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Working Paper

Growth and financial exposition in times of crisis

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Growth and financial exposition in times of crisis*

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Abstract

The financial crisis of 2007-2008 has had an important impact on the real economy, particularly in Europe: analyzing the trasmission channels through which this happened is however far from simple. We focus on the effect of financial constraints on the performance of manufacturing firms by employing several indirect measures of such constraints. We first study non-parametrically the relation between credit exposition and growth of firms, providing robust evidence that such relation has changed sharply from the pre-crisis period to the post-crisis one. We then enrich an existing model of market selection with proxies of financial constraints, originating both from raw balance sheet data, and with data from the SAFE survey on access to credit, ran by the ECB on a vast sample of European firms. We confirm that firms which tend to rely more on external financing performed worse in the aftermath of the crisis, and that the propensity to have suffered from financing constraints is also a predictor of low growth.

Keywords: Credit crunch, Market selection, Financial constraints, Productivity decomposition.
JEL classification: C23, D22, H12, L20, O16, O47.

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1 Introduction

That the financial crisis of 2007-2008 has taken its toll on economies all around the world in what has been described as the "Great Recession", and that the losses suffered by the real economy have still not been recovered in the EU - assuming that recovery even started - is considered today as self-evident. How exactly this happened, however, is less obvious: not because of the lack of a plausible explanation, but rather because multiple explanations are available. The decline of housing prices following what is now believed to have been a bubble, the self-reinforcing pessimism concerning the economic prospects, the large debt accumulated by some members of the EU, the decreasing demand on behalf of consumers and the credit crunch which affected the ability of firms to finance their operations are some of the different explanations, clearly interdependent and non-exclusive, which have been provided for the economic turmoil. And while in principle these can all be viewed as different faces of the Minskyan *"paradox of deleveraging, in which precautions that may be smart for individuals and firms - and indeed essential to return the economy to a normal state - nevertheless magnify the distress of the economy as a whole"* (Yellen, 2009), distinguishing them, conceptually and empirically, is crucial in order to shape policy responses.

In principle, the European policy response to the last of the channels mentioned, the credit crunch, was strong, with the ECB abruptly lowering the main interest rate from the level of 4.25% (close to the record high of 4.75% reached between 2000 Q4 and 2001 Q1) held until October 7, 2008 to the 1% reached on July 13, 2011 (never to surpass 1.5% since). But in practice, the efficacy of these measure (and of the quantitative easing program that the ECB started in January 2016) in restarting demand on behalf of consumers and investment on behalf of firms as been debated, with many influential voices, inside and outside the academia, questioning the fact that the liquidity directed at banks will ultimately be channeled towards the financing of non-financial firms and households.

In the present study, we focus on the relation between credit availability and growth for European manufacturing firms in the period from 2004 to 2013. By combining information on financial constraints originating from large scale surveys and micro-data concerning financial variables from the balance sheets of individual firms, we provide novel evidence of the relevance of credit constraints. Focusing on the manufacturing sectors, and further disaggregating the analysis in the different subsectors of manufacturing, allows us to compare firms with relatively similar structures and operating today in the common European market.

2 Data

2.1 Survey data

The clearest evidence concerning the reduction in credit possibilities that EU firms suffered in the aftermath of the financial crisis is probably provided by the surveys that EUROSTAT ("Access to finance" survey) and the ECB ("SAFE") ran (independently) on subsamples of the population of firms.

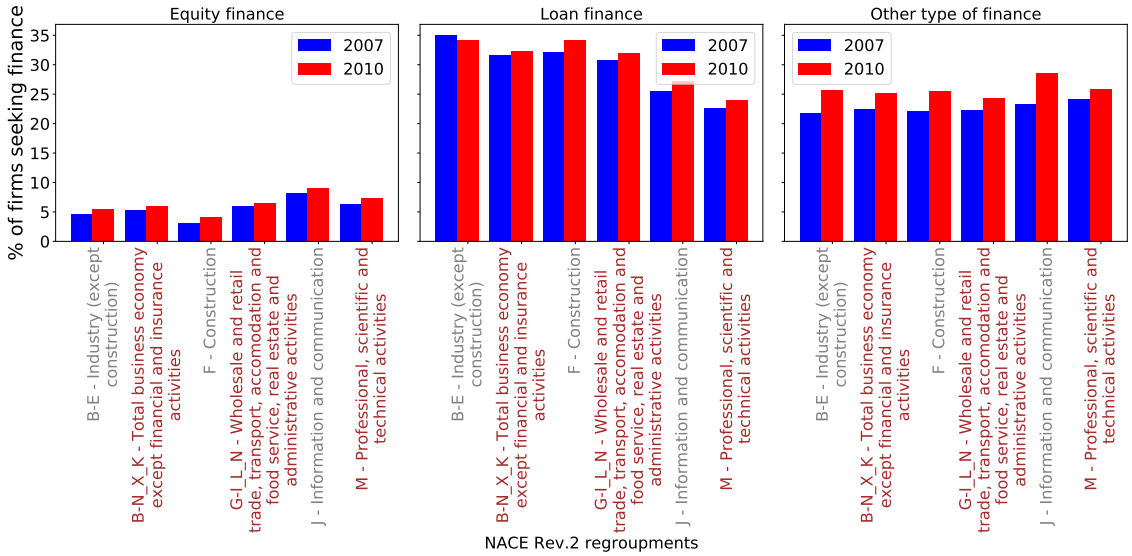


Figure 1: Percentages of firm seeking finance, by NACE regroupments

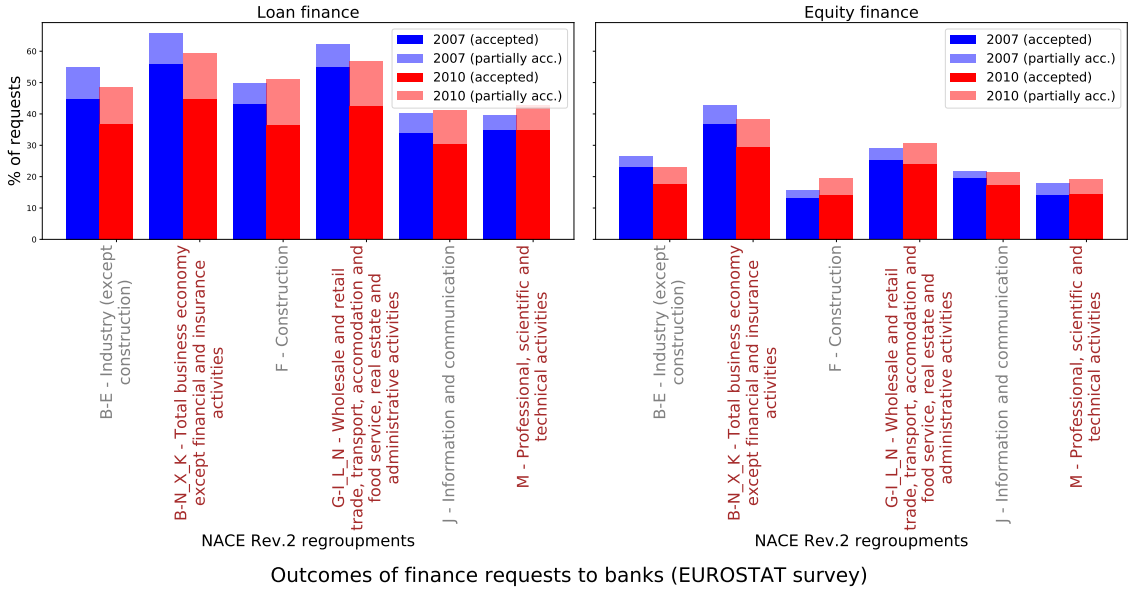


Figure 2: Percentages of succesful financing requests to banks, by NACE regroupements

Figures 1 and 2 provide evidence from the former survey, ran on 25 000 enterprises with 10 to 249 employees, in 20 participating countries. Such a survey allows us to compare perceived financial constrainedness across manufacturing and services sectors (sector K - financial services - was excluded from the analysis) just before the financial crisis exploded, and a couple of years after. While it might not be obvious whether a share of 20% to 35% (in the case of bank loans - middle panel of Figure 1) of firms "seeking finance" is an alarming number, what is striking is that across all macro-sectors and across the three categories of financing source, in the overwhelming majority of cases firms there were more firms seeking finance in 2010 than in 2007. And while in principle this could be a sign of increase in business opportunities, rather than of a decrease in credit opportunities, Figure 2, which reports the aggregate statistics of financing requests outcomes, clearly shows that the share of rejected, or only partially accepted, requests has also declined: again, the pattern is strikingly general across regroupments of sectors.

Data sets such as the EUROSTAT "access to finance" and the ECB "SAFE" are useful to researchers and policy makers because of their obvious interpretation - directly assessing the probability of a firm being in need of credit, or being rejected a request for credit. Their limits, on the other hand, are not just that as any survey data their reliability might be questioned: the fact that their results are aggregated and do not include performance measures makes it impossibly to study the relation between, for instance, credit access and firm growth. This is why a study of the impact of the credit crunch on firm growth needs other sources of data, which we describe in the following section and which we will combine with survey data in Section 4.

2.2 Balance sheet data

The firm level data required for the present study is sourced from the Bureau van Dijk Amadeus database: this is the European version of Orbis, which is nowadays an important tool for the reconstruction of representative populations of firms (Kalemli-Ozcan et al., 2015). The analysis focuses on manufacturing firms (as identified by their NACE Rev. 2 "Section"), which will in turn be classified according to their sectors (as identified by their NACE 2-digits classification, resulting in 23 sectors, enumerated from 10 to 33). It encompasses all European countries, where not otherwise specified. Sales figures are deflated using the sector-, month- and country-specific deflators provided by EUROSTAT (table "nama_10_a64").

The specificities of the source of data must be taken into account: the "Loans" variable provided in Amadeus includes both expositions to banks and to other lenders, including through bonds.[1] However, it is well known that bonds are used as financing opportunities by only a very small minority of firms.

In order to define a measure of firms' growth, three different variables will be used (and in particular, their relative change over time will be analyzed):

- fixed assets,

[1]For instance in the case of Italy this variable is the sum of the following balance sheet items: "Obbligazioni", "Obbligazioni Convertibili", "Debiti Vs Banche", "Debiti Vs Altri Finanziatori".

- number of employees,
- sales.

2.2.1 Sample

There are around 21 million firms in the Amadeus database: restricting to those active in manufacturing yields a sample of 1 756 613 firms. The data covers years from 2004 to 2013, and for the purposes of analyzing the effect the crisis, such period of time is split in two time spans: 2004-2007 and 2008-2013.

It should be noticed, however, that not for all firms which are present in the database there is data for each variable and for each year. On the contrary, the attrition rate is quite high. Since the analysis includes average levels and lagged differences, we need to formally define those concepts in the presence of missing values. For what concerns the means, a firm is considered as "present" in a given timespan if there is at least one valid observation for one of the years involved. For instance, a firm is considered in the sample for the "04-07" period if the variable under observation is available for at least one of the years 2004, 2005, 2006, and 2007, and the mean e.g. of loans in that period is then defined as the mean of loans for the available years. For what concerns value changes, a firm is considered in a given timespan if there are at least *two* valid observations, and the change is defined as the last available value minus the first available value. Since such two years will not necessarily be the first and the last in the considered timespan (e.g. because an observation is available for 2004 and 2005 but not for 2006), measures of temporal change may need to be interpreted as lower bounds.

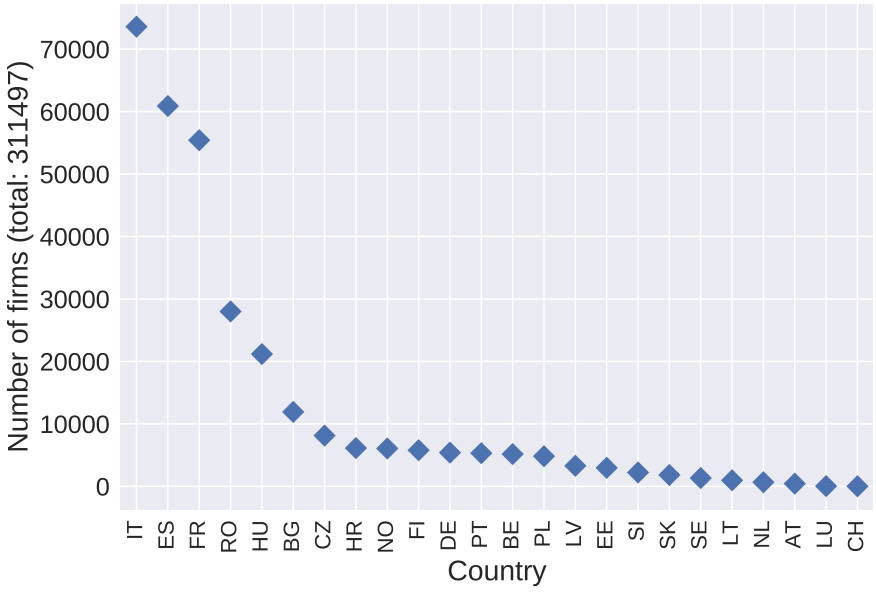


Figure 3: Number of observations per country considered in the panel analysis of Section 4.

Once firms which do not satisfy these criteria are discarded, we are left with a sample size between 264 551 and 564 710, depending on the timespan and specific variable (e.g. "sales" is more often missing than "fixed assets", and "employees" even more often; most recent years are the ones for which more firms are missing). Figure 3 shows the distribution across countries of firms which will appear in the panel analysis (Section 4). The fact that the sample changes between different periods of time could possibly lead to endogeneity issues (i.e. identifying dynamics which are only due to a different propensity of having data reported, or of having survived the crisis): to limit this risk, the nonparametric analyses presented in Section 3.1 were also ran for a "quasi-balanced" panel, that is by imposing that a firm is present (where "present" has the meaning described above) in both periods examined: the sample size decreases further (295 741 when considering sales, 186 052 when considering employees, 397 306 when considering fixed assets), but the results present only very minor differences.[2]

2.2.2 Financial indicators

Several financial indicators will be considered and compared. Two of them are based on a matching between the Amadeus database and the already mentioned SAFE survey on credit constraints. Several attempts in this direction have been reported in the literature, but some of them (Bankowska et al., 2015) require access to the identifiers of the surveyed firms: we adopt instead an approach analogous to the Nearest Neighbour Distance Hot Deck used by Ferrando and Mulier (2015), based on matching each firm in the Amadeus data to a given cell (as defined by sector, country and turnover classes) in the SAFE survey, and attributing to such firm the average indicator for its class.

3 Analysis

We start by providing some aggregate evidence in order to substantiate the decrease in growth of European firms in the time span under analysis, and to put in context our later findings.

Figure 4 exploits data from the financial section of the COMPNET database (Ferrando et al., 2015), recently assembled by the BCE, in order to highlight the downturn in aggregated turnover for the manufacturing sector after the year 2008, and in particular the fact that as of 2012, the levels had still not recovered ground lost since 2008. This could in principle be due to two different factors: an exceptionally high number of firms ceasing their activity, and an exceptionally low level of growth for active firms.

[2]It is worth noticing that there is no no reliable way to know if a firm which for instance is present only in the first of the three periods is still operating, and vice-versa for firms present only in the last of the three periods if they were already operating in the previous years. Although there is a variable with this purpose in Amadeus, "Status", it is not considered as reliable, because Bureau van Dijk does not typically receive notifications of mergers and end of operations.

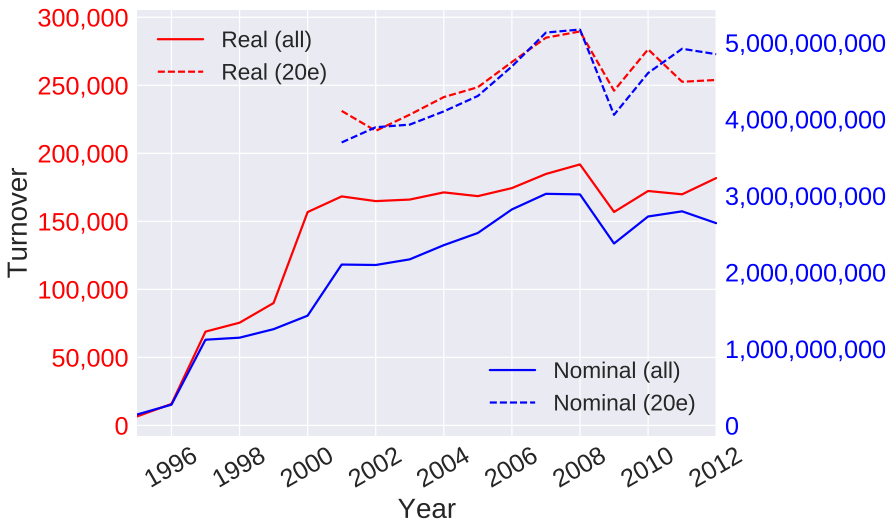


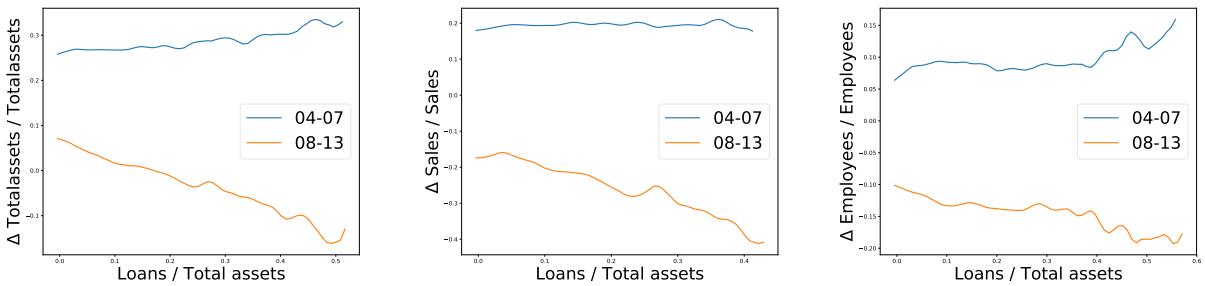
Figure 4: Real and nominal turnover from Compnet data. "20e" refers to a smaller sample of countries for which however longer time series are available.

3.1 Financial exposition and growth - nonparametric analysis

Figures 5, 6 and 7 explore the relationship between the financial exposition of firms and their growth, before and after the crisis. This is done nonparametrically by plotting the kernel regression of three alternative indicators of growth (sales, fixed assets, employment) over a measure of financial exposition (loans), both normalized by the amount of fixed assets (Figure 5) or sales (Figure 6).[3]

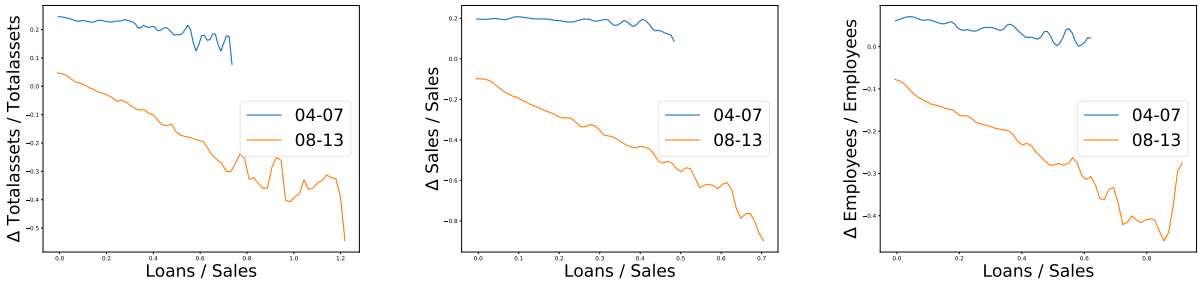
Figures 5, 6 and 7 all share the fact that the line referring to the post-crisis period (orange

[3]Because of the - widely recognized - noisiness of Amadeus data, the top 1% and bottom 1% of the distribution were dropped for both the dependent and the independent variable, eliminating for instance a number of firms for which negative loans were reported.



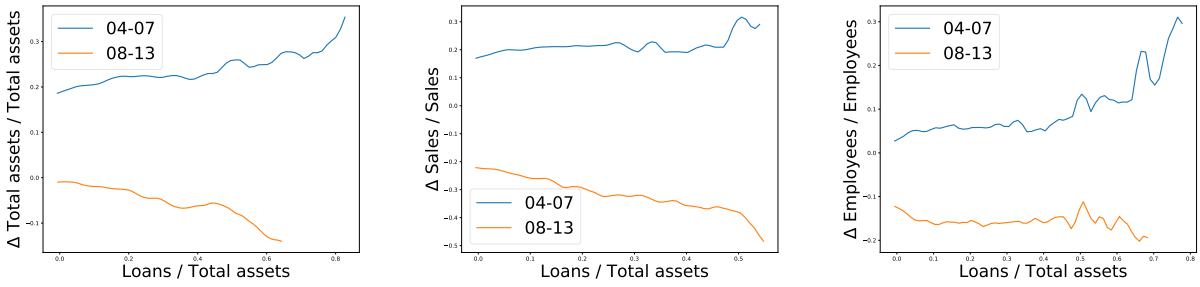
(a) (b) (c)

Figure 5: Kernel regressions of the different growth measures, related to euros of outstanding loans per euro of total assets.



(a) (b) (c)

Figure 6: Kernel regressions of the different growth measures, related to euros of outstanding loans per euro of sales.



(a) (b) (c)

Figure 7: Equivalent of Figure 5 conditioning on the *initial* level of the independent variable rather than on its average over the period.

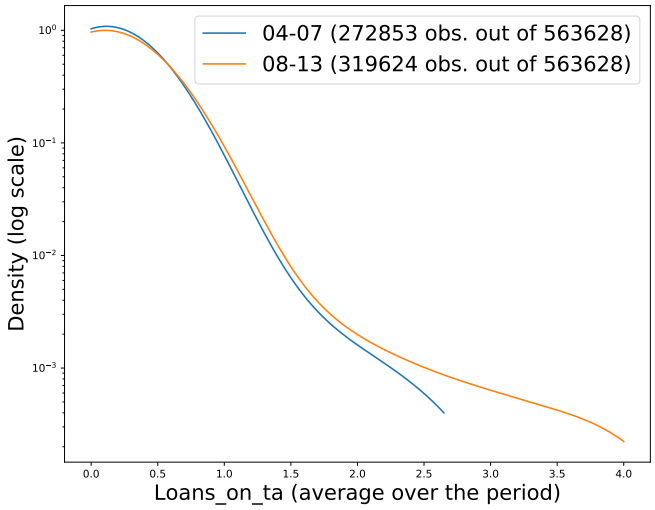


Figure 8: Kernel density of the $\frac{\text{“loans”}}{\text{“total assets”}}$ ratio.

line) is significantly lower than the line referring to the pre-crisis period (blue line), reflecting the declining growth rates during and after the crisis.

The fact that the orange line often extends more to the right reflects, then, the fact that firms were on average more indebted after the crisis than before (or more precisely, that the last percentile of relative exposure is positioned at larger ratios than before the crisis), whatever variable we use to normalize the measure of financial exposition. This observation is made evident in Figure 8, which plots the reconstructed distribution for ratio $\frac{\text{loans}}{\text{total assets}}$: firms consistently tend to be more exposed in relative terms in the last years than in the previous periods (or alternatively, firms which typically rely less on loans are having more difficulties in obtaining them).

The negative slope of curves in figures 5 and 6 also evidences the fact that more indebted firms are growing less (and this in spite of the idea that lenders should be more willing to lend to firms which are growing, or are expected to grow). It is then particularly evident when looking at sales (Figures 5 (b) and 6 (b)) that this relation has become stronger after the crisis (more negative slope). This might mean that firms which rely more on external credit may have suffered more from the credit crunch which followed the crisis.

Did firms which relied on external credit have trouble, or did troubled firms resort to external credit? Were they able to? An attempt to clarify this is issue is undertaken in the next section, in which we focus on different proxies of financial constrainedness.

4 Parametric investigation

In the present section, we explicitly focus on the issue of financing sources as a driver of growth by enriching the model of Dosi et al. (2015) with information on the financial exposition/constraints of firms. Specifically, we consider the following regression:

$$growth_{i,t} = \alpha + \beta fin_{i,t} + \gamma_0 prod_{i,t} + \gamma_1 prod_{i,t-1} + \delta X_t + \epsilon_{i,t} \quad (1)$$

where *growth* measure the increase of sales since the previous year (measured as difference of logarithms[4]) the variables *prod* (lagged by 1 and 2 years, respectively) represent (past) productivity, measured as (the logarithm of) total value added divided by number of employees, and X_t is a matrix including sector- and country-specific fixed effects, as well as firm age.[5] The novelty lies in the introduction in the model of a financial indicator fin, which will allow us to investigate the effect of dependence on external souces of credit on the performance of firms. For the sake of comparison, in what follows we will also consider the original model, i.e. Equation 1 with the "fin" variable omitted, and we will refer to it as the "BASE" model.

4.1 Financial indicators

The literature on financial constraints faces a substantial difficulty: while data on financial exposition is sometimes available, data on (failed) requests for financing is virtually impossible to access.[6] Several approaches have been proposed in the literature to devise proxies of financial constraints: the most widespread ones however either involve predictors that are naturally related also to growth (Hadlock and Pierce, 2010), or which are typically only available for listed firms (Fazzari et al., 1987; Kaplan and Zingales, 1997), or they require higher frequency data than what is available for a large sample of firms across different countries (Almeida et al., 2004). Moreover, doubts have been cast on whether even the most sofisticated indicators based on balance sheet declarations of firms are able to really capture financial constraints (Farre-Mensa and Ljungqvist, 2015). In the present paper, we take a different stance: rather than adopting or devising sofisticated measures, which by design tend to be lacking a simple interpretation, and hence to be at the risk of low external validity (e.g. across different countries and sectors compared to those for which they were calibrated), we study on one hand two simple measures of the financial exposition of a firm (in the spirit of Fagiolo and Luzzi, 2006; Molinari, 2013), and on the other hand two measures derived from the SAFE survey on financing constraint. The perfect measure of financial constraints would not just be authoritative and accurate: it would allow to link credit and growth at the level of resolution of the firm and it would directly look at the phenomenon of interest (credit constrainedness). So in the absence of a measure satisfying all these characteristics,

[4]This is coherent e.g. with Fagiolo and Luzzi (2006).

[5]While sector-specific fixed effects have an important role, removing country-specific fixed effects and firm age results in only minor changes in the estimated parameters.

[6]Among the very few exceptions are surveys akin to the ones mentioned in Section 2.1, affected by the already mentioned limitations.

we base our analysis on two simple authoritative measures, available for the individual firm, but which are not able to dig deep in the distinction between financial *preferences* of firms and financial *constraints*; and on two measures which vice-versa are only available at an aggregated level (details are provided below) but directly tackle the phenomenon of interest, since they focus explicitly on the issue of credit constrainedness.

The two balance sheet-based measures are

- "LEV" (leverage), defined as the ratio

$$LEV_{i,t} = \frac{LOANS_{i,t}}{TA_{i,t}}$$

  where TA are total assets, and

- "SCF", proposed by Fagiolo and Luzzi (2006) and defined as

$$SCF_{i,t} = \frac{CF_{i,t}}{SALES_{i,t}}$$

  where CF are cash flows.

Notice that each of this measures is defined for each firm and for each year.

The two measures based on the SAFE survey are instead:

- "SAFEi1", based on the question Q0, "What is currently the most pressing problem your firm is facing?". A firm is considered credit constrained if it answered "Access to finance".

- "SAFEi2", based on questions Q7A ("Have you applied for the following types of financing in the past six months?") and Q7B, ("If you applied and tried to negotiate for this type of financing over the past six months, what was the outcome?").[7] A firm is considered credit constrained if one of the two holds:

  - in question Q7A, it answers "Did not apply because of possible rejection" for at least one source of financing, and for no source of financing it answers "Applied"
  - in question Q7A, it answers "Applied" for at least one source of financing, and in question Q7B answers one of "Refused because the cost was too high", "Was rejected" and "Received below 75%".

The SAFE survey provides only very stylized characteristics of each respondent firm: they basically reduce to information on the country, and size class in terms of employees and turnover class. Cells are created based on such variables, and average propensities to be financially constrained are calculated in each cell, and attributed to all firms in Amadeus

[7] The classes of financing considered in the survey are "Bank loan", "Trade credit" and "Other external financing".

which would fall in such cell. One crucial difference between the two measures based on balance sheet data and the two measures derived from the SAFE survey is then that the latter are not available for all years being analyzed: rather, they were calculated for the year 2009, the first useful year.[8]

Dosi et al. (2015) estimate their model on panel data with random effects, in order to capture both the variability in time and across firm characteristics. In the present analysis we follow two different approaches: on one hand, we look at cross-sectional estimates and at their change over time; on the other hand, we run a panel analysis with both fixed and random effects, focusing hence on the changes over time for the same firms. Clearly, because of the aforementioned limitation, survey-based indicators will be excluded from the panel analysis.

We start our parametric analysis by estimating, with OLS, cross-sectional versions of Equation (1) for each year, and studying the behaviour of the coefficient for the financial indicator: see Figure 9 and tables 1, 2, 3, 4 and 5. A high leverage can be a characteristic of firms with many investment opportunities, and so in principle could be correlated with positive growth; however, if there is a credit shortage, firms which are more dependent from external credit will have more difficulties. Indeed, from the plot relative to the "leverage" variable (Figure 9, top left panel) it is evident that while at the beginning of the period of observation the coefficient was undistinguishable from 0, it had decreased to less than -0.4 in 2009, and has always been significantly negative until 2013, partially recovering from 2009 to 2011 but again decreasing significantly from 2011 to 2012. The results obtained for the second financial variable, normalized cash flows (SCF), can however seem counterintuitive at first: since cash flows represent an opportunity for investment, not subject to the availability of external credit, it could be expected to be positively related to growth, and particularly so during a credit crunch, when external credit is rationed: instead, we see that the relation is mostly negative, and features a negative peak in year 2008. However, this can also be seen as an example of the subtleties nested in even simple measures of credit constrainedness: while Fagiolo and Luzzi (2006), for instance, run their analysis in "normal" times (from 1996 to 2000), the crisis which started in 2008 was characterized by a fall in demand and generalized pessimism: so the tendency to hoard cash in the immediate aftermath of the crisis might reflect not just an absence of credible business opportunities (due to the expected low demand), but also an expectation that reserves might be needed in the following years. This is particularly evident if we compare the negative peak observed in 2008 with Figure 4, where year 2008 can be observed to *not* feature a decrease in turnover (it was actually still increasing, in real terms): so the abrupt change in the β_1 coefficient for SCF is bound to be related to *expectational* motives rather than to the reaction to harsh market conditions. Interestingly, this does not hinder the interpretation of SCF as a proxy for financial constrainedness: even assuming that the increase of cash flow was precautionary, it is reasonable to expect that firms which, for whatever reason, face a higher risk to be financially constrained will have

[8] Although the SAFE survey was administered in multiple waves, and we have data for waves from 2009 to 2015, they differ in the questions proposed, and are not aligned with the fiscal years which characterize data from AMADEUS.

Year Variable	2005	2006	2007	2008	2009	2010	2011	2012	2013
prod0	0.221***	0.228***	0.235***	0.184***	0.233***	0.240***	0.200***	0.281***	0.247***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
prod1	-0.202***	-0.205***	-0.212***	-0.168***	-0.206***	-0.207***	-0.155***	-0.271***	-0.226***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

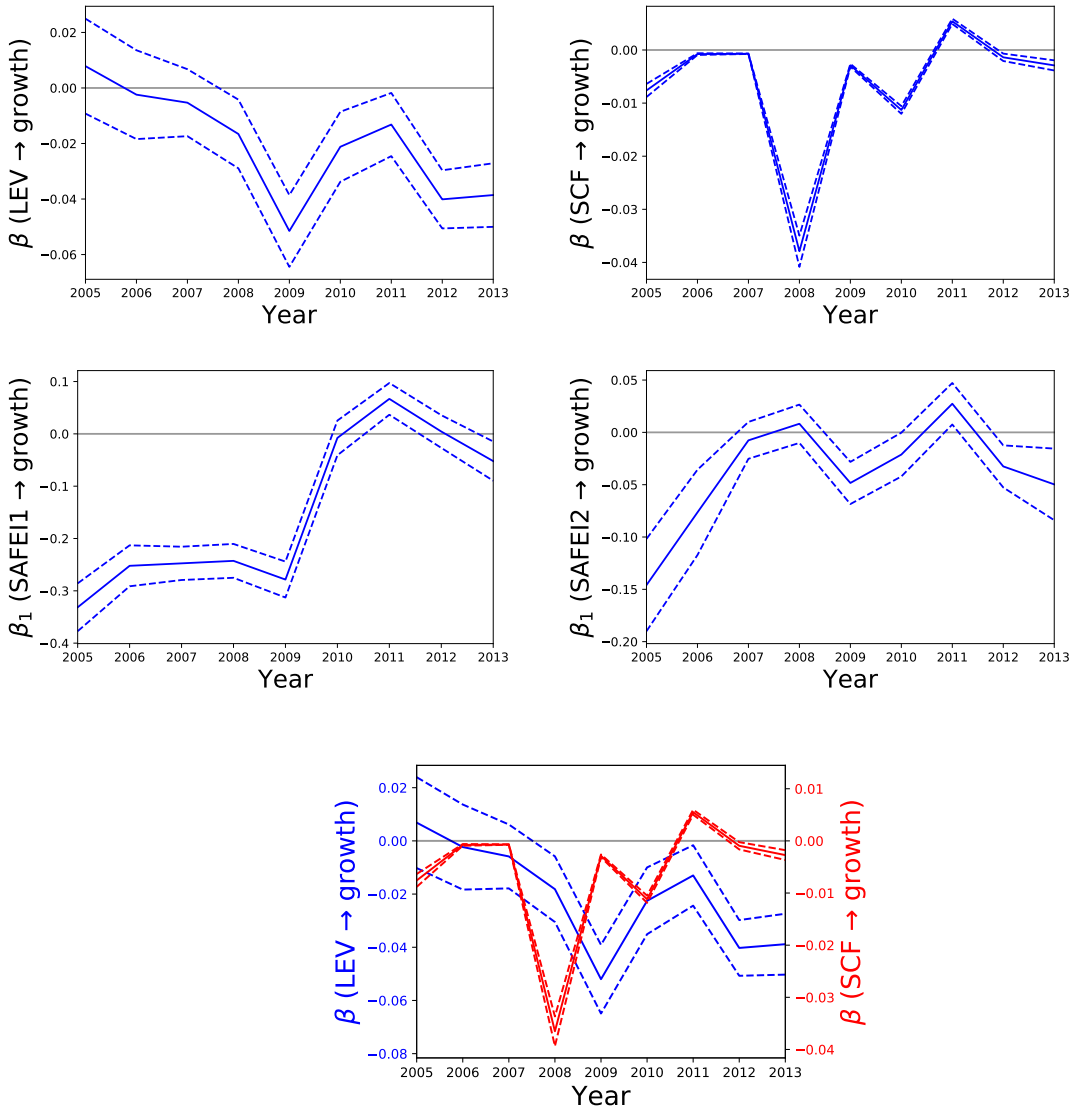
Table 1: Results of the BASE model

stronger incentives to put asides reserves than firms which are more confident in their access to external credit. The increase of the coefficient in years following 2009 might then be a combination of the need to consume reserves precisely for firms experiencing lower growth, to the point that in 2011 cash flow becomes *positively* correlated with growth, and remains close to 0 afterwards.

When looking at the two survey-based indicators, it is important to recall first that they are static measures, referring to year 2009: so it is worth starting by looking at the value of the β_1 coefficient in such year, and it is in both cases significantly negative: less constrained firms grow more. We can then observe that the relation between being financially constrained in 2009 and growth is, for both measures, negative or non-significant in all years except 2011 - the same year for which the SCF variable also features a positive coefficient. And in general, coefficients for the two survey-based financial variables feature similar patterns to the coefficient for LEV, with a negative peak in 2009 and a hump-shaped path in the following years.

In the last plot of Figure 9, we can see the coefficients for LEV and SCF estimated together in a same equation (so where the term $fin_{i,t}$ in Equation (1) actually includes two distinct variables with their own coefficients): the result is virtually undistinguishable from the separate estimation, reflecting the fact that the correlation between the two variables is very low. In fact, the four financial variables considered all have pairwise correlations close to 0, with the obvious exception of SAFEi1 and SAFEi2, which are strongly positively correlated, as one would except given that they reflect the same perception of credit-constrainedness. In light of this independence between them, the similarity of coefficients of Equation (1) is particularly striking: all panels in Figure 9 feature similar patterns, with the exception of SCF, which features the negative peak one year in advance: and SCF is actually, among the four measures, the only one which can strongly react to expectations (it reflects an investment or disinvestment choice of the firms, potentially unaffected by the contemporaneous availability or unavailability of external financing). Also particularly telling is that all four measures show a reversal after the immediate negative peak, but also a further decrease in the last couple of years covered by our data.

Figure 9: Variation of β over time. First row: "LEV" (left) and "SCF" (right); middle row: "SAFEI1" (left) and "SAFEI2" (right); bottom: model with both "LEV" and "SCF".



Year Variable	2005	2006	2007	2008	2009	2010	2011	2012	2013
scf	-0.008***	-0.001***	-0.001***	-0.038***	-0.003***	-0.011***	0.005***	-0.001***	-0.003***
	(0.001)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
prod0	0.222***	0.228***	0.235***	0.189***	0.234***	0.242***	0.199***	0.282***	0.248***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
prod1	-0.202***	-0.205***	-0.212***	-0.169***	-0.206***	-0.207***	-0.155***	-0.271***	-0.226***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

Table 2: Results of the SCF model

Year Variable	2005	2006	2007	2008	2009	2010	2011	2012	2013
levta	0.008	-0.002	-0.005	-0.017***	-0.052***	-0.021***	-0.013**	-0.040***	-0.039***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.005)	(0.006)
prod0	0.221***	0.228***	0.240***	0.176***	0.232***	0.244***	0.196***	0.287***	0.248***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
prod1	-0.201***	-0.205***	-0.217***	-0.161***	-0.203***	-0.214***	-0.153***	-0.281***	-0.230***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

Table 3: Results of the LEV model

Year Variable	2005	2006	2007	2008	2009	2010	2011	2012	2013
safei1	-0.331***	-0.252***	-0.247***	-0.243***	-0.278***	-0.008	0.067***	0.004	-0.052***
	(0.023)	(0.020)	(0.016)	(0.017)	(0.018)	(0.017)	(0.015)	(0.016)	(0.019)
prod0	0.221***	0.229***	0.232***	0.184***	0.229***	0.242***	0.205***	0.286***	0.255***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
prod1	-0.206***	-0.212***	-0.210***	-0.171***	-0.206***	-0.208***	-0.159***	-0.276***	-0.233***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

Table 4: Results of the SAFEi1 model

Year Variable	2005	2006	2007	2008	2009	2010	2011	2012	2013
safei2	-0.146***	-0.076***	-0.008	0.008	-0.048***	-0.021**	0.027***	-0.033***	-0.050***
	(0.023)	(0.021)	(0.009)	(0.009)	(0.010)	(0.011)	(0.010)	(0.010)	(0.017)
prod0	0.222***	0.230***	0.233***	0.185***	0.229***	0.242***	0.205***	0.286***	0.255***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
prod1	-0.204***	-0.211***	-0.209***	-0.170***	-0.204***	-0.208***	-0.159***	-0.276***	-0.233***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

Table 5: Results of the SAFEi2 model

	base	safe1	safe2	scf	levta
2005	0.8769	0.8779	0.8794	0.8756	0.8775
2006	0.8209	0.8255	0.8267	0.8203	0.8214
2007	0.8562	0.8614	0.8629	0.8506	0.8498
2008	0.8943	0.8922	0.8937	0.8905	0.8947
2009	0.6802	0.6813	0.6824	0.6783	0.6655
2010	0.8336	0.8376	0.8376	0.8284	0.8275
2011	0.8841	0.8835	0.8836	0.8814	0.8815
2012	0.8381	0.8330	0.8330	0.8381	0.8281
2013	0.8747	0.8692	0.8692	0.8745	0.8733

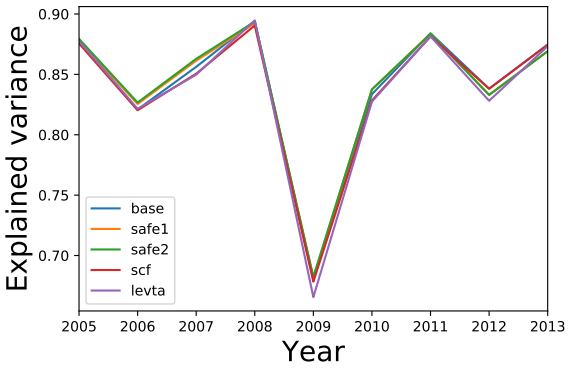


Table 6: Percentage of variance explained by each model in each year under analysis. See text for details.

4.1.1 Explained variance

Table 9 compares the explained variance for each of the four models considered variable: the fact that no model succeeds in explaining more than 9% of the variance in growth across firms (in spite of the clear patterns discussed in the previous section) is a reminder of the important unobserved heterogeneity affecting firms growth: the fact, however, that the explained variance is *particularly low* in correspondence of the year 2009 suggests that such heterogeneity has played a particularly strong role in the immediate aftermath of the crisis, when the credit crunch was harsher and hence for instance unobserved reputation with regards to banks might have made a stronger difference in the resilience of firms.

4.2 Panel analysis

Our analysis has begun with a set of cross-sectional estimates because we expected that the coefficients of interest were *changing* in time - and this change was precisely what we looked for, and what we found. On the other hand, given the structure of our data, it is natural to complement such estimates with a panel analysis, restricting to the two indicators which change in time (SCF and leverage) and allowing us to take advantage of the possibility

proxy	(Base)		LEV		SCF		LEV+SCF	
period	04-07	08-13	04-07	08-13	04-07	08-13	04-07	08-13
LEV			-0.088***	-0.052***			-0.088***	-0.052***
			(0.013)	(0.005)			(0.013)	(0.005)
SCF					-0.001***	0.000**	-0.001***	0.001***
					(0.000)	(0.000)	(0.000)	(0.000)
$prod_t$	0.160***	0.213***	0.167***	0.211***	0.160***	0.212***	0.167***	0.211***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
$prod_{t-1}$	-0.211***	-0.210***	-0.200***	-0.215***	-0.211***	-0.210***	-0.200***	-0.215***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Obs.	362740	959355	350751	886906	362740	959355	350751	886906
R^2	0.086	0.096	0.084	0.098	0.090	0.096	0.088	0.098

Table 7: Results of the panel analysis - fixed effects estimation

proxy	(Base)		LEV		SCF		LEV+SCF	
period	04-07	08-13	04-07	08-13	04-07	08-13	04-07	08-13
LEV			0.006	-0.028***			0.006	-0.028***
			(0.004)	(0.003)			(0.004)	(0.003)
SCF					-0.001***	-0.002***	-0.001***	-0.002***
					(0.000)	(0.000)	(0.000)	(0.000)
Intercept	-0.031***	-0.063***	-0.007***	-0.059***	-0.032***	-0.063***	-0.007***	-0.060***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$prod_t$	0.228***	0.240***	0.226***	0.243***	0.228***	0.241***	0.226***	0.244***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$prod_{t-1}$	-0.206***	-0.228***	-0.210***	-0.231***	-0.206***	-0.228***	-0.210***	-0.232***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Obs.	362740	959355	350751	886906	362740	959355	350751	886906
R^2	0.094	0.105	0.094	0.108	0.096	0.106	0.096	0.108

Table 8: Results of the panel analysis - random effects estimation

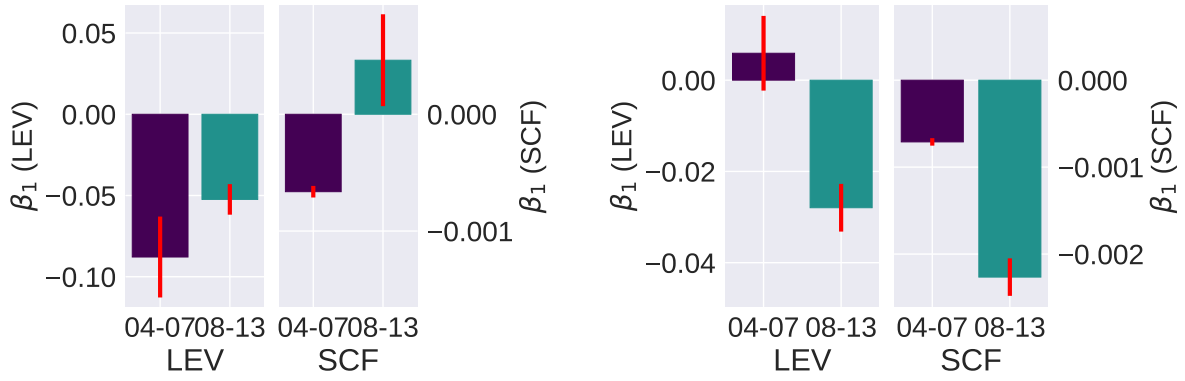


Figure 10: Coefficients for proxies of financial constrainedness - all sample, indicators "LEV" and "SCF". Left: fixed effects, right: random effects estimation.

to apply firm-fixed effects, hence studying the relations between variables of interest over time *regardless* of static firm-specific characteristics. Figure 10 plots the estimates obtained separately for the pre-crisis and post-crisis periods, including a random effects estimation, for comparison. Notice that in the fixed effects estimation, the term X_t from Equation (1) was obviously dropped, since it only included static variables.

In general, we see that at the firm level (left panel of Figure 10) the coefficient for the LEV variable is negative: firms grow less in those years in which they are more exposed. It can be easily argued that there might be a reverse causality at play, with firms becoming more indebted precisely in those years in which their sales shrink. Looking at the change of coefficients for the LEV variable from the pre-crisis to the post-crisis periods allows us to shed some light on these dynamics: in the presence of lower access to external credit, a lower growth should have a stronger impact on the leverage of a firm. On the other hand, if the other channel is dominating, with growth reacting to availability of financing, then access to the (scarce) external sources of financing should be a *positive* predictor of growth: and indeed, the coefficients of LEV in Figure 10 (left) grow from the pre-crisis to the post-crisis period, with the negative link between leverage and growth decreasing in intensity. Section 3.1 has made it evident that more exposed firms suffered more from the crisis: the fact that the panel analysis shows instead a comparatively positive effect of leverage is a clear sign of the fact that, *at the firm level*, access to loans during the credit crunch, when available, has provided relief to the benefiting firms.

Looking at the results for the SCF coefficient suggests a similar picture. In a "Modigliani-Miller world", i.e. in which external and internal sources of financing were freely interchangeable, firms would have no incentive at all to keep liquid assets. In practice, such indicator can reflect different phenomena, and can be both backwards and forwards looking. An increase in cash flows can be the result of unexpected increases in sales; however, in normal times, the level of cash flows at the firm level can be expected to be relatively stable, with revenues from sales being reinvested, or redistributed to owners/shareholders. In the presence, however, of scarce business opportunities, and of a pessimistic view of future financing possibilities, firms

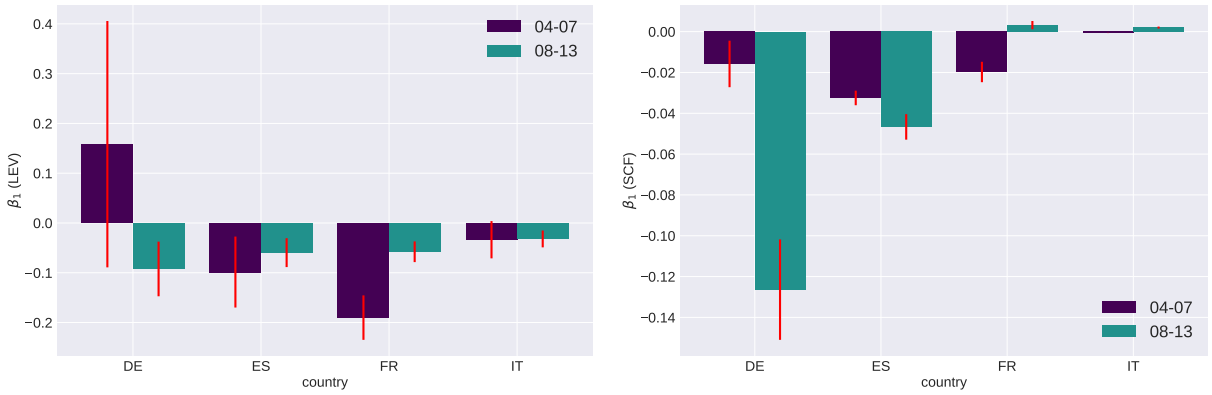


Figure 11: Country-specific coefficients for the "leverage" (left) and "SCF" (right) estimates from the panel analysis (fixed effects estimation) restricted to the most represented countries.

might want to hoard more cash. Indeed, both panels of Figure 10 feature a small but negative coefficient before the crisis: but when we look at the post-crisis period, results change significantly depending on the type of estimation. At the single firm level (fixed effects analysis, left panel), cash flows become positively correlated with growth - firms are able to build up reserves in those years in which they perform better (the panel analysis shows this is a significant relation, while it was at most episodical in the cross sectional analysis - recall Figure 9, top right). However, when looking at the entire population of firms (random effects analysis, right panel), cash flows are much more strongly correlated with bad performances than before - again, because they reflect pessimistic expectations concerning either profits or access to external financing, or more simply the absence of profitable investments.

We complement our analysis with the equivalent of Figure 10 ran on different subsamples of our population of firms. This is important not just because of the possibilty that dynamics of interest differ across European countries, but also because of the very heterogeneous coverage that unfortunately characterizes the Amadeus data (Figure 3). Figure 11 represents the result of the exercise ran separately on each of the four most important economies in Europe.[9] Concerning the LEV variable, the only country featuring a significant difference between the pre-crisis and post-crisis periods (France) is coherent with the sign observed at the aggregate level. France and Italy are also consistent with the aggregate analysis when looking at the SCF variable, but Germany (the most severely under-represented country) and Spain feature opposite dynamics, suggesting that different European countries might have been hit differently by the consequences of the crisis. Moreover, the countries have significant differences in levels: this is coherent with anecdotal evidence, as well as evidence from the SAFE survey, suggesting that the effect of the credit crunch has different across countries, and has been particularly tough in Italy.

Figure 12 plots instead the coefficients for the financial indicators resulting from an estimation of Equation (1) on each manufacturing sector separately (with fixed effects).

[9]UK is missing because of the lack of relevant variables in the Amadeus database.

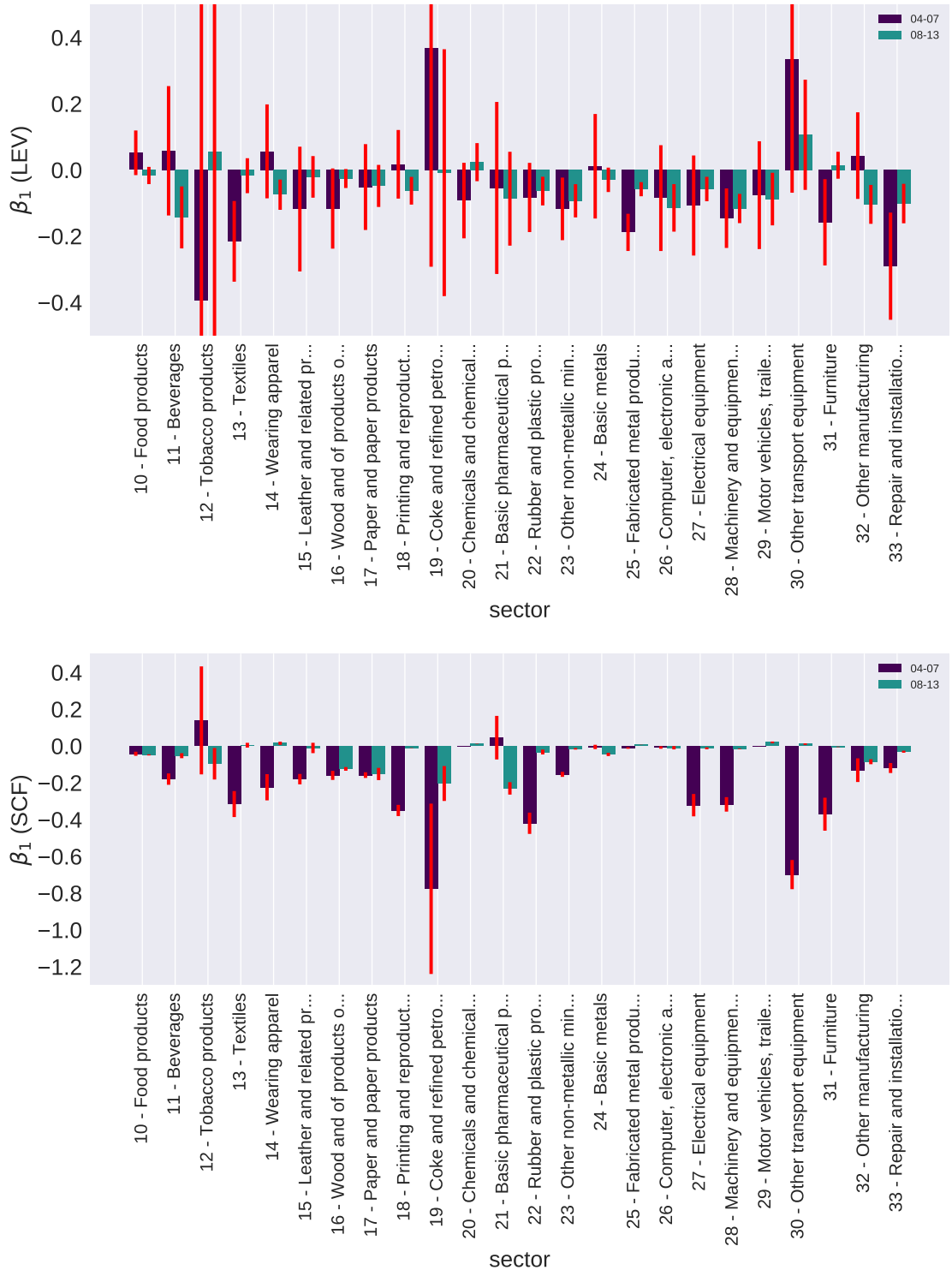


Figure 12: Coefficients for the financial variables (top: leverage, bottom: SCF) from the panel analysis (fixed effects estimation) restricted to each manufacturing sector.

Looking at the LEV variable, for most of the sectors the coefficients are not significantly different from 0 (possibly because of the minor role of financial constraints in some sectors, and of the low numerosity of others), suggesting strong heterogeneity across sectors; when they are, however, they are always negative, and in the two sectors for which the difference across period is significative ("Textiles" and "Fabricated metal products"), such difference also has the expected sign. Coefficients for the SCF variable are much more stable across sectors, and again coherent with the aggregate results: the estimate is significantly negative for most sectors, but with the absolute value of the coefficient decreasing in the post-crisis period.

4.3 Quantile regressions

The results presented in the previous sections are in agreement with the anecdotal evidence concerning the effect of the financial crisis according to which such effect has been differentiated across firms: while a large number of them suffered the decrease in demand and in financing opportunities, some might have profited from new opportunities. While pure regression analysis allows to summarize an entire industry in few figures, it is not the best tool to reconstruct the dynamics which characterize specific groups of firms. In what follows, we hence study the effect of financial variables at different points in the distribution of firms growth, in two distinct ways.

First, we run a traditional quantile estimation of the pooled data from each of the two periods (pre- and post-crisis).[10] The results are presented in tables 9 and 10 (for quartiles of the distribution), and in Figure 13 (same analysis, for deciles of the distribution). We find a marked difference for firms in the lowest deciles of the distribution, with the LEV variable being a negative predictor of growth before the crisis, and positive afterwards; results for the SCF variable are similar, although estimates are more noisy. The very clear relation between leverage and growth across classes of firms is enlightening: for firms which (conditioning on age and on sector and country fixed effects), are performing best, the crisis period does not seem to have had any effect on the relevance of external financing. However, the difference is evident for underperforming firms, which are apparently responsible for the dynamics observed in Figure 10 (right), that is for the (cross-sectional) relation between leverage and growth switching from positive to negative across the financial crisis.

It is worth emphasizing that in this approach, the position of a given firm in the distribution of growth levels, and hence the definition of the quantiles, changes from year to year. Moreover, it depends on the *conditional* growth: that is, it helps explaining the share of growth which is not explained by the regressors, but it does not cut homogeneously across the *entire* distribution of growth levels (e.g. as done in the nonparametric analysis of Section 3.1).[11]

As a complementary approach, we hence split the population of firms based on their growth *at the beginning* (during the first year) of the period. Figure 14 reproduces the panel

[10] This is done with the "rq" method from the "quantreg" R package.

[11] See Firpo et al. (2009) for a more extensive comparison between conditional and unconditional quantile regressions.

Year	04-07			08-13		
Quantile	0.25	0.50	0.75	0.25	0.50	0.75
Variable						
(Intercept)	-0.214***	-0.024***	0.183***	-0.309***	-0.082***	0.139***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)
levta	10.465***	11.249***	1.608	-24.810***	-13.321***	-6.375***
	(2.871)	(2.219)	(3.445)	(1.679)	(1.979)	(1.604)
prod0	0.195***	0.199***	0.202***	0.248***	0.237***	0.223***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
prod1	-0.154***	-0.182***	-0.211***	-0.205***	-0.218***	-0.228***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Obs.	350751	350751	350751	886906	886906	886906

Table 9: Quantile estimation of the LEV model. The coefficient for the "lev" variable is expressed in terms of effect of an increase of one thousand in the value of the variable. See Figure 13 (left) for a graphic representation at the level of the decile.

Year	04-07			08-13		
Quantile	0.25	0.50	0.75	0.25	0.50	0.75
Variable						
(Intercept)	-0.246***	-0.044***	0.171***	-0.312***	-0.071***	0.160***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
scf	-0.698***	-0.703***	-0.708***	-3.073***	-2.868***	1.844
	(0.085)	(0.060)	(0.099)	(0.233)	(0.125)	(7.599)
prod0	0.201***	0.204***	0.205***	0.247***	0.235***	0.219***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
prod1	-0.152***	-0.181***	-0.210***	-0.204***	-0.219***	-0.229***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Obs.	362740	362740	362740	959355	959355	959355

Table 10: Quantile estimation of the SCF model. The coefficient for the "scf" variable is expressed in terms of effect of an increase of one thousand in the value of the variable. See Figure 13 (right) for a graphic representation at the level of the decile.

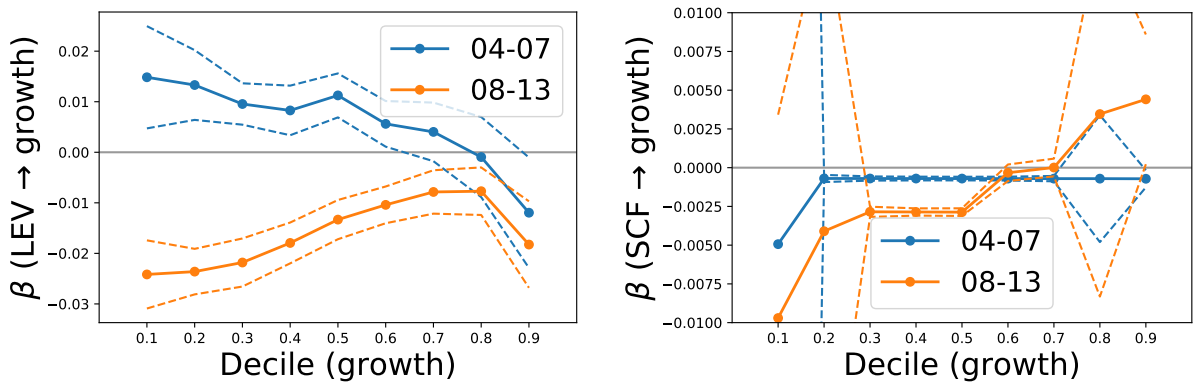


Figure 13: Coefficients for proxies of financial constrainedness from a quantile regression estimation.

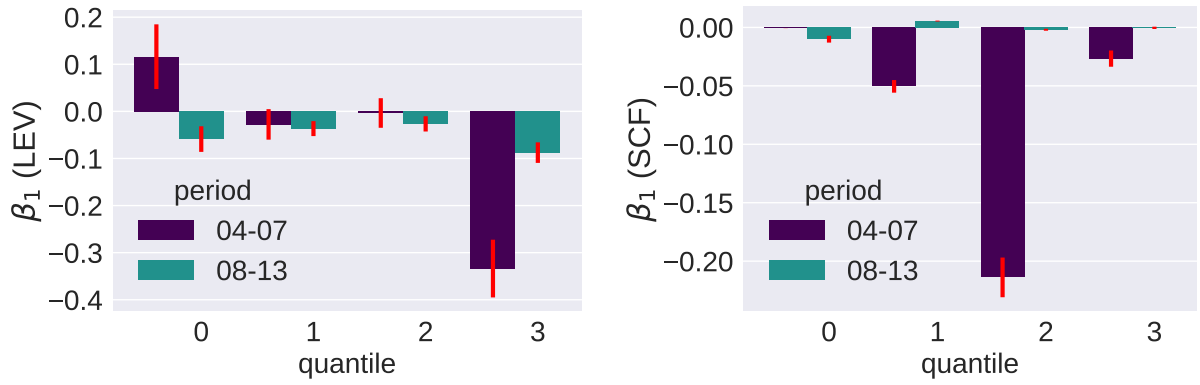


Figure 14: Coefficients for proxies of financial constrainedness, estimated, with fixed effects, on the different quartiles of the "growth" variable at the beginning of the period (2005 and 2009, respectively).

analysis on the different subgroups defined in such a way. For the LEV variable, the pattern is similar as with the traditional quantile regression, but the difference across periods is more evident, with fastest growing firms at the beginning of the period having a much less negative effect of leverage in the post-crisis than in the pre-crisis period, possibly reflecting their easier access to external sources of credit compared to firms which are growing less. The coefficient for the SCF variable also exhibits strong heterogeneity across classes of firms, showing that the general progression observed for instance in Figure 10 (left) is to be attributed mostly to firms which were growing faster at the beginning of the period.

4.4 Differential estimation

Given their definition, financial proxies based on the SAFE survey naturally define a categorization of firms represented in our sample. That is, each of them combines observable

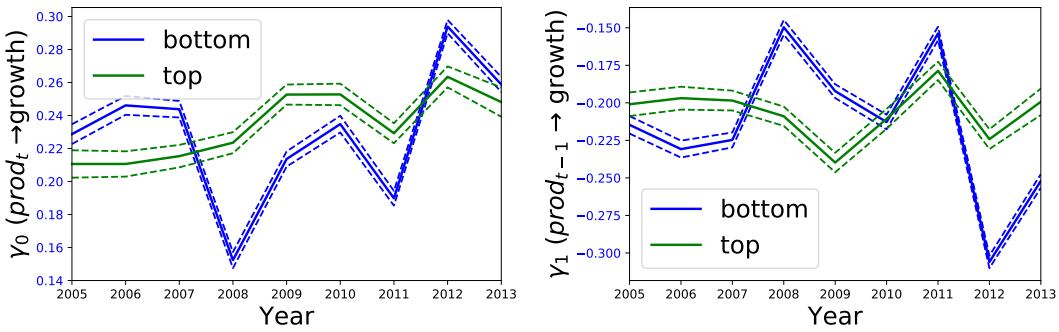


Figure 15: Change in time of the coefficient associated to current (left), and past (right) productivity, on a stratified sample based on the value of the SAFEi1 variable (BASE model).

variables from balance sheet data in a single index of financial constrainedness, ranging from 0 to 1. This allows us to separately estimate our model of growth on different samples, expected to be affected to a different extent by financial constraints.

More specifically, we stratify our sample of firms by subdividing them into "constrained" (SAFEi1 value above the sample median) and "not constrained" (SAFEi1 value below the sample median) firms. We focus on the SAFEi1 variable on one hand for its more immediate interpretation (as directly proxying the perceived credit constrainedness), and on the other because its distribution is less concentrated in proximity of 0 (mean of 0.13 and standard deviation of 0.11, as opposed to the mean of 0.10 and standard deviation of 0.08 featured by SAFEi2). We then estimate different versions of Equation 1 separately on the two samples, and compare the results.

We start from the BASE version of the model (i.e. without any financial constraint), and compare the coefficients associated to present and past productivity (see Figure 15). It can be immediately noticed that the two samples of firms feature very different dynamics, and that the difference becomes more relevant with the outset of the financial crisis. Namely, in the left panel it can be clearly noticed that in the first years after the crisis, productivity matters strongly for firms in the bottom half of the sample (lower propensity to financial constrainedness), compared to the other firms. Lines are inverted in the right panel, featuring a sort of rebound effect between past and present productivity which was already present both in the results previously exposed, and in the work of Dosi et al. (2015).

We next study the role of balance sheet-based financial indicators in the two different samples (see Figure 16). While the two lines are clearly different, and more specifically, differ significantly for several of the years under analysis, no obvious pattern can be identified. Still, it is worth noticing that only less constrained firms feature a significantly positive value for SCF, and only in 2011 (recall that the panel analysis found a strongly positive coefficient in the post-crisis period).

Figure 17 presents the stratified panel analysis (that is the equivalent of Figure 8, for each of the two subsamples defined by the SAFE1 variable), again evidencing a difference between

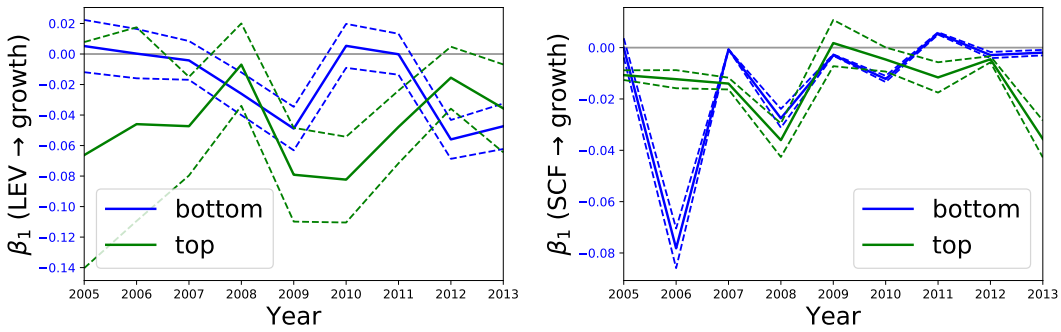


Figure 16: Change in time of the coefficient associated to balance sheet-based financial indicators LEV (left) and SCF (right), estimated via the BASE model enriched with the respective variable, on a stratified sample based on the value of the SAFEi1 variable (BASE model).

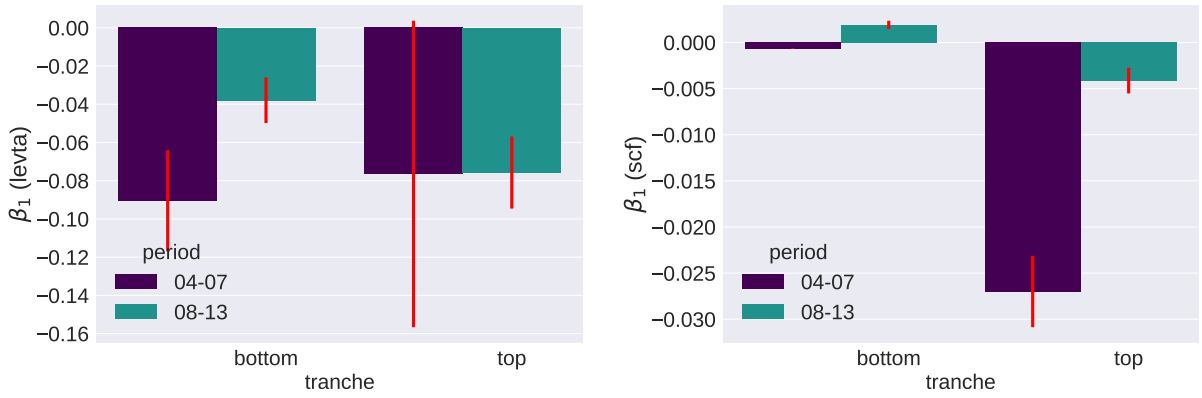


Figure 17: Stratified regression analysis ran on the two different subperiods: each "tranche" refers to a subsample defined by the SAFE1 indicator.

the two samples. More clear patterns emerge however if we differentiate firms based on their conditional growth level, again separately for the two samples: this is done in Figure 18. We can observe a much stronger change agross deciles for constrained firms ("top" sample) than for non-constrained firms. In particular, the effect of leverage is non significant for both, for the top deciles, but it is stronger for lower deciles of more constrained firms. Concerning the SCF indicator, again most constrained firms show a strong difference across the deciles of the growth distribution, which is entirely absent for less constrained firms.

In general, while these figures might lack the clarity and ease of interpretation of results presented in Section 4.2, they provide robust evidence that the stratified samples from the survey-based indicators differ significantly in their relation of credit exposition to growth.

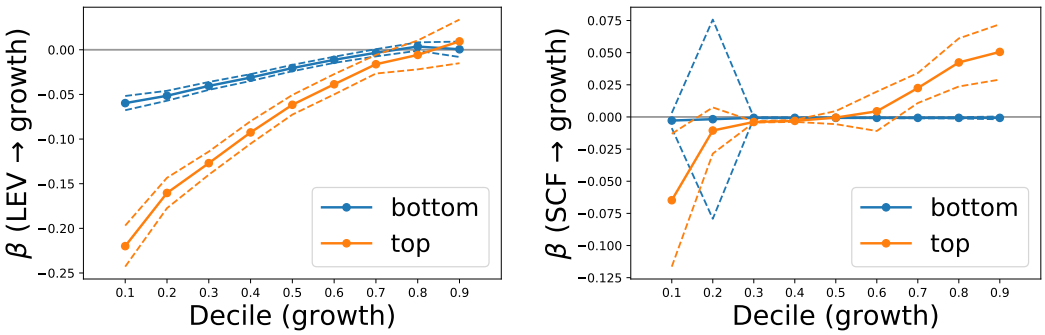


Figure 18: Stratified quantile panel regression analysis ran on the entire period: each line refers to a subsample defined by the SAFE1 indicator.

5 Conclusions

Evaluating the impact of credit constraints on the performance of firms has always been a problem of paramount importance in the literature on growth dynamics, because on the one hand the availability of sources of financing is a crucial element for the ability of a firm to invest and growth, and on the other hand researchers have always struggled to find reliable and general measures of credit constrainedness. The issue is particularly important in the aftermath of the financial crisis of 2007-2008, in order to analyze the effect of the credit crunch, and to single it out in a period in which firms were also hit by a fall in demand, of economic expectations, and hence possibly in a reduction in investment *opportunities*.

In the literature on credit constrainedness, several indicators have been proposed, which have been shown to predict the likelihood of a firm being credit constrained; however they either rely on specific assumptions or were calibrated on specific samples of firms which might limit their external validity (Fazzari et al., 1987; Kaplan and Zingales, 1997; Almeida et al., 2004; Hadlock and Pierce, 2010; Farre-Mensa and Ljungqvist, 2015). In the present study, we take a radically different approach in order to draw a comprehensive assessment of the relation between credit and firms growth in Europe. First, we study nonparametrically the relation between several measures of growth and of credit exposition, showing a drastic and statistically robust change in the aftermath of the crisis: such relation was positive, if any, before, and it is clearly negative afterwards.

We then performed a regression analysis comparing two simple balance sheet-based indicators with two indicators based on a survey on credit constrainedness. Although the indicators originate from completely different sources of data, and have very low correlation among them, they capture similar dynamics in the importance of external sources of financing across the crisis.

Finally, we run panel estimates on different subsets of the data, based on sector, country or classes of growth, evidencing the strong variability of the response to financial constraints across several dimensions of firms.

From a methodologic point of view, we provide robust evidence that different indicators of financial constrainedness can be used in a complementary way to identify credit constrained firms. From a more substantial point of view, we show the importance of financial constraints in the aftermath of the 2007-2008 crisis in European countries.

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