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Assessing the economic impacts of forest certification in Spain: A longitudinal study

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ABSTRACT

Forest certification has become a strategic instrument for businesses, particularly for accessing sensitive environmental markets and within sustainability commitments. This trend is also visible in Spain, where PEFC (Program for the Endorsement of Forest Certification) certification has increased by 91% in the past five years. However, there is a weak understanding of the certification impacts at the level of companies, especially when it comes to economic impacts. This study applies a longitudinal methodology to measure financial performance before and after obtaining PEFC-certification in Spain by analysing treatment and selection effects. The results show significant differences in economic profitability and turnover between certified and non-certified companies prior to certification. However, these differences are not significant in subsequent periods. Therefore, we could not confirm a treatment effect between forest certification and improved financial performance. Instead, we find a positive selection effect: companies with better financial performance have a greater propensity for certification, as has been previously detected for standards such as ISO 9001/14001. Compared to previous studies that predominantly assess economic impacts qualitatively, we use economic-financial data to avoid possible distortion emerging from perceptions and opinions. The main contribution of this study lies in the quantitative assessment of the impacts of forest certification on economic profitability and turnover.

1. Introduction

The development of management norms or standards now covers a wide range of aspects of business activity, such as quality management (ISO 9001), environmental management (ISO 14001), energy management (ISO 50001), occupational risk prevention, and the provision of workplace health and safety standards (OHSAS 18000) and corporate social responsibility (SA 8000) (Heras-Saizarbitoria and Boiral, 2013; Fiore et al., 2020). This intense transformation has also materialized in the forest sector. In recent years the implementation and dissemination of forest management systems has attracted increasing interest from practitioners and academics in the sector (Galati et al., 2017). Forest certification is a voluntary verification tool for sustainable forest management and the wood processing industry influencing private and public purchasing policies. It has become a component of emerging wood harvesting and trade legality schemes (Paluš et al., 2017; Paluš et al., 2018b). Certification schemes assist forest managers in managing

forests responsibly through the provision of standards and guidelines (Ponte et al., 2011). These standards are audited by an independent certification body, to assess if land managers comply with the requirements of the applicable standard criteria on sustainable forest management (Fonseca et al., 2017). Hence, forest certification allows forest managers to be assessed independently according to sustainable management standards (Tian et al., 2021), ensuring that forest resources are managed sustainably (Garzon et al., 2020). Forest certification has the potential to inform investors on the long-term sustainability of forest management (Damette and Delacote, 2011) by serving as an indicator of social and environmental performance (Bouslah et al., 2010). There has been a growing importance of the forest industry (through forest products) for achieving the SDG goals. Forest certification, which addresses the three pillars of sustainability, social, economic, and environmental dimensions, forms the core of the 17 SDGs (Malek and Abdul Rahim, 2022). For these reasons, forest certification has become a strategic instrument for businesses, particularly for companies selling or exporting

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their certified products to environmentally sensitive markets (Suryani et al., 2011; Galati et al., 2017).

The most important forest certification schemes worldwide are the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). While the FSC system adopts common principles globally, the PEFC endorses national forest certifications, thus functioning as an umbrella scheme (Galati et al., 2017). The PEFC is currently the most implemented globally, covering 58% of the certified forest area worldwide (PEFC Spain, 2021). As of June 2021, this area covered >325 million ha of PEFC certified forests and spanned 35 countries. In addition, >20,000 companies were PEFC Chain of Custody certified in 72 countries (PEFC Spain, 2021). Most of the PEFC-certified forest areas are located in North America (52%) and Europe (36%), followed by Russia (10.25%) Asia Pacific (9%), Central and South America (3%), and Africa (<1%) (Malek and Abdul Rahim, 2022).

The large share of the PEFC relative to FSC certification is particularly pronounced in Spain, with 85% of the certified forest area being PEFC certified (2,440,331 ha certified with PEFC versus 407,245 ha certified by FSC) (FSC Spain, 2021, PEFC Spain, 2021). PEFC certified companies in Spain have also increased significantly, specifically 91% in the last five years.

With an increase in certified forest areas, interest in the impacts of forest certification has also increased. A large share of literature on forest certification has focused on analysing the motivations for certification, specifically in Europe (Chen et al., 2011, Galati et al., 2017, Halalisan et al., 2019, Paluš et al., 2017). Among the most important are market and financial motivations, such as the procurement of new markets or keeping market access, increase in sales volume, and profit margin (Owari et al., 2006; Zubizarreta et al., 2021; Paluš et al., 2019; Paluš et al., 2018a, Paluš et al., 2018b). Besides economic motivations, organizational credibility, image improvements, and moral and ethical reasons have driven companies to enter certification (Zubizarreta et al., 2021; Galati et al., 2017; Lidestav and Lejon, 2011). In Spain specifically, PEFC certification has been driven by expectations of improved market benefits (company competitiveness and differentiation), signaling mechanisms (e.g., customer satisfaction and public image), and moral responsibility (environmental sustainability) (Zubizarreta et al., 2021). However, despite a large share of studies assessing the motivations of certification, fewer studies assess if the expected economic benefits have been achieved in practice.

In this context, we assess if the economic motivations of PEFC-certified companies materialize in practice using the case study of Spain (Zubizarreta et al., 2021). Specifically, we focus on the impacts of PEFC certification on financial performance by analysing “economic profitability” and “variation in turnover” variables, following similar studies in the field of forest certification and the ISO (International Organization for Standardization) standards (Michal et al., 2019; Halalisan et al., 2019; Narasimhan et al., 2015; Dick et al., 2008; Heras-Saizarbitoria and Arana, 2011). We apply a longitudinal methodology that measures the levels of financial performance before and after certification accounting for the so-called “treatment effect” and “selection effect” (Heras-Saizarbitoria et al., 2011). Both effects analyze whether voluntary management standards distinguish adopters as having superior management practices. We assess whether there is an ex-post improvement effect on financial performance due to the treatment that certification entails (i.e., treatment-effect) (Heras-Saizarbitoria et al., 2011). In addition, we test whether an ex-ante selection mechanism exists where better-performing firms have a greater propensity to become certified (i.e., a positive selection effect). The selection effect has been previously supported from the theoretical (Wagner et al., 2002) and empirical (Heras-Saizarbitoria et al., 2011) point of view for environmental management systems but has not yet been reported in the case of forest certification. In this study, we follow similar approaches that have been applied in studying the impact of ISO 14001 (Heras-Saizarbitoria et al., 2011), ISO 9001 quality management standard (Dick et al., 2008), and ISO 50001 energy management standard (Pham,

2015).

Compared to previous studies that predominantly base their findings on case studies (He et al., 2015; Yuan and Eastin, 2007), perceptions or opinions (Barbosa de Lima et al., 2009; Butterfield et al., 2005; Ebeling and Yasué, 2009), we provide a quantitative analysis of the impacts of forest certification on economic profitability and variation in turnover.

This study is divided into six sections. Section 2 provides a background on the economic impacts of forest certification and other ISO Management Standards. Section 3 presents the methodology on which the study is based. The obtained results are presented in Section 4, followed by the discussions in Section 5 and the conclusions, limitations, and future research lines in Section 6.

2. Economic impacts of forest certification

2.1. ISO management system standards

In the field of ISO, studies have analysed if the adoption of the quality management standard ISO 9001, the environmental management standard ISO 14001, or the energy management standard ISO 50001 penalizes or rewards the performance of the company (Dick et al., 2008; Pham, 2015; Heras-Saizarbitoria et al., 2011). These studies have measured the company's economic performance through financial performance indicators (profitability, cost efficiency, and increased sales or market value).

For quality management standards, improved business performance was gained by emphasizing quality, which implied a reduction of waste, and the duplication of work, a reduction of production costs, increased sales volume, and consequently higher profitability (Dick et al., 2008). However, no clear consensus on this relationship exists, and different authors have emphasized the challenge of attributing certification as a cause of better business performance due to selection effects, meaning that better business performance might have existed prior to certification (Dick et al., 2008; Naveh and Marcus, 2005).

Attributing better business performance to the certification of a management system is complex. A dearth of research methodologies has robustly demonstrated that improved business performance can be attributed to quality system certification (Häversjö, 2000; Naveh and Marcus, 2005). Dick et al. (2008) identified a significantly higher increase in sales in certified companies than in the control group of non-certified companies. However, using an attribution testing method on the same data, they found that none of these benefits could be attributed to quality certification. Dick et al. (Dick et al., 2008) analysed the causal links between quality management system certification (ISO 9001) and improved business performance. They concluded that although there is some evidence that quality management system certification has some causal influence on business performance, there is also evidence of a selection effect. The companies with the best performance are those that adopt certification. This reverse attribution was also identified in other studies (e.g., Häversjö, 2000; Naveh and Marcus, 2005; Wayhan et al., 2002), suggesting that when performance benefits are associated with quality certification, only a modest proportion of the benefits can be attributed to the causal influence of certification. These studies conclude that no simple inference about the direction of causality between certification of ISO 9001 management systems and better business performance exists.

In environmental management standards, the ISO 14001 2015 edition adopted the Annex SL structure, which requires that organizations analyze their internal context and emphasize performance improvement by minimizing water and energy consumption and producing less emission and waste. Moreover, it introduced a life cycle perspective and developed an external and internal communications strategy to consider the reporting demanded by regulatory agencies and the expectations of other interested parties (Fonseca and Domingues, 2018). Also in the case of this standard, a contradictory relationship between companies' environmental management practices and their economic performance

has been found (Cañón-de-Francia and Garcés-Ayerbe, 2009, Filbeck and Gorman, 2004). In contrast to several studies that analysed the impact of certification on environmental performance, only a few studies have analysed the impacts on economic performance (Pham, 2015). Furthermore, studies that have examined the relationship between ISO 14001 certification and the financial performance of companies have never reached a uniform conclusion (Concepción López-Fernández and Serrano-Bedia, 2007, Djekic et al., 2014, Singh et al., 2015, Wang and Zhao, 2020).

In energy management and ISO 50001 standard, there is also no consensus on the relationship between this standard and business performance (Laskurain et al., 2015). Böttcher and Müller (2016) concluded that energy management positively affects economic performance, this effect being stronger for certified energy management systems, such as ISO 50001 or EN 16001. António da Silva Gonçalves and Mil-Homens dos Santos (2019) concluded that ISO 50001 effectively reduces energy performance and energy cost reduction but not greenhouse gas emissions and environmental impacts. Pham (2015), in contrast, highlighted a complex relationship between environmental and financial performance and rejected the hypothesis that ISO 50001 certification generates positive returns in the market value of certified companies.

2.2. Forest certification impacts

Studies that have assessed the economic impact of forest certification in the forest industry have focused on the barriers and motivations for getting certified (Chen et al., 2011, Galati et al., 2017, Halalisan et al., 2019, Paluš et al., 2017). There are also a few desktop studies that provide literature reviews and desktop analysis on a global (Thorner et al., 1999; Auld et al., 2008) or cross-country scale (Hirschberger, 2005; Rametsteiner and Simula, 2003; Burivalova et al., 2017). In addition, these studies assess forest certification's impact or effectiveness on sustainable forest management.

In a literature review on the social, economic, and environmental impacts of forest certification, Burivalova et al. (2017) found that market access and price premiums for certified products were reported in most reviewed studies on economic impacts but rarely met the expectations of forest managers. Furthermore, reported price premiums varied over time and were highly species-, product-, and country-dependent (Burivalova et al., 2017; Wolff and Schweinle, 2022). According to Kameyama and Sugiura (2021), without awareness concerning the differentiation of PEFC-certified products among consumers, it is hard to achieve price premiums. Evidence of both market access and price premiums gained from forest certification was found in China (e.g., Wang et al., 2005; Yuan and Eastin, 2007; Zhao et al., 2011; He et al., 2015), Europe (e.g., Paluš et al., 2018a; Oy, 2005; Lidestav and Lejon, 2011), Vietnam (Tham et al., 2020), and North America (Espinoza et al., 2012; Hayward and Vertinsky, 1999; Moore et al., 2012). Improved market access is frequently reported as a critical outcome of certification, associated with improving corporate image and credibility in international markets (Butterfield et al., 2005; Cabbage et al., 2010; Moore et al., 2012; Oy, 2005; Malek and Abdul Rahim, 2022). While adopting certification initially increases costs, higher revenues and improved reputation can offset these costs, giving certified companies a competitive advantage (He et al., 2015; Moore et al., 2012).

As such, indirect economic effects of certification can be gained from larger sales and keeping market shares. Some studies also emphasize non-economic benefits, such as market recognition, external credibility (Cabbage et al., 2010), signaling and learning (Araujo et al., 2009; Carlson and Palmer, 2016), and improved consultation with stakeholders (Halalisan et al., 2018) that can also contribute to the economic viability of a firm.

Several studies concluded that certified companies benefit from market access yet do not obtain a higher economic return in terms of a price premium. Evidence of such impacts exists in Europe (e.g., Dias

et al., 2013; Halalisan et al., 2013; Hirschberger, 2005; Gulbrandsen, 2005), South America (e.g., Ebeling and Yasué, 2009; Tricallotis et al., 2018; Barbosa de Lima et al., 2009; Araujo et al., 2009), North America (e.g., Butterfield et al., 2005; Narasimhan et al., 2015; Wilson et al., 2001; George et al., 2022) and Africa (Frey et al., 2021).

Calculating changes in the stock price of certified wood, Bouslah et al. (2010) found that forest certification did not have a short-term impact on the financial performance of companies in Canada and the USA, regardless of the certification scheme adopted. However, forest certification negatively impacted the firm's financial performance, as associated benefits did not cover the costs (Bouslah et al., 2010).

Forest certification is assumed to increase profits by procuring new markets or keeping market access, increasing sales volume and profit margin (Owari et al., 2006; Zubizarreta et al., 2021; Paluš et al., 2019; Paluš et al., 2018a, Paluš et al., 2018b). However, only a few studies have explicitly addressed the impacts of forest certification on the certified firms' economic profitability or turnover. These studies have focused on small-scale plantation forestry in Southeast Asia (Frey et al., 2018, Tham et al., 2021). For example, Frey (2018) analysed the financial impact on smallholder and state forestry enterprises of forest plantations in Vietnam to evaluate their competitiveness and profitability. They found that forest certification was profitable using a household survey, standing stock estimation, and financial analysis. In addition, certified wood yielded a 20% price premium over uncertified wood. Tham et al. (2021) compared the financial and economic performance of three Acacia hybrid timber value chains comprising woodchip, non-FSC furniture, and FSC-certified furniture in Thua Thien Hue province, central Vietnam. Interviews with key informants, timber producers, traders, woodchip, furniture processing, and exporting companies found that the woodchip value chain is profitable. The FSC-certified furniture value chain contributes most to economic development (Tham et al., 2021). However, the effect of the certification on sales, profits, and the added value of companies seemed more effective over a longer timeframe (from 4 years to >10 years). Another study in North America assessed the profitability and market share generated through forest certification and found that forest certification was not perceived as economically beneficial (Vidal et al., 2005). In general, most such studies have focused on the FSC scheme and have assessed the economic impact of forest certification mainly through qualitative methods, such as questionnaires and interviews, often combined with statistical analysis (Wolff and Schweinle, 2022).

In Europe, studies that addressed the profitability of forest certification have focused on assessing perceptions through surveys. In Sweden, about 37% of forest owners perceived certification to affect profitability, 5% negative, and the remaining noticed no considerable effect or had no opinion (Lidestav and Lejon, 2011). In the Czech Republic, certification costs of the FSC were higher than financial revenues.

2.3. The challenge of quantifying economic impacts

Forest certification underlies a chain of influences that impact financial and sales performance. Thus, considerable challenges relate to the attribution of the causal effects of forest certification (van der Ven and Cashore, 2018; Nordén et al., 2016). Certification is often assumed to lead to sustainable forest management and better economic performance (He et al., 2015; Nordén et al., 2016). Nevertheless, the opposite effect can be true, meaning that already sustainable forest management practices and stable economic condition of the company make it more likely that a firm certifies. Thus, quantifying the impacts of forest certification requires controlling for pre-existing characteristics of certified forest management units (FMUs) and firms (Blackman et al., 2018). For example, firms that already meet the required certification criteria do not need to drastically change their forest management which is often associated with lower costs (Blackman et al., 2018). Therefore, studies that do not control for such pre-existing characteristics of certified firms

may generate overly optimistic conclusions because they wrongly attribute producers' higher average performance to forest certification.

This raises the question of whether the claims for attribution of improved performance to forest certification are valid. For causation to be attributed, it is necessary to show that better financial performance did not precede certification.

In this context, we used the evolution of sales and economic profitability to measure financial performance, such as in similar studies (Annex 1). We focus on these two variables because they are standard accounting measures of financial performance according to widely accepted economic studies (Kahloul et al., 2022, Ben Lahouel et al., 2020, Yu et al., 2022). In addition, studies on the impacts of the management standards ISO 9001 and ISO 14001 have used these two variables to quantitatively evaluate financial performance (Dick et al., 2008; Heras-Saizarbitoria and Arana, 2011). Finally, the authors had access to said information through the SABI database (<https://sabi.bvdinfo.com>).

Based on these arguments, the following working hypothesis is established:

H1. There is a positive “treatment effect” between forest certification and improved financial performance of companies.

In addition to analysing the effect of forest certification on financial performance, it may also be relevant to study, i.e. whether the fact that a company achieves better financial performance may influence its decision to certify. Based on this assumption, we state the second hypothesis of the paper:

H2. There is a positive “selection effect” between the level of financial performance of companies and their propensity to get certified.

3. Methods

3.1. Study context

On 1 January 2021 in Spain 1522 companies had obtained PEFC certification. These companies were mainly active in four main sectors “Building materials and furniture” (558 companies), “Wood and Cork industry” (518), “Graphic arts” (231) and “Paper industry” (153). The remaining 72 companies, less than the 5% of the universe, were active in a various sectors and have been grouped under “others”.

Fig. 1 shows that the number of certified companies is growing. In the last 5 years, the number of certifications in Spain has grown by 91% from 809 to 1522. This growth has been slower in the sectors “Building materials and furniture” (71%) and “Paper industry” (73%) and faster in “Wood and Cork industry” (106%) and especially in “Graphic Arts” (120%).

3.2. Sample

The empirical study investigates the influence of the adoption and certification of the PEFC standard on financial performance. For this purpose, the financial indicators of a group of certified companies are analysed and compared with those of another group of companies that are not PEFC certified. We first analysed the sample of certified companies provided by PEFC Spain and cross-checked it with the SABI database to develop this comparison. SABI is an economic-financial information database of Bureau Van Dick. Economic-financial information was accessed for 14 financial years from 2006 to 2019. In total, we accessed data from 377 PEFC-certified companies between 2003 and 2020. Subsequently, a filtering process was carried out. Firstly, the final sample only considered companies that had collected the turnover and economic profitability indicators in all periods. The percentage variation in turnover for the previous year was calculated based on the turnover indicator. Secondly, a homogenisation process was carried out. In this process, companies with records for the period between 2006 and 2019 that had turnover variation and economic profitability outside the bilateral confidence interval for a probability of 95%, were eliminated from the study. It was taken as a null hypothesis that the elements outside this interval are marginal; in some cases, they come from possible errors and significantly distort the actual results of the distribution. For these reasons, we reduced the sample to 247 certified companies at the end of the cleaning process (Osborne and Overbay, 2004). In addition, we collected sectoral information, the number of employees in 2019 and the level of exports from this information. In a second step, to carry out the comparison, a list of three non-certified companies with similar characteristics was selected in SABI for each certified company, initially based on sectoral information and subsequently on the number of employees and level of exports. The aim was to eliminate possible sources of distortion and errors in the comparison between the two samples since some of the specific characteristics of

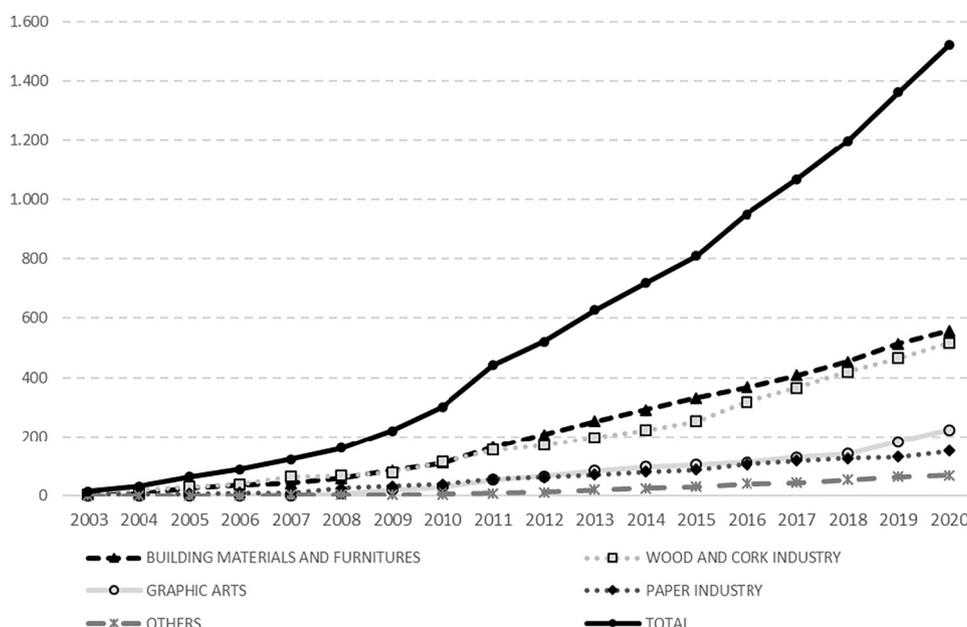


Fig. 1. Spread of PEFC certification in Spain.

certified companies have to be considered for non-certified companies and the other to increase the contrast effect, as these differences could otherwise be attributed to significant differences that would alter the study results (Dattalo, 2008). This sample was also purged following the same process, but in this case, the companies were replaced with others that met the purging requirements. In the end, we worked with a total sample of 988 companies, of which 247 were certified, and 741 were not certified (Table 1). That is, we had access to 27,664 economic and financial information records, specifically, 3458 records of both turnover and economic profitability of certified companies and 10,374 of both variables of non-certified companies.

As expected from the selection process, applying the Mann-Whitney U two-tailed test, it was found that there were no significant differences between the two samples in terms of size and export capacity. For these reasons, the comparison between certified and non-certified companies was carried out in an aggregate form in the initial phase. Then in a second phase, the results were broken down to the sectoral level.

However, prior to the comparison of means, the coefficients of asymmetry were analysed, and it was observed that in no case was the difference >0.43 . Likewise, kurtosis was analysed, and it was observed that in no case was the difference >0.57 .

3.3. Statistical methods

The statistical analysis was carried out using SPSS statistic Ver.26 software. First of all, an attempt was made to detect possible sources of distortion between the two samples, since some of the specific characteristics of the certified companies with respect to the non-certified companies must be considered, given that, otherwise, the existence of significant differences in terms of the variables analysed could be attributed to these differences. Applying the Mann-Whitney U two-tailed test, no differences in size and export capacity between the samples of companies that were certified in each specific year from 2007 to 2020 and the control sample were found. However, applying the Anova analysis, differences in the average year of certification in each sector for a confidence level of $\alpha = 0.05$ were measured (Ott and Longnecker, 2015). These previous analyses helped us refine the research methodology, which is explained below.

Following the criteria established by Downie and Heath (1998), we opted to use the Student's *t*-test to analyze the difference in means of the variation in turnover and economic profitability depending on whether they were certified in 2021 and whether they were certified in the corresponding year. Likewise, the Kruskal-Wallis test was carried out to examine the influence of belonging to a specific sector on both turnover and profitability (Breslow, 1970).

Based on these results, we proceeded to study the selection and treatment effects. To this aim, the annual differences in the change of the turnover and economic profitability in each sector were analysed in both the sample of certified and non-certified companies in 2021 to avoid sectoral and temporal biases (Heras-Saizarbitoria and Arana, 2011). The

absolute time scale of each indicator was also transformed into a relative scale according to the year of certification (year 0). The significance of these differences was analysed using the Student's *t*-test (Downie and Heath, 1998). In the first step, we analysed this using the calendar year as a time reference, and in the second one, using the periods of approximation and internalization of the standard as a reference (Bouslah et al., 2010; Miteva et al., 2015; De Jong et al., 2014).

Finally, using Pearson correlation coefficient measurements (Taylor, 1990), the influences of size, exporting capacity, and belonging to a sector on change in turnover and economic profitability were analysed.

4. Results

The first step in the analysis of results was to analyze whether there were significant differences between the sample of certified companies in January 2021 and the control sample. To this end, Table 2 presents the aggregate data for the variation in turnover and economic profitability. It shows that the average increase in turnover in certified companies is significantly higher than in the sample of non-certified companies in 2006–2019 for a confidence level of $\alpha = 0.01$. Specifically, the average annual increase in turnover is 3.583% in the certified companies and 2.340% in the sample of non-certified companies. Furthermore, of the thirteen periods analysed, there are only significant differences in the variation in turnover in three years: 2010 and 2011 for a significance level of $\alpha = 0.01$ and in 2013 for a confidence level of $\alpha = 0.05$, with the increase in turnover in the sample of certified companies being higher in all cases. However, no significant differences are observed in the average economic profitability, with an increase of 3105% for certified companies and 2790% for non-certified companies. However, in two periods the economic profitability of the sample of certified companies is higher than that of the sample of non-certified companies. Specifically, in 2013 and 2016, the economic profitability of the sample of certified companies is higher for a confidence level of $\alpha = 0.05$. However, this comparison does not allow us to specify whether these differences are due to the selection effect or the treatment effect.

Regarding the treatment effect, a significant difference in economic profitability between certified and non-certified companies was only detected in 2007. However, this result should be interpreted with caution. There were only 20 certified companies in this period, and the samples did not maintain the same sectoral, size, and export capacity proportions.

We also compared the differences in turnover between the sectors (Tables 3 and 4). Differences are only observed in the average increase in turnover in the “Building materials and furniture” sector, significant for $\alpha = 0.05$. Notably, these differences have been especially relevant in the periods 2010, 2011, and 2012, periods in which the companies in this sectorial grouping in Spain were trying to recover from the global financial crisis in the previous years that had deeply affected them. Significant differences were also detected in the other sectors in specific years. In the “Wood and Cork industry” sectors, differences were

Table 1
Sectoral distribution of the sample of analysed companies (as of 1 January 2021).

	Certified				Non cert.			Total
	Universe NU	Sample NS (NS/NU)	Employees mean (SD)	Export (%) mean (SD)	Sample N (%)	Employees mean (SD)	Export (%) mean (SD)	Sample N (%)
Wood and Cork industry	518	82 (0.16)	25.8 (28.1)	31.6 (33.5)	246	27.2 (27.5)	33.3 (29.4)	328
Paper Industry	153	22 (0.14)	124.5 (101.0)	36.8 (24.0)	66	118.5 (97.0)	33.2 (26.2)	88
Graphic art	231	54 (0.24)	45.8 (46.5)	12.1 (9.9)	162	47.2 (42.3)	14.1 (11.2)	216
Bulding materials & furniture	558	67 (0.12)	36.2 (45.1)	25.5 (25.7)	201	33.2 (41.2)	25.0 (22.9)	268
Others	72	22 (0.31)	154.1 (179.9)	43.1 (19.5)	66	126.1 (147.2)	42.3 (22.4)	88
Total	1,522	247 (0.16)	53.2 (81.5)	29.2 (24.9)	741	50.1 (89.2)	27.8 (26.1)	988

Note: Applying the Mann-Whitney U two-tailed test, no significant differences were detected in relation to size (number of employees) and export capacity between the samples of certified and non-certified companies for a significance level $\alpha = 0.05$.

Table 2
Comparison of the change in turnover and economic profitability of PEFC certified and non-certified companies (2006–2019).

	Change in turnover ¹			Economic profitability ¹				
	Certified in 2021		Not certified	Certified in 2021			Not certified	
	Certified	Not yet certified		Certified	Not yet certified	Total		
2019	7.060 (17.644)	2.053 (15.002)	2.806 (15.493)	4.436 (16.861)	4.936 (6.809)	4.108 (7.420)	4.233 (7.324)	4.146 (6.797)
2018	6.989 (13.911)	5.065 (13.362)	5.454 (13.468)	7.041 (16.883)	4.771 (6.592)	4.434 (7.608)	4.502 (7.402)	4.200 (6.621)
2017	6.465 (14.335)	7.886 (13.523)	7.501 (13.733)	7.653 (16.946)	5.433 (6.917)	4.702 (6.499)	4.900 (6.609)	4.153 (6.077)
2016	4.230 (15.771)	6.730 (14.560)	5.830 (15.024)	6.085 (16.279)	4.022 (10.412)	4.559 (8.774)	4.366* (9.380)	3.255* (5.665)
2015	10.655 (16.991)	9.214 (18.320)	9.833 (17.741)	10.836 (17.978)	4.463 (6.138)	3.572 (7.818)	3.954 (7.146)	4.069 (6.917)
2014	10.598 (18.738)	11.152 (17.832)	10.856 (18.287)	8.859 (23.022)	2.320 (7.483)	3.060 (5.924)	2.665 (6.798)	2.146 (6.903)
2013	5.130 (16.965)	3.624 (15.163)	4.538* (16.266)	1.346* (18.677)	1.685 (6.538)	2.024 (8.260)	1.818* (7.248)	0.711** (7.290)
2012	-3.118 (16.513)	-6.797 (14.780)	-4.191 (16.085)	-5.541 (21.293)	0.638 (7.177)	0.331 (8.588)	0.548 (7.598)	0.180 (7.122)
2011	3.847 (18.179)	7.269 (15.589)	4.470** (17.755)	-0.757** (19.270)	1.259 (6.698)	0.690 (9.285)	1.156 (7.220)	0.436 (7.660)
2010	11.303 (20.875)	13.209 (19.137)	11.573** (20.611)	3.216** (19.915)	1.957 (6.823)	1.455 (4.561)	1.886 (6.545)	1.434 (6.879)
2009	-16.968 (17.492)	-19.736 (17.906)	-17.192 (17.505)	-18.757 (20.067)	1.267 (6.663)	-0.273 (6.025)	1.143 (6.615)	1.530 (7.210)
2008	-5.316 (18.508)	-8.604 (12.853)	-5.489 (18.250)	-5.911 (17.828)	3.750 (6.145)	0.104 (4.332)	3.558 (6.111)	3.189 (7.395)
2007	10.561 (15.269)	11.545 (13.088)	10.601 (15.165)	11.908 (17.706)	4.669* (7.486)	0.728* (3.949)	4.509 (7.412)	5.088 (6.705)
2006					-2.533 (2.166)	4.287 (6.996)	4.205 (6.995)	4.528 (6.581)
Average ²	3.961 (8.081)	3.280 (9.522)	3.583** (4.690)	2.340** (5.274)	3.167 (1.679)	2.269 (1.871)	3.105 (4.239)	2.790 (3.924)

Source: Prepared by the authors. ¹ The mean is provided as an indicator of centrality and the standard deviation is provided as an indicator of dispersion in brackets. ² The comparative tests between certified and not yet certified companies have been carried out based on annual averages in order to avoid the influence of economic cycles linked to the certification rate. Note: ** Statistically significant differences in means using Student's t-test for a confidence level $\alpha = 0.01$ (two-tailed test). * Statistically significant differences in means using the Student's t-test for a confidence level $\alpha = 0.05$ (two-tailed test).

Table 3
Sectoral comparison of the change in turnover of PEFC certified and non-PEFC certified companies (2006–2019).

	Wood and cork industry ¹		Paper industry ¹		Graphic art ¹		Building materials and furniture ¹		Others ¹	
	Certified	Non cert.	Certified	Non cert.	Certified	Non cert.	Certified	Non cert.	Certified	Non cert.
2019	-0.522 (14.417)	3.438 (17.404)	4.887 (10.362)	2.409 (8.501)	4.766 (17.514)	4.196 (16.237)	2.948 (12.915)	5.584 (17.475)	7.735 (22.808)	7.279 (20.236)
2018	6.087 (14.800)	6.938 (17.683)	7.702 (7.644)	4.587 (9.393)	1.832 (13.811)	6.028 (17.217)	8.492 (12.042)	8.452 (15.524)	0.491 (13.734)	8.066 (22.061)
2017	9.857 (14.231)	9.034 (18.867)	5.475 (8.467)	6.577 (9.405)	6.389 (15.244)	3.885 (14.367)	5.747 (14.038)	9.232 (16.872)	8.818 (10.485)	8.023 (20.005)
2016	3.968 (14.308)	7.517 (16.380)	2.786 (8.435)	3.028 (7.674)	5.638 (11.420)	2.293 (15.121)	10.244 (18.598)	9.058 (14.966)	2.836 (16.502)	4.065 (24.633)
2015	11.540 (18.084)	11.269 (18.625)	6.142 (10.285)	4.834 (8.952)	5.824 (14.100)	7.553 (16.129)	10.879 (18.972)	12.375 (16.566)	13.812 (24.490)	18.590 (25.894)
2014	14.416 (21.470)	9.998 (23.032)	5.734 (8.140)	8.893 (20.018)	6.106 (12.737)	9.518 (20.363)	15.428** (19.342)	6.613 (25.051)	0.446 (13.143)	9.801 (25.560)
2013	5.946** (15.242)	0.043** (18.486)	3.933** (10.731)	-1.708** (10.625)	0.026 (13.420)	-0.782 (16.967)	5.447 (18.868)	5.001 (18.901)	8.205 (20.920)	3.345 (26.183)
2012	-5.347 (18.523)	-1.550 (21.060)	1.462 (7.594)	2.653 (17.574)	-5.601 (14.822)	-5.778 (18.624)	-3.750** (15.798)	-11.775** (22.444)	-3.412 (16.301)	-9.037 (22.596)
2011	10.280** (18.750)	1.584** (19.991)	5.936 (11.930)	9.003 (11.584)	2.491 (10.446)	-0.751 (18.482)	0.102** (21.533)	-5.806** (16.571)	-0.486 (15.207)	-3.878 (26.265)
2010	14.567** (19.886)	4.109** (21.422)	15.355 (20.472)	11.287 (12.447)	6.005 (14.326)	4.067 (17.190)	10.957** (23.578)	-2.580** (12.267)	12.173 (25.210)	7.376 (28.085)
2009	-24.776 (18.016)	-20.663 (20.518)	-5.158 (13.938)	-7.604 (15.479)	-10.028* (13.546)	-15.847* (15.695)	-20.364 (15.966)	-23.142 (20.258)	-8.880 (16.314)	-16.586 (25.682)
2008	-8.806 (20.258)	-5.528 (19.144)	4.186 (12.096)	1.891 (11.425)	-1.948 (12.962)	-4.686 (15.260)	-9.212 (18.788)	-11.394 (17.181)	-0.154 (19.786)	-1.444 (21.027)
2007	8.480 (15.452)	9.633 (16.896)	11.342 (10.090)	10.452 (12.832)	13.210 (13.761)	13.308 (18.107)	8.356 (16.520)	12.551 (18.299)	18.202 (14.944)	16.451 (20.912)
Average	3.515 ⁺⁺ (4.752)	2.755 ⁺⁺ (5.347)	5.368 ⁺⁺ (4.111)	4.331 ⁺⁺ (3.674)	2.670 ⁺⁺ (4.324)	1.770 ⁺⁺ (5.125)	3.482 ⁺⁺⁺ (5.128)	1.090 ⁺⁺⁺ (5.179)	4.599 ⁺⁺ (4.159)	4.004 ⁺⁺ (5.885)

Source: Prepared by the authors. ¹ The mean is provided as an indicator of centrality and the standard deviation is provided as an indicator of dispersion in brackets. Note: ** Statistically significant differences in means using Student's t-test for a confidence level $\alpha = 0.01$ (two-tailed test). * Statistically significant differences in means using the Student's t-test for a confidence level $\alpha = 0.05$ (two-tailed test). ⁺⁺ Statistically significant sectoral differences in average means using the Kruskal-Wallis test for a confidence level $\alpha = 0.01$ (two-tailed test).

observed for $\alpha = 0.01$ in 2010, 2011, and 2013, in the “Paper industry” in 2013 for $\alpha = 0.01$, and in “Graphic Art” in 2009 for $\alpha = 0.05$. In none of the tests, significant differences were detected that indicate that the sample of non-certified companies had a more significant increase in sales in a particular period than the sample of certified companies in 2021.

Concerning economic profitability, only in the sectoral group, “others” is the profitability of certified companies higher than that of

non-certified companies. In this sector group, the main differences occurred in 2008, 2009, and 2010 and are significant for $\alpha = 0.01$. For the rest of the sectoral groups, it is observed that there are differences for $\alpha = 0.01$ in “Building materials and furniture” in the periods 2013 and 2016 and in “Paper Industry” in 2016, 2017, and 2018. However, no significant differences have been detected in the “Graphic Art” sector. Finally, it should be noted that in the “Wood and Cork industry”, significant differences were detected, but in the opposite direction, i.e.,

Table 4
Sectoral comparison of the change in economic profitability of PEFC certified and non-certified companies (2006–2019).

	Wood and cork industry ¹		Paper industry ¹		Graphic art ¹		Building materials and furniture ¹		Others ¹	
	Certified	Non cert.	Certified	Non cert.	Certified	Non cert.	Certified	Non cert.	Certified	Non cert.
2019	2.743 (6.481)	4.276 (7.358)	8.855 (4.929)	6.961 (6.790)	3.182 (6.876)	2.946 (7.957)	4.966 (8.502)	4.423 (5.077)	5.442 (7.614)	2.946 (5.120)
2018	3.007 (8.432)	4.764 (6.195)	9.535** (7.073)	5.315** (8.568)	3.644 (6.374)	3.075 (8.419)	4.949 (6.505)	4.257 (5.011)	5.786 (6.523)	3.565 (4.705)
2017	3.854 (5.258)	4.453 (5.756)	9.038** (5.700)	5.741** (7.631)	4.710 (7.909)	3.993 (6.539)	4.770 (6.885)	3.675 (5.997)	5.527 (6.546)	3.296 (4.036)
2016	2.264 (9.985)	3.758 (5.749)	10.393** (5.581)	3.885** (6.396)	4.436 (11.653)	3.532 (6.705)	4.547** (7.128)	2.271** (3.985)	5.446 (7.479)	3.064 (5.921)
2015	1.998 (7.031)	3.582 (6.955)	7.787 (6.522)	6.199 (6.147)	4.232 (8.361)	5.040 (8.878)	4.523 (6.636)	3.420 (5.445)	5.001 (4.170)	3.348 (5.338)
2014	1.981 (6.204)	1.482 (8.103)	6.269 (4.727)	4.163 (5.916)	1.440 (7.399)	3.073 (7.573)	2.976 (7.445)	1.505 (4.842)	3.669 (6.125)	2.275 (6.048)
2013	1.180 (8.099)	0.193 (7.823)	3.254 (7.427)	2.741 (5.810)	-0.022 (6.462)	0.976 (8.513)	3.428** (6.859)	0.609** (6.164)	2.376 (5.742)	0.278 (6.211)
2012	-0.512 (7.525)	-0.195 (7.018)	3.453 (11.579)	4.043 (7.876)	0.218 (6.518)	-0.280 (7.813)	0.738 (7.223)	0.157 (5.896)	1.828 (6.110)	-1.088 (7.330)
2011	-0.215 (7.534)	-0.074 (7.382)	5.077 (4.992)	3.847 (6.621)	1.200 (5.653)	-0.073 (9.642)	0.796 (8.548)	0.502 (6.538)	3.330 (5.256)	-0.024 (6.584)
2010	1.564 (6.199)	1.294 (6.094)	3.819 (6.152)	4.883 (7.478)	1.255 (5.050)	0.473 (8.128)	1.257 (7.916)	1.375 (6.041)	4.618** (6.322)	1.049** (7.235)
2009	-0.710** (7.242)	1.196** (6.635)	3.434 (5.851)	4.892 (7.879)	0.410 (4.994)	-0.056 (8.219)	1.914 (6.525)	2.416 (6.237)	5.204** (6.317)	0.612** (7.444)
2008	2.330 (6.096)	3.071 (6.679)	2.872 (2.628)	2.436 (6.733)	3.352 (5.952)	2.645 (7.722)	4.843 (6.669)	4.408 (8.308)	5.410** (6.536)	2.003** (6.451)
2007	2.868** (6.499)	4.477** (5.609)	2.980 (4.525)	4.177 (6.427)	4.232 (6.882)	5.050 (6.806)	6.496 (8.239)	6.607 (7.724)	6.787 (9.804)	3.749 (6.516)
2006	2.732 (5.816)	3.858 (5.490)	2.769 (5.060)	3.144 (6.953)	3.338 (6.661)	4.865 (6.298)	5.735 (7.132)	5.416 (7.466)	8.595 (10.253)	4.880 (7.412)
Average	1.784** (3.781)	2.581** (3.780)	5.681** (3.383)	4.459** (4.475)	2.545** (4.523)	2.518** (4.062)	3.709** (3.936)	2.931** (3.865)	4.930** (4.931)	2.140** (3.304)

Source: Prepared by the authors. ¹ The mean is provided as an indicator of centrality and the standard deviation is provided as an indicator of dispersion in brackets. Note: ** Statistically significant differences in means using Student's *t*-test for a confidence level $\alpha = 0.01$ (two-tailed test). * Statistically significant differences in means using the Student's *t*-test for a confidence level $\alpha = 0.05$ (two-tailed test). ** Statistically significant sectoral differences in average means using the Kruskal-Wallis test for a confidence level $\alpha = 0.01$ (two-tailed test).

higher economic profitability among non-certified companies in the periods 2007 and 2009 for $\alpha = 0.01$.

Considering to account for the differences in the certification status and its impact on the sectors these were integrated into the aggregate analysis. To this end, for each record of variation in turnover and economic profitability of the sample of certified companies, the corresponding average of the variation in turnover or economic profitability of the sample of non-certified companies belonging to the same sector and corresponding to the same year was subtracted. This transformation has helped us undertake the next step of the analysis, in which we tested the selection and treatment effects. To this end, the difference in

turnover and economic profitability records were classified according to the year in which the companies obtained PEFC certification. According to this classification, year 0 is the year of certification. Years with a negative value are before certification, and years with a positive value are after certification.

As shown in Fig. 2, companies before certification have had a more positive change in turnover, which partially confirms the existence of a selection effect related to this indicator. The differences in turnover are significant in the years “- > 5”, “-5” and “-2”. This means that certified companies have had a better evolution of their turnover five or more years before, five years before, and two years before.



Fig. 2. Difference in the change in turnover between certified and non-certified companies compared to the certification date.

Source: Prepared by the authors. Note: * Statistically significant mean differences using Student's *t*-test for a confidence level $\alpha = 0.05$ (two-tailed test).

However, this hypothesis cannot be confirmed concerning the treatment effect, since neither in the certification year nor in subsequent years is a positive or negative difference detected with regard to the change in turnover.

When analysing the selection effect for economic profitability (Fig. 3), it is observed that in the relative years “-3” and “-2” there are significant differences for a confidence level of $\alpha = 0.05$. Therefore, the existence of a selection effect is again partially confirmed. However, as was the case with the variable for variation in turnover, no positive or negative differences are detected for the treatment effect, so this hypothesis cannot be accepted.

To clarify the selection and treatment effect of certification, we divided the certification process into five periods, following previous literature. The first period is 5 or more years prior to certification. The second period “Approaching” is the period in which the decision is usually taken to adopt and certify the standard, and the process of approximation to the standard begins (includes periods -4, -3, and -2). The third, “Certification” period includes the process of adoption, certification, and internalization (-1,0,1). The fourth, “Improving” period, includes the following three years, in which the company acquires experience. Finally, the last period “Experience” represents the results of companies with more than five years of experience working with PEFC (Bouslah et al., 2010; Miteva et al., 2015; De Jong et al., 2014).

Fig. 4 helps to confirm the selection effect. Companies before certification have a significantly greater change in turnover and in the approaching period, that is when they usually decide to certify themselves, they have a greater economic profitability. However, the treatment effect is not confirmed in any case, since the difference in the periods of “improvement” and “experience” the differences in turnover and economic profitability are not significant.

Finally, a correlation analysis was used to analyze the influence of company characteristics on whether these differences in the variation of turnover and profitability are more or less significant (Table 5).

Firstly, it was analysed whether larger PEFC-certified companies (number of employees) had a greater difference in the variation of turnover and economic profitability. No significant impact on either of the two variables was found. Secondly, we analysed whether the level of exports impacted these differences and found that it did not impact the difference in turnover but did positively impact profitability at a confidence level of $\alpha = 0.01$ (correlation coefficient 0.212). Finally, the impact on these variables of belonging to one or other sectoral grouping was analysed. In relation to turnover, certified companies belonging to the “Building materials and furniture” sector group have obtained a greater increase in turnover ($\alpha = 0.05$). Companies belonging to the “Building materials and furniture” and “Paper industry” sectors have

achieved a greater difference in “Economic profitability” ($\alpha = 0.05$). On the other hand, belonging to the “Wood and cork industry” sector has a negative impact on the difference in economic profitability between certified and non-certified companies.

5. Discussion

In this study, we have measured the levels of financial performance before and after certification in a sample of 247 Spanish PEFC certified companies and compared them with a sample of 741 non-certified companies, using a longitudinal methodology. This methodology offers the benefits of having extended time frames and establishing causal relationships between variables, allowing the real trends to be separated from chance occurrences. In this study, the data come from an economic-financial information database corresponding to 14 financial years for each company.

The first hypothesis (H1), which analyses if there exists a positive “treatment effect” between forest certification and its impact on improving companies' financial performance, could not be confirmed in this study. No significant difference could be detected in the post-certification periods in any of the two variables analysed; turnover and economic profitability. The results show that an important motivation of PEFC certified companies to increase competitiveness has not (yet) materialized in practice. These results differ from the results obtained in previous studies based on the evaluation of questionnaires or structured interviews with company managers (Nebel et al., 2005; Wang et al., 2005; Cashore et al., 2006; Ebeling and Yasué, 2009; Moore et al., 2012; Narasimhan et al., 2015; Burivalova et al., 2017; Paluš et al., 2018a). Through such qualitative methodologies, obtaining generalizable evidence regarding the impact of forest certification on business financial performance is challenging because the results may have a particular bias, as has been mentioned in different studies that have analysed other standards (Wayhan et al., 2002; Wayhan and Balderson, 2007; Heras et al., 2002). In the case of the present study, our results are based on objective indicators obtained from financial and economic databases. Differences in results obtained through subjective data and data obtained through economic databases have also been reported in studies that have analysed other management systems, such as ISO 14001 (Heras-Saizarbitoria et al., 2011) or ISO 9001 (Häversjö, 2000).

The second hypothesis (H2), which assumes a positive selection effect between companies' financial performance and their propensity to get certified, can be partially accepted. The difference in turnover and economic profitability variables is always positive. Although the difference is not significant in all periods prior to certification, it is significant in two of the five periods for the variation in turnover and three periods for economic profitability. The positive “selection effect” can be

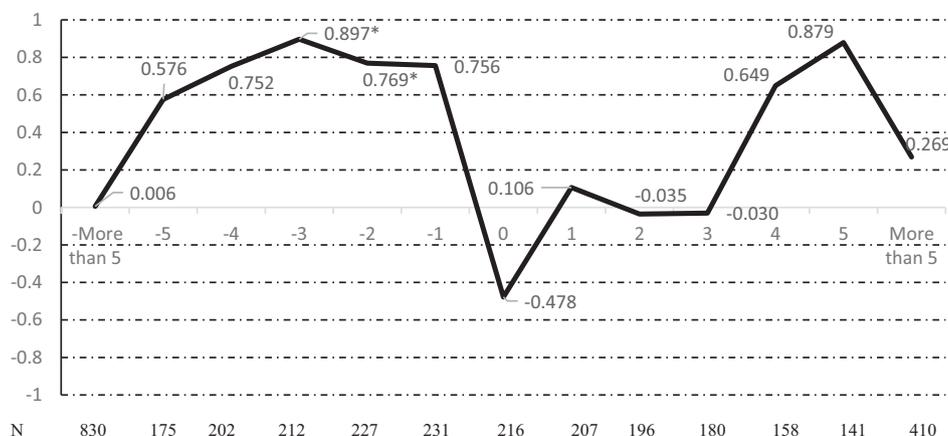


Fig. 3. Difference in the change in economic profitability between certified and non-certified companies compared to the certification date. Source: Prepared by the authors. Note: * Statistically significant mean differences using Student's t-test for a confidence level $\alpha = 0.05$ (two-tailed test).

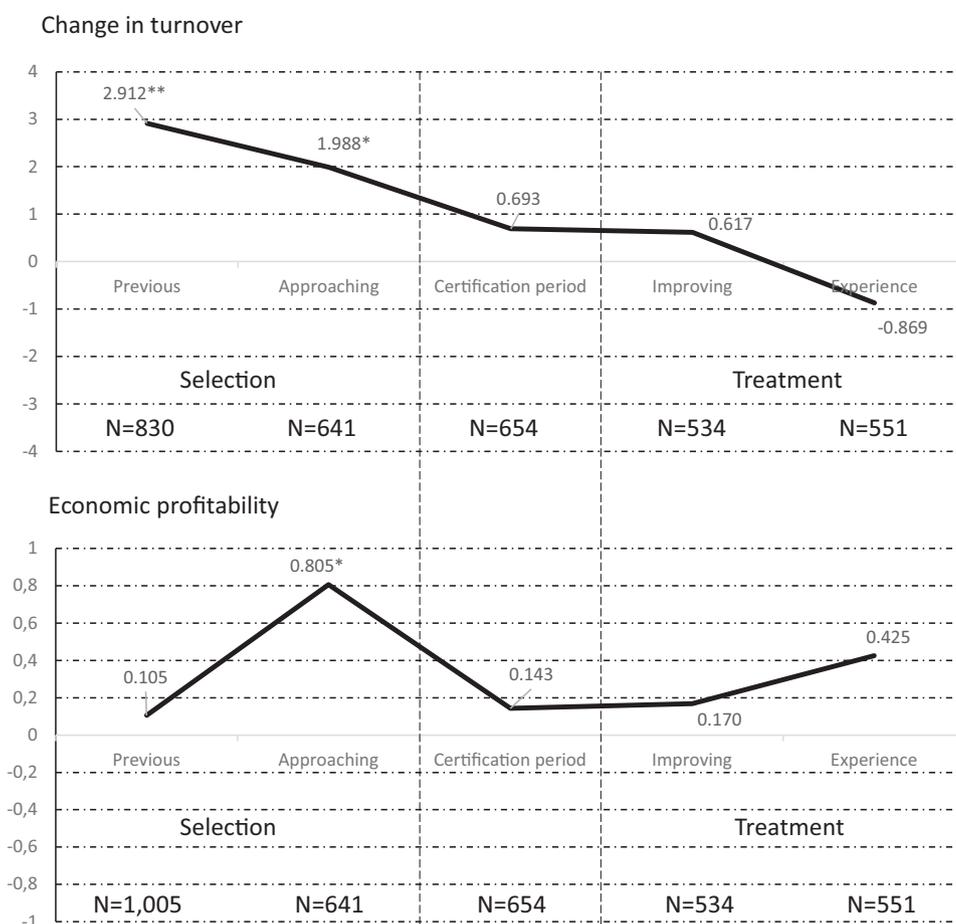


Fig. 4. Selection effect versus Treatment effect.

Source: Prepared by the authors. Note: ** Statistically significant mean differences using Student's t-test for a confidence level $\alpha = 0.01$ (two-tailed test). * Statistically significant mean differences using Student's t-test for a confidence level $\alpha = 0.05$ (two-tailed test).

Table 5

Correlation analysis of the differences between certified and non-certified samples of the variation in turnover and economic profitability according to the characteristics of the companies.

	Size (Employees)	Export level	Wood and Cork industry	Paper industry	Graphic art	Building materials and furniture	Others
Turnover	-0.013	-0.032	-0.020	-0.004	-0.011	0.042*	-0.012
Economic profitability	0.022	0.212**	-0.108**	0.040*	-0.021	0.040*	0.108**

Source: Prepared by the authors. Note: * Correlation level significant for $\alpha = 0.05$. Significant correlation level for $\alpha = 0.01$ (two-tailed test).

explained by the fact that companies with good financial results can more efficiently allocate resources to technologies and activities targeted at sustainability, such as forest certification. These results are in line with previous studies that have focused on environmental management systems such as the ISO 14001 standard (Heras-Saizarbitoria et al., 2011), ISO 14006 eco-design standard (Arana et al., 2013) or ISO 9001 quality management standard (Heras et al., 2002; Häversjö, 2000). In such studies, it is suggested that companies with greater efficiency and competitive capacity (i.e., higher economic profitability and sales growth) show a greater propensity for certification. On the other hand, external credibility, such as company image and market recognition, or ethical and moral reasons, such as signaling and learning, have been important motivations to enter certification (Zubizarreta et al., 2021; Paluš et al., 2018a). This may explain why some firms did enter certification despite missing positive financial effects.

The size of the company (measured by employees) did not significantly influence profitability or turnover. These findings are contrary to

those of studies on the impacts of Environmental Management Systems where the economic benefits obtained from certification were greater for large-scale firms. (Wang, J. and Zhao 2020; Johnstone and Labonne, 2009). However, the analysis of the economic impacts of EMS and its variation according to the companies' characteristics is still highly controversial, with limited understanding of the potential advantages of EMS.

Export levels did not impact turnover yet affected profitability. The positive connection between export growth and financial performance has also been highlighted in other studies (Chung et al., 2019; Ullah et al., 2020).

Considering differences in turnover and economic profitability between sectors, certified companies belonging to the "Building materials and furniture" subsector group obtained a higher increase in turnover and economic profitability than other subsectors, especially in 2010, 2011, and 2012. The higher financial performance in these years can be explained by the fact that this subsector has the most direct relationship

with the construction sector in Spain, which, in the aforementioned years, was trying to recover from the most severe economic crisis in its history (2007–2012). That emerged as a consequence of the ‘housing bubble’ that burst in 2007 and drastic cuts in the budget for public infrastructure (Zubizarreta et al., 2017). Proof of this fact is that between 2007 and 2011, the sector had a 75% reduction in residential building production (Zubizarreta et al., 2017). Consequently, companies supplying the construction sector, such as those belonging to the “Building materials and furniture” subsector, had to look for new markets abroad (Oviedo-Haito et al., 2013). Such reorientation has also happened to the construction sector. Moreover, forest certification is an entry requirement for exporting building materials and furniture products to the EU, which is the primary destination of Spanish wood products (Spanish Ministry of Agriculture, Fisheries and Food, 2018). Therefore, access to new markets allowed the sector to continue its activity, unlike the non-certified companies, which can explain why the certified companies, in that period, had a better result in terms of turnover and economic profitability.

6. Conclusions, limitations and future research lines

Spain has the third largest forest area in the European Union. The number of certified companies has also grown significantly in recent years, highlighting the importance of forest certification at the national level. This fact raises the question of the impacts of forest certification on companies in the forestry sector. However, studies analysing the impact of forest certification in Spain are limited. This is especially true for the economic impacts of forest certification on financial performance of companies, for which we could not find a single study. To assess the economic impact of PEFC-certification on Spanish companies, we have applied a longitudinal methodology to measure the levels of financial performance before and after obtaining the certification, analysing the treatment and selection effects. As a result of this study, a selection effect has been detected, relating companies' financial performance and their propensity to get certified. Such selection effect has been previously supported from the theoretical (Wagner et al., 2002) and empirical (Heras-Saizarbitoria et al., 2011) point of view for other management systems, but it had not yet been assessed or supported in the case of forest certification. The selection effect could be explained by the greater capacity of companies with good financial performance to allocate more resources to activities for obtaining forest certification.

In terms of performance, an important aspect addressed in this research has been the multitude of variables that influence company performance. The assumption of a cause-effect relationship between forest certification and improved financial performance is difficult to demonstrate. Assuming that a company's improved performance can be solely and directly be attributed to forest certification is risky since it is likely that other variables play a determining role in the company's performance and should not be ignored. One of these variables is the financial performance of companies before certification, which we found to be higher than that of non-certified companies. However, other aspects, such as prior certification with, e.g., FSC and ISO 9001 or 14,001 standards, could have favoured companies to self-select for PEFC certification, given the already sustainable processes present in the

company. Unfortunately, we did not have access to such information, given the reliance on the SABI database that only provides information on turnover and profitability.

The impacts resulting from adopting a management system tend to appear in the long term (Heras et al., 2002; Wolff and Schweinle, 2022). Therefore, we have analysed 14 years of economic and financial information per company to account for long term economic developments. Moreover, the large number of observations required to avoid errors must be considered. Specifically, 26,676 financial results records have been used, which might not be enough to eliminate statistical distortions due to the variables analysed ($n = 2$), the period-variable relationship ($n = 27$), the sector groups ($n = 5$), and the certification dates analysed ($n = 14$). However, the final global comparison processes always included at least 141 observations to minimize these distortions. In addition, the samples of certified and non-certified companies were formed, ensuring the same proportion, size, and export capacity of companies in each sectoral group.

The fact that only information from a single database has been used may subtract randomness when obtaining the data from the samples. Nevertheless, we think that the results obtained and the methodology used to contribute to presenting interesting conclusions for this research line. Furthermore, compared to other studies that base their findings on qualitative information, such as interviews and surveys, we have used quantitative information from an economic-financial database to avoid distortion from perceptions and opinions on financial performance. Therefore, the main contribution of this study lies in the quantitative impacts of forest certification on economic profitability and turnover, which is a novel contribution in the field of forest certification impacts study in Spain.

Finally, it is important to note that studies linking certain environmental management practices to corporate financial performance should be interpreted with caution. Apart from the financial performance, other structural characteristics may differentiate certified companies from non-certified companies, which can influence the results.

Regarding future research lines, database-based studies should be encouraged to objectively analyze environmental indicators related to chain custody, material consumption, or waste generation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgments

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Annex 1

Summary table of the literature review.

Reference	Country	Analysed certification	N	Type of study - methodology	Impacts
(Thornber et al., 1999)	Worldwide	FSC	Discussion paper	Review	Certification cannot guarantee market access or share, only enhance them if products already meet existing certified market requirements.
(Hayward and Vertinsky, 1999)	USA Canada	FSC	20 certified forest owners 117 companies	Qualitative methods: structured interviews Survey + descriptive statistics	Price premiums, improved management, market advantage, public confidence, recognition

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Annex 1 (continued)

Reference	Country	Analysed certification	N	Type of study - methodology	Impacts
(Wilson et al., 2001)		ISO 14,001, CSA, FSC, FORESTCARE			Better corporate image and credibility, market access and maintenance, and improvements in forest operations, manufacturing and logistics.
(Bass, 2001)	Worldwide	FSC	156 FSC certificates + Field case studies + interviews	Qualitative methods	Even there have been some positive experiences, most firms have yet to see a significant increase in their incomes after certification. In most cases, the higher prices obtained for certified timber have been offset by the increased costs of production and marketing
(Rametsteiner and Simula, 2003)	Europe	FSC, PEFC	130 CARs	Literature Review	For industry and trade, it is an instrument for environmental marketing and market access. For forest owners and managers, it is a tool for market access or gaining market advantage.
(Vidal et al., 2005)	North America	FSC, CSA, SFI, PEFC	158 firms	Survey to firms + cluster analysis + determinant function analysis	While marketing incentives have been an important part of what forest certification proposes, certified companies, on average, do not perceive that they are receiving benefits from this process. This fact promotes the idea that chain of custody certification is not an effective tool
(Butterfield et al., 2005)	North America and Europe	FSC, SFI, PEFC	6 company case studies	Qualitative methods: interviews	Improved market access, environmental image, better market communication.
(Oy, 2005)	Finland, Sweden, Norway	FSC, PEFC	3 selected pilot regions	Questionnaires + Interviews with forestry authorities	Forest management improvement, price premium, market access
(Newsom et al., 2005)	21 countries	FSC	129 certified operations	Descriptive statistics	The most prevalent economic impacts of certification were increased understanding of operation profitability and efficiency.
(Nebel et al., 2005)	Bolivia	FSC	FSC, SRA, Bolivian for. Ind chamber data	Descriptive statistics	Market access and higher prices, in the range of 5–51%, were paid for the majority of exported certified timber products.
(Gulbrandsen, 2005)	Norway, Sweden	FSC, PEFC	2 forest markets	Comparison analysis	Forest certification in both Norway and Sweden has been effective in terms of participation, market penetration, and – in some measure – conflict management
(Hirschberger, 2005)	6 EU countries	FSC	2817 CARs	Document analysis	Certification has improved the marketing of forest products
(Wang et al., 2005)		FSC, Smartwood			Certified wood from Changhua has more advantages in the international market with a price premium of about US\$29.41–51.47 per m3
(Cashore et al., 2006)	Worldwide	SFI, FSC, PEFC, CSA	16 case studies	Case studies + Qualitative research	Improved market access, better prices and better production efficiency.
(Yuan and Eastin, 2007)	China	FSC	41 companies	Case Study	The prices of certified forest products generally exceed the average price of forest products, by 6.3, 5.1, and 1.5%, respectively
(Auld et al., 2008)	Worldwide	SFI, FSC, PEFC, CSA	n/a	Literature review	Market access, forests management improvement and protection, deforestation reduction.
(Araujo et al., 2009)	Brazil	Cerflor, FSC	48 survey responses	Survey + exploratory factor an. + Interpretative phenomenological analysis	Certification has become more a market access requirement rather than a tool for eliciting premiums, greater product sales, or customer loyalty
(Barbosa de Lima et al., 2009)	Brazil	FSC	7 FSC certified and 7 non-certified firms	Field observations and interviews using structured questionnaires	FSC forest certification resulted in positive impacts on all socio-environmental aspects evaluated. FSC certification fulfills its role as a market tool
(Peña-Claros et al., 2009)	Tropical Region	FSC	138 CAR reports from 213 certified FMU-s	Statistical analysis (Chi square, multiple regression analyses...)	FSC certification is recognized as a useful marketing label
(Ebeling and Yasué, 2009)	Ecuador and Bolivia	FSC	78 semi-structured interviews	Interviews with government, timber industry, NGOs...	Certification can provide economic incentives for better forest management by securing a greater market share for certified producers and improving their corporate image
(Bouslah et al., 2010)	Canada and USA	FSC, SFI, CSA, ISO14001	160 third-party certification events	Event-study methodology	Certification has, on average, a negative impact on firm Financial Performance. Firms seem to adopt certification for reasons other than maximizing shareholder returns. Firms may adopt certification for ethical considerations and to respond to stakeholders pressures.
(Cubbage et al., 2010)	Argentina, Chile	FSC, CERTFOR	10 firms	Managers' opinions + secondary data from audit reports	Market recognition, No price benefits for certification
(Lidestav and Lejon, 2011)	Sweden	FSC, PEFC	449 forest owners	Analysis of 2 datasets + survey + binary logistic regression	Market access. Certified Swedish forest owners seems to have a somewhat higher price for certified timber
(Zhao et al., 2011)	China	FSC	1 Case study	Document analysis + case study	Market access, price premium.
(Espinoza et al., 2012)	USA	SFI, FSC, ATFS, PEFC	137 U.S. hardwood lumber producers	Survey + statistical analysis	Price premiums, market access, reputation
(Moore et al., 2012)	USA and Canada	FSC, SFI	92 SFI and 98 FSC certified firms	Survey + statistical analysis	Market share and better timber prices, increasing stock price

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Annex 1 (continued)

Reference	Country	Analysed certification	N	Type of study - methodology	Impacts
(Ulybina and Fennell, 2013)	Russia	FSC, PEFC	107 interviews	Qualitative methods: interviews, and participatory observation	Certification is regarded as a necessary tool for its expansion into other markets.
(Dias et al., 2013)	Portugal	FSC	209 species and 86,582 ha of savannas	National Forest Inventory data + FSC certified area analysis	Improved market access and market share
(Halalisan et al., 2013)	Romania	FSC	70 CoC certified firms	K-means cluster analysis	Market access maintenance, better reputation and international recognition. The surveyed companies mentioned that the price premium is not a benefit they obtained as a result of CoC certification
(Narasimhan et al., 2015)	USA	FSC, ISO 14001	59 firms	FSC Certificate + Compustat data analysis + Event Study Method	Positive market benefits are primarily realized by downstream firms and depend on firm's position in the supply chain. Certification can increase accountability and public credibility.
(He et al., 2015, Nordén et al., 2016)	China	FSC	20 forest stakeholders	Case study	Market benefits. Certified wood had an average price 30% higher than non-certified wood.
(Nordén et al., 2016)	Sweden	FSC, PEFC	1240 plots +327 survey responses	Descriptive statistics	Certification may create opportunities to access new markets that favour certified forest products.
(Burivalova et al., 2017)	Africa, Asia, and America	FSC	50 studies	Literature Review	Market access, price premiums for certified products were reported in most cases, but they rarely met the expectations of forest managers. Furthermore, reported price premiums varied over time and were highly species-, product-, and country-dependent.
(Paluš et al., 2018a)	Slovakia	PEFC, FSC	273 survey responses	Survey + Mann-Whitney U test + chi-square test	FSC-certified forest owners perceive mainly economic benefits connected to market penetration, increased sales volume, and potential price premiums.
(Tricallotis et al., 2018)	Chile	FSC, PEFC	72 Chilean forestry sector actors	Qualitative research: in-depth Q:interviews	Certification allowed all large companies to maintain their traditional access environmentally sensitive markets. Small-medium PFBs gained access to markets that otherwise they would not be able to access without certification. No Chilean company reported premium prices for selling certified timber.
(Frey et al., 2019)	Mexico	FSC	27 Community Forest Enterprises (CFEs)	Descriptive statistics + production functions	Evidence suggests that capacity development support programs and forest certification jointly do increase productivity of timber harvest and also increase community income. Forest certification in particular seemed to have a positive effect on community income.
(Frey et al., 2021)	Southeastern Tanzania	FSC	14 FSC-certified community forests	Economic/financial analysis using the Green Value Tool	To date, most timber from the Community Forests, although certified, has been sold at the same price as uncertified timber harvested from Tanzania's government forest reserves.
(Tham et al., 2021)	Central Vietnam	FSC	66 forest industry stakeholders	Qualitative research: interviews	woodchip value chain is financially profitable, with the FSC-certified furniture value chain contributing most to economic development
(George et al., 2022)	Northeast USA	FSC, SFI, ATFS, PEFC	157 survey responses	Descriptive statistics	Forest certification programs (FCP) have not delivered price premiums while also increasing financial and bureaucratic burdens on forest managers. The prohibitive cost of forest certification auditing and lack of price premium are the greatest challenges.
(Malek and Abdul Rahim, 2022)	Worldwide	FSC and PEFC	70 articles	Thematic review	Forest certification also has a positive impact in terms of economic benefits to businesses. The benefits of access to new markets are linked to increases in sales volume and timber prices.

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