RESEARCH ARTICLE

WILEY

Sustainable university entrepreneurship: Revisiting firm growth patterns

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Abstract

Previous research on the firm growth of the university spin-offs (USOs) and its drivers yields inconclusive results. Recently, the literature on the high-growth firms (HGFs) has relied on regression quantile methods to study how the effects of growth determinants may differ along the firm growth distribution. This study builds a bridge between the two strands of literature by exploring how firm-specific characteristics may shape sales and employment growth patterns of USOs. To this end, it applies panel data quantile regression models in a sample of 531 Spanish USOs over the period of 2001–2013. The results show that the growth drivers not only differ between employment growth and sales growth but also along the growth distributions.

KEYWORDS
firm growth, panel data, quantile methods, sustainable entrepreneurship, university spin-offs

1 | INTRODUCTION

"Universities must contribute to their region's economic development" has recently become a mantra for politicians, public administrations and academic institutions. To accomplish this 'third mission', the creation of firms (university spin-offs or USOs) has become a key element and gained more attention than other knowledge transfer mechanisms like patents or contracts (Hess & Siegwart, 2013; Lockett et al., 2005).

With the rise of USOs' popularity, research has outlined their role in strengthening technology transfer, economic development and job creation (Cantner & Goethner, 2011; Zhang, 2009). Nevertheless, other authors have questioned their contribution to the economy (Mustar et al., 2008; Siegel & Wright, 2015). While it is true that USOs have been seedbeds of a considerable number of high-growth ventures in contexts such as MIT, North Caroline, and Stanford, (Hesse & Sternberg, 2017; Rasmussen & Wright, 2015), in many other scenarios, especially in peripheral regional economies (Brown, 2016), results appear disappointing (Harrison & Leitch, 2010) as the majority of USOs grow slowly or remain small for long time (Galati et al., 2017). Thus, Colombo et al. (2010) and Hesse and Sternberg (2017) indicate that most of science-based entrepreneurial firms create only a few jobs while the 'gazelles' are rather the exception. Moreover, Brown and Mason (2014) clearly remark that very few USOs become HGFs in the case of Scottish economy.

These findings have put university entrepreneurship at the centre of the debate as governments and universities have invested a large amount of public funds in targeting this kind of start-ups (Leendertse et al., 2021), which only makes sense if these firms grow. The creation of economically sustainable firms is also important because their greater human and financial resources favour environmentally committed business practices (Balasubramanian et al., 2021; Martínez-Ferrero & Frías-Aceituno, 2015). However, the limited resources of

small firms make investment in environmentally oriented business practices a costly and risky strategy (Andersén et al., 2020).

To analyse the real contribution of USOs, a significant strand of the literature on USOs has focused on its growth. In this field, some empirical studies analyse whether USOs grow more than similar firms, while others explore the determinants of the USOs' growth at macro, mezzo and micro levels (Mathisen & Rasmussen, 2019; Miranda et al., 2018). Within this last group of studies, few works have examined the role of firm-specific characteristics, obtaining inconclusive results about the growth drivers of USOs. This scarcity of empirical studies concerning the growth determinants at a firm level is somewhat surprising given that a set of firm characteristics, such as age or innovative activities, has been traditionally pointed out by the literature on firm growth (see Coad, 2009). This approach is also supported from the resource-based view (RBV) of the firm (Barney, 1991; Penrose, 1959), which considers resources and capabilities, such as financial, human capital and technological resources, among others, sources of competitive advantages for firms in general (Teruel-Sánchez et al., 2021) and for USOs in particular (Berbegal-Mirabent et al., 2015; Lockett & Wright, 2005).

Moreover, a recent stream of the literature on firm growth posits that the influence of growth determinants may differ along the firm growth distribution (Bianchini et al., 2015). This strand of literature is mostly focused on high-growth firms (HGFs) whose proven contribution to job creation (Acs, 2015; Henrekson & Johansson, 2010; Moreno & Coad, 2015) and to economic growth in developed countries (Martínez-Fierro et al., 2020) makes them a topic of growing interest for academics and governments.

In this paper, we rely on the two aforementioned branches of the literature to enlighten the debate on the determinants of the USOs' growth at the firm level. More specifically, the inconclusive results regarding the determinants of the USOs' growth (first branch) might be partly due to a neglect of the heterogeneity of the firm growth rate distributions, which use to follow a 'tent shape' (Bianchini et al., 2015). To deal with this issue, the literature on the HGFs (second branch) has recently relied on regression quantile methods to study how the effects of growth determinants may differ along the firm growth distribution. Bringing together the contributions of both branches of the literature may provide a more complete picture of the USOs' growth. This approach is also logical since some university entrepreneurship ecosystems have become a source of HGFs (Rasmussen & Wright, 2015), and USOs share characteristics with HGFs such as the high presence of knowledge-intensive firms (Fernández-López et al., 2019).

Thus, this paper explores the effect of firm-level growth drivers of USOs through the application of panel data quantile regression models. We argue that this analysis can yield more robust findings regarding the determinants of the USOs' growth at the firm level. First, unlike standard regression analysis, quantile regression allows for a description of the entire conditional distribution of the USOs' growth (Coad et al., 2016; Coad & Rao, 2008). Second, as shown in the following sections, the USOs' growth rates follow a 'tent-shaped' distribution, discarding the least squared methods based on the

assumption of normally distributed errors. Third, the dynamic nature of firm growth can be captured more clearly by applying panel data methodology.

This study extends previous research along two dimensions. First, it enlightens the debate on the determinants of the USOs' growth at a firm level, which is still rather limited, particularly in the field of sustainable entrepreneurship literature (Klapper et al., 2021) The second contribution is related to the attention given to HGFs. While scholars have defended the high potential growth of USOs, no study has attempted to determine which firm-level determinants may boost the USOs' growth over the 'average firm', which could be analysed by using regression quantile methods. To the best of our knowledge, no study has used this empirical approach in the case of USOs.

This paper is organized as follows. Section 2 includes the literature review. In Section 3, the data and the variables are described, as well as the econometric models. The empirical findings are presented in Section 4. Finally, Section 5 presents the main conclusions, limitations and future research lines.

2 | LITERATURE REVIEW

In this paper, we capitalize on the overlaps of two strands of the literature on firm growth. The first branch analyses the determinants of the USOs' growth, while the second one explores the driver forces of the HGFs.

2.1 | The USOs' growth: A brief summary of the empirical results

The increasing availability of microdata triggered a bourgeoning body of literature on the USOs' growth. The studies on the topic can be classified into two main groups (Mathisen & Rasmussen, 2019): The first group compares the USOs' growth rate with that of similar counterparts and the second group explores the growth drivers of USOs.

Regarding the former group, several works show that USOs outgrow similar firms (Criaco et al., 2014; Rodríguez-Gulías et al., 2016; Rodríguez-Gulías, Rodeiro-Pazos, & Fernández-López, 2017a; Zahra et al., 2007), whereas other authors find the opposite result (Colombo & Piva, 2005; Ensley & Hmieleski, 2005; Salvador, 2011; Wennberg et al., 2011; Zhang, 2009). Moreover, a non-negligible number of studies in this group yield inconclusive results (Cantner & Goethner, 2011; George et al., 2002; Ortín & Vendrell, 2014).

Regarding the second group of studies, the authors have used multiples perspectives in order to identify the growth drivers of USOs at macro, mezzo and micro levels (Mathisen & Rasmussen, 2019; Miranda et al., 2018). Within this branch of the literature, the mezzo level is probably the most widely researched level, where the emphasis is placed on the role played by the universities and technology transfer offices (TTOs) and their respective policies in enhancing the USOs' growth (Bonardo et al., 2010; Colombo et al., 2010; Epure et al., 2016; Mustar et al., 2008; Zahra et al., 2007).

At the macro level, namely, at a regional level, several studies have recently explored how the environment of USOs affects their growth (Epure et al., 2016; Fini et al., 2017; Rodríguez-Gulías, Rodeiro-Pazos, & Fernández-López, 2017b).

Finally, studies at the micro level focus on firm-level variables that explain the USOs' growth. Broadly speaking, a large number of papers within this group of studies pay attention to the entrepreneur team, mainly considering the characteristics of founders and their networks (Ben-Hafaïedh et al., 2018; Colombo et al., 2010; Mustar et al., 2008; Tagliazucchi et al., 2021; Wennberg et al., 2011). In contrast, few studies have explored the role played by firm-specific characteristics, which is somewhat surprising since the literature on firm growth has highlighted a set of firm characteristics, such as size, age or innovative activities, among others, as main determinants of firm growth (see Coad, 2009). Indeed, studies testing the effect of a broad set of firm characteristics on the USOs' growth have only emerged in the last decade. Thus, Table 1 summarises the results of that papers on the USOs' growth that consider at least five firm-level characteristics in the empirical analysis.

This study aims to fill this gap of the literature. Thus, the wide literature on firm growth emphasizes the need of analysing the role played by firm-specific characteristics in firm growth. Moreover, the RBV of the firm (Penrose, 1959), which has been the most widely used theoretical approach to explore the USOs' growth in the above-mentioned studies, also establishes how a set of factors at a firm level can become invaluable resources and allow for the deployment of strong capabilities, giving firms a competitive advantage. Therefore, this paper tests a wide set of firm-level variables to determine whether they contribute to the USOs' growth.

2.2 | The HGF: The importance of a quantile regression approach

In line with the increasing interest in USOs, a strand of literature on firm growth has recently posited that the effects of growth drivers may vary along the firm growth distribution (Bianchini et al., 2015). This branch of the literature has mainly focused on the study of HGFs. Although the literature has employed different definitions of HGF (see Delmar et al., 2003; Moreno & Coad, 2015 for a more extensive review), the one proposed by Eurostat and the OECD in 2007 is the most widely accepted definition for empirical purposes (OECD, 2007). According to OECD (2007) and Eurostat (2007), a company with 10 or more employees with an average annual growth rate of at least 20% during a period of 3 years could be considered a HGF. In this respect, growth can be measured by the number of employees or by sales.

In recent years, HGFs have gained the attention of academics (see Llantada et al., 2012; Coad et al., 2014; Moreno & Coad, 2015 for an extensive review) and policymakers because of their importance for the economy (Henrekson & Johansson, 2010), mainly due to their high capacity for job creation. To a certain extent, USOs share characteristics with HGFs (Fernández-López et al., 2019). Thus,

TABLE 1 Literature review of the firm-level determinants of the USOs' growth

Authors	Firm age	Profitability	Founders	Team	Financing	Venture capital	R&D and innovation	Patents	Industry	University links	Size	Location
Serarols et al. (2011)			()		*	0	+	+	+			
Czarnitzki et al. (2014)			+		+		+	+		+		
Van Geenhuizen et al. (2015)	+			*	*				0		+	0
Gubitta et al. (2016)			()		+	+		0	*			
Rodríguez-Gulías, Rodeiro-Pazos, and Fernández-López (2017a)	U	+			+	+			*			
Corsi and Prencipe (2018)	0	+	()	+	0	0			0		−	
Fernández-López et al. (2019)	0	+		+	+	0	0		0		+	−
Salvador et al. (2019)	+	+	+			+	+	0	0			0
Sciarelli et al. (2021)	0		*	+	0						+	
Vega-Gómez et al. (2020)			()	*	0			0		*	+	

Note: The table include the most recent studies on the USOs' growth that consider at least five firm-level characteristics in the empirical analysis. (+)/(−)/()/* denote a positive/negative/no evidence/several relationships between the firm's characteristic considered (in column) and the USOs' growth.

knowledge-intensive firms tend to be overrepresented in both HGFs (Daunfeldt et al., 2015) and USOs (Calvo et al., 2017; Fernández-López et al., 2017). Moreover, according to Autio et al. (2007), universities seem to be a natural environment for the application of support measures in favour of HGFs since many of them use innovative technology developed by academics and/or are located in university incubators. In fact, some university environments, namely, MIT and Stanford, are seedbeds of a non-negligible number of high-growth ventures initially born as USOs (Rasmussen & Wright, 2015). To a lesser extent, this circumstance holds in other university contexts. Thus, after analysing a sample of 246 Spanish USOs, Rodríguez-Gulías, Fernández-López, et al. (2017) conclude that HGFs are more overrepresented between USOs than in the 'population' of overall Spanish firms.

In spite of these similarities, only the study by Fernandez-López et al. (2019) have analysed which factors contribute to turning a USO into a HGF. Their results partly coincide with those of other studies performing a similar analysis for the overall population of firms (Table 2). Thus, Fernandez-López et al. (2019) use a probit model and conclude that the USOs' probability of being a HGF is positively influenced by their number of employees, export activities, profitability and indebtedness, and negatively by their location in some Spanish regions. Again, the results on the USOs' growth drivers are inconclusive, especially in regard to the growth determinants widely highlighted by the literature such as the firm age or innovation.

A potential explanation for the contradictory results obtained in the aforementioned studies may be partly due to the econometric methodologies applied. More specifically, prior research has placed attention on the 'average firm' (Bianchini et al., 2015; Coad & Rao, 2008) and has mostly adopted a static (cross-sectional) approach, which hampers the ability to capture the intrinsic long-term dynamic nature of firm growth (Rodríguez-Gulías, Rodeiro-Pazos, & Fernández-López, 2017b).

In sum, the literature on the USOs' growth remarks the need of analysing the role played by some firm-level factors in explaining the USOs' growth. To the date, the empirical evidence on this issue is rather limited. Moreover, recent literature on HGFs acknowledges that the impact of growth determinants may differ along the firm growth distribution (Bianchini et al., 2015). By bringing together both previous branches of the literature on firm growth, this paper argues that applying panel data quantile regression models could yield more robust findings. To the best of our knowledge, no study has applied this method to analyse the effects of the firm-level determinants of USO's growth.

3 | METHODOLOGY

3.1 | The sample and data

To explore whether and how the growth drivers influence the USOs' growth, a unique and original longitudinal dataset was constructed by combining data from three main sources. First, the Spanish Network of University Knowledge Transfer Offices (RedOTRI) provided us a list of almost 1,000 companies created by Spanish universities before January 2011 that included detailed information about the firms' name, website, address and age. Second, only 531 of these firms were recorded in the SABI database, which was employed to construct the dependent and independent variables about firm-specific characteristics and financial information. Third, a manual search (i.e., entering the name of each company) was carried out through the ESPACENET database to create the independent variable about the firms' patent activity.

The final dataset was an unbalanced panel consisting of 531 Spanish USOs observed between 2001 and 2013.

3.2 | Definition of variables

For the purpose of this study, two dependent variables were defined in order to estimate complementary models for growth, namely, sales growth and employment growth. These are the most common indicators of firm growth in the study of new venture firms (Wennberg et al., 2011).

In recent literature on USOs, sales growth has been broadly used as a firm success measure (Colombo & Piva, 2005; Criaco et al., 2014; Ensley & Hmieleski, 2005; George et al., 2002; Salvador, 2011; Wennberg et al., 2011; Zahra et al., 2007). However, the fact that USOs could grow without having sales due to the existence of long pre-commercial stages to develop technologies or proofs of concept could limit the usefulness of this measure (Rodríguez-Gulías et al., 2016). For that reason, employment growth was included as a complementary measure of growth. This indicator has also been widely employed by the literature on the USOs' growth (Cantner & Goethner, 2011; Colombo & Piva, 2005; Criaco et al., 2014; Ortín & Vendrell, 2014; Wennberg et al., 2011; Zhang, 2009). Nevertheless, it also presents limitations such as the that employment growth may simply be due to the funding provided by some stakeholders to keep the company running (Ferguson & Olofsson, 2004), or vice versa, a firm could grow without hiring new personnel due to changes in workforce productivity resulting from technological advances (D'Orazio, 2020; Rodríguez-Gulías, Rodeiro-Pazos, & Fernández-López, 2017a).

In summary, to reduce such limitations when measuring the growth of USOs, separate models for sales and employment growth were estimated. The growth rates were calculated in the usual way as the log-differences of size:

$$\text{Growth}_{i,t} = ln(S_{i,t}) - ln(S_{i,t-1}), \tag{1}$$

where $S_{i,t}$ and $S_{i,t-1}$ represent sales and employment for the firm i in the period t and $t-1$.

Regarding the explanatory variables, a set of potential growth drivers at firm level were selected based on the previous literature. These factors refer to firm-specific characteristics, financial

TABLE 2 Literature review of HGFs determinants

Authors	Arrighetti and Lasagni (2011)	Daunfeldt et al. (2015)	Hernández et al. (2000)	Hölzl (2009)	López-García and Puente (2012)	Mazzucato and Parris (2015)	Segarra and Teruel (2014)	Segarra et al. (2016)	Fernández-López et al. (2019)
Country	Italy	Sweden	Catalonia	Crossnational (16 countries)	Spain	USA	Spain	Crossnational (15 countries)	Spain
Period	1998–2003	1997–2010	1995–1997	1998–2000	1996–2003	1963–2002	2004–2008	2006–2008	2007–2014
Sample	780	500,000	254 gazelles	20,400	100,000	303	5,017	67,279	237
HGF definition	Superior decil of growth in 5 years	Percentile 99 for 3, 5 and 7 years	15% growth in a 3 year period or double sales in 4 years	Decil 95 and PYMES	OECD definition	Percentile 90 sales growth	Percentile 80 in sales or employees	OECD based on sales	OECD based on employment
Methodology	Probit model	Descriptive	Descriptive	Quantitative regression	Probit model	Quantitative regression	Quantitative regression and Probit model	Probit model	Probit model
Results	Age (−); Sector (+); Size (−); Productivity (+); Profitability (); Human capital (+); Property (+)	Age (−); Size (+);	Age (−); Size (−); Innovation (+); Profitability (+); Human capital (+); Property (+)	Size (−); Innovation (+); Internationalization (+)	Age (−); Productivity (+); Indebtedness (+); Human capital (+); Persistence (+)	Age (); Size (−); Innovation (+); Alliances (+)	Age (−); Size (−); Innovation (+); Alliances (+)	Size (−); Internationalization (−); Innovation (); Alliances (+)	Age (); Sector (); Size (+); Location (−); Internationalization (+); Innovation (); Alliances (); Productivity (); Profitability (+); Indebtedness (+)

Source: Elaborated from Fernández-López et al. (2019).

performance and innovative activities. Table 3 displays the independent variables, their definitions and their expected effects on the USOs' growth.

3.3 | Model

In order to analyse the determinants of the USOs' growth at a firm level, Equation 2 was estimated:

$$Growth_{i,t} = \beta_1 + \beta_2 ln(S_{i,t-1}) + \beta_3 X_{i,t} + \omega_i + \sum \psi_t + \varepsilon_{i,t}, \qquad (2)$$

where $X_{i,t}$ refers to a set of firm-specific characteristics, financial performance and innovative activities for USO i during period t, ω_i represents the unobserved time invariant firm-specific effect, and ψ_t corresponds to the macroeconomic conditions. Finally, $\varepsilon_{i,t}$ is the usual error term.

Additionally, Equation 2 is based on the model introduced by Evans (1987) and widely used as a starting point in many studies that test the validity of Gibrat's law (Gibrat, 1931). If Gibrat's law is a valid assumption, there will be no relationship between firm size and growth, which implies that the coefficient β_2 has to be equal to 0. If β_2 is positive (negative), it means that the larger (smaller) firms grow faster.

Equation 2 was estimated by applying quantile regression techniques for panel data. This kind of methods is preferable to others based on the 'average effect' of the 'average firm' since it allows to obtain information on the entire conditional distribution of the dependent variable and estimate asymmetries in the relationship between growth and independent variables (Coad et al., 2016; Coad & Rao, 2008). In addition, as shown in the next section, the USOs' growth rates follow a 'tent-shaped' distribution, so the standard least squared assumption of normally distributed errors does not hold for our dataset (Coad & Rao, 2008).

As Bianchini et al. (2015) point out, quantile regressions were designed for the analysis of cross-sectional data. Nevertheless, recent theoretical developments have extended this type of methodology to panel datasets (Canay, 2011; Galvao, 2011). Similar to Bianchini et al. (2015) and Coad et al. (2016), the fixed effect quantile regression estimator was used. Essentially, the method consists of a transformation of the response variable that allows the firm fixed effect to be 'washed out'. The estimation procedure comprises two stages. In the first stage, the fixed effects are estimated as usual, obtaining $\widehat{\varepsilon_{i,t}}$. In the second stage, the quantile regression is estimated with the results obtained in the first stage with a new dependent variable $\left(\widehat{Growth_{i,t}}\right)$ which is a transformation of the dependent variable and is estimated from the independent variables $X_{i,t}$. In so doing, the firm fixed effects are removed. Thus, Equation 2 can be rewritten as follows:

$$\widehat{Growth}_{i,t} = \beta_1 + \beta_2 X_{i,t} + \omega_i + \varepsilon_{i,t}, \qquad (3)$$

where $X_{i,t}$ accounts for all independent variables, ω_i is the unobserved time-invariant effect, and $\varepsilon_{i,t}$ reflects the error term, with $E(Growth_{it}|\omega_i,\beta_{it}) = 0$.

4 | EMPIRICAL RESULTS

4.1 | Descriptive analysis

Figure 1 shows that the distribution of sales and employment density function follows a 'tent-shaped' distribution, which is in line with the descriptive results of the studies referred to HGFs (Coad, 2009).

Table 4 shows the mean annual growth rates of sales and employment. The Spanish USOs grew at decreasing rates until 2011. Over the next 2 years, USOs suffered drops in both sales and employment, coinciding with the years when the financial crisis had the worst

TABLE 3 Independent variables: Definition and expected relationship

Firm-level factors	Variables	Hypothesis	Measure
Previous growth	l.gsales	( )	Sales growth delayed 1 period
Innovation	pat	(+)	1 if the firm had any patent activity, and 0 otherwise[a]
Age	ln_age	(−)	Natural logarithm of the firm's age
	ln_agesquar	(+)	Natural logarithm of the firm's age squared
Legal form	ltd	(−)	1 if the firm is a private limited liability company
Exporting	export	(+)	1 if the firm had any export activity and 0 otherwise
Profitability	roa	(+)	Net income/total assets
Current ratio	current_ratio	(+)	Current assets/current liabilities
Leverage ratio	lev_ratio	(+)	Total debt/total assets
Sector	KIBS	(+)	1 if the company operate in knowledge intensive business services (KIBS) industries and 0 otherwise[b]

[a]Patent activity involves both patent applications and patents granted. The patent data has been compiled from ESPACENET.
[b]The technological KIBS firms are the companies with the CNAE codes (REV 2) 721, 722, 723, 724, 725, 729, 731, 732, 742 and 743; whereas the professional KIBS are the companies with the CNAE codes 741, 744, 745 and 748.

Sales growth | Employment growth
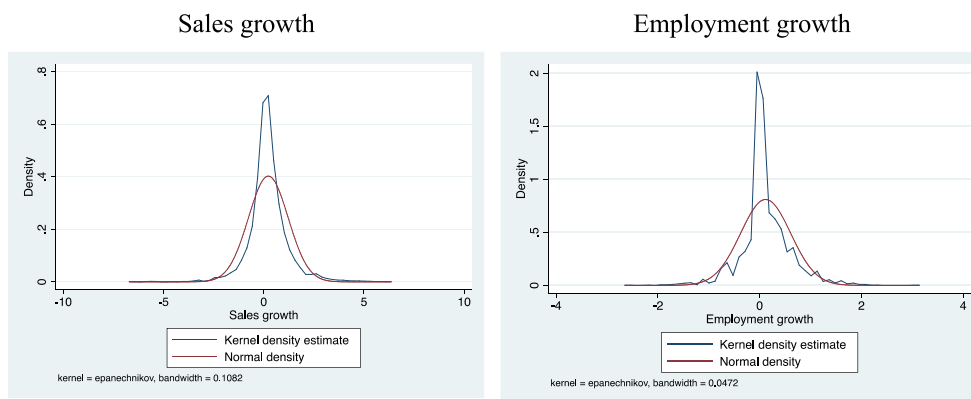
FIGURE 1 Kernel estimates (Epanechnikov kernel)

TABLE 4 Descriptive statistics for sales and employment growth rates by year (2002–2013)

	Sales growth					Employment growth				
Year	Obs.	Mean	Standard Deviation	Skewness	Kurtosis	Obs.	Mean	Standard Deviation	Skewness	Kurtosis
2002	49	0.561	1.141	1.626	7.970	35	0.371	0.607	0.749	3.337
2003	102	0.629	1.317	0.786	8.818	73	0.215	0.644	0.293	3.996
2004	147	0.609	1.221	0.361	5.619	111	0.210	0.492	0.881	6.132
2005	177	0.534	0.939	0.683	5.667	139	0.234	0.567	1.416	7.817
2006	198	0.391	1.036	−1.166	14.407	168	0.184	0.570	0.073	4.417
2007	224	0.378	1.093	0.286	9.270	197	0.192	0.518	−0.492	6.212
2008	228	0.372	0.964	0.865	5.697	204	0.275	0.578	−0.214	6.461
2009	311	0.101	1.082	0.089	11.912	286	0.121	0.452	0.793	6.119
2010	345	0.151	0.869	0.462	7.043	315	0.085	0.427	0.120	7.569
2011	348	0.127	0.871	0.558	11.196	335	0.071	0.452	−0.247	5.570
2012	326	−0.075	0.798	−0.475	5.997	304	−0.024	0.429	−0.212	7.400
2013	274	−0.015	0.754	−1.585	16.650	255	−0.010	0.375	−0.813	6.003

Note: Obs. means number of observations in the sample.

consequences on the Spanish economy and led governments to make drastic cuts in public expenditure (Heyes et al., 2012). In this respect, it is noteworthy that a non-negligible share of the USOs is strongly supported by universities and other publicly-funded R&D support programmes (Bruneel et al., 2012).

Table 4 also displays the kurtosis values of the growth rates distributions, with values greater than 3. Compared to the normal distribution, the Laplace distribution is a better representation of growth rates, and the least squared estimations do not fulfil the requirement to be used (Coad, 2009).

Finally, Table 5 shows the descriptive statistics for the explanatory variables selected relying on the literature on firm growth, and particularly on HGFs. The average age of USOs is around 6 years. The percentages of observations with patent and export activities indicate that less than 10% of USOs have patent activity or sell to the international markets. The mean of the return on assets is negative (−11.7%), while the leverage ratio indicates that USOs are mostly financed by debt (over 70%). The current ratio shows a high level of liquidity in the sample USOs. Finally, the percentage of observations indicates

that around 20% of USOs operate in knowledge-intensive business services (KIBS).

4.2 | Multivariate analysis

Tables 6 and 7 show the quantile regressions at 10th, 25th, 50th, 75th and 90th percentiles for sales growth and employment growth, respectively. The estimated coefficients can be interpreted as the marginal change in dependent variable (y) at the θth conditional quantile due to marginal change in an explanatory variable (Coad et al., 2016).

The empirical evidence reveals that an increase in firm size has a large negative impact on all the quantiles of the sales growth distribution. Moreover, the magnitude of the estimated coefficients is more pronounced when moving to the tails of the distribution. These negative coefficients mean that the sales of the smaller USOs grow faster. These results partly coincide with those of Arrighetti and Lasagni (2011) and López-García and Puente (2012). However, for the

TABLE 5 Descriptive statistics for explanatory variables

Variable	Obs.	Mean	Standard Deviation	Min.	Max.
l.gsales	2,213	0.281	1.007	−6.599	6.254
pat	3,696	0.066	0.249	0	1
age*	3,696	5.710	3.326	1	16
ltd	3,696	0.080	0.271	0	1
export	3,696	0.081	0.274	0	1
roa	3,655	−0.117	1.649	−87.446	6.93
current_ratio	3,645	7.951	147.882	0.00029	8,636.098
lev_ratio	2,488	0.785	0.679	0.0053	13.393
KIBS	3,696	0.197	0.398	0	1

Note: *means variable without logarithmic transformation. Obs. denotes number of observations. Min. and Max. denote minimum and maximum value, respectively.

TABLE 6 Fixed effects quantile regression estimates for sales growth

Variables	q_10	q_25	q_50	q_75	q_90
l.gsales	−0.243***	−0.174***	−0.127***	−0.169***	−0.247***
	(0.023)	(0.029)	(0.022)	(0.016)	(0.034)
pat	−0.163	−0.011	0.203***	−0.022	−0.172
	(0.134)	(0.054)	(0.034)	(0.036)	(0.103)
ln_age	−1.356***	−1.310***	−1.160***	−2.699***	−3.430***
	(0.298)	(0.179)	(0.059)	(0.193)	(0.899)
ln_agesquar	0.259**	0.279***	0.181***	0.539***	0.644**
	(0.079)	(0.048)	(0.017)	(0.049)	(0.236)
ltd	0.037	−0.260*	0.126*	0.297***	0.038
	(0.241)	(0.116)	(0.056)	(0.026)	(0.102)
export	0.026	−0.001	0.220***	0.018	0.699*
	(0.070)	(0.079)	(0.048)	(0.026)	(0.302)
roa	1.022***	1.250***	1.231***	0.757***	0.883***
	(0.102)	(0.072)	(0.222)	(0.047)	(0.195)
current_ratio	−0.028***	−0.027***	−0.010***	−0.011***	−0.015***
	(0.005)	(0.005)	(0.002)	(0.003)	(0.001)
lev_ratio	−0.306***	0.077*	0.274***	0.128***	0.182***
	(0.076)	(0.037)	(0.057)	(0.009)	(0.044)
KIBS	−0.209	0.156*	−0.113*	−0.252***	0.283***
	(0.149)	(0.074)	(0.057)	(0.059)	(0.080)
Obs.	1,655	1,655	1,655	1,655	1,655

Note: Regressions include a full set of year dummies. Robust standard errors in parenthesis, clustered at firm level: ***, ** and * indicate significance at 0.1%, 1% and 5% level, respectively.

USOs' employment growth, the estimated coefficients show a positive impact on almost all the quantiles, and especially in the lower quantiles. The findings referred to employment growth are partly consistent with those of van Geenhuizen et al. (2015), Fernández-López et al. (2019), Sciarelli et al. (2021) and Vega-Gómez et al. (2020). Given that the firm size has been measured as the growth in sales, these results suggest that the USOs' employment growth requires growth in sales.

The estimate coefficients show a U-shaped relationship between firm age and the USOs' growth, regardless of the type of growth studied. This result suggests that after some time, the USOs could be consolidated and start to grow. This result is somewhat consistent with

the empirical evidence that indicates that most of HGFs are older than previously believed (Brown et al., 2017). Thus, research has found that HGFs exhibit an average age of 25 years or more in the United States (Acs et al., 2008) and Scotland (Mason et al., 2015). Additionally, the studies of Mazzucato and Parris (2015) and Fernández-López et al. (2019) found no bias towards younger firms among. Moreover, in the empirical literature on the USOs' growth, the positive relationship between age and growth has been found by van Geenhuizen et al. (2015) and Salvador et al. (2019).

Regarding financial performance, an increase in firm profitability has a positive impact on almost all the quantiles of sales growth distribution. This results it somewhat similar to those by Rodríguez-Gulías,

Variables	q_10	q_25	q_50	q_75	q_90
l.gsales	0.022**	0.023*	0.012	0.030***	−0.022
	(0.007)	(0.011)	(0.007)	(0.002)	(0.015)
pat	−0.005	0.003	0.004	0.016***	0.001
	(0.066)	(0.032)	(0.015)	(0.005)	(0.051)
ln_age	−1.022***	−0.465**	−1.038***	−0.875***	−1.219***
	(0.183)	(0.157)	(0.184)	(0.019)	(0.184)
ln_agesquar	0.193***	0.082	0.212***	0.150***	0.181***
	(0.057)	(0.050)	(0.038)	(0.005)	(0.040)
ltd	−0.019	−0.063*	−0.011	−0.000	0.045
	(0.063)	(0.031)	(0.016)	(0.003)	(0.035)
export	0.030	0.028	0.020	0.028***	0.019
	(0.031)	(0.043)	(0.017)	(0.002)	(0.063)
roa	0.039	0.089**	0.068***	−0.010***	0.092
	(0.031)	(0.033)	(0.013)	(0.003)	(0.052)
current_ratio	0.009***	0.006***	0.003	0.003***	0.003
	(0.001)	(0.001)	(0.002)	(0.000)	(0.003)
lev_ratio	−0.120***	−0.127***	−0.029***	−0.094***	−0.044
	(0.027)	(0.030)	(0.006)	(0.002)	(0.034)
KIBS	0.194**	0.041	0.006	−0.016***	−0.106
	(0.072)	(0.038)	(0.010)	(0.001)	(0.058)
Obs.	1,466	1,466	1,466	1,466	1,466

TABLE 7 Fixed effects quantile regression estimates for employment growth

Note: Regressions include a full set of year dummies. Robust standard errors in parenthesis, clustered at firm level: ***, ** and * indicate significance at 0.1%, 1% and 5% level, respectively.

Rodeiro-Pazos, and Fernández-López (2017a), Corsi and Prencipe (2018), Fernández-López et al. (2019) and Salvador et al. (2019) referred to USOs. Nevertheless, it is noteworthy that the effects of profitability on sales growth decrease across the quantiles. In contrast, in the employment growth, firm profitability is positively associated with growth at the lower quantiles and negatively associated at the 75th quantile. Although some authors posit that high profitable firms are more likely to become HGFs (Arrighetti & Lasagni, 2011; Llantada et al., 2012), the obtained results indicate that firm profitability mainly contributes to the USOs' sales growth rather than to the employment growth. This finding suggests that profitability can contribute to finance growth, particularly in financially constrained firms, as is often the case with USOs (Lindström & Olofsson, 2001).

Whereas firm indebtedness is positively associated with sales growth, the opposite is found for employment growth. Similar to profitability, financial debt could serve to enhance the USOs' sales growth by alleviating their financial constraints (López-García & Puente, 2012). This result is in line with those of Arrighetti and Lasagni (2011). However, an increase in the leverage ratio has a negative effect on almost all the quantiles of employment growth distribution. This could be partly explained by the fact that the USOs rule out hiring new employees when they have important service debt payments or even when creditors impose certain restriction on hiring new staff.

An increase in firm liquidity has a negative effect on all the quantiles of sales growth distribution. In contrast, in the employment growth, firm liquidity is positively associated with growth at the lower quantiles. This finding outlines that firm liquidity may hamper the sales growth of USOs. A potential explanation is that the current ratio can capture an increase in current assets not justified by the growth rate in sales. This can generate an excess of liquidity that leads to hiring new employees in those USOs growing at a slower pace.

Export activities seem to have a positive effect on the USOs' growth, especially on sales growth, but only at the higher quantiles. The estimated coefficients partly are in line with the results of Hölzl (2009) and Fernández-López et al. (2019). This finding suggests that the USOs with access to international markets have a greater chance of accelerating their growth.

Operating in KIBS industries is positively associated with the USOs' sales growth at the 90th quantile but is negatively associated with sales growth at the 50th and 75th quantiles. These results partly coincide with those of Daunfeldt et al. (2015), who conclude that knowledge-intensive companies are the most overrepresented within HGFs. Industry also affects employment growth, starting with a positive effect for USOs operating in KIBS industries at the lowest quantile (10th) and reaching negative values at the upper quantiles. Taken together, these results indicate that operating in competitive sectors such as KIBS can favour the growth of USOs that achieve higher sales growth rates but hamper the growth of USOs with low employment growth rates.

The coefficients of the patenting activities are mostly non-significant at conventional levels regardless of the type of growth.

The results are to some extent similar to those found by Segarra et al. (2016) and Fernández-López et al. (2019), suggesting that there is no clear evidence in favour of an effect of patenting on the USOs' growth. The descriptive studies have shown that HGFs tend to be more innovative than non-HGFs (Daunfeldt et al., 2015; NESTA, 2009). This lack of significance in the estimated coefficients can be partly explained because the variable referred to patenting activities captures only a part of the innovative activities developed by the USOs. Thus, the obtained results are not comparable with those of the studies on HGFs that measure the firm innovation through product innovation and process innovation. In this respect, Hinton and Hamilton (2013) remark that HGFs tend to be modifiers of existing technologies, rather than disruptive innovators. In the innovation surveys, these modifications would be considered product or process innovation.

The coefficients related to the legal form of the USOs are mostly non-significant for employment growth. However, they are significant within the centre of the sales growth distribution; being a limited company is negatively associated with sales growth at the 25th quantile, but positively associated with sales growth at the 50th and 75th quantiles. The results could be partly explained by the fact that limited companies are likely to have lesser rigid decision-making processes compared to corporations, which may favour the sales growth of the USOs growing at a faster pace.

In summary, the results obtained from the analysis show that a set of firm characteristics play a key role in promoting the USOs' growth. Moreover, these growth drivers not only differ across the kinds of growth studied but also along the growth distributions.

5 | CONCLUSIONS

The USOs' growth and its drivers have long been at the centre of challenging political and scientific debates. This study takes an in-depth look at firm-level growth drivers and provides insight into how they may shape sales and employment growth patterns of USOs. More specifically, this paper analyses the influence of firm-level growth drivers by applying panel data quantile regression models in a sample of 531 Spanish USOs over the period of 2001–2013.

The major findings of the study are that the growth drivers not only differ between employment growth and sales growth, but also along the growth distributions. Thus, whereas smaller USOs grow faster than larger ones in terms of sales, the opposite is found for employment growth. Similarly, the effects of the USOs' financial performance on sales growth are the opposite of those found on employment growth. More specifically, whereas the increases in debt and profitability levels enhance sales growth, they hamper employment growth. In turn, a high level of liquidity positively influences employment growth, but it prevents sales growth. Also, operating in KIBS industries affects the USOs' growth differently by enhancing sales growth and hampering employment growth, both at the higher quantiles. Additionally, the legal form of the USOs only influences the sales growth.

Unlike the aforementioned firm-level growth drivers, firm age and export activities have the same influence on the USOs' growth regardless of the type of growth studied. Thus, younger USOs grow more than older ones. Exporting also favours the USOS' growth, but only for those that achieve high growth rates. Finally, patenting activities do not seem to play a crucial role in the USOs' growth.

The findings of the study have interesting policy and managerial implications. While politicians are likely to be more interested in promoting USOs that boost job creation, they should be aware that sales growth may be a necessary condition to enhancing employment growth. Hence, USOs should develop timely and accurate sales forecasts before establishing their employee hiring policies. This is not only a good practice at the management level, but it should also be a requirement from those responsible for supporting USOs at the mezzo and macro levels.

Similarly, the USOs' financial performance has proven essential in driving firm growth. In this respect, the results speak in favour of finding enough financial resources, both internal (profitability) and external (debt), to boost sales. Nevertheless, a high level of debt hampers employment growth. In this sense, specific financial mechanisms should be designed to support the USOs' growth in order to avoid the harmful effect of traditional credits on the employment growth of USOs. In other words, the criteria for granting loans must take into account the particular characteristics of the USOs' business (e.g., long time-to-market, knowledge-based firms, etc.).

Regardless of the type of growth to drive, USOs need to maintain fast decision-making processes, which encourage quick response actions in competitive environments. The results also speak in favour of the supporting internationalization policies. However, not all USOs should be pushed towards internationalisation processes, but only those growing at a faster pace.

The contribution of this paper is twofold. First, it provides insight into the forces that shape the USOs' growth patterns at a firm level; solid evidence on this topic remains virtually non-existent. Second, it allows for a better understanding of how firm-level determinants may enhance the USOs' growth over the 'average firm' by applying quantile regression methodology. In so doing, it yields more robust results since the USOs' growth rates follow a 'tent-shaped' distribution, which advises against the use of the least squared methods based on the assumption of normally distributed errors.

This study also presents some limitations that open the door to future research. For example, the dataset lacks information about the characteristics of the USOs' founders, which have been highlighted by a branch of the literature on the USOs as a potential source of firms' competitive advantage and consequently of firm growth. Future research could benefit from collecting this information (experience, managerial skills, different professional backgrounds, etc.). Moreover, patenting has been used as a measure of the innovative activities of USOs. However, the literature on HGFs has traditionally captured innovation through other kind of variables, namely, process and product innovation. Also, the period of analysis was limited until 2013 as a result of the unavailability of data. Future research will benefit from larger samples and a longer

longitudinal evaluation which includes the potential effects of the COVID 19 pandemic. Obtaining this information would also be useful since the role of innovation in fostering the USOs' growth has long been at the center of the scientific debate.

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