast to Corbett & Kirsch, our econometric model uses a lagged dependent variable. This allows us to control for the dynamics of ISO 14001 uptake and, with it, the well-documented propensity of firms in countries with previous experience of ISO 14001 to adopt the standard[2] (Delmas, 2002; Kollman & Prakash, 2002). Without a panel data set, Corbett & Kirsch see no alternative to using ISO 9000 take-up as a proxy for modelling this diffusion process, a shortcoming we correct with our research design.[3] As such, we are better able to investigate other variables thought to influence the take-up of ISO 14001. Inclusion of the lagged dependent variable also mitigates potential omitted variable bias since it is correlated

[2] These so-called "path dependencies" in certification are commonly explained by the accumulation of internal (e.g., know-how in documentation, procedural standardisation, etc.) and external (e.g., consultancy services, registered auditors, etc.) capabilities which lower the subsequent costs, as well as the perceived risks, of adopting ISO 14001 (Corbett & Kirsch, 2000; Kollman & Prakash, 2002).

[3] It is telling that if we include the count of ISO 9000 certified companies as a further explanatory variable in our estimation, its coefficient is clearly statistically insignificant.

with any such variable (Finkel 1995). Because no model is ever complete, omitted variables always represent a problem, potentially biasing the estimations. The inclusion of a lagged dependent variable mitigates this problem as the omitted variables are indirectly controlled for.

In the next section we develop a series of hypotheses about how various economic, market and regulatory factors influence the national count of ISO 14001 certifications. For guidance, we draw not only from the findings of studies reviewed above, but also a growing body of literature examining the take-up of environmental management systems at the firm-level. This work has identified several reasons for implementing an EMS and suggests that adoption decisions are often based on a number of different motives (e.g., Matouq, 2000; Khanna & Anton, 2002; Morrow & Rondinelli, 2002). At the outset, it is worth pointing out that our choice of variables is necessarily limited by the availability of data. Supply-side factors, such as the availability of assistance from non-governmental bodies, are especially problematic in this respect. Still, we believe that our study offers an innovative test of several of the most important variables implicated in the variable take-up of ISO 14001.

Development of hypotheses

No doubt, one of the most important predications supplied by the existing literature is that firms will only implement and certify themselves to ISO 14001 where they face strong demand-side incentives to do so. These are said to be provided by two principal actors, markets and civil society. Beginning with the former, a great deal has been written about pressure from business customers in export markets, and particularly developed economy ones. If anecdotal reports are believed, a growing number of firms in these countries are requiring their local and overseas suppliers to be certified to ISO 14001. Moreover, expecting ISO 14001 to become a *de facto* standard in the coming decade, many suppliers are obtaining certification in order to "future-proof" themselves (Chin & Pun, 1999; Steger, 2000; Cosbey, 2002; Rock, 2002). According to more sophisticated accounts, however, supply chain requirements for ISO 14001 are only a significant factor for exporters of goods and services to Europe and Japan[4] (Roht-Arriaza, 1997; Tanner, 1998; Kollman & Prakash, 2002). Only a handful of larger firms in the US, by contrast, are mandating certification meaning that the incentive to adopt ISO 14001 is likely to be comparatively low (Delmas, 2002). Indeed, as Table 2 above has shown, in relative terms there are very few ISO 14001 certifications in the US. Hence:

Hypothesis 1. Countries that export a higher share of goods and services relative to their output to European Union states or Japan will have a higher number of ISO 14001 certifications, whereas exports to the US do not matter.

Another source of market demand discussed in the literature comes from transnational corporations (TNCs). Many of these firms, and particularly the larger, more visible ones, are vulnerable to negative publicity regarding their environmental performance (Willetts, 1998; Hastings, 1999). Consequently, a growing number of

[4] Tanner (1998) describes how many firms in developing Asia found themselves unprepared to meet customer requirements for ISO 9000 in Europe. Consequently, they are rapidly certifying themselves to ISO 14001, anticipating that the standard will similarly become a condition for doing business in the near future.

them are requiring their local affiliates and subsidiaries to adopt voluntary environmental codes (UNCTAD, 1999; Steger, 2000; Haufler, 2001). In practice, this often means ISO 14001 which provides a single, flexible standard that can be applied and adapted across business units in different countries (Epstein & Roy, 1998; Rondinelli & Vastag, 2000; Perry & Singh, 2002). Going further, in order to guard against environmental and reputational liabilities in supply chains, many leading TNCs are requesting their suppliers to implement and certify ISO 14001 compliant environmental management systems (Chang-Xing, 1999). This probably explains Khanna & Anton's (2002) finding that US firms with a stronger multinational presence are more likely to adopt an EMS. Taken together, then, these accounts suggest that the local presence of transnationals is likely to be supportive of ISO 14001 certification. Thus:

Hypothesis 2. Countries with higher levels of TNC involvement will have a higher number of ISO 14001 certifications.

A third market-based motive for implementing an EMS that has received widespread coverage in the recent literature is to secure competitive advantage through improvements in operating performance. Of these, productivity gains appear to be the most important, with proponents claiming that firms which implement ISO 14001 can save significant costs by way of enhanced operational efficiency (Rondinelli & Berry, 2000). Systematic evidence for these gains has yet to be established. However, according to several commentators, they are likely to be greatest amongst firms with low levels of productivity. Such firms, it is argued, have still to exploit many low cost, high return investments in operational efficiency (so-called “low hanging fruit”) and are therefore well placed to gain substantially from implementing systems that assist in the identification and realisation of these opportunities (Davy, 1997; Tanner, 1998). Companies with already high levels of efficiency, by contrast, stand relatively little to gain from implementing an ISO 14001 compliant management system, reducing their incentive to adopt the standard. Indeed, these claims are supported by recent survey evidence, revealing that ISO 14001 has brought greater gains to certified firms in developing countries (where one might assume productivity levels are relatively low) than their counterparts in developed ones (where productivity are likely to be higher) (Raines, 2002):

Hypothesis 3. Countries with lower levels of productivity will have a higher number of ISO 14001 certifications.

Non-governmental organisations (NGOs) and other civil society groups are another set of stakeholders widely implicated in generating demand for ISO 14001. According to an influential body of work such groups are assuming growing importance in “regulating” the activities of corporations. Not only are they acting as surrogate enforcement officials, putting pressure on corporations to adhere to regulatory norms, but NGOs are also taking a lead role in defining norms of appropriate and legitimate environmental behaviour. This, the literature suggests, owes much to the regulatory vacuum created by the failure of public law and enforcement to keep pace with rising environmental demand which has meant that firms must increasingly secure a “licence to operate” directly from civil society by demonstrating their commitment to sound levels of environmental performance (Neale, 1997; Rodgers, 2000; Perry & Singh, 2002).

One way of accomplishing this is through the adoption of self-regulatory codes such as ISO 14001. These signal conformity with a recognisable standard and can help firms to communicate their environmental achievements to external stakeholders (Davy, 1997; Prakash, 1999; Bansal & Bogner, 2002). As such, they can help ward-off criticism from NGOs, delay calls from these groups for the introduction of more stringent government regulation, and even provide firms with rewards from customers and financial institutions (Gunningham & Sinclair, 2002). No doubt this explains why firms, both in developing and especially developed economies, recurrently cite "public image" and "social responsibility" as one of the primary motives for implementing and certifying ISO 14001 (Matouq, 2000; Delmas, 2002; Mbohwa & Fukada, 2002; Morrow & Rondinelli, 2002; Perry & Singh, 2002; Raines, 2002).

Clearly, however, the incentive to adopt ISO 14001 will depend on the degree of pressure from civil society groups (Gunningham & Sinclair, 2002; Hanks, 2002). Where there are few NGOs to monitor and enforce standards of corporate behaviour, the benefits of adopting the standard on public relations grounds alone are likely to be relatively low. By contrast, where environmental demand is high, manifest in a dense network of NGOs, the incentive will be far greater. Thus:

Hypothesis 4. The higher the number of environmental NGOs relative to population size present in a country the higher the number of ISO 14001 certifications.

Given the suggestion that firms must also secure legitimacy for their activities from society at large certification pressures are also likely to depend on the general level of public demand for environmental quality. Assuming, as many analysts do, that the environment is a normal good (McConnell, 1997), this implies that ISO certification counts will be greatest in rich countries and least in poor ones.

Yet, as well as influencing demand, income is also portrayed in the literature as determining the ability of firms to supply environmental self-regulation. According to analysts, this stems from the relatively high start-up and subsequent maintenance costs of ISO 14001 (Chin & Pun, 1999), particularly where firms: (a) have little or no previous experience of environmental or quality management systems; (b) lack the necessary financial, technological and managerial resources and capabilities to implement and certify to ISO 14001; and (c) do not have the support of a network of governmental and/or non-governmental organisations committed to promoting the standard (Steger, 2000; Bansal & Bogner, 2002). In practice, experience suggests that both of these conditions are most likely to be found in developing countries, especially in the small-and-medium-scale sector (Chang-Xing, 1999; Raines, 2002). Indeed, the high costs of implementation and certification are recurrently cited as one of the key reasons for low levels of ISO 14001 certification in low-income countries (Davy, 1997; Mbohwa & Fukada, 2002). Taken together, therefore, these demand- and supply-side considerations suggest:

Hypothesis 5. The higher the per capita income the higher the number of ISO 14001 certifications.

More conceptually, it has been argued that the recent growth of industry self-regulation has gone hand-in-hand with the shift towards a smaller, more market-driven state (Haufler, 2001). Thus, according to critics, globalisation has heightened concern over the impact of environmental regulations on industrial competitiveness (Stewart, 2001; Evans et al., 2002; Welford, 2002). As a result, a growing number of governments in both developed and developing countries are turning towards voluntary initiatives, promoted as a more flexible and cost-effective alternative to conventional directive- or market-based forms of regulation (Hillary & Thorsen, 1999; Haufler, 2001; Newell, 2001; Gunningham & Sinclair, 2002; Wilson, 2002).

What this suggests is that, far from being a complement to tougher public law and enforcement, self-regulatory codes such as ISO 14001 are more likely to be acting as a substitute. Moreover, given the implication that the shift towards corporate voluntarism is part of a broader neo-liberal project to transfer the political and administrative costs of regulation from the public to the private domain (Finger & Tamiotti, 1999), one might expect the uptake of ISO 14001 to be most advanced in governmental regimes with limited state intervention. Thus:

Hypothesis 6. Countries with lower levels of state intervention are likely to have a higher number ISO 14001 certifications.

Research design

ISO (2002) publishes the number of facilities certified to ISO 14001 at the country level. To make this variable comparable, we normalise by population size so that our dependent variable is the number of ISO 14001 certifications per one million inhabitants (*ISO14001 p.c.*). The data cover the period from 1996, the official release date of ISO 14001, to 2001. Our ten explanatory variables are as follows. The value of exports relative to gross domestic product (GDP) is measured by three separate variables, referring to goods and services exported to the 15 countries of the European Union (EU15), the US, and Japan (*EXPEU15GDP*, *EXPUSGDP*, *EXPJAPANGDP*). Data are taken from OECD (2003). For the EU countries the *EXPEU15GDP* variable refers to exports to the other 14 EU members, for the US and Japan the *EXPUSGDP* and the *EXPJAPANGDP* variables are coded zero, respectively. We measure the level of transnational involvement by the stock of FDI relative to GDP since this better captures the overall impact of foreign TNCs in the host economy than volatile short-term inflows (*FDISTOCKGDP*). These data are sourced from UNCTAD (2003). For productivity we have divided GDP in purchasing power parity (PPP) by the size of the labour force, yielding a measure of product per worker (*GDPPERWORKER*). Data are taken from World Bank (2003). As our measure of demand from civil society we use the per capita number of environmental non-governmental organisations (*ENVIROGROUPS p.c.*) per country as reported by Europa Publications (2001). This variable refers to the late-1990s and is time-invariant due to lack of data. This is not problematic as the level of demand from civil society is unlikely to have changed much over such a short period as 1996 to 2001. Per capita income (*GDP p.c.*) is measured by per capita GDP in PPP, taken from World Bank (2003). It is important to use income data in PPP, and not the conventional income data at foreign exchange rates, since the latter are known to substantially underestimate effective purchasing power in poor countries. As stated above, per capita income potentially captures both demand- and supply-side factors implicated in the take-up of ISO 14001. However, since we control for environmental demand through the inclusion of environmental NGOs, our income variable might be expected to predominantly measure supply-side aspects.

With respect to government intervention, we would ideally have liked to use a variable which specifically measures the stringency of public environmental law and enforcement. Yet no such variable is available for our full sample of countries. In its absence, we take a variable published by the conservative Heritage Foundation (2003), which forms part of their Index of Economic Freedom, as a proxy for the extent of general government intervention in the economy (*GOVINTERVENTION*). The Foundation grades countries on a one to five scale according to: (a) the level of government consumption as a percentage of the economy; (b) the extent of government ownership of businesses and industries; (c) the share of government revenues from state-owned enterprises; (d) government ownership of property; and (e) economic output produced by the government.

As a further control variable we use total GDP in PPP as a proxy for economic size (*GDP*), taken from World Bank (2003). Without recourse to data representing the total number of firms in a country, we realistically assume that bigger economies are likely to have more firms. A higher number of firms makes it more likely that some of them are front-runners that experiment with ISO 14001 certification and stimulate a self-reinforcing process of take-up through the domestic economy via coercive and demonstrative influences. We therefore expect a positive effect of economic size on the per capita ISO 14001 count. A final control variable is the manufacturing share of GDP (*%MANUFACT*), taken from World Bank (2003) and supplemented by CIA (2002). All nominal variables have been converted to real 1996 prices using the United States GDP deflator, taken from World Bank (2003). Table 3 provides summary descriptive variable information. Note that the panel is not fully balanced since, in the case of a small number of countries, one or more observations are missing due to insufficient data on one of the explanatory variables. Table 4 lists the countries included in the sample.

< Insert Tables 3 and 4 about here >

We estimate the following model:

$$y_{it} = \alpha + \beta_1 y_{it-1} + \beta_2 x_{it} + \gamma_t T_t + v_{it}.$$

The subscript i represents each country in year t, *y* is the number of ISO 14001 certifications and *x* is the vector of explanatory variables. The year-specific dummy variables *T* capture general developments such as the worldwide spread of awareness about the standard and correct for unobserved time effects. The v_{it} is a stochastic error term. We estimate equation (1) with Beck & Katz's (1995) popular and commonly applied time-series cross-sectional estimator with panel-corrected standard errors. The error term is presumed to be heteroskedastic and contemporaneously correlated across panels. Beck & Katz provide evidence from Monte Carlo analysis showing that their estimator is more conservative and less likely to underestimate standard errors than feasible generalized least squares (FGLS), the alternative estimator. Their estimator is thus less likely to wrongly attribute statistical significance to a coefficient, which is in fact insignificant. Such conservatism suits our research purpose well.

As argued above, the inclusion of a lagged dependent variable mitigates any omitted variable bias. It does so more comprehensively than estimation with country fixed-effects because the lagged dependent variable even mitigates the bias of time-varying omitted variables. This is why we use Beck & Katz's (1995) time-series cross-sectional estimator with panel-corrected standard errors and a lagged dependent variable rather than a fixed effects model. Another reason for this choice is that one of our variables is time-invariant and some others do not change much over time. A fixed-effects estimator cannot estimate the former and would estimate the latter only very inefficiently.

We take the natural log of the dependent variable after adding one to the absolute number of ISO 14001 counts to make such logging possible for values of zero in order to mitigate the heteroscedasticity of the data. As concerns the explanatory variables, we log all variables, which are strictly positive. In other words, our model is a log-linear one for most explanatory variables, which allows an easy to understand elasticity interpretation of the estimated coefficients. For a logged independent variable, an estimated coefficient of, say, 0.9 means that a one per cent increase in this variable is associated with a 0.9 per cent increase in ISO14001 certification. This model also exhibited a much better fit to the data.

Results

Column I of Table 5 reports estimation results for the full sample and column II for a sample that excludes all developed countries, namely Canada and the US, the 15

European Union countries, Iceland, Norway, Switzerland, Japan, New Zealand and Australia.

Consistent with a priori expectations, countries with greater exports of goods and services to the European Union and Japan have a higher uptake of ISO 14001 in per capita terms. The coefficient of the exports to the US variable is negative and statistically significant. A higher level of transnational involvement as measured by *FDISTOCKGDP* leads to a higher number of ISO 14001 certifications. So does a higher level of demand from civil society as measured by *ENVIROGROUPS p.c.* Richer countries have more ISO 14001 certified facilities per capita. Countries in which the government intervenes more in the economy have a lower certification count, as do countries with higher productivity.

As concerns the control variables, the lagged dependent variable is highly significant and positive, thereby conforming with expectations. As anticipated, we find that bigger economies have more certifications per capita, but a higher manufacturing share of GDP is not related to take-up of ISO 14001.

Results are very similar in terms of coefficient sign and statistical significance if the sample is restricted to the non-developed countries (column II). The only difference is that EXPEU15GDP turns insignificant in this smaller sample. This suggests that our main results are not merely driven by the inclusion of developed countries in the sample.

< Insert Table 5 about here >

How strong is the effect of each variable? Since variables are held in different units and have different distributions the estimated coefficients cannot be compared directly with each other. However, the method of so-called (semi-)standardized coefficients allows us to compare the effect of variables held in different units with each other. Table 6 presents the percentage increase in per capita ISO 14001 take-up following a substantial increase in one of the explanatory variables, where we take a one standard deviation increase in a variable to represent a 'substantial' increase (estimates refer to the full sample model). With the presence of the lagged dependent variable in the model, these are to be interpreted as short-term or instantaneous increases, but the ranking of variables in terms of magnitude of effect does not change if we were to compute long-term changes instead. It is clear that per capita income, exports to the EU, economic size and productivity are the substantively most important factors, followed by the export to Japan and the US variables. The penetration of the economy with foreign capital is about equally important as environmental NGO presence and the extent of government intervention in the economy. The share of manufacturing is not only statistically insignificant, but also substantively unimportant.

< Insert Table 6 about here >

Discussion and conclusions

This study seeks to advance understanding of the factors that determine take-up of ISO 14001, the international, voluntary standard for environmental management systems. To this end, it quantitatively examines the influence of several hypothesised demand- and supply-side variables believed to influence certification counts using data for a panel of 142 developed and developing countries. We control for the dynamics of ISO 14001 take-up with the help of a lagged dependent variable which, as expected, is found to be highly statistically significant. Countries with a larger economy as measured by total GDP also have a greater number of certified facilities in per capita terms. We do not know why the variable measuring exports per GDP to the US is not merely statistically insignificant in line with our expectation, but instead significant with a negative coefficient. The result might simply be down to chance, but in future research we want to explore in more detail whether an export orientation towards the US market could have a deterrent effect on the up-take of ISO 14001.

Overall, we find support for the commonly made suggestion that variations in the take-up of ISO 14001 can be explained by differences in the incentive structures facing firms. Our hypotheses linking environmental demand with certification counts are confirmed by the econometric estimations. Firms, in other words, are more likely to adopt ISO 14001 where they face strong incentives to do so.

Going further, our findings lend weight to the claim that the emergence and diffusion of self-regulatory initiatives is bound-up with new sources of environmental governance "beyond the state". The level of demand from civil society and market actors are individually statistically significant determinants of ISO 14001 certification counts in our estimations. Reinforcing the findings of recent work, therefore, the present study shows that non-state actors can indeed function as surrogate "regulators" encouraging firms to adopt beyond-compliance codes of conduct

(Rodgers, 2000; World Bank, 2000).[5] Moreover, challenging critics who suggest that trade and investment liberalisation are inimical to heightened environmental commitment, the findings of the present research suggest that they can actually strengthen it. Both the stock of investments by TNCs and exports to Japan and the EU (full sample only) are positively correlated with ISO 14001 certification counts.

Of note, apart from the exports to the EU variable, these results are indifferent to the inclusion of developed economies in the sample, indicating that the influence of market actors is not simply restricted to a handful of rich countries. This, of course, is not to say that growing integration with the global economy is not without its environmental costs. Yet the study's findings contribute to a growing body of evidence which suggests that economic globalisation is associated with the diffusion of environmentally-beneficial policies, technologies and operating practices (Reppelin-Hill, 1999; Garcia-Johnson, 2000; Haufler, 2001; Mielnik & Goldemberg, 2002).

Our evidence additionally confirms the proposition that supply-side factors have shaped the uneven diffusion of ISO 14001. We find a statistically significant negative correlation between productivity and certification counts. This is consistent with recent survey evidence which suggests that efficiency gains are a more important motive for implementing environmental management systems in developing countries (Tanner, 1998; Raines, 2002).

[5] Interestingly, like Damiana et al. (2003) we find that environmental NGOs play a more important role in developing countries than in developed ones.

The present study furthermore provides support for the positive relationship between income and number of ISO certifications. Given that we control for demand-side dynamics (i.e., demand for environmental quality from civil and market actors) using our environmental NGOs variable, this result is most likely a product of supply-side influences. Specifically, it suggests that firms in low income countries may indeed find it more costly and difficult to implement and certify ISO 14001 compliant management systems, presumably because of a lack of internal (weak finances, low levels of technological know-how, etc.) or external capabilities (limited availability of consultancy firms, third-party accreditation bodies, etc.). Further work is required, however, to clarify the respective role and importance of demand- and supply-side factors on ISO certifications.

Finally, the findings of our study lend measured support to recent conceptual accounts which suggest that the evolution and diffusion of private environmental law has gone hand-in-hand with the "retreat of the state" (Finger & Tamiotti, 1999; Bendell, 2000; Stewart, 2001). Lower levels of state involvement are, according to our estimations, significantly associated with higher certification counts. Unfortunately, our analysis does not allow us to say whether ISO 14001 exists as a substitute or complement to public law and regulation, although they hint towards the latter. Clearly, a major challenge for future research is to investigate this question using a measurable proxy for the stringency of domestic environmental regulation. To our knowledge, however, no adequate measure currently exists to perform such an analysis.

What does our study suggest for policy-makers charged with accelerating the diffusion of self-regulatory initiatives? We point to two key areas of leverage. The first centres on supply chains. A number of authors have speculated that environmental requirements in export markets are capable of stimulating the up-take of ISO 14001 (e.g., Cosbey, 2002; Rock, 2002). Our results support this thesis and suggest that public policy could play a role in the global diffusion of EMS activity by encouraging firms to specify ISO 14001 as a routine contractual requirement. These include, of particular significance, major TNCs whose regional and/or international network of suppliers means that they are especially well-placed to promote certification activity in both domestic and foreign markets.

The second point of leverage for policy-makers, meanwhile, is civil society. According to our regression analysis demand from environmental NGOs has been a significant factor driving firms to certify to the ISO standard. We believe that there is considerable scope for governments to strengthen these pressures by publicly disseminating information on the take-up of standardised EMS. Similar approaches have proved successful when applied to pollution release data (Tietenberg, 1998; World Bank, 2000) and offer a low cost means for public regulators to harness the regulatory functions of civil society.

Yet, recognising the potential difficulties faced by firms in lower income countries in implementing and certifying ISO 14001, these and other demand-side initiatives will need to be accompanied by supply-side ones aimed at providing financial, technical and managerial assistance. Failure to do so might see many small- and medium-scale firms excluded from supply chains, with potentially negative consequences for local economic development.

Acknowledgement

We would like to thank three anonymous referees for many helpful and constructive comments.

References

Bansal, P, Bogner, W C, 2002, "Deciding on ISO 14001: Economics, Institutions and Context" *Long Range Planning*, **35** 269-290

Beck, N, Katz, J K, 1995, "What to Do (and Not to Do) with Time-Series Cross-Section Data" *American Political Science Review,* **89** (3) 634-647

Bendell, J. 2000, “Introduction: Working with Stakeholder Pressure for Sustainable Development”, in *Terms for Endearment: Business, NGOs and Sustainable Development* Ed J Bendell (Greenleaf, Sheffield) pp 14-29

Chang-Xing, D 1999, "ISO 14001: The Severe Challenge for China. An Overview of the Problems Faced in the Implementation and Certification of ISO 14001", in *Growing Pains: Environmental Management in Developing Countries* Eds W Wehrmeyer, Y Mulugetta (Greenleaf Publishing, Sheffield) pp 101-116

Chin, K-S, Pun, K-F, 1999, "Factors Influencing ISO Implementation in Printed Circuit Board Manufacturing Industry in Hong Kong" *Journal of Environmental Planning and Management*, **42** (1) 123-134

CIA, 2002 *CIA World Factbook 2002* (Central Intelligence Agency, Washington, D.C.)

Clapp, J, 2001 *Toxic Exports: The Transfer of Hazardous Wastes and Technologies from Rich to Poor Countries* (Cornell University Press, Ithaca)

Corbett, C J, Kirsch, D A, 2000, "ISO 14000: An Agnostic's Report from the Front Line" *ISO 9000 + ISO 14000 News*, **9** (2) 4-17

Corbett, C J, Kirsch, D A, 2001, "International Diffusion of ISO 14000 Certification" *Production and Operations Management*, **10** (3) 327-342

Cosbey, A 2002, "The Trade, Investment and Environment Interface", in *Trade and Environment. Difficult Policy Choices at the Interface* Ed R K Shahrukh (Zed Books, London) pp 7-16

Damiana, R., Fredriksson, P.G., Gates S., Neumayer, E., 2003, "Environmentalism, Democracy and Pollution Control", Working Paper, London School of Economics

Davy, A 1997, "Environmental Management Systems: ISO 14001 Issues for Developing Countries", in *ISO 14001 and Beyond* Ed C Sheldon (Greenleaf, Sheffield) pp 169-182

Delmas, M A, 2002, "The Diffusion of Environmental Management Standards in Europe and the United States: An Institutional Perspective" *Policy Sciences*, **35** 91-119

Epstein, M, Roy, M-J, 1998, "Managing Corporate Environmental Performance: A Multinational Perspective" *European Management Journal*, **16** (3) 284-296

Europa Publications, 2001 *The Environment Encyclopedia and Directory* (Europa Publications Limited, London)

Evans, G, Russell, G, Sullivan, R 2002, "An International Regulatory Framework?" in *Moving Mountains: Communities Confront Mining and Globalisation* Eds G Evans, J Goodman, N Lansbury (Zed Books, New York) pp 207-222

Finger, M, Tamiotti, L, 1999, "New Global Regulatory Mechanisms and the Environment: The Emerging Linkages between the WTO and the ISO" *IDS Bulletin*, **30** (3) 8-15

Finkel, S E, 1995 *Causal Analysis with Panel Data* (SAGE Publications, London)

Garcia-Johnson, R, 2000 *Exporting Environmentalism: U.S. Multinational Chemical Corporations in Brazil and Mexico* (MIT Press, London)

Gunningham, N, Sinclair, D, 2002 *Leaders and Laggards: Next-Generation Environmental Regulation* (Greenleaf, Sheffield)

Hanks, J 2002, "Promoting Corporate Environmental Responsibility: What Role for "Self-Regulatory" and "Co-Regulatory" Policy Instruments in South Africa", in *The Greening of Business in Developing Countries: Rhetoric, Reality, and Prospects* Ed P Utting (Zed Books, London) pp 187-215

Hastings, M, 1999, "A New Operational Paradigm for Oil Operations in Sensitive Environments: An Analysis of Social Pressure, Corporate Capabilities and Competitive Advantage" *Business Strategy and the Environment*, **8** 267-280

Haufler, V, 2001 *A Public Role for the Private Sector: Industry Self-Regulation in a Global Economy* (Carnegie Endowment for International Peace, Washington, D.C.)

Heritage Foundation, 2003 *The Index of Economic Freedom* (Heritage Foundation, Washington, D.C.)

Hillary, R, Thorsen, N, 1999, "Regulatory and Self-Regulatory Measures as Routes to Promote Cleaner Production" *Journal of Cleaner Production*, **7** 1-11

Hoffman, A J, 2001 *From Heresy to Dogma: An Institutional History of Corporate Environmentalism* (expanded edition) (Stanford University Press: Stanford)

ISO, 2002 *The ISO Survey of ISO 9000 and ISO 14000 Certificates. Eleventh Cycle: Up to and Including 31 December 2001* (International Organization for Standardization, Geneva)

Khanna, M, Anton, W R Q, 2002, "Corporate Environmental Management: Regulatory and Market-Based Incentives" *Land Economics*, **78** (4) 539-558

King, A A, Lenox, M J, Barnett, M L 2002, "Strategic Responses to the Reputation Commons Problems", in *Organizations, Policy and the Natural Environment* Eds A J Hoffman, M J Ventresca (Stanford, Stanford University Press) pp 393-406

Kollman, K, Prakash, A, 2002, "EMS-based Environmental Regimes as Club Goods: Examining Variations in Firm-Level Adoption of ISO 14001 and EMAS in U.K., U.S. and Germany" *Policy Sciences*, **35** 43-67

Krut, R, Gleckman, H, 1998 *ISO 14001: A Missed Opportunity for Sustainable Global Industrial Development* (Earthscan, London)

Matouq, M, 2000, "A Case-Study of ISO 14001-Based Environmental Management System Implementation in the People's Republic of China" *Local Environment*, **5** (4) 415-433

Mbohwa, C, Fukada, S, 2002, "ISO 14001 Certification in Zimbabwe: Experiences, Problems and Prospects" *Corporate Environmental Strategy*, **9** (4) 427-436

McConnell, K E, 1997, "Income and the Demand for Environmental Quality" *Environment and Development Economics*, **2** (4) 383-399

Melnyk, S A, Sroufe, R P, Calantone, R, 2003, "Assessing the Impact of Environmental Management Systems on Corporate and Environmental Performance" *Journal of Operations Management*, **21** 329-351

Mendel, P J 2002, "International Standardisation and Global Governance: The Spread of Quality and Environmental Management Standards", in *Organizations, Policy and the Natural Environment* Eds A J Hoffman, M J Ventresca (Stanford University Press, Stanford) pp 407-424

Mielnik, O, Goldemberg, J, 2002, "Foreign Direct Investment and Decoupling between Energy and Gross Domestic Product in Developing Countries" *Energy Policy*, **30** (2) 87-89

Milstein, M B, Hart, S L, York, A S 2002, "Coercion Breeds Variation: The Differential Impact of Isomorphic Pressures on Environmental Strategies", in *Organizations, Policy and the Natural Environment* Eds A J Hoffman, M J Ventresca (Stanford University Press, Stanford) pp 151-172

Morrow, D, Rondinelli, D, 2002, "Adopting Corporate Environmental Management Systems: Motivations and Results of ISO 14001 and EMAS Certification" *European Management Journal*, **20** (2) 159-171

Neale, A, 1997, "Organisational Learning in Contested Environments: Lessons from Brent Spar" *Business Strategy and the Environment*, **6** (93-103)

Newell, P 2001, "Campaigning for Corporate Change: Global Citizen Action on the Environment", in *Global Citizen Action* Eds M Edwards, J Gaventa (Earthscan, London) pp 189-201

OECD, 2003, “International Trade by Commodity Statistics”, www.sourceoecd.org

Paton, B 2002, "Voluntary Environmental Initiatives and Sustainable Industry", in *Voluntary Environmental Agreements: Process, Practice and Future Use* Ed P ten Brink (Greenleaf, Sheffiled) pp 37-49

Perry, M, Singh, S 2002, "Corporate Environmental Responsibility in Singapore and Malaysia", in *The Greening of Business in Developing Countries: Rhetoric, Reality, and Prospects* Ed P Utting (Zed Books, London) pp 97-131

Prakash, A, 1999, "A New-Institutionalist Perspective on ISO 14000 and Responsible Care" *Business Strategy and the Environment*, **8** 322-335

Quazi, H A, Khoo, Y-K, Tan, C-M, Wong, P-S, 2001, "Motivation for ISO 14000 Certification: Development of a Predictive Model" *Omega*, **29** 525-542

Raines, S S, 2002, "Implementing ISO 14001 - an International Survey Assessing the Benefits of Certification" *Corporate Environmental Strategy*, **9** (4) 418-426

Reppelin-Hill, V, 1999, "Trade and Environment: An Empirical Analysis of the Technology Effect in the Steel Industry" *Journal of Environmental Economics and Management*, **38** (3) 283-301

Rock, M T, 2002 *Pollution Control in East Asia: Lessons for Newly Industrialising Economies* (Resources for the Future, Washington, D.C.)

Rodgers, C 2000, "Making It Legit: New Ways of Generating Corporate Legitimacy in a Globalising World", in *Terms for Endearment: Business, NGOs and Sustainable Development* Ed J Bendell (Greenleaf, Sheffield) pp 40-48

Roht-Arriaza, N, 1997, "Environmental Management Systems and Environmental Protection: Can ISO 14001 Be Useful within the Context of APEC?" *Journal of Environment and Development*, **6** (3) 292-316

Rondinelli, D A, Berry, M A, 2000, "Corporate Environmental Management and Public Policy: Bridging the Gap" *American Behavioral Scientist*, **44** (2) 168-187

Rondinelli, D A, Vastag, G, 2000, "Panacea, Common Sense, or Just a Label? The Value of ISO 14001 Environmental Management Systems" *European Management Journal*, **18** (5) 499-510

Segerson, K, Li, N 1999, "Voluntary Approaches to Environmental Protection", in *The International Yearbook of Environmental and Resource Economics* 1999/2000 Eds H Folmer, T Tietenberg (Edward Elgar, Cheltenham) pp 273-306

Starkey, R 1996, "The Standardization of Environmental Management Systems", in *Corporate Environmental Management: Systems and Strategies* Ed R Welford (Earthscan, London) pp 59-91

Steger, U, 2000, "Environmental Management Systems: Empirical Evidence and Further Perspectives" *European Management Journal*, **18** (1) 23-37

Stewart, K 2001, "Avoiding the Tragedy of the Commons: Greening Governance through the Market or the Public Domain?" in *The Market or the Public Domain: Global Governance and the Asymmetry of Power* Ed D Drache (Routledge, London) pp 202-228

Tanner, D, 1998, "Updates and Trends on ISO 14000 Implementation in Asia" *Corporate Environmental Strategy*, **5** (3) 71-76

Tietenberg, T, 1998, "Disclosure Strategies for Pollution Control" *Environmental and Resource Economics*, **11** (3-4) 587-602

UNCTAD, 1999 *World Investment Report 1999: Foreign Direct Investment and the Challenge of Development* (United Nations, Geneva)

UNCTAD, 2003 *World Investment Directory* (United Nations Conference on Trade and Development, Geneva)

Welford, R 2002, "Disturbing Development: Conflicts between Corporate Environmentalism, the International Economic Order and Sustainability", in *The Greening of Business in Developing Countries: Rhetoric, Reality, and Prospects* Ed P Utting (Zed Books, London) pp 135-158

Willetts, P 1998, "Political Globalisation and the Impact of NGOs Upon Transnational Companies", in *Companies in a World of Conflict: NGOs, Sanctions and Corporate Responsibility* Ed J V Mitchell (Earthscan, London) pp 195-226

Wilson, G K 2002, "Regulatory Reform on the World Stage", in *Environmental Governance: A Report on the Next Generation of Environmental Policy* Ed D F Kettl (Brookings Institution Press, Washington, D.C.) pp 118-145

World Bank, 2000 *Greening Industry: New Roles for Communities, Markets, and Governments* (Oxford University Press, New York)

World Bank, 2003, "World Development Indicators Online", www.worldbank.org

Table 1 Regional share of ISO 14001 certifications (in 2001)

Region	Certifications (absolute numbers)	Certifications (per one million inhabitants)	Share of world total (% of absolute numbers)
Africa/West Asia	923	0.61	2.51
Central and South America	681	1.78	1.85
North America	2700	7.74	7.34
Europe	18243	21.43	49.62
Far East	12796	5.70	34.80
Australia and New Zealand	1422	61.16	3.87
World	36765	5.88	100

Source: ISO (2002)

Table 2 Top ten countries by certification count (in 2001)

Country	Certifications (absolute numbers)	Certifications (per one million inhabitants)	Share of world total (% of absolute numbers)
Japan	8123	63.96	22.09
Germany	3380	41.07	9.19
UK	2722	46.29	7.40
Sweden	2070	232.74	5.63
Spain	2064	50.22	5.61
USA	1645	5.77	4.47
Australia	1370	70.62	3.73
Italy	1295	22.37	3.52
France	1092	18.45	2.97
China	1085	0.85	2.95
Total	24846		67.58

Source: ISO (2002) and World Bank (2003)

Table 3 Descriptive variable information

Variable	Obs	Mean	Std. Dev.	Min	Max
ln ISO14001 p.c.	843	-3.31	4.02	-6.91	5.45
ln ISO14001 p.c. (lagged)	843	-4.08	3.77	-6.91	5.04
EXPEU15GDP	843	0.13	0.57	0.00	6.64
EXPUSGDP	843	0.06	0.33	0.00	4.06
EXPJAPANGDP	843	0.17	0.80	0.00	9.49
ln FDISTOCKGDP	843	2.68	1.17	-3.11	5.60
ENVIROGROUPS p.c.	843	2.39	4.12	0.00	22.14
ln GDP p.c.	843	8.37	1.12	6.07	10.69
ln GDPPERWORKER	843	22.96	1.30	17.68	26.96
GOVINTERVENTION	843	2.68	0.88	0.00	5.00
ln GDP	843	24.41	1.89	19.69	29.82
ln %MANUFACT	843	2.73	0.57	1.09	4.09

Table 4 Countries in sample

Albania, *Algeria*, *Angola*, Argentina, *Armenia*, Australia, Austria, *Azerbaijan*, *Bahamas*, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, *Benin*, Bolivia, *Bosnia and Herzegovina*, Botswana, Brazil, Bulgaria, *Burkina Faso*, *Burundi*, *Cambodia*, Cameroon, Canada, *Cape Verde*, *Chad*, Chile, China, Colombia, *Congo (Dem. Rep.)*, *Congo (Rep.)*, Costa Rica, *Cote d'Ivoire*, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, *El Salvador*, Estonia, *Ethiopia*, *Fiji*, Finland, France, *Gabon*, *Gambia*, *Georgia*, Germany, *Ghana*, Greece, Guatemala, *Guinea*, *Guinea-Bissau*, Guyana, Honduras, Hong Kong, China, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea (Rep.), Kuwait, *Kyrgyz Republic*, *Laos* Latvia, Lebanon, *Lesotho*, Lithuania, Luxembourg, Madagascar, *Malawi*, *Malaysia*, *Mali*, Malta, *Mauritania*, Mauritius, Mexico, *Moldova*, Mongolia, Morocco, *Mozambique*, Namibia, *Nepal*, Netherlands, New Zealand, *Nicaragua*, *Niger*, Nigeria, Norway, Oman, Pakistan, Panama, *Papua New Guinea*, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, *Rwanda*, Saudi Arabia, *Sierra Leone*, Singapore, Slovak Republic, Slovenia, *Somalia*, South Africa, Spain, Sri Lanka, *Suriname*, *Swaziland*, Sweden, Switzerland, Syrian Arab Republic, *Tajikistan*, *Tanzania*, *Togo*, Trinidad and Tobago, Tunisia, Turkey, *Turkmenistan*, *Uganda*, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, *Uzbekistan*, Venezuela, Vietnam, *Yemen*, Zambia, Zimbabwe.

Note: Countries in italics have no ISO 14001 certifications over the period 1996 to 2001.

Table 5 Estimation results

	I	II
	Full sample	Developing countries only
ln ISO14001 p.c. (lagged)	0.817	0.838
	(6.55)***	(6.38)***
EXPEU15GDP	0.478	0.290
	(2.12)**	(0.87)
EXPUSGDP	-0.917	-0.739
	(2.30)**	(1.72)*
EXPJAPANGDP	0.227	0.214
	(2.66)***	(2.62)***
ln FDISTOCKGDP	0.155	0.126
	(2.56)**	(3.07)***
ENVIROGROUPS p.c.	0.040	0.050
	(1.69)*	(2.01)**
ln GDP p.c.	0.657	0.564
	(2.60)***	(2.95)***
ln GDPPERWORKER	-0.212	-0.223
	(2.16)**	(2.68)***
GOVINTERVENTION	-0.184	-0.194
	(2.80)***	(2.54)**
ln GDP	0.164	0.160
	(2.91)***	(2.42)**
ln %MANUFACT	0.011	0.046
	(0.07)	(0.36)
# Observations	843	705
# Countries	142	119

Notes: Dependent variable is ln ISO14001 p.c. OLS with panel-corrected standard errors. Absolute t-values in parentheses. Coefficients of constant and year-specific time dummies not shown. * significant at .1 level ** at .05 level *** at .01 level.

Table 6 Estimated short-term or instantaneous percentage increase in ISO 14001 take-up following a one standard deviation increase in an independent variable

ln GDP p.c.	73.9%
EXPEU15GDP	31.3%
ln GDP	30.6%
ln GDPPERWORKER	-27.5%
EXPUSGDP	-25.9%
EXPJAPANGDP	20.0%
ln FDISTOCKGDP	18.1%
ln ENVIROGROUPS p.c.	17.9%
GOVINTERVENTION	-15.1%
ln %MANUFACT	-0.7%