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ISO 14001 CERTIFICATION AND ENVIRONMENTAL PRACTICES OF MANUFACTURING SMEs: EVIDENCE FROM TURKEY

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Abstract

The purpose of this study is to explore the role of ISO 14001 adoption on environmental practices by manufacturing small-and-medium-sized enterprises (SMEs) in Turkey. It asks: (a) Does ISO 14001 adoption leads to an SME's utilization of precautions to increase its resource efficiency? (b) Does ISO 14001 adoption lead an SME to obtain any considerable gain from resource efficiency investments made recently? (c) Does ISO 14001 adoption influence firms' attitudes towards protecting natural resources and environmental sustainability? (d) Is ISO 14001 adoption associated with firms' consideration of environmental risks before deciding on new investments or arrangements with new suppliers? We use firm-level data and estimate various models using three different estimation techniques - ordinary least squares, entropy balancing, and instrumental variables - which the related research on the subject matter has utilized on various occasions. The results show that even though the ISO 14001 adoption and environmental practices of firms are positively correlated, once the endogeneity of the certification decision is accounted for, the adoption of ISO 14001 does not facilitate the environmental practices of Turkish manufacturing SMEs. These results imply that ISO 14001 adoption by a manufacturing SME may not be interpreted as a signal that the company is also adopting environmental practices as part of its management strategy. Instead, having ISO 14001 certification could be led by different motives. The paper contributes to the scanty literature on the impact of ISO 14001 certification on SMEs' environmental practices in developing economies and the discussions on the symbolic role of certifications on environmental practices.

Key words: environmental practices, ISO 14001, small-and-medium-sized enterprises, Turkey

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1. Introduction

The adoption of processes and activities to reduce the detrimental effects of production on the environment has become widespread among firms. One of these processes and activities, ISO 14000 standards, emerged based on 21 items, including environmental management system, environmental auditing, environmental performance evaluation, environmental labeling, life cycle assessment, and environmental aspects in product standards (ISO, 2009). Among those ISO 14000 standards, ISO 14001 is the most popular member of the family. As a standard designed to minimize the different types of environmental pollutants, it establishes a framework that enables organizations to enhance their environmental performance and fulfill compliance obligations. ISO 14001, as a certified environmental management system, has become popular among enterprises (Arimura et al., 2016; Laskurain et al., 2019; Gomis et al., 2018). Only in 2017, the number of ISO 14001 certifications reached 317,941 worldwide (ISO, 2021). With this increase in the worldwide adoption of this certificate, the number of studies on how the adoption of this certificate affects the performance of the firms has also increased (Sartor

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et al., 2019; Tarí et al., 2012). Some of these studies have focused on the performance effects of ISO 14001 on business processes (Ferrón-Vílchez, 2016; Link and Naveh, 2006; Prajogo et al., 2014), while some other papers' primal interest has been the financial performance of companies that adopt ISO 14001 (Barla, 2007; Boiral, 2007; He et al., 2015; He and Shen, 2019; Heras-Saizarbitoria et al., 2011; Lo et al., 2012; Paulraj and de Jong, 2011; Huian and Mironiuc, 2019). Nevertheless, as ISO 14000 standards aim to reduce the detrimental effects of production on the environment, the most crucial performance dimension related to ISO 14001 certification is environmental performance.

Empirical studies to date have produced mixed results about the impact of ISO 14001 certification on environmental performance (Arimura et al., 2016). While some papers show that ISO 14001 adopters outperform non-adopters on environmental dimensions (Arimura et al., 2008; Dasgupta et al., 2000; Potoski and Prakash, 2005), some other papers do not point to a performance-enhancing effect (Barla et al., 2007; Blackman, 2012; Darnall and Sides, 2008). According to Arimura et al. (2016), differences in institutional factors and regulatory settings and how the endogeneity of ISO 14001 adoption is tackled explain the findings of equivocal results. Related to variations in institutional factors and regulatory settings, Arimura et al. (2016) hypothesize that stricter environmental regulations create incentives for enterprises to reduce their environmental impact via employing ISO 14001. Thus, one could expect that the impact of ISO 14001 certification on firms' environmental practices could be weak or non-existent in developing economies where environmental regulatory agencies are ineffective, law enforcement capacity is limited, and incentives for environmental compliance is weak (Earnhart et al., 2014). Furthermore, environmental compliance can be even weaker for small-and medium-sized enterprises (SMEs) in these economies since they lack the capacity and resources to tackle environmental issues, and their main focus is on day-to-day activities (Brammer et al., 2012).

According to the trend analysis of published environmental management system research by Salim et al. (2018), the related literature on disaggregated micro-level studies has mainly focused on the performance effects of ISO 14001 adoption on companies in developed economies (with few exceptions in developing economies such as Ann et al. (2006), Blackman (2012), He et al. (2015), Ikram et al. (2019)). Furthermore, Salim et al. (2018) also indicate that ISO 14001 research in SMEs is underrepresented (as of 2013, only 3 publications in journals indexed by Scopus and Web of Science). However, given that SMEs constitute the largest portion of the global economy, a scientific understanding of SMEs' environmental management is critical for improved sustainability (Johnstone and Hallberg, 2020). Thus, both developing economies' and SMEs' under representation in the related literature and their prominence in the world economy motivate us to conduct the current study where we test the hypothesis that "*the impact of ISO 14001 certification on firms' environmental practices could be weak or non-existent in a developing country*" in the Turkish case. According to OECD (2019) Report, Turkey's environmental performance lags behind the Organisation for Economic Co-operation and Development (OECD) countries regarding the number of new certifications, which decreased between 2006 and 2018 in Turkey. The report also emphasizes that the country faces significant environmental challenges and suggests that compliance monitoring should be strengthened.

In testing the hypothesis, the study uses firm-level data obtained from the Ministry of Science and Technology of Turkey, administered to 10,063 firms in the manufacturing industry in 2016. Various models are estimated using three different estimation techniques (ordinary least squares, instrumental variables, entropy balancing) for four different environmental practices. Thus, the impact of ISO 14001 certification on environmental performance is investigated in a variable-rich setting by also addressing the endogeneity problem indicated by Arimura et al. (2016) in a technically-appropriate way.

The main contribution of the current study emanates from that it is one of the scarce analyses of the impact of ISO 14001 certification on environmental practices of SMEs in a developing country. By analyzing the relation between ISO 14001 certification and SMEs' environmental practices, we also aim to contribute to the discussion of the symbolic role of certification on environmental practices (Johnstone, 2020).

2. Material and methods

2.1. Data

For our analyses, we utilize firm-level data obtained from the Ministry of Science and Technology, administered to 10,063 firms in the manufacturing industry in 2016. The survey data represent 24 divisions (NACE Rev. 2, divisions 10-33) in the manufacturing industry (section C), such as "Manufacture of food products, beverages, and tobacco products," "Manufacture of paper and paper products," "Chemical industry," "Manufacture of pharmaceutical products," "Manufacture of basic metals," and "Manufacture of furniture; Other manufacturing." The data also represent 26 regions of Turkey based on the European Commission's Nomenclature of Territorial Units for Statistics (NUTS). Besides, the data is representative of firms based on their size, which is measured by whether the firm has 1-19 employees or 20+ employees.

An independent research company conducted the questionnaire via face-to-face interviews and transferred the data into an electronic environment. The General Directorate of Productivity (GDOP) contacted the company that applied the questionnaire

at every stage of the fieldwork and checked the data accuracy. When the research company cannot reach a firm for the survey, the GDOP provided the contact information of another firm in the same region-scale-sector level to the research company that ran the questionnaire to preserve the sample's representation power. The Ministry of Science and Technology keeps the records of all companies operating in the manufacturing industry from which the information regarding the sampling space was obtained. Using this information, the company has decided on the number of firms surveyed in each of 1,248 layers. Afterward, the sampling procedure was carried out to ensure statistical validity at 95% confidence level and ±7.5% confidence interval to determine the required number of firms to participate in the survey.

The survey covers a wide range of topics, including firms' employee profile, legal status and access to financial tools, resource efficiency and sustainability, technology and innovation level, production network, and management and organizational structure. We focus on four different discrete outcome measures related to the resource efficiency of firms. The first question being asked to firms is whether the firm utilizes precautions to increase its resource efficiency. The second question asked whether firms in the last three years have obtained any considerable gain from resource efficiency investments they have made. The third outcome variable that we are interested in is measuring whether the ISO 14001 certification impacts firms' attitudes towards the protection of natural resources and environmental sustainability. With the final outcome variable, we want to understand whether the link exists between having ISO 14001 by firms and consideration of environmental risks before firms' decisions on new investments or arrangements with new suppliers.

The survey asks questions that allow for controlling some background information. For instance, we control for firms' size (*SIZE*), which indicates the number of employees (1-19 or 20+ employees) and foundation year of the firm (*YEAR*). The size and age variables are common variables included in analyzing the effects of certification on firm performance (Babakri et al., 2004; Jabbour, 2015; Nee and Wahid, 2010). Furthermore, we include in our analyses whether firms have any sort of certification or not (*PRIOR_CERT*) (Aravind and Christmann, 2011), whether firms take advantage of new machines or equipment (*NO_NEW_TECH*, *SMWHT_NEW_TECH*, *NEW_TECH*), and the level of utilization of information technology such as computers, printers, and the internet (*NO_IT*, *MED_IT*, *HIGH_IT*). The inclusion of the variables *PRIOR_CERT*, *NO_NEW_TECH*, *SMWHT_NEW_TECH*, *NEW_TECH*, *NO_IT*, *MED_IT*, *HIGH_IT* emanates from the fact that they reflect the experience and sophistication of companies in their manufacturing operations. A firm's previous experience with advanced manufacturing techniques, information technology, and manufacturing practices results in a track record and capacity to boost its capability to carry out advanced environmental practices (Florida et al., 2001). We also control firms' sector information on which division they conduct their business based on the aforementioned classification in the manufacturing industry (*SECTORAL*). Besides, we control for 26 regions of Turkey in our analyses to shed some light on regional differences (*REGIONAL*). Table 1 presents a description of these variables.

Table 2 displays descriptive statistics of the variables in Table 1 by ISO 14001 ownership status. The descriptive statistics indicate that manufacturing firms with ISO 14001 certificate are more likely to utilize precautions to increase their resource efficiency, to obtain any considerable gain from resource efficiency investments that they have made, are keener on the protection of natural resources and environmental sustainability, and more likely to consider environmental risks before making their decisions on new investments or arrangements with new suppliers in comparison to manufacturing firms without ISO 14001. Simple comparisons of mean coefficients show that the differences between firms with and without ISO 14001 certificate with respect to the dependent variables are statistically significant (mostly at the 1% level). Furthermore, manufacturing firms with ISO 14001 are larger, older, and more likely to have other forms of certification. Finally, companies with ISO 14001 are more likely to take advantage of new machines or equipment and utilize information technology at a high level.

Nevertheless, these descriptive statistics only show mere correlations, and to examine the causal impact of ISO 14001 on environmental practices, we have to implement a more comprehensive multivariate analysis. The next subsection describes the details of various empirical methodologies to be employed.

2.2. Empirical methodology

To study the impact of ISO 14001 certification on environmental practices of Turkish manufacturing SMEs, we estimate an economic model where environmental practices are a function of ISO 14001 ownership, firm size, prior certification, firm's age, firm's technological level of production machines, firm's utilization of information technology, and indicator variables for manufacture sector divisions and regions. As explained in the previous section, the choice of these variables arises from the related literature. The estimation equation is displayed in (Eq. 1). Equation (1) is estimated using three different approaches. We first estimate (Eq. 1) by ordinary least squares (OLS) to report baseline results.

Then, to correct the bias led by self-selection, we employ the entropy balancing (EB) matching method. Finally, to account for possible endogeneity of the ISO 14001 certification variable due to omitted variable bias or reverse causality, we implement the instrumental variables (IV) estimation method to remove the bias from coefficients.

Table 1. Description of the variables used in the study

Dependent variables	
RES_EFFIC	A dichotomous variable that shows whether the firm utilizes precautions to increase its resource efficiency.
GAIN_RES_EFFIC	A dichotomous variable that shows whether firms in the last three years have obtained any considerable gain from resource efficiency investments that they have made.
PROTECTION	A dichotomous variable on firms' attitudes towards the protection of natural resources and environmental sustainability.
ASSESSMENT	A dichotomous variable that shows whether firms consider environmental risks before their decisions on new investments or arrangements with new suppliers.
Variable of Interest	
ISO_14001	A dichotomous variable that indicates whether the firm has an ISO 14001 certificate or not.
Independent Variables	
SIZE	A dichotomous that indicates the number of employees at the firm (1-19 or 20+ employees) (Source for the related literature: Babakri et al., 2004; Nee and Wahid, 2010).
PRIOR_CERT	A dichotomous variable that shows whether firms have any sort of certification except for ISO 14001 or not. (Source for the related literature: Aravind and Christmann, 2011).
YEAR	A continuous variable that indicates the foundation year of the firm. (Source for the related literature: Jabbour, 2015).
NO_NEW_TECH	A dichotomous variable that indicates whether firms take no advantage of new machines or equipment. (Source for the related literature: Florida et al., 2001).
SMWHT_NEW_TECH	A dichotomous variable that indicates whether firms somewhat take advantage of somewhat new machines or equipment. (Source for the related literature: Florida et al., 2001).
NEW_TECH	A dichotomous variable that indicates whether firms take advantage of new machines or equipment. (Source for the related literature: Florida et al., 2001).
NO_IT	A dichotomous variable that shows no utilization of information technology. (Source for the related literature: Florida et al., 2001).
MED_IT	A dichotomous variable that shows the utilization of information technology at a medium level. (Source for the related literature: Florida et al., 2001).
HIGH_IT	A dichotomous variable that shows the utilization of information technology at a high level. (Source for the related literature: Florida et al., 2001).
SECTORAL	Sectoral fixed effects defined at NACE Rev. 2 level for manufacturing industries.
REGIONAL	Regional fixed effects defined at the NUTS level.

Table 2. Descriptive statistics by ISO 14001 ownership status

Dependent Variables	***ISO 14001 ownership***		***Full sample***
	No	***Yes***	
RES_EFFIC	0.367 (0.482)	0.509*** (0.500)	0.386 (0.487)
GAIN_RES_EFFIC	0.802 (0.399)	0.893*** (0.309)	0.818 (0.386)
PROTECTION	0.331 (0.471)	0.496*** (0.500)	0.354 (0.478)
ASSESSMENT	0.882 (0.323)	0.927** (0.260)	0.890 (0.313)
Independent Variables			
SIZE	0.319 (0.466)	0.457*** (0.498)	0.339 (0.473)
PRIOR_CERT	0.614 (0.487)	0.860*** (0.347)	0.650 (0.477)
YEAR	1998.122 (11.865)	1996.436*** (12.523)	1997.878 (11.976)
NO_NEW_TECH	0.111 (0.314)	0.101 (0.302)	0.109 (0.312)
SMWHT_NEW_TECH	0.396 (0.489)	0.326*** (0.469)	0.386 (0.487)
NEW_TECH	0.493 (0.500)	0.573*** (0.495)	0.504 (0.500)
NO_IT	0.114 (0.318)	0.095* (0.293)	0.111 (0.315)
MED_IT	0.337 (0.473)	0.250*** (0.433)	0.325 (0.468)
HIGH_IT	0.549 (0.498)	0.655*** (0.476)	0.564 (0.496)
N	7,782	1,318	9,100

Notes: mean coefficients; standard deviation in brackets, * p < 0.05, ** p < 0.01, *** p < 0.001. Stars refer to the statistically significant difference between firms with and without ISO 14001 certificate with respect to the variables specified in the same row.

$$y_i = \gamma_0 + \delta ISO\_14001_i + \theta X_i + \varepsilon_i \quad (1)$$

where i denotes a manufacturing SME, y_i can be any resource efficiency indicators, including whether firms utilize any precautions to increase resource efficiency (*RES_EFFIC*), any considerable gain from these investments (*GAIN_RES_EFFIC*), firms' attitudes towards the protection of natural resources and environmental sustainability (*PROTECTION*), and finally considering environmental risks before firms' decisions on new investments or arrangements with new suppliers (*ASSESSMENT*). X_i denotes some characteristics for firms such as firms' age (*YEAR*), firms' size (*SIZE*), whether firms own any management certification (*PRIOR_CERT*), firms' technology level (*NO_NEW_TECH*, *SMWHT_NEW_TECH*, *NEW_TECH*), and firms' level of information technology utilization (*NO_IT*, *MED_IT*, *HIGH_IT*), sectoral fixed effects (*SECTORAL*), including 24 divisions of manufacturing industry, and regional fixed effects controlling for 26 regions of Turkey (*REGIONAL*). θ is a vector of parameters to be estimated. ε_i is the error term. The parameter of interest in this estimation equation is δ, which shows the effect of having ISO 14001 certification on environmental practices.

The self-selection problem originates from the fact that some manufacturing SMEs self-select themselves into a quality management program (Ozbugday, 2019). Thus, ISO 14001 adoption is non-random and could be affected by confounding factors. In other words, since ISO 14001 certification is a choice variable, and its adoption is non-random, the estimation of the impact of ISO 14001 certification on environmental practices will be biased.

One potential solution to the selection problem is the matching approach. Here, the basic idea is to find a group of non-ISO 14001- certified SMEs that are similar if not identical to the manufacturing SMEs with ISO 14001 certification in all relevant observable characteristics. Then, differences in the adoption of environmental practices can be ascribed to ISO 14001 certification.

A popular matching method is the propensity score matching (PSM) which is also used in quality certification studies (He et al., 2015; Ozbugday, 2019). Nevertheless, PSM may suffer from the problem of unbalanced matching until the matching in independent variables is manually and cyclically improved. This procedure disrupts the balance in other variables, although it improves the balance in some independent variables. Entropy Balancing (EB), however, is based on the maximum entropy weighting algorithm.

By assigning a weight to each unit, it matches the treatment and control groups at the 1st, 2nd, and 3rd moments (Hainmueller, 2012). This helps to create a balanced sample in observational studies where the treatment group is defined by a binary variable (as in this study). Entropy balancing does not require checking the post-matching balance. Because of these significant advantages it provides, the entropy balancing method is utilized in this study as the matching method (for further technical details, see Hainmueller, 2012; Hainmueller and Xu, 2013).

In addition to the baseline estimates obtained via OLS regression and the estimates obtained via entropy balancing, we also estimate (Eq. 1) using instrumental variables (IV) estimation technique. The utilization of the IV technique arises from the potential endogeneity of ISO 14001 certification. One source of endogeneity is reverse causality. It could be the case that more environmentally-sensitive firms that adopt environmental practices are obtaining ISO 14001 certificates. Another source of endogeneity is omitted variables bias. Both Turkish manufacturing SMEs' environmental practices and their decisions to adopt ISO 14001 could be affected by unobserved omitted variables that are correlated with the unobserved error term ϵ_i. An instrument for ISO 14001 certification could be the adoption ratio of ISO 14001 by rival SMEs in the same region and industry. Here, the argument is that a manufacturing SME's ISO 14001 certification decision is positively linked to closely competing SMEs' ISO 14001 adoption because of peer pressure (He et al., 2015). Furthermore, it is also argued that competing SMEs' certification only affects an SME's environmental practices through ISO 14001 adoption led by competitive pressure from peer SMEs (Barla, 2007). Therefore, in the first stage of IV (2-stage least squares) estimation, we estimate (Eq. 2) to obtain the fitted values for *ISO 14001* variable and re-estimate Eq. (1) using these fitted values.

$$ISO\_14001_i = \beta_0 + \beta_1 ISO\_14001_{rs} + \alpha X_i + \xi_i \qquad (2)$$

In Eq. (2), ISO_14001_{rs} is the adoption ratio of ISO 14001 in region *r* and sector *s*. α is a vector of parameters to be estimated and ξ is the error term.

Having described the details of various empirical methodologies used, we present the estimation results in the next subsection. We report the results of three variants of estimation (Eq. 1). The 1st model only includes firm characteristics such as size, prior certification, foundation year, technological level of production machines, and utilization of information technology. Then, for the 2nd model, we also include fixed effects for manufacturing sector divisions. Finally, in the 3rd model, we include regional fixed effects. All three models are estimated using OLS, EB, and IV.

3. Results and discussion

Before interpreting the estimation results, we first check whether entropy balancing achieves a good match between firms with and without ISO 14001 certification and whether the instrument we use, the adoption ratio of ISO 14001 by rival SMEs in the same region and industry (ISO_14001_{rs}) is a valid instrument. Table 3 presents the results for covariate adjustment for entropy balancing. As can be seen from the table, the mean, variance, and skewness of the covariates (1st, 2nd, and 3rd moments) are very similar,

if not identical, across firms that adopted ISO 14001 and firms without ISO 14001 certification. This suggests that the quality of the matching by entropy balancing is well enough.

Table 4 displays the results for the weak instrument test. As shown from the table, the F statistics in each IV estimation -where different dependent variables are used and where manufacture sector fixed effects and region fixed effects are included in the first-stage regressions- are much larger than the rule-of-thumb value 10 (Stock and Yogo, 2002). These results suggest that there is no concern for the weak instrument in the current context. Thus, we can turn to interpret the findings obtained via entropy balancing or instrumental variables estimation.

Table 5 reports regression results for the outcome variable, which measures whether the firm takes precautions to improve resource efficiency. Overall, the results indicate that larger or older firms, or firms with other management certification (except for ISO 14001) are more likely to report taking some precautions towards improving their resource efficiency: the coefficients on the variables *SIZE*, *PRIOR_CERT*, and *YEAR* are statistically significant in all three models that are estimated by OLS, EB or IV. The coefficients on the variables that indicate the technological level of production machines (*SMWHT_NEW_TECH* and *NEW_TECH*) are negative. Even though this seems to suggest that Turkish manufacturing SMEs with newer production technologies are less likely to report taking some precautions towards improving their resource efficiency, these variables' statistical significance alters across models or estimation methods, making it difficult to reach a definitive conclusion.

As to the role of information technology, we see that manufacturing SMEs that utilize information technology at a high level are more likely to take resource efficiency actions: the coefficient on *HIGH_IT* is positive and statistically significant (at the 1% level) in all models and methods.

Table 3. Covariate adjustment for entropy balancing

Before weighting	***Having ISO 14001***			***Not Having ISO 14001***		
	Mean	***Variance***	***Skewness***	***Mean***	***Variance***	***Skewness***
SIZE	0.476	0.250	0.094	0.322	0.218	0.762
PRIOR_CERT	0.867	0.115	-2.162	0.614	0.237	-0.470
YEAR	1996.000	157.600	-1.288	1998.000	140.200	-1.639
SMWHT_NEW_TECH	0.314	0.216	0.802	0.398	0.240	0.416
NEW_TECH	0.583	0.243	-0.338	0.493	0.250	0.030
MED_IT	0.248	0.187	1.165	0.336	0.223	0.696
HIGH_IT	0.657	0.226	-0.659	0.550	0.248	-0.203
Model 1: Industry and region fixed effects are not included.						
After weighting	***Having ISO 14001***			***Not Having ISO 14001***		
	Mean	***Variance***	***Skewness***	***Mean***	***Variance***	***Skewness***
SIZE	0.476	0.250	0.094	0.476	0.250	0.095
PRIOR_CERT	0.867	0.115	-2.162	0.866	0.116	-2.152
YEAR	1996.000	157.600	-1.288	1996.000	157.500	-1.224
SMWHT_NEW_TECH	0.314	0.216	0.802	0.314	0.216	0.800
NEW_TECH	0.583	0.243	-0.338	0.583	0.243	-0.337
MED_IT	0.248	0.187	1.165	0.249	0.187	1.163
HIGH_IT	0.657	0.226	-0.659	0.656	0.226	-0.658
Model 2: Industry fixed effects are included, but region fixed effects are not.						
After weighting	***Having ISO 14001***			***Not Having ISO 14001***		
	Mean	***Variance***	***Skewness***	***Mean***	***Variance***	***Skewness***
SIZE	0.476	0.250	0.094	0.476	0.250	0.095
PRIOR_CERT	0.867	0.115	-2.162	0.866	0.116	-2.151
YEAR	1996.000	157.600	-1.288	1996.000	157.500	-1.219
SMWHT_NEW_TECH	0.314	0.216	0.802	0.314	0.216	0.800
NEW_TECH	0.583	0.243	-0.338	0.583	0.243	-0.337
MED_IT	0.248	0.187	1.165	0.249	0.187	1.163
HIGH_IT	0.657	0.226	-0.659	0.656	0.226	-0.658
Model 3: Both industry and region fixed effects are included.						
After weighting	***Having ISO 14001***			***Not Having ISO 14001***		
	Mean	***Variance***	***Skewness***	***Mean***	***Variance***	***Skewness***
SIZE	0.476	0.250	0.094	0.476	0.250	0.095
PRIOR_CERT	0.867	0.115	-2.162	0.866	0.116	-2.150
YEAR	1996.000	157.600	-1.288	1996.000	157.500	-1.215
SMWHT_NEW_TECH	0.314	0.216	0.802	0.314	0.216	0.800
NEW_TECH	0.583	0.243	-0.338	0.583	0.243	-0.337
MED_IT	0.248	0.187	1.165	0.249	0.187	1.163
HIGH_IT	0.657	0.226	-0.659	0.656	0.226	-0.658

Table 4. Weak instrument test results

	Models with dependent variables			
	RES_EFFIC	***GAIN_RES_EFFIC***	***PROTECTION***	***ASSESSMENT***
First Stage R-squared	0.099	0.120	0.104	0.131
F-statistic	156.241	38.701	170.968	64.135
p-value	0.000	0.000	0.000	0.000
Minimum Eigenvalue Statistic	193.946	45.049	215.316	75.743

Notes: Manufacture sector fixed effects and region fixed effects are included in the first-stage regressions.

Table 5. Regression results for resource efficiency actions

	Model (1)			***Model (2)***			***Model (3)***		
Dep. Var.: RES_EFFIC	***OLS***	***EB***	***IV***	***OLS***	***EB***	***IV***	***OLS***	***EB***	***IV***
ISO_14001	0.096***	0.089***	0.464***	0.094***	0.081***	0.519***	0.064**	0.051***	0.019
	(0.032)	(0.016)	(0.071)	(0.032)	(0.016)	(0.097)	(0.031)	(0.016)	(0.100)
SIZE	0.086***	0.147***	0.111***	0.073***	0.150***	0.102***	0.078***	0.134***	0.121***
	(0.017)	(0.016)	(0.013)	(0.017)	(0.017)	(0.014)	(0.016)	(0.017)	(0.013)
PRIOR_CERT	0.144***	0.147***	0.071***	0.148***	0.143***	0.071***	0.150***	0.136***	0.117***
	(0.021)	(0.022)	(0.015)	(0.021)	(0.022)	(0.017)	(0.021)	(0.022)	(0.016)
YEAR	-0.002*	-0.001**	-0.001***	-0.002**	-0.001**	-0.001**	-0.002**	-0.002**	-0.002***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
Technological level of production machines									
SMWHT_NEW_TECH	-0.098***	0.001	-0.060***	-0.097***	-0.007	-0.056**	-0.069**	-0.022	-0.048**
	(0.034)	(0.031)	(0.023)	(0.034)	(0.031)	(0.023)	(0.035)	(0.032)	(0.022)
NEW_TECH	-0.067*	-0.013	-0.059**	-0.065*	-0.020	-0.054**	-0.050	-0.025	-0.047**
	(0.036)	(0.031)	(0.023)	(0.037)	(0.031)	(0.024)	(0.036)	(0.031)	(0.022)
Utilization of information technology									
MED_IT	0.032	0.019	0.015	0.038	0.026	0.017	0.124***	0.075**	0.073***
	(0.033)	(0.033)	(0.021)	(0.033)	(0.033)	(0.022)	(0.035)	(0.033)	(0.021)
HIGH_IT	0.193***	0.169***	0.173***	0.193***	0.179***	0.169***	0.217***	0.196***	0.186***
	(0.033)	(0.032)	(0.022)	(0.034)	(0.032)	(0.022)	(0.036)	(0.032)	(0.022)
SECTORAL FIXED EFFECTS	NO	NO	NO	YES	YES	YES	YES	YES	YES
REGIONAL FIXED EFFECTS	NO	NO	NO	NO	NO	NO	YES	YES	YES
R-squared	0.092	0.079	0.014	0.106	0.100		0.213	0.155	0.184
N	8274	8274	7421	8274	8274	7421	8274	8274	7421

*Notes: Clustered standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01. We cluster standard errors at the firm level. The reference category for the variable "Technological level of production machines" is unsatisfactory. The reference category for the variable "Utilization of information technology" is low utilization. The reference category for "Manufacture sector divisions (NACE)" is the manufacture of food products. The reference category for "26 Regions (NUTS2)" is TR10-İstanbul. The firm size variable is 1 if firms employ 20 or more employees and 0 otherwise. Any certification variable is 1 if the firm has any management certification other than ISO 14001, otherwise 0.*

The variable of interest, *ISO_14001*, enters positively into the estimation equations. Its coefficient is statistically significant (mostly at 1% level) in all models except for model (3) that incorporates regional fixed effects and is estimated by the IV method. Thus, once regional fixed effects are included, and the endogeneity of the adoption of ISO 14001 is accounted for, the positive impact of ISO 14001 on manufacturing SMEs' taking precautions towards improving their resource efficiency disappears. It seems that controlling regional fixed effects is of great importance to isolate the true impact of ISO 14001 on firms' resource efficiency.

Table 6 reports the results for the outcome variable for which the question being asked is whether there existed a considerable gain for the firm in the last three years due to investments in resource efficiency. The findings indicate that only larger firms report reaping the benefits of resource efficiency investments in the last three years: the coefficient on *SIZE* is positive and statistically significant (mostly at 1% level).

In Table 6, the coefficient on *NEW_TECH* is positive and statistically significant (at the 1% level) in most models. This implies that Turkish manufacturing SMEs with newer production technologies are more (around 11%, all else equal) likely to have benefitted from resource efficiency investments. Furthermore, the signs of the coefficients on *MED_IT* and *HIGH_IT* and the associated significance levels are alternating across models and estimation methods. This leads us to conclude that one cannot be sure about the role of information technology on gains due to investment in resource efficiency.

As displayed by Table 6, the coefficients on the variable of interest, *ISO_14001*, are statistically significant and positive in models estimated via OLS and EB. However, in all models estimated via the IV method, the statistical significance vanishes. The result suggests that when the endogeneity problem is addressed in an IV estimation context, the statistically significant association between ISO 14001 and our outcome of interest disappears. Therefore, we

conclude that there is no causal link between ISO 14001 adoption and gains from resource efficiency investments for Turkish manufacturing SMEs.

Table 7 reports the results on whether the firm engages in precautions that protect natural resources and provide a sustainable environment. According to the results displayed by the table, larger firms or firms with other management certification (except for ISO 14001) are more likely to take precautions that protect natural resources and environmental sustainability: the coefficients on the variables *SIZE* and *PRIOR_CERT* are statistically significant in all three models that are estimated by OLS, EB or IV. Moreover, the coefficients on *HIGH_IT* are positive and statistically significant at 1% level, which suggests that manufacturing SMEs that utilize information technology at a high level are more predisposed to engaging in precautions that protect natural resources and provide a sustainable environment.

As in Table 7, the coefficient on the variable of interest, *ISO_14001*, is positive and statistically significant (mostly at 1% level) in all models except for model (3) that includes regional fixed effects and is estimated by the IV method. Therefore, when we control for regional fixed effects and address the endogeneity of the adoption of ISO 14001, the positive and statistically significant effect of ISO 14001 on manufacturing SMEs' taking precautions to protect natural resources and provide a sustainable environment fades.

The outcome variable in Table 8 that we are interested in is whether the firm considers environmental risks before making new investments. According to the results, many of the coefficients on the variables are insignificant. More importantly, even though the coefficients on *ISO_14001* are positive and statistically significant in the models estimated by OLS and EB, they turn to insignificant in models estimated by the IV method. Thus, we cannot verify that Turkish manufacturing firms with ISO 14001 are more likely to report considering environmental risks before deciding on new investments.

The findings above indicate that the results of OLS estimations and EB are somewhat similar, yet they diverge from the results obtained by IV. This firstly suggests that the endogeneity problem is not entirely solved by the EB method, and there are unobservable characteristics that affect Turkish manufacturing SMEs' ISO 14001 adoption decisions. Once the adoption decision's endogeneity is accounted for, it is revealed that the adoption of ISO 14001 certification does not facilitate Turkish manufacturing SMEs' environmental practices. Accordingly, firms adopting the certification may have slight performance improvements, but it does not necessarily imply that they achieve "the desired level" of an environmental management system. In other words, the presence of ISO 14001 certification by a manufacturing SME should not be considered as that the firm's business is entirely "green."

Theoretically, the ISO 14001 certification is expected to support companies' environmental performance in many ways. As the standards were designed to minimize the different types of environmental pollutants, ISO 14001 aimed to boost companies' environmental performance.

Table 6. Regression results for any gain due to investment in resource efficiency

	Model (1)			***Model (2)***			***Model (3)***		
Dep. Var.: GAIN_RES_EFFIC	OLS	EB	***IV***	***OLS***	***EB***	***IV***	***OLS***	***EB***	***IV***
ISO_14001	0.080***	0.078***	0.110	0.075***	0.065***	-0.247	0.067**	0.052***	-0.092
	(0.027)	(0.015)	(0.075)	(0.027)	(0.015)	(0.154)	(0.026)	(0.015)	(0.148)
SIZE	0.052***	0.068***	0.052	0.046**	0.064***	0.073***	0.051***	0.050***	0.048***
	(0.019)	(0.016)	(0.015)	(0.020)	(0.016)	(0.018)	(0.020)	(0.016)	(0.016)
PRIOR_CERT	-0.041	0.096**	0.002	-0.046*	0.084**	0.049*	-0.037	0.090***	0.040
	(0.027)	(0.037)	(0.021)	(0.028)	(0.035)	(0.028)	(0.028)	(0.033)	(0.027)
YEAR	0.001	0.000	0.001	0.001	0.000	0.000	0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Technological level of production machines									
SMWHT_NEW_TECH	0.102*	0.074*	0.075	0.098*	0.072*	0.086***	0.087	0.049	0.064**
	(0.053)	(0.039)	(0.032)	(0.052)	(0.038)	(0.033)	(0.053)	(0.036)	(0.032)
NEW_TECH	0.133***	0.097**	0.107	0.139***	0.113***	0.128***	0.123**	0.101***	0.108***
	(0.050)	(0.038)	(0.031)	(0.049)	(0.038)	(0.032)	(0.050)	(0.035)	(0.031)
Utilization of information technology									
MED_IT	-0.018	-0.064	0.017	-0.023	-0.071*	-0.008	-0.024	-0.058	0.003
	(0.058)	(0.043)	(0.038)	(0.058)	(0.043)	(0.039)	(0.058)	(0.042)	(0.038)
HIGH_IT	0.110**	0.069*	0.128	0.099*	0.045	0.112***	0.076	0.039	0.097***
	(0.052)	(0.038)	(0.035)	(0.052)	(0.039)	(0.037)	(0.052)	(0.039)	(0.036)
SECTORAL FIXED EFFECTS	NO	NO	NO	YES	YES	YES	YES	YES	YES
REGIONAL FIXED EFFECTS	NO	NO	NO	NO	NO	NO	YES	YES	YES
R-squared	0.054	0.077	0.054	0.070	0.088		0.097	0.130	0.083
N	3088	3088	2875	3088	3088	2875	3088	3088	2875

Notes: See the notes under Table 5.

Table 7. Regression results for protection of natural resources and environmental sustainability

	Model (1)			***Model (2)***			***Model (3)***		
Dep. Var.: PROTECTION	***OLS***	***EB***	***IV***	***OLS***	***EB***	***IV***	***OLS***	***EB***	***IV***
ISO_14001	0.100***	0.115***	0.512***	0.096***	0.103***	0.499***	0.073**	0.072***	0.009
	(0.030)	(0.016)	(0.068)	(0.031)	(0.016)	(0.088)	(0.030)	(0.016)	(0.090)
SIZE	0.093***	0.142***	0.108***	0.081***	0.138***	0.103***	0.087***	0.137***	0.125***
	(0.017)	(0.016)	(0.013)	(0.017)	(0.017)	(0.013)	(0.016)	(0.017)	(0.013)
PRIOR_CERT	0.149***	0.131***	0.081***	0.154***	0.121***	0.090***	0.162***	0.109***	0.136***
	(0.020)	(0.021)	(0.015)	(0.020)	(0.022)	(0.016)	(0.020)	(0.021)	(0.015)
YEAR	-0.001	-0.001*	-0.001	-0.001	-0.001	-0.001*	-0.001*	-0.001*	-0.002***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
Technological level of production machines									
SMWHT_NEW_TECH	-0.070**	-0.006	-0.020	-0.070**	-0.005	-0.016	-0.059*	-0.013	-0.010
	(0.034)	(0.031)	(0.022)	(0.034)	(0.031)	(0.022)	(0.034)	(0.030)	(0.021)
NEW_TECH	-0.022	0.045	0.009	-0.026	0.057*	0.013	-0.019	0.049	0.021
	(0.036)	(0.032)	(0.023)	(0.037)	(0.031)	(0.023)	(0.036)	(0.031)	(0.021)
Utilization of information technology									
MED_IT	-0.019	-0.014	-0.034	-0.014	-0.015	-0.034	0.049	0.030	0.018
	(0.030)	(0.032)	(0.021)	(0.031)	(0.032)	(0.021)	(0.034)	(0.032)	(0.021)
HIGH_IT	0.167***	0.121***	0.110***	0.170***	0.119***	0.109***	0.191***	0.146***	0.136***
	(0.032)	(0.032)	(0.022)	(0.033)	(0.032)	(0.022)	(0.035)	(0.032)	(0.021)
SECTORAL FIXED EFFECTS	NO	NO	NO	YES	YES	YES	YES	YES	YES
REGIONAL FIXED EFFECTS	NO	NO	NO	NO	NO	NO	YES	YES	YES
R-squared	0.115	0.087	0.014	0.133	0.102	0.030	0.234	0.162	0.201
N	8190	8190	7336	8190	8190	7336	8190	8190	7336

Notes: See the notes under Table 5.

Table 8. Regression results for assessment on environmental risks

	Model (1)			Model (2)			Model (3)		
Dep. Var.: ASSESSMENT	OLS	EB	IV	OLS	EB	IV	OLS	EB	IV
ISO_14001	0.045**	0.038***	0.094*	0.041**	0.037***	0.062	0.037**	0.030**	0.003
	(0.019)	(0.013)	(0.055)	(0.019)	(0.013)	(0.095)	(0.018)	(0.013)	(0.094)
SIZE	0.014	0.012	0.004	0.012	0.013	0.003	0.018	0.009	0.005
	(0.014)	(0.013)	(0.012)	(0.015)	(0.014)	(0.014)	(0.015)	(0.014)	(0.013)
PRIOR_CERT	0.051*	0.008	-0.011	0.055*	0.004	-0.003	0.059**	0.013	0.015
	(0.029)	(0.024)	(0.017)	(0.029)	(0.024)	(0.020)	(0.030)	(0.023)	(0.020)
YEAR	-0.002**	-0.001**	-0.001	-0.001**	-0.001**	-0.001	-0.002**	-0.001	-0.001
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Technological level of production machines									
SMWHT_NEW_TECH	0.012	0.034	0.042	0.018	0.032	0.045*	0.018	0.017	0.039
	(0.058)	(0.037)	(0.028)	(0.056)	(0.037)	(0.028)	(0.056)	(0.035)	(0.027)
NEW_TECH	0.078	0.069**	0.057**	0.092*	0.073**	0.060	0.086*	0.052	0.055**
	(0.048)	(0.035)	(0.027)	(0.047)	(0.035)	(0.027)	(0.047)	(0.032)	(0.026)
Utilization of information technology									
MED_IT	0.105	0.019	0.024	0.104	0.023	0.027	0.096	0.018	0.022
	(0.075)	(0.039)	(0.031)	(0.071)	(0.039)	(0.031)	(0.071)	(0.039)	(0.031)
HIGH_IT	0.156**	0.048	0.067**	0.155**	0.052	0.073**	0.140**	0.047	0.068**
	(0.071)	(0.035)	(0.028)	(0.067)	(0.035)	(0.028)	(0.068)	(0.036)	(0.029)
SECTORAL FIXED EFFECTS	NO	NO	NO	YES	YES	YES	YES	YES	YES
REGIONAL FIXED EFFECTS	NO	NO	NO	NO	NO	NO	YES	YES	YES
R-squared	0.069	0.022	0.012	0.086	0.033	0.029	0.117	0.070	0.058
N	2941	2941	2728	2941	2941	2728	2941	2941	2728

Notes: See the notes under Table 5.

However, our findings show that having an ISO 14001 certification by a Turkish manufacturing SME does not facilitate further environmental practices, such as taking precautions to increase resource efficiency or assessing environmental risks before making decisions on new investments or arrangements with new suppliers. Even though this finding seems somewhat contrary to the main expectations and the main conclusion of the related studies that suggest that ISO 14001 certification enhances companies' environmental performance, it verifies the hypothesis that the impact of ISO 14001 certification on firms' environmental practices could be weak or non-existent in a developing country. As argued in the introduction, incentives for environmental compliance by SMEs in developing

countries are much weaker (Brammer et al., 2012; Earnhart et al., 2014), and environmentally-oriented management could be a greater challenge for SMEs. Therefore, the paper's main finding indicates that adopting an environmental management system such as ISO 14001 does not enhance manufacturing SMEs in Turkey to adopt environmental practices as part of their management strategy, and ISO 14001 certification does not help SMEs embrace environmental practices.

The finding that certification has no impact on firm performance is also in accord with the findings of the studies on Turkish manufacturing firms. Ozbugday (2019) finds no evidence that ISO 9001 certification leads to increased total factor productivity of Turkish SMEs, which is attributed to weak internal motivation of certified companies. Local surveys on Turkish manufacturing SMEs show that the marketing allurement of certification is more dominant for firms, and their way of implementing quality management (be it ISO 9001 or ISO 14001) is not compatible with their strategic orientation (Ozbugday, 2019). This explanation concurs with the related literature's suggestion that internally motivated certified companies have greater performance than externally motivated certified companies (Curkovic and Pagell, 1999; Terziovski et al., 1997). Thus, in the words of Johnstone (2020), the external symbolic reasoning for ISO 14001 certification seems to have dominated internal substantive reasoning to boost environmental performance.

The lack of evidence on the contribution of ISO 14001 to environmental practices in the Turkish manufacturing sectors does not necessarily imply that ISO 14001 is unnecessary or dysfunctional. There could be many other aspects of ISO 14001 adoption that we are unable to observe or measure in the current context. For instance, ISO 14001 accreditation could be a key to opening up to new markets for Turkish manufacturing SMEs. Furthermore, it should not be forgotten that instead of highlighting actual environmental performance measures, ISO 14001 standards put emphasis on processes to manage environmental effects (Arimura et al., 2016). Therefore, we abstain from proposing a managerial implication that advises against the adoption of ISO 14001.

4. Conclusions

The paper contributes to the scanty literature on the impact of ISO 14001 certification on SMEs' environmental practices in developing economies and the discussions on the symbolic role of certifications on environmental practices. The results show that even though the ISO 14001 adoption and environmental practices of firms are positively correlated, once the endogeneity of the certification decision is taken care of, it is affirmed that the adoption of ISO 14001 does not facilitate environmental practices of Turkish manufacturing SMEs. These findings imply that ISO 14001 adoption by a manufacturing SME may not be interpreted as a signal that the company is also adopting environmental practices as part of its management strategy.

Our study has some limitations. First, the dataset that we utilize does not have a panel nature, which would allow us to control for time-invariant unobserved effects across firms. The lack of panel data prevents us from making comparisons of the changes in the environmental practices of SMEs with certification with that of noncertified manufacturing companies. Furthermore, since many of the variables used in the study are dichotomous, we cannot capture the impact of continuous changes in these variables.

Notwithstanding the limitations, we have contributed to the existing literature exploring the relationship between firms' environmental practices and ISO 14001 adoption by approaching the question from a broad perspective that includes significant estimation methods. Future studies would be better to analyze the same firms to ensure that time-invariant factors are considered.

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