The effect of ISO 14001 certifications on emissions: any role for EU agreements with environmental protection provisions?*

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Abstract

Trade policy development and implementation has over past two decades embraced an array of non-trade issues, reflecting the broader blurring of the distinction between external-facing trade policy instruments and domestic regulation. One area where this mixing of the domestic and international is most obvious is in environmental regulation. The generation of negative externalities – pollution being merely most obvious – provides an incentive for international cooperation in the generation of agreed standards. It is not obvious, however, how effective these standards are. Firms may seek to exploit national differences notwithstanding international agreements. Compliance with the standards may also be symbolic. This paper seeks to extend our understanding of whether ISO environmental certifications affect a country's level of emissions of greenhouse gases and pollutant, and whether the EU's environmental standards – as mediated through trade agreements – condition this response. Our results suggest that membership of an EU trade agreement which contain environmental protection provisions is associated with lower emissions of air pollutants (sulphur dioxide and nitrogen oxide) but has no effect on emissions of greenhouse gases. These latter appear instead to be affected by the adoption of ISO 14001 certifications, which lead to lower emissions of methane and carbon dioxide. For carbon dioxide, importantly, we find that the negative effect of ISO certifications is only at work for countries which become part of EU trade agreements with environmental provisions, implying an interaction effect between the former and the latter.

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1. Introduction

Environmental concerns are increasingly driving both firms and regulators to seek less polluting and more sustainable methods of production. Adoption of more sustainable practices arises both from corporate self-interest – a desire to exploit a market advantage – and regulatory pressure. Nonetheless, the precise motivations for the adoption of specific environmental standards remains contested. The International Standards Organisation (ISO) environmental standard 14001 has attracted particular attention in the literature. There are several reasons for this. First, it has diffused widely among the corporate community (see Figure 1) across both industries and economic regions. In short, it has been a success and so investigating its impacts is apposite. Second, it is a private standard, and so its diffusion speaks to the phenomenon of private – as distinct from state – regulation in the international economy (Buthe, 2010). Private regulatory regimes have gained considerable academic attention in the past two decades, as their existence and development appear to challenge conventional notions of state-centric governance. A central question in the private-public governance debate is the extent to which private regulatory regimes are complementary to public regulation. Private regulatory regimes, on the face of it, present opportunities for anti-competitive practice; alternatively, they may act to fill institutional voids in states where public governance arrangements are found wanting.

This paper explores jointly the effects of both public and private environmental regulation on emissions. The effectiveness of voluntary environmental programs has been questioned, although the recent work of Potoski and Prakash (2013a) detected a negative relation between the number of ISO 14001 certifications and the level of sulphur dioxide (SO_2) emissions at the country level. This paper revisits their study but extends the scope of the analysis to a broader set of emissions including greenhouse gases and, importantly, analyses the additional impact of the EU's effort of introducing environmental principles in its bilateral trade agreements. We find that membership of EU trade agreements with EP provisions is associated with lower emissions of air pollutants (sulphur dioxide and nitrogen oxide) but has no effect on emissions of greenhouse gases. These latter appear instead to be affected by the adoption of ISO 14001 certifications, which lead to lower emissions of methane and carbon dioxide. For carbon dioxide, importantly, we find that the negative effect of ISO certifications is only at work for countries which become part of EU trade agreements with environmental provisions, implying an interaction effect between the former and the latter.

The remaining parts of this paper are organized as follows. Section 2 provides a review of the literature; section 3 describes the data and exposed the empirical methodology; section 4 presents the empirical results; section 5 concludes.

2. Literature Review

Cross-border economic activity raises the prospect of firms exploiting national differences and engage in regulatory arbitrage. In the context of environmental standards, concerns that firms would use investments in developing countries to escape more stringent regulations at home gave rise to the pollution haven thesis. The extent of this downward pressure on standards is disputed, however. Potoski and Prakash argued across a series of papers that the diffusion of ISO environmental standards challenged the pollution haven thesis (2007). There is also evidence that the political unit, namely its economic strength, also affects the ability of firms to lower standards. The well-known 'California Effect' is an example where the economic weight of a political unit is such that it can enforce its policy preferences of higher levels of compliance on firms (Vogel, 1985).

Broadly, regulatory arbitrage can be reduced through formal governmental agreement or voluntary, self-regulatory action by firms. International certifiable standards, such as the ISO 14001, provide a mechanism to reduce the scope for arbitrage, although whether these standards actually work to reduce pollution is disputed in the literature.

Various studies have focussed on the specific reasons why firms adopt ISO 14001 (e.g. Aragon-Correa and Sharma, 2003; Darnall et al., 2008; Christmann, 2004). These suggest that pressure from lead firms in the value chain, international regulators, and other stakeholders such local NGOs form important reasons for manufacturing plants to adopt ISO 14001. Direct benefits to firms from the adoption of ISO 14001 have been found to be: improved efficiency of energy and resources consumption (Radonjic and Tominc 2006), lesser risks of environment-related accidents, better compliance environmental regulations, improved corporate image, better motivated employees working in pollution-intensive manufacturing, and greater competitiveness in the market (Morrow and Rondinelli, 2002; Delmas, 2001). Recent studies also focus on the 'spillover' benefits of ISO 14001 and suggest that in China, firms adopting the standard were found to be associated with greater innovative capabilities (He and Shen, 2019).

However, several studies (for a full review, see Boiral et al, 2018) also do not find any significant effect of ISO 14001 adoption on the above aspects, thus resulting in an overall mixed evidence on the impact of the standard. In this respect, contingency factors related to the ways in which the standard is implemented has been argued as important in achieving success from ISO 14001. Managerial commitment forms an important contingency factor in many studies (Chan and Wong 2006; Curkovic and Sroufe 2011), while effective training and involvement of employees in the adoption of the standard also plays an important contingent role (Djekic et al. 2014; Ivanova et al. 2014). Company size and maturity of the certification has also been found to have a moderating / contingent effect – as such, larger firms with greater resources and capabilities are known to implement the standard more successfully (Yin and Schmeidler 2009, Lopez-Fernandez and Serrano-Bedia 2007). It is entirely plausible that firms may conform to only the minimal extent, perhaps because of the costs of doing so. It may also be possible that compliance is low because of a lack of enforcement mechanisms. On the other hand, because ISO 14001 is a detailed process-orientated certification that aims at continuous improvement of business unit performance, it is conceivable that firms implement and comply with the standard simply because of its positive impact on the competitiveness of the firm (Darnall, 2006). Baek similarly argues that firms adopt environmental programmes because of their signalling effect on third parties (including consumers) that enhances the competitive position of the firm (2017).

A number of studies have also focussed on whether the adoption of ISO 14001 has a positive impact on the environment. Boiral et al (2018) suggest that waste minimisation and air emission reduction to be the most important indicators used to assess the impact of ISO 14001 on firms' environmental performance. They suggest that, again, the evidence is mixed on the impact of ISO 14001 on both waste management and emission reduction; yet, a larger number of studies report a positive impact of the standards. Potoski and Prakash (2014), for instance, find that greater adoption of ISO 14001 in countries is associated with reduced levels of SO2 and other particulate matter (PM10) emissions. However, whereas most studies have focussed on the impact of ISO 14001 on air emissions, very few studies have studies investigate the impact of ISO 14001 on reduction in water contamination (Gomez and Rodriguez 2011; Potoski and Prakash 2013a), and these did not find that the ISO 14001 standard contributes significantly to this issue

In the absence of positive effects of private, voluntary, environmental regulation, it is conceivable that internationalised production presents the opportunity for, effectively, the export of domestic regulation via firms through global value chains. Institutional literature speaks to this pressure on firms to adopt certain processes in response to pressure from the external environment, typically government (DiMaggio and Powell, 1983). In the strategy literature, institutional perspectives have been used to explain the observed phenomenon on strategic isomorphism, where different firms arrive at more or less identical competitive strategies. They do so because of the constraints imposed by the external environment, including government regulations and market access. Only the most powerful and largest trade blocs or countries can do this, however. The prerequisites are a population of large, internationalised firms that engage in significant cross border trade; and a large domestic market where exclusion from that market would represent a considerable loss to a given firm. In this context, the European Union has been successful in exporting its regulatory model. The EU has both a large internal market and a large number of firms that are not only internationalised but also sit at the head of global value chains and so are in a position to enforce regulatory standards. These standards, of course, speak to domestic politics where social and environmental concerns voiced by electorates manifest themselves as an extra-territorial application of EU regulation. Moreover, international regulatory standards can be co-opted by states and promulgated by private regulatory activity. This occurred in respect of international accounting standards, where the EU adopted International Financial Regulations in preference to the US Generally Agreed Accounting Principles (GAAP). More pertinently here, intergovernmental or non-governmental organisations such as the International Standards Organisation (ISO) have been catalysts for the internationalisation of regulatory standards.

Enforcement of international standards, especially private standards, is an area of concern. While lead firms may well insist on, for example, a given ISO standard for their lower tier suppliers, the degree to which firms faithfully conform can be uncertain. Christmann and

Taylor (2006) for example, find that suppliers in China manipulate their conformity with ISO standards. They find that firms choose a degree of compliance with ISO standards depending on their assessment of the likelihood of inspection. The authors distinguish between substantive and symbolic conformity, where the latter is nothing more than a thin commitment to regulatory compliance. Another study of Chinese firms came to a different conclusion. In their study of Chinese firms that adopted ISO 14001, He, Yang and Choi argue that private regulation through ISO complemented public governance efforts by providing enforcement mechanisms.

The European Union is widely seen as the “greenest” of major economic powers, but it was not always thus. As Keneman and Vogel (2010) argue, until 1990 the United States led multilateral efforts to develop international environmental cooperation. European interest developed later, in response to domestic political pressures for greater environmental protection in the wake of several food safety scandals. The increasing integration of EU states via the Single Market also had an effect of enhancing the coherence of EU policy-making at the supranational level. EU experience of regulating a large internal market was, essentially, ‘exportable’ (Lavenex 2014:887 and Damro 2012).

The European Union has used its trade policy to export its regulatory model to third countries. The EU uses the attractiveness of access of its home market to incentivise firms to adopt certain production standards. This ‘Brussels Effect’ is version of the ‘California Effect’ articulated by Vogel (1985) whereby the largest and most populous US state was able to unilaterally implement environmental regulations, knowing that firms would comply or risk exclusion from the market. Across a range of issue areas, the European Union has acted similarly, exporting its regulatory model in areas aside from environmental compliance to include labour standards (Sinopoli and Purnhagen, 2016). Firms wishing to export to Europe may have to satisfy a range of produce and process standards that sit well away from the consumer. This exportation, however, is not necessarily direct; rather it is intermediated by firms – typically larger firms employing subcontractors in third countries – who provide adopt the role of *de facto* inspector (Heritier, Mueller-Debus and Thauer, 2009)

3. Methodology and data

3.1. Empirical model

To estimate how countries' emissions are affected by the adoption of ISO 14001 certifications, together with the impact of EP provisions in EU trade agreements, we follow the empirical approach of Potoski and Prakash (2013a) and use a generalized method of moments (GMM) estimator in a dynamic panel setting. Formally, we estimate the following equation:

$$lnY_{i,t} = \alpha + \delta lnY_{i,t-1} + \boldsymbol{\gamma} lnISO14001_{i,t-1} + \boldsymbol{\vartheta} TA^{EU}_{i,t-1} + \boldsymbol{\rho}\left(lnISO14001_{i,t-1} * TA^{EU}_{i.t-1}\right) + \sum_{z} \beta_z X_{i,t} + \sigma_i + \tau_t + \varepsilon_{i,t}$$

where $Y_{i,t}$ denotes the level of emissions of country i in year t, $Y_{i,t-1}$ denotes the level of emissions in year t-1, $ISO14001_{i,t-1}$ denotes the number of ISO 14001 certifications in country i in year t-1, $TA^{EU}_{i,t-1}$ is a binary variable denoting countries part of EU trade agreements with EP provisions in year t-1, $X_{i,t}$ denotes a vector of control variables at the country-year level, σ_i denotes country fixed effects, τ_t denotes time fixed effects and $\varepsilon_{i,t}$ denotes an idiosyncratic error term.

The main equation is estimated with the system GMM estimator developed by Blundell and Bond (1998). The system GMM jointly estimates the dynamic model both in differences and in levels, using lagged levels as instruments for the regression in differences and lagged differences as instruments for the regression in levels.[1] This estimator allows us to account for the strong persistence in the level of emissions, by use of a lagged dependent variable, while at the same time addressing a series of endogeneity concerns. The use of a lagged dependent variable in a specification with fixed effects at the level of the cross-sectional panel dimension (i.e. countries, in our application) is problematic, as it generates a correlation with the error term (Nickel bias). This requires instrumenting $Y_{i,t-1}$, and the GMM estimator does so exploiting further lags of the dependent variable. Additionally, the number of ISO 14001 certifications could spur reverse causality concerns: exploiting lags of ISO 14001 certifications as instruments in the GMM setting allows us to deal also with this source of endogeneity.

[1] Estimating the model in both differences and levels addresses the weak instrument problem arising from using lagged-levels of persistent explanatory variables as instruments for the regression in differences (Blundell and Bond, 1998).

The main coefficients of interest are $\boldsymbol{\gamma}$, the effect of ISO 14001 certifications, $\boldsymbol{\vartheta}$, the effect of being part of an EU trade agreement with EP provisions, and $\boldsymbol{\rho}$, which picks up the differential effect of ISO 14001 certifications for countries part of such trade agreements. We expect $\boldsymbol{\gamma}$ and $\boldsymbol{\vartheta}$ to be negative, implying that a larger number of ISO certifications, as well as the presence of environmental provisions in EU trade agreements, determine a reduction in the level of emissions. The $\boldsymbol{\rho}$ coefficient on the interaction term is also expected to be negative, if the effect of EU trade agreements is to reinforce the impact of ISO certifications on emissions.

3.2. Data, main variables and descriptive evidence

We exploit a panel dataset of 147 countries over the 1999-2014 period to analyse how the adoption of ISO 14001 certifications affects countries' emissions of a variety of gases and pollutants.

The time period under analysis is dictated by the available data. We extract the number of ISO certifications per country from the ISO 14001 survey[2], available from 1999 to 2017. We matched the ISO data with data on emissions from the 2018 Environmental Performance Index (EPI) report. We use information on all emissions with data over the 1999-2014 period (2014 being the latest available year): carbon dioxide (CO_2), methane (CH_4) nitrous oxide (N_2O) and black carbon (BLC), which are greenhouse gases; sulphur dioxide (SO_2) and nitrogen oxide (NO_x), which air pollutants.[3]

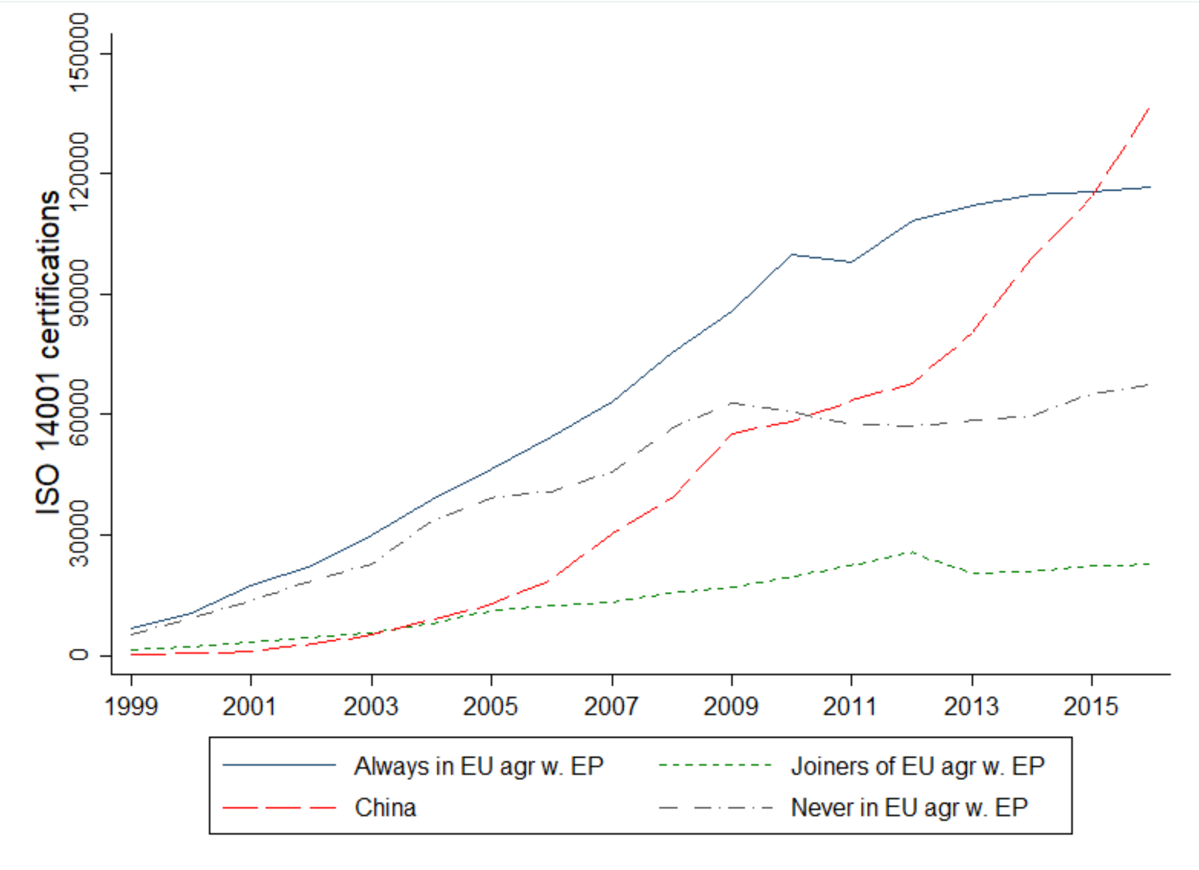
In order to assess the role of EU trade agreements which feature EP provisions we combine the data on the content of trade agreements from the DESTA project (Dür et al, 2014), together with data on the degree of legalization of each agreement built by Lechner (2016). DESTA allows us to identify countries which become part of trade agreements, the year in which the agreement entered into force, and the countries which participate in each agreement. Lechner's data is based on the set of agreements in the DESTA project, and extends its content identifying agreements with EP provisions, as well as the degree of EP

[2] https://www.iso.org/the-iso-survey.html

[3] The EPI data also includes other emissions, such as nitrogen oxide (NOx) and black carbon, but these are available only up to 2010. This reduced time period results in issues in the empirical analysis, as we detail below.

legalization of each agreement. Lechner identifies all the EP provisions included in an agreement and classifies them according to three dimensions of legalization – obligation, precision and delegation – according to a methodology first introduced by Abbot (2000). A score for each dimension is computed as the total number of areas covered.[4] We then construct two trade policy indicators, one identifying countries part of EU trade agreements which feature EP provisions, and one identifying countries part of EU trade agreements with an above median number of EP provisions.

Figure 1: ISO 14001 certifications and members of EU agreements with EP provisions



Source: Authors' elaboration on data from ISO survey and DESTA

The rationale behind the construction of two indicators is that EU trade agreements differ widely in their coverage of EP issues, with a marked gap represented the EU Treaty of Lisbon in 2009: it is since then that "sustainable development", the umbrella under which EP issues are included in trade agreements, has become one of the key principles of the EU's trade policy (Borchert et al, 2019). EP principles have acquired a significantly bigger dimension in all

[4] We refer the reader to Lecher's 2016 paper for more details on the calculation of the legalization score.

the "new generation" trade agreements, starting with the EU-Cariforum agreement, this marking a neat distinction between the agreements signed since the late 2000s and the preceding ones.

Figure 1 shows the uptake of ISO 14001 certifications over time, cumulated by groups of countries: we distinguish between countries which, from 1999 onwards, were always members of an EU trade agreements containing EP provisions (e.g. EU countries, north-African countries), countries which over this period entered EU agreements with EP provisions (e.g. African countries members of European Partnership Agreements, Canada, Chile, central American countries), countries that never entered EU agreements with EP provisions (e.g. Australia, India, Russia and the USA, among others), and China, by far the country with the largest number of certifications. Figure 1 speaks not so much to differences in the total number of ISO 14001 certifications, due to the uneven country composition across the four groups. However, since the group composition is fixed over time, we can inspect differences in the growth rates. The growth of ISO 14001 certifications was rapid, but it was uneven across countries, with differences emerging mostly in the post-2009 period, when the overall growth slowed down. Countries in EU trade agreements with EP provisions kept increasing the number of ISO 14001 certifications, and so did China, at an even faster rate. In countries that never entered EU trade agreements with EP provisions, instead, the growth of ISO 14001 certifications seems instead to have plateaued post 2009. Joiners of EU trade agreements find themselves in the middle, exhibiting a modest growth of ISO certifications throughout the period under analysis.

The introduction of EP provisions in trade agreements does not appear to be a prerogative of the EU; however, the effectiveness of the EU in doing so might well be different from that of other countries, with this latter point being investigated in our empirical analysis. Finally, given the dominant position of China in terms of number of ISO 14001 certifications, we will investigate whether the relation between certifications and emission is affected by the inclusion of China in our sample.

Table 1 offers some insights on the distribution of ISO 14001 certifications across countries, and shows, for each of the groups exploited in Figure 1, the top ten countries in terms of total number of ISO 14001 certifications since 1999. China is by far the country with most certifications, followed by Japan and the big European countries.

Table 1: Number of ISO 14001 certifications by country

Always in EU agr. w. EP		Joiners of EU agr. w. EP		Never in EU agr. w. EP	
Italy	230,508	Korea	97,330	China	960,990
Spain	208,522	Canada	23,566	Japan	427,126
UK	192,233	Colombia	21,403	USA	84,213
Germany	106,871	Singapore	17,338	India	63,956
France	83,220	Mexico	14,871	Australia	40,277
Romania	79,338	South Africa	12,663	Brazil	39,807
Sweden	64,935	Chile	11,125	Thailand	33,869
Czech Rep.	55,785	Vietnam	9,089	Malaysia	23,217
Switzerland	38,158	Croatia	7,885	Indonesia	16,872
Netherlands	29,536	Peru	3,690	Argentina	15,540

Source: Authors' elaboration on data from the ISO survey.

We conclude this section with the description of the other (control) variables that we exploit in the empirical model. To isolate the effect of ISO 14001 certifications on emissions we compile a list of controls by following Potoski and Prakash (2013a).

From the World Bank World Development Indicators (WDI) we extract data on countries' GDP, GDP per capita, the share of industrial production in GDP, and the share of urban population. GDP and GDP per capita control for countries' size and wealth, factors which might affect positively both the level of emissions and the number of ISO certifications. Similarly, urbanization and a higher share of GDP coming from manufacturing sectors are often viewed as domestic factors that can affect greenhouse gas emissions and pollution levels.

To account for the role of international factors, we use the share of exports in GDP (WDI data) and the stock of inward Foreign Direct Investment (FDI) from UNCTAD: a higher level of exports, signalling trade dependence, can lead governments to tolerate higher pollution levels, with a similar argument that can be made for FDI.

To account for political and regulatory factors we include in the analysis a country's level of democracy (Polity2 database) and, importantly, the effect of environmental regulations coming from international treaties. This latter variable has been constructed exploiting the number of each country's environmental treaty commitments in each year, from the

International Environmental Agreements (IEA) database (Mitchell, 2002-2019)[5]. Other than on the countries part of the agreements, environmental treaties could have also an effect on emissions through exports, as importers whose citizens demand environmental protection might indirectly pressure the exporter to reduce its level of pollution (Vogel 1995). To capture this aspect, we construct a variable which measures each country's exports as a proportion of its GDP, weighted by the number of environmental treaties in the destination country.

This list of control variables accounts fairly rigorously for time-varying country specific confounding factors such as countries' size and wealth, industrial activity, international economic involvement (trade and investment), and regulatory policies. Our empirical approach, described in the previous section, also controls for all time-constant factors within each country (country fixed effects) and all time-varying effects common to all countries (time fixed effects).

4. Empirical results

4.1. Choice of estimator and replication of Potoski and Prakash (2013a)

In this section we describe the results of our empirical analysis assessing the impact of ISO 14001 certifications and EU trade agreements with EP provisions on countries' emissions of greenhouse gases and pollutants. As mentioned above, the analysis of the effect of ISO 14001 certifications is inspired by the work of Potoski and Prakash (2013a) – henceforth PP, which we extend to a broader set of emissions. In order to outline more neatly our contribution and contrast more effectively our findings with those in their paper, we begin by attempting to replicate the main result of PP for emissions of sulphur dioxide (SO_2). A perfect replication exercise is, unfortunately, impaired by the lack of data on ISO 14001 certifications over the same period that PP use in their analysis. PP use data over the 1991-2005 period, whereas the ISO survey we have access to includes data that start in 1999 only. We were able to retrieve, from the ISO archives[6], data on certifications from 1995 to 1999, although we were

[5] Data from Ronald B. Mitchell. 2002-2019. *International Environmental Agreements Database Project (Version 2018.1).* Available at: http://iea.uoregon.edu/. We thank Prof. Michell for his precious help with extracting information from the IEA database.

[6] We thank Laurent Charlet from the ISO for help with this.

warned that these initial years cannot be considered as informative as data post-1999.[7] We nonetheless tried to replicate the results of PP, exploiting data over the 1995-2005 period, being aware of the limitations imposed by the provisional nature of pre-1999 ISO 14001 data, and the lack of data from 1991 to 1995. Table 1 shows these results.

Table 1 – Emissions of SO_2 – Comparison with Potoski and Prakash (2013a)

	(1)	(2)	(3)	(4)	(5)
Dep Var:	Ln(SO2)	Ln(SO2)	Ln(SO2)	Ln(SO2)	Ln(SO2)
Estimator	PP 2013 - Difference GMM	Within-FE	System GMM	System GMM	System GMM
Years	1995-2005	1995-2005	1995-2005	1995-2014	1999-2014
$Ln(SO2)_{t-1}$	0.482***	0.717***	0.976***	0.985***	0.985***
	(0.139)	(0.0270)	(0.0213)	(0.0104)	(0.0107)
$Ln(ISO\ 14001)_{t-1}$	**-0.0137**	**-0.00519**	**-0.00571'**	**-0.000634**	**0.00672**
	(0.0111)	**(0.00706)**	**(0.00380)**	**(0.00310)**	**(0.00503)**
$Ln(GDP)_t$	0.609***	0.218*	0.0417	0.0209	0.00339
	(0.163)	(0.124)	(0.0296)	(0.0150)	(0.0167)
GDPpc	-0.000021*	-0.000021**	-0.000004'	-0.0000026*	-0.0000023*
	(0.000012)	(0.00001)	(0.000002)	(0.0000013)	(0.0000014)
GDPpc^2	7.36e-11	1.06e-10'	3.60e-11'	1.83e-11	1.95e-11'
	(1.07e-10)	(6.83e-11)	(2.25e-11)	(1.28e-11)	(1.19e-11)
$Ln(Industry)_t$	-0.0460	0.0407	0.0139	0.00174	0.0183
	(0.0677)	(0.0608)	(0.0224)	(0.0185)	(0.0201)
$Ln(FDI)_t$	0.00438	-0.00710	0.00586	0.00557	0.00681
	(0.0158)	(0.0140)	(0.00570)	(0.00565)	(0.00623)
$Ln(Exports)_t$	0.0661	-0.000380	0.00408	-0.00258	-0.00779
	(0.0464)	(0.0380)	(0.0211)	(0.00940)	(0.0112)
$Ln(Urb,\ Pop)_t$	0.248	-0.00410	-0.0401**	-0.0264'	-0.0233
	(0.479)	(0.213)	(0.0187)	(0.0165)	(0.0174)
$Ln(Exp.\ Treaties)_t$	-0.00839	-0.0113	-0.0142'	-0.00322	-0.00325
	(0.0176)	(0.0165)	(0.00962)	(0.00497)	(0.00642)
$Ln(Env.\ Treaties)_{t-1}$	0.328	-0.725'	-0.140***	-0.132***	-0.109**
	(0.691)	(0.460)	(0.0465)	(0.0450)	(0.0547)
Ln(Pop.)	0.813	0.0840	-0.0169	-0.00749	0.000353
	(0.635)	(0.217)	(0.0141)	(0.00839)	(0.0103)
N Observations	1135	1135	1135	2050	1616
N GMM Instr.	58		92	175	169
GMM Lags	t-2-t-3		t-2-t-4	t-2-t-5	t-2-t-6
AR 2 p-value	0.462		0.149	0.376	0.450
Hansen p-value	0.227		0.213	0.784	0.542

Notes: We instrument the lagged dependent variable and the number of ISO 14001 certifications with lagged levels in the equation in difference (GMM lags) and lagged differences. The number of lags is adjusted across specifications to obtain estimates with valid instruments according to the AR and Hansen tests. Robust errors in parentheses; ' p <0.15, * p <0.10, ** p <0.05, ***p < 0.01. *Source*: Authors' calculations.

[7] The ISO 14001 survey was at its very preliminary stages in 1995, and for this reason a decision was made by ISO to only make the 1999 onwards data available in the online version of the ISO survey. Additionally, another limitation is that the sample of countries included in the 1995-1999 data is only half of that included in the 1999-onwards data.

In column 1 we adopt the same methodology as PP, i.e. a difference GMM estimator (Arellano and Bond, 2001). We confirm that ISO 14001 certifications have a negative impact on emissions of SO_2, as in PP, but the coefficient that we estimate is smaller and statistically insignificant. The lack of significance can be attributed to the shorter time period at our disposal, and so for the difference in size.

To guide the choice of the estimator and reassure about the correct specification of the GMM model, in the remaining columns of table 1 we compare results from exploiting different estimators and periods of analysis. In contrast with PP, in this paper we make a choice in favour of the system-GMM estimator. In column 2 and 3 of we compare results from a fixed-effects (FE) “within” estimator and a system-GMM estimator. While being biased in a dynamic panel setting, the FE estimator can be taken as a lower bound estimate of the lagged dependent variable coefficient. Bond (2002) suggests that the system-GMM is to be preferred to the difference-GMM in case the GMM estimate of the lagged dependent variable ($Ln(SO2)_{t-1}$) is close to or below the FE estimate: the difference-GMM estimate in column 1 is well below the FE estimate in column 2, suggesting that the system-GMM is the preferable estimator to use in our context.

In columns 4 and 5 we show how results change when we extend the period under analysis to 2014, the latest available year in our data. In column 4, the effect of ISO 14001 certifications is reduced a great deal with respect to the results up to 2005, and in column 5, where we restrict the data to the (preferred) post-1999 period, the sign switches to positive: in both cases, however, the coefficients lack completely of statistical significance.

4.2. Main empirical findings

Given the findings in Table 1, for the reminder of the analysis we exploit the system GMM estimator, and data from 1999 to 2014. The subsequent tables report the results for emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and black carbon (BLC), as well air pollutants such as sulphur dioxide (SO_2) and nitrogen oxide (NO_x). All tables have the same structure and show the estimates which include the impact of EU trade agreements: the first two columns shows the results with the trade agreement variables identifying countries in EU trade agreement with any number of EP provisions; in the second two columns the trade agreement variables identify countries in agreements with an above median number of provisions, i.e. with a high degree of EP legalization. At the bottom of each table, we report the specification tests for the validity of our instrumentation strategy: the p-value of residuals autocorrelation (AR) test (of order given in brackets) and p-value of the Hansen test of overidentifying restrictions. Both tests are satisfied if we fail to reject the null with a high enough degree of significance.

Table 2: Emissions of CO_2 and CH_4.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ln(CO_2)				Ln(CH_4)			
	EU TA EP		**EU TA EP > med.**		**EU TA EP**		**EU TA EP > med.**	
Ln(Y)$_{t-1}$	0.981***	0.980***	0.986***	0.983***	0.989***	1.003***	0.988***	0.996***
	(0.00972)	(0.00857)	(0.0102)	(0.00934)	(0.0166)	(0.0161)	(0.0171)	(0.0172)
Ln(ISO 14001)$_{t-1}$	**-0.00965*** **	**-0.00485**	**-0.00824*** **	**-0.00532'**	**-0.0103*** **	**-0.00597** **	**-0.0105*** **	**-0.00634*** **
	(0.00329)	**(0.00348)**	**(0.00301)**	**(0.00338)**	**(0.00390)**	**(0.00242)**	**(0.00409)**	**(0.00241)**
Ln(GDP)$_t$	0.0300***	0.0276***	0.0233**	0.0249***	0.0232	0.00676	0.0243	0.0126
	(0.0105)	(0.00887)	(0.0109)	(0.00957)	(0.0166)	(0.0159)	(0.0180)	(0.0180)
Ln(GDPpc)$_t$	-0.0149***	-0.0144***	-0.0118**	-0.0139***	-0.0105	0.00128	-0.0110	-0.00367
	(0.00524)	(0.00489)	(0.00550)	(0.00535)	(0.0139)	(0.0159)	(0.0136)	(0.0154)
Democracy$_t$	0.000586	0.000737	0.000771	0.000516	-0.000679	-0.000444	-0.00105	-0.000673
	(0.00116)	(0.00109)	(0.00116)	(0.00112)	(0.00122)	(0.000903)	(0.00104)	(0.00117)
Ln(Industry)$_t$	0.0287**	0.0312**	0.0243*	0.0263**	0.0136	0.00534	0.0106	0.00850
	(0.0130)	(0.0126)	(0.0128)	(0.0123)	(0.0124)	(0.0147)	(0.0107)	(0.0100)
Ln(FDI)$_t$	0.00239	0.00285	0.00289	0.00264	-0.00155	-0.000954	-0.000573	-0.000647
	(0.00357)	(0.00344)	(0.00344)	(0.00342)	(0.00284)	(0.00227)	(0.00238)	(0.00228)
Ln(Exports)$_t$	0.00925*	0.00958*	0.00839'	0.00978*	0.00724	0.00975*	0.00889'	0.00901**
	(0.00544)	(0.00522)	(0.00529)	(0.00548)	(0.00573)	(0.00512)	(0.00569)	(0.00417)
Ln(Urb, Pop)$_t$	-0.00165	-0.00552	-0.00523	-0.00464	-0.00918	-0.0158'	-0.00770	-0.0127
	(0.0108)	(0.0104)	(0.0117)	(0.0111)	(0.0101)	(0.0107)	(0.00947)	(0.0126)
Ln(Exp. Treaties)$_t$	-0.00578*	-0.00598**	-0.00541*	-0.00591**	-0.00238	-0.00390	-0.00276	-0.00331
	(0.00298)	(0.00302)	(0.00279)	(0.00297)	(0.00315)	(0.00285)	(0.00306)	(0.00232)
Ln(Env. Treaties)$_{t-1}$	-0.0837***	-0.0498**	-0.0716***	-0.0557***	-0.0228	-0.00636	-0.0241	-0.00762
	(0.0208)	(0.0202)	(0.0195)	(0.0187)	(0.0260)	(0.0241)	(0.0267)	(0.0157)
EU T.A. env.$_{t-1}$	**0.0127**	**0.0305** **	**-0.00386**	**0.0231'**	0.0227	0.0190	0.0155	0.0193
	(0.0114)	**(0.0140)**	**(0.0108)**	**(0.0152)**	(0.0202)	(0.0292)	(0.0153)	(0.0263)
Ln(ISO 14001)$_{t-1}$*EU TA		**-0.00705*** **		**-0.00547** **		-0.00248		-0.00293
		(0.00248)		**(0.00249)**		(0.00447)		(0.00402)
Country FEs	Y	Y	Y	Y	Y	Y	Y	Y
Time FEs	Y	Y	Y	Y	Y	Y	Y	Y
N Observations	1889	1889	1889	1889	1889	1889	1889	1889
N GMM Instr.	130	168	130	168	146	191	147	192
AR(2) p-value	0.408	0.404	0.414	0.409	0.163	0.162	0.162	0.161
AR(3) p-value					0.476	0.472	0.476	0.473
Hansen p-value	0.246	0.703	0.212	0.772	0.243	0.975	0.233	0.982

Notes: Estimates are obtained with a system-GMM estimator. For CO_2, we instrument the lagged dependent variable and the number of ISO 14001 certifications with lagged levels dated from t-2 to t-3 in the equation in difference and lagged differences dated t-1 in the equation in levels. For CH_4, we instrument the lagged dependent variable and the number of ISO 14001 certifications with lagged levels dated from t-2 to t-3 in the equation in difference and lagged differences dated t-1 in the equation in levels Robust errors in parentheses; ' p <0.15, * p <0.10, ** p <0.05, ***p < 0.01. *Source*: Authors' calculations.

The coefficient on the lagged dependent variable is positive and strongly significant, in all the reported specifications, and in all the results tables. This is an expected finding, confirming that emissions have a very high degree of persistence from one year to the next, and that our empirical model needs to include this regressor.

Table 2 shows that the number of ISO14001 certifications has a negative impact on emissions of CO_2, with this finding being statistically robust to the inclusion of all the control variables. Importantly, this negative impact is strongly driven by the subset of countries which are part of an EU trade agreement with EP provisions, with no impact of ISO14001 certifications for countries not part of such agreements. On the other side, by themselves EU trade agreements are not associated with lower CO_2 emissions: no impact is detected on aggregate (columns 1 and 3), and a positive coefficient is found for countries part of an EU trade agreement with EP provisions but with zero ISO certifications.

This latter, apparently odd, finding can be explained by comparing columns 2 and 4. Countries with no ISO certifications are those at a lower level of development and tend to have a low number of EP provisions in their agreements with the EU. When we restrict the trade agreement indicator to identify only those countries in agreements with a high degree of EP legalization (columns 3 and 4), the positive effect for countries with zero ISO certifications almost vanishes, while the negative interaction between ISO certifications and trade agreements remains negative and significant. Taken together, these findings suggest ISO certifications are crucial for lowering CO_2 emissions, but only for countries also part of EU trade agreements with EP provisions. Simply being part of an EU trade agreement with EP issues, however, especially where EP issue are not strongly legalized, has no impact on CO_2 emissions.

Table 2 shows also the results for emissions of CH_4. Similarly to CO_2, ISO 14001 certifications have a strong and negative impact on emissions of methane. The impact is robust to including all controls, but it does not appear to be driven by members of EU trade agreements with EP provisions. Interacting the trade agreements indicators with the number of ISO certifications, in columns 6 and 8, cuts the coefficient of ISO certifications approximately in half, but does not yield a statistically significant coefficient on the interaction term. This implies that that ISO certifications reduce methane emissions regardless of countries' membership of EU trade agreements with EP provisions. Finally, there is no statistically significant impact on methane emissions from these trade agreements per se.

Table 3: Emissions of N_2O and BLC

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ln(N_2O)				Ln(BLC)			
	EU TA EP		**EU TA EP > med.**		**EU TA EP**		**EU TA EP > med.**	
Ln(Y)$_{t-1}$	0.998***	0.991***	0.995***	0.990***	1.054***	1.027***	1.037***	1.018***
	(0.00996)	(0.00865)	(0.0115)	(0.00735)	(0.0140)	(0.0154)	(0.0126)	(0.0147)
Ln(ISO 14001)$_{t-1}$	**-0.00306**	**-0.000221**	**-0.00147**	**0.000644**	**-0.00227**	**-0.00182**	**-0.00226**	**-0.00477**
	(0.00315)	**(0.00258)**	**(0.00297)**	**(0.00347)**	**(0.00469)**	**(0.00539)**	**(0.00451)**	**(0.00444)**
Ln(GDP)$_t$	0.0106	0.0133*	0.0108	0.0141**	-0.0493***	-0.0235	-0.0317**	-0.00889
	(0.00872)	(0.00752)	(0.00903)	(0.00693)	(0.0146)	(0.0171)	(0.0143)	(0.0164)
Ln(GDPpc)$_t$	-0.00866	-0.0138*	-0.0104	-0.0167***	0.0322***	0.00887	0.0221**	0.00481
	(0.00981)	(0.00728)	(0.0103)	(0.00635)	(0.0116)	(0.0132)	(0.00996)	(0.0132)
Democracy$_t$	-0.000479	-0.0000849	-0.000395	-0.00000155	-0.00193	-0.00120	-0.00127	-0.000587
	(0.000857)	(0.000739)	(0.000859)	(0.000822)	(0.00160)	(0.00165)	(0.00182)	(0.00132)
Ln(Industry)$_t$	0.00223	0.00143	0.0000582	0.000399	0.00827	0.0132	0.00929	0.0111
	(0.00787)	(0.00697)	(0.00715)	(0.00709)	(0.0146)	(0.0148)	(0.0134)	(0.0122)
Ln(FDI)$_t$	-0.00343	-0.00276	-0.00296	-0.00262	-0.00366	-0.00455	-0.00570	-0.00578
	(0.00256)	(0.00265)	(0.00264)	(0.00234)	(0.00449)	(0.00533)	(0.00432)	(0.00412)
Ln(Exports)$_t$	0.00988**	0.00784*	0.00774	0.00675	0.00271	0.00390	0.00405	0.00406
	(0.00504)	(0.00461)	(0.00572)	(0.00494)	(0.00981)	(0.00862)	(0.00809)	(0.00795)
Ln(Urb, Pop)$_t$	-0.00734	-0.00641	-0.00417	-0.00330	0.0380***	0.0256*	0.0235*	0.0142
	(0.00765)	(0.00603)	(0.00660)	(0.00576)	(0.0140)	(0.0142)	(0.0132)	(0.0109)
Ln(Exp. Treaties)$_t$	-0.000563	0.000368	0.000335	0.00145	-0.00344	-0.00290	-0.00226	-0.00150
	(0.00255)	(0.00227)	(0.00267)	(0.00237)	(0.00532)	(0.00517)	(0.00587)	(0.00514)
Ln(Env. Treaties)$_{t-1}$	-0.00669	0.0169	0.00404	0.0175	0.0503	0.0370	0.0430	0.0181
	(0.0200)	(0.0152)	(0.0174)	(0.0132)	(0.0417)	(0.0424)	(0.0387)	(0.0342)
EU T.A. env.$_{t-1}$	**0.0164**	**0.0140**	**0.00337**	**0.0142**	**-0.00950**	**-0.0356***	**-0.0206'**	**0.00231**
	(0.0155)	**(0.0195)**	**(0.0118)**	**(0.0164)**	**(0.0184)**	**(0.0202)**	**(0.0141)**	**(0.0298)**
Ln(ISO 14001)$_{t-1}$*EU TA		**-0.00266**		**-0.00321**		**0.00507**		**-0.00135**
		(0.00307)		**(0.00257)**		**(0.00438)**		**(0.00501)**
Country FEs	Y	Y	Y	Y	Y	Y	Y	Y
Time FEs	Y	Y	Y	Y	Y	Y	Y	Y
N Observations	1889	1889	1889	1889	1360	1360	1360	1360
N GMM Instr.	141	185	141	185	108	141	137	181
AR(2) p-value					0.755	0.749	0.741	0.756
AR(4) p-value	0.0824	0.0802	0.0817	0.0793				
AR(5) p-value	0.236	0.238	0.237	0.237				
Hansen p-value	0.194	0.980	0.231	0.983	0.225	0.317	0.434	0.949

Notes: Estimates are obtained with a system-GMM estimator. For N_2O, we instrument the lagged dependent variable and the number of ISO 14001 certifications with lagged levels dated from t-5 to t-8 in the equation in difference and lagged differences dated t-1 in the equation in levels. For BLC, we instrument the lagged dependent variable and the number of ISO 14001 certifications with lagged levels dated from t-2 to t-4 in the equation in difference and lagged differences dated t-1 in the equation in levels Robust errors in parentheses; ' p <0.15, * p <0.10, ** p <0.05, ***p < 0.01. *Source*: Authors' calculations.

Table 3 shows the results for emissions of nitrous oxide (N_2O) and black carbon (BLC). For nitrous oxide (columns 1-4), neither ISO 14001 certification, nor membership in an EU trade agreement with EP provisions appears to have an impact on emissions. For black carbon (columns 5-8), ISO 14001 certification appear to have no impact on these emissions, after all the controls are added in estimation. There is a negative effect emerging when inspecting the role of trade agreements with any number of EP provisions: surprisingly, this is found to be significant only for countries with no ISO certifications (in column 6). When exploiting the stricter trade policy indicator, a negative effect on emissions (although only mildly significant) is detected for all countries, with no significant interaction with ISO certifications. Taken together, also for black carbon there is little evidence that either ISO certification or EU trade agreements influence countries' emissions.

Table 4: Emissions of SO_2 and NO_x

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ln(SO_2)				Ln(NO_x)			
	EU TA EP		**EU TA EP > med.**		**EU TA EP**		**EU TA EP > med.**	
Ln(Y)$_{t-1}$	1.004***	1.000***	1.002***	0.999***	0.994***	0.990***	0.984***	0.999***
	(0.00693)	(0.00653)	(0.00837)	(0.00803)	(0.0154)	(0.0135)	(0.0177)	(0.0138)
Ln(ISO 14001)$_{t-1}$	**0.0103***	**0.00974***	**0.0139****	**0.0102***	**0.00527**	**0.00107**	**0.00465**	**-0.00003**
	(0.00545)	**(0.00500)**	**(0.00684)**	**(0.00608)**	**(0.00582)**	**(0.00540)**	**(0.00608)**	**(0.00548)**
Ln(GDP)$_t$	-0.0180*	-0.0124	-0.0177'	-0.0132	0.00475	0.0130	0.0156	0.00765
	(0.00937)	(0.00941)	(0.0116)	(0.0102)	(0.0153)	(0.0119)	(0.0169)	(0.0131)
Ln(GDPpc)$_t$	-0.00470	-0.00763	-0.00695	-0.00729	-0.0137	-0.0168**	-0.0189*	-0.0111
	(0.00675)	(0.00655)	(0.00768)	(0.00792)	(0.00954)	(0.00818)	(0.0102)	(0.00814)
Democracy$_t$	0.00134	0.000715	0.00180	0.00162	0.00105	0.000994	0.00139	0.00150
	(0.00166)	(0.00176)	(0.00189)	(0.00193)	(0.00113)	(0.00122)	(0.00114)	(0.00123)
Ln(Industry)$_t$	0.0237'	0.0232	0.0199	0.0240	0.0220	0.0171	0.0287*	0.0149
	(0.0154)	(0.0175)	(0.0192)	(0.0190)	(0.0169)	(0.0152)	(0.0165)	(0.0136)
Ln(FDI)$_t$	0.00386	0.00378	0.00309	0.00457	-0.00194	-0.00184	-0.00295	-0.00434'
	(0.00515)	(0.00526)	(0.00525)	(0.00496)	(0.00293)	(0.00280)	(0.00287)	(0.00282)
Ln(Exports)$_t$	-0.00829	-0.00385	-0.00131	-0.00152	0.0147**	0.0197***	0.0158**	0.0188**
	(0.01000)	(0.00938)	(0.0101)	(0.00978)	(0.00685)	(0.00705)	(0.00672)	(0.00858)
Ln(Urb, Pop)$_t$	-0.0192	-0.0166	-0.0242*	-0.0221*	-0.00697	0.00285	-0.00547	-0.00724
	(0.0136)	(0.0123)	(0.0130)	(0.0122)	(0.0110)	(0.0124)	(0.0104)	(0.0113)
Ln(Exp. Treaties)$_t$	-0.00389	-0.00279	-0.00353	-0.00216	-0.0107**	-0.0115***	-0.0115***	-0.0110***
	(0.00445)	(0.00512)	(0.00521)	(0.00581)	(0.00444)	(0.00388)	(0.00400)	(0.00418)
Ln(Env. Treaties)$_{t-1}$	-0.0672	-0.0719	-0.0455	-0.0729	0.0177	-0.0265	-0.00274	-0.0111
	(0.0512)	(0.0595)	(0.0504)	(0.0576)	(0.0307)	(0.0295)	(0.0297)	(0.0235)
EU T.A. env.$_{t-1}$	**-0.0281'**	**-0.0332**	**-0.0481****	**-0.0498**	**-0.0430***	**-0.0710*****	**-0.0292'**	**-0.0478**
	(0.0182)	**(0.0280)**	**(0.0200)**	**(0.0396)**	**(0.0220)**	**(0.0259)**	**(0.0188)**	**(0.0352)**
Ln(ISO 14001)$_{t-1}$*EU TA		**0.00131**		**0.00306**		**0.00806***		**0.00424**
		(0.00492)		**(0.00712)**		**(0.00466)**		**(0.00549)**
Country FEs	Y	Y	Y	Y	Y	Y	Y	Y
Time FEs	Y	Y	Y	Y	Y	Y	Y	Y
N Observations	1616	1616	1616	1616	1360	1360	1360	1360
N GMM Instr.	132	173	152	201	135	179	136	180
AR(2) p-value	0.786	0.794	0.786	0.796	0.0614	0.0610	0.0673	0.0618
AR(3) p-value					0.979	0.987	0.985	0.995
Hansen p-value	0.205	0.792	0.260	0.979	0.224	0.880	0.170	0.893

Notes: Estimates are obtained with a system-GMM estimator. For SO_2, we instrument the lagged dependent variable and the number of ISO 14001 certifications with lagged levels dated from t-2 to t-4 in the equation in difference and lagged differences dated t-1 in the equation in levels. For NO_x, we instrument the lagged dependent variable and the number of ISO 14001 certifications with lagged levels dated from t-3 to t-9 in the equation in difference and lagged differences dated t-1 in the equation in levels Robust errors in parentheses; ' $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source*: Authors' calculations.

Tables 4 explores the effect of ISO certification and EP issues in EU trade agreements on air pollution. We first examine the impact of emissions of sulphur dioxide (SO_2). For this pollutant, ISO 14001 certification are found to have a positive effect on emissions. Other than unexpected, this finding is at odds with the results of Potoski and Prakash (2013a), who found a negative impact of ISO certification on SO_2 (see Table 1 and section 4.1 for a discussion of the differences between our findings and those of Potoski and Prakash). On a more positive note, however, being part of EU trade agreements containing EP provisions, in particular agreements with an above median number of EP provisions, has a negative impact on SO_2 emissions. The negative effect of trade agreements is larger than the positive effect of ISO certifications, but the interaction term between the two variables is not statistically significant.

Finally, also nitrogen oxide (NO_x) emissions appear to be negatively affected by the membership in EU trade agreements with EP provisions, but not by ISO certifications.

5. Conclusion

This paper sought to build on and extend existing literature on the impact of international governance mechanisms on environmental compliance and emissions. There is an extensive literature on the reasons for the adoption of ISO 14001, which includes the role of the expectations of companies higher up the supply chain on lower tier suppliers. This paper looks at how ISO certification interacts with broader political and regulatory expectations by considering EU trade agreements and the environmental protections contained therein. The results paint a somewhat more complicated picture than might be expected. Membership of an EU trade agreement is associated with lower emissions of harmful pollutants. However a country' overall level of development conditions its ability to constrain carbon dioxide emissions even in the presence of environmental provisions, suggesting that the domestic regulatory environment needs to be considered. Thus, for a subset of countries, ISO certification is a necessary and complementary condition to trade agreement membership.

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