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MODELLING ITALIAN FIRMS' FINANCIAL VULNERABILITY

by Antonio De Socio and Valentina Michelangeli[1]

Abstract

We develop a model to assess the evolution of the Italian corporate sector's financial vulnerability. We use micro data to take into account the heterogeneity of firms and their demography and we integrate them with macroeconomic forecasts in order to estimate EBITDA, interest expense and financial debt for each individual firm over a two-year horizon. In this way we obtain a projection of the share of vulnerable firms (those with negative EBITDA or whose interest expense-to-EBITDA ratio is above 50 per cent) and of their debt well in advance of the availability of actual data. By applying the model to the 2013 individual firm data (available only in early 2015), we estimate an increase in the share of vulnerable firms in 2014, followed by a sizeable decrease in 2015, mainly due to the reduction in interest rates and the economic recovery. The model is then used to evaluate stress scenarios for interest rates and profitability.

JEL Classification: D22, G32.
Keywords: firms' vulnerability, debt, stress test

Contents

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1. Introduction

In this paper we evaluate the financial vulnerability of Italian firms by developing a model to monitor the evolution of individual interest expense-to-EBITDA ratios, a standard indicator of firms' ability to service their debt. Assessing the financial conditions of the corporate sector has been repeatedly stressed as a key element in evaluating the potential buildup of systemic risks in the financial sector (e.g. IMF, 2013a). This evaluation is especially important in countries like Italy where the liabilities of firms represent a large share of the assets of banks. In this respect, our model provides a tool for evaluating the evolution of firms' vulnerability, both under the baseline macro-scenario and under adverse alternatives considered in stress test analysis.

We define as vulnerable those firms whose interest expense-to-EBITDA ratio is above 50 per cent or whose EBITDA is negative. To estimate the share of vulnerable active non-financial firms and the share of their debt over a two-year horizon, we combine individual balance sheet data provided by Cerved[2] and the forecast of macro and financial variables. The use of micro data allows us to account for both the heterogeneous evolution of vulnerability across different types of firms and the high rates of entry and exit in the economy. Since micro data become available with a delay of about 15 months, we use macroeconomic data (disseminated with higher frequency and for which forecasts are available) on aggregate firm profitability, interest rates and debt to estimate the evolution of these variables at the firm level. In particular, starting from the 2013 data, we provide projections of the share of vulnerable firms and their debt through 2015, whereas the actual balance sheets for 2015 will be available only in the early months of 2017.

The main elements of our model are the following. First, we define different groups of firms according to their size, sector of activity and volatility of profitability; for each group we estimate the correlations between macro and micro variables of (i) profitability, (ii) interest expense and (iii) financial debt. Second, we use these estimated correlations to project the changes in our three variables at the group level based on the forecast of macro and financial variables. In this way the estimated interest expense-to-EBITDA ratio of each firm will depend on its past individual balance sheet data and on the estimated changes in the three variables for its group. Finally, we allow for the entry and exit of firms in the economy to avoid potential survivorship bias. This is especially important as the turnover of firms is high (the ratio of entry plus exit over the population of the previous year is around 25 per cent) and the exiting firms are on average more vulnerable than both average entry and existing firms.

The results of our baseline assessment for 2014-2015 show that the share of vulnerable firms is estimated to have risen in 2014 to about 35 per cent from 32 per cent in 2013, mainly due to the contraction in operating income. The debt at risk is projected to have remained almost stable at 43 per cent of the total financial debt, mostly due to the persistent reduction in firm debt, especially among the most fragile.[3] In 2015, instead, the expected economic recovery, coupled with the decrease in interest rates to historic lows, drives a reduction in the share of vulnerable firms and

[2] See Section 2 for a description of the data. The firms included in the Cerved database are similar to those included in Orbis, a source commonly used for international comparisons. However, Cerved provides much more detailed information. For our analysis, the most relevant difference is the precise identification of financial debt, which is not possible using the Orbis database.

[3] This finding is confirmed by the fact that the changes in bank loans to firms have been quite heterogeneous depending on the riskiness of the borrowers (Bank of Italy, 2015).

their debt respectively to about 27 and 36 per cent. The exit of the most vulnerable firms, especially in 2013 and 2014, also contributes to this outcome by reducing the overall vulnerability of the surviving active companies. The improvement, common across all sectors and size classes, is larger for manufacturing, services, medium-sized and large firms.

We also evaluated three stress scenarios for 2015. With respect to the baseline macro projections, we considered a 100 basis points increase in the interest rate, a 5 per cent decrease in operating profitability[4] and a combination of the two scenarios. In each of the first two stress tests, the share of vulnerable firms is projected to increase with respect to the baseline, respectively, to 29 and 34 per cent, still below the levels estimated for 2014. When the two stress scenarios are considered jointly, the increase in vulnerability is more sizeable: the share of vulnerable firms and debt at risk reaches, respectively, 36 and 42 per cent in 2015, roughly in line with the levels expected for 2014.

Our work builds on the literature that uses micro data to develop indicators of financial distress in the corporate sector or to model individual firm's default risk. The interest expense-to-profitability ratio as an indicator of vulnerability has already been used by Bank of Italy (2011) and IMF (2013b) for Italian firms and by IMF (2013a) to analyse the debt overhang in European countries. However, those works do not allow for heterogeneous firm response to changes in the macroeconomic variables. Furthermore, they focus on a closed sample and thus the estimates may suffer from a survivorship bias. Hence our model, which accounts both for heterogeneity in firms' responses to macroeconomic changes and for firms' entry and exit, is more appropriate for policy analysis and the evaluation of stress scenarios. Works that employ Cerved data to estimate the probability of default are, among others, Cerved (2010) and Bonaccorsi et al. (2014); the latter authors find a strong positive relationship between the leverage ratio and the probability of default. Instead, in our paper, we aim to identify a wider concept of vulnerability that captures the short-run ability of the firm to service its debt, which is relevant from a policy perspective since corrective actions can be put in place before actual distress sets in. In addition, in our paper, the leverage ratio is implicitly considered; as shown in Appendix A1, the interest expense-to-EBITDA ratio accounts for a firm's operating profit, its leverage and cost of debt. Finally, our work is related to another strand of literature that develops dynamic micro-econometric simulation models for firms (e.g. Shahnazarian, 2011). Similarly to us, they use macroeconomic variables as explanatory ones to estimate firm behaviour; however, given our focus on financial stability, we are not deriving a dynamic optimization model.

The paper is organized as follows. Section 2 presents the data used in the analysis. Section 3 discusses the main features of our indicator of firms' vulnerability and shows its evolution between 2004 and 2013, linking it to macroeconomic developments, to firms' heterogeneity and demography, and to default on loans. Section 4 describes the model. Section 5 presents the main results for the backtesting over past years, the estimations for 2014 and 2015 and the stress tests. Section 6 contains our conclusions.

[4] The decrease in profitability has been modelled as the combination of a reduction in the value added and an increase in the cost of labour. A bigger change in only one variable that generates the same impact on aggregate profitability leads to similar results with respect to firms' vulnerability.

2. Data and descriptive statistics

2.1 Micro data: the Cerved database

The source of the information on firms' EBITDA, interest expense (IE) and financial debt is the Cerved database, which contains anagraphic and balance sheet data for Italian limited liability companies. We focus on active firms and thus we include in our dataset only firms whose revenues and total assets are greater than zero. The total number of firms averaged 660,000 over the period 2004-13 and they represent around 75-80 per cent of the value added and financial debt of Italian non-financial corporations.

The composition of our sample is shown in Table 1**,** where firms are classified according to their size[5] or their sector of economic activity.[6] Most of the firms are either micro or small (85 and 11 per cent, respectively), reflecting the high fragmentation of the Italian productive system; the remaining ones are medium-sized or large (3 and 1 per cent, respectively). With respect to the sector of economic activity, we identify seven classes: agriculture and energy&mining include only a few thousands firms; manufacturing and construction consist of around 100,000 firms each; and the tertiary sector (other services, trade, real estate) includes two thirds of the total companies.

Table 1: Composition of Cerved data by size and sector (averages 2004-2013)

	Number of firms	Percentage
Size class		
micro	565,220	85.5
small	70,289	10.6
medium-sized	20,946	3.2
large	4,920	0.7
Sector of economic activity		
agriculture	10,704	1.6
energy&mining	4,775	0.7
construction	94,678	14.3
manufacturing	115,909	17.5
other services	201,602	30.5
trade	92,091	13.9
real estate	141,616	21.4

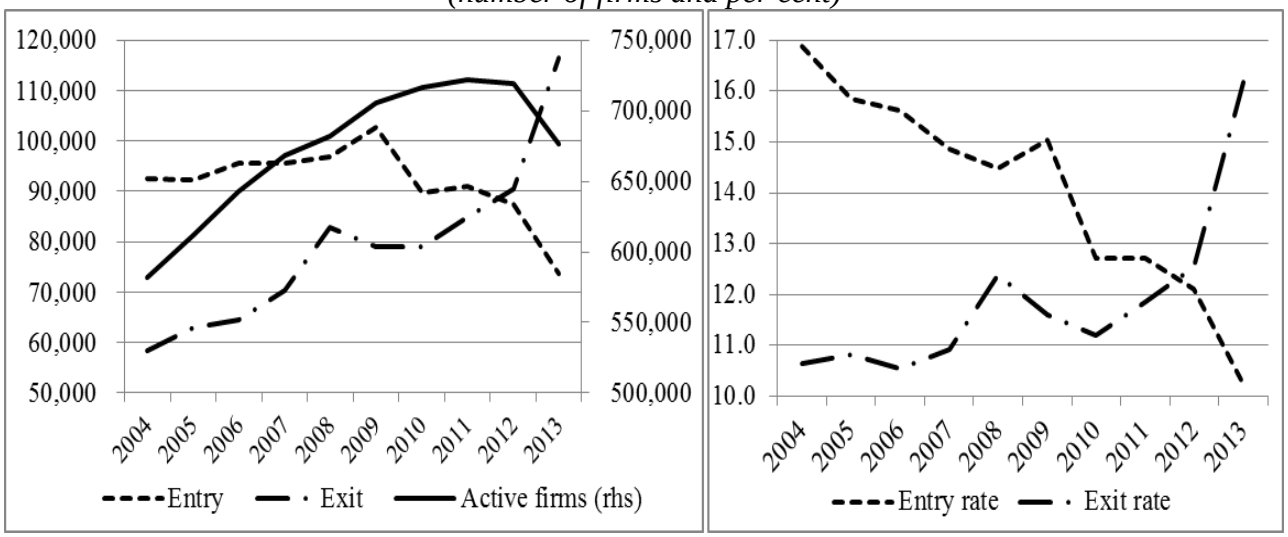
[5] We identify four size classes of firms, in line with the 2003 European Commission recommendation: a) micro-firms have fewer than 10 employees and revenues or total assets below 2 million euros; b) small firms have fewer than 50 employees and revenues or total assets below 10 million euros; c) medium-sized firms have fewer than 250 employees and revenues or total assets below 50 and 43 million euros, respectively; d) large firms include the remaining firms.

[6] Sectors are based on the ATECO 2007 classification. More specifically, the ATECO sections of each sector are the following: A for agriculture, B, D, E for energy and mining, C for manufacturing, F for construction, G for trade, L for real estate and I, H, J, M, N, O, P, Q, R, S for other services. The financial sector (K) is excluded. In our projections, we separate firms in the tertiary sector into two sub-sectors (real estate and 'services'), however, for some of our econometric analysis, we further divide 'services' into trade and other services due to the large number of companies in these sectors (around half of the total).

Figure 1 shows some statistics on the number of firms in the period 2004-13 and on the entry and exit rates in our sample. The number of active non-financial companies progressively increased from 2004, reaching a peak above 720,000 in 2011. The turnover is also high: the number of firms that file their balance sheets for the first time ('entry') or that stop reporting it due to bankruptcy or voluntary closure ('exit') represents on average a share of 25 per cent of the firms in each year.[7] In 2013 we observe a significant reduction in the total number of firms, as there was a huge decrease in the number of new firms (73,000) and a massive increase in the number of firms that stopped reporting their financial statements (above 115,000). Also, the entry rate decreased to 10 per cent (the average over the period 2004-12 was 14.5 per cent), while the exit rate increased to 16 per cent (the average over the period 2004-12 was 11.4 per cent).

Figure 1: Dynamics of active firms (2004-2013)

(number of firms and per cent)



2.2 Macro data: national and financial accounts and bank lending

To evaluate firms' vulnerability, we employ macroeconomic data, based on the national accounts of non-financial corporations, and credit data, based on financial accounts and bank lending statistics.

The macroeconomic data used are the value added and labour costs, whose difference is the gross operating income (GOI), i.e. the macroeconomic aggregate most comparable to the firms' EBITDA. Over the period 2004-13, the growth rates of value added and labour cost are highly correlated (the coefficient of correlation is 0.94) and the growth rates of value added moves almost one-to-one with that of GOI (the coefficient of correlation is 0.96).

[7] Since we focus on active firms, there are potential differences when defining 'entry' or 'exit' based on the date of incorporation or of liquidation. In fact, a firm could be incorporated in year X, but not file its financial statements until the following year or later. Also, a firm could terminate its activity before its liquidation. The number of 'entries' is similar to that reported by Cerved (2014), which focuses on SME start-ups. Even considering these differences (they use the dates of incorporation and exclude large firms, which, however, account for a very tiny number of start-ups), the number of new firms is around 90,000-100,000 each year and has been declining since 2010. The dynamics of the exits is similar to that of Cerved (2015): the number of liquidated or bankrupt firms was around 40,000 before 2008, increasing in the following years to more than 60,000 in 2012-14. These numbers are smaller than ours as they include only limited liability companies that have been active in the last three years.

With respect to the credit granted to firms at the aggregate level, we employ two different measures. First, we consider the total amount of financial debt (bank loans, other loans and securities) taken from the financial accounts. While this measure is the most comprehensive of the overall debt of the non-financial sector, it is available only with some delay with respect to macroeconomic aggregates (e.g. data for 2014 became available in June 2015) and there are no forecasts of its evolution. Second, as we aim to evaluate vulnerability in the corporate sector for the two years beyond the release of balance sheet figures by firms, we use information on bank loans to firms. Forecasts of this variable are routinely available and it is highly correlated with the total financial debt (the coefficient of correlation is 0.95), as around two thirds of the credit to firms (especially to SMEs) come from banks.

Finally, we use the interest rate on new bank loans as a proxy for the financing cost paid by firms. We consider it a good approximation of the dynamics of the cost of debt since i) bank loans are the main component of financial debt, ii) around one third of them are short term and thus frequently re-priced, and iii) most long-term loans are at variable interest rates, i.e. priced at Euribor plus a fixed spread. This proxy could have two main shortcomings: the spread over Euribor of outstanding long-term loans is fixed in the past, thus it does not change unless a firm refinances its debt, and the cost of overdrafts, included in short-term debt, is not accounted for. However, as shown in Figure 2.b, this variable approximates well the change in the cost of the debt of firms.

2.3 Profitability and interest expense: dynamics of micro and macro data

Figure 2a shows the changes in firm operating profitability based on micro (EBITDA) and macro (GOI) data. They are strongly related (the coefficient of correlation is 0.9) and the values are usually higher in the micro data, possibly due to the exclusion of distressed or inactive firms, which are instead included in the national accounts. Over the period 2004-07 the growth rate of profitability was overall positive, becoming mostly negative starting from 2008 (with the sole exception of the years 2010-2011, i.e. the period in between the financial crisis and the sovereign debt crisis). The negative growth rate in profitability was the result of different factors. In 2008, its main drivers were both the increase in labour cost and the deterioration in the growth of value added; in 2009, labour cost declined, but its positive effect was more than offset by the sharp reduction in value added; finally, in 2012, both factors reduced firms' profitability.

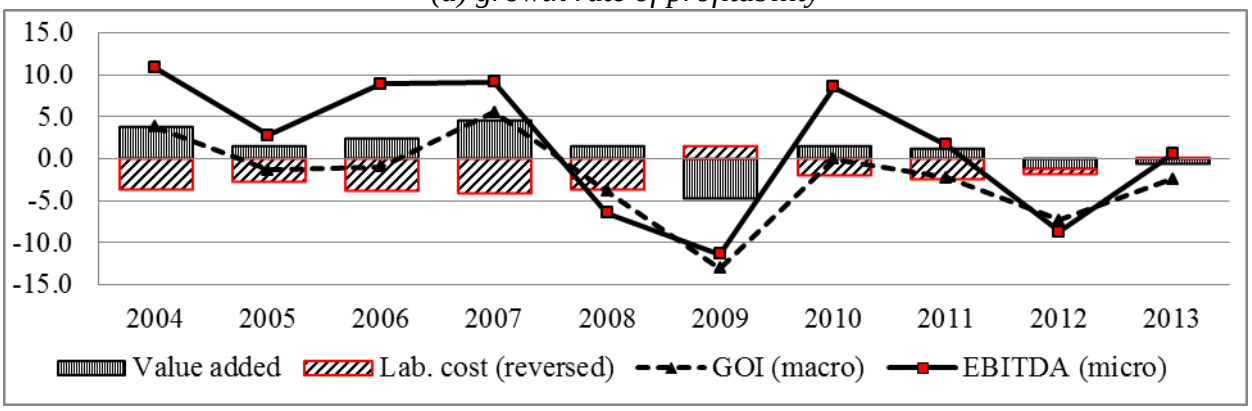
Figure 2b shows the dynamics of the implicit interest rate (interest expense over financial debt from micro data) and the change in the cost of new bank loans. In this case as well, the correlation is very high (0.95) and the variables are also similar in absolute value. The dynamics during the crisis mostly reflect the evolution of monetary policy and financial market tensions up to 2008, the effects on expansive monetary policy in 2009 and those of the sovereign debt crisis later on.

Figure 2c describes the evolution of debt growth. Overall, the dynamics of micro and macro data are quite similar and the coefficient of correlation is 0.85. Furthermore, there are no major differences between the dynamics of the two macro series (financial debt or bank debt) up to 2010, while they differ slightly after 2011. More specifically, bank debt decreases more than financial debt, mostly due to the rebalancing of firms' financial structure towards securities rather than loans.

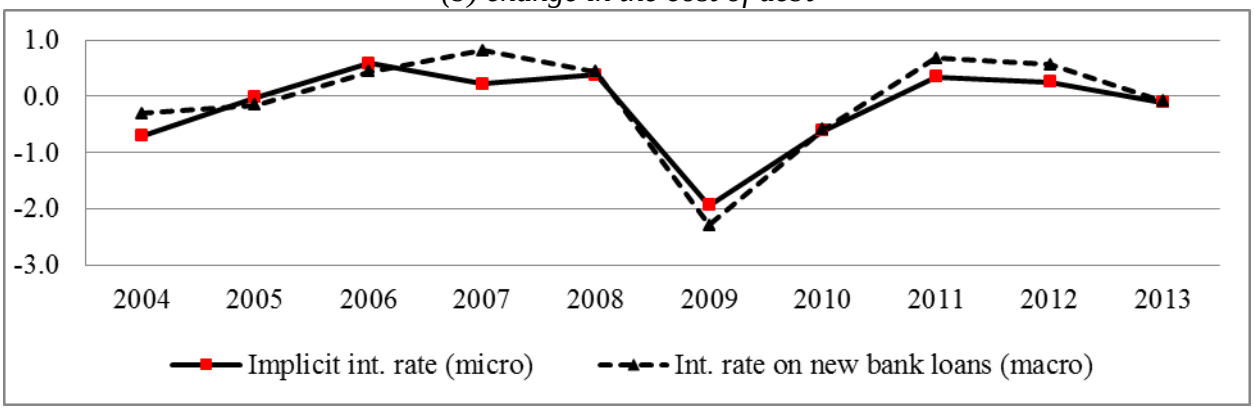
Figure 2: Profitability, interest rates and debt: micro vs. macro variables (2004-2013)

(per cent)

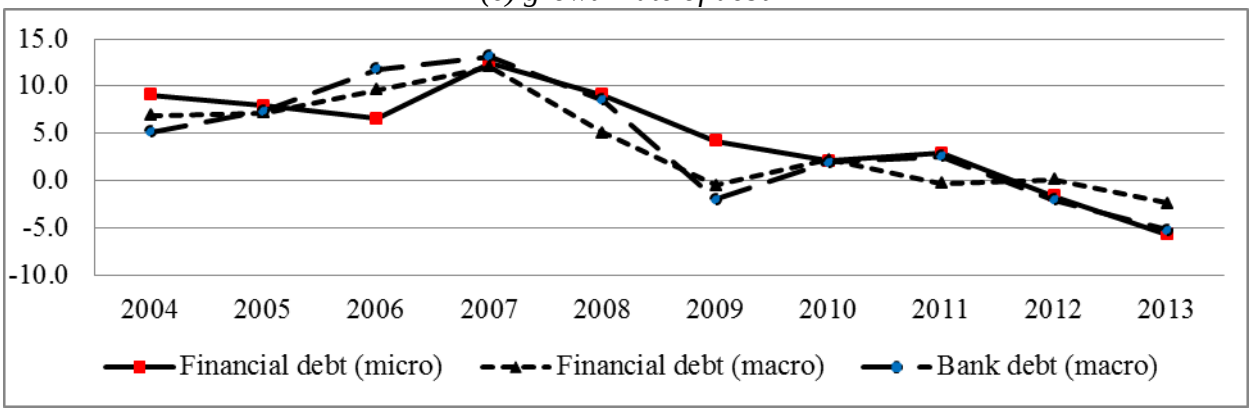
(a) growth rate of profitability



(b) change in the cost of debt



(c) growth rate of debt



3. Vulnerability of Italian firms

3.1 Definition of financial vulnerability

Our indicator of vulnerability is based on the ratio of two balance sheet variables: interest expense and EBITDA. The numerator captures the effect of credit conditions, as it includes the impact of both the level of debt and its cost. The denominator reflects the effect of the business cycle on operating profitability.[8] We define a firm as vulnerable if its IE-to-EBITDA ratio is greater than 50 per cent or if its EBITDA is not positive. This definition encompasses both very risky firms (with a

[8] We prefer EBITDA to EBIT as a measure of operating profitability, as the former does not net out amortization and depreciation, hence it is a better proxy for the cash flow at a firm's disposal before paying interests.

ratio above 1) that are not able to cover their interest expense with their operating income, and potentially risky firms (0.5<=IE/EBITDA<1) that can be hurt by a shock to their income and/or to the cost of debt.[9] The choice of the threshold is also based on the evaluation of the relationship between the vulnerability of firms and their ability to remain active. As shown in Appendix A.2, the share of exit ranges between 6-7 per cent for most of the distribution of IE-to-EBITDA ratio, but it displays a jump at the value of IE-to-EBITDA equal to 0.5 (the seventeenth ventile of the distribution; see Figure A3). Appendix A.2 also shows the results obtained using different thresholds.

According to our definition, being vulnerable does not necessarily mean that the firm is defaulting on its debt. Indeed, not all loans of a vulnerable firm are non-performing loans (NPL), i.e. past-due, substandard, restructured, or bad loans. To evaluate the relationship between vulnerability and default, we combine our Cerved database with the Credit Register (CR). For this subsample of firms we have information on the quality of loans granted by financial intermediaries.[10] Table 2 presents the average composition in our dataset in terms of shares of firms and debt. Nearly half (47 per cent) of the firms are not included in the CR database and thus we do not have complete information on their default position; on the other hand, their share of debt is significantly small (8 per cent of the total). The table also shows, as expected, that the ratio of firms with NPL to the total of those signalled in CR is higher for vulnerable firms than for non-vulnerable ones (16 per cent and 6 per cent, respectively); for the share of debt, the difference in the ratio of NPL is lower.

Table 2: Vulnerability and credit quality (averages over 2004-13)
(per cent)

	Performing (A)	NPL (B)	Not in CR (C)	Total (A)+(B)+(C)	*Share of NPL (B)/(B+A)*
Share of firms					
Vulnerable	17	3	13	33	*16*
Non -vulnerable	31	2	34	67	*6*
Share of debt					
Vulnerable	29	10	3	43	*26*
Non -vulnerable	39	12	5	57	*23*

[9] Our indicator is similar to the interest coverage ratio (ICR), defined as the ratio between EBITDA and IE, and used in some analysis of European firms in the IMF's Global Financial Stability Report between 2013 and 2015. Our indicator provides a more precise evaluation of firms' vulnerability. In fact, while our ratio is always defined except when EBITDA=0 (which happens in a limited number of cases), ICR is not defined if IE=0, which is not uncommon when very small companies are included in the analysis; in our dataset only 1 per cent of firms have EBITDA=0, while around 30 per cent have IE=0 and around 5 per cent of firms have IE=0 and EBITDA<0. In the latter case, an analysis based on ICR would imply that these firms are not vulnerable; on the contrary, our indicator rightly classifies those firms as vulnerable.

[10] A firm is signalled in CR i) if the sum of credit granted or used, whether performing or not, is at least 30,000 euros (75,000s euro up to 2008) or ii) if any of its loans are classified as bad debt. Hence some firms with debts owed to financial intermediaries are not recorded in CR. Indeed we only know if they have bad debt, but not if they have any other type of NPL (past-due, substandard, and restructured loans).

To assess the relationship between vulnerability and default, it is important to consider not only the distinction between firms with performing and non-performing loans, but also the transition from one status to another. In fact, the transition matrices, presented in Table 3, confirm that vulnerable firms are at greater risk.

The matrices present the average changes experienced in one and three years' time for both vulnerable and non-vulnerable firms. In the initial period *t*, a firm's loans could be either performing or not, while in the final period (*t+1* or *t+3*) they could be performing, NPL, or the firm could have not been signalled in CR or have exited from our Cerved dataset. The top-left table shows four results which all support our definition of vulnerability as a leading indicator of default. First, the percentage of vulnerable firms whose loans remain performing is lower than that of non-vulnerable ones (74 and 84, respectively); second, the percentage of vulnerable firms with performing loans that default is more than twice as large (8 versus 3 per cent); third, the percentage of vulnerable firms in default that return to performing status is lower (22 versus 35 per cent); fourth, the share of vulnerable firms that exit is higher. These results are confirmed when we consider the share of debt (top-right matrix) or the evolution over three years for both share of firms (bottom-left matrix) and share of debt (bottom-right matrix).

Table 3: Transition matrices: firms and debt (averages over 2004-13)

(per cent)

Share of firms

t \ t+1	Performing	NPL	Not in CR	Not in Cerved	Total
Vulnerable					
Performing	74	8	6	12	100
NPL	22	46	4	29	100
Non -vulnerable					
Performing	84	3	7	5	100
NPL	35	42	5	17	100

Share of debt

t \ t+1	Performing	NPL	Not in CR	Not in Cerved	Total
Vulnerable					
Performing	78	13	3	6	100
NPL	31	56	1	12	100
Non -vulnerable					
Performing	86	9	3	3	100
NPL	27	71	0	2	100

t \ t+3	Performing	NPL	Not in CR	Not in Cerved	Total
Vulnerable					
Performing	56	9	8	27	100
NPL	21	23	5	51	100
Non -vulnerable					
Performing	72	5	11	13	100
NPL	37	22	7	35	100

t \ t+3	Performing	NPL	Not in CR	Not in Cerved	Total
Vulnerable					
Performing	63	16	5	16	100
NPL	33	39	2	27	100
Non -vulnerable					
Performing	75	12	4	8	100
NPL	29	65	1	6	100

Note: Firms at time *t* are those recorded both in Cerved and in CR. Firms at time *t+1* or *t+3* are those same firms, categorized according to their status after one or three years. Firms still recorded in both CR and Cerved may have performing loans or NPL; firms recorded in Cerved, but not in CR, are classified as 'Not in CR'; non-active firms are classified as 'Not in Cerved'.[11]

[11] As this paper focuses on firms recorded in Cerved, these transition matrices classify firms according to their Cerved status. However, at time *t+1* or *t+3*, some non-active firms ('Not in Cerved') may be signalled in CR. Appendix A.3 compares the transition matrices for the period 2012-13 obtained starting with two different classifications of firms, one based on Cerved (as in the main text) and another based on CR (non-active firms signalled in CR but not in Cerved are classified as performing or NPL, instead of 'Not in Cerved'). As expected, in the latter classification the share of firms with NPL increases significantly. The remaining conclusions regarding vulnerability are confirmed.

These results suggest that vulnerable firms are more likely to default than non-vulnerable firms, and this is especially relevant for financial stability purposes, given the direct effect on the financial system. Nevertheless, our concept of vulnerability is broader, as vulnerable firms may avoid a default by relying on their liquidity, cutting investment plans, selling assets, or drawing on available credit lines. A simple econometric analysis confirms the negative relationship between vulnerability and liquidity or investment. Table 4 shows the results of two regressions over the period 2004-2013: controlling for size, sector of activity, geographic location and year, vulnerable firms have lower liquidity than non-vulnerable ones (the change in liquidity over total assets is 0.1 percentage points lower compared with an average value of 0.1 per cent) and accumulate less capital (the ratio between investment and assets is 1.1 percentage points lower compared with an average value of 5.0 per cent). We obtain similar quantitative results in regressions that include only firms whose debt is performing both at time *t-1* and *t*.

Table 4: Relationship between vulnerability and liquidity or investment
(per cent)

	Delta liquidity/assets	Investment/assets
Lag (vulnerability indicator)	-0.12***	-1.13***
Area	Y	Y
Size	Y	Y
Sector of economic activity	Y	Y
Year	Y	Y
N	5295945	5318303

legend: * p<.1; ** p<.05; *** p<.01
Estimated using pooled OLS with robust standard error.
Observations below the 1st percentile and above the 99th percentile are excluded

3.2 Financial vulnerability over time

The evolution of our vulnerability indicator between 2004 and 2013 is reported in Figure 3, panel a). The share of vulnerable firms (solid line) was fairly constant between 2004 and 2007, a period characterized by positive growth in EBITDA, which more than offset the growth in interest expense. After reaching a low of 31.0 per cent in 2006, the share of vulnerable firms progressively increased, peaking at 36.2 per cent in 2008. That increase is the result of the combination of a decrease in profitability and a rise in interest expense (panel b). Sustained growth in debt contributed to the increase in firms' vulnerability up to 2008, while it played a smaller role thereafter. Between 2008 and 2010 the vulnerability indicator decreased, mainly because of the sharp reduction in the cost of debt in 2009 and the recovery of profitability in 2010. The recession and the increase in the cost of debt following the sovereign debt crisis in 2011 explain the subsequent increase in the share of vulnerable firms up to a new peak in 2012 of 34.0 per cent. The situation slightly improved in 2013 as the cost of debt fell due to the effects of monetary policy. The dynamics of the debt held by vulnerable firms (dashed line, panel a) is similar since it increased by 9 percentage points between 2006 and 2008, when it peaked at 50 per cent.

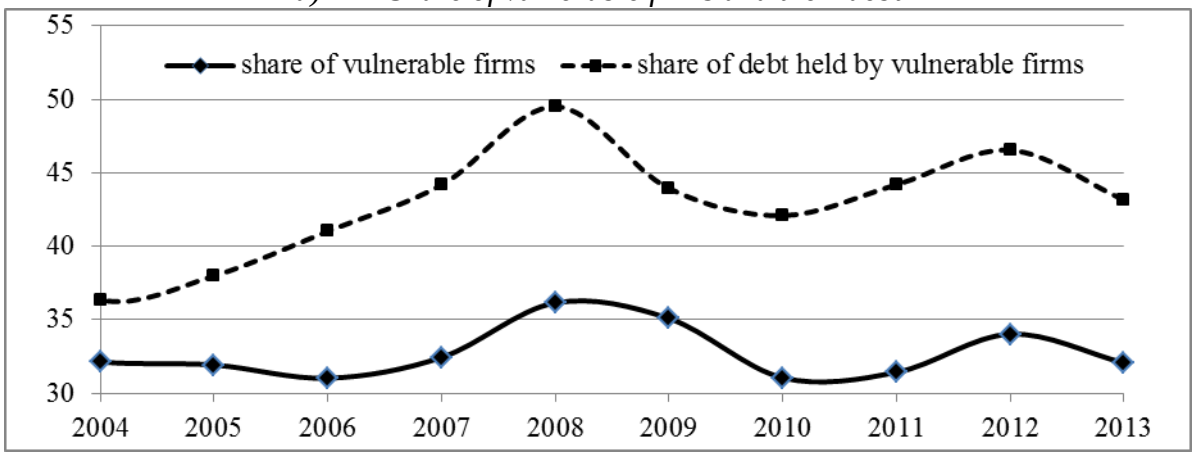
Figure 4 shows the relationship between our indicator of vulnerability and the rate of entry into default for the corporate sector, as obtained from CR. Over the period 2005-2013, we find a positive correlation between the share of debt held by vulnerable firms in year *t* and the share of debt going

into default in *t+1*, equal to 0.7, while the contemporaneous correlation is significantly smaller and close to zero. This is further evidence that the share of vulnerable firms is a leading indicator of default in the corporate sector.

Figure 3: Vulnerability of firms over time (2004-2013)

(per cent)

a) Share of vulnerable firms and their debt



b) *link to profitability and interest expense*

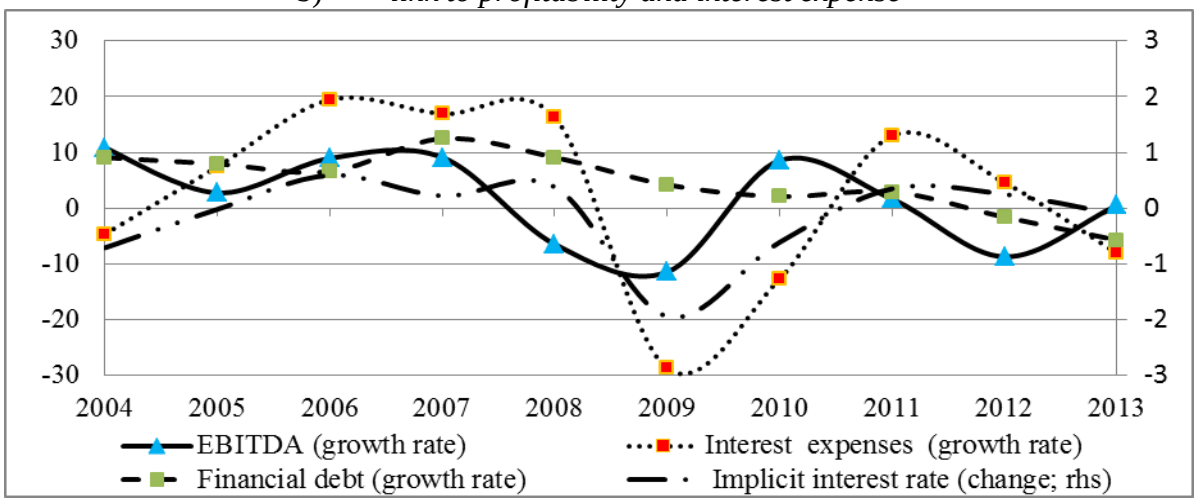


Figure 4: Vulnerability of firms and entry rate into default (CR)

(per cent)

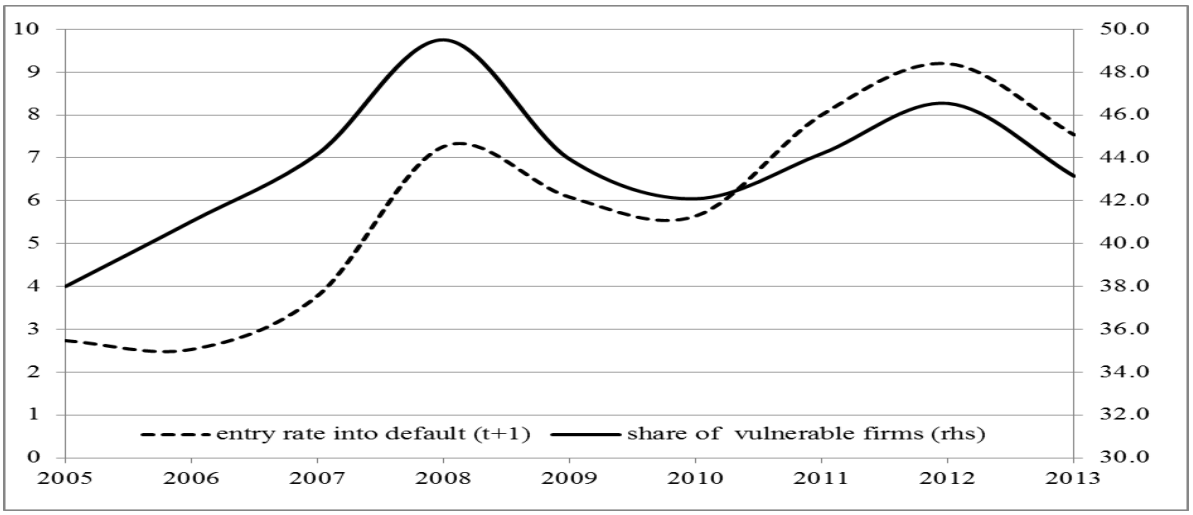


Table 5 shows the evolution of the vulnerability indicator by firm size (panel a) and by sector of economic activity (panel b). While the dynamics over the decade of the four size classes are similar, the share of vulnerable firms is always higher among the micro-firms. Similarly, the average debt at risk ranges from a minimum of 35 per cent for large firms to a maximum of 55 per cent for micro-firms. The dynamics of firms' vulnerability are also similar across economic sectors. Overall, during the decade the most vulnerable sectors have been agriculture, construction, trade, and real estate, whose decline in the share of vulnerable firms after 2008 is mostly due to the exit of micro-firms. Firms operating in manufacturing and in services other than trade or real estate are instead less vulnerable, partly due to the larger average size of the firms operating in these latter sectors. Across the entire period, firms operating in the construction sector held the largest share of debt at risk, significantly higher than the average for the corporate sector.

Table 5: Firms' vulnerability over time (2004-2013)

(per cent)

a) by size class

	Micro	Small	Medium-sized	Large	Total
Share of firms					
2004	33.2	27.2	23.6	23.0	32.1
2005	32.8	27.4	25.6	24.4	31.9
2006	31.8	26.9	26.1	25.7	31.0
2007	33.1	29.2	28.6	28.5	32.4
2008	36.6	33.9	33.9	33.6	36.2
2009	35.7	31.5	30.8	29.8	35.1
2010	32.1	25.3	23.3	22.7	31.1
2011	32.2	27.1	24.9	24.5	31.4
2012	34.6	31.3	29.1	27.5	34.0
2013	32.9	27.8	24.9	24.9	32.1
Share of debt					
2004	53.3	44.6	36.2	26.9	36.4
2005	53.6	44.2	38.7	29.4	38.0
2006	55.3	47.5	40.7	32.4	41.0
2007	59.7	53.1	47.0	33.2	44.2
2008	64.3	59.2	54.3	36.8	49.5
2009	59.3	52.4	45.9	31.9	43.9
2010	54.4	45.0	36.7	36.1	42.1
2011	55.2	49.0	40.4	38.1	44.2
2012	57.1	52.6	44.8	39.5	46.5
2013	54.5	48.4	38.5	37.3	43.1

b) by sector

	Agriculture	Energy&mining	Construction	Manufacturing	Other services	Real estate	Trade	Total
Share of firms								
2004	50.1	22.6	32.0	27.8	29.8	35.9	35.9	32.1
2005	49.9	25.7	31.0	27.2	30.0	36.3	35.3	31.9
2006	49.9	26.1	30.7	26.0	28.2	37.5	33.9	31.0
2007	50.1	31.5	33.2	26.6	28.7	40.8	35.0	32.4
2008	51.9	35.0	37.6	31.6	31.6	44.2	38.7	36.2
2009	49.4	31.4	36.9	34.7	30.9	37.4	37.6	35.1
2010	46.4	30.2	34.3	26.9	28.4	33.5	33.2	31.1
2011	45.3	29.9	35.0	27.2	28.3	33.5	34.4	31.4
2012	46.7	31.3	38.2	31.2	30.6	32.4	38.6	34.0
2013	45.1	31.7	36.8	27.9	29.6	29.6	36.5	32.1
Share of debt								
2004	56.4	9.8	61.4	31.2	22.8	54.8	45.2	36.4
2005	56.4	16.4	62.2	31.4	25.0	54.4	47.5	38.0
2006	59.8	27.5	56.4	35.8	27.7	59.7	48.8	41.0
2007	63.9	13.8	64.0	39.6	30.7	67.0	53.0	44.2
2008	68.5	19.8	69.5	46.8	31.2	70.9	60.3	49.5
2009	61.3	19.3	63.8	45.3	26.4	60.4	52.2	43.9
2010	54.2	51.8	59.6	36.6	27.4	53.5	41.6	42.1
2011	53.0	51.9	63.3	38.8	28.8	55.3	46.1	44.2
2012	54.7	41.7	68.4	43.8	34.8	53.4	50.9	46.5
2013	49.7	49.1	66.8	39.8	27.4	49.6	47.2	43.1

Vulnerability is also affected by the entry and exit of active firms. The effect of the turnover depends both on the proportion of vulnerable firms among entries and exits (a 'qualitative effect') and on the entry and exit rates themselves (a 'quantitative effect'). Table 6 presents the total entry and exit rates, accounting as well for a distinction between vulnerable and non-vulnerable firms, and the share of vulnerable firms among the entries and exits.[12] These figures show that overall the 'qualitative effect' of the turnover reduces the vulnerability, since firms that exit are worse than average (above 50 per cent are vulnerable), while those that enter are similar to the average (about 36 per cent of the entrants are vulnerable and that share decreases starting from 2010). With the exception of 2013, the exit rates are fairly stable over the years, averaging at around 6 per cent both for vulnerable and non-vulnerable firms. The entry rates decreases over the sample period for both vulnerable and non-vulnerable firms. That decrease is more evident from 2010 onward, thus reducing the positive 'quantitative effect' of new firms (i.e. the share of non-vulnerable entries has fallen). In 2013, the pattern abruptly changes, as there is a large increase in the exit rate (2 percentage points, to around 8 per cent for both types of firms) and a decrease of 1 percentage point in the entry rate for both types of firms.[13]

[12] Basically, the table presents a more detailed breakdown of the two rates presented in Figure 1 using as the numerator the number of vulnerable and non-vulnerable firms that enter or exit over the population of the previous period.

[13] Overall, there is an improvement in the indicator of vulnerability of around 1 percentage point up to 2008 due to these effects. Starting from 2009 the ratio of vulnerable firms decreases by about 2 percentage points due to the combination of two factors: i) the decrease in the entry rate and the increase in the exit rate, and ii) the lower vulnerability of firms starting their activity.

Table 6: Entry, exit and vulnerability (2004-2013)

(per cent)

	Entry and Exit rates			Share of vulnerable firms
	Total	*of which*		
		Vulnerable firms	*Non-vulnerable firms*	
		Entry		
2004	16.9	*6.4*	*10.5*	37.8
2005	15.8	*5.9*	*9.9*	37.2
2006	15.6	*5.7*	*9.9*	36.5
2007	14.8	*5.5*	*9.3*	37.3
2008	14.5	*5.8*	*8.7*	39.7
2009	15.2	*5.6*	*9.6*	37.0
2010	12.8	*4.3*	*8.4*	33.8
2011	12.7	*4.3*	*8.5*	33.5
2012	12.1	*4.2*	*7.9*	35.0
2013	10.2	*3.5*	*6.7*	34.6
		Exit		
2004	10.6	*5.7*	*4.9*	53.9
2005	10.8	*5.7*	*5.1*	52.8
2006	10.5	*5.5*	*5.0*	52.3
2007	10.9	*5.5*	*5.4*	50.6
2008	12.4	*6.1*	*6.3*	49.1
2009	11.6	*6.4*	*5.2*	55.1
2010	11.2	*6.2*	*5.0*	55.4
2011	11.9	*6.2*	*5.7*	52.0
2012	12.5	*6.6*	*6.0*	52.4
2013	16.2	*8.3*	*7.9*	51.2

4. Model

In this section we describe the features of our model. The basic idea is to predict the changes in each firm's EBITDA, IE and financial debt from the previous period. To this end, we first create homogeneous groups of firms and then we use the correlations between macro and micro variables to derive the heterogeneous effects for each group. Finally, we incorporate the possibility of the firms' entry into and exit from the economy.

4.1 Constructing groups of firms

To take into account the heterogeneous impact of macroeconomic changes on firm profitability and interest expense, our first step is to construct *N* groups of firms that share similar characteristics. Having small and relatively homogeneous groups is very important for obtaining precise estimates for each microeconomic variable. This approach allows us to reduce the problems associated with the high dispersion in the parameter estimates that result from considering highly heterogeneous firms together. Furthermore, we can capture the dynamics of each group, while at the same time maintain some significance and variability across groups.

The groups are defined by combining firm size (micro, small, medium-sized, large) and sector (agriculture, energy&mining, manufacturing, construction, real estate, trade, other services).[14] We obtain 24 groups[15] and for each group we estimate the parameters linking the changes in the IE and total financial debt as a function of the macroeconomics variations.

As for the estimation of EBITDA, the microeconomic data indicate a high heterogeneity in profitability, therefore splitting the firms on the basis of size and sector alone does not result in a satisfactory projection of EBITDA. Thus, following Stein et al. (2002), we further divide the largest groups of firms (construction, manufacturing, trade and other services) based on EBITDA volatility (quintiles or deciles depending on the group size). In this way, we better account for the distinctive EBITDA dynamics of the more volatile firms. We thus obtain 88 groups to be used in estimating the yearly changes in EBITDA as a function of the macroeconomic variables.

A final step is required to include entrant firms in the analysis. In fact, to compute EBITDA volatility for a firm, we need at least two observations, therefore newly active firms belonging to construction, manufacturing, trade or other services cannot be classified among any of the 88 groups. Thus we create nine additional groups, differentiated by size and sector, to which we assign a specific estimated change in EBITDA (see Section 4.3). We therefore then have 88 groups of firms that are used in estimating EBITDA and 97 groups in forecasting it.[16]

4.2 Regression analysis

4.2.1 EBITDA growth dynamics

For each firm *i* belonging to group *j*, the change in EBITDA at period *t* can be approximated by a function of changes in related macroeconomic variables (value added and labour cost):[17]

$$\Delta ebitda(i,j,t) = \alpha_{j0} + \alpha_{j1}\,\Delta\, av(t) + \alpha_{j2}\,\Delta\, lc(t) + \varepsilon_j \quad \text{for } i=1,\dots,I_j,\ j=1,\dots,88,\ t=t\text{-}5,\dots,t\text{-}1 \qquad (1)$$

[14] We assess the robustness of the results by also grouping the Italian firms by geographic area. This increases the computational time, but not the quality of the fit.

[15] We have 24 instead of 28 groups since we impose a further condition on the number of firms included in each group (at least 300). Due to the small number of large firms in four sectors (agriculture, energy&mining, construction and real estate), in these cases we create four groups that include large and medium-sized firms.

[16] Using 97 groups to also forecast IE and financial debt significantly increases the computational time, but does not improve the quality of the fit. As a matter of fact, the change in IE and total financial debt does not display a high variability within each of the 24 groups. Thus we prefer to use 24 groups in forecasting IE and financial debt.

[17] Similar to Stein (2002), we do not include in our equations data that are older than five years in order to exclude any outdated information that may affect the estimates. The model could be further improved by estimating the model parameters, distinguishing between two different regimes (recession and expansion). We leave this extension to further research. We have also considered other alternative specifications, but the one presented in the paper offers the best fit for the data. The first alternative we computed is based on the correlation between the change in EBITDA of each group *j* and the change in the symmetric macroeconomic variable GOI:

$$\Delta ebitda(i,j,t) = \alpha_{j0} + \alpha_{j1}\,\Delta\, GOI(t) + \varepsilon_j$$

The second alternative we evaluated is to separate the change in value added and in the labour cost, so that the total change in EBITDA is given by the arithmetic sum of the two.

$$\Delta va(i,j,t) = \alpha_{j0} + \alpha_{j1}\,\Delta\, av(t) + \varepsilon_j$$
$$\Delta cl(i,j,t) = \alpha_{j0} + \alpha_{j2}\,\Delta\, lc(t) + \varepsilon_j$$
$$\Delta ebitda(i,j,t) = \Delta\, va(i,j,t) - \Delta\, cl(i,j,t)$$

where $\Delta ebitda(i,j,t) = ebitda(i,j,t) - ebitda(i,j,t-1)$, $\Delta av(t)$ and $\Delta lc(t)$ are respectively the growth rate in value added and in labour cost in the economy at time *t*. We obtain the coefficients $\widehat{\alpha_{j0}}, \widehat{\alpha_{j1}}, \widehat{\alpha_{j2}}$, which we employ to compute the projected change in EBITDA in group *j*:

$$\widehat{\Delta ebitda(j,t)} = \widehat{\alpha_{j0}} + \widehat{\alpha_{j1}}\,\Delta av(t) + \widehat{\alpha_{j2}}\,\Delta lc(t) \qquad \text{for } j=1,\dots,88 \text{ and } t=t,\ t+1 \qquad (2)$$

The projected EBITDA for each firm *i* belonging to group *j* is given by:[18]

$$\widehat{ebitda(i,j,t)} = ebitda(i,j,t-1) + \widehat{\Delta ebitda(j,t)} \qquad \text{for } i=1,\dots,I_j,\ j=1,\dots,97 \qquad (3a)$$

$$\widehat{ebitda(i,j,t+1)} = \widehat{ebitda(i,j,t)} + \widehat{\Delta ebitda(j,t+1)} \qquad \text{for } i=1,\dots,I_j,\ j=1,\dots,97 \qquad (3b)$$

4.2.2 Interest expense and financial debt growth dynamics

For each of the 24 groups defined by firm size and sector we estimate the following equations for the change in interest expense $\Delta ie(i,j,t)$ and in total financial debt $\Delta FD(i,j,t)$:

$$\Delta ie(i,j,t) = \beta_{j0} + \beta_{j1}\,\Delta Debt(t) + \beta_{j2}\,\Delta \mathrm{i}(t) + \beta_{j3}\mathrm{DV(i,j,t-1)} * \Delta Debt(t) + \beta_{j4}\mathrm{DV(i,j,t-1)} * \Delta \mathrm{i}(t) + \xi_j \qquad \text{for } i=1,\dots,I_j,\ j=1,\dots,24 \text{ and } t=t,\ t+1 \qquad (4)$$

$$\Delta FD(i,j,t) = \gamma_{j0} + \gamma_{j1}\,\Delta Debt(t) + \gamma_{j2}\,\Delta \mathrm{i}(t) + \gamma_{j3}\mathrm{DV(i,j,t-1)} + \epsilon_j \qquad \text{for } i=1,\dots,I_j,\ j=1,\dots,24 \text{ and } t=t,\ t+1 \qquad (5)$$

where:

$\Delta Debt(t)$ equals either the growth rate in total financial debt in the economy (in *t*) or the growth rate in bank debt (in *t+1*). It is more appropriate to use the first definition of debt given that it accounts for several types of firm indebtedness. However, forecasts are not available for period *t+1*, thus we employ the forecast for bank debt as described in Section 2.3;

$\Delta \mathrm{i}(t)$ is the change in interest rates on new bank loans;

$\mathrm{DV(i,j,t-1)}$ is a dummy variable equal to one if the firm *i* is vulnerable at time *t-1* and equal to zero otherwise. It accounts for a shift in the change in firm IE and financial debt for those firms that were already vulnerable in the previous period. In fact, the decision of financial intermediaries to supply credit is affected by the current level of the IE-to-EBITDA ratio facing the firm. This approach has already been used by Djoudad (2010) to estimate the growth dynamics of debt for financially vulnerable households.

For each firm *i* belonging to group *j*, the estimated projections for interest expense and financial debt in period *t* and *t*+1 are calculated in the same way as shown in (3a) and (3b).

[18] The number of groups is different due to the specific treatment of some firms that enter in year *t-1*. See Section 4.3 and Note 20 for the details.

4.2.3 Vulnerable firms

After we estimate the level of profitability and interest expense for each firm, we determine its vulnerability by referring to the IE-to-EBITDA ratio. More precisely, a firm is defined as vulnerable if:

$\frac{\widehat{ie(\iota,t)}}{\widehat{ebitda(\iota,t)}} \geq 0.50$ or $\widehat{ebitda}(\iota,t) \leq 0$ for *t=t, t+1*

4.3 Entry and exit

In our model we allow for firms to enter into and exit from the economy in order to avoid having the result affected by survivorship bias, which is known to potentially lead to wrong estimates in closed sample models (see Table 8, column 4 for the results of a comparable closed sample model). Furthermore, our approach greatly increases the realism of our model itself. Given that the change in the share of (vulnerable and non-vulnerable) firms entering and exiting the economy follows a random walk, and the correlation with the business cycle is not well defined, we assume for each group that the best approximation of those shares is that available for the last period of data. However, in our projection of firms' vulnerability for 2014-15, we take into account the fact that using the entry and exit rates of the last year available (2013) could bias the results due to the sharp changes discussed in Section 3.2.[19]

4.3.1 Entry

We compute the entry rate for each of the 24 groups of firms defined by size and sector, differentiating between vulnerable and non-vulnerable firms. We consider only 24 groups, instead of 88, as we do not have ex ante information on the EBITDA volatility of each entrant. For each group *j*, the share of new entrants at time *t* over the population at time *t-1*, $\theta_k(j,t)$ equals the share of entrants for the same group in the previous period, $\theta_k(j,t-1)$, for k=V, NV.

The share of vulnerable entrants is given by:

$\theta_V(j,t) = \theta_V(j,t-1)$ for *j=1,…,24* and *t=t, t+1* (6)

and the share of non-vulnerable entrants is given by:

$\theta_{NV}(j,t) = \theta_{NV}(j,t-1)$ for *j=1,…,24* and *t=t, t+1* (7)

The entrants are assigned a value for EBITDA, IE, and financial debt equal to that of the firms that entered the same group in the last year for which data is available. In this way, we assume that there are no significant differences in the characteristics of new entrants in two consecutive years. In our projection, we also need to use the changes in EBITDA, IE, and financial debt. For the latter two variables, we assume that the changes are equal to those estimated for each of the 24 groups. For

[19] We tried to model entry and exit through correlations with macroeconomic variables, but the fit of the model was poorer, especially for 2013, since there was an abrupt change in entry and exit rates (see Figure1). This could be due to the delay in the effects of the business cycle, which possibly accumulated over time so that they are much larger in 2013 after five years of negative or low economic growth.

EBITDA, we assign the changes estimated based on 88 groups. For those firms entering in the last year and belonging to groups created based on EBITDA volatility (i.e. construction, manufacturing, and services), the change in EBITDA is equal to the average of the same groups of firms with at least two observations.[20]

4.3.2 Exit

We use 97 groups to compute the share of exit. The previous information on EBITDA volatility, in addition to that concerning firm size and sector, is relevant in our computation of the exit rate for each group and thus it has been incorporated in our analysis. As a matter of fact, other things being equal, firms with a more volatile EBITDA have a different probability of exit that those with a less volatile EBITDA. For each group *j*, the share of exits at time $\varphi_k(j,t)$ equals the share of exits for the same group in the previous period, $\varphi_k(j,t-1)$, for k=V, NV.

The share of vulnerable exits is given by:

$$\varphi_V(j,t) = \varphi_V(j,t-1) \qquad \text{for } j=1,\dots,97 \text{ and } t=t,\ t+1 \qquad (14)$$

and the share of non-vulnerable entrants is given by:

$$\varphi_{NV}(j,t) = \varphi_{NV}(j,t-1) \qquad \text{for } j=1,\dots,97 \text{ and } t=t,\ t+1 \qquad (15)$$

After having computed the number of vulnerable and non-vulnerable firms that should exit, we randomly selected those firms that actually exit from our sample.

5. Results

5.1 Backtest of the model

We first perform a backtesting exercise on previous years to evaluate the ability of our model to predict the share of vulnerable firms and their debt. As we are interested in the effects of macroeconomic variables in the short to medium term, the exercises cover a two-year period. In particular, we present the out-of-sample evaluations of our model and the comparable data for the two most recent two-year periods for which we have complete data, i.e. for 2011-12 and 2012-13. The projections are based on historical macroeconomic data so that the results are not negatively affected by incorrect model inputs.[21]

Figures 5 and 6 show the results of the model over these two time spans. The black bars represent observed data of firms' vulnerability. The dotted bars represent the model predictions of the total number of vulnerable firms, by sector of activity and size classes in the first year of the prediction, while the diagonal striped bars represent the model predictions for the second year of analysis.

[20] For example, the estimated change in the EBITDA of micro-firms in the manufacturing sector that entered in year *t-1* is equal to the average of the estimated changes of the 10 groups that satisfy the following conditions: a) micro-firms (entered in the sample at least in *t-2*), b) manufacturing sector and c) belongs to one of the deciles of the EBITDA volatility distribution.

[21] The backtesting exercise differs from the evaluations for future years, for which we rely on macroeconomic forecasts instead of actual data.

Overall, the model performs quite well in replicating both the dynamics and the share of vulnerable firms and their debt. The model projections are also in line with the observed data for most sectors and size classes. The errors have different signs, hence our results are not biased towards overestimation or underestimation of firms' vulnerability. As expected, the errors associated with the projections of the debt at risk are larger than those associated with the share of vulnerable firms, given that the first ratio is more influenced by larger firms.

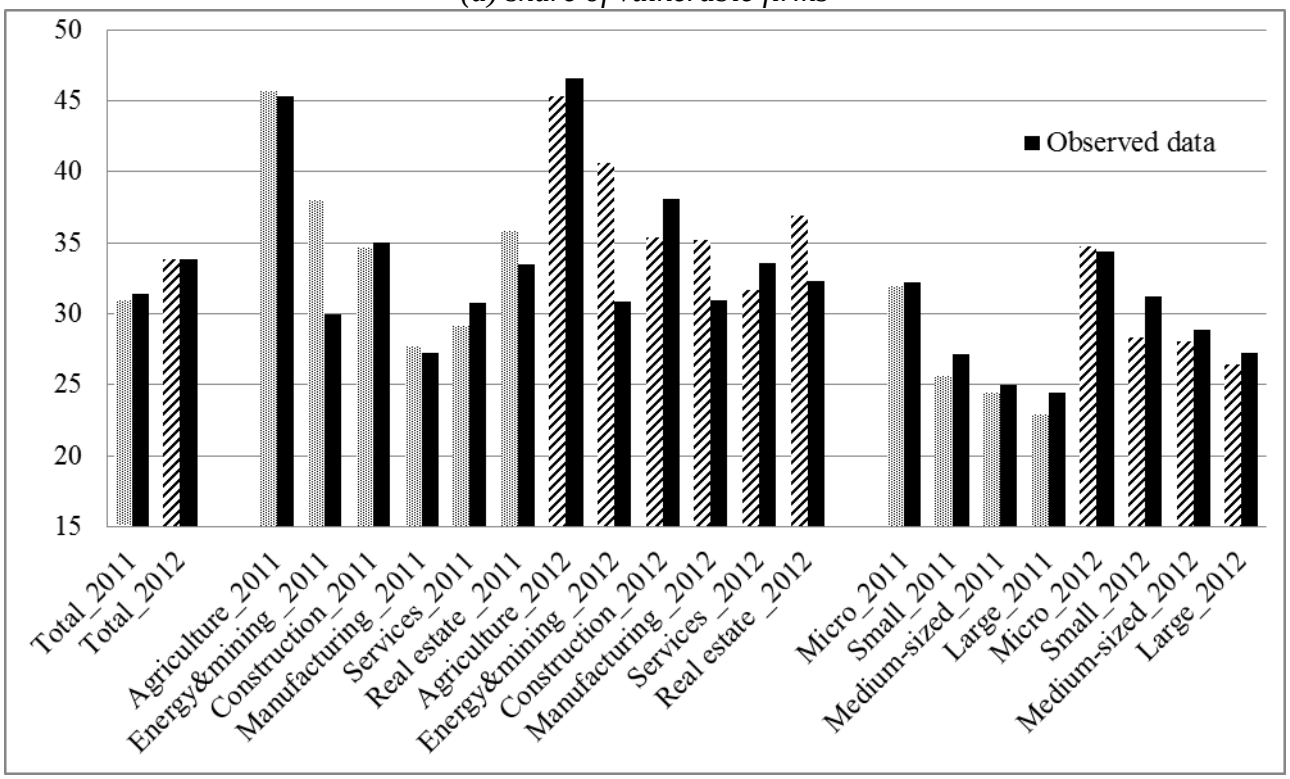
Looking at it in more in detail and focusing on the evaluations for 2011-12, the differences between the model predictions and the observed data with respect to the total share of vulnerable firms are negligible in both years. Those differences are also very small with respect to firm size. With regard to the sector of activity, the prediction errors are somewhat larger for energy&mining; as this sector includes just few thousands firms, the errors could be largely due to the misclassification of a small number of firms. Overall, the errors are very small in the first year of the backtesting exercise and somewhat larger for the different sectors in 2012, but we capture very well the dynamics, i.e. the increase in firms' vulnerability in all sectors and size classes.

The goodness of the fit is confirmed for 2012-2013, as we are able to replicate the improvement, mainly due to the decrease in interest rates. In this case, the model prediction for the first year is slightly less precise, but the main dynamics are replicated. The overestimation of vulnerability may in part reflect the selection process due to the exit of firms, which began to grow stronger in 2012. Furthermore, the model reproduces very well the share of debt at risk, both for the totals and for all firm sizes.

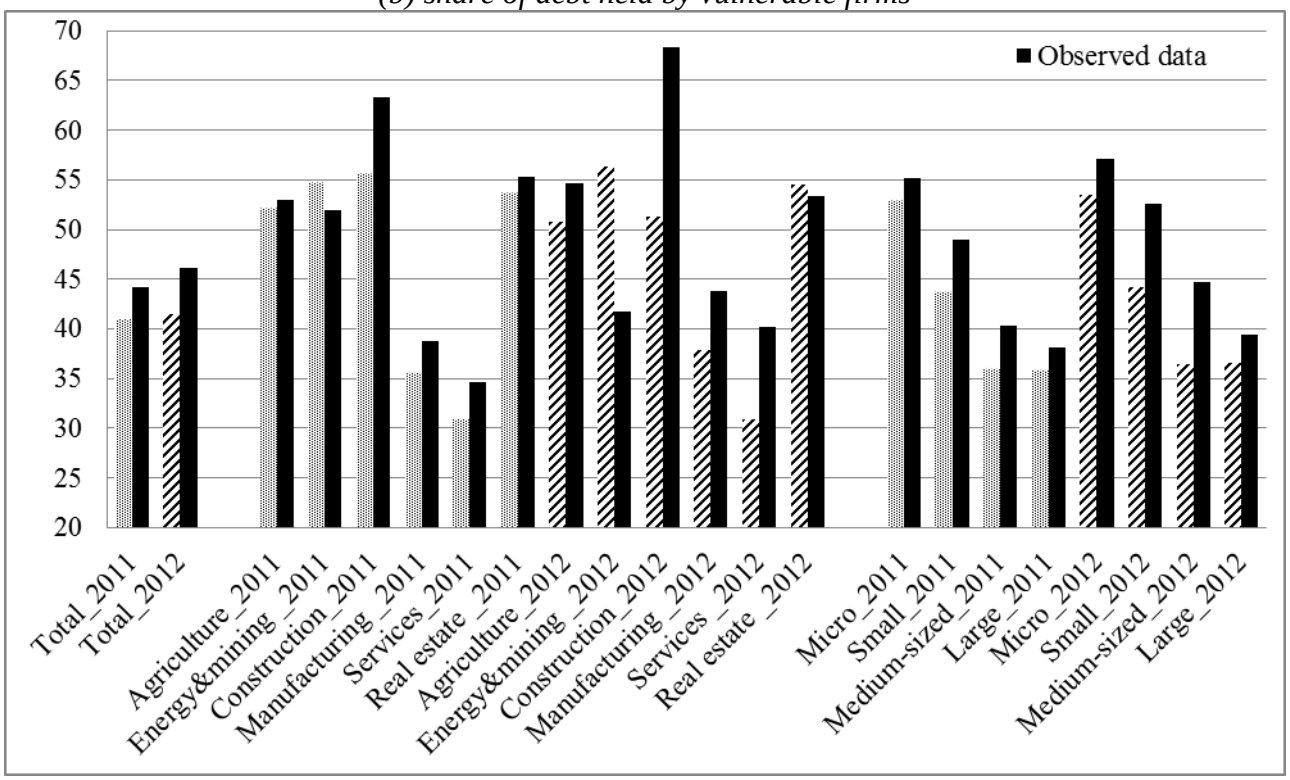
Figure 5: Backtest of firms' vulnerability (2011 and 2012)

(per cent)

(a) share of vulnerable firms



(b) share of debt held by vulnerable firms

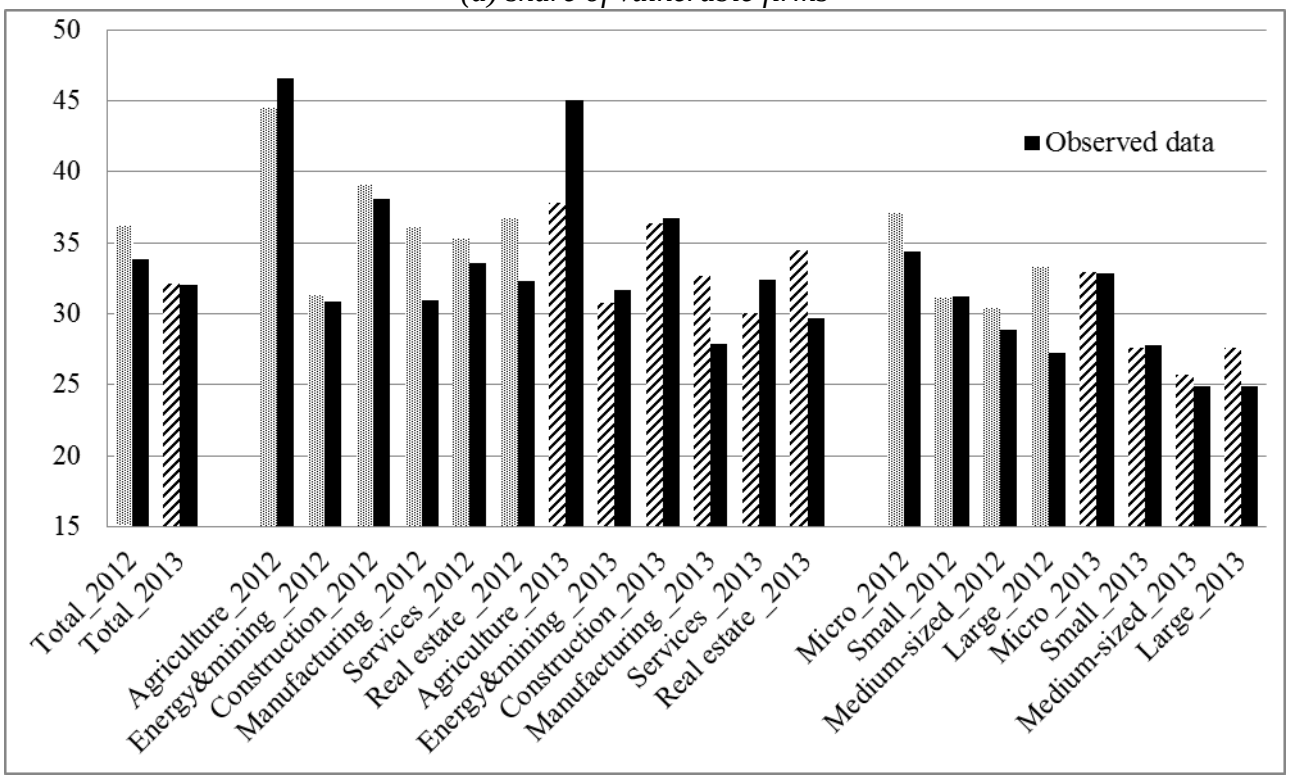


Note: Black bars: observed data; dotted bars: model predictions of the totals, sectors and size classes for 2011; diagonal striped bars: model predictions of the totals, sectors and size classes for 2012.

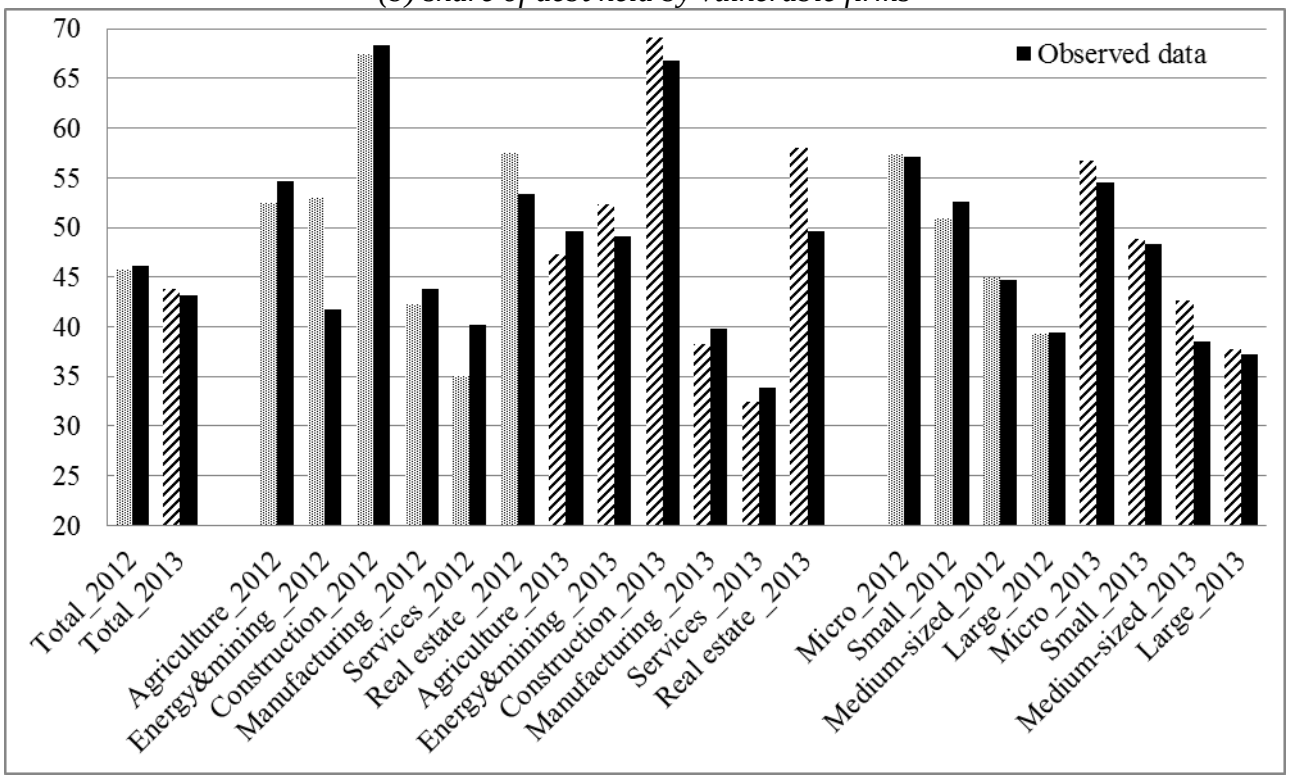
Figure 6: Backtest of the vulnerability of firms (2012 and 2013)

(per cent)

(a) share of vulnerable firms



(b) share of debt held by vulnerable firms



Note: Black bars: observed data; dotted bars: model predictions of the totals, sectors and size classes for 2012; diagonal striped bars: model predictions of the totals, sectors and size classes for 2013.

5.2 Evaluation of firms' vulnerability in 2014 and 2015

In this section we present the macroeconomic forecasts and we assess the impact on firms' vulnerability in 2014 and 2015 under baseline and alternative assumptions and stress test scenarios.

The projections of macroeconomic and credit variables are based on estimates obtained from internal econometric models developed at the Bank of Italy and summarized in Table 7.

Table 7: Macroeconomic variables (2014-2015)
(per cent)

	2014	2015
Growth rate of value added	-0.1	1.6
Growth rate of labour cost	1.7	2.0
Growth rate of GOI	-6.5	0.3
Growth rate of financial debt	-1.6	n.a.
Growth rate of bank loans	-2.3	0.0
Change in interest rate on new loans	-0.3	-0.8

First, we employ macroeconomic data on value added and labour costs. Aggregate data show that the growth rate of value added remains negative in 2014 and becomes positive and equal to 1.6 per cent in 2015. The growth rate in labour cost, even if lower than the historical average, is equal to 1.7 in 2014 and remains positive (2 per cent) in 2015. Those two variables imply a negative growth rate in GOI in 2014 and a positive growth rate in 2015, and are equal, respectively, to -6.5 and 0.3 per cent.

With respect to credit growth in the total economy, we employ two different definitions. First, we consider the total amount of financial debt of non-financial corporations, which is available only up to 2014. Thus, for the second year of the simulation, i.e. 2015, we make use of projections of the growth of bank loans to firms. The growth rate of financial debt remains negative in 2014 (-1.6 per cent), while the growth rate of bank loans is projected to move towards zero in 2015.

We also use historical data and projections of the average annual interest rate on new loans made to non-financial firms. Reflecting the improvement in financial markets and the effect of expansive monetary policy, the change on the interest rate is negative in 2014 and is projected to remain very negative in 2015 (-76 basis points) as well.

5.2.1 Baseline forecast

In our baseline forecast, we rely on all our model assumptions except one, since we consider the entry and exit rates in 2013 as outliers that cannot be used for both 2014 and 2015. Given the protraction of the recession in 2014 and given the availability of some additional information on exits,[22] we assume that in 2014 the entry and exit rates for vulnerable and non-vulnerable firms are the same as in 2013. In 2015, however, we do expect a larger share of entries and a smaller share of

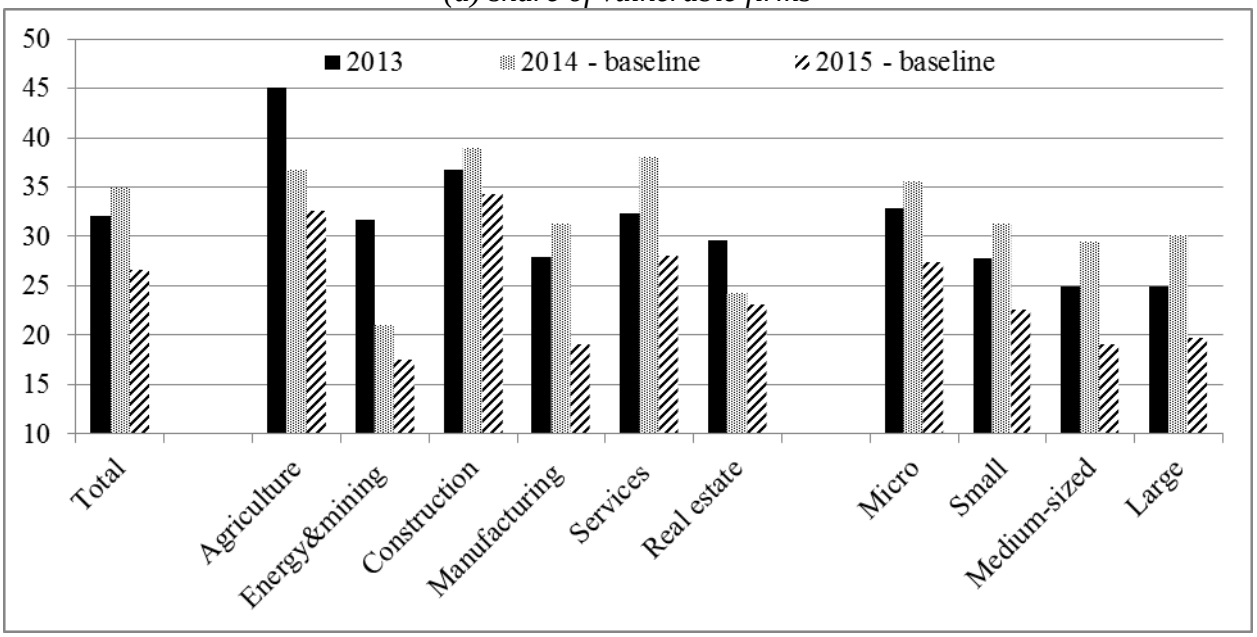
[22] According to Cerved (2015), the number of limited liability companies active in all the previous three years that exited the market in 2014 due to liquidation or bankruptcy is similar to that for 2013 and 2012 (see also Banca d'Italia, 2015).

exits following the economic recovery. We thus assume that both shares are equal to their long-term average over the period 2003-12. Results are presented in Figure 7.

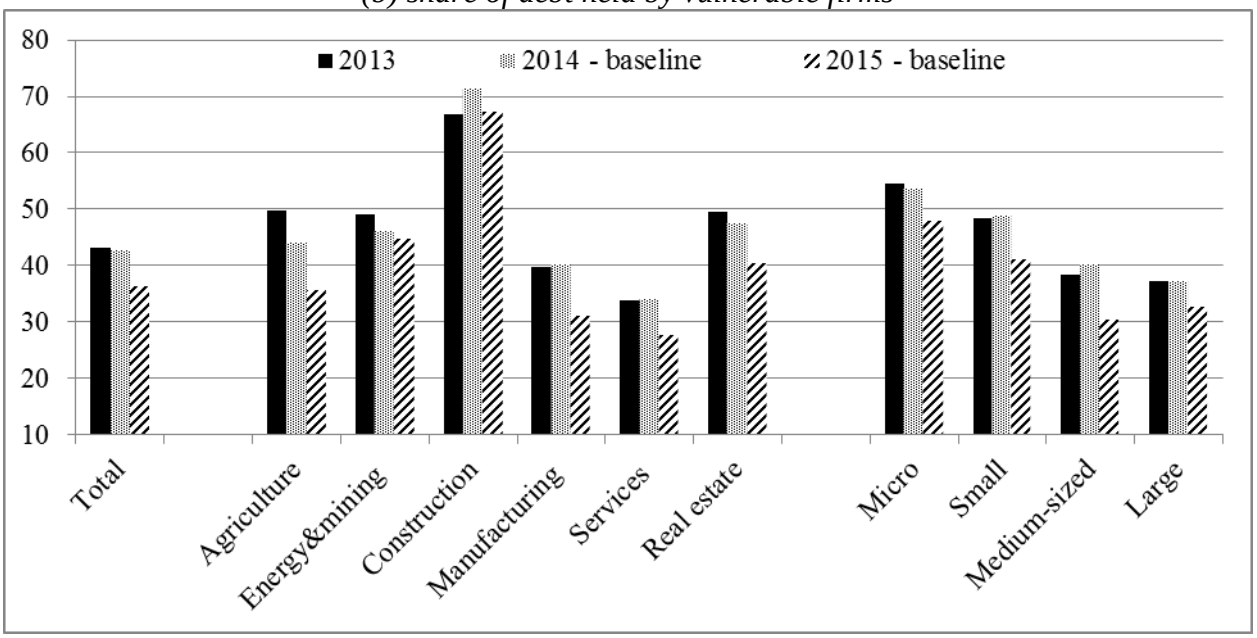
Figure 7: Baseline evaluation of vulnerability (2014-2015)

(per cent)

(a) share of vulnerable firms



(b) share of debt held by vulnerable firms



Note: Black bars: 2013 observed data; dotted bars: model predictions of the totals, sectors and size classes for 2014; diagonal striped bars: model predictions of the totals, sectors and size classes for 2015.

In 2014 the share of vulnerable firms is estimated to have increased by about 3 percentage points over the previous year, to 35 per cent. The negative growth in value added and the increase in labour cost are the main drivers of the rise in the percentage of vulnerable firms; the reduction in the interest rate is not enough to offset the slowdown in economic activity. The largest increase in the share of vulnerable firms occurs in the sectors of manufacturing and services. With respect to firm size, the large and medium firms suffer the most from the deterioration in the economic activity.

Nevertheless, in 2014 the highest percentage of vulnerable firms remains with the micro-firms, rising to 36 per cent from 33 per cent in 2013. The share of debt at risk is estimated to have been about stable in 2014. This could mainly be the result of the negative growth rate in total financial debt. As a matter of fact, vulnerable firms found it more difficult to increase their indebtedness given the selectiveness of banks and financial intermediaries and thus the impact on the debt at risk was minimal. Only firms operating in the construction sector experience a large increase in debt at risk. That may reflect the greater difficulties firms operating in this sector found in repaying their debt.

In 2015 the share of vulnerable firms is projected to significantly decrease to about 27 per cent of the total. The recovery in economic activity, shown by a positive growth rate in value added and mildly positive growth in GOI, combined with one of the largest historical decreases in the interest rate (76 basis points) are the drivers of this fairly sizable drop in the share of vulnerable firms. The decrease also reflects the substantial selection process of the previous years, in particular that observed in 2013 and assumed to have occurred in 2014; as the more vulnerable firms exit from the economy, the remaining ones are both less vulnerable and more ready to benefit from the favourable macroeconomic conditions (see also Section 5.2.2). The improvement is visible across all the different sector of activities, being larger for manufacturing and services, i.e. for those sectors that were more affected by the economic slowdown in 2014. Similarly, the medium and large firms are projected to experience the largest reduction in vulnerability. The vulnerability among micro-firms remains the highest, but also for them the improvement is sizeable, with the share moving towards 27 per cent. The total debt at risk is projected to decrease significantly, to about 37 per cent in 2015 from about 43 per cent in 2014. The main force contributing to that reduction is the improvement in economic activity. All the economic sectors experience a reduction in the debt at risk, being more noticeable for manufacturing, services and real estate. Similarly, all size classes show a reduction in debt at risk, with such reduction being larger for medium and small firms.

5.2.2 Alternative assumptions for entry and exit rates

As 2013 was anomalous with respect to firm entry and exit dynamics, we evaluate the sensitivity of our baseline evaluations of four alternative assumptions for the entry and exit rates in the years of the forecast. The first two reflect plausible values for entry and exit rates (extended-baseline), the last two act as robustness checks. First, we assume that in both 2014 and 2015 the entry and exit rates, different for vulnerable and non-vulnerable firms, are equal to the averages computed for each group over the period 2003-12. In other words, we assume that 2013 is an outlier and thus we employ longer historical averages to project entries and exits. Second, we assume that the rate of entry and exit in 2014 and 2015 equals the average share over the last five years of available data (2008-12). Again, this assumption relies on the idea that 2013 is an outlier, but we use only the last five years of data to better capture the dynamics of entry and exit. Third, we use the exit and entry rates for 2013 in both 2014 and 2015, in line with the previous backtest exercises. Fourth, we consider a model without entry and exit to evaluate the role of survivorship bias.

The results for the two extended-baseline scenarios are reported in Table 8 (columns 1-2, respectively). The results of both specifications are substantially in line with our baseline scenario. Starting from the 2013 data, in 2014 the model displays an increase in the share of vulnerable firms

equal to about 3 percentage points, while in 2015 there is still be a large drop in the fraction of vulnerable firms. The debt at risk is about stable in 2014 and shows a large decrease in 2015. The baseline results are also confirmed across sectors and firm sizes.

The results for the two robustness checks are reported in Table 8 (columns 3-4, respectively). The first robustness check shows a lower share of vulnerable firms than in the baseline scenario in 2015. This underestimation of the vulnerability is a result of using higher values for the exit rate and lower values for the entry rate (as they are both based on 2013); a large number of vulnerable firms is thus projected to exit from the population instead of remaining in the economy as in the baseline scenario. On the other hand, the second robustness test confirms that the vulnerability of the corporate sector increases in a closed sample where we do not allow for entry and exit, given that the most fragile firms are not substituted with new less fragile entrants. Quantitatively, in both 2014 and 2015 the share of vulnerable firms and debt at risk is about 2-3 percentage points higher than in the baseline, which captures the survivorship bias. Given the macroeconomic and financial conditions, the four alternative scenarios offer a range of possible values for the vulnerability of the corporate sector.

Table 8: Evaluation of vulnerability under alternative assumptions (2014-2015)
(per cent)

	Share of vulnerable firms					Share of debt held by vulnerable firms				
	Baseline	Extended-baseline		Robustness checks		Baseline	Extended-baseline		Robustness checks	
		(1)	(2)	(3)	(4)		(1)	(2)	(3)	(4)
Total (2014)	35	35	36	35	37	43	43	43	43	44
Total (2015)	27	27	28	26	30	36	36	37	36	39
Agriculture (2014)	37	37	38	38	38	44	44	44	45	46
Energy&mining (2014)	21	21	23	23	21	46	46	46	46	46
Construction (2014)	39	39	40	39	42	71	71	72	72	72
Manufacturing (2014)	31	31	32	32	34	40	40	41	40	41
Services (2014)	38	38	39	38	40	34	34	34	34	35
Real estate (2014)	24	24	27	26	27	47	47	48	48	49
Agriculture (2015)	33	33	34	34	33	36	36	35	36	42
Energy&mining (2015)	17	17	16	17	21	45	45	44	44	46
Construction (2015)	34	34	35	34	38	67	67	68	67	68
Manufacturing (2015)	19	19	20	19	21	31	31	31	30	33
Services (2015)	28	28	28	28	32	28	28	28	28	30
Real estate (2015)	23	23	25	23	24	40	40	41	40	47
Micro (2014)	36	36	37	36	38	54	54	55	54	56
Small (2014)	31	31	32	32	33	49	49	49	49	49
Medium-sized (2014)	29	29	30	30	30	40	40	40	40	41
Large (2014)	30	30	30	30	30	37	37	37	37	37
Micro (2015)	27	27	28	27	31	48	48	49	48	53
Small (2015)	23	23	23	22	24	41	41	41	41	43
Medium-sized (2015)	19	19	19	19	20	30	30	31	30	33
Large (2015)	20	20	20	20	20	33	33	32	32	34

Note: Assumptions on entry and exit rates for each of the 48 groups, defined based on their vulnerability (2 types) and size and sector (24 groups): (baseline) 2014 is equal to 2013, 2015 is equal to the average over 2003-12. – (extended-baseline 1) 2014 and 2015 are equal to the 2003-12 average. – (extended-baseline 2) 2014 and 2015 are equal to the 2008-12 average. – (robustness 3) 2014 and 2015 are equal to 2013. – (robustness 4): no entry/exit.

5.3 Stress tests

Finally we consider how the share of vulnerable firms and their debt changes under three stress scenarios: one with respect to the interest rate, one with respect to profitability, and the last as a combination of the first two. Results are presented in Figure 8, while the breakdown by sector of activity and size is presented in Figure 9.

First, we assume that the interest rate on new loans increases relative to the baseline scenario by 100 basis points in 2015, i.e. it increases by about 25 basis points from its level in 2014. With respect to the baseline scenario, the share of vulnerable firms is projected to increase by more than 2 percentage points, to a value above 29 per cent. The largest increase in the share of vulnerable firms occurs in the construction and real estate sectors, while it is smallest for the manufacturing and the services sectors. With respect to size, the groups that suffer the most are those that include small and large firms. The total debt at risk reaches a value greater than 39 per cent, about 3 percentage points greater than that in the baseline scenario, but still smaller than that in 2014. Overall, in this adverse scenario, firms' vulnerability is higher than in the baseline forecast for 2015, but the recovery in economic activity driven by positive growth in value added and GOI still offsets the adverse effects of the credit conditions.

Second, we consider a decrease of 5 per cent in GOI in 2015 relative to the baseline scenario, i.e. it decreases by 4.7 per cent from its level in 2014. The total share of vulnerable firms now exceeds 33 per cent in 2015, only a bit lower than the estimated level in 2014 (35 per cent), thus the large decrease in interest rates would only partially offset the large economic deterioration behind this stress test scenario. The manufacturing and services sectors face the largest increase in their share of both vulnerable firms and debt at risk.[23] As to firm size, the model projects that medium-sized firms are more exposed to this negative shock, facing the largest increase in both share of vulnerable firms and debt at risk. The comparison of these two stress tests suggests that a decrease of 5 per cent in the GOI seems to dominate a 100 basis point shock to interest rates in its impact on the fragility of the corporate sector. Nevertheless, we acknowledge that different sizes in the profitability or interest rate shocks may lead to different conclusions over the dominant effect.

Third, we consider a combined stress to both interest rate and GOI: the interest rate on new loans increases by 100 basis points and GOI decreases by 5 per cent relative to the baseline scenario in 2015. The total share of vulnerable firms increases to above 36 per cent, thus exceeding the level estimated in 2014 by more than 1 percentage point. The manufacturing and services sectors experience the largest increase in vulnerability, reflecting the fact that those sectors are more sensitive to changes in both macroeconomic conditions and in interest rates. As to firm size, medium-sized firms experience the largest increase in vulnerability. Finally, in this stress test as well, the largest share of vulnerable firms and debt at risk remains among the micro-firms, reaching, respectively, a value of 38 and 54 per cent.

[23] The results for two residual sectors (agriculture and energy & mining) show that the share of vulnerable firms and their debt would decrease in this scenario of stress. This may be due to the fact that in 2012 and 2013 (the last two years used to obtain the estimated coefficients) the two sectors displayed a countercyclical behaviour in profitability. This evidence adds up to larger prediction errors for the agriculture and energy & mining sectors, as shown in Figures 5 and 6 for the backtest exercises. However, their impact on the overall vulnerability of the corporate sector is small since these two sectors include a minority of firms.

Figure 8: Stress tests and vulnerability - Total (2015)

(per cent)

(a) Share of vulnerable firms *(b) Share of debt held by vulnerable firms*

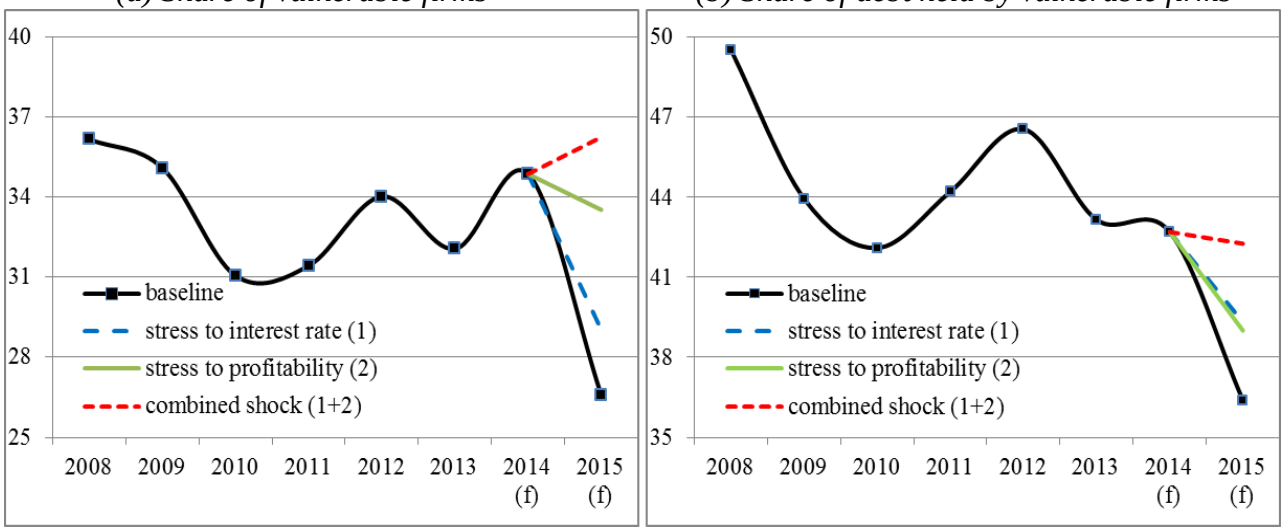
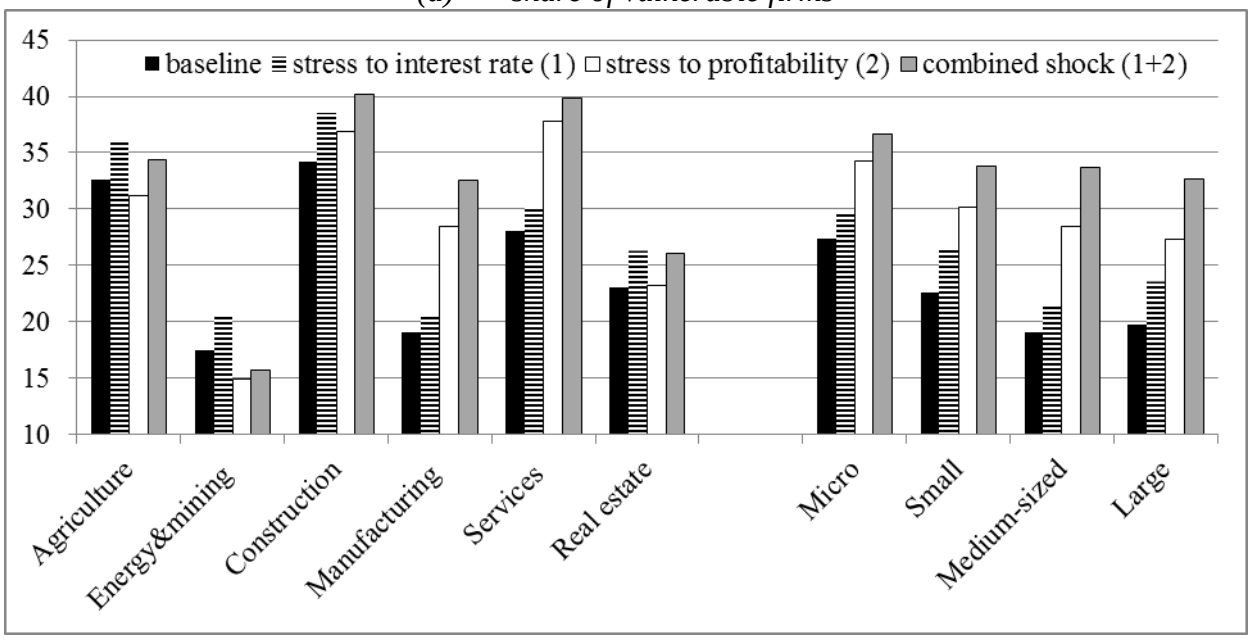


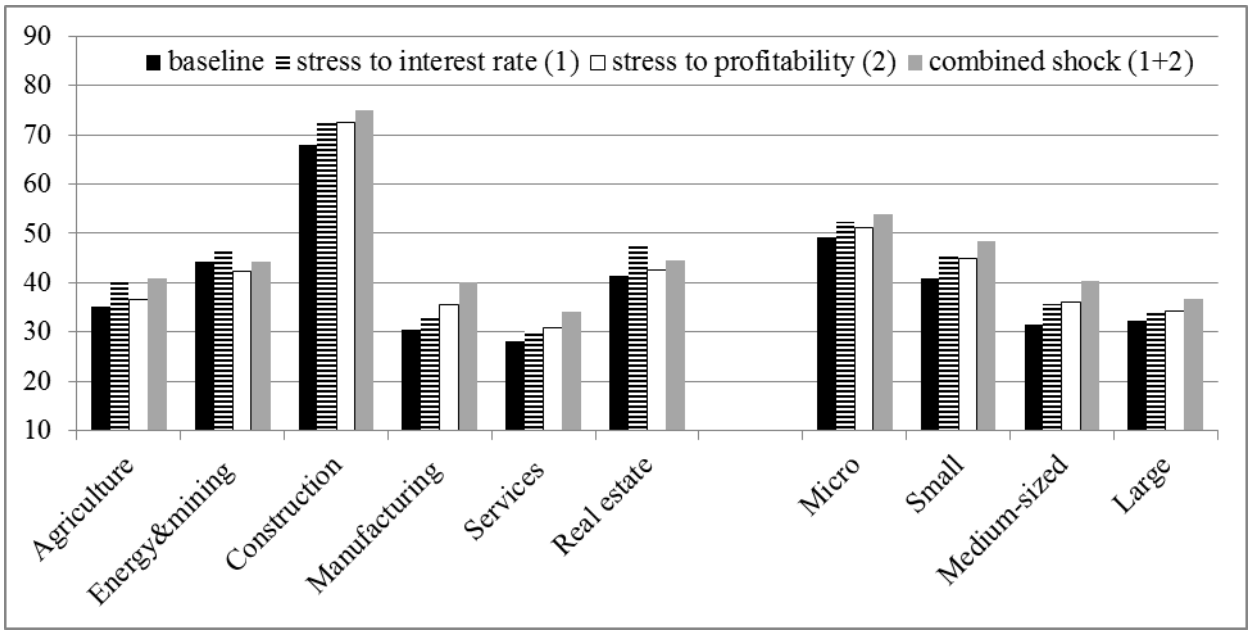
Figure 9: Stress tests and vulnerability – By size and sector (2015)

(per cent)

(a) share of vulnerable firms



(b) share of debt held by vulnerable firms



6. Conclusion

In this paper, we build a model to evaluate the vulnerability of Italian firms. Starting with microeconomic data at the firm level and employing macroeconomic forecasts, we project the evolution of the share of vulnerable firms and their debt at risk. Our model is able to capture the heterogeneity of the firms, which is crucial for both policy evaluation and analysis of stress scenarios. The model has been backtested over the previous years for which historical macroeconomic data are available. For the future years, the quality of the projections relies on the accuracy of macro and financial forecasts that serve as inputs for the model.

The model has been used for the 2014-15 evaluation of firms' vulnerability. It shows an increase in firms' vulnerability in 2014, mainly due to the deterioration in economic activity. Nevertheless, the economic recovery expected for 2015, coupled with interest rates at historic lows, would drive a large reduction in firms' vulnerability in this year.

The model has also been used to evaluate stress scenarios. Relative to the baseline scenario, we consider a 100 basis point increase in the interest rate, a 5 per cent decrease in the GOI, and a scenario where the two shocks are combined. In the first two stress tests we impose deterioration on only one variable and we find an increase in the vulnerability of the corporate sector, which is however projected to remain lower than in 2014. Instead, a scenario with the two stresses combined would be quite painful for the corporate sector, such that the share of vulnerable firms would increase by more than 1 percentage point with respect to levels expected in 2014 (about 9 percentage points relatively to the baseline scenario).

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Appendix

A.1. Implicit components of the vulnerability indicator

Assume for the sake of simplicity that there is no taxation, extraordinary expenditures and non-financial debt, so that we can define

(1) Profit= EBITDA-IE
(2) A (assets)=D (debt)+E (equity)
(3) ROE (return on equity)=Profit/E
(4) ROA (return on assets)= EBITDA /A
(5) ROD (cost of debt)=IE/D

Then equation (1), which includes the two variables used in our vulnerability indicator, can be rewritten as:[24]

(6) ROE=ROA+(ROA-ROD)*(D/E)

From (6) it is clear that our indicator includes the effects of i) leverage (D/E), ii) return on assets, based on operating income, and iii) its spread with respect to the cost of debt. It is also apparent that firms' vulnerability depends on the volatility of the operating profit: the higher the dispersion in ROA, the higher the likelihood that the differential (ROA-ROD) is negative. This aspect is at the base of the distance to default models, in which equity is considered a call option on the firm's assets, taking into account their volatility. The value of the implied put option represents the firm's credit risk. Default occurs when the value of the firm's liabilities exceeds that of its assets (weighted for volatility), so that it is possible to calculate the probability of default using put-call parity.

A.2. Different thresholds for the vulnerability indicator

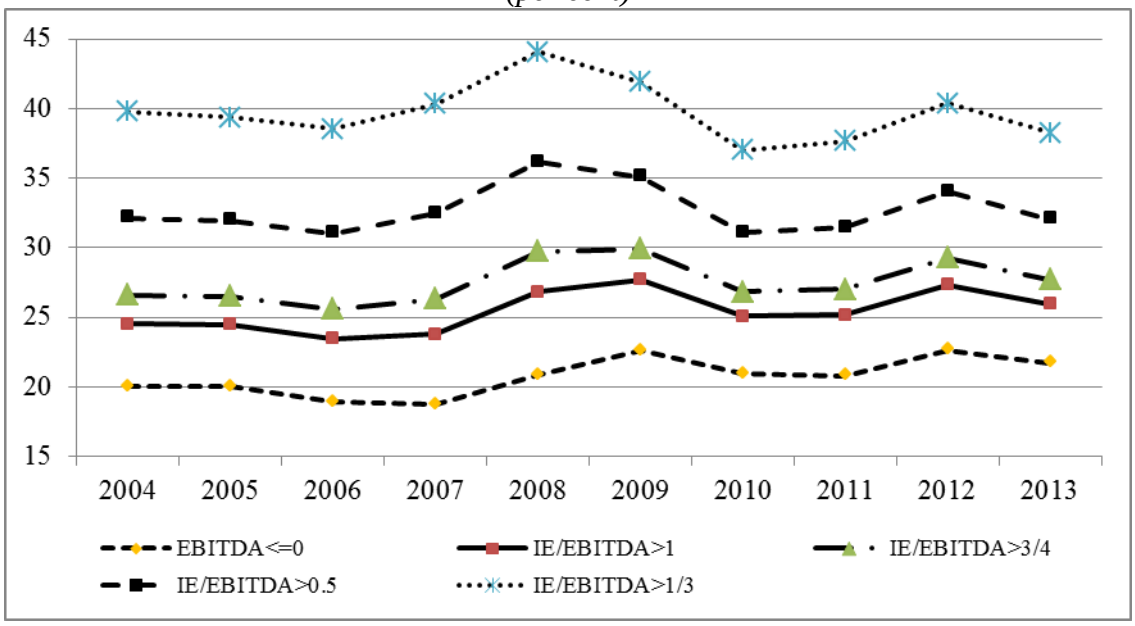
Figure A1 presents the share of vulnerable firms and its dynamics based on different thresholds of the ratio interest expense (IE) over EBITDA. The strictest version classifies only firms with EBITDA<=0 as vulnerable, which accounts for around 20 per cent of all firms. The share of vulnerable firms increases by around 5 (7) percentage points if a threshold of 1 (3/4) is used. A far smaller and more conservative threshold of 1/3 yields a share of vulnerable firms of 40 per cent, around 7 percentage points higher than the results obtained in the paper, where we use a threshold of 0.5. Independent of the threshold, the dynamics of the share of vulnerable firms are similar. These aggregate results are influenced by the large number of micro-firms, as above 20 per cent of them have EBITDA<=0 (the proportion for other size classes is above 10 per cent). However the spread in the share of vulnerable firms between this definition of vulnerability and the less conservative one (threshold at 1/3) is around 20 percentage points, independent of the size class. The dynamics over time are also similar.

[24] If (1) is divided by E, then the left-hand side can be rewritten as ROE using (3). The right-hand side of (1) can be preliminary rewritten as (EBITDA/A)*(D+E)+ROD*D=ROA*(E+D)+ROD*D, using (2) and (5) in the first passage and (4) in the second; after regrouping and dividing by E, it can be written as ROA*E/E+(ROA-ROD)*(D/E), which yields the right-hand side of (6).

The main difference between the stricter thresholds (such as one) is the fact that the indicator peaks in 2009, instead of 2008. This could be due to the fact that the recession greatly increased the number of firms with negative income, which is reflected in the steady increase over these two years. Instead, lower thresholds (like 0.5 or 1/3) make it possible to include a larger number of viable firms, which are less affected by negative shocks. This interpretation is confirmed by the fact that using these two thresholds generally causes larger fluctuations in the indicator over time.

Figure A1: Share of vulnerable firms with different thresholds (2003-2013)

(per cent)

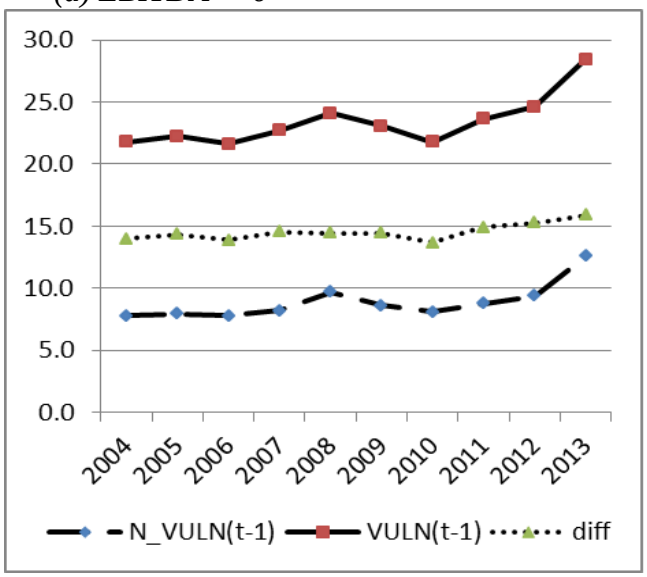


In addition to the reasons stated in this paper, we decided to classify vulnerable firms using a threshold of 0.5 in order to also identify those firms that are more likely to exit from the economy. As explained in the paper, we are not modelling a probability of default or the probability of exit from our dataset, which includes both bankruptcy and voluntary closures. However, it is reasonable to evaluate if firms classified as vulnerable have a higher probability of going out of business. Figure A2 shows the time series of the probability of exit for vulnerable and non-vulnerable firms based on two definitions: EBITDA<=0 or our definition. It can be seen that, in both cases, there are large differences between the two subsamples. As expected, differences are larger when a stricter definition is used: the probability is around 23 and 9 per cent using EBITDA<=0 (19 and 8 per cent if the threshold is IE/EBITDA>0.5). From this evidence it is clear that our threshold, which selects potentially vulnerable firms, has a similar capacity to distinguish between firms, as the probability of exit doubles if a firm is vulnerable, especially in the last few years. To further assess this finding, we also calculated, for the last few years, the probability of exit over more than one year: in 2009, it was above 30 per cent and 42 per cent for a two-year and three-year period. Taking 2013 as the final year, the probability increased to 38 per cent (based on being vulnerable in 2011) and 48 per cent (based on being vulnerable in 2010).

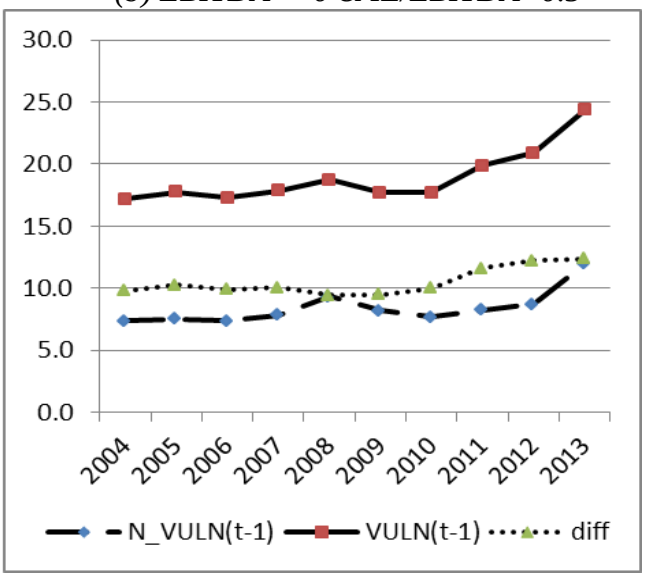
Figure A2: Share of exit and vulnerability under different thresholds (2003-2013)

(per cent)

(a) EBITDA<=0



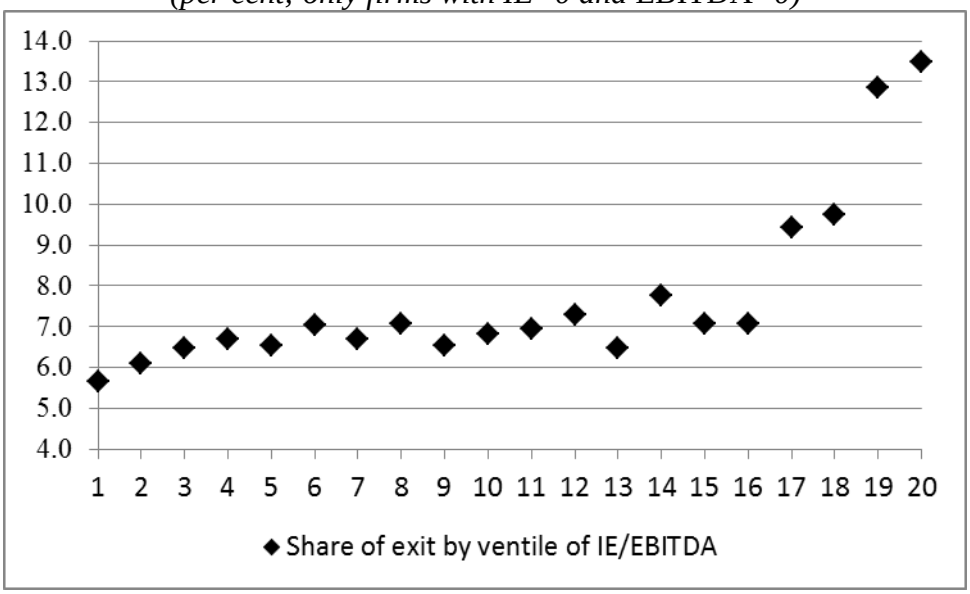
(b) EBITDA<=0 & IE/EBITDA>0.5



Finally, we also evaluate our threshold using a univariate analysis of the distribution of our ratio and the probability of going out of business. More precisely, we calculate the exit ratio for each ventile of the IE/EBITDA ratio if both are positive for our time span. The results for each of these 20 classes are shown in Figure A3: the share of exit ranges between 6-7 per cent for most of the ventiles, but it jumps at the seventeenth ventile of the distribution to 9.5 per cent, up to 13.5 per cent for the right tail. As the minimum value of the IE/EBITDA ratio for firms belonging to this part of the distribution is 0.49, we use this result to further corroborate our decision to set a threshold at 0.5 for identifying vulnerable firms.

Figure A3: Share of exit and ventiles of IE/EBITDA (averages 2003-2013)

(per cent; only firms with IE>0 and EBITDA*>0)*



A.3. Transition matrices

We compare the transition matrices for the period 2012-13, obtained starting with two different classifications of firms, one based on Cerved (as in the main text) and another based on CR (loans of non-active firms, which are signalled in CR but not in Cerved, are classified as performing or NPL, instead of 'Not in Cerved'). The top panels refer to the share of vulnerable and non-vulnerable firms, while the bottom panels refer to their share of debt.

The main difference from our baseline specification based on Cerved data is that the share of vulnerable firms that go into or remain in default is higher. The other main findings are confirmed: debt held by vulnerable firms is more likely to become non-performing and, once in non-performing status, it is less likely to return to performing status. Vulnerable firms are also more likely to exit from the economy.

Cerved Classification

Share of firms

t \ t+1	Performing	NPL	In Cerved & Not in CR	Not in Cerved	Total
Vulnerable					
Performing	70	8	6	16	100
NPL	10	49	2	39	100
Non -vulnerable					
Performing	82	3	8	7	100
NPL	21	48	4	27	100

Share of debt

t \ t+1	Performing	NPL	In Cerved & Not in CR	Not in Cerved	Total
Vulnerable					
Performing	71	21	2	7	100
NPL	11	68	0	20	100
Non -vulnerable					
Performing	90	5	2	3	100
NPL	14	83	0	3	100

CR Classification

Share of firms

t \ t+1	Performing	NPL	In Cerved & Not in CR	Not in Cerved & Not in CR	Total
Vulnerable					
Performing	79	11	6	3	100
NPL	12	83	2	2	100
Non -vulnerable					
Performing	87	3	9	1	100
NPL	24	70	4	2	100

Share of debt

t \ t+1	Performing	NPL	In Cerved & Not in CR	Not in Cerved & Not in CR	Total
Vulnerable					
Performing	75	23	2	1	100
NPL	12	87	0	0	100
Non -vulnerable					
Performing	91	6	2	1	100
NPL	14	86	0	0	100