

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

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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 with 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 policymakers 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 (Gunningham and Sinclair, 2002; Paton, 2002; Rondinelli and Berry, 2000). 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 (Haufler, 2001; Segerson and Li, 1999). 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. ISO 14001 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; Melnyk et al, 2003; Quazi et al, 2001). 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 both in developed and in developing countries (Rondinelli and Vastag, 2000; Wilson, 2002).⁽¹⁾

⁽¹⁾ The term ‘firm’ is used broadly here to denote all private sector and public sector entities, ranging from manufacturing units to administrative buildings, capable of acquiring ISO 14001 certification.

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 greatest in Japan, followed by a number of leading European countries, the USA, 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 come mostly from comparative analyses of certification counts in Europe and the USA (Delmas, 2002; Kollman and Prakash, 2002; Prakash, 1999). 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 the findings. This points to the need for multiple-country, quantitative, research. Yet the only study of this kind is itself problematic (Corbett and Kirsch, 2001), with its reliance on a handful of dubious proxy variables and the omission of a large number of developing countries from the sample.

This paper is a response to the gap in the existing literature: we undertake more systematic and broad-based analysis of international variation 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, with the aid of a set of measurable proxies. Briefly our results suggest that take-up of ISO 14001 has been influenced both by supply-side and by 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, page 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 and Gleckman, 1998). Yet it was not until the next 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; King et al, 2002; Stewart, 2001). The first EMSs were unilateral, firm-level, initiatives. Since the early 1990s, however, a number of 'standardised' environmental management systems have been developed by various national

(for example, the British Standards Institute's 7750) and regional (for example, the European Union's Eco-Management and Audit Scheme) bodies (Starkey, 1996).

ISO 14001 continues this trend toward standardisation at the international level. It was developed by the ISO, a Swiss-based nongovernmental 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, starting 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 the systematic improvement of 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 five main 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 and Gleckman, 1998, pages 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: for example, ISO 14010/11/12 (Environmental Auditing). Others, meanwhile, are process-evaluation and product-evaluation standards which, as their names suggest, focus on the analysis and evaluation of product and process characteristics: for example ISO 14020 (Environmental Labelling) (Melnik et al, 2003).

ISO 14001 is the only certifiable standard in the 14000 series. Firms which comply with its requirements have two choices: to declare themselves in compliance; or to use a registered auditor to verify that the organisation's operations conform to the documented environmental management system (Mendel, 2002; Rondinelli and Vastag, 2000). 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 criticism has centred on the fact that the standard does not require certified facilities to reduce their environmental impacts or to 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 (Bansal and Bogner, 2002; Clapp, 2001; Krut and Gleckman, 1998; Roht-Arriaza, 1997). Supporters, however, claim that such criticism is misplaced. They argue that it is precisely the flexibility of the standard that makes it a useful tool with which 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 (over), 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

Table 1. Regional share of ISO 14001 certifications in 2001 (source: ISO, 2002).

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	2 700	7.74	7.34
Europe	18 243	21.43	49.62
Far East	12 796	5.70	34.80
Australia and New Zealand	1422	61.16	3.87
World	36 765	5.88	100

Table 2. Top-ten countries by certification count in 2001 (source: ISO, 2002; World Bank, 2003).

Country	Certifications (absolute numbers)	Certifications (per one million inhabitants)	Share of world total (% of absolute numbers)
Japan	8 123	63.96	22.09
Germany	3 380	41.07	9.19
United Kingdom	2 722	46.29	7.40
Sweden	2 070	232.74	5.63
Spain	2 064	50.22	5.61
USA	1 645	5.77	4.47
Australia	1 370	70.62	3.73
Italy	1 295	22.37	3.52
France	1 092	18.45	2.97
China	1 085	0.85	2.95
Total	24 846		67.58

been comparatively low. In fact, only ten countries account for nearly 70% of world certifications, seven of which are member states of the European Union.

Review and critique of the existing literature

What accounts for the uneven diffusion of ISO 14001 worldwide? This question has recently been addressed in two bodies of literature. Drawing heavily from institutional theory the first group of studies have taken a largely qualitative approach (Delmas, 2002; Kollman and Prakash, 2002; Milstein et al, 2002; Prakash, 1999). Their starting point is the belief that firms will implement ISO 14001 only where the apparent benefits more than offset the costs; moreover, 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 USA are explained in terms of the distinctive demand-side and supply-side characteristics of the national institutional environments. Thus, Kollman and Prakash (2002) and Delmas (2002) point to the pivotal role played by the British Standards Institute (BSI) in promoting ISO 14001 in the United Kingdom, and how the absence of an equivalent body has hindered similar take-up of the standard in the USA. They also draw a contrast between Germany, where certified firms have often received ‘relief’ from regulatory agencies, and the USA, whose more adversial and legalistic tradition has prohibited similar concessions 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 in the USA, many European countries had prior experience of formal EMSs (for example, the EU's ECO-Management and Audit Scheme). 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 an attempt to identify the determinants of ISO 14001 adoption with the aid of data from a far larger sample of countries. It is represented by a single study, by Corbett and Kirsch (2001), who use a regression model to estimate the influence of four variables for a sample of sixty-three 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 aforementioned works have done much to increase our understanding of various demand-side and supply-side variables implicated in the uneven diffusion of the ISO 14001 environmental management standard across the globe. Neither approach, 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 and 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 this too is not without its weaknesses. Partly as a result of data limitations, only a few variables are investigated. Moreover, several of these variables rely on proxies which are at best weakly rooted in the actual concepts the authors purport to measure. For example, Corbett and 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" (page 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 the ratio of aggregate exports to GDP to capture supply-chain pressures for certification in foreign markets has only limited appeal, as reports strongly indicate that these requirements are only currently important in Europe and Japan (Roht-Arriaza, 1997; Tanner, 1998).

More generally, although Corbett and Kirsch include the majority of countries with ISO 14001 certifications in their sample (63), they omit all the countries that do not have certifications. 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 this could go some way to explaining the surprising result that per capita income has no statistically significant effect on certification counts.

In this paper we seek 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 and Kirsch, our study features a much larger sample (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-side and supply-side variables using measures more firmly rooted in the actual decision of firms to implement and certify ISO 14001.

Third, in contrast to Corbett and Kirsch's work, in our econometric model we use 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 (Delmas, 2002; Kollman and Prakash, 2002).⁽²⁾ Without a panel dataset, Corbett and 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 as it is correlated 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 the 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 (for example, Khanna and Anton, 2002; Matouq, 2000; Morrow and 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 nongovernmental bodies, are especially problematic in this respect. Nevertheless, 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 markets, a great deal has been written about pressure from business customers in export markets, and particularly developed-economy ones. If anecdotal reports are to be 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 and Pun, 1999; Cosbey, 2002; Rock, 2002; Steger, 2000). 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 (Kollman and Prakash, 2002; Roht-Arriaza, 1997).⁽⁴⁾ By contrast only a handful of larger firms in the USA are

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

⁽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

mandating certification, meaning that the incentive to adopt ISO 14001 is likely to be comparatively low (Delmas, 2002). Indeed, as table 2 shows, in relative terms there are very few ISO 14001 certifications in the USA. 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 USA 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 (Hastings, 1999; Willetts, 1998). Consequently, a growing number of them are requiring their local affiliates and subsidiaries to adopt voluntary environmental codes (Haufler, 2001; Steger, 2000; UNCTAD, 1999). 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 and Roy, 1998; Perry and Singh, 2002; Rondinelli and Vastag, 2000). 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 and 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 which has received widespread coverage in the recent literature is the need 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 and 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, so their incentive to adopt the standard is lower. 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 to their counterparts in developed countries (where productivity is likely to be higher) (Raines, 2002). Thus:

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

Nongovernmental 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; Perry and Singh, 2002; Rodgers, 2000).

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 (Bansal and Bogner, 2002; Davy, 1997; Prakash, 1999). This 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 and Sinclair, 2002). No doubt this explains why firms, both in developing and especially in developed economies, recurrently cite 'public image' and 'social responsibility' as among the primary motives for implementing and certifying ISO 14001 (Delmas, 2002; Matouq, 2000; Mbohwa and Fukada, 2002; Morrow and Rondinelli, 2002; Perry and Singh, 2002; Raines, 2002).

Clearly, however, the incentive to adopt ISO 14001 will depend on the degree of pressure from civil society groups (Gunningham and 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 and 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 nongovernmental bodies committed to promoting the standard (Bansal and Bogner, 2002; Steger, 2000). In practice, experience suggests that both of these conditions are most likely to be found in developing countries, especially in the small-scale and medium-scale sectors (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 and Fukada, 2002). Taken together, therefore, these demand-side 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 (Evans et al, 2002; Stewart, 2001; Welford, 2002). As a result, a growing number of governments both in developed and in developing countries are turning towards voluntary initiatives, promoted as a more flexible and cost-effective alternative to conventional directive-based or market-based forms of regulation (Gunningham and Sinclair, 2002; Haufler, 2001; Hillary and Thorsen, 1999; Newell, 2001; 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 neoliberal project to transfer the political and administrative costs of regulation from the public to the private domain (Finger and 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

The 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 (ISO14001pc). 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 fifteen countries of the European Union (EU15), the USA, and Japan (EXPEU15GDP, EXPUSGDP, and EXPJAPANGDP). Data are taken from the OECD (2003). For the EU countries the EXPEU15GDP variable refers to exports to the other fourteen EU members; for the USA and Japan the EXPUSGDP and the EXPJAPANGDP variables are coded zero, respectively. We measure the level of transnational involvement by the stock of foreign direct investment (FDI) relative to GDP (FDISTOCKGDP) as this better captures the overall impact of foreign TNCs in the host economy than do volatile short-term inflows. 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 the World Bank (2003). As our measure of demand from civil society, we use the per capita number of environmental nongovernmental organisations (ENVIROGROUPSpC) per country as reported by Europa Publications (2001). This variable refers to the late 1990s and is time invariant because of 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 the four years from 1996 to 2001. Per capita income (GDPpc) 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, as the latter are known to underestimate effective purchasing power substantially in poor countries. As stated above, per capita income potentially captures both demand-side and supply-side factors implicated in the take-up of ISO 14001. However, because we control for environmental demand through the inclusion of environmental NGOs, our income variable might be expected to measure predominantly 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 the World Bank (2003). Without resource 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 who experiment with ISO 14001 certification and pass their experience on to other firms via diffusion effects. 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 the World Bank (2003) and supplemented by the CIA (2002). All nominal variables have been converted to real 1996 prices by using the United States GDP deflator, taken from the World Bank (2003).

Table 3 provides summary descriptive variable information. Note that the panel is not fully balanced as in the case of a small number of countries one or more observations are missing, because of insufficient data on one of the explanatory variables. Table 4 lists the countries included in the sample.

We estimate the following model:

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

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 and Katz’s (1995) popular and commonly applied time-series cross-sectional estimator with panel-corrected standard errors.

Table 3. Descriptive variable information.

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
lnISO14001pc	843	−3.31	4.02	−6.91	5.45
lnISO14001pc (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
lnFDISTOCKGDP	843	2.68	1.17	−3.11	5.60
ENVIROGROUPSpC	843	2.39	4.12	0.00	22.14
lnGDPpc	843	8.37	1.12	6.07	10.69
lnGDPPERWORKER	843	22.96	1.30	17.68	26.96
GOVINTERVENTION	843	2.68	0.88	0.00	5.00
lnGDP	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.

<i>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 (Democratic Republic), Congo (Republic), 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 (Republic), 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.</i>

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

The error term is presumed to be heteroskedastic and contemporaneously correlated across panels. Beck and Katz provide evidence from Monte Carlo analysis showing that their estimator is more conservative and less likely to underestimate standard errors than feasible generalised least squares (FGLS), the alternative estimator. Their estimator is thus less likely to attribute statistical significance wrongly 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 and 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 heteroskedasticity of the data. Concerning 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 1% increase in this variable is associated with a 0.9% increase in ISO 14001 certification. This model also exhibited a much better fit to the data.

Results

The first column of table 5 (over) shows estimation results for the full sample and the second column for a sample that excludes all developed countries—namely, Canada and the USA, the fifteen 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

Table 5. Estimation results with absolute *t*-values shown in parentheses.

Variable ^a	Full sample	Developing countries only
lnISO14001pc (lagged)	0.817 (6.55)***	0.838 (6.38)***
EXPEU15GDP	0.478 (2.12)**	0.290 (0.87)
EXPUSGDP	−0.917 (2.30)**	−0.739 (1.72)*
EXPJAPANGDP	0.227 (2.66)***	0.214 (2.62)***
lnFDISTOCKGDP	0.155 (2.56)**	0.126 (3.07)***
ENVIROGROUPSpc	0.040 (1.69)*	0.050 (2.01)**
lnGDPpc	0.657 (2.60)***	0.564 (2.95)***
lnGDPPERWORKER	−0.212 (2.16)**	−0.223 (2.68)***
GOVINTERVENTION	−0.184 (2.80)	−0.194 (2.54)**
lnGDP	0.164 (2.91)***	0.160 (2.42)**
ln%MANUFACT	0.011 (0.07)	0.046 (0.36)
Number of observations	843	705
Number of countries	142	119

* significant at 0.1 level, ** at 0.05 level, *** at 0.01 level.
^a Dependent variable is lnISO14001pc. OLS with panel-corrected standard errors. Coefficients of constant and year-specific time dummies are not shown.

significant. A higher level of transnational involvement as measured by *FDISTOCKGDP* is associated with a higher number of ISO 14001 certifications. So too is a higher level of demand from civil society, as measured by *ENVIROGROUPSpc*. 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 nondeveloped countries. The only difference is that *EXPEU15GDP* becomes insignificant in this smaller sample. This suggests that our main results are not merely driven by the inclusion of developed countries in the sample.

How strong is the effect of each variable? Because 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)standardised coefficients allows us to compare the effect of variables held in different units with each other. Table 6 shows 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 compute long-term changes instead. It is clear that per capita income, exports to the EU, economic size, and productivity are substantively the most important factors, followed by the export to Japan and the US variables. The penetration of the economy by 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.

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

Variable	Percentage increase
lnGDPpc	73.9
EXPEU15GDP	31.3
lnGDP	30.6
lnGDPPERWORKER	−27.5
EXPUSGDP	−25.9
EXPJAPANGDP	20.0
lnFDISTOCKGDP	18.1
lnENVIROGROUPSpc	17.9
GOVINTERVENTION	−15.1
ln%MANUFACT	−0.7

Discussion and conclusions

In this paper we seek to advance understanding of the factors that determine take-up of ISO 14001, the international voluntary standard for environmental management systems. To this end, we have quantitatively examined the influence of several hypothesised demand-side 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 USA 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 uptake 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. In other words, firms 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 nonstate actors can indeed function as surrogate ‘regulators’ encouraging firms to adopt beyond-compliance codes of conduct (Rodgers, 2000; World Bank, 2000). 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 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 (Garcia-Johnson, 2000; Haufler, 2001; Mielnik and Goldemberg, 2002; Reppel-Hill, 1999).

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 (Raines, 2002; Tanner, 1998).

Furthermore, the present study provides support for the positive relationship between income and number of ISO certifications. Given that we control for demand-side dynamics (that is, demand for environmental quality from civil and market actors is lower in poorer countries) 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 (limited availability of consultancy firms, third-party accreditation bodies, etc) capabilities. Further work is required, however, to clarify the respective role and importance of demand-side 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' (Bendell, 2000; Finger and Tamietti, 1999; 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 for 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 enable us to perform such an analysis.

What does our study suggest for policymakers 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 uptake of ISO 14001 (for example, 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 both in domestic and in foreign markets.

The second point of leverage for policymakers, 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 EMSs. Similar approaches have proved successful when applied to pollution-release data (Tietenberg, 1998; World Bank, 2000) and offer a low-cost means by which public regulators can 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-sized firms excluded from supply chains, with potentially negative consequences for local economic development.

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