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Does eco-innovation lead to company growth?

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Abstract

Purpose – This study presents new empirical evidence to the relatively scarce number of research papers on the correlation between eco-innovation and company growth. It sheds light on the causal relationship between these two variables.

Design/methodology/approach – Data from the Spanish Technological Innovation Panel from 2008 to 2016. Propensity Score Matching is applied to avoid self-selection problems.

Findings – The study found that engaging eco-innovation has no statistically significant impact on employment and sales growth. Therefore, the main benefits of transitioning to green innovations are in the environmental aspect.

Practical implications – The research findings provide a clear direction for policymakers. Such directions suggest the design of instruments that make the adoption of eco-innovations mandatory with the firm promise of substantial environmental benefits.

Originality/value – The paper explores an important issue for environmental policy. If being an eco-innovator is positively or at least neutrally related to growth, policymakers could create measures that encourage this type of green innovation. This would benefit the environment, and if the impact is positive, it would also have a positive social effect.

Keywords Eco-innovation, Employment, Manufacturing, Propensity score matching, Sales

Paper type Research paper

Introduction

Though daunting, the challenges of achieving sustainable growth also create a unique space for companies to introduce eco-innovations (EI). Governments are imposing increasingly stringent regulations and standards in their commitment to international standards, such as the Agenda 2030 and the Sustainable Development Goals. However, it is the companies, with their innovative spirit, that are at the forefront of developing more environmentally friendly solutions (Demirel, Iatridis, & Kesidou, 2018). Companies will only pursue sustainable innovations if they have a positive not only on the environment but also on their business performance. This impact will be measured through economic, financial, or growth indicators (Zheng & Iatridis, 2022).

The traditional view among political decision-makers and business managers postulates a compromise between environmental protection and company performance (Jové-Llopis &

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Segarra-Blasco, 2018). Implementing measures to reduce pollution and environmental damage can result in higher costs for the company. However, an alternative hypothesis suggests that ecological regulation can boost Eco-Innovation (EI), positively impacting company performance (Porter & Van der Linde, 1995). Building on this, Banerjee (2001) presents a compelling argument. He suggests that the adoption of Eco-Innovation not only reduces production costs but also enhances processes, leading to the integration of environmentally friendly practices. This, in turn, can significantly improve economic performance, offering a promising outlook for companies. It is important to consider the time horizon when assessing the impact of environmental practices on company performance. In the long run, strategies such as reducing energy/material consumption, adopting renewable energy sources, and recycling can yield substantial cost savings (Horbach & Rammer, 2020). However, in the short term, the initial implementation of these practices may lead to increased costs due to investments in equipment and organizational adjustments, which can potentially affect a company's competitiveness. Soltmann, Stucki, and Wörter (2015) found a U-shaped relationship between EI and long-term corporate performance, based on a study of 12 OECD manufacturing sectors over 30 years.

Another perspective suggests that EI-based products can provide companies with a competitive edge by being early entrants to the market and establishing a green status niche (Demirel & Kesidou, 2011). This advantage is augmented if customers are willing to pay more for environmentally friendly products, stimulating demand. Certifications and eco-labels can emphasize product attributes aligned with EI (Brécard, Boubaker, Sterenn, Perraudeau, & Salladarré, 2009), especially in environmentally conscious regions where EI enhances a company's image (Horbach & Rammer, 2019).

Extensive empirical research has been conducted on the relationship between a company's ecological innovations (EI) and economic and financial performance. However, the results have yet to be conclusive. While the debate on green and sustainable growth policies in the European Union is significant, limited research explores the role of EI in promoting company growth. A study by Jové-Llopis and Segarra-Blasco (2018) highlighted this limited research, and the results are so far remained uncertain.

Considering the above considerations, our paper attempts to provide new empirical evidence for two research questions: (1) what is the causal relation between EI and company growth? and (2) are there differences in the impact of EI on sales and employment growth patterns? More precisely, this paper aims to examine the *direct causal* relationship between EI and company growth using a dataset of Spanish manufacturing companies from 2008 to 2016. We are analyzing the sales and employment growth trends of Spanish manufacturing companies that have implemented eco-innovation (EI) compared to those that have not, using the Propensity Score Matching (PSM) technique. This is a relevant issue for environmental policy. If adopting eco-innovation has a positive or even neutral causal relation with growth, policymakers could design instruments that require the introduction of this type of green innovation since at least the environment would benefit. There would also be a positive social impact if the causal effect were positive. This paper makes significant contributions to the existing literature. Firstly, it provides new empirical evidence on the relatively understudied relationship between eco-innovation and company growth. Secondly, it establishes a robust and reliable causal link between these variables using the PSM method, a gold standard in research methodology. It is considered the most suitable approach for this purpose. This emphasis on the PSM method is sure to instill confidence in our esteemed audience. Thirdly, it focuses specifically on Spanish manufacturing companies, offering valuable insights into the country's unique context. Despite having a weak innovation system (Cornell University *et al.*, 2020) and less stringent environmental regulations than other European countries (European Environment Agency, 2019), Spain ranks eighth among the top eco-leading nations according to the European Eco-innovation Index for 2021.

Literature review

Some theoretical insights

The study of eco-innovation has been approached through two main lines of research. The first line aims to investigate the determinants of eco-innovation in various contexts and perspectives. No single body of literature has succeeded in providing a comprehensive framework for the study of these determinants. However, several complementary theoretical approaches, such as environmental economics, the innovation systems and evolutionary economics approach, the resource-based view, and the natural resource-based view have been used to understand these determinants (del Rio, Peñasco, & Romero-Jordán, 2015). For a review, please see Bitencourt, Santini, Zanandrea, Froehlich, and Ladira (2020), Hu, Xu, Yang, and Ni (2023) The second line of research focuses on examining the effects of eco-innovation on firm performance (economic, financial and growth). Although yielding inconclusive findings, extensive empirical research has been conducted on the relationship between EI and company economic/financial performance. However, the number of studies investigating the impact of EI on company growth is relatively limited, and the results obtained thus far are mixed. Please see Zheng and Iadritis (2022), Hizarci-Payne, Ipek, and Gumus (2020) for a review. An eco-innovation refers to an innovation aimed at reducing the use of natural resources and the emission of harmful substances (Lasisi, Alola, Muoneko, & Eluwole, 2022). Hence, it implies a positive impact on the environment. While innovation's contribution to growth is widely recognized (Coad, 2009), and is thought to result in superior growth as innovators are rewarded by the market (Demire & Mazzucato, 2013), the effect of e-strategies is not straightforward. Traditionally, it was believed that environmental initiatives incurred additional costs for firms, reducing their performance (Jové-Llopis & Segarra, 2018). It has been suggested that investing in eco-innovation could help to balance costs and improve firm performance over time (Porter & Van der Linde, 1995). In addition, companies can gain a competitive advantage by being the first to offer eco-innovation-based products in the market (Demirel & Kesidou, 2011). Furthermore, if customers are willing to pay a premium for eco-friendly products, the demand for such products may increase (Horbach & Rammer, 2019).

Closely related strands of research to EI are the Environmental, Social and Governance (ESG) and Corporate, Social Responsibility (CSR) practices. The inclusion of EI in the company strategy may promote corporate competitiveness (Chen, Zeng, Lin, & Ma, 2015), creating long-term value for shareholders (Ilyas & Osiyevskyy, 2021) while maintaining environmental benefits (Zhang, Rong, & Ji, 2019). Social pressures drive companies to recognize eco-innovation as a tool for improving ESG and SCR performance (Carrasco & Buendía-Martínez, 2016). Halbritter and Dorfleitner noted in 2015 that the impact of ESG/SCR on company performance is inconclusive. Gillan, Koch, and Starks (2021) examined various characteristics that could influence the relationship between ESG/SCR and company performance (firm value). These characteristics include a countrýs economic development, legal system and culture, company ownership and company risk.

This research focuses on the relationship between eco-innovation (EI) and business growth. Past studies on this topic have typically used proxies for firm growth, such as employment and sales growth (Cainelli, Mazzanti, & Zoboli, 2011; Leoncini, Marzucchi, Montresor, Rentocchini, & Rizzo, 2017). Although there are theoretical arguments supporting the positive impact of EI on sales growth, the relationship with employment is less clear. This uncertainty exists because the effects on employment can vary depending on the type of EI activity. In the following pages, we will delve deeper into these issues.

Eco-innovation and company sales growth

Several researchers have delved into the link between eco-innovation and sales growth, with the aim of evaluating how different forms of eco-innovation can affect sales growth. They specifically distinguish between product and process EI. Product innovation, particularly vital in dynamic markets, plays a key role in the firm's success and survival (Eisenhardt & Tabrizi, 1995). This type of eco-innovation introduces new or improved products reducing environmental impact (Cheng & Shiu, 2012). Chiou, Chan, Lettice, and Chung (2011) posited that growth is likely when companies offer desired products/services. Product eco-innovation, a source of competitive advantage, involves the adaptation of manufacturing processes to minimize environmental harm. This approach focuses on efficiency gains, cost reduction, waste reduction, and environmental impact (Rennings, 2000) with an uncertain impact on sales growth.

The impact of eco innovation (EI) on sales growth remains uncertain from an empirical standpoint. The early work of Cainelli *et al.* (2011) studied Italian companies and discovered a negative link between environmental innovations and short-term sales growth. They suggested that this negative impact could be outweighed by long-term benefits, such as increased value-added, or that it might depend on the observed time period. Jové-Llopis and Segarra-Blasco (2018) studied the impact of eco-efficiency measures on sales growth in a large sample of European businesses. They found that not all eco-strategies are positively related to better performance, at least not in the short term. In their study, Demirel and Danisman (2019) discovered that only eco-design has a positive impact on sales growth. In contrast, other forms of eco-innovations, such as energy reduction, do not affect growth. Moreover, they found that small and medium-sized enterprises (SMEs) must invest more than 10% of their sales in eco-innovations to benefit from these environmental innovations. Colombelli, Krafft, and Quatraro (2021) investigate the impact of EI on company growth processes, focusing primarily on companies with above-average growth rates. They show that EI-oriented companies are characterized by higher sales growth rates than those that only engage in generic innovations. Horbach and Rammer (2020) also show that EI positively affects sales growth.

Eco-innovation and company employment growth

Many researchers have studied the link between eco-innovation and employment growth. They have focused on how various forms of eco-innovation can impact job growth. The researchers have distinguished particularly between two main categories: product and process eco-innovation. Process-related eco-innovation could lead to reduced labor needs through increased productivity (Horbach & Rammer, 2019. Adapting processes to achieve eco-innovation (EI) goals often involves reworking the production process, which could mean replacing labor with capital. In the process, activities related to eco-innovation (EI) may lead to an increased demand for labor if they require more investment or specialized employees. Positive effects on employment may occur if productivity gains improve price competitiveness and product demand (Horbach & Rammer, 2019).

The impact of product-related EI on employment growth is not clearly understood (Harrison, Jaumandreu, Mairesse, & Peters, 2014). The introduction of new EI-related products may create new demand for the company, leading to an increase in labor demand to meet the supply of the new product. However, an overall increase in employment would only happen if the new product does not replace an older one that had required more labor (Horbach & Rammer, 2019).

There is no definitive agreement on the impact of eco-innovation (EI) on employment growth from an empirical standpoint. Early studies found positive effects of EI, although these effects tend to differ according to the type of EI. Pfeiffer and Rennings (2001) indicate that cleaner production is more likely to boost employment than end-of-pipe technology. This finding is also supported by Rennings, Ziegler, and Zwick (2004) and Horbach and Rennings (2013).

The impact on employment can vary depending on the objectives of the innovations. Innovations driven by cost-cutting goals generally lead to reduced employment. On the other hand, if the goals are focused on increasing market share, the impact can be positive or negative based on the success of the company's strategy (Horbach, 2010). Licht and Peters (2013, 2014), analyzed data from the Community Innovation Survey (CIS) for various European countries in 2008 and found that both environmental and non-environmental product innovations led to employment growth, but non-environmental product innovations are more likely to boost employment. However, Cainelli *et al.* (2011), using a sample of service Italian firms, discovered a negative association between environmental improvements and job creation in the short run.

Very recent studies have also revealed a positive relationship between EI and employment growth. Using data for Spain from 2007 to 2011, Kunapatarawong and Martínez-Ros (2016) found a positive association, particularly for companies in the "dirty" industries. This finding is in line with Hojnik and Ruzzier (2016), who used data from 223 Slovenian companies. Gagliardi, Marin, and Miriello (2016) and Leoncini *et al.* (2017) examined Italian firms and revealed evidence of a positive impact of this specific group of technologies on employment growth.

The insights from this literature review lead us to our research questions: (1) what is the causal link between eco-innovation and business growth in Spain? and (2) are there differences in the impact of EI on sales and employment growth patterns?

Data and methods

Data

The data used come from the Spanish Technological Innovation Panel (PITEC) which was collected by the Spanish Statistical Office (INE) from 2008 to 2016. This yearly survey summarizes the responses of Spanish companies in the Community Innovation Survey (CIS). This dataset consists of an unbalanced panel of Spanish manufacturing and service companies, providing sampling information for companies with fewer than two hundred employees and exhaustive data for companies with two hundred or more employees. A subsample comprising manufacturing companies with more than ten employees from 2008 to 2016 has been selected.

The authors created a balanced panel, a significant part our empirical analysis. This panel, consisting of 17,748 company-year observations from 1,972 companies [1], is the backbone of our research. The key to our findings is the EI variable, derived from self-reported data on the objectives of the company's innovations in the past two years. The variable construction is based on the following question: "The innovative activity in your company may have been aimed at different objectives. Please, indicate the degree of importance of the following objectives: (1) Reduced materials per unit produced; (2) Less energy per unit produced; (3) Reduced environmental impact". The degree of importance for each objective is marked using a 4-point Likert scale: "Null", "Reduced", "Intermediate" and "High". This proxy has also been used in other research papers (Kunapatarawong & Martinez Ross, 2016; Jove-Llopis & Segarra, 2018). The dummy variable we construct is of utmost importance. It takes a value of 1 if the company' innovation objective is high or medium for reducing environmental impact, material consumption, or energy consumption per unit produced, and 0 if not. This variable is a key indicator of the company's focus on sustainable innovation.

There are four types of companies based on their approach to eco-innovation. The first type is persistent non-eco-innovating companies, which have not yet engaged in any activities related to eco-innovation at any time. The second type is persistent eco-innovating companies, which have consistently conducted EI actions every year. The third type is eco-transitioning companies, which have transitioned from not engaging in EI activities to performing them on an ongoing basis during the study period. These companies are defined as those that, having not performed EI activities during the two previous years, maintain their EI engagement for at least three consecutive years after initiating EI. This category includes those companies that reported that they were not engaged in EI in the years prior to 2010, but that started the transition to EI in a given year during the period 2010–2014 and continued to do so until 2016. Finally, intermittent-eco-innovating firms engage in some form of eco-innovative (EI) activity but fail to do so within two years or any other specific period. Our focus, however, is on comparing: (1) persistent non-eco-innovating companies and (2) eco-transitioning companies. They represent 12.4% and 5.8% of total number companies, respectively [2].

Methods

To address the issue of selection bias, we use the Propensity Score Matching (PSM) method to analyze how transitioning to EI affects company growth. PSM involves creating a control group of companies that have never pursued EI, which serves as a comparison group. The goal of matching is to compare the companies that have pursued EI with similar companies that have yet to do it based on observable characteristics. First, we use a logit model, to estimate the probability (propensity score-PS) of transitioning to EI based on observable traits in both the control and treated groups before 2010. Second, we use matching techniques to pair each eco-transitioning company with control group companies from before 2010, when all companies were not focusing on eco-innovation. These control companies are similar to the treated companies in terms of observable characteristics. Any differences observed between the two groups after treatment can be attributed solely to the treatment. After the matching process, we can calculate the Average Treatment effect on the Treated (ATT) as the average difference between the outcomes of the treated and the matched counterfactual group.

There are a few different methods for implementing PSM. Two of the most used algorithms are "Nearest Neighbour" and "Kernel," both of which involve replacement. In the Nearest Neighbor method, each eco-transitioning company is matched with a non-eco-innovator that has the closest PS, and the same control unit can be used more than once. This method uses only a small number of observations from the comparison group to create the counterfactual outcome for a treated unit. Kernel matching is used as an alternative method to verify the reliability of the matching results. This non-parametric technique compares each treated unit to a weighted average of all control companies. The weights are inversely proportionate to the distance between the treated and control units' PS. This algorithm has a lower variance because more information is utilized. One limitation of this technique is that some observations could be better matched (Caliendo & Kopeinig, 2008).

Two key assumptions must be present if one needs to ensure that the PSM approach provides reliable estimates of the causal impact of EI on company growth: unconfoundedness (or conditional independence) and overlap (or common support condition). Unconfoundedness assumes that differences in outcome between the two groups of companies are solely due to the treatment. This assumption is strengthened by controlling as many observable variables as possible. The overlap assumption requires that poor matches be removed from the control group, ensuring that all attributes observed in eco-transitioning companies also exist in the control group.

Results

Propensity scores

In Table 1 the results of the logit regression are presented. These results provide us with the predicted probabilities of companies transitioning to an eco-innovative status. The findings

Dependent variable: Transitioning to eco-innovation from 2010 to 2014 Explanatory variables	
Company size (in log)	−0.326***
	(0.109)
Share of externally contracted R&D	−1.091
	(3.027)
Share of in-house R&D	0.420
	(0.971)
Group of companies	0.391
	(0.282)
Geographical market	
National	0.227
	(1.135)
Exportation	−0.617
	(1.027)
Industry technology-level dummies	Yes
Constant	1.355
	(1.105)
Number of companies	358
Prediction	68.99%
Pseudo R^2	0.1748

Note(s): *** Significance at the 1%; ** Significance at the 5%; * Significance at the 10%. Standard errors in brackets

The variables used in the study include the total number of employees (in logs), the share of externally contracted R&D expenditure over turnover, the share of in-house R&D expenditure over turnover, the geographical market of sales destination (national market or exportation market, with the latter as the reference category), whether a company belongs to a group of companies, and the technology level to which a company belongs (high-tech, middle-high tech, middle-low tech, and low-tech, with the latter as the reference category). All explanatory variables refer to the period of 2008–2009, as none of the companies were eco-innovative at that time

Source(s): Table by author

Table 1.
Probit results

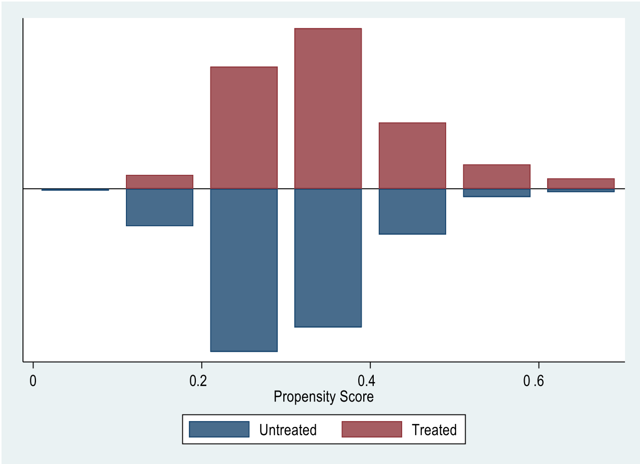
indicate that larger companies are less inclined to adopt eco-innovations. Furthermore, the variables related to the market and R&D are not statistically significant.

Figure 1 displays the PS distribution and the overlapping region between treated and untreated groups. The widespread support requirement is met since the treatment group's support overlaps the control group's support. Within the widespread support area, the sample contains 112 eco-transitioning companies and 244 persistent non-eco-innovators.

The PSM balancing test (available upon request) demonstrates that the samples of eco-transitioning companies and persistent non-eco-innovators are not statistically different in terms of the observable characteristics included in the estimation after matching. Matching reduces the mean bias between the two groups. Companies that have performed EI are smaller, spend more on R&D, sell more in national markets, and are less likely to be part of a group of companies.

Impact of eco-transitioning on company performance

After matching eco-transitioning and persistent non-eco-innovating companies, the ATT is estimated by comparing the outcomes of the treated and untreated companies in the matched sample. To be clear, the treatment effect is calculated as the difference between the mean outcome of the treated and the mean outcome of the untreated companies in the matched



Source(s): Figure by author

Figure 1. Distributions of the propensity score between treated and untreated companies

sample after the eco-transition. Table 2 shows the ATT estimates for sales (panel A) and employment (panel B) growth, using different matching algorithms for 1 (t+1) and 2 (t+2) years post-transition to EI. The estimated ATT is consistent in both algorithms. A significance level of 0.05 (5% alpha error) is necessary for all statistical analyses.

Sample	Methodology	Treated	Controls	Difference	SE	Bootstrapped *t*-value
Panel A: PSM results for sales						
Treatment	Eco-transitioning in any year during 2010–2014					
Outcome	Sales growth after 1 year of eco-transitioning (t+1)					
ATT	Nearest neighbor	0.003	0.033	−0.030	0.022	−1.46 (0.144)
	Kernel	0.003	0.036	−0.033	0.022	−1.33 (0.183)
Outcome	Sales growth after 2 years of eco-transitioning (t+2)					
ATT	Nearest neighbor	0.052	0.018	0.033	0.026	1.09 (0.275)
	Kernel	0.052	0.022	0.030	0.025	1.15 (0.250)
Panel B: PSM results for employment						
Treatment	Eco-transitioning in any year during 2010–2014					
Outcome	Employment growth after 1 year of eco-transitioning (t+1)					
ATT	Nearest neighbor	−0.013	0.016	−0.028	0.017	−1.40 (0.116)
	Kernel	−0.012	0.010	−0.023	0.016	−1.60 (0.109)
Outcome	Employment growth after 2 years of eco-transitioning (t+2)					
ATT	Nearest neighbor	−0.010	0.021	−0.031	0.016	−1.82 (0.069)
	Kernel	−0.010	0.017	−0.027	0.015	−1.61 (0.107)

Note(s): In kernel matching, epanechnikov kernel type is used with bandwidth of 0.06. Standard error in parenthesis. Bootstrapped standard errors with 50 replications. ***Significant at 1%; **Significant at 5%. *p*-values in brackets

Note: The outcome variables are the growth in employment and turnover in the manufacturing sector since the companies decided to engage in EI. The log difference of the number of employees (turnover) is used to approximate employment (turnover) growth. These outcomes are measured at two different points in time: between t0 and t + 1, and between t0 and t + 2, where t0 is the year of the eco-transitioning; t +1 is the year after the eco-transitioning, and t +2 refers to two years after the eco-transitioning

Source(s): Table by author

Table 2. Average treatment effect on the treated

The results regarding sales show that the causal effect is negative, though non-statistically significant in the first year. In contrast, it is positive and not statistically significant in the second year after the eco-transitioning. This may suggest that, in the longer term, engagement in EI could have a positive effect on sales.

These findings contrast with the positive results (Jové-Llopis & Segarra, 2018; Colombelli *et al.*, 2021; Horbach & Rammer, 2020) as well as the negative ones (Cainelli *et al.*, 2011) reported by other authors. However, they align, to some extent, with Demirel and Danisman (2019), who find no evidence of an impact of eco-innovation (except for eco-design) on sales growth. The lack of statistical significance in our results may be due to the fact that the investment made by Spanish companies did not reach a level high enough to generate significant sales growth. According to INE, the investment in environmental protection by Spanish manufacturing companies in 2016 represented only 0.084% of sales turnover, which fell below the threshold considered significant by the authors for a positive impact on sales growth. Furthermore, several companies still need to benefit from the positive effects of EI due to the short-term cost implications of introducing technical or organizational changes. Moreover, the lack of significance may be related to the highly productive structure of Spanish manufacturing. The complexity of eco-innovation may vary according to the sector (Frondel, Horbach, Rennings, & Requate, 2005), and this complexity is likely to be related to the ability of the firm to pass any increased costs on to the consumer (Doran & Ryan, 2012).

It is important to note that our findings while indicating a negative causal effect on employment are statistically non-significant at a 5% level at both time points. This means that the impact on employment is not statistically significant. Specifically, eco-transitioning companies show an average negative employment growth of 1.2–1.3% in the year after adopting EI and around 1.0% in the following two years. In contrast, control firms exhibit, on average, positive growth of 1.0–1.6% and 1.7–2.1% before and after t0. This indicates that eco-transition companies experienced a more significant decrease in employment than they would have experienced if they had remained non-eco-innovators. However, it is important to note that this difference is not statistically significant.

These results contrast with the positive findings reported in other studies (Kunapatarawong & Martínez-Ros, 2016; Hojnik & Ruzzier, 2016). This divergence could be explained by the presence of multiple effects within the Spanish manufacturing sector. The adoption of measures aimed at reducing energy/material consumption may boost productivity and create a favorable climate for job growth. However, EI might induce structural changes in specific sectors (related to reduced consumables) that adversely affect employment in companies within those sectors.

For both sales and employment growth, external factors, such as market conditions, economic fluctuations, or industry-specific dynamics could influence the relationship between EI and sales or employment growth as suggested by Gillan *et al.* (2021). These factors might also overshadow the impact of eco-innovation in the observed results.

Sensibility analysis

I conducted a sensibility analysis using the same methodology as the overall analysis. I divided the sample into two segments based on the technological intensity of the sectors to which the companies belong. I have distinguished between companies within high and medium-high technology sectors and companies within medium-low and low technology sectors. This approach aims to explore the possibility that the impact of eco-innovation on long-term sales growth may be higher in companies within higher technology sectors than in lower technology ones. The close proximity of companies in the first group to the forefront of knowledge, along with their increased technology opportunities, allows them to create more advanced eco-innovations. This results in higher interest among consumers and clients, as well as increased market demand. The chemical industry was excluded from the sensibility analysis due to its unique characteristics, which could significantly influence the results. The chemical industry often involves production processes that result in significant chemical emissions and waste. According to data from the Spanish Statistical Institute (INE) in 2021, this industry was responsible for 17.2% and 34.1% of the total carbon dioxide and methane emissions, respectively, emitted by the manufacturing industry. It is reasonable to think that producing more sustainable chemical products could entail higher costs. If the company decides to pass on some of these costs to product prices this could affect sales.

The analysis results show that the impact of eco-innovation on sales at t+2 for high and medium-high technology companies is positive and statistically significant at the 5% level. The nearest neighbor analysis yielded a bootstrapped *t*-value of 2.11 and a *p*-value 0.035, while the kernel analysis showed a bootstrapped *t*-value 1.97 and a *p*-value of 0.048. On the other hand, for medium-low and low technology companies, the effect is positive but not statistically significant. The nearest neighbor analysis resulted in a bootstrapped *t*-value 0.40 and a *p*-value of 0.688, and the kernel analysis showed a bootstrapped *t*-value of 50 and a *p*-value of 0.616. The remaining coefficients, including those about employment growth, are not statistically significant, although they remain negative. This outcome aligns, to a certain degree, with the research conducted by Cainelli *et al.* (2011). Even though they discovered a negative correlation between environmental innovations and short-term sales growth, they argued that this finding might indicate a short-term sales growth impact that is balanced out over the long term [3].

Based on our overall findings, the results of the first research question, which examines the causal relationship between EI and company growth, still need to be more conclusive. The data from the first post-eco-transition year shows a non-significant negative impact on sales, followed by a non-significant positive effect in the second year. This suggests a potential long-term positive causal effect, particularly in high and medium-high technology industries, as highlighted in the sensibility analysis. Regarding employment, a non-statistically significant negative causal effect is observed at both time points. The results unveil distinctive trends for the second research question (are there differences in EI impact on sales and employment growth patterns?). The sales in high and medium-high technology industries have a positive long-term effect, while employment experiences a non-statistically significant decline. Although the findings are inconclusive, they suggest that the impact of eco-innovation on sales is more substantial than its effect on employment, especially over the long term.

Conclusion

In this paper, the Spanish section of the CIS is used to examine the causal relationship between EI and company growth in Spanish manufacturing companies from 2008 to 2016 by applying the PSM framework.

The findings of the study have important implications for environmental policymakers. The overall results show that the decision to adopt eco-innovations does not have a statistically significant impact on both employment and sales growth in Spanish manufacturing firms. This means that transitioning to green innovations mainly benefits the environment. However, the sensibility analysis suggests that in the long term, eco-innovation could have a positive effects on sales for high and medium-high technology companies. This perspective highlights the need for environmental policies to be tailored to the specific characteristics and dynamics of different technological sectors.

Legislators' role is to maximize the social and environmental impact of public resources by encouraging companies to seek sustainable innovations. They can design instruments that mandate the introduction of eco-innovations, ensuring that the environment benefits from these instruments, at least to some extent, when they focus on non-eco-innovative companies as the main beneficiary group. Policymakers can also promote eco-innovation using taxes and incentives. In a 2022 study, García-Quevedo, Martinez-Ros, and Tchorzewska (2022) concluded that that environmental taxation does not effectively drive the development of green technologies in Spain. On the other hand, they found that subsidies and investment tax incentives have a positive impact. Additionally, raising awareness and educating people about the importance of eco-innovation through communication campaigns would improve the understanding among companies and consumers. The study observed that Spanish consumers are less willing to pay for green products than their European counterparts (European Commission, 2017). Finally, fostering collaboration between companies, academic institutions, government, and other stakeholders can promote the adoption of eco-innovations and lead to the transformation of companies into more socially responsible companies.

Limitations and further research

This research contributes to advancing the understanding of the relationship between innovation and company growth. However, one of the drawbacks of our study is that the results are specific to the manufacturing of one country and that the period is pretty short. New lines of research should be proposed to obtain a deeper understanding of the results. First, expanding the analysis period would capture long-term effects, potentially revealing some impacts that may need to be apparent in a shorter analysis timeframe. Additionally, it is crucial to take into account other factors that could influence the effects, such as a company's commitment to sustainability. Sustainability certificates, green patents, or investments in clean technologies can demonstrate this. Also, because companies adopt diverse eco-innovation practices, the impact on sales and employment growth may vary, affecting the causal significance. Investigating differences across various industrial sectors could also help us better understand how the industrial context yields diverse outcomes. Lastly, considering alternative estimation techniques, such as Coarsened Exact Matching (CEM), could be beneficial, as this approach may enhance the precision of causal effect estimation and mitigate bias in observational studies.

Notes

1. Statistics of variables for the balanced and unbalanced panels are available under request.
2. Persistent eco-innovating companies represent 21.9% while intermittent eco-innovating ones, 59.9%.
3. Full results are available from the author upon request.

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