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On the heterogeneity of the long-term leverage-growth relationship: A cross-country analysis of manufacturing firms

Sebastiano Cattaruzzo*, Mercedes Teruel

ECO-SOS, Department of Economics, Universitat Rovira i Virgili, Av. Universitat, 1, 43204, Reus, Spain

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ABSTRACT

Despite a great deal of studies, the relationship between firm leverage and its impact on growth remains still unclear. We offer an analytical framework, which based on a comprehensive literature review and of related empirical reasoning, helps explaining the long-term leverage and firm growth nexus. Both the theoretical views and empirical evidence are mixed, and the lack of consensus may be the result of inconsistent estimation techniques and of the dual interpretation that firm leverage has. Analysing debt from credit institutions to firms in France, Italy, and Spain, and observed from 2010 to 2016, we bring a selection framework to trial. The comparative perspective seeks the establishment of regularities, while the use of a dynamic quantile panel estimator unravels its heterogeneity. Strong non-linearities are detected, but the selection framework finds no support. On the contrary, only firms in the lowest-growing deciles of the growth distributions benefit consistently from leverage.

1. Introduction

The interest for the finance–growth nexus has raised during the last decades. However, limiting to techniques yielding the "average" effect and/or the study of single countries or specific industries led to considerable uncertainty in the economic and finance literature relatedly to the behavior of this relationship. Further, the fact that leverage may have a dual interpretation adds complexity to the picture. If on the one hand it signals access to credit, reaching high levels of it may likely induce financial constraints. With the aim of offering a comprehensive approach, this paper proposes an alternative take on the subject and looks at the finance-growth nexus all along the firm growth distribution, and it does so by directly studying the relation between long-term leverage and two indicators, sales and productivity growth. Questions like whether the access and use of long-term debt fosters productivity and sales growth or not, and whether it affects particularly high-growth firms or not, have failed to obtain an empirically sound answer. Due to the extreme heterogeneity of these situations, theoretical models largely fail in capturing accurately the phenomenon, making this mostly an empirical matter.

When analyzing it, explicitly considering the asymmetric effects on firm growth and productivity is of utmost importance. Bottazzi et al. (2014) observed an unequal impact of financial constraints over the firm growth distribution. The authors point out the existence of a potential “loss effect” for low-growing firms, as opposed to a “pinioning effect” for high-growth firms. Changing the standard firm growth view from financial constraints to the actual intake of debt and its effect on firm growth offers a possibly wider perspective to build policies aimed at curbing these frictions, which can be avoided once we gain understanding regarding where, along the growth distribution, each form of debt is more beneficial. Here, we do so for long-term leverage (henceforth, LTleverage).

This paper characterizes the relationship between LTleverage and firm growth of manufacturing companies across France, Italy and Spain. Following a comprehensive survey of the literature, we bring forward some reflections and hypotheses on the existence of a selection mechanism that explains the firm growth and leverage nexus, and that may affect firms in lower growth quantiles less positively than those in the top quantiles. The data is harmonized, retrieved from BvD-Amadeus database for the period 2010–2016, and the LTleverage variable contains all credit granted from credit institutions. Applying Powell’s (2016) dynamic quantile panel esti-

* Corresponding author.

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mator, we unravel the extent of the heterogenous relation between our leverage variable and firm growth, as proxied by sales or labor productivity growth. The choice of a single but representative debt indicator such as long-term leverage follows the rationale that it allows to fully explore the empirical results in terms of countries and growth measures, while keeping the model relatively simple. Although this choice excludes the possibility to capture the full complexity of firms' financial structures, it focuses on the typically more concentrated, and thus representative item.

The empirical findings show that this nexus is subject to many non-linearities across the growth distributions. Only few stable trends could be detected. Undoubtedly, low-growth firms' profile shows considerable reliance on LTleverage, which contributes positively to their growth. This also suggests the presence of disciplinary effects on the management responsible for the use of these resources, which given their positions, tend not to undertake risky behaviors. Similar results are also present for some central deciles of the growth distributions and vanishes or become negative for the right-tails.

The contributions are several and of different nature. First, we systematize the existing knowledge on the leverage-growth nexus at firm-level. Indeed, the academic effort on this narrow topic has been large and also are the associated theories and evidence. Second, building on this, we offer some additional considerations and propose a selection framework, where the relation across quantile is increasing, meaning that high-growing firms have a stronger positive association to long-term leverage. On this, the result is a negative one, in the sense that our findings do not show evidence of the selection effect, and if anything, they point to an opposite scenario.

Although unexpected, the results can be interpreted insightfully from an economic standpoint. Indeed, low-growth firms are intrinsically in need of growth-enhancing resources to broaden their strategic moves and/or to serve their liquidity needs, but they need to do it in a risk-minimizing way. Thus, they find benefit from LTleverage. Contrarily, this strategy seems not to work equally for high-growth firms, whose projects and financial needs are likely to be more complex, wider, and uncertain. For them, exceeding in leverage would imply financial constraints that eventually would hurt their paths. Finally, we stress that the comparative perspective does not chase explanation, but rather the mere establishment of common associative patterns across different countries. The large heterogeneity of the results is itself a relevant contribution, as it highlights the complexity of the studied relationship and the inapplicability of one-fits-all explanations.

The structure of the paper is the following. The second section reviews the literature on leverage and firm growth and builds the analytical framework applied in the paper. The third section presents our dataset and a preliminary exploration of the available data. The fourth section develops our econometric methodology. The fifth section discusses the main empirical results. The final section highlights the main conclusions and suggests further research.

2. Analytical framework

The vast literature that studies firms' financial structure has pointed out the access to external funds as a key determinant of their ability to invest and differentiate their funding sources for expansion (Almeida et al., 2012; Faulkender and Petersen, 2006; Ferrando and Pal, 2006). Nevertheless, the accumulation of excessive external debt in relation with firm's size may signal higher risk to banks and credit institutions who could decide to decline further financing and make it financially-constrained. Using these lenses, the current section reviews the literature on firm-level leverage and its relation to growth. Particularly, it reports the heterogeneity of the empirical results according to two widely-used growth indicators (productivity and sales), and it offers an alternative framework to look at the above relationship.

2.1. The dual interpretation of firm-level leverage

On the one hand, more leverage implies more access to long-term debt in relation with a firm's assets and it allows existing companies to aim at faster growth thanks to a larger capacity to finance possibly productive investments. On the other hand, at least since Lang et al. (1996), it was found that leverage may affect negatively firms whose growth opportunities are either not recognized by the capital markets due to informational asymmetries, such as in cutting-edge innovation projects, or those firms that do not have good investment opportunities but might want to grow anyway. A candidate explanation is precisely that these firms may have accumulated too much debt already and thus, they are seen as not worth by credit institutions when asking for debt. These institutions may think that continuing the increase in leverage may ultimately hurt firms' growth and make them unable to re-pay the debt. For instance, Coricelli et al. (2012) propose a threshold model to identify what they call "excessive leverage", a level of debt over assets beyond which taking up more debt decreases productivity growth.

Well performing firms find themselves in a demanding position as they may have expansionary plans but at the same time, they suffer from strong uncertainty, given the intrinsic randomness that surrounds firm growth (Coad, 2021). Contrarily, firms that perform averagely or below it are likely to be more subject to management discipline and banking constraints that push them to obtain finance for strictly necessary actions, such as liquidity needs, which are by nature less risky and more likely to bring benefits to the organization. Taken together, these factors may result in well performing firms having more unbalanced leverage positions that eventually are detrimental to growth, while normal or low performing ones are forced to be in more controlled leverage positions. Finally, we stress how the accumulation of leverage derives often from the exhaustion of internal sources of funding, which already signals demanding firms. The ultimate objective of these demands is to be established and it lies between liquidity needs and expansionary plans.

2.2. Heterogeneity in the growth-leverage nexus

Considering the above presented two-fold interpretation of leverage, its relationship with firm growth is difficult to determine. Additionally, both variables share a multidimensional nature that may constitute further issues in the theoretical prediction and assessment of their behaviours, thus making it mostly an empirical matter.

One first obstacle appears because when appraising the nexus between leverage and firm growth, most of the literature focuses on financial growth indicators (e.g. market v. book value, profitability or Tobin's q); on the contrary, to keep the link with the firm growth literature, we use as growth indicators sales and labor productivity growth. This not only ensures comparability with the majority of the existing results, but also it refers to two measures that are often targets for firms' management. Secondly, given these variables nature and distribution, the choice of estimation technique, which often focuses exclusively on average impacts, and the consideration of single countries in the analysis are likely sources of heterogeneity.

On the one side, there exists evidence suggesting a positive impact of leverage on firm growth, implying that long-term leverage can ensure the accomplishment of the desired expansion plans (Almeida et al., 2012; Faulkender and Petersen, 2006;

Table 1
Summary of the literature review on the leverage-growth nexus.

Reference	Methodological choices	Sign of the estimated relation
Leverage impact on sales growth		
Honjo & Harada (2006)	Long-term debt ratio to total assets	(+)
Huynh & Petrunia (2010)	Debt-to-asset ratio	(+) non-linear
Rahaman (2011)	Long-term debt ratio to total assets	(+)
Molinari (2013)	Leverage modeled with a quadratic term	(+) (-) non-linear
Anton (2019)	Debt-to-asset ratio	(-)
Leverage impact on productivity growth		
Nickell et al. (1997)	Interest paid over labor productivity	(+)
Nickell & Nicolitsas (1999)	Interest paid over labor productivity	(+)
Maçãs Nunes et al. (2007)	Total liabilities ratio over labor productivity	(-) but also positive
Weill (2008)	Total liabilities ratio over cost efficiency	country-dependent
Coricelli et al. (2012)	Total debt ratio impact on TFP growth	non-linear
Avarmaa et al. (2013)	Long-term leverage and total debt over labor productivity	(-) non-linear
Levine & Warusawitharana (2021)	Debt-to-asset ratio	(+)

Source: own elaboration.

Ferrando and Pal, 2006).[1] For instance, for British and Irish firms, Rahman (2011) found that when firms have larger share of external financing, its scope was financing its growth. Also, firms' leverage may bring further growth phenomena via the financial pressure channel. For a sample of UK manufacturing firms, Nickell et al. (1997) and Nickell and Nicolitsas (1999) showed that leveraged positions can be positively associated with productivity growth, indicating that leverage can lead to a quasi-competition effect. Levine & Warusawitharana (2021) study the same countries under consideration in this article and find a general positive effect of leverage over productivity, but the magnitude of it being dependent negatively on the degree of financial frictions.

On the other side, another set of evidence gives support to a negative relationship between the leverage level and firm growth. For instance, in Demirgüç-Kunt et al. (2017), long-term leverage is associated with a negative impact on productivity growth. The main argument is that long-term debt increases the inefficiency as it triggers possible wasteful activities by managers. This is also in line with the evidence by Coricelli et al. (2012) and Avarmaa et al. (2013), who find that excessive leverage hurts productivity growth. In this vein, Anton (2019) shows how excessive leverage hurts particularly high-growing and gazelle firms, as identified under several firm growth indicators.

Further, there exists also evidence supporting the view of a non-linear relationship across the growth distribution. For Japanese SMEs, Honjo and Harada (2006) found a positive impact on sales growth, Huynh and Petrunia (2010) had similar findings for new Canadian manufacturing firms, but for both there appear non-linearities as the sensitivity of growth to leverage is highest for firms between the lowest and intermediate leverage quintiles. Finally, for Italian manufacturing firms Molinari (2013) found an inverted U-shaped relationship. In particular, this paper shows that for low levels of leverage there appears a positive influence on growth, but it becomes negative for highly leveraged firms. In terms of productivity growth, Maçãs Nunes et al. (2007) show for Portuguese firms a generally negative impact of leverage on labor productivity, but positive for higher productivity firms. The same non-linear relationship is also confirmed by Coricelli et al. (2012) and Avarmaa et al. (2013).

Concluding this review summarized in Table 1, it shall be clear that the current evidence points at contrasting results. In addition to differences in sample composition and to estimation choices focusing on specific points of the growth distributions, we stress how this could also be an artifact of the dual interpretation that firm leverage has.

2.2.1. How leverage relates to sales and productivity growth

So far, we treated growth under a relatively general approach, we now characterize the relation under study, for the two growth indicators of interest, starting from sales growth. Despite the above-mentioned heterogeneity of the empirical results, studies show that leverage and sales growth tend to be positively related, while sometimes the relation is subject to non-linearities. The internal mechanisms that are at the basis of this relationship follow various channels. The most likely and prominent looks at the borrowing and leverage accumulation as enabling tools for expansionary plans. Being these plans expansionary in either geographical, marketing or production diversification terms, it is clear how the possibility to invest (positively) affect sales growth. Nevertheless, it must be stressed how excessive debt overhang may also force managers to pass on these plans and to induce under investment in an attempt to preserve the firm's financial health. This would necessarily induce negative (or null) effects of leverage, while still having to re-pay back the borrowed amount with the addition of interest.

Instead, focusing on the possible effects of leverage on productivity growth, the channels of transmission are obviously different. On the one hand, the obtainment of leverage allows the firm's management to carry out productive investment, for instance aimed at the development or adoption of process and organizational innovations. Nevertheless, leverage is rarely conceded to finance investment on intangible assets or R&D activities, which are the ones whose positive relationship with productivity growth is sounder (Mina et al., 2013). Contrarily, banks normally lend money subject to investment in tangible assets, which could be more productive plants, working tools, equipment, or on-the-job training (Heil, 2018). On the other hand, high levels of leverage increase the probability of bankruptcy and it also involves a leverage cost (Coricelli et al., 2012) that may become larger than the advantage obtained. This may eventually reduce the managers' incentives to pursue productive investment and deviate their attention from them to the pressing needs of generating cash-flows to re-pay their debts.

Also we stress how the use of resources to obtain productivity gains is intrinsically harder to achieve than the effort toward sales increase. The latter is mostly a strategic and marketing matter, while the former takes more time to implement, train the employees, and its benefits are more diffused in time.

Due to the considerably different channels through which the relationship can unfold for each indicator, we choose to focus on both sales and labor productivity growth. Further, given the con-

[1] As pointed out by Cooley and Quadrini (2001) referring to firms' debt dynamics, "more debt allows them [the firms] to expand the production scale and increase their expected profits".

siderably opposite possible effects of leverage on these growth indicators, we adopt and bring to empirical trial an approach derived from the evolutionary economics literature (Coad, 2010), which could reconcile these dynamics. The theory of fitter firms implies that poorly performing firms are unlikely to recognize highly profitable investment opportunities, while successful firms are in a better position to recognize and appropriate them. Furthermore, presumably, low-performing firms are supposed to lack the cognitive and managerial abilities to point at high returns from investment (Dosi et al., 2008). Under this view, firms have heterogeneous "leverage capacities" depending on their idiosyncratic firms' abilities. The argument is based on the different capacity that firms possess to obtain economic returns from their leverage. For instance, Aivazian et al. (2005) found that Canadian firms with lower growth opportunities are more negatively affected by leverage than the "fitter" others. Similarly, Bottazzi et al. (2014) point out the existence of a potential "loss effect" for low-growing firms, as opposed to a "pinioning effect" for high-growth firms. This positive association between leverage and firm growth is also confirmed by Guariglia et al. (2011) for Chinese firms. More recently, Molinari et al. (2016) find that this relation is not constant across the firm growth distribution. In particular, high-growth firms heavily rely on external debt. Their results are in line with Fazzari et al. (2000), who acknowledge that high-growth firms will have a greater demand for finance.[2]

Given all the above considerations, we bring to trial the following hypotheses:

- **H1:** The relationship between long-term leverage and firm growth, measured either by productivity or sales growth, is highly non-linear.
- **H2:** High growing firms are able to benefit more from long-term leverage, if compared to less growing firms.
- **H3:** Given the nature of sales and productivity growth, long-term leverage is more beneficial to sales growth, if compared to productivity growth.

3. Data and statistics

3.1. Data source

The data comes from the Amadeus database, a pan-European dataset compiled by Bureau van Dijk and it provides data on financial and productive activities for public and private, domestic and international companies. One advantage of focusing on European countries is that company reporting is compulsory (Gopinath et al., 2017). Hence, this data source provides information about financial accounting from detailed harmonized balance sheets, income statements, profits or taxes obtained by the companies. Moreover, this data source offers complementary information on the foundation year of the companies. Unfortunately, the data requires considerable attention when dealing with it. The main weaknesses are its biasedness toward medium and larger company and the incompleteness of some variables. Nevertheless, this is one of the most used sources of data in several recent studies on the topics (for example, Demmou et al., 2020, and Levine and Warusawitharana, 2021), a fact which makes the current analysis even more comparable with the novel literature. Further, the nature of the data does not allow to track the life-cycle of firms; for this reason and to avoid possible biases, we only consider incumbent firms that are stably present across the period under consideration.[3]

The two key variables of the study, LTleverage and firm growth, are defined as follows. LTleverage is computed as the ratio between the sum of all long-term financial obligations of a firm to credit institutions and its total assets. To measure firm growth, we use two indicators which proxy for growth in terms of size and of efficiency. The first is computed as the log-difference in terms of sales volume between two consecutive years, while the other as the log-difference in value added per employee. This choice allows to track with only a few variables, key aspects of the firms' path. Finally, following previous peer-reviewed studies using the same data (Brouthers, 2002; Desai et al., 2003; Klapper et al., 2004; Konings et al., 2003; Weill, 2008; Levine and Warusawitharana, 2021), we apply several refinements. First, we remove the observations reporting equal sales and employment growth rates for the same year, given the unlikelihood of these two events (Duschl, 2016). Second, we remove observations that report a year of birth earlier than 1800 and later than 2016. Third, we considered winsoring for the triplet sector, year, country at the 5-th percentile level on the extrema in order to avoid considering possible episodes of inorganic growth.[4] Additionally, to avoid the bias that the often erratic growth path of micro-firms would induce, we put a minimum threshold on three employees[5] (Coad, 2009; Duschl, 2016). To ensure the arbitrariness of this choice does not affect the results, we remove the threshold without seeing them significantly affected. Finally, in line with the exclusion of life-cycle properties of the firms mentioned above, we balance the panel. This operation entailed a moderate loss of observations, while improving the quality of our estimates considerably.

3.2. Countries and period

We select firms from France, Italy and Spain between 2010 and 2016. The reason why we chose these three countries and this time period is by nature multi-dimensional. Being the objective of the study the establishment of empirical regularities, the diverse nature of these countries has been a pushing factor. In this, the choice of an appropriate econometric setting makes the emergence of possible cross-country common findings even more robust. Finally, from a preliminary exploration of the data, it is undeniable that for these three countries, there exist significantly better quality firm-level reports.

Given the heterogeneity of the leverage-growth relationship and the undoubtable influence of institutional characteristics (Weil, 2008), at least two elements need to be considered in a comparative perspective: the access to credit, given by the supply of banks and firms' demand, and its allocation. Situations with high credit supply and with the non-efficient firms receiving it would generate inevitable market mis-allocations, or financial frictions, which can damage firms' performance. In other unwanted combinations of these two factors, similar situations would arise. Despite the simplification of complex mechanisms linked also to the legal and banking systems, this is a useful to understand how

[2] A final point to be stand out is that commonly, high-growth firms have been associated with technological firms. However, it is well-known (see the survey of Brown et al., 2017), high-growth firms are present in all sectors. In fact firms, in technological sectors may suffer of more information asymmetries and as a result their risk increases, as their probability to be financially-constrained (Beck and Demigüç-Kunt, 2006; Beck et al. 2005; Binks and Ennew 1996; Nitani and Riding 2013). Colla et al. (2013) find that firms with high growth opportunities and R&D expenses specialize in few types of debt, while profitable firms with more tangible assets, high leverage, and use multiple sources.

[3] Ideally, one would have also information on firms' death in order to clean the results from the so-called survivorship bias. However, being this information unreliable in the Amadeus repository, we preferred to focus only on incumbent firms, keeping in mind the reduced external validity induced by the choice.

[4] At the expense of sacrificing possible truly extreme growth performances, the exclusion of inorganic growth events is key to avoid possible biases in our estimation framework. Such an operation is quite standard in the literature, see Levine and Warusawitharana (2021) for a recent example.

[5] In addition, this criterion gets rid of both shell and shelf companies, mostly existing for tax purposes.

Table 2
Coverage analysis.

	Firm size	Relative number of enterprises			Relative turnover		
		2010					
		France	Italy	Spain	France	Italy	Spain
Amadeus database	4–19	33.86%	41.62%	63.25%	0.49%	4.32%	3.10%
	20–249	56.18%	53.41%	33.40%	6.96%	27.18%	22.76%
	250+	9.97%	4.97%	3.35%	92.33%	68.51%	74.14%
Structural Business Statistics	1–19	91.52%	92.67%	90.82%	11.3%	21.0%	13.7%
	20–249	7.76%	7.02%	8.75%	28.0%	40.1%	36.4%
	250+	0.72%	0.31%	0.44%	60.7%	38.9%	49.9%
		2016					
		France	Italy	Spain	France	Italy	Spain
Amadeus database	4–19	27.25%	42.28%	52.91%	0.46%	4.57%	2.58%
	20–249	59.21%	54.04%	42.64%	7.04%	35.79%	26.78%
	250+	13.55%	3.68%	4.46%	92.50%	59.64%	70.64%
Structural Business Statistics	1–19	92.45%	92.54%	90.64%	9.58%	10.49%	11.61%
	20–249	6.92%	7.14%	8.88%	25.99%	45.69%	36.50%
	250+	0.63%	0.32%	0.48%	64.44%	43.82%	51.89%

Source: Own elaboration of data from Amadeus database and European manufacturing firms at country-level from the Office for Structural Business Statistics.

countries' structural differences can influence the empirical exercise.

More practically, countries like Spain and Italy, which can be classified as "stressed economies", have had a higher percentage of credit-constrained firms, if compared to France. This also implies a smaller supply of credit to firms, which if not correctly oriented, unlikely benefits the "promising", or fitter, firms. Also, leverage have been found to represent a drag on investment, which can further slow down firms' productivity growth (Ferrando et al., 2015). These differences emerge even more from indicators of credit efficiency at country-level, putting France much higher in the rankings than Italy and ultimately, Spain (Weil, 2008).

Additionally, differently from French banks, Spanish and Italian banks are heavily exposed to the traditional intermediation business, albeit with a substantial loan-to-deposit gap (Sola and Ruiz, 2015). Indeed, most of the Spanish and Italian banks are very similar. They tend to be strongly biased towards financial intermediation, they share similar risk profiles and are marked by a gap between loans and deposits. In contrast, this traditional intermediation approach holds much less weight in France, where banks' strategies are more heavily dominated by capital markets and investment banking activities.

Despite the considerable difference in terms of debt suppliers, this does not reflect similar heterogeneity in terms of financially-constrained firms. Although subject to regional specificities, the three countries under consideration have extremely similar levels of constrained firms (ECB, 2016). This non-trivial fact supports the comparability of the three country samples at least in terms of firm-level debt demand.

Finally, the time window follows the 2007 financial crisis. During this period, financial constraints have largely increased for firms (especially for smaller ones) and we suppose that this put pressure on firms in selecting and putting at use their leverage resources.

3.3. Coverage analysis

With the aim of appraising the external validity of our study, Table 2 presents the coverage of our data with the respect to the population of reference. In order to do so, we recover data for all European manufacturing firms at country-level from the Office for Structural Business Statistics. Then, we compare the sample and the population in terms of key variables such as turnover and number of enterprises both at the beginning and at the end of our period of observation, classifying firms according to the number of employees.

From the comparison, it emerges a biased coverage in line with other studies using Amadeus samples. The distribution inevitably exhibits differences with regard to the actual structural compositions. This happens because in the cleaning process of the data a minimum threshold of more than three employees for a firm was imposed, but also due to the well-known bias toward medium and large firms intrinsic to Amadeus. Consequently, micro and small firms are relatively under-represented with respect to the real population. This could hinder the validity of our estimates in standard estimation settings, but quantile regression alleviates this bias.[6]

Following the refinements outlined in the previous section, we obtain a sample of manufacturing firms for France, Italy and Spain composed of respectively, 2348, 17,955, and 8626 firms, which lead to a total of 16,436, 125,685, and 60,382 year-firm observations for the period 2010–2016.

3.4. Descriptive statistics

With the final aim of keeping this analysis the most agnostic and clear possible, we isolated a limited set of variables whose interactions have shown empirically to influence firms' performance most strongly. In particular, we include the following variables: total assets, long-term debt,[7] employment, sales, age, and added value. From this, we compute labor productivity as the ratio between value added and the number of employees in the firm, and the long-term leverage (LTleverage) computed as long-term debt over total assets. For the definition of the two key variables and of the other regressors, please refer to Table A1, while for the corresponding correlation matrix to Table A2.

Table 3 presents the descriptive statistics for all the variables included. As we can see, at aggregate level, Spanish firms are smaller and more leveraged than their counterparts. It also emerges how the French sample likely includes some considerably big firms, which biases the mean levels of sales and assets, but not their median. Finally, the LTholders ratio, corresponding to the percentage of firms holding LTleverage, is not characterized by excessive zeroes and quite homogenous across countries.

As a preliminary step, we analyze first the shape of the firm growth distribution for productivity and sales overlaid by country (Fig. 1). Specifically, Spanish and Italian sales growth distributions look more skewed on the left-tail, in line with the actual industrial trend of the three countries under consideration. Confirming the existing stylized fact (Botazzi and Secchi, 2006), we observe that the growth rates exhibit fatter tails than the normal distribution, indicating that most firms have growth rates close to zero while a non-negligible proportion of firms experience rapid growth or decline. An additional observation is the higher peak for the sales variable in the French distribution, which is likely due to the slighter higher number of big companies compared to small ones.

To analyze the degree of heterogeneity in the use of long-term debt across the firm growth distributions we provide more fine-grained statistics relating our main variables of interest. Particularly, Table 4 below reports the value of long-term leverage for firms across deciles of both the productivity and the sales growth distributions for each country of the study.

[6] For instance, having a sample biased toward medium and larger firms would imply a greater weight for firms that rarely show big relative growth rates, as their size makes them intrinsically smaller. This would affect the conditional mean of standard OLS settings, while quantile regression sub-samples the main sample mitigating this bias and avoiding sample selection issues.

[7] Long-term debt is defined as the sum of all long-term financial obligations of firms to credit institutions.

Table 3
Descriptive statistics (2010–2016).

	France			Italy			Spain		
	mean	median	s.d.	mean	median	s.d.	mean	median	s.d.
Sales growth	0.03	0.03	0.18	0.03	0.03	0.24	0.01	0.02	0.25
Sales level	193,435	6859	3,036,783	34,133	5654	888,266	29,728	1828	432,237
Productivity level	67.61	55.27	77.25	69.17	56.52	310.94	55.98	40.16	239.37
Productivity growth	0.02	0.02	0.34	0.02	0.02	0.35	0.02	0.01	0.36
Long-term debt	58,361	159	1,436,712	5267	430	185,131	6511	193	104,877
Assets	351,878	4586	7,814,629	40,555	6168	1,204,361	31,881	1674	400,324
LTleverage	0.08	0.04	0.16	0.11	0.08	0.1	0.19	0.13	0.19
LTholders	0.89	1	0.31	0.88	1	0.32	0.95	1	0.23
Age	41.97	38	15.77	39.79	38	14.55	34.51	32	12.33
Number of firms	2,348			17,955			8,626		

Note: LTholders corresponds to the percentage of firms holding a value of LTleverage different from zero. The variables in levels are expressed in thousands Euros, Age in years, and Labor Productivity in thousands euros per employee. Source: own elaboration from Amadeus database.

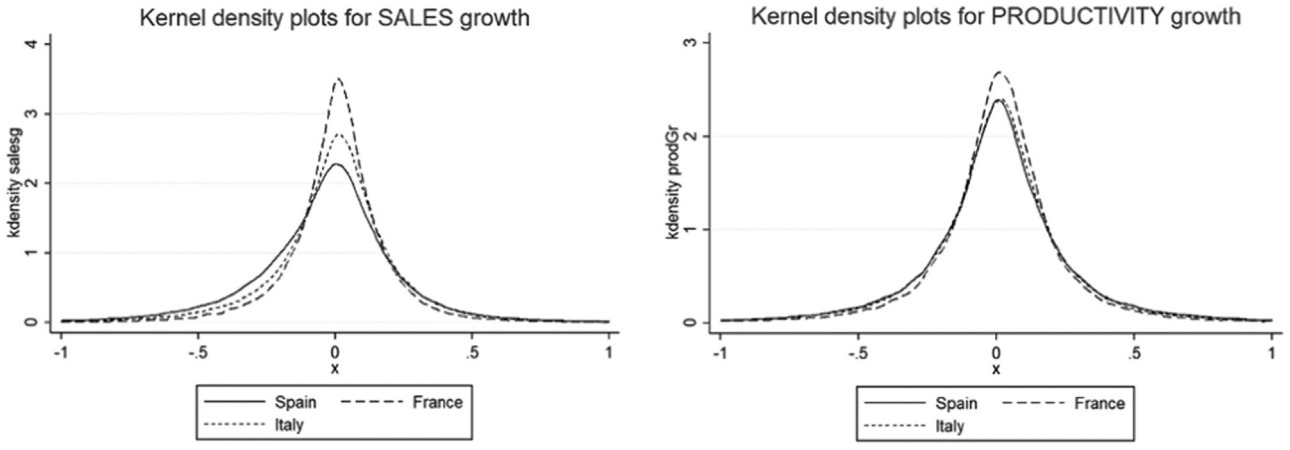


Fig. 1. Kernel density estimates for the firm growth distribution of Spanish, Italian and French manufacturing firms. The kernel density is estimated with an Epanenchnikov kernel bandwidth equal to 0.5. Source: Own elaboration of data from Amadeus database.

Table 4
The heterogeneity of LTleverage.

	LTleverage								
	across sales growth deciles								
	FRANCE			ITALY			SPAIN		
Decile	mean	median	s.d.	mean	median	s.d.	mean	median	s.d.
0.1	0.072	0.037	0.116	0.112	0.080	0.116	0.222	0.158	0.222
0.2	0.071	0.040	0.095	0.109	0.082	0.107	0.205	0.145	0.209
0.3	0.078	0.047	0.107	0.110	0.085	0.105	0.188	0.129	0.193
0.4	0.075	0.046	0.099	0.107	0.083	0.102	0.181	0.125	0.183
0.5	0.078	0.046	0.100	0.108	0.084	0.103	0.177	0.124	0.179
0.6	0.081	0.048	0.106	0.110	0.084	0.104	0.174	0.117	0.189
0.7	0.077	0.049	0.090	0.109	0.085	0.102	0.166	0.117	0.170
0.8	0.087	0.045	0.423	0.107	0.082	0.102	0.179	0.127	0.182
0.9	0.075	0.047	0.094	0.103	0.078	0.101	0.188	0.130	0.189
1	0.079	0.045	0.106	0.102	0.074	0.104	0.193	0.138	0.189
	across productivity growth deciles								
	FRANCE			ITALY			SPAIN		
Decile	mean	median	s.d.	mean	median	s.d.	mean	median	s.d.
0.1	0.086	0.043	0.129	0.112	0.081	0.114	0.214	0.148	0.221
0.2	0.073	0.044	0.099	0.107	0.079	0.106	0.193	0.136	0.196
0.3	0.071	0.046	0.084	0.107	0.083	0.102	0.185	0.134	0.180
0.4	0.073	0.042	0.094	0.109	0.086	0.102	0.182	0.128	0.183
0.5	0.072	0.047	0.082	0.108	0.085	0.101	0.169	0.121	0.166
0.6	0.070	0.046	0.081	0.108	0.085	0.100	0.171	0.122	0.172
0.7	0.070	0.045	0.082	0.106	0.082	0.100	0.178	0.128	0.173
0.8	0.088	0.043	0.425	0.107	0.082	0.102	0.179	0.123	0.182
0.9	0.081	0.046	0.103	0.105	0.077	0.105	0.187	0.125	0.203
1	0.089	0.041	0.136	0.108	0.074	0.114	0.214	0.143	0.226

Source: own elaboration from Amadeus database.

From Table 4, two facts emerge. First, the difference between mean and median values points at a considerably skewed nature of LTleverage, across all deciles and countries. Secondly, if for productivity growth, firms in the tails of the distribution are slightly more leveraged than central ones, the same does not hold for sales growth, where the situation is more mixed. More in detail, in France, firms on the right-part of the distribution tend to be marginally more leveraged, while the opposite holds for Spain and Italy. This could hint at a possible misallocation of credits and/or at an intake of debt for different scopes (i.e., profitable investments v. liquidity needs). Nevertheless, given the magnitude of the associated standard deviations, significant differences across growth quantiles do not emerge, implying heterogenous but comparable levels along the firm growth distribution. Finally, it is clear how the "weight of borrowing", which can generate drags on investment strategies, is much more pronounced for Spanish firms, while considerably more nuanced for Italy, and France particularly.

4. Econometric approach

Also, for the sake of comparability, we strive to keep the model as simple as possible. In order to estimate the impact of leverage on productivity and sales growth, we estimate the following base growth models:

$$\begin{aligned}\Delta\log(Sales)_{i,t} &= \beta_{10} + \beta_{11}\Delta\log(Sales)_{i,t-1} \\ &+\beta_{12}\log(Sales)_{i,t-1} + \beta_{13}\log(Age)_{i,t} \\ &+\beta_{14}\log(Age)^2_{i,t} + \beta_{15}\log(LTleverage_{i,t-1}) \\ &+u_{1i} + \varepsilon_{1i,t} \end{aligned} \quad (1)$$

$$\begin{aligned}\Delta\log(Prod)_{i,t} &= \beta_{20} + \beta_{21}\Delta\log(Prod)_{i,t-1} + \beta_{22}\log(Prod)_{i,t-1} \\ &+\beta_{23}\log(Age)_{i,t} + \beta_{24}\log(Age)^2_{i,t} \\ &+\beta_{25}\log(LTleverage_{i,t-1}) + u_{2i} + \varepsilon_{2i,t} \end{aligned} \quad (2)$$

Where β_i are the coefficients, u_i is the unobserved, time-invariant fixed effect and ε_{it} is the usual error term of firm i at time t. Both dependent variables correspond to the growth of sales, $\Delta log(Sales)$, and of labor productivity, $\Delta log(Prod)$. Annual firm growth rates are calculated by taking log-differences of size (e.g., Törnqvist et al., 1985; Coad, 2009). Our key explanatory variable is (the log of) long-term debt over total assets, or $\log(LTleverage_{t-1})$, that captures the use of long-term debt and its relation with firm performance controlling for the magnitude of firms' assets. The remaining explanatory variables follow from previous work on the determinants of firm growth (see Coad, 2009, for a survey) and of capital structure (Coleman, 2006; Giannetti, 2016), hence we include the lagged value of the firm sales, $\log(Sales)$, or firm productivity, $\log(Prod)$, the logarithmic firm age, $\log(Age)$, and its squared value, $\log(Age)^2$. Controlling for firm past performance and age allows us to obtain cleaner estimates, as these two variables have proven to be very influencing for firm growth itself, but also for their relationship with leverage.

Given the nature of our research questions and the econometric specification, we apply Powell's (2016) quantile panel data estimator. The author proposed a fixed-effect, non-additive panel estimator that through an alternative way to model the disturbance term is proved to be more consistent for small T and more accommodating with heterogeneous samples. This alternative estimator exploits GMM-type of estimation trying to overcome a possible problem in the derivation of fixed effects in typical quantile, panel fixed effects framework. If with the typical quantile panel estimation procedure, we obtain estimates of the distribution $Y_{it} - u_i|D_{it}$; following Powell (2016), we estimate for $Y_{it}|D_{it}$, where D_{it} is the set of explanatory variables, while is u_i the fixed effect.[8]

Quantile regression has been frequently applied to analyze issues related to the distribution of firm growth (Coad and Rao, 2006,2008; Hölzl, 2009; Kaiser, 2009; Segarra and Teruel, 2011; Falk, 2012; Mata and Woerter, 2013; Bartelsman et al., 2014; Mazzucato and Parris, 2015; Capasso et al., 2015; Coad et al., 2016). The reasons why we apply quantile regression and why it is preferable to the more usual regression methods are both conceptual and technical. Conceptually, we are not interested in the behavior of the average firms, which tend to either do not grow or grow very little, but rather in the heterogeneous behavior of firms alongside the major points of the growth distribution. Technically, there are several reasons why in the field of firm growth studies, results estimated with quantile regression techniques are more informative. For instance, as well-established in the literature and shown in Figure 2, the firm growth distribution shows heavy tails. This empirical setting implies the presence of numerous outliers, which would affect the estimates, mostly distorting the estimation of the conditional mean. Further, quantile regression goes beyond the incomplete picture given by the average effect, while avoiding the sample selection problems that would arise splitting the sample and applying the standard OLS technique to each sub-sample (Buchinsky, 1994).

Further, the estimator of choice shall tackle the so-called Nickell's bias (1981), typical of dynamic models, and at the same time give the possibility to unbiasedly estimate effects across the distribution. Two natural solutions would be following either the GMM approach (Arellano and Bond, 1991) or the IV approach (pioneered by Anderson and Hsiao (1982) and expanded to this context by Galvao Jr. (2011)). Our estimator of choice, Powell (2016),[9] is on the line of the second approach. Powell's method has several perks in this context. First, it is one of the few quantile panel data estimators that allows the use of instrumental variables. Also, it permits the instruments to be correlated with the estimated fixed effects and at the same time, it yields estimates that can be interpreted as cross-sectional results, contrary to other quantile panel data estimators.

Finally, we want to address at least partially, the possible endogeneity concern that may arise from this estimation. Although it cannot be ruled out completely, we deal with it using many precautions and post-estimation checks. In terms of precaution, we include time lagged variables that are particularly helpful in this form of estimation Galvao Jr., 2011) and thanks to the fixed effect estimation, we control for potentially, time-invariant confounding variables. For robustness' sake, we run also the same estimations as in Eqs. (1) and ((2), but instrumenting either for lagged growth or lagged levels with an additional lag. Concluding, endogeneity between firm growth and leverage is something to bear in mind, and it does not allow us to make any casual claim, but instead we merely want to identify the associative relationship between these two important variables for industrial dynamics.

5. Results

5.1. Leverage and its conditional impact on growth

Tables 5 and 6 report the estimations of the base model with cuts at each decile of the distribution for our key performance in-

[8] Among the consequences of this framework, we have that observations at the top of $Y_{it} - u_i$ do not incur the risks of falling at the bottom of the Y_{it} distribution. Also, thanks to this, the estimated coefficients are more directly interpretable.

[9] The estimations are carried out in Stata 15 using the package provided by the author of the article, namely "qregpd". Do-file and additional explanations are available on request to the authors.

Table 5
LTleverage coefficients estimates on sales growth – Base model – no instruments.

Quantile	France	Italy	Spain
0.1	0.0233 (0.0198)	0.244*** (0.0255)	0.0699*** (0.0064)
0.2	0.0061 (0.0061)	−0.0309*** (0.0023)	0.0487*** (0.0038)
0.3	−0.0044** (0.0020)	−0.0109*** (0.0010)	−0.145*** (0.012)
0.4	0.0084*** (0.0032)	−0.0018** (0.0009)	−0.0020 (0.0050)
0.5	0.0107*** (0.0016)	0.0443*** (0.0035)	0.0614*** (0.0041)
0.6	−0.0204 (0.0152)	0.0119** (0.0050)	0.0086*** (0.0027)
0.7	−0.0152 (0.130)	−0.0169** (0.0071)	−0.0037* (0.0021)
0.8	−0.0220*** (0.0074)	−0.117*** (0.0072)	0.0086*** (0.0020)
0.9	−0.0043 (0.0046)	0.0003 (0.0026)	0.0036 (0.0035)

Number of firms: France (2,348), Italy (17,955) and Spain (8,626) observed over seven years. Significance levels corresponding to * $p<0.1$, ** $p<0.05$, *** $p<0.01$. A constant term and other variables are included in each regression but not reported here. Standard errors in parentheses.

Table 6
LTleverage coefficients estimates on productivity growth – Base model – no instruments.

Quantile	France	Italy	Spain
0.1	0.0089 (0.0145)	0.270*** (0.0238)	0.202*** (0.0328)
0.2	0.0060 (0.0075)	0.183*** (0.0171)	0.462*** (0.0393)
0.3	0.0002 (0.0032)	−0.0472*** (0.0050)	−0.0087*** (0.0017)
0.4	−0.0306*** (0.0054)	−0.0278*** (0.0012)	−0.0239*** (0.0017)
0.5	0.0049 (0.0033)	0.0544*** (0.0025)	0.0257 (0.0221)
0.6	−0.0328*** (0.0046)	0.0204*** (0.0033)	0.0881*** (0.0080)
0.7	−0.0153*** (0.0056)	0.0189*** (0.0017)	0.0326*** (0.0031)
0.8	−0.0372 (0.0318)	−0.0546*** (0.0032)	−0.0641*** (0.0055)
0.9	0.0190 (0.0750)	−0.0008 (0.0031)	0.0026 (0.0050)

Number of firms: France (2,348), Italy (17,955) and Spain (8,626) observed over seven years. Significance levels corresponding to * $p<0.1$, ** $p<0.05$, *** $p<0.01$. A constant term and other variables are included in each regression but not reported here. Standard errors in parentheses.

dicators: sales and productivity growth. For the sake of brevity, we only expose results for our main variable of study: LTleverage.[10]

Clearly, the chosen estimation technique, quantile regression, unravels the underlying heterogeneity to a great extent and thanks to the introduction of non-additive fixed effects, we obtain directly interpretable estimations. Graph A1 in the Appendix compares the coefficient estimates obtained for the growth distributions. It highlights a high degree of heterogeneity of the LTleverage-growth nexus across quantiles and countries. Despite coefficients for Spain and Italy showing some similarities, non-linear behavior characterizes strongly this relation.

Before starting, we clarify that the country dimension is introduced with the aim of establishing empirical regularities for the LTleverage-growth nexus across countries. Thus, we do not seek explanations of each emerging difference, which would be impossible with this limited set of variables. On the contrary, the study focuses on detecting similarities, as candidate stylized facts. Below, we interpret the results country-by-country.

The French case is the least insightful of the three cases under consideration. As it emerges from Graph 1, most of the estimated coefficients are very close to zero, subject to considerable deviations, and rarely significant, especially for the sales growth distribution. When significant, LTleverage has a mixed impact on sales growth, while it is negative impact for productivity growth. The core of the relationship with sales growth is on the left-central quantiles (from the 0.3 up to the median), while for productivity the significant effects are found mostly in the right-half of the distribution (precisely at the quantiles 0.6 and 0.7). This first evidence already questions the existence of a clear-cut relationship between LTleverage and any of our two growth indicators of choice.

[10] Detailed results for the other coefficient estimates are available upon request to the authors.

In terms of magnitude, the elasticities vary in a limited range, between 0.0044 and 0.0328 in absolute values, showing limited impact for the French sample. Also, the use of a single indicator such as LTleverage, which partially measures firms' financial composition focusing only on what arises from credit institutions, may be a direct explanation for the result. As larger firms, as French ones, have access to a diversity of funding sources (i.e. the stock market) that smaller businesses cannot exploit in the same manner.

The findings relative to Spanish firms are richer in terms of shape, following up-and-down patterns, and quite different across growth indicator (Graph 2). For sales growth, despite a positive and significant impact for firms at the very bottom of the distribution (quantiles 0.1 and 0.2), an estimated minimum of −0.145 for firms in the third decile is present. This hints at a strong adverse effect for firms adopting LTleverage in that group. Nevertheless, the remaining effects on the sales distribution are positive and start to reduce in magnitude on the right-tail.

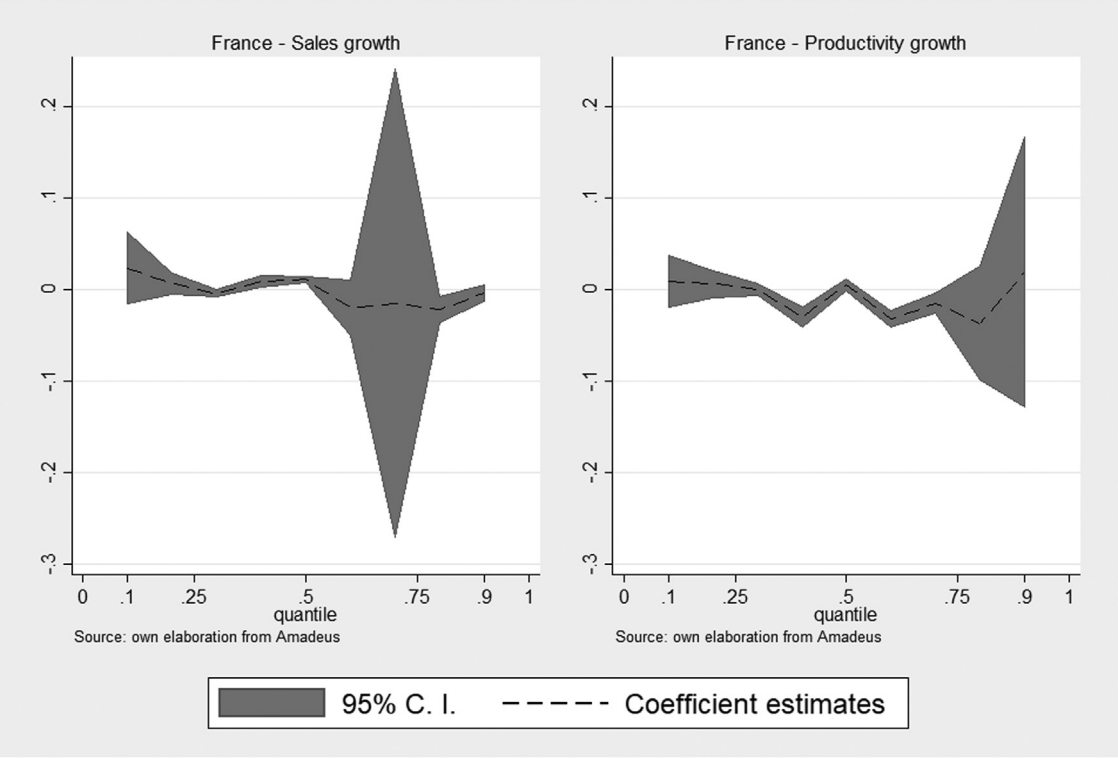
For productivity, strong positive effects are evident in the left-tail of the distribution, but they diminish strongly in magnitude and show more an alternation of negative and positive signs up to the high-growth tail, where they lose significance. Again, if anything, the Spanish case puts even more complexity to the interpretability aspect of this relationship.

To conclude, the Italian case is quite peculiar (Graph 3). As for Spanish firms, the coefficients estimated for the extreme left-tail of the distributions (0.1 and 0.2 quantiles for sales growth, while only the 0.1 for productivity) are of considerable magnitude and strongly positive. Then, similarly to the effects found on the Spanish productivity growth distribution, the trend is fluctuating, showing some positive effects in the center of the distribution, which then become negative and vanish for high-growth firms occupying the top growth quantile.

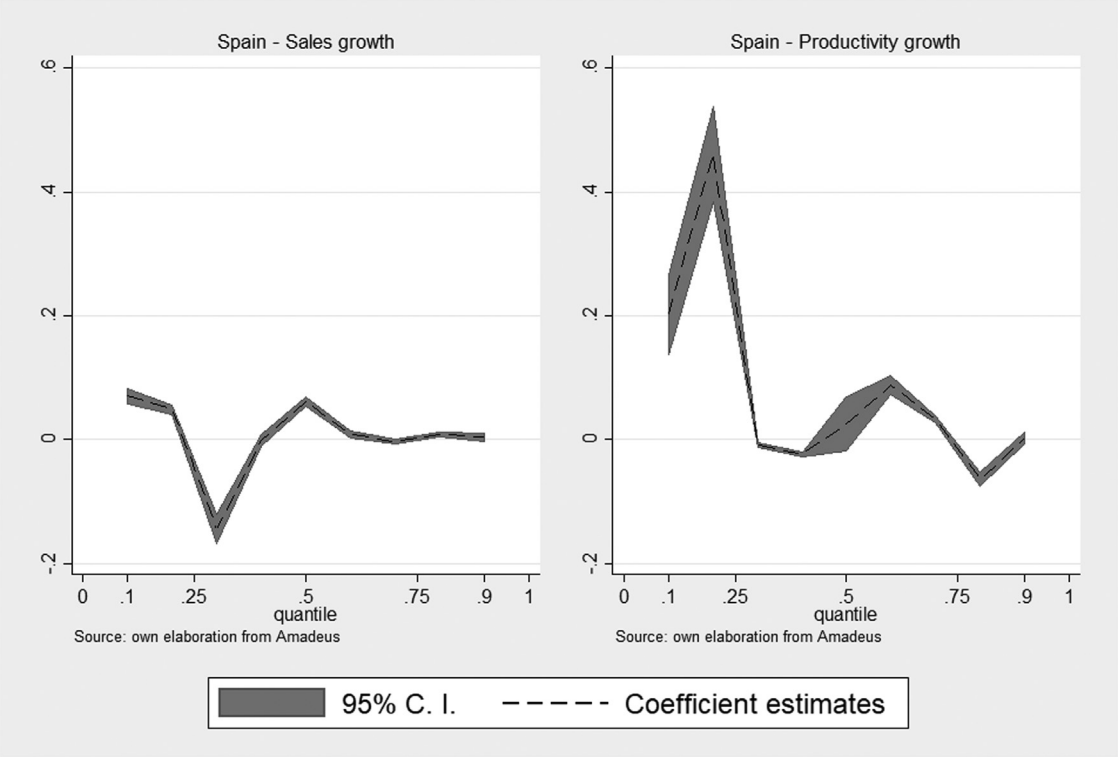
Despite the conspicuous degree of non-linearities and irregularities detected, some common pattern emerges and contribute to the understanding of the LTleverage-growth nexus.

On the one hand, the firms in the very low-growth deciles are the ones which consistently benefit from increasing their long-term leverage position. In line with Molinari (2013), this makes sense as leverage can have a growth-enhancing effect for these firms by providing additional resources and enlarging opportunities. These firms are already under the pressure of debt overhang and must be extremely efficient and avoid risky behaviors, given their weakly performing position. This may also imply that leverage is adopted more as a liquidity tool or for working capital needs, rather than as an enabler of strategic investment on tangible assets and thus, partially questioning the standard views on leverage. A very similar situation applies to firms occupying the central part of the growth distributions, whose growth rates are close to zero, seems to benefit from the same effect and their LTleverage coefficients are consistently positive. Nevertheless, these firms are rarely recognized as particularly innovative or in a locus of high opportunities.

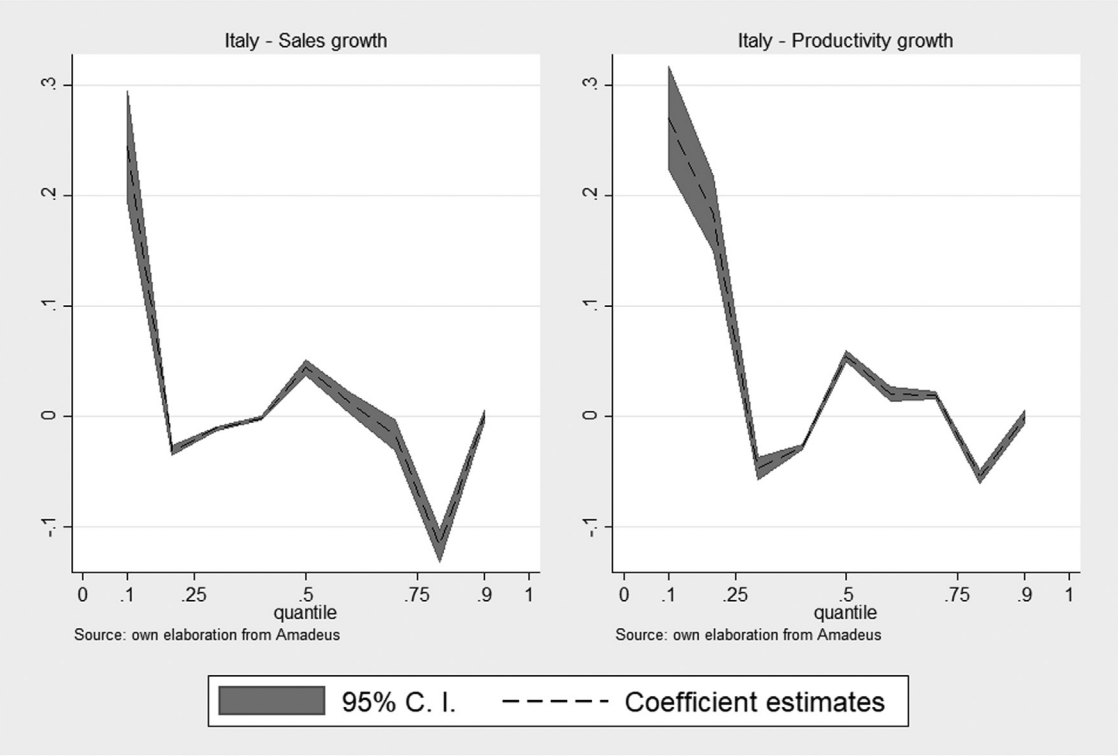
On the other hand, the right-tails of the distribution exhibit either negative or non-significant coefficients. This can be interpreted as evidence that truly growth-enhancing projects, such as innovative efforts, require resources non-compatible with the nature of long-term leverage. Such an interpretation is also in line with the findings by Singh and Faircloth (2005), who found a negative relationship ongoing between financial leverage and R&D investment. Indeed, it is unfruitful for firms in those highly-performing quantiles to have leverage as their main strategic targets often share uncertain outcomes and strong information asymmetries. And if they did, they would be likely candidates to become financially-constrained due their hard to persistently sustain positions.



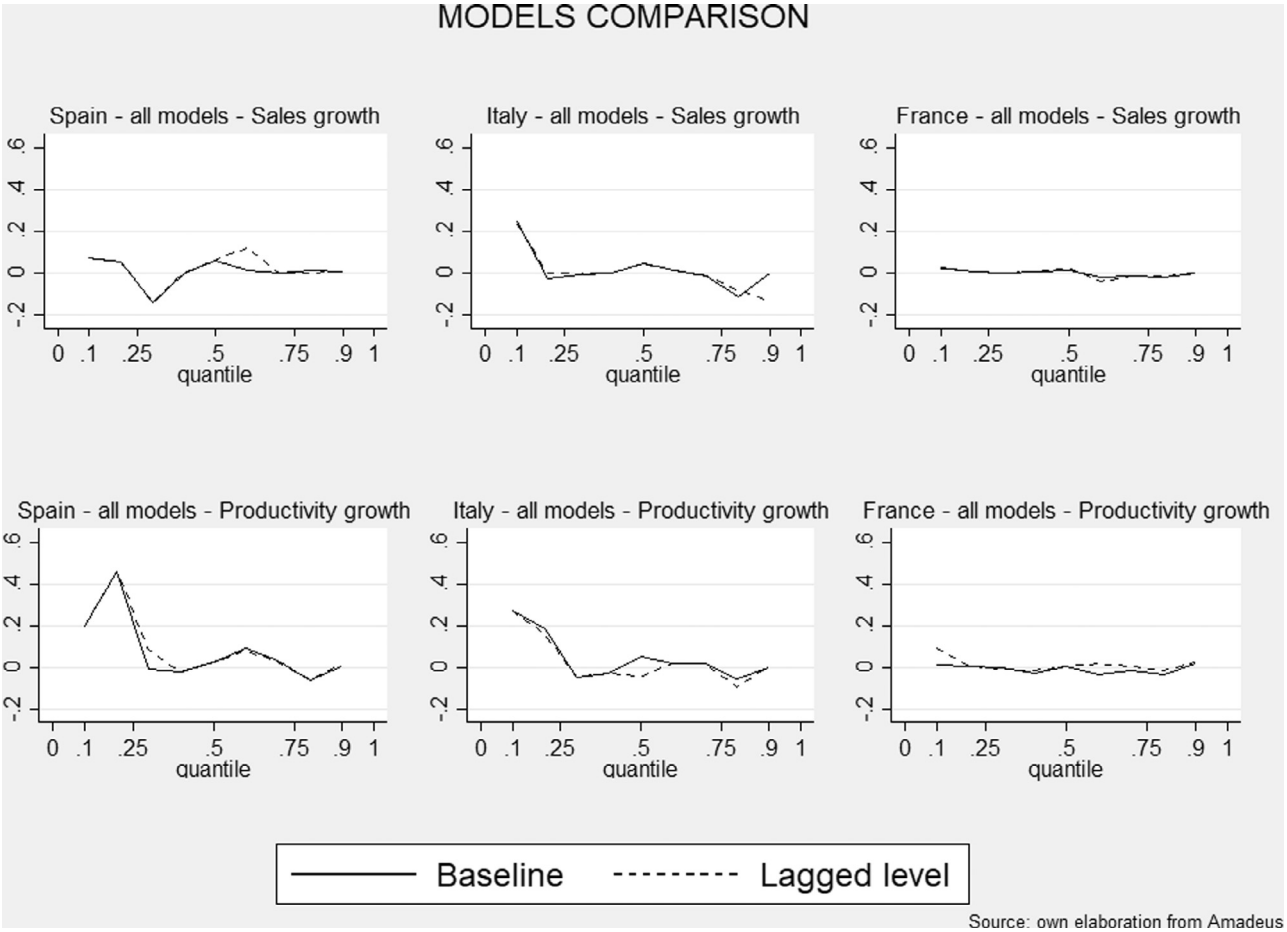
Graph 1. Plots of LTleverage coefficients for France on sales and productivity growth indicators, Source: own elaboration from Amadeus database.



Graph 2. Plots of LTleverage coefficients for Spain on sales and productivity growth, Source: own elaboration from Amadeus database.



Graph 3. Plots of LTleverage coefficients for Italy on sales and productivity growth, Source: own elaboration from Amadeus database.



Graph 4. Coefficients of LTleverage for each country, comparing instrumented and non-instrumented models, Source: own elaboration from Amadeus database.

Finally, no clear distinguishable trends emerge in terms of magnitude differences in the coefficients between the model based on sales growth and the one based on productivity growth.

All the above strongly support our main hypotheses about the non-linearity of the effects. The estimated coefficients are far from uniform across the growth distributions and are undoubtedly subject to the influence of the firm performance quintile. On the contrary, our second and third hypotheses are largely contradicted by the findings. Not only the magnitudes of the relations are comparable in a close range, but also the existence of a "selection effect", at least when looking at long-term leverage, is not proven. It is likely that other financial tools exist and are pursued by needy firms in fitter and more competitive positions, but this does not seem the case for the variable under study. Overall, it seems only to emerge a "regulatory effect" that pushes the management of badly or normally performing firms to make wise use of their available resources, long-term leverage particularly.

5.2. Robustness checks

With the aim of reducing likely endogeneity biases, we also estimate the models outlined in Eqs. (1) and (2) instrumenting the lagged values with an additional lag (Galvao Jr., 2011). This procedure does not affect the estimations in any significant manner, as the path and the magnitudes across quantiles follow common shapes for each country and performance indicator. The estimated coefficients can be found in Table A3 and in Table A4 of the Appendix, and they are graphically represented in Graph 4.

6. Conclusions

This study deeply explores the long-term leverage-growth relation and establishes the presence of numerous non-linearities, together with some characteristics in common across countries and growth indicator. First, it collects existing theoretical and empirical evidence on the topic. Then, with the use of advanced techniques, such as dynamic panel quantile regression with non-additive fixed effects, we estimate this relation for firms located in France, Italy and Spain, along two growth indicators, sales and productivity. The extended literature review on the subject highlights substantial modeling efforts, both empirical and theoretical. Nevertheless, both the dual nature of firm-level leverage and the heterogeneity intrinsic to each growth distributions point at a complex, non-linear picture. We test the evolutionary implications of a model where the fitter should benefit more from leverage and where productivity gains should be harder to grasp than sales one.

Besides providing a comprehensive literature review on a farthan-settled subject, we contribute to economic understanding in other ways. Particularly, we do not find support for the hypothesis that more growing firms embodies better capabilities to exploit long-term leveraged situation. On the contrary, our findings show the opposite. A stable, positive relationship has been established only for the lowest growing deciles, and for some cases of centrally-located firms. The nexus becomes duskier and fluctuating as we move toward the right-tail of the growth distributions.

Although the results do not support our selection hypothesis, a candidate explanation is the fact that low-growing firms are more likely to depend on external finance, and the obtainment of long-term leverage broadens their struggling strategic portfolio. Further, given their weakly performing position, they are disciplined in making an efficient use of the obtained resources.

This growth-enhancing effect may apply also for firms in the central part of the distribution, which are usually far from being the virtuous, innovative, and disruptive ones. On the contrary, as we move toward the highest-growing decile, the effects are negative or insignificant, probably hinting at the fact that truly growth-enhancing activities rely on a more complex network of financial tools and arrangements. Also, relying on leverage for these firms is a risky behavior. Indeed, exceeding thresholds of leverage may make them financially-constrained and hurt significantly their growth paths. Our results are in line and strengthen also the previous findings by Garcia-Quevedo et al. (2018), who found that one of the main causes of innovative project abandonment are external financial constraints.

Further, in line with the pecking-order theory (Berger and Udell, 1998; Gregory et al., 2005), highly profitable firms prefer to finance their investments via internal resources. Indeed, Vanacker and Manigart's (2010) show that internal finance and financial debt are the most frequently used financing alternatives for high-growth firms. In parallel, long-term leverage may be beneficial also for non-fitter firms as it creates value by disciplining managers in companies with no or very scarce growth opportunities (Jensen, 1986).

An emerging result is also the diffused heterogeneity in the way the long-term leverage relationship is framed at firm-level, and more effort shall be put in the understanding of the underlying mechanisms both at theoretical and empirical level. Particularly, from an applied perspective, the use of more insightful datasets, which track the possible channels of propagation from leverage issuing to actual growth, are needed. An important prescription stemming from the present study is that these channels of propagation are likely to differ considerably for firms growing following different paths.

Indeed, some of the limitations arise from the nature of our dataset. On the one hand, we decide to focus only on long-term leverage to maximize the exploration of the parameter space in terms of countries and growth indicators. Meaning that we intentionally leave the model relatively simple, but we change the conditions (growth indicators) and settings (countries) to which we apply it in the pursuit of regularities. Such a choice does not allow to make considerations on the complex financial structure of firms. On the other hand, Amadeus has no reliable information regarding the death of firms, and consequently, our analysis focuses only on incumbent firms, avoiding any consideration of life-cycle properties of firms, which on the contrary would be part of some strategic choices. Focusing exclusively on incumbent firms can indeed over-estimate[11] the impact of leverage on performance on the whole universe of firms, as we miss the impact of leverage on "dying" firms. Nevertheless, the focus of the empirical exercise is computing the quantile elasticities between LTleverage and growth measures. The interpretation is focused mostly on the analysis of their behavior over different growth quantiles, and not on the magnitude of the estimated coefficients. Being aware of this, results still have a strong validity for the sub-universe of incumbent firms, that contribute in a major way to the economy.

Concluding, this finding has strong implications in terms of financing allocation and policy aimed at easing credit constraints. Under an efficiency perspective, it becomes key to match the appropriate financing tools with the needs of firms, which tend to differ considerably according to their position along the growth distribution.

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[11] Nevertheless, here we stress that the focus of the estimations is computing the quantile elasticities between LTleverage and growth measures. The interpretation is focused mostly on the analysis of their behavior over different growth quantiles, and not on the magnitude of the latter.

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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.

CRediT authorship contribution statement

Sebastiano Cattaruzzo: Conceptualization, Methodology, Software, Data curation, Writing – original draft. **Mercedes Teruel:** Visualization, Investigation, Supervision, Writing – review & editing.

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Appendix

Table A1
Variables definition.

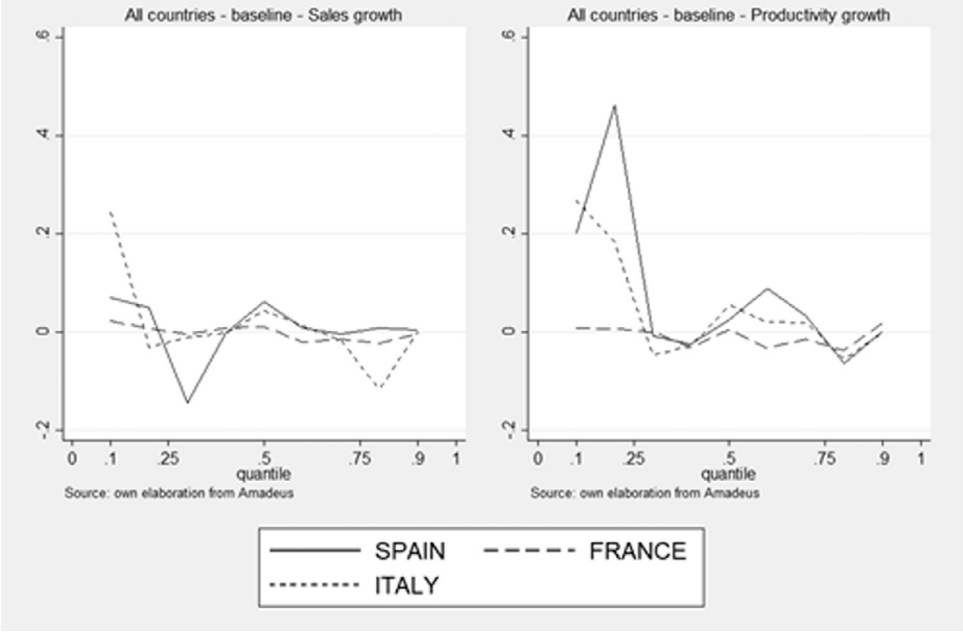
Variable of interest	Definition
Age	2018 minus the age of birth
Total assets	Total assets (Fixed assets + Current assets)
Long term debt	Long term financial debts (e.g. to credit institutions (loans and credits), bonds)
Number of employees	Total number of employees included in the company's payroll
Sales	Net sales
Added value	Profit for period + Depreciation + Taxation + Interests paid + Cost of employees
Labor productivity	Added value over number of employees
LTD ratio	Long term debt over total assets

Source: AMADEUS user guide.

Table A2
Pairwise correlation matrix – Pooled sample.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Sales growth	1.00							
(2) Sales level	0.01	1.00						
(3) Productivity growth	0.27*	0.00	1.00					
(4) Productivity level	0.02*	0.02*	0.13*	1.00				
(5) Long-term debt	0.00	0.81*	0.00	0.01*	1.00			
(6) Total assets	0.00	0.85*	0.00	0.01*	0.98*	1.00		
(7) LTleverage	−0.04*	0.00	−0.01*	0.00	0.02*	0.00	1.00	
(8) Age	−0.01*	0.04*	0.00	0.01*	0.03*	0.03*	−0.11*	1.00

Significance stars corresponding to the 5% significance levels or more.



Graph A1. Plots of LTleverage coefficients by country and growth indicator.

Table A3
LTleverage coefficients estimates on sales growth – Instrumented model with additional lag on sales level.

Decile	France	Italy	Spain
0.1	0.0204 (0.0147)	0.235*** (0.0324)	0.0701*** (0.0078)
0.2	0.0061 (0.0061)	−0.0011 (0.0011)	0.0517*** (0.0069)
0.3	−0.0022 (0.0027)	−0.0057*** (0.0009)	−0.144*** (0.012)
0.4	0.0084*** (0.0033)	−0.0003 (0.0011)	0.0025 (0.0034)
0.5	0.0212*** (0.0040)	0.0449*** (0.0016)	0.0616*** (0.0040)
0.6	−0.0408*** (0.0090)	0.0117*** (0.0024)	0.122*** (0.0079)
0.7	−0.0151*** (0.0039)	−0.0121 (0.0122)	−0.0037* (0.0021)
0.8	−0.0148*** (0.0044)	−0.0843*** (0.0044)	0.0011 (0.0025)
0.9	−0.0017 (0.132)	−0.134*** (0.0294)	0.0030 (0.0039)

Number of observations: France (2,348), Italy (17,955) and Spain (8,626) observed over seven years. Significance levels corresponding to * $p<0.1$, ** $p<0.05$, *** $p<0.01$. A constant term and other variables are included in each regression but not reported here. Standard errors in parentheses.

Table A4
LTleverage coefficients estimates on productivity growth – Instrumented model with additional lag on productivity level.

Decile	France	Italy	Spain
0.1	0.0914** (0.0460)	0.270*** (0.0238)	0.202*** (0.0328)
0.2	0.0066 (0.0072)	0.159*** (0.0076)	0.462*** (0.0393)
0.3	−0.0081 (0.0178)	−0.0472*** (0.0049)	0.0832*** (0.0049)
0.4	−0.0166*** (0.0044)	−0.0278*** (0.0012)	−0.0239*** (0.0017)
0.5	0.0043 (0.0072)	−0.0435*** (0.0085)	0.0255*** (0.0036)
0.6	0.0159 (0.0361)	0.0204*** (0.0033)	0.0786*** (0.0037)
0.7	0.0053 (0.0032)	0.0190*** (0.0013)	0.0262*** (0.0041)
0.8	−0.0160** (0.0076)	−0.0933*** (0.0044)	−0.0607*** (0.0058)
0.9	0.0214** (0.0099)	0.0023 (0.0031)	0.0143*** (0.0041)

Number of observations: France (2,348), Italy (17,955) and Spain (8,626) observed over seven years. Significance levels corresponding to * $p<0.1$, ** $p<0.05$, *** $p<0.01$. A constant term and other variables are included in each regression but not reported here. Standard errors in parentheses.

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