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Energy Saving in Transition Economies: Environmental Activities in Manufacturing Firms

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Abstract: This study seeks to explore the relationship between active environmental activities and energy saving in firms operating in a set of Transition countries. For this purpose, we exploit the enterprise survey data collected by the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB) and the World Bank Group (WBG). Employing a probit regression model, the main finding shows a positive relation between environmental practices and energy saving, controlling several firms' characteristics such as size, affiliation, credit line, ownership status and age. The results are also confirmed when we perform the robustness check. Interestingly, medium and small firms appear to save more energy than large ones.

Keywords: industrial energy saving; Transition economies; active environmental practices; manufacturing sector

Citation: Biscione, A.; de Felice, A.; Gallucci, T. Energy Saving in Transition Economies: Environmental Activities in Manufacturing Firms. *Sustainability* **2022**, *14*, 4031. https://doi.org/10.3390/su14074031

Received: 12 February 2022
Accepted: 23 March 2022
Published: 29 March 2022

1. Introduction

In this paper, we highlight the role of the adoption of environmental practices to save energy in manufacturing firms operating in a set of Transition countries. We focus on the manufacturing industry since it is energy-intensive (it is responsible for 24% of final energy consumption [1] (data refer to 2018)).

In recent years, the study of energy saving, or energy conservation, has gained particular attention among scholars both for the adoption of environmental policies and for the implementation of industrial strategies with the objective of stopping climate change and saving the planet. As a result of COVID-19, energy use, measured by the energy intensity, was reduced by 5.8% during the year 2020. Despite this improvement, global energy-related CO_2 emissions have remained high [2]. This is below the level required to meet the global climate and sustainability goals of the Energy Efficiency Directive 2012/27/EU as supplemented by Directive 2018/2002. Both directives are designed to mitigate climate change.

The importance of curbing emission and helping the industry to a green transition is underlined by the fact that in 2019 the European Commission published the 'European Green Deal'. The aim of this plan is to promote a series of measures to make production more sustainable and less harmful to the environment with the stopping of net greenhouse gas emissions by 2050. In other words, the idea is to support SMEs to invest in environmentally friendly technologies facilitating industry involving practical innovation actions to drive enterprises to become more energy efficient.

Therefore, implementing energy saving and using green and innovative technologies in different sectors are key elements to save the environment. In this context, companies that voluntarily adopt green activities to reduce their effect on the environment deserve peculiar attention since they can be considered as adding value to firms [3]. These voluntary

green activities by which firms reduce their negative effect on the environment [4–7] are a relevant topic to explore since proactive firms' activities could have a positive effect on energy saving.

The literature on this topic is extensive and heterogeneous. Some papers investigate determinants of energy-saving [8–10], others focus on internal organizational factors such as energy-saving activities [11,12], environmental strategies [6,7], and voluntary energy programs [13,14]; and some more examine external factors such as institutional policies [4,15,16] and the role played by stakeholders, customers, and suppliers [17].

Moreover, while existing literature explores the different environmental activities that firms can implement to reduce their impact on industrialized economies [7,18–20] and on some developing countries [21–24], the Transition countries are less analyzed [25,26]. These countries have been moving from a planned to a market economy [27–29] (although we base our analysis on a traditional definition of transition economies [27–29], this concept has evolved over time. In particular, Besley et al. [30] provided a new definition of a 'transition concept' that redefines the role of institutions and considers the qualitative rather than quantitative transition aspects. In other words, it is necessary to focus on achieving well-functioning markets) since the fall of the communist regime. At the beginning of this process, almost all countries were characterized by very intensive energy use, especially in the industrial sector. During the transition process, energy use is decreased since market reforms mitigate problems such as resource misallocation and price distortions [31]. This reduction, which differs across countries and transition areas, may be also due to other determinants, such as a decrease in production and a collapse in economic activity [32].

Most of the studies on energy saving of firms in these countries are based on case studies, while a lack of empirical evidence emerges when attention is paid to the relationship between firms' environmental activities and energy saving. Therefore, this paper makes contributions to this strand of literature to check: (i) the relationship between voluntary environmental practices and energy saving in a sample of firms of 28 Transition countries during the period 2018–2020 and (ii) the role played by firms' size and firms' age. Specifically, we enrich this stream investigating the role of a set of environmental active practices on energy saving. Whereas most of the empirical literature investigates energy saving employing the stochastic frontier model [32–34] or the DEA approach [35,36], in this paper, given the nature of the variable that captures energy saving, we use a probit regression model. Therefore, energy saving is the dependent variable, and four environmental practices are the main explanatory variables of interest. Other control variables are included in the analysis to account for other factors that are likely to affect firms' energy saving such as firms' characteristics and geographical areas. The main findings show that environmental activities and, in particular, environmental strategies impact positively on a firm's decision to save energy. Furthermore, results also highlight that the environmental positive effect on energy saving is greater for younger and smaller firms with respect to older and bigger ones.

The paper is structured as follows. Section 2 focuses on the literature review. Section 3 describes material and methods. Section 4 discusses both the results of the baseline model and those obtained from the robustness check. Finally, the last section concludes and summarizes the article.

2. Literature Review

Firms are gradually beginning to incorporate energy-saving actions into their business strategy since the financial cost of energy-saving programs may be not considered a strong barrier that could be reducing their competitiveness [37]. Specifically, firms can adopt different practices " ... to reduce pollution, minimize the use of resources, increase efficiency, and material reuse" [38] (p. 277). Some activities known as active or proactive are designed to transform processes and technologies and adopt more friendly resources to reduce the environmental impact [7]. Other activities defined as passive are conceived to modify the entire production with no structural change, and they are often required by

external factors such as the market and the institution context [3,39]. So far, the role played by environmental activities in the energy saving literature has not been extensively covered. Most of the research in the environmental field has mainly explored the determinants that affect firms to implement energy saving in industrialized countries [8–10,40–45].

Other works have investigated firms' energy saving in specific developing countries such as India [46], China [47,48], Bangladesh [49,50], Indonesia [51], and Thailand [52], or in a sample of developing countries [53,54]. Only a few studies have focused on energy saving measures adopted by firms localized in a set of Transition economies [32] or in a single Transition country [55,56]. For instance, Hochman and Timilsina [55] using a logit model investigate the energy saving in Ukrainian companies in both commercial and manufacturing sectors. In their study, the authors emphasize the need to implement a targeted economic policy in the commercial sector since this sector invests less in energy-efficient technologies due to the absence of regulation. Considering a set of Transition economies and some OECD European countries, Carvalho [32], using a stochastic frontier model, has measured the electricity consumption efficiency in both industrial sector and households during the period 1994–2007. This work shows that differences in efficient use of electricity are found in groups of countries where market economy reforms were not complete; on the contrary, convergence behavior is evident among Western economies and groups of transition countries except for Balkan and Far East countries.

A more recent analysis on Slovenian manufacturing SMEs [56] reveals the most relevant determinants that affect energy saving by comparing past and present decisions. In particular, this study points out that cost reductions related to past investments and energy savings connected to future investments are the main drivers, while financial resources are limited in companies willing to adopt energy saving measures.

Overall, despite the fact a significant amount of the literature has examined determinants that affect firms to implement energy saving, only a few papers have focused on environmental activities to reduce environmental impact [7,38] and to save energy [10]. Traditionally, these studies have been conducted for companies in industrialized countries such as Danish [57] and Swedish firms [58], and for firms localized in China [4], Japan [11], and the Republic of Korea [12]. All these works underline the key role played by the top managers to support energy saving, especially for SMEs. Yet, other works highlight that firms can introduce, into their strategies, environmental objectives to: (i) change the productive process; (ii) decrease production costs; (iii) reduce environmental impact [7,20]; and (iv) prevent pollution [6,12]. The results arising from the strategies that consider environmental aspects depend on several specific contexts. For instance, using a semi-structured interview for Spanish firms (70% are SMEs), Muñoz-Villamizar et al. [7] show that in 2016 only a few enterprises employed environmental strategic activities within their organizations, while the majority of firms mainly adopted operational activities (i.e., recycling, waste reduction, and remanufacturing). In a more recent study, Do and Nguyen [59], exploiting firms' data collected during the year 2019 in Vietnam, found that the adoption of proactive environmental strategies improves energy consumption and minimizes waste. They also show that larger firms are more engaged to implement environmental strategies than small ones. Other studies analyze voluntary energy programs, such as energy audit and long-term agreements, to explain the companies' choices to save energy [13,60]. Energy audits are considered a relevant measure for a firm to establish its energy saving potential [61] and energy consumption [62]. For instance, Gordic et al. [63] show that in a Serbian car manufacturer, energy audit adoption has reduced total energy consumption.

Energy audits are also recognized as an instrument to overcome barriers to energy efficiency in the sector of Swedish SMEs [60]. In a recent study focusing on German firms, Schubert et al. [62] show that energy audits directly affect not only the implementation of energy efficiency measures but also increase the probability to obtain financial support, which in turn increases their adoption. In addition, other studies focus on proactive measures achievable using renewable sources, investments in green products, and cleaner production processes [64,65]. In this regard, literature shows that despite the fact this use

is far from uniform across industry, sector, and countries, renewable energy is part of the driving force to save energy [66]. For example, using a semi-structured interview, the work of Alayòn et al. [67] shows that manufacturing firms in Sweden save energy and that most of them produce renewable energy from waste incineration. Notwithstanding this wide literature, the existing research is limited to analyzing the determinants of industrial energy saving or some specific management activities. Evidence of the role of active environmental activities that specifically improve energy saving in firms operating in Transition countries remains unexplored. In these countries, market liberalization improved energy intensity [68]. In addition, energy saving policy has changed in Transition economies industry since the reform packages have given an incentive for the more efficient use of energy through government policies, price signals, and improved management practices [32] (p. 559). Therefore, the aim of this study is to help bridge this gap through the examination of firms operating in a set of 28 Transition countries.

3. Materials and Methods

3.1. Data Description and Variables

To explore the impact of a firm's environmental practices on the adoption of energy saving improvement measures, we exploit firm-level data collected by the World Bank's Enterprise Surveys (hereinafter ES) with the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), and the World Bank Group (WBG). Surveys have been carried out on a sample of firms designated by following a stratified random sample approach, specifically, the stratification levels used are: (i) region, (ii) sector, and (iii) firm dimension, providing information on firms operating in private sector (the population of study consists of firms in manufacturing, construction, services, transportation, warehousing, communications, and IT, as classified by ISIC Group Revision 3.1). In particular, the surveys provide details on: (i) innovation behavior of firms; (ii) innovative activities, organizational practices, management, and employees; and (iii) other general information on firms. The last survey presents an additional section related to the environment aspects that allow us to observe the role of a set of environmental practices on energy saving measures adopted by manufacturing firms in Transition countries. It is based on data from about 15,246 firms located in 28 countries of Eastern Europe and Central Asia (Table A1, in Appendix A contains the list of countries included in our analysis) (data on other transition countries such as Turkmenistan, Cambodia, China, Laos, Vietnam, and Botswana were not available). To identify the Transition economies, we combine the FMI [28] and the World Bank [29] classifications. Our dependent variable is energy saving measures, and we construct a dummy variable equal to 1 if the firm has implemented at least one of the following measures: (i) more climate-friendly energy generation on site, (ii) energy management, (iii) improvements to lighting systems, and (iv) heating and cooling improvements. The main explanatory variables of interest are a set of environmental activities that may influence the adoption by the firms of measures for energy saving. Specifically, we consider whether the firm: (i) has a manager responsible for environmental issues; (ii) has strategic objectives that include environmental or climate change aspects; (iii) uses energy from its own renewable sources; and, finally, (iv) has performed an external audit of its energy consumption.

Several control variables are added in the analysis to account for other factors that affect firms' energy saving actions. To investigate the impact of firm's ownership on the decision to implement energy saving measures, we include two variables: a dummy variable taking a value equal to 1 if the firm has female owners, 0 otherwise, and a variable that defines the degree of ownership concentration in family hands. The age of the firm is computed as the difference between the year in which the survey was conducted and the year in which the firm started business. Other characteristics have also been considered: (i) size, a categorial variable that is equal to 1 for small firms (5–19 employees), 2 for medium firms (20–99 employees), and 3 for large firms (more than 100 employees); (ii) the geographical dimension of markets; and (iii) whether the firm belongs to a group of

firms (taking the value of 1) or it is an independent economic entity (taking 0). We also employ a sector variable; firms are aggregated according to the level of their technological intensity (high, medium, and low-tech) using the Eurostat classification based on NACE Rev. 2 at 2-digit level. Then, these transition countries are subdivided into categories to consider their geographical location and level integration in EU market [69]. From a purely geographical point of view, we group the countries into four regions: (i) European Former-USSR Countries, (ii) Former Yugoslavian Countries and Albania, (iii) Eurasian Former-USSR Countries, and (iv) Central European countries [70,71]. Finally, to classify countries by their degree of integration into the EU market, we use a categorial variable equal to 1 for companies operating in a country that does not join the EU, 2 for companies based in countries that belong to the EU, and 3 for firms located in EU candidate countries. Table 1 contains the description of variables to account for factors that could affect the adoption of energy-efficient measures from firms. Table 2 reports the descriptive statistics.

Table 1. Description of variables.

Variable	Description
Energy saving	1 if a firm, in the last three years, has adopted an energy saving measure, 0 otherwise
Environmental Manager	1 if a firm has a manager responsible for environmental and climate change issues, 0 otherwise
Renewable Sources	1 if a firm uses energy from its own renewable sources, 0 otherwise
Environmental objectives	1 if a firm has strategic objectives that mention environmental or climate change issues, 0 otherwise
Energy Consumption Audit	1 if a firm has completed an external audit of its energy consumption, 0 otherwise
Multi-implant	1 if a firm is a part of a multi-establishment, 0 otherwise
Owner	Percentage held by largest owner or owners
Firm's Age	Difference between the current year and the year the firm registers to start the business activity
Female Ownership	1 if a firm has female owners, 0 if firm ownership is exclusively male
Credit line	1 if a firm, in the fiscal year, has a line of credit or a loan from a financial institution, 0 otherwise
Firm Size	
Small Firm	1 if a firm has $\leq$ 19 employees
Medium Firm	2 if a firm has $\geq$ 20 and $\leq$ 99
Large firm	3 if a firm has $\geq$ 100
Industry Sector	
Low Tech	1 if a firm is a part of low-tech sector
Medium Tech	2 if a firm is a part of medium tech sector
High Tech	3 if a firm is a part of high-tech sector
European Union	
	1 for EU Countries
	2 for Candidate EU Countries
	3 for non-EU Countries
Country Regions	
European Former-USSR Countries	1 for European Former-USSR Countries
Central European Countries	2 for Central European Countries
Former Yugoslavian Countries and Albania	3 for Former Yugoslavian Countries and Albania
Eurasian Former-USSR Countries	4 for Eurasian Former-USSR Countries

Table 2. Descriptive statistics of variables.

Variable	Obs.	Mean	Proportion	Std. Dev.	Std. Err.
Energy saving	9338		0.69		0.005
Environmental Manager	9535		0.16		0.004
Renewable Sources	9423		0.06		0.002
Environmental objectives	9544		0.022		0.004
Energy Consumption Audit	6233		0.30		0.006
Firm's Age	9655	19.27		15.40	
Firm Size	9749				
Small			0.38		0.005
Medium			0.37		0.005
Large			0.25		0.004
Multi-implant	9749		0.09		0.003
Credit Line	9612		0.17		0.005
Owner	9481	81.7		25.15	
Female Ownership	9672		0.34		0.005
Industry Sectors	9559				
Low Tech			0.52		0.005
Medium Tech			0.44		0.005
High Tech			0.04		0.002
European Union	9751				
Eu Countries			0.42		0.005
Candidates EU Countries			0.05		0.002
Non-EU Countries			0.53		0.005
Country Regions	9751				
Central European Countries			0.35		0.005
Eurasian Former-USSR Countries			0.24		0.004
Former Yugoslavian Countries and Albania			0.11		0.003
European Former-USSR Countries			0.30		0.005

3.2. Empirical Strategy

The main purpose of this paper is to assess the impact of a set of environmental voluntary activities on energy saving. Given the nature of our dependent variable, we employ binary probit model to investigate the impact. The regression coefficients of the probit model have effects on a cumulative normal function of the probabilities that $Y = 1$ (in our case, the probability that a firm adopts energy saving improvement measures). The equation can be expressed as follows [72]:

$$\begin{aligned} P(Y = 1|x_1, \ldots, x_k) \\ = \phi(\beta_0 + \beta_1 environmental\ manager \\ + \beta_2 renewable\ sources + \beta_3 envriromental\ objectives \\ + \beta_4 energy\ consumption\ audit + \beta_5 X \end{aligned}$$

where ϕ indicates the cumulative probability distribution function of the standard normal distribution and transforms the regression into the range (0,1). Therefore, our dependent variable Y takes value 1 if the firm implements energy saving measures and 0 otherwise. The environmental manager, renewable sources, environmental objectives, and energy consumption audit constitute the set of environmental voluntary activities; they take value 1 if enterprises have adopted them and 0 otherwise. Finally, X is a vector of controls

for firms' characteristics. Finally, we compute the marginal effects of each explanatory variable on the probability that the observed dependent variable is equal to 1, which is more informative than leaving the results expressed as odds ratios or relative risks [73,74].

Then, we explore the effect of environmental practices on energy saving by considering (i) the three size classes of firms and (ii) the firm age. Therefore, we re-run the baseline model splitting our sample according to the size and the age of the firms. With reference to the size class of firms, the probability of firms to adopt energy saving measures can be expressed as follows:

$$P\left(Y_j = 1 \middle| x_{1j}, \ldots, x_{kj}\right) = \phi(\beta_{0j} + \beta_{1j} environmental\ manager + \beta_{2j} renewable\ sources + \beta_{3j} envriromental\ objectives + \beta_{4j} energy\ consumption\ audit + \beta_{5j} X$$

Y_j is equal to 1 if a firm of the group j (j = A, B, C) has implemented energy saving solutions and 0 otherwise. Note that A is for small firms, B indicates medium firms, and C stands for large firms.

While, in relation to firms' age, the equation is defined as:

$$P(Y_z = 1 | x_{1z}, \ldots, x_{kz}) = \phi(\beta_{0z} + \beta_{1z} environmental\ manager + \beta_{2z} renewable\ sources + \beta_{3z} envriromental\ objectives + \beta_{4z} energy\ consumption\ audit + \beta_{5z} X$$

Y_z is 1 if a firm of the group z (z = A, B) has introduced energy saving actions and 0 otherwise. In this case, A is for younger firms and B indicates older firms. To do this, we use the statistical software for data science STATA version 14.

4. Results and Discussion

4.1. Baseline Results

This section illustrates the results of the basic specification. Table 3 collects the empirical results. Table A2 in Appendix A displays the marginal effects. Specifically, Column 1 presents the findings referring to a simple model when all countries in our sample are included. Column 2 presents the results obtained using information on the location of firms in EU member states, EU candidate states, or non-EU countries. Column 3 shows the results of the model that include the classification of the countries in five macro regions.

Table 3. Estimation results: energy saving and firm environmental activities.

VARIABLES	(1)	(2)	(3)
Environmental Manager	0.103	0.107 *	0.116 *
	[0.065]	[0.061]	[0.062]
Renewable Sources	0.247 **	0.293 ***	0.324 ***
	[0.099]	[0.096]	[0.095]
Environmental objectives	0.439 ***	0.435 ***	0.459 ***
	[0.059]	[0.055]	[0.055]
Energy Consumption Audit	0.371 ***	0.293 ***	0.271 ***
	[0.051]	[0.047]	[0.047]
Firm's Age	0.003 **	0.003 *	0.003 **
	[0.001]	[0.001]	[0.001]
Ref. Cat Small Firms			
Medium Firms	0.177 ***	0.158 ***	0.157 ***
	[0.046]	[0.045]	[0.045]
Large Firms	0.359 ***	0.275 ***	0.275 ***

Table 3. ′Cont.

VARIABLES	(1)	(2)	(3)
	[0.058]	[0.055]	[0.055]
Multi-implant	0.058	0.116	0.121*
	[0.074]	[0.071]	[0.071]
Credit Line	0.079 *	0.05	0.077*
	[0.043]	[0.041]	[0.041]
Owner	−0.002 **	−0.002 ***	−0.002 ***
	[0.001]	[0.001]	[0.001]
Female Ownership	−0.002	−0.043	−0.029
	[0.044]	[0.042]	[0.043]
Ref. Cat. Low Tech			
Medium Tech	−0.001	−0.019	−0.003
	[0.043]	[0.040]	[0.040]
High Tech	0.286 **	0.232 **	0.252 **
	[0.122]	[0.116]	[0.116]
Country Dummies	YES		
Ref. Cat. EU Countries			
Candidates EU Countries		−0.014	
		[0.090]	
Non-EU Countries		0.071	
		[0.043]	
Ref. Cat. Central European Countries			
Eurasian Former- USSR Countries			0.297 ***
			[0.057]
Former Yugoslavian Countries and Albania			0.131 *
			[0.067]
European Former-USSR Countries			0.160 ***
			[0.050]
Constant	0.584 ***	0.558 ***	0.429 ***
	[0.190]	[0.095]	[0.097]
Observations	5688	5688	5688

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The main results confirm the relevance for businesses to adopt environmental measures to save energy. Specifically, our findings show that three of these activities, namely, the renewable sources use, the strategic environmental objectives, and the adoption of an external audit, are always statistically significant for the three specifications even though they differ in magnitude; in fact, the relationship seems to be stronger for the second activity. The positive relationship between the environmental strategies and the energy saving is in line with the results found by Thollander and Dotzauer [13] and Do and Nguyen [59], although in the first paper only one activity is examined, while in the second one it seems not to be a standard combination of the main environmental activities. Furthermore, and differently from previous studies [4,12,58] that reveal a crucial role of top management in supporting energy-saving decisions in firms localized in developing and industrialized countries, our findings show that the role of the environmental manager is not relevant when we consider the fixed effect. This result probably depends on the different geographic context covered by our analysis. The environmental manager variable begins to be significant with the other two specifications at the minimum conventional level of 10%.

Moving on to the industry sectors in which firms produce, we find that firms with high tech activities are more energy saving with respect to low technological activities. This is because high-tech firms use energy-efficient technologies [75], and in accordance with the industry 4.0 paradigm, a high degree of environmental measurement occurs through technological implementation [7].

Regarding the size of firms, the large and medium ones have better energy saving activities than the small ones. This finding is in accordance with the empirical research reporting that firm size is significantly associated with energy saving since larger organizations are more proactive [12,59]. Larger firms have more financial resources to invest in environmental measures [76]. On the contrary, it seems that for the smaller ones it is less profitable to invest in the environment [77] due to capital constraints [78]. In this regard, existing literature [77] at the same time suggests that these conclusions may be hasty given that smaller firms may be more responsive due to stakeholder pressure.

Although having financial resources is necessary to spend money on environment and energy saving [12], our results show that the firms located in Transition countries have limited credit line or loans from a financial institution. In fact, their relationship with energy saving is positive but weakly significant. It is inexistent when we focus on the division among the firms localized in EU member states, EU candidate states, or non-EU countries. Turning to the owner variable, which shows the interaction between ownership and control, it is negatively correlated with the decision to implement energy saving compared to firms where the degree of ownership concentration is not in the hands of one or more owners. It follows that more concentrated ownership goes hand in hand with poorer environmental practices [79]. In other words, when the concentration degree is high, entrepreneurs do not have a proper understanding of the environmental protection because they do not have a strong sense of environmental responsibility. Looking at the firm's characteristics, the firm's age is positively correlated with energy saving. In this regard, considering the firm's age as a proxy for firm's experience accumulated over time [80], the plausible explanation is that the older the firms the more experience they have. In turn, this experience is used to create new ideas mainly used to innovate the production process and to be more efficient [81].

Considering the firms localized in the different macro areas and taking the Central European countries as a reference, we can remark that firms in Eurasian Former-USSR Countries, Yugoslavian Countries and Albania, and in European Former-USSR Countries exhibit a significant and positive relation with the adoption of energy saving. This result, in contrast to our expectations, could be because firms operating in these areas implement more voluntary and pro-environmental activities and have a higher awareness of energy saving with respect to the firms in Central European countries, where directives and targets are more stringent. In fact, in transition areas the application of environmental strategies is not influenced by EU standards but rather by a form of self-regulation [26].

4.2. Robustness Check

Hereafter, one can find the robustness check results. Table 4 reports the findings for small, medium, and large firms. The main results are confirmed when we perform this further estimation to examine and highlight the firms' dimension heterogeneity. Differences are found in the value of the estimated coefficient for each environmental activity and firms' size. In fact, the likelihood to implement energy saving is greater in large firms when we consider that the presence of the environmental manager and the concentration degree is low since entrepreneurs have a strong sense of environmental responsibility by relying on managers. The effect of both environmental strategies and the adoption of an external audit is relevant for all the firms regardless of their size, although the magnitude is higher for small ones, while the use of renewable sources to save energy is significant only for SMEs.

As regard to the last result, small and medium firms are more dynamic and prone to implement environmental activity to save energy with respect to large ones. This probably depends on the fact that the medium and large firms have a low level of entrepreneurship concentration that is negatively related to the decision to implement energy saving. On the contrary, small firms are more dynamic with respect to medium and large ones. Interestingly, our findings show that the multi-implant variable is associated positively with small firms' energy saving. This probably means that small firms are small group affiliations, and they comply with the proactive environmental defined by the group. In addition, small firms are the most efficient since they are specialized in high technology and they are the

youngest ones too. Finally, as obtained in the main estimation, results show that firms located in Eurasian Former-USSR Countries are more proactive than those located in EU countries, regardless of their size. Conversely, in European Former-USSR Countries, larger firms are more active probably because they have changed their energy policy [32].

Table 4. Regression results for firms' size.

	Firm Size								
	Small			Medium			Large		
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Environmental Manager	0.014	0.016	0.041	−0.016	−0.031	−0.027	0.324 ***	0.320 ***	0.325 ***
	[0.166]	[0.156]	[0.157]	[0.100]	[0.095]	[0.095]	[0.104]	[0.094]	[0.095]
Renewable Sources	0.422 **	0.502 ***	0.526 ***	0.255 *	0.279 *	0.301 **	0.125	0.184	0.226
	[0.198]	[0.190]	[0.191]	[0.149]	[0.147]	[0.146]	[0.176]	[0.165]	[0.163]
Environmental objectives	0.675 ***	0.656 ***	0.682 ***	0.466 ***	0.462 ***	0.482 ***	0.244 **	0.265 ***	0.300 ***
	[0.122]	[0.115]	[0.115]	[0.094]	[0.088]	[0.089]	[0.103]	[0.094]	[0.095]
Energy Consumption Audit	0.402 ***	0.262 ***	0.231 ***	0.353 ***	0.277 ***	0.263 ***	0.370 ***	0.329 ***	0.317 ***
	[0.091]	[0.084]	[0.084]	[0.082]	[0.075]	[0.074]	[0.094]	[0.087]	[0.088]
Firm's Age	0.008 **	0.008 **	0.011 ***	0.001	0.001	0.001	0.003	0.003	0.003
	[0.004]	[0.003]	[0.004]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Multi-implant	0.352 **	0.448 ***	0.452 ***	−0.076	−0.033	−0.023	0.056	0.106	0.104
	[0.179]	[0.169]	[0.170]	[0.116]	[0.111]	[0.112]	[0.119]	[0.111]	[0.112]
Credit Line	0.145*	0.096	0.127*	0.109	0.083	0.104	−0.063	−0.093	−0.056
	[0.075]	[0.070]	[0.071]	[0.068]	[0.065]	[0.065]	[0.085]	[0.080]	[0.081]
Owner	0.002	0.001	0	−0.003 **	−0.003 **	−0.003 **	−0.004 **	−0.005 ***	−0.004 ***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]	[0.002]
Female Ownership	0.032	−0.044	−0.029	0.011	−0.015	−0.006	−0.016	−0.076	−0.071
	[0.073]	[0.069]	[0.069]	[0.070]	[0.068]	[0.068]	[0.097]	[0.090]	[0.090]
Ref. Cat. Low Tech									
Medium Tech	0.049	0.032	0.03	−0.02	−0.044	−0.025	−0.081	−0.064	−0.015
	[0.069]	[0.065]	[0.065]	[0.070]	[0.065]	[0.066]	[0.097]	[0.086]	[0.086]
High Tech	0.721 ***	0.626 ***	0.644 ***	0.123	0.067	0.078	0.113	0.14	0.195
	[0.246]	[0.235]	[0.234]	[0.184]	[0.174]	[0.174]	[0.216]	[0.206]	[0.207]
Country Dummies	YES			YES			YES		
Ref. Cat. EU Countries									
Candidates EU Countries		0.155			−0.004			−0.19	
		[0.165]			[0.152]			[0.152]	
Non-EU Countries		0.11			0.09			0.006	
		[0.074]			[0.071]			[0.087]	
Ref. Cat. Central European Countries									
Eurasian Former- USSR Countries			0.358 ***			0.248 ***			0.339 **
			[0.093]			[0.094]			[0.132]
Former Yugoslavian Countries and Albania			0.166			0.102			0.116
			[0.118]			[0.110]			[0.127]
European Former-USSR Countries			0.124			0.185 **			0.193 **
			[0.086]			[0.082]			[0.098]
Constant	0.948*	0.093	−0.013	1.318 ***	0.843 ***	0.733 ***	0.817 ***	1.165 ***	0.932 ***
	[0.533]	[0.162]	[0.167]	[0.390]	[0.149]	[0.152]	[0.251]	[0.183]	[0.184]
Observations	1885	1896	1896	2141	2158	2158	1565	1634	1634

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

In Table 5, we report the findings distinguished for young and old firms. In general, results of the baseline estimate are also confirmed. The four environmental activities are consistent with firms' energy saving. Specifically, environmental strategies and energy audit practices appear to have a positive impact regardless of the firm's age. This result probably depends on the fact that the high cost of renewable sources is the most important barrier of investment decisions for energy saving practice. Young firms may have difficulty accessing credit lines or may have few financial resources to use for the adoption of environmental activities. Additionally, they are too young to have an environmental manager, therefore they prefer to implement environmental strategies and save energy with the use of auditing. In this regard, Suk et al. [12] show that financial incentives can be essential to invest in corporate energy saving and efficiency.

Table 5. Regression results for firms' age.

	Young Firms	Old Firms	Young Firms	Old Firms	Young Firms	Old Firms
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Environmental Manager	0.055	0.115 *	0.056	0.121 *	0.068	0.128 *
	[0.176]	[0.070]	[0.158]	[0.066]	[0.159]	[0.066]
Renewable Sources	0.356	0.244 **	0.156	0.313 ***	0.182	0.345 ***
	[0.255]	[0.107]	[0.245]	[0.104]	[0.244]	[0.104]
Environmental objectives	0.411 ***	0.444 ***	0.399 ***	0.450 ***	0.438 ***	0.473 ***
	[0.139]	[0.064]	[0.127]	[0.061]	[0.127]	[0.061]
Energy Consumption Audit	0.456 ***	0.334 ***	0.312 ***	0.283 ***	0.277 ***	0.261 ***
	[0.111]	[0.057]	[0.099]	[0.053]	[0.100]	[0.053]
Ref. Cat Small Firms						
Medium Firms	0.256 ***	0.156 ***	0.241 ***	0.136 ***	0.265 ***	0.124 **
	[0.094]	[0.054]	[0.088]	[0.052]	[0.089]	[0.052]
Large Firms	0.407 ***	0.361 ***	0.392 ***	0.274 ***	0.420 ***	0.262 ***
	[0.139]	[0.064]	[0.132]	[0.061]	[0.131]	[0.061]
Multi-implant	0.065	0.056	0.15	0.116	0.148	0.119
	[0.220]	[0.079]	[0.200]	[0.076]	[0.202]	[0.077]
Credit Line	0.089	0.083 *	0.019	0.062	0.057	0.089 *
	[0.093]	[0.048]	[0.086]	[0.046]	[0.087]	[0.046]
Owner	0.002	−0.003 ***	0.001	−0.003 ***	0.001	−0.003 ***
	[0.002]	[0.001]	[0.002]	[0.001]	[0.002]	[0.001]
Female Ownership	0.023	0.005	−0.117	−0.017	−0.085	−0.008
	[0.095]	[0.050]	[0.091]	[0.048]	[0.091]	[0.048]
Ref. Cat. Low Tech						
Medium Tech	0.007	−0.003	−0.013	−0.017	−0.021	0.007
	[0.089]	[0.049]	[0.083]	[0.046]	[0.083]	[0.046]
High Tech	0.568*	0.245*	0.384	0.219*	0.429	0.231 *
	[0.303]	[0.133]	[0.284]	[0.127]	[0.284]	[0.127]
Country Dummies	YES	YES				
Ref. Cat. EU Countries						
Candidates EU Countries			0.126	−0.028		
			[0.256]	[0.096]		
No EU Countries			0.089	0.049		
			[0.107]	[0.048]		
Ref. Cat. Central European Countries						
Eurasian Former- USSR Countries					0.327 ***	0.236 ***
					[0.126]	[0.067]
Former Yugoslavian Countries and Albania					0.304	0.127*
					[0.198]	[0.071]
European Former-USSR Countries					0.026	0.196 ***
					[0.128]	[0.055]
Constant	0.54	0.636 ***	0.287	0.688 ***	0.173	0.571 ***
	[0.438]	[0.210]	[0.203]	[0.103]	[0.210]	[0.104]
Observations	1246	4465	1256	4465	1256	4465

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$.

5. Conclusions

The purpose of this study was to investigate the effect of different environmental practices on energy saving by examining a set of firms belonging to 28 Transition countries by using firm-level data drawn from the World Bank Enterprise Surveys. We have employed a probit model to observe the different effect of each environmental activity on energy saving. We have also checked for firm-size and firm-age.

Empirical findings show that each environmental activity plays a crucial role in saving energy, in particular the activity related to the strategic environmental objectives. Results also underline differences across areas: firms in Eurasian Former-USSR Countries, Yugoslavian Countries and Albania, and European Former-USSR Countries save more energy with respect to firms in the Central European countries. The findings are also confirmed when we perform the estimations considering the three classes of firms and the firm age. In addition, these results suggest that (i) medium and small firms appear to save more energy than large ones when we consider the magnitude effects; (ii) small and young firms are more energy-efficient since they use more recent and efficient technologies. Our paper presents some limitations mainly concerning the use of a survey carried out over a short period, and we employ cross-sectional data. Future research could be conducted by only one area and one sector given the specificity of firms' characteristics. Our analysis suggests that the policy implications that are able to speed up the implementation of energy

saving measures in transition countries can be grouped into two categories. First, to support energy saving, policy makers should stimulate all those initiatives whose purpose is to increase the awareness among entrepreneurs and managers on how firms can better use energy. Second, institutions should remove financial barriers and encourage firms to invest in innovation or in more efficient technology. Investing in clean and green technologies to achieve energy savings represents an asset for increasing energy efficiency, and a cost-effective improvement. To do this, it is strategic to provide to a firm's loans, guarantees, and other forms of debt finance, particularly innovation-driven and technology procurement debt finance.

To conclude, institutions play a pivotal role in overseeing new policy instruments for energy saving and creating new energy efficiency measures, especially in countries with companies that have a higher energy consumption. Meeting energy saving targets could lead to the enhancement of the general competitiveness of firms, generating economic, social, and environmental benefits as well.

Author Contributions: Conceptualization, A.d.F.; methodology, A.B.; validation, A.B.; data curation, A.B.; writing—original draft preparation, A.d.F.; writing—review and editing, A.d.F. and T.G.; visualization, A.d.F.; supervision, T.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Informed Consent Statement: Not applicable.

Data Availability Statement: https://www.enterprisesurveys.org/en/enterprisesurveys (accessed on 10 February 2022).

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Countries across macro-regions.

European Former-USSR Countries	Former Yugoslavian Countries and Albania	Eurasian Former-USSR Countries	Central European Countries
Belarus	Albania	Azerbaijan	Bulgaria
Georgia	Croatia	Armenia	Czech Republic
Lithuania	Montenegro	Kyrgyz Republic	Romania
Estonia	North Macedonia	Tajikistan	Slovak Republic
Latvia	Bosnia and Herzegovina	Uzbekistan	Poland
Moldova	Serbia	Kazakhstan	Hungary
Ukraine	Slovenia		
Russia	Kosovo		

Table A2. Marginal effect: energy saving and firm environmental activities.

VARIABLES	dy/dx	dy/dx	dy/dx
Environmental Manager	0.025	0.028 *	0.030 *
	[0.016]	[0.017]	[0.017]
Renewable Sources	0.061 **	0.077 ***	0.085 ***
	[0.025]	[0.026]	[0.025]
Environmental objectives	0.110 ***	0.118 ***	0.124 ***
	[0.014]	[0.015]	[0.015]
Energy Consumption Audit	0.096 ***	0.083 ***	0.076 ***
	[0.013]	[0.013]	[0.013]
Firm's Age	0.001 **	0.001 *	0.001 **
	[0.000]	[0.000]	[0.000]
Ref. Cat Small Firms			
Medium Firms	0.049 ***	0.046 ***	0.046 ***
	[0.012]	[0.013]	[0.013]

Table A2. *Cont.*

VARIABLES	dy/dx	dy/dx	dy/dx
Large Firms	0.090 ***	0.075 ***	0.075 ***
	[0.014]	[0.015]	[0.015]
Multi-implant	0.013	0.029	0.031
	[0.019]	[0.019]	[0.019]
Credit Line	0.021 **	0.015	0.022 **
	[0.011]	[0.011]	[0.011]
Owner	−0.000 **	−0.001 ***	−0.001 ***
	[0.000]	[0.000]	[0.000]
Female Ownership	−0.002	−0.012	−0.008
	[0.011]	[0.011]	[0.011]
Ref. Cat. Low Tech			
Medium Tech	0	−0.005	−0.001
	[0.011]	[0.011]	[0.011]
High Tech	0.064 ***	0.055 **	0.059 **
	[0.024]	[0.026]	[0.025]
Country Dummies	YES		
Ref. Cat. EU Countries			
Candidates EU Countries		−0.005	
		[0.025]	
Non-EU Countries		0.019	
		[0.012]	
Ref. Cat. Central European Countries			
Eurasian Former- USSR Countries			0.080 ***
			[0.015]
Former Yugoslavian Countries and Albania			0.034 *
			[0.018]
European Former-USSR Countries			0.042 ***
			[0.013]
Observations	5761	5761	5761

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A3. Marginal effect: energy saving and firms' size.

	Firm Size								
	Small			Medium			Large		
VARIABLES	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx
Environmental Manager	0.009	0.012	0.02	−0.008	−0.012	−0.011	0.060 ***	0.064 ***	0.064 ***
	[0.048]	[0.050]	[0.050]	[0.026]	[0.026]	[0.026]	[0.020]	[0.019]	[0.019]
Renewable Sources	0.130 **	0.162 ***	0.168 ***	0.058	0.068 *	0.073 *	0.026	0.04	0.048
	[0.058]	[0.061]	[0.061]	[0.037]	[0.039]	[0.039]	[0.034]	[0.033]	[0.033]
Environmental objectives	0.191 ***	0.205 ***	0.211 ***	0.125 ***	0.130 ***	0.135 ***	0.046 **	0.054 ***	0.061 ***
	[0.034]	[0.036]	[0.036]	[0.024]	[0.023]	[0.024]	[0.020]	[0.019]	[0.019]
Energy Consumption Audit	0.124 ***	0.092 ***	0.083 ***	0.090 ***	0.075 ***	0.071 ***	0.074 ***	0.070 ***	0.067 ***
	[0.026]	[0.027]	[0.027]	[0.021]	[0.020]	[0.020]	[0.018]	[0.018]	[0.018]
Firm's Age	0.002 **	0.002 **	0.003 ***	0	0	0	0	0.001	0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.000]	[0.000]	[0.000]
Multi-implant	0.110 **	0.150 ***	0.150 ***	−0.02	−0.01	−0.008	0.007	0.018	0.018
	[0.052]	[0.054]	[0.054]	[0.029]	[0.030]	[0.030]	[0.022]	[0.022]	[0.022]
Credit Line	0.045 **	0.034	0.043 *	0.030 *	0.025	0.030 *	−0.014	−0.02	−0.013
	[0.022]	[0.022]	[0.022]	[0.017]	[0.017]	[0.017]	[0.016]	[0.016]	[0.016]
Owner	0.001	0	0	−0.001 **	−0.001 **	−0.001 **	−0.001 **	−0.001 ***	−0.001 ***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Female Ownership	0.005	−0.016	−0.012	0.003	−0.003	−0.001	−0.003	−0.016	−0.014
	[0.021]	[0.022]	[0.022]	[0.018]	[0.018]	[0.018]	[0.018]	[0.018]	[0.018]
Ref. Cat. Low Tech									
Medium Tech	0.015	0.011	0.01	−0.007	−0.013	−0.007	−0.016	−0.014	−0.004
	[0.020]	[0.021]	[0.021]	[0.018]	[0.018]	[0.018]	[0.019]	[0.018]	[0.018]
High Tech	0.162 ***	0.155 ***	0.159 ***	0.029	0.014	0.017	0.022	0.029	0.039
	[0.045]	[0.048]	[0.047]	[0.042]	[0.043]	[0.043]	[0.036]	[0.035]	[0.034]
Country Dummies	YES			YES			YES		
Ref. Cat. EU Countries									
Candidates EU Countries		0.052			−0.014			−0.037	
		[0.051]			[0.043]			[0.035]	
No EU Countries		0.032			0.025			0.003	
		[0.024]			[0.019]			[0.017]	
Ref. Cat. Central European Countries									
Eurasian Former-USSR Countries			0.108 ***			0.068 ***			0.072 ***
			[0.029]			[0.025]			[0.027]
Former Yugoslavian Countries and Albania			0.048			0.021			0.03
			[0.037]			[0.029]			[0.026]
European Former-USSR Countries			0.032			0.050 **			0.042 **
			[0.027]			[0.022]			[0.020]
Observations	1928	1928	1928	2186	2186	2186	1647	1647	1647

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A4. Marginal effect: energy saving and firms' age.

	Young Firms	Old Firms	Young Firms	Old Firms	Young Firms	Old Firms
VARIABLES	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx
Environmental Manager	0.018	0.027	0.017	0.030 *	0.021	0.032 *
	[0.046]	[0.017]	[0.045]	[0.017]	[0.045]	[0.017]
Renewable Sources	0.094	0.059 **	0.043	0.081 ***	0.051	0.089 ***
	[0.067]	[0.026]	[0.071]	[0.027]	[0.070]	[0.027]
Environmental objectives	0.104 ***	0.110 ***	0.115 ***	0.120 ***	0.125 ***	0.125 ***
	[0.036]	[0.016]	[0.036]	[0.016]	[0.036]	[0.016]
Energy Consumption Audit	0.118 ***	0.087 ***	0.088 ***	0.080 ***	0.077 ***	0.074 ***
	[0.028]	[0.014]	[0.028]	[0.014]	[0.028]	[0.014]
Ref. Cat Small Firms						
Medium Firms	0.070 ***	0.043 ***	0.071 ***	0.040 ***	0.077 ***	0.036 **
	[0.025]	[0.014]	[0.026]	[0.015]	[0.026]	[0.015]
Large Firms	0.104 ***	0.090 ***	0.111 ***	0.073 ***	0.116 ***	0.070 ***
	[0.033]	[0.016]	[0.034]	[0.016]	[0.033]	[0.016]
Multi-implant	0.017	0.013	0.045	0.029	0.043	0.03
	[0.058]	[0.020]	[0.058]	[0.020]	[0.058]	[0.020]
Credit Line	0.028	0.021 *	0.01	0.017	0.02	0.024 **
	[0.024]	[0.012]	[0.025]	[0.012]	[0.025]	[0.012]
Owner	0	−0.001 ***	0	−0.001 ***	0	−0.001 ***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Female Ownership	0.005	0	−0.033	−0.005	−0.024	−0.003
	[0.025]	[0.012]	[0.026]	[0.013]	[0.026]	[0.013]
Ref. Cat. Low Tech						
Medium Tech	0.001	0	−0.004	−0.004	−0.006	0.001
	[0.023]	[0.012]	[0.024]	[0.012]	[0.024]	[0.012]
High Tech	0.132 ***	0.054 **	0.104 *	0.049 *	0.114 **	0.052 *
	[0.049]	[0.027]	[0.057]	[0.028]	[0.054]	[0.028]
Country Dummies	YES	YES				
Ref. Cat. EU Countries						
Candidates EU Countries			0.018	−0.007		
			[0.072]	[0.026]		
No EU Countries			0.023	0.013		
			[0.032]	[0.013]		
Ref. Cat. Central European Countries						
Eurasian Former-USSR Countries					0.092 ***	0.063 ***
					[0.036]	[0.018]
Former Yugoslavian Countries and Albania					0.084	0.032*
					[0.055]	[0.019]
European Former-USSR Countries					0.008	0.049 ***
					[0.037]	[0.015]
Observations	1272	4522	1272	4522	1272	4522

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

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