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The impact of ISO 14001 environmental standards on exports

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Inter-American Development Bank
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The Impact of ISO 14001

environmental standards on exports

Juan S. Blyde



The Impact of ISO 14001 environmental standards on exports*

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Inter-American Development Bank

October, 2021

Abstract

Analyses that examine the role of international standards on export performance has been concentrated on quality certifications. Very little is known about the impact of environmental certifications on exports. In this paper we employ firm-level data from Ecuador to assess the impact of the ISO 14001 environmental certification on export outcomes. The results show that holding an ISO 14001 increases the likelihood of becoming an exporter by 0.31 percentage points (equivalent to 4%), and that this positive effect is concentrated among large firms. We did not find evidence that the environmental certification has a causal impact on the level or the growth rate of exports. Consequently, the results suggest that the ISO 14001 certification is most useful in reducing information frictions, allowing firms to initiate export transactions.

Keywords: Exports, environmental standards

JEL Classification: F14, F18, Q56

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1 Introduction

Whether firms must comply with international standards as a condition for accessing foreign markets is a topic that has received increasing attention in recent years. Studies linking standards and exports have typically found a positive relationship between the two (Élisabeth Lefebvre and Lefebvre, 2000; Castagnino, 2006; Mangelsdorf et al., 2012; Volpe et al., 2010; Otsuki, 2011). But this literature has mainly focused on certifications related to quality, such as the ISO 9000. Very little is known about the impact of environmental certifications on exports. Although there is a literature on environmental certifications, the main focus has been to examine the impacts of these standards on environmental-related variables (Ibanez and Blackman, 2016; Rueda and Lambin, 2013; Takahashi and Todo, 2013). It is relatively unknown if environmental certifications improve companies' access to foreign markets. This study seeks to fill this gap in the literature.

In general, certifications could reduce information frictions between suppliers and buyers and could create favorable perceptions about a supplier that is conforming to an international norm. By presenting consistent and reliable information to other firms and to potential buyers, a certification could facilitate access to foreign markets which could be particularly important for firms with no history or reputation in that market. In this analysis we address the question of whether environmental certifications, and in particular the ISO 14001 certification, are important to export.¹

Introduced in 1996, the ISO (International Organization for Standardization) 14001 is a voluntary standard to reduce footprints through an environmental management system (EMS). The EMS includes organizational structure, planning activities, responsibilities, practices, procedures, processes, and resources for developing, implementing, achieving, reviewing and maintaining an environmental policy.

The ISO 14001 is not a performance standard. In other words, it does not tell organizations what environmental performance they must achieve. Instead, the standard describes a system that will help an organization to achieve its own objectives. The assumption is that a better management will lead to improved environmental performance.

Similar to the ISO 9000 on quality control, the ISO 14001 can be applied to any business and is not limited to the agricultural sector or any particular industry. For example, ISO data reveal that among all the ISO 14001 certifications granted in the world in 2018, electrical and optical equipment as well as machinery were among the sectors that received the most certifications, with a combined share of 14%.

In this paper we employ a panel of firm-level data from Ecuador to measure the impacts of holding an ISO 14001 certification on a number of export outcomes, including, whether the firm is an exporter, the change in export status, the level of exports, and the growth rate of exports. We use a rich set of fixed effects and controls in an instrumental variable specification to identify causal effects.

We found no evidence that ISO 14001 certifications have an effect on the level or the growth rate of exports. However, we found positive and significant effects on the change in the export status. In particular, holding an ISO 14001 certification increases the likelihood of becoming an exporter in around 0.31 percentage points (equivalent to 4%). We found that this positive effect

¹<https://www.iso.org/standard/60857.html>

is concentrated among large firms. We also found that holding the environmental certification increases the likelihood of becoming an exporter not only in highly polluting sectors but also in sectors that are less pollution-intensive.

Finally, we show that the positive impact on the change in the export status is statistically significant among firms belonging to sectors with large numbers of ISO 14001 certifications granted worldwide. As the number of ISO 14001 certifications around the world is significant in many industries that are not necessarily pollution-intensive, this last result indicates that exporters are expected to adhere to the ISO 14001 standard when entering foreign markets in sectors where this standard is ubiquitous, even in sectors that are not pollution-intensive.

This study contributes to various lines of research. First, the analysis provides a contribution to a literature that examines the effect of certifications on firm’s exports (Élisabeth Lefebvre and Lefebvre, 2000; Castagnino, 2006; Mangelsdorf et al., 2012; Volpe et al., 2010; Otsuki, 2011). Our paper expands this literature beyond the impact of quality certifications by measuring the export effects of the ISO 14001 environmental certification. Our study also contributes to a growing number of papers that examine the relationship between export status and the level of pollution emitted by firms (Holladay, 2016; Cui et al., 2016; Forslid et al., 2018; Richter and Schierschb, 2017). In general, these papers find that exporters are more emission efficient than not-exporters, but this literature does not examine the role of certifications behind such a relationship. We contribute to this literature by showing the extent to which environmental certifications are behind the likelihood that firms become exporters.

The rest of the paper is divided as follows. Section 2 provides a description of the dataset. Section 3 presents the empirical strategy and discusses the results. Finally, section 4 provides some concluding remarks.

2 Data description

We use a firm-level dataset from Ecuador covering the period 2012-2018. In particular, we employ an annual survey called ENESEM, *Encuesta Estructural Empresarial*, conducted by Ecuador’s statistical office, *Instituto Nacional de Estadística y Censos* (INEC).² The establishments are coded with a unique identifier which allows their traceability across the entire period. The survey contains detailed information on firm characteristics, such as employment, output, sales, and exports among other variables. Importantly, the survey also includes information on whether the company holds an ISO 14001 environmental certification. The industry classification in the survey is at the 4-digit International Standard Industrial Classification (ISIC rev 4).³

Table 1 presents some basic characteristics of the firms. There are on average 750 firms per year, with slightly more firms towards the end of the period and slightly less towards the beginning. The shares of small, medium and large firms in the ENESEM survey are 22%, 45% and 33%, respectively.⁴ Around 40% of the firms are exporters.

²<https://www.ecuadorencifras.gob.ec/encuesta-a-empresas/>

³The terms establishments and firms are used instinctively. We exclude the establishments in the service sectors. There are 123 industry sectors at the ISIC 4-digit.

⁴Firm size, measured in terms of total employment, is defined by INEC according to the following groups: small firms (less than 50 employees), medium size (between 50 and 200 employees), and large firms (more than 200

Table 2 provides information regarding the ISO 14001 certification. Around 11% of the firms hold this environmental certification with the share increasing in firm size. While 15% of the exporting firms hold an ISO 14001 certification, only 8% of the non-exporting firms hold the certification. Among the exporting firms, there are not large differences in terms of the average export level, but there are notable differences in terms of the export growth. For instance, the average annual growth rate of exports for firms holding an ISO 14001 certification is 0.4%, while for the firms without the certification this growth rate is -1.9%. Finally, among the non-exporting firms that hold an ISO 14001 certification in any given year, 10.6% of them become exporters the following year. Conversely, among the non-exporting firms that do not hold an ISO 14001 certification in any given year, only 8.1% of them become exporters.⁵ In summary, this table presents evidence indicating some positive correlation between ISO 14001 certifications and a number of export outcomes. While suggestive, this exercise does not control for the role of many other factors and does not signal any causality. For this reason we estimate an econometric model in the next section.

3 Empirical estimation

In this section we introduce an econometric model to measure the extent to which holding an ISO 14001 certification impacts export outcomes after controlling for year, sector, and firm characteristics. In particular, the baseline specification is given by the following expression:

$$Y_{ijt} = \alpha_0 + \beta \cdot ISO_{it} + \bar{X}_{it} \cdot \gamma + \alpha_i + \alpha_j + \alpha_t + e_{ijt} \quad (1)$$

where Y_{ijt} is an export outcome of firm i in sector j in year t ; ISO_{it} is a dummy variable that is equal to 1 if firm i holds an ISO 14001 certification in year t ; \bar{X}_{it} is a vector of firm characteristics that includes firm size, measured in terms of total employment, and labor productivity.⁶ The term α_i is a set of firm fixed-effects that capture time-invariant firm characteristics. The term α_j is a set of sector fixed-effects that captures time-invariant sector characteristics. The term α_t is a set of year fixed-effects that captures aggregate shocks that affect all firms in a given year. We also include a set of fixed effects for the region where the firm is located. Finally, e_{ijt} is the error term that is clustered at the firm-level.⁷

The intuition behind equation (1) is that after controlling for time and sector fixed effects, as well as for firm characteristics that are likely to impact export performance, the coefficient β will capture the impact of holding an ISO 14001 certification on export outcomes. One concern in estimating equation (1), however, is that if holding an ISO 14001 certification is correlated with unobserved factors that affect the firm's export performance, the estimation of β will be biased.

employees).

⁵Note that the unconditional probabilities of becoming an exporter reported in Table 2 are calculated as simple ratios: we take the number of non-exporters in any given year and look at the percentage of these firms that became exporters the next year. We report the average for all the years in the table.

⁶The variables comprising physical capital in the ENESEM are not consistently measured through the period of analysis. This prevents us from constructing other productivity measures, like total factor productivity.

⁷Note that we are analyzing the impact on export outcomes of holding an ISO 14001 certification. An alternative specification could be used to measure the impact on export outcomes of a change in the ISO14001 certification status. Unfortunately, during the period of analysis the change in the ISO14001 status of the firms does not happen very often. Accordingly, there is not enough power to obtain precise estimates of the effects employing such an approach.

Accordingly, beyond the inclusion of a rich set of fixed effects, we employ an instrumental variable (IV) estimation. Ideally the instrument is a variable that affects the likelihood of holding an ISO 14001 certification without impacting the export performance of the firm. We argue that a reasonable candidate for the instrumental variable is the number of ISO 14001 granted to the other firms in the same sector of firm i . The exclusion restriction is that through peer effects, there is a positive correlation between the number of firms in the sector with ISO 14001 certifications and the likelihood that firm i holds that certification, but the number of firms in the sector with ISO 14001 certification does not affect the export performance of firm i .

We also add additional controls at the sector-year level. Note that since the instrument varies at the sector-year level, we cannot explicitly include a time-variant sector fixed effect. To overcome this limitation, we add sector-specific trends by including a large set of predetermined sector characteristics interacted by year dummies. In particular, we add the following sector variables: (i) the total number of firms in the sector, (ii) the total employment level in the sector, (iii) the average labor productivity of all the firms in the sector, and (iv) the average percentage of exports in total sales of the sector. We take the start of the period values for all these variables and interact them with year dummies. In this way, we avoid controlling for contemporaneous values of sector-level variables that could be endogenous to firm performance.⁸

3.1 Estimation results

We analyze the effect of ISO 14001 certifications a number of export outcomes. First, we examine the results when the outcome is the firm’s total value of exports (in logs). Table 3 presents the results. The first column, which includes only year and sector fixed effects, shows a positive and significant impact of the ISO 14001 certification on the level of exports after controlling for firm’s size and productivity. The number of firms in the sector with ISO 14001 certification is positively correlated with the likelihood of firm i holding the certification. The F-test implies that we do not have a weak identification problem. In the next columns of Table 3 we present alternative sets of fixed effects. Adding the fixed effects and the sector controls significantly weakens the estimated impact of the environmental certification. For example, in column (5), the more stringent specification, the impact of ISO 14001 is still positive but no longer significant at conventional levels. Accordingly, we cannot say with confidence that the ISO 14001 certification has a causal effect on the level of exports of the firm.

Table 4 explores the results for alternative export outcomes. For comparison purposes, column (1) in this table repeats the result shown in column (5) of Table 3. The additional export outcomes in Table 4 are the annual growth rate of exports between t and $t + 1$ (column 2), a dummy variable that is equal to 1 if the firm is an exporter in year t (column 3), and a dummy variable that indicates whether the firm changed its export status between year t and year $t + 1$ (column 4). The last variable is constructed as follows: the dummy variable is equal to 0 if a non-exporter in year t remains a non-exporter in year $t + 1$, or if an exporter in year t remains an exporter in year $t + 1$; the dummy variable takes the value of 1 if a non-exporter in year t becomes an exporter in year $t + 1$. Finally, the case when an exporter in year t becomes a non-exporter in year $t + 1$ is relatively rare (7% of the observations) and is treated in alternative ways. In one option, the dummy variable takes the value of 0. In a second option, we allow the variable to take the value of -1. Finally, in a

⁸This is a standard practice in the labor economics literature.

third option we eliminate these observations when constructing the dummy variable. The results are practically identical regardless of the options that we use. In what follows we show the results when this dummy is constructed using the third option.

Columns (2) and (3) of Table 4 show the results for the growth rate of exports and for the export dummy. Similar to the export level, the estimated coefficients for the ISO 14001 certification are not statistically significant at conventional levels; thus, we find no evidence that the environmental certification has a causal impact on these export outcomes. We find, however, a positive and significant effect of ISO 14001 on the *change* in export status. The result indicates that having an ISO 14001 certification increases the likelihood of becoming an exporter by around 0.31 percentage points. Note that the unconditional likelihood of becoming an exporter for firms not holding an ISO 14001 certification is 8.1% (see last row in Table 2). Therefore, the estimated impact of holding an ISO 14001 certification is equivalent to an increase in the likelihood of becoming an exporter of 4%.⁹

3.2 Heterogeneous impacts across groups of firms

In Table 4 we measured the average impact of ISO 14001 across all the firms. But the average effect can mask potential heterogeneous impacts across different groups of firms. We now present results when the effects are separated by groups of establishments according to size. Using total employment as a measure of size, we create two groups: i) small and medium firms, and ii) large firms.

The results for each of the groups are reported in Table 5. Note that each cell in this table is a regression that includes the full cell of controls as in Table 4. Once again, we fail to detect any significant effect on the export outcomes related to the export levels, the export growth, or the export dummy. In the case of the change in the export status, however, we find that the positive results shown earlier are concentrated among the group of large firms. In other words, the large non-exporters holding an ISO 14001 certification in year t are more likely to become exporters the following year. In particular, holding an ISO 14001 certification increases the likelihood of these firms to become exporters by 0.41 percentage points, which is equivalent of an increase in 5%.¹⁰ This result is not entirely surprising. According to the seminal work by Melitz (2003), when one considers the fringe of non-exporter firms, the large and most productive firms are more likely to become exporters. Our results are consistent with this prediction. The ISO 14001 certification increases the likelihood of becoming an exporter, but such an effect is observed only among the large firms.

Another dimension that is worth exploring is the pollution-intensity of the sector. It is possible, for instance, that the positive impact of ISO 14001 certification on export outcomes is limited to the firms that are in pollution-intensive sectors. This could be the case, for example, if complying with environmental standards is not a binding requirement to exporting goods in sectors that are not highly intensive in pollution. We explore this dimension in Table 6.

We separate the firms in two groups according to the pollution-intensity of the sector. In

⁹4% = (0.31/8.1)*100

¹⁰The unconditional likelihood of becoming an exporter for large firms not holding an ISO 14001 certification is 8.3%. (5% = (0.41/8.3)*100).

particular, we separate sectors in two groups based on their pollution intensity using the ranking developed by [Shapiro and Walker \(2018\)](#). Excluding agricultural sectors which are not part of the ENESEM survey, the sectors (ISIC 2-digits) that are relatively more pollution-intensive according to this ranking are: extraction of petroleum and natural gas (ISIC 06), mining of metal ores (ISIC 07), other mining and quarrying (ISIC 08), wood and wood products (ISIC 16), coke and refined petroleum products (ISIC 19), and chemicals and chemical products (ISIC 20). Table A1 in the Appendix shows the share of firms holding ISO 14001 certifications in each of the 2-digit sector of the ENESEM. The table shows in general that with the exception of metal ores, the pollution-intensive sectors exhibit some of the largest shares of firms holding ISO 14001 certification.

Table 6 shows the estimations for the four export outcomes when the sample of firms is separated between those in more pollution-intensive sectors and those in less pollution-intensive sectors. Again, we fail to detect any significant impact with respect to the first three export outcomes - export levels, export growth and export dummy. For the change in the export status, however, we find positive impacts in both groups. The impact is much larger among the firms in pollution-intensive sectors. For firms in these sectors, holding an ISO 14001 certification induces an increase in the likelihood of becoming an exporter of about 1.49 percentage points, which is equivalent of an increase of 17%.¹¹ For firms in less pollution-intensive sectors, holding an ISO 14001 certification increases the likelihood of becoming an exporter in about 0.39 percentage points, which is equivalent of an increase of 5%.¹²

The results in Table 6 are interesting because they indicate that holding an environmental certification like the ISO 14001 increases the likelihood of becoming an exporter not only in highly polluting sectors but also in sectors that are less pollution-intensive. This is likely to be related to the type of environmental certification that we are studying. As mentioned before, the ISO 14001 certification is not related to a product but to a management system, which can be implemented in any sector. The evidence in Table 6 indicates that adhering to the terms specified in the ISO 14001 certification increases the likelihood of becoming an exporter even in sectors that are not necessarily pollution-intensive.

One potential explanation why the ISO 14001 standard is important to export in sectors that are not necessarily pollution-intensive is that this certification might be pervasive across firms in many other countries. In other words, if the ISO 14001 is regularly used by companies in many parts of the world even in sectors that are not pollution-intensive, it could then be reasonable to expect that companies that try to enter foreign markets in those sectors would need to adhere to the same standards.

To explore this idea, we employ global data on the ISO 14001 standard. In particular, using data from 2018 we compute the sum of all the ISO 14001 certifications granted in the world in each 2-digit ISIC sectors and calculate the share of each sector on all the ISO 14001 granted globally. Table A2 in the appendix shows the results.¹³ Interestingly, some of the sectors with the highest shares of ISO 14001, such as electrical equipment, are not necessarily sectors in traditional pollution-intensive industries, like agriculture. This is an early indication that the use of ISO 14001 might be ubiquitous in many industries that are not necessarily pollution-intensive.

¹¹The unconditional likelihood of becoming an exporter for firms in more pollution-intensive sectors not holding an ISO 14001 certification is 8.6%. $17\% = (1.49/8.6)*100$.

¹²The unconditional likelihood of becoming an exporter for firms in more pollution-intensive sectors not holding an ISO 14001 certification is 8.1%. $5\% = (0.39/8.1)*100$.

¹³To compute these shares, we exclude the ISO 14001 granted to the service sectors.

For the regression exercise we work at the 4-digit ISIC level. In particular, we construct the same shares as in Table A2 but at the 4-digit ISIC level. With this information, we separate the firms in the ENESEM in two groups: firms in sectors with widespread ISO 14001 certifications worldwide and firms in sectors with a small number of ISO 14001 certifications worldwide. We employ the median of the shares at the 4-digit ISIC level to split the firms in these two groups. The results of the regressions are shown in Table 7. Once again, we do not find any significant impact with respect to the first three export outcomes. We find, however, that the positive impact on the change in the export status is statistically significant among the firms that belong to sectors with widespread ISO 14001 certifications granted globally. For firms in these sectors, holding an ISO 14001 certification induces an increase in the likelihood of becoming an exporter of about 0.49 percentage points, which is equivalent of an increase of 4.6%.¹⁴ The results in Table 7 support the idea that the ISO 14001 certification is pervasive across firms in many parts of the world in sectors that are not necessarily pollution-intensive, and thus it is expected that companies that try to enter foreign markets in those sectors will need to adhere to these same standards.

4 Concluding remarks

International trade transactions can be hampered by information frictions. Certifications can lower these frictions by conveying consistent and reliable information to other firms and potential buyers about the capabilities and the production of a firm. The ISO 9000 certification on quality control has been found to be positively associated with export performance. In this paper we measure the export impact of the ISO 14001, a voluntary environmental certification.

The ISO 14001 standard sets the guidelines to reduce environmental footprints through an environmental management system. The standard can be applied to any firm and is not limited to the agricultural sector. Indeed, evidence from case studies indicate that many corporations in the world in various manufacturing sectors require their suppliers to comply with ISO 14001 certifications, including IBM, Xerox, Honda, Toyota, Ford, GM, Bristol-Myers Squibb or Quebec Hydro (Curkovic and Sroufe, 2011).

Complying with international standards can be particularly important for firms in developing countries that lack a history or reputation in foreign markets. We employ firm-level data from a developing country, Ecuador, to assess the impact of holding the ISO 14001 certification on a number of export outcomes. We found that holding an ISO 14001 certification increases the likelihood of becoming an exporter by around 0.31 percentage points (equivalent to 4%), and that this positive effect is concentrated among large firms. We also found that holding the environmental certification increases the likelihood of becoming an exporter not only in highly polluting sectors but also in those that are less pollution-intensive.

Although we found an effect on the change in the export status, we did not find evidence that ISO 14001 has a causal impact on the firm's level of exports or on the growth rate of exports. Consequently, the results suggest that the ISO 14001 certification is most useful in reducing information frictions, allowing firms to initiate export transactions.

¹⁴The unconditional likelihood of becoming an exporter for firms in sectors with widespread ISO 14001 certifications granted globally is 10.7%. $4.6\% = (0.497/10.7)*100$

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Table 1: Basic statistics, firm characteristics

	Average 2012-2018
Number of firms per year	750
Exporter (%)	40
Non-exporter (%)	60
Small (%)	22
Medium (%)	45
Large (%)	33

Table 2: ISO 14001 related statistics

	Average 2012-2018
Share of firms with ISO 14001 (%)	11
Share of small firms with ISO 14001 (%)	5
Share of medium firms with ISO 14001 (%)	7
Share of large firms with ISO 14001 (%)	19
Share of exporters with ISO 14001 (%)	15
Share of non-exporters with ISO 14001 (%)	8
Average exports of firms with ISO 14001 (logs)	14.7
Average exports of firms without ISO 14001 (logs)	14.5
Growth rate exports of firms with ISO 14001 (%)	0.4
Growth rate exports of firms without ISO 14001 (%)	-1.9
Change in export status of firms with ISO 14001 (%)	10.6
Change in export status of firms without ISO 14001 (%)	8.1

Table 3: Dependent variable: total exports (logs)

	(1)	(2)	(3)	(4)	(5)
ISO 14001	1.758* (1.0451)	1.770* (1.0632)	1.546* (0.8575)	1.592 (1.0190)	0.1185 (0.4051)
Total employment	0.798*** (0.0933)	0.804*** (0.0919)	0.4386** (0.1735)	0.431*** (0.2036)	0.8475*** (0.1108)
Labor productivity	0.876*** (0.1024)	0.857*** (0.1048)	0.6149*** (0.1420)	0.638*** (0.1666)	0.8658*** (0.1304)
Year FE	yes	yes	yes	yes	yes
Sector FE	yes	yes	no	yes	yes
Province FE	no	yes	no	yes	yes
Firm FE	no	no	yes	yes	yes
Sector controls x year dummies	no	no	no	no	yes
R2	0.556	0.564	0.907	0.908	0.934
Observations	2106	2106	1969	1964	1964
IV: number of firms in sector with ISO 14001	0.054*** (0.0102)	0.032*** (0.0030)	0.038*** (0.0082)	0.038*** (0.0094)	0.079*** (0.0127)
F statistic	28.5	27.7	21.3	16.9	38.9

Notes: Each column reports results from regressions over the period 2012-2018. The dependent variable is total exports of the firm (in logs). The main explanatory variable is a dummy variable equal to 1 if the firm holds an ISO 14001 certification and 0 otherwise. The instrument is the number of firms in the sector that hold an ISO 14001 certification. The control variables are the firm's size (total employment in logs) and labor productivity (in logs). Additional controls are fixed effects for year, sector, province and firm. The regressions also include start of the period values for sector variables (total number of firms, total employment level, average labor productivity, and average share of exports in sales) interacted with year dummies. Robust standard errors in parentheses are clustered by firm level. The weak identification test is the Kleibergen-Paap Wald F statistic.

*** ; ** ; * significant at the 1%, 5% and 10% level respectively.

Table 4: Alternative export outcomes

	Exports (logs) (1)	Growth rate of exports (2)	Exporter dummy (3)	Change in export status (4)
ISO 14001	0.1185 (0.4051)	0.3518 (0.3466)	-0.0051 (0.1840)	0.3080** (0.1426)
Total employment	0.8475*** (0.1108)	-0.4710*** (0.1226)	0.0265 (0.0191)	-0.0234 (0.0252)
Labor productivity	0.8658*** (0.1304)	-0.4907*** (0.1174)	0.0242*** (0.0040)	0.0075 (0.0169)
Year FE	yes	yes	yes	yes
Sector FE	yes	yes	yes	yes
Province FE	yes	yes	yes	yes
Firm FE	yes	yes	yes	yes
Sector controls x Year dummies	yes	yes	yes	yes
R2	0.934	0.286	0.765	0.344
Observations	1964	1232	5200	2636
	2SLS			
IV: number of firms in sector with ISO 14001	0.079*** (0.0127)	0.085*** (0.0151)	0.026*** (0.0048)	0.062*** (0.0084)
F statistic	38.9	32.3	31.4	55.3

Notes: Each column reports results from regressions over the period 2012-2018. The dependent variable is total exports (1), growth rate of exports (2), exporter dummy (3) and change in the export status (4). The main explanatory variable is a dummy variable equal to 1 if the firm holds an ISO 14001 certification and 0 otherwise. The instrument is the number of firms in the sector that hold an ISO 14001 certification. The control variables are the firm's size (total employment in logs) and labor productivity (in logs). Additional controls are fixed effects for year, sector, province and firm. The regressions also include start of the period values for sector variables (total number of firms, total employment level, average labor productivity, and average share of exports in sales) interacted with year dummies. Robust standard errors in parentheses are clustered by firm level. The weak identification test is the Kleibergen-Paap Wald F statistic.

*** ; ** ; * significant at the 1%, 5% and 10% level respectively.

Table 5: Impact of ISO 14001 by firm size

	Exports (logs) (1)	Growth rate of exports (2)	Exporter dummy (3)	Change in export status (4)
Small and medium firms	0.3668 (1.2419)	1.4862 (2.4906)	-0.1871 (0.3704)	0.1750 (0.3029)
Large firms	0.2107 (0.3799)	0.2687 (0.3433)	-0.0085 (0.1708)	0.4065** (0.1640)

Notes: Each cell reports results from regressions over the period 2012-2018. All regressions include the same IV and the same controls and fixed effects as in table 4. Robust standard errors in parentheses are clustered by firm level.

*** ; ** ; * significant at the 1%, 5% and 10% level respectively.

Table 6: Impact of ISO 14001 by pollution intensity of the sector

	Exports (logs) (1)	Growth rate of exports (2)	Exporter dummy (3)	Change in export status (4)
Firms in more pollution-intensive sectors	-1.8862 (1.1925)	4.5982 (4.9209)	-0.4019 (0.3031)	1.4897* (0.9005)
Firms in less pollution-intensive sectors	-0.1033 (0.4971)	0.3707 (0.4755)	0.1882 (0.2537)	0.3864** (0.1795)

Notes: Each cell reports results from regressions over the period 2012-2018. All regressions include the same IV and the same controls and fixed effects as in table 4. Robust standard errors in parentheses are clustered by firm level.

*** ; ** ; * significant at the 1%, 5% and 10% level respectively.

Table 7: Impact of ISO 14001 by sector, according to the incidence of ISO 14001 certifications worldwide

	Exports (logs) (1)	Growth rate of exports (2)	Exporter dummy (3)	Change in export status (4)
Sectors with large number of ISO 14001 certifications	0.1485 (0.7302)	0.2945 (0.4513)	-0.5468 (0.6409)	0.4967** (0.2222)
Sectors with small number of ISO 14001 certifications	-0.6093 (0.7191)	0.9277 (0.9202)	-0.0815 (0.1492)	0.2529 (0.2742)

Notes: Each cell reports results from regressions over the period 2012-2018. All regressions include the same IV and the same controls and fixed effects as in table 5. Robust standard errors in parentheses are clustered by firm level.

*** ; ** ; * significant at the 1%, 5% and 10% level respectively.

Appendix A Additional tables

Table A1: Share of firms with ISO 14001 certification by sector (ISIC 2-digit). Average 2012-18

	Percent
Tobacco	100.0
Petroleum and gas	50.0
Coke and petroleum products	47.6
Basic metals	27.9
Chemicals	25.3
Machinery and equipment n.e.c.	17.6
Wood products	17.3
Motor vehicles	16.9
Non-metallic mineral products	16.0
Other mining	14.5
Electrical equipment	13.0
Pharmaceuticals	13.0
Other transport equipment	11.4
Beverages	10.5
Paper	9.4
Rubber and plastic	6.9
Food	5.3
Metal products	4.5
Apparel	4.1
Printing	3.7
Computer, electronic and optical products	3.1
Textiles	2.5
Other manufacturing	2.2
Leather	1.3
Furniture	1.2
Metal ores	0.7

Table A2: Share of ISO 14001 certifications granted in the world by sector (ISIC 2-digit), 2018

	Percent
Electrical equipment	13.3
Machinery and equipment n.e.c.	13.1
Motor vehicles	9.8
Other manufacturing	9.4
Metal products	9.0
Computer, electronic and optical products	7.9
Other transport equipment	6.5
Basic metals	4.7
Wood products	4.6
Paper	3.2
Rubber and plastic	3.0
Pharmaceuticals	2.9
Furniture	2.3
Leather	1.8
Chemicals	1.7
Food	1.2
Printing	1.1
Non-metallic mineral products	0.8
Petroleum and gas	0.7
Other mining	0.7
Textiles	0.6
Coke and petroleum products	0.6
Beverages	0.3
Metal ores	0.3
Apparel	0.2
Tobacco	0.1