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Producers of electricity from photovoltaic energy in Spain:
A structural and financial analysis

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The environmental scope of electricity generation that results in lower production costs and greater economic benefits is a main concern for planning post carbon cities. We perform a comparative economic and financial analysis of Spanish firms in the sector of photovoltaic energy production to, in order to check the impact of regulatory changes in the industry, and to compare firms in A Coruña and Galicia in the Spanish context. The effect of changes in regulation are obvious in terms of investment: In Spain and Galicia, more than 90% of the firms were launched in the decade of 2000s, and no asset increase by existing firms is observed in recent years. Firms launched in Galicia in that decade were relatively very small, and barely generated any employment. 95% of the firms in Spain are micro enterprises, but the structural analysis shows the negative impact on the competitiveness of the sector in Galicia of lacking large or medium companies. Finally, the exploratory statistical analysis shows a counter-intuitive result in terms of profitability: despite micro Galician firms have lower operating margins and generate a lower economic return than their Spanish counterparts, they are more profitable in terms of their return to shareholders.
KEYWORDS: renewable energies, photovoltaic energy, economic-financial analysis, sustainable building, PLEA

1. INTRODUCTION

The increased energy consumption, price volatility, and depletion of fossil energy resources has driven the search for cleaner technologies to produce, distribute and use energy [1]. The environmental scope of electricity generation that results in lower production costs and greater economic benefits is a main concern for planning post carbon cities [2].

In the EU, renewable energies account only for 11% of the production mix (in year 2015). After the Lisbon Treaty (2007), a key objective is to promote efficiency, energy savings and new forms of renewable energy. The European Commission launched SET (COM/2009/0519), which sets the strategy to develop a low-carbon economy and reduce energy dependence. Renewable sources are seen as an opportunity, not only at the environmental level, but in terms of promoting economic growth [3]. However, each country in the EU has some freedom to choose the mix of energy generation. In Spain, the Government fostered in 2007 the use of renewable technologies – particularly, producing electricity from photovoltaic energy by means of a compensation system for each MW/h produced – only to cap those incentives in 2010 above a maximum number of hours of production paid per year. In 2012, the new Government issued Law 15/2012 on fiscal measures for energy sustainability, which further penalized electricity generation with renewable technologies with a 7% tax.

In planning the post-carbon cities, the use of renewable energies in sustainable building becomes essential, and the production of electricity from photovoltaic energy has several advantages here: it promotes construction costs reduction, energy efficiency since the electricity generated may be consumed in situ, technical quality, and safety.

The goal of this article is to perform a structural, economic and financial analysis of the firms in the industry of electricity production from photovoltaic energy in Spain, years 2012 to 2018. This allows us to provide both a longitudinal analysis, to check the impact of regulatory changes in the industry and the financial crisis, as well as a regional cross-section analysis to compare firms in A Coruña province and Galicia (where the PLEA Congress is held) in the Spanish context. To such purpose, we use the SABI database to filter the sector of interest – "Production of electricity of other types" (code 3519 in the Spanish CNAE-2009), and retrieve any active companies with positive revenues in years 2012, 2015 and 2018 (which are to be used for comparative purposes).

The rest of the article is structured as follows. Section 2 briefly develops the conceptual framework, and describe the sample and data of analysis. Section 3 characterizes the population of firms in Spain, Galicia and A Coruña province in terms of the UE 2003/361 classification, in order to perform a structural analysis of the sector, comparatively among regions. Then, Section 4 provides an economic and financial analysis of the firms. Section 5 concludes. A statistical appendix can be provided upon request to the authors.

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2. CONCEPTUAL FRAMEWORK, SAMPLE AND DATA

2.1 Sustainable building and renewable energy production: European context

Using renewable energies in sustainable building, three goals must be achieved: technical quality of the electricity-generation technology and constructive characteristics, energy efficiency to preserve the environment, and safety. Photovoltaic technologies show many advantages here, that stem from their integration in the buildings themselves [4]. The photovoltaic elements may offset the cost of construction, and the electricity generated may be consumed in situ, enabling energy savings and optimization [5]. For a review on the state of the art of the architectural integration of photovoltaic modules and construction materials in sustainable building, see [6]. For a review of the critical factors in reducing the cost of building integrated photovoltaic systems, see [7].

This article is oriented to analyse the industry of electricity production from photovoltaic energy. Thus, we summarise the recent changes in the EU in the last two decades. These are characterized by an increasing orientation of the policies of Member States to help improving the conditions of energy production through renewable sources [8]. The EU Energy Policy evolved towards renewable energies such as biomass, as wind energy had a high degree of maturity. Directive 2009/28/EC for the promotion of renewable energies includes sustainability requirements for biofuels and bioliquids (Arts. 17 to 19) and encourages the use of other renewable sources (photovoltaic) whose systems do not require as much space.

Today, the EU has a leading position in the field of renewable energy, with 40% of the world's patents for this type of technology [9]. In 2012, Europe had almost half of the world's renewable electricity production capacity, excluding hydro. Five European countries are among the top ten in the world by accumulated installed solar photovoltaic capacity in 2015, and Spain ranks eighth with 5.4GW [10].

2.2 Sample and variables

We use data from the SABI database, which provides financial information on Spanish MSME firms. We retrieve data from the individual financial statements (that is, not consolidated), years 2012 to 2018, of any companies classified as 'no incidents' (excluding merged, absorbed, closed and other non-existing firms). We consider the firms from sector "Production of electricity of other types" (code 3519 in the Spanish CNAE-2009, in accordance with EC 1893/2006 for the statistical classification of economic activities in the EU (NACE) Rev.2.), and filter out any companies with zero or negative revenues. All monetary data are expressed in thousands of euros.

We retrieve the variables: date of business registration, region, and for each year of analysis, the number of employees, total assets and equity from the balance sheets, and revenues, EBITDA, EBIT, and net profit (NP) from the income statements. Using these items, the following ratios are estimated. For cross-sectional analysis, we obtain the total asset turnover ("Rota"), return on assets (ROA), return on equity (ROE), operating margin ("margin", estimated at the EBITDA level), and capital ratio ("capital"). For longitudinal analysis, we get the annual growth ratios for assets ("Cassets"), revenues ("Creven"), net profit ("Cprofit"), employees ("Cemp") and operating margin ("Cmargin"). To avoid extreme outliers that are common in the use of financial ratios, we winsorise data at 5% and 95% for all ratios. The list of variables is provided in Table 1.

Table 1: Variables and descriptive statistics.

	N	Mean	St.Dev	min	p25	Median	p75	max
Age	1882	13.003	3.588	7	12	12	13	50
Assets18	1882	11617.25	308000	2.611	194.312	358.812	579.842	1.30e+07
Revenues18	1882	2171.325	53207.98	1.812	56.88	71.065	85.356	2228568
Employees18	1882	2.409	82.368	0	0	0	0	3565
EBIT18	1882	855	25556.38	-4061	2.919	15.766	32.79	1094007
EBITDA18	1882	1294.579	38717.24	-3936	36.494	51.008	65.139	1666520
NP18	1878	641.365	18774.19	-7615	-2	5	23	797393
Equity18	1882	4242.918	133000	-22900	-8.891	67.517	219.781	5719090
Rota18	1703	.297	.284	.08	.14	.2	.33	1.94
ROA18	1694	4.861	5.778	-5.97	1.45	3.575	7.21	32.95
ROE18	1692	9.241	18.136	-24.54	-.845	4.155	15.435	84.8
Margin18	1694	66.143	22.955	.29	61.46	75.13	80.5	90.07
Capital18	1694	24.762	36.957	-98.7	.29	21.335	51.92	93.71
Cassets18	1695	-7.383	7.077	-27.38	-11.57	-6.69	-2.62	9.26
Creven18	1694	-2.22	3.7	-10.02	-4.93	-2.21	.34	12.27
Cprofit18	1555	-45.869	92.881	-275.44	-100	-10.61	17.12	95.74
Cemp18	205	-19.033	39.811	-100	-20.63	0	0	31.04
Cmargin18	1693	-1.595	9.434	-28.82	-6.24	-.53	2.05	30.03

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3. STRUCTURAL ANALYSIS, YEAR 2018

3.1 Profiling according to types UE 2003/361

We perform the structural analysis at two levels: by size (MSME typology) and by age groups. Our goal is to describe the structure of the sector, comparatively between the Spanish, Galician and A Coruña regions. We firstly observe the number of firms registered in the Commercial Registers in each region, the average size (assets and revenues) and average number of employees per group in year 2018 – see Table 2.

Table 2: Number of firms and average size by assets, revenues and employees. Year 2018.

Group	Firms	Assets	Revenues	Employees
A Coruña	25	1,705.7	668.4	0.5
Galicia	154	853.3	188.8	0.1
Spain	1,703	12,736.1	2,372.7	2.7

Using data from year 2018, we may see that Galician firms are noticeably much smaller in size than Spanish companies, in terms of assets and revenues. Firms from A Coruña province, instead, are larger on average than Galician firms (twice as much), and with a higher rotation – their average revenue is more than three times higher. Another feature to highlight is the fact that Galician companies barely hire employees (an average of 0.1 workers per firm, 0.5 in the case of companies in A Coruña). Therefore, in the analysis that follows, we want to classify firms by size, in order to better interpret where these differences among groups take place. Thus, we define micro, small and medium enterprises, MSMEs, following the criteria laid down in the EU Recommendation 2003/361/EC by the European Commission. That is, individual firms are classified as small (micro) enterprises if staff headcount is less than 50 (10) and either turnover or balance sheet total is less than 10 (2) million. Medium-sized firms are those with less than 250 workers, and either less than 50 million annual turnover or 43 million in assets. Any other firms that do not fit in those categories are considered to be large.

3.2 Structural analysis by MSME typology

After firms are classified according to the MSME types, and compared whether they are from A Coruña province, Galicia or Spain, we have Figure 1 next. In it, we also compare the average assets, revenues and employees per region and group of analysis.

We may see that 95% of the producers of electricity from photovoltaic energy in Spain are micro enterprises. Most of them fall under that category because few companies in this sector in Spain hire more than 10 employees. Moreover, the percentage of big and medium firms in Spain is 0.3% and 0.7% (5 and 12 companies out of 1703, respectively). Clearly a minority, but still relevant: while there are no big or medium firms in Galicia, this 1.0% of firms account for 87% of the revenues and employees in Spain.

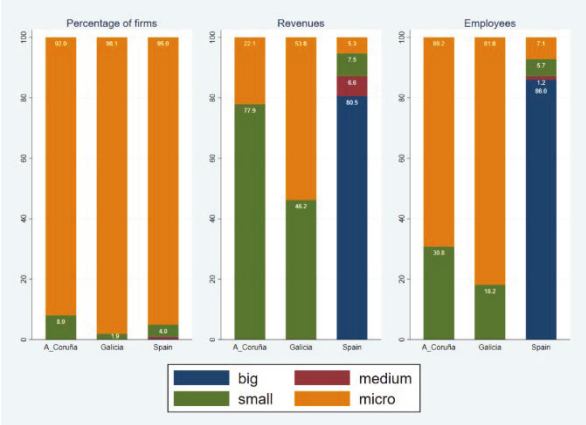

Figure 1: MSME typology (% of firms, revenues and employees). Year 2018.

The combined information from the three graphs shows the negative impact on the competitiveness in Galicia of not having large or medium companies. In A Coruña province, the structure is quite similar to that of Galicia. Nonetheless, the ratio of micro enterprises is 92% versus 98.1% in Galicia. Hence, the greater proportion of small companies in A Coruña makes that almost 80% of the revenues and 30% of the jobs come from these firms, compared to 46% and 18% in Galicia.

A statistical analysis that compares Galician versus Spanish firms shows that micro enterprises in Galicia are significantly smaller than micro Spanish firms ($p \approx 0.07$): 0.5 million euros in assets vs. 0.83 million, respectively. Nonetheless, we observe no statistically significant differences in revenues. Finally, micro Galician firms have significantly less employees hired than micro Spanish firms ($p \approx 0.01$), although the number of employees is negligible in both cases (0.06 employees per firm in Galicia; 0.20 in Spain).

Finally, we analyse the degree of concentration in the industry; that is, to what extent are the revenues and profits generated in the sector in the hands of a few number of companies. To that purpose, we estimate the percentage of revenues that the top decile of firms by revenues in each region obtain over the total, and then we do the same with net profits.

We find that the sector is more concentrated in Spain: the largest producers of electricity from photovoltaic energy hold 97% of the revenues and 101% of the profits. The sector is clearly biased towards these major players: the second decile by profits only account for 0.6% of the total, and deciles 2 to 9 cannot even obtain as much profit as to compensate for the losses of firms in decile 10. In A Coruña and, particularly, Galicia, revenues and profits are not so highly concentrated. The top decile firms in

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Galicia account for 66.2% of the revenues, while the top decile by profits, with 93.4%, is closer to the degree of concentration in Spain. However, the second decile in Galicia is able to generate as well 39.3% of total profits, and deciles 2 to 9 up to 55.3% of the profits. What makes the difference here is the fact that the worst performing firms in Galicia lose 2.5 million euros (almost half of the total profits), when in Spain the number of firms and the size of the losses of the worst performing companies is clearly lower.

3.3 Structural analysis by age

We perform the structural analysis considering, for each region, three different groups of firms according to the decade they were registered – see Figure 2.

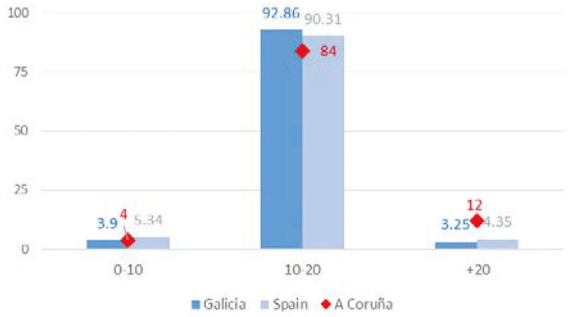

Figure 2: Structure by firm age (% by region - Year 2018).

Firms are classified as either having less than 10 years since inception, between 10 and 20 years, and over 20 years. The most important result is clear: the effect of changes in regulation of production of electricity from photovoltaic energy was a surge of firms launched in the decade of 2000s, only to drop back at minimum levels after the incentives were withdrawn in 2010. In Spain and Galicia, more than 90% of the firms are between 10 and 20 years old. A minor detail, in A Coruña province the increase was not as important in relative terms: seven times more firms were registered in that decade compared to those existing before year 2000, whereas in Spain that ratio was over 20 times, and almost 30 times in Galicia.

We may compare as well the average data for total assets, revenues and number of employees in each of these groups by region and age. This will tell us more on the level of investments (measured as assets and employment today) fostered by the regulation in the 2000s, and whether it was followed by a better or worse performance at income level.

Firms launched in Galicia in the decade of 2000s were really tiny, compared against those launched in Spain. Thus, the 143 firms in Galicia that are between 10 and 20 years old have an average size of 775 thousand euros in assets, 15 times smaller than their Spanish counterparts (more than 1,500 firms). Moreover, Galician firms barely generated any employment (their average number of employees per firm is below 0.1, compared to 2.8 in Spain). Finally, in terms of revenues they didn't perform any better, as the cross-section ratio is similar (15 times smaller for Galician firms). This gap has been largely reduced in the last decade, when Spanish firms are only double the size of Galician start-ups, both in terms of assets and revenues – although Galician firms continue to generate no employment at all.

Expressed in relative terms for median levels per group, most revenues and employment in A Coruña come from firms more than 20 years older. The structure in Spain and Galicia is quite similar at revenues level, but different in terms of employment: the number of jobs created in A Coruña and Galicia over the last 20 years is minimum, while in Spain most of it is driven by younger firms. Nonetheless, the variability within groups is quite large: the statistical analysis shows that there are no significant differences in assets, revenues or number of employees for Galicia vs. Spain across the same age groups.

4. ECONOMIC-FINANCIAL ANALYSIS

4.1 Return and capitalization

The first goal in our economic and financial analysis of companies in the photovoltaic sector in A Coruña, Galicia and Spain, is to compare the return – operating margin, return on assets (ROA) and return on equity (ROE) – and the capital ratio of companies across size and age groups.

Considering size, we use MSME types to compare the median values across groups of the four variables. The results are summarized in Figure 3. First thing to notice is the evidence that we cannot compare large and medium categories, since only Spanish firms are available here. In the other categories, we see a clear outperformance of small firms from A Coruña, both in terms of ROA and ROE, and they are better capitalized, too. Nonetheless, we must remember there are only three firms in this group. Consequently, we perform a statistical analysis to show any differences between Galician and Spanish firms that are significant. They follow in order. First, micro Galician firms are significantly ($p<0.001$) less profitable than micro Spanish firms in terms of ROA (3.0% vs. 4.9% on average). However, on the contrary, micro Galician firms are significantly more profitable ($p<0.001$) than micro Spanish firms in terms of ROE (14.3% vs 8.3%, respectively). These counter-intuitive and opposite results must come from lower levels of depreciation and amortization (D&A) by Galician firms (due to their smaller size), higher income from public grants (this, if true, would be related to regulation), or a positive impact in terms of taxes and leverage (although the latter doesn't seem to be a plausible interpretation, since we observe in Figure 3 that median capitalization values are similar for both regions).

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Figure 3: Return and capitalization by MSME typology. Median values, year 2018.

A similar analysis can be performed by age (figure not provided here). It shows that the counter-intuitive result of a lower ROA but higher ROE is observed particularly for companies from A Coruña that were launched in the 2000s and, to a lesser extent, for Galician firms of the same age group. Nothing surprising since, as we saw, more than 90% of the firms, both in Galicia and Spain, were launched in that decade. In fact, a statistical analysis shows that these Galician firms are significantly less profitable ($p<0.001$) than their Spanish counterparts (an average ROA of 3.1% compared to 4.9% for Spanish firms), while they are significantly more profitable ($p<0.001$) in terms of ROE (15.1% vs 8.3%, respectively).

4.2 Dynamics between years 2012 and 2018

In this subsection we make use of the retrieved information from years 2012 and 2015. In particular, our goal is to analyse the recent performance of the sector in terms of total assets and revenues – over periods 2012 to 2015 and 2015 to 2018 – as well as in terms of profitability and employment creation after 2015, comparatively for A Coruña, Galicia and Spain.

Data in Figure 4 uses median values to avoid the effect of outliers (potentially causing larger bias when dealing with growth ratios). The first clear result comes from the analysis of assets growth: most firms in the sector are reducing assets (the median value indicates a reduction of 6-8% each 3-year period in all regions). This probably corresponds with a situation where most companies are not making any new investments after they were launched, such that assets are simply reduced by the D&A expense amount every year. Nonetheless, some differences are observable among groups: a statistical analysis shows that older Galician firms (+20 years) reduced assets over the period 2015-18 at a faster pace than their Spanish counterparts (an average of -13.9% in 3 years vs. -5.2% in Spain, $p<0.05$).

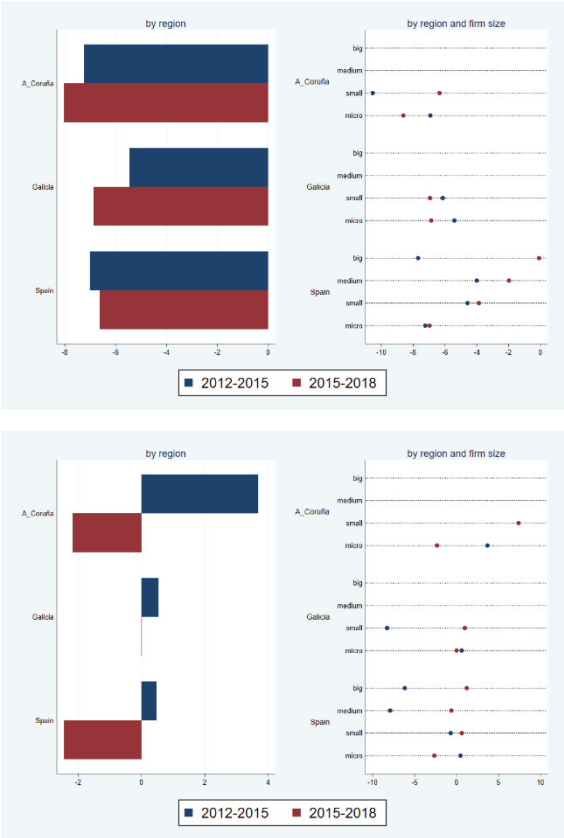

Figure 4: Assets growth and revenue growth, 2012-2015 and 2015-2018. By region and size.

The analysis of revenue growth suggests a stagnation of revenues after changes in regulation, with a slight negative trend in Spain (-2% in 3 years) after year 2015. The statistical analysis shows that most Galician firms performed better: Spanish micro firms and those that were launched in the 2000s decade reduced revenues over 2015-18 at a faster pace than their Galician counterparts (-1.5% Galicia vs. -2.5% Spain for micro firms, -1.4% vs. -2.3% for the referred age groups, both results statistically sound at $p<0.01$).

Consequently, we focus on period 2015 to 2018, when firms faced a worse environment, to observe their performance in terms of profits and employment creation. This is illustrated in Figure 5.

Median values indicate a moderate scenario in terms of profits: in the groups of small and medium size firms we may find more than half of the companies with a positive growth in profits. However, average values are negative, due to the presence of firms with large losses. Here, the statistical analysis shows that profit deterioration was stronger ($p<0.05$) for micro Spanish firms than for micro Galician firms (-20% vs. -48%). Again, that difference comes basically from firms launched in the 2000s (-9% vs. -48%, $p<0.01$). In terms of employment, all groups reduced the number of jobs between 2015 and 2018. No statistically significant differences were found in employment creation across same size or age groups.

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Finally, changes in median ROEs suggest that, despite the context of reduced revenues, a majority of firms of all regions and sizes were able to improve their return to shareholders in year 2018 compared to 2015.

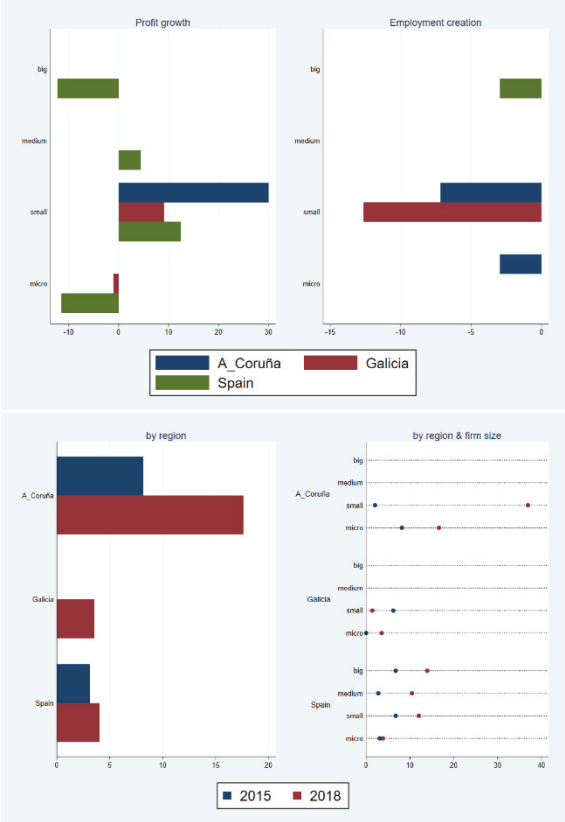

Figure 5: Profit growth, employment creation and ROE, 2015 a 2018. By regions and size.

5. CONCLUSION

We performed a structural and financial analysis of producers of electricity from photovoltaic energy in Spain. We provided a longitudinal analysis, to check the impact of regulatory changes in the industry and the financial crisis, and a cross-section analysis to compare firms in A Coruña and Galicia (where the PLEA Congress is held) in the Spanish context.

In a context where 95% of the firms in Spain are micro enterprises, Galician firms are noticeably much smaller in size than their Spanish counterparts, both in terms of assets and revenues, and most of them hire no employees at all. This shows the negative impact on the competitiveness of the sector in Galicia of not having large or medium companies: in Spain, these firms represent only 1% of the sector, but account for 87% of the revenues and employees. Indeed, the sector in Spain is clearly biased towards these major players: the top decile holds 100% of the profits, and the second decile only 0.6%. In Galicia, the worst performing firms lose 2.5 million euros (almost half of the overall profits). The exploratory statistical results suggest that micro enterprises in Galicia are smaller than micro Spanish firms, and hire less employees.

The structural analysis by age shows the effect of changes in regulation: there was a huge increase of firms launched in the decade of 2000s, only to drop back at minimum levels after the incentives were withdrawn in 2010. In Spain and Galicia, more than 90% of the firms are between 10 and 20 years old. Firms launched in Galicia in that decade of 2000s were really tiny: on average, 15 times smaller than their Spanish counterparts, and barely generated any employment.

The financial analysis shows a counter-intuitive result in terms of profitability: despite Galician firms (particularly, micro enterprises) have lower operating margins and generate a lower economic return than their Spanish counterparts, they are significantly more profitable in terms of their return to shareholders. This result must come from lower levels of depreciation and amortization (D&A) by Galician firms (due to their smaller size), higher income from public grants (related to regulation), or a favourable impact in terms of taxes and leverage. Finally, the dynamics between years 2012 and 2018 shows a sector where no new investments are being performed, revenues are stagnated or decreasing slightly (with Galician firms performing better), and companies were able to sustain profits only by reducing employment.

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