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Medium-term investment responses to activity shocks: the role of corporate debt

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Abstract

This paper analyses the implications of corporate indebtedness for investment following large economic shocks. The empirical analysis is based on a large Orbis-iBACH firm-level data set for euro area countries from 2005 to 2018. Our results suggest that investment of high-debt firms is significantly depressed for an extended period in the aftermath of economic crises. In the four years after a negative economic shock, the cumulative loss of capital of high-debt firms is around 15% higher than that of firms with lower debt burdens. The negative impact of high debt on investment is most evident for firms in Southern and Eastern Europe and for micro firms. These findings suggest a potentially significant negative impact of increased corporate indebtedness on investment in the post-COVID-19 recovery.

JEL codes: E22, F34, G31, G32

Keywords: Corporate debt, leverage, investment, local projections, COVID shock

Non-technical summary

The corporate sector has been hit hard by the COVID-19 pandemic and the associated containment measures and supply disruptions. The rapid pace of the decline in revenue in conjunction with the difficulty of adjusting costs sufficiently led to a sudden increase in liquidity needs. Notably firms operating in sectors that were sensitive to lockdown measures had to resort to additional borrowing via loans and securities. While the additional lending helped covering corporates' increased liquidity needs, it also increased corporate debt levels which had already been high in several euro area countries before the pandemic.

We investigate whether the high corporate debt burden in many euro area countries holds back investment of the non-financial corporate sector in the aftermath of economic crises. Our analysis is based on a comprehensive firm-level data set including small private firms from the ORBIS and iBACH databases. The dataset consists of more than 15 million observations, covering firms in 14 euro area countries over the period from 2005 to 2018. We construct resampling weights to improve representativeness. We assess the differential impact on investment of different levels of leverage. We condition on country-sector-specific cyclical conditions using two-digit industry value added growth and control for time-invariant sector and country characteristics as well as for cross-country common shocks. We also control for firm characteristics such as size, age, profits, sales growth, interest burden and cost of capital.

Our results highlight the important role of firm balance sheet factors for investment. We find a strong interaction between firm indebtedness and investment amid activity shocks. Firms with higher leverage reduce investment significantly more than their peers with lower debt. Over the four years after a large economic contraction, the growth rate of tangible fixed capital of high-debt firms is some 15 percentage points below that of their counterparts with lower debt burdens. This result is most pronounced for micro firms, which experience a sustained fall in investment post-crisis. Highly-indebted micro firms reduce their capital by close to one fifth in the four years after a shock, which compares to some eight percent in the case of small and medium-sized firms. Investment by larger firms, which typically face lower financial frictions, is not significantly influenced by higher leverage.

There are also significant cross-country differences. The effect of high leverage on investment is strongest for firms in Southern and Eastern European countries, possibly due

to weaker banks and less efficient insolvency frameworks. Our main findings are robust to alternative definitions of investment and different computations of activity shocks.

Applying our findings to the COVID-19 crisis, a simple back-of-the-envelope calculation suggests that the COVID-19 shock may lead to a 5% decline in the aggregate stock of tangible fixed assets by 2024. The decline stems mostly from the large fall in investment of high-debt firms, which are estimated to reduce their capital by one fifth over this period. By contrast, low-debt firms show greater resilience to the shock and increase their capital.

Our results question the capacity of the corporate sector to promote the recovery from the COVID-19 crisis via an increase in capital spending. The ramifications of the Russian war in Ukraine, the fight against climate change and the digital transition will also require large-scale corporate investments. Addressing these challenges warrants structural policies to address concerns about corporate debt overhang and strengthen the resilience of the corporate sector to future shocks. Failing to address the high leverage of SMEs could lead to an increase in the number of non-viable firms with subdued investment prospects. Moreover, strengthening the incentives for equity financing would be conducive to sustainable investment growth in euro area countries.

1. Introduction

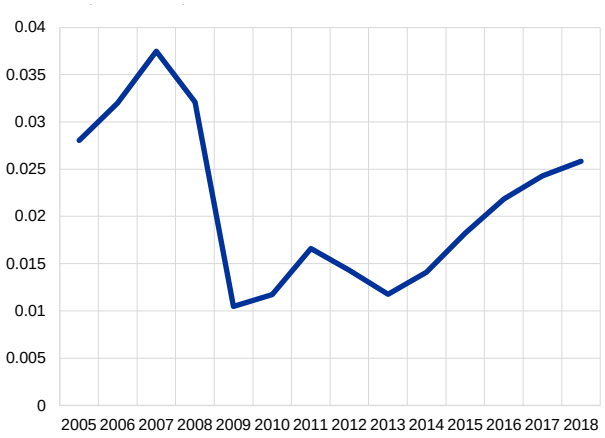
The corporate sector has been hit hard by the COVID-19 pandemic. In most euro area countries non-financial corporations substantially increased their debt since the end of 2019. For the euro area as a whole, the outstanding amount of corporate debt increased by 5 percentage points between the end of 2019 and end-2021, to 84% of GDP, thereby coming close to the historical peak before the COVID-19 crisis. Notably firms operating in sectors that were sensitive to lockdown measures had to resort to additional borrowing, often compounded by policy responses to the pandemic, which tended to focus on instruments that enabled firms to increase their leverage (for instance through direct lending or loan guarantees). This additional financing has helped covering corporates' increased liquidity needs as cash-flows plummeted, limited the number of insolvencies and preserved employment. At the same time, however, it increased concerns about undercapitalisation. Small and medium-sized enterprises (SMEs) in particular were affected due to their higher prevalence in COVID-sensitive sectors (such as tourism), more difficult access to finance and lower capital and liquidity buffers (OECD 2020, Nicoletti et al. 2022).

The legacy of high debt could negatively impact on the economic recovery in the medium-term. The corporate finance literature suggest that high debt has a bearing on corporate investment (Jensen and Meckling 1976, Myers 1977, Bernanke and Gertler 1999). High corporate indebtedness implies higher interest expenses and thus fewer funds available for investment. Firms with high leverage also find it harder to obtain new funds from external financing sources due to their higher default risk. Moreover, the desire to repair weak balance sheets leads firms to deleverage, and thereby forgo investment opportunities, potentially also with negative implications for profits.

A negative link between high debt and investment is well established empirically by the large body of literature that investigates the link between indebtedness and investment at the firm level. Several studies have shown that high debt can exacerbate constraints on firms' access to credit, which restrains firm investment. Many economists have suggested that corporate indebtedness in euro area countries inhibits investment spending and economic recovery, whenever debt levels are "excessively" high (see e.g. Cecchetti et al. 2011, Durante et al. 2022). The empirical literature also finds non-linear effects of debt on investment (Martinez-Carrascal and Ferrando 2008, Goretti and Souto 2013, Popov et al. 2018, , Rodriguez Palenzuela and Dees 2016, Gebauer et al. 2018, Auer et al. 2021, Kalemli-Özcan et al. 2022).

To the best of our knowledge, the empirical literature has however not analysed the medium- and long-term impact of activity shocks on investment for firms at different points of the leverage distribution. Previous recessions have indicated strong, persistent effects of negative activity shocks on the growth of capital, especially of intangibles. For example, in spite of easy financing conditions, investment was rather weak in the aftermath of the Great Recession, with investment only recovering to pre-crisis levels after seven years (Figure 1). It has also been shown that investment was hit hardest in those countries that had accumulated the largest debt imbalances during the pre-crisis credit boom (Lane and Milesi-Ferretti 2011).

Figure 1 – Net investment rates in the euro area



Source: Eurostat.
Note: Net investment is computed as the differences between gross fixed capital fornation and consumption of fixed capital over value added.

This paper builds on these considerations and investigates the link between firm-level indebtedness and investment following large economic shocks. In particular, we address the following questions: What are the implications of corporate indebtedness for investment in a crisis? Does high corporate indebtedness provide a drag on investment in the recovery phase? Which structural features determine the investment sensitivity to debt (e.g. firm size, sector, country-specific framework conditions)?

Our findings suggest that investment of high-debt firms is significantly depressed for an extended period following an economic crisis. In the four years after a large economic contraction, investment of high-debt firms is some 15% below that of their counterparts with lower debt burdens. This result is driven in particular by micro firms and by firms in Southern European countries, which experience a more protracted fall in investment post-crisis than

larger firms. Applying these findings to the COVID-19 crisis suggests that the COVID-19 shock may lead to a 5% drop in the aggregate stock of tangible fixed assets by 2024.

The remainder of the paper is structured as follows: Section 2 presents the data set and provides some illustration of the descriptive statistics on the debt and investment link. In section 3, we report results of the baseline model estimations on the debt-investment nexus and then provide evidence on structural differences according to firm size and region. Section 4 presents robustness tests, including an instrumental variable approach based on dynamic panel estimations. We conclude in Section 5.

2. Data and descriptive statistics

Our analysis is based on firm-level data from fourteen euro area countries covering the period from 2005 to 2018 using the Bureau Van Dijk's Orbis and the European Committee of Central Balance Sheet Data Offices' BACH (Bank for the Accounts of Companies Harmonised) datasets, which report balance sheet and profit-and-loss data for both listed and unlisted companies in the euro area (BACH working group 2015). For ORBIS, historical vintages are used to improve the representativeness of the data and reduce the sampling bias, as explained in Kalemli-Özcan et al. (2019). For the six countries for which iBACH data is available – Belgium, France, Italy, Spain, Portugal, and Slovakia – the ORBIS and iBACH datasets are merged to improve coverage. Whenever a duplicate firm is observed, we keep the one from ORBIS.

For the construction of our dataset, we closely follow Kalemli-Özcan et. al (2019) and Gopinath et. al (2017) to pursue a standard cleaning procedure. In particular, we keep only unconsolidated accounts, corporate firms, and remove sole proprietorships.[1] We restrict our analysis to non-financial and non-governmental sectors (NACE Rev. 2 codes B to N except K), and remove firms in the mining and quarrying (B) and real estate (L) sectors. In addition, we remove firm-year observations with inconsistent balance sheet or income statement relations, including those with negative asset holdings (see Appendix for details). We also exclude five euro area countries for which limited data was available (Cyprus, Latvia, Lithuania, Luxembourg and Malta).

Furthermore, due to the dynamic nature of our econometric analysis, we keep only firms with at least five consecutive years of reporting. Finally, all variables are winsorised at the 1st and

[1]The inclusion of consolidated accounts would combine the financials of subsidiaries across different countries and industries and thus complicate comparisons across countries and sectors.

99th percentiles, except for the investment ratios, which are winsorised at the 95th percentile to account for the variables' fat tail distribution. The resulting dataset covers approximately three million firms and more than 15 million firm-year observations from fourteen euro area countries for the period from 2005 until 2018.

A well-known concern with Orbis data is the poor representativeness of the data for some countries and sectors. In Table A1, we benchmark our dataset with Eurostat's Structural Business Statistics data which shows the total population of firms. The coverage of our dataset is highly heterogeneous, varying from 8% of the firms' population in Ireland to more than 90% in Portugal. In order to replicate the national account aggregates of fixed tangible assets (the relevant variable in our study) and improve the representativeness of the data we use inverse population weights according to the following formula:

$$w_i = \frac{TFA_S^{Eurostat}}{TFA_S^{Sample}}$$

where w_i is the weight of firm i in our dataset and S is the country-sector (one-digit) in which the firm operates. Thus, the weight of a firm in a given sector is the ratio between the total fixed assets of the sector in Eurostat and in our sample (see Table A2 for more information on the sectoral distribution of assets).

Our main dependent variable of interest is investment, defined as the annual change in tangible fixed assets over previous year's tangible fixed assets. The reasons for focusing on net investment as opposed to gross investment (net investment plus depreciation) are twofold. First, net investment is more relevant from a policy point of view than gross investment given its close link to an economy's level of productivity (Kalemli-Özcan, Laeven and Moreno 2022). Second, due to different reporting standards, the depreciation variable in our dataset is non-harmonised and contains many missing values. The available variable, "Depreciation and Amortization", refers, in some cases, to tangible fixed assets depreciation only, while in other cases it also includes amortization of intangibles. The use of gross investment could therefore introduce an additional degree of measurement error to our dataset. This notwithstanding, we conduct robustness checks using both gross and net investment by resorting to EUKLEMS depreciation rates, which are available at the country-sector level and allow us to discern between average depreciation rates for tangibles and intangibles assets. This comes at the cost of introducing some measurement error at the firm level, which explains some negative gross investment ratios.

The other key variable of interest is the debt ratio, which is defined as the ratio of long-term debt and other current liabilities (mainly pension liabilities, accounts payable and trade credit) to total assets.

In the baseline regressions we also control for firms' size, age, profits, sales growth, and interest burden. In addition, we include the country-level cost of borrowing for corporations from the ECB MFI interest rate statistics to control for the cost of capital.

Table 1 – Firm variable definitions

Variable	Definition
Net Tangible Investment	Annual change in tangible fixed assets over previous year's tangible fixed assets (in percent)
Net Intangible Investment	Annual change in intangible fixed assets over previous year's intangible fixed assets (in percent)
Net Total Investment	Annual change in total fixed assets over previous year's total fixed assets (in percent)
Gross Tangible Investment	Annual change in tangible fixed assets plus depreciation over previous year's tangible fixed assets (in percent)
Gross Intangible Investment	Annual change in intangible fixed assets plus depreciation over previous year's intangible fixed assets (in percent)
Gross Total Investment	Annual change in total fixed assets plus depreciation over previous year's total fixed assets (in percent)
Debt Ratio	Ratio of current liabilities plus long-term debt over total assets
Size	Logarithm of total assets
Age	Current year minus the year of incorporation
Interest Burden	Ratio of interest payments to EBITDA
Profitability	Ratio of earnings before interest, taxes, depreciation and amortisations (EBITDA) over total assets
Sales Growth	Annual growth rate of sales

Tables 1 and 2 present the definitions and summary statistics of our regression variables. Overall, there is significant heterogeneity in the variables of interest across firms. While the mean firm in our sample has a net investment rate of 5 percent, the median firm's net investment rate is a negative 7 percent. Firms' debt-to-asset ratio amounts to 70 percent on average.

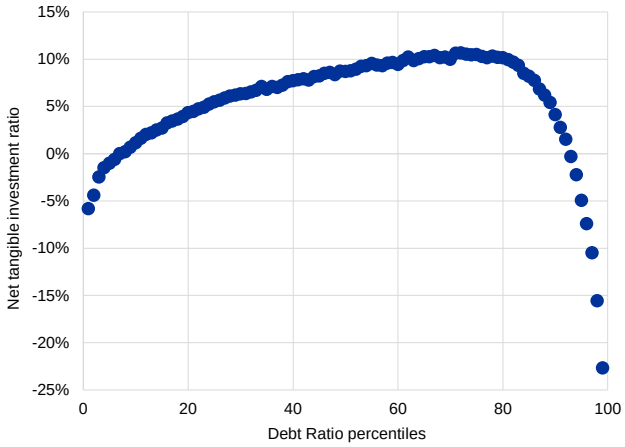
Table 2 – Summary statistics

	P10	P50	P90	Mean	Std. Deviation
Net Total Investment Ratio	-0.40	-0.06	0.67	0.04	0.55
Net Tangible Investment Ratio	-0.42	-0.07	0.74	0.05	0.60
Net Intangible Investment Ratio	-0.92	-0.09	0.48	-0.01	1.23
Gross Total Investment Ratio	-0.28	0.04	0.79	0.17	0.55
Gross Tangible Investment Ratio	-0.33	0.01	0.83	0.14	0.60
Gross Intangible Investment Ratio	-0.65	0.19	0.75	0.27	1.23
Gross Total Investment Ratio	-0.28	0.04	0.79	0.17	0.55
Debt-to-asset Ratio	0.19	0.66	1.03	0.69	0.51
Size (log assets)	10.99	12.95	15.22	13.04	1.66
Age (years)	2.00	11.00	31.00	14.65	13.60
Interest payments (net) to EBITDA	-0.07	0.05	0.46	0.11	0.47
Profitability	-0.06	0.08	0.28	0.09	0.19
Sales Growth	-0.34	0.01	0.50	0.16	1.05

Note: All variables are expressed in real terms using the OECD STAN's price deflators, see Gal (2013). Number of observations: 15,618,397. Note that the number of observations in our empirical exercises below is lower as not all variables are available for all firm-years.

Figure 2 provides a first indication that leverage becomes a constraint for investment beyond certain thresholds. Firms' debt ratios are classified into percentiles of the historical (2005-2018) debt ratio distribution. Percentiles are calculated at the two-digit sectoral level as some sectors (such as construction) have structurally higher debt ratios than other sectors (trade, services). For lower percentiles of debt, any extra degree of leverage is associated with highly positive increase in the investment ratio. As we go along the distribution, this relationship becomes weaker, eventually turning negative at around the 80th percentile of the debt ratio distribution. Interestingly, this hump-shaped curve is consistent across sectors (Figure A1), regions (Figure A2), and size-classes (Figure A3). As such, it is possible to distinguish three types of firms: low-debt firms, which are below the 20th percentile of the debt ratio distribution; medium-debt firms, which are positioned between the 20th and the 80th percentile; and high-debt firms, which record debt ratios above the 80th percentile of the leverage distribution. Throughout the paper, we refer to these groups as low-, medium-, and high-debt firms, respectively.

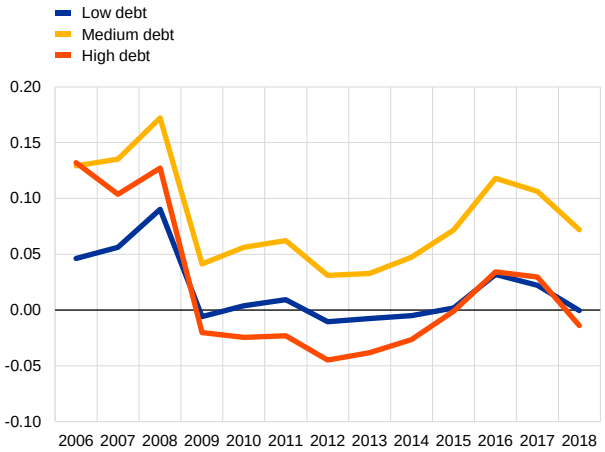
Figure 2 – Debt ratio and net tangible investment



Note: The percentiles of the debt-to-assets ratio are defined at the two-digit sector level for a sample of 14 euro area countries from 2005 to 2018. The investment ratio is defined as the annual change in tangible fixed assets over previous year's tangible fixed assets.

Figure 3 plots net tangible investment over time for the three different types of firms. While the global financial crisis led to large negative effects on investment for all firms, the subsequent recovery was heterogeneous. Even though investment remained below pre-crisis levels for all types of firms, low- and medium-debt firms recovered faster than their high-debt counterparts whose investment ratio turned positive again only in 2015.

Figure 3 – Net tangible investment ratio by firm leverage



Note: Low debt firms are below the 20th percentile of the debt ratio distribution; medium-debt firms are positioned between the 20th and the 80th percentile; and high-debt firms record debt ratios above the 80th percentile of the leverage distribution. The leverage distribution is defined at the sectoral level.

In the following, we investigate whether Figure 2 simply reports a correlation that fades after controlling for country-, sector- and firm-specific characteristics, such as sales, profits, or size. To do so, we run the following OLS regression

$$Investment\ Ratio_{i,t} = \alpha + \beta Debt\ Ratio_{i,t-1} + \boldsymbol{\gamma} \sum_{l \in Debt\ Bins} \mathrm{D}_{l_{i,t-1}} + \boldsymbol{\psi} \sum_{l \in Debt\ Bins} \mathrm{D}_{l_{i,t-1}} \times Debt\ Ratio_{i,t-1} + \boldsymbol{\Omega}\, X_{i,t-1} + \phi Sector\ VA\ growth_{i,t-1} + Country_i + Sector_i + Year_i + u_{i,t} \quad (1)$$

where Investment Ratio refers to the net tangible investment ratio, and $Debt\ Bins \in$ {low-debt, high-debt}, $D_l = 1$ if the firm belongs to debt bin l and $D_l = 0$ otherwise. The reference group is medium-debt firms. We add a vector of covariates X_i that includes firm profitability, size, age, interest burden, sales growth and the country-specific lending rate to corporations. We furthermore include controls for country-, two-digit-sector-, and year-fixed effects to account for potential correlation between country- or sector-specific characteristics and regressors, and to take macroeconomic factors into account. We lag all time-varying right-hand-side variables by one year to address endogeneity concerns.

Note that, as in equation (1), we do not control for firm-specific fixed effects. The inclusion of firm fixed-effects would risk confounding our key coefficient of interest, $\boldsymbol{\beta}$, as firm' debt bins, D_l, have little time variation. However, the rich set of firm-specific controls coupled with the country-, two-digit sector-, and year-fixed effects mitigate concerns about individual unobserved heterogeneity.

The results in Table 3 confirm the unconditional correlations and highlight the importance of accounting for different debt bins. The first column estimates the average impact of leverage on investment (that is, without considering different debt bins), suggesting a negative relationship between debt and investment. Column 2 allows for the elasticity of investment to leverage to vary for highly leveraged firms relative to the rest of firms and column 3 distinguishes between low-, medium- and high-debt firms. The results support the view that firm's leverage ratio affects its investment in a non-linear way. The results are also economically significant. While firms with moderate debt levels increase their investment by 1.76 to 2.59 pp in the year after a 1 pp increase in the debt ratio, high-debt firms decrease it by 2.96 to 3.29 percentage points (Table 3).

Table 3 – OLS regression results

	(1)	(2)	(3)
Debt Ratio	-.0125***	.0259***	.0176***
	(.0006)	(.0009)	(.0016)
High-debt = 1		.0318***	.0263***
		(.0016)	(.0018)
High-debt x Debt Ratio		-.0585***	-.0505***
		(.0015)	(.0019)
Low-debt = 1			-.0140***
			(.0015)
Low-debt x Debt Ratio			.0399***
			(.0047)
Sector Value Added Growth	.0325**	.0325**	.0325**
	(.0103)	(.0102)	(.0103)
Profits	.2690***	.2588***	.2578***
	(.0016)	(.0016)	(.0016)
Sales Growth	.0004**	.0004**	.0004**
	(.0001)	(.0001)	(.0001)
Size	.0061***	.0053***	.0054***
	(.0001)	(.0001)	(.0001)
Age	-.0013***	-.0013***	-.0013***
	(.0002)	(.0002)	(.0002)
Lending Rate	-2.1261***	-2.1011***	-2.1001***
	(.0533)	(.0533)	(.0533)
Interest Burden	4.95e-07	4.63e-07	4.66e-07
	(6.04e-07)	(6.15e-07)	(6.14e-07)
Constant	.0431***	.0332***	.0387***
	(.0028)	(.0028)	(.0030)
R-squared	.0269	.0271	.0271
Observations	13,210,039	13,210,039	13,210,039
Country FE	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: Dependent variable: net tangible investment ratio. Standard errors clustered at the firm-level. The reference group is the medium-debt bin. Sector value added growth defined for the 2-digit level aggregation available in Eurostat National Accounts. Standard errors in brackets. * p < 0.1; ** p < 0.05; *** p < 0.01.

3. Empirical Methodology and Results

3.1. Aggregate impact and heterogeneous effects of debt

In the next step, we estimate the dynamic effects of firms' debt ratio on corporate investment in the aftermath of large economic shocks. The objective is to analyse how investment evolves

after boom and after bust periods. To do this, we resort to panel regressions using the local projections framework developed by Jordà (2005) and recently applied by Cloyne et al. (2018), Jeenas (2019) and Ottonello and Winberry (2020) in a similar context.

We start by assessing whether positive and negative shocks have a symmetric impact on investment. In this first exercise we pool all firms together. The estimated equation is as follows:

$$\Delta_h y_{i,t+h} = \alpha + \psi_1 \varepsilon_{P_t} + \psi_2 \varepsilon_{N_t} + \boldsymbol{\Omega X}_{i,\,t-1} + Country_i + Sector_i + Year_i + u_{i,t+h} \qquad (2)$$

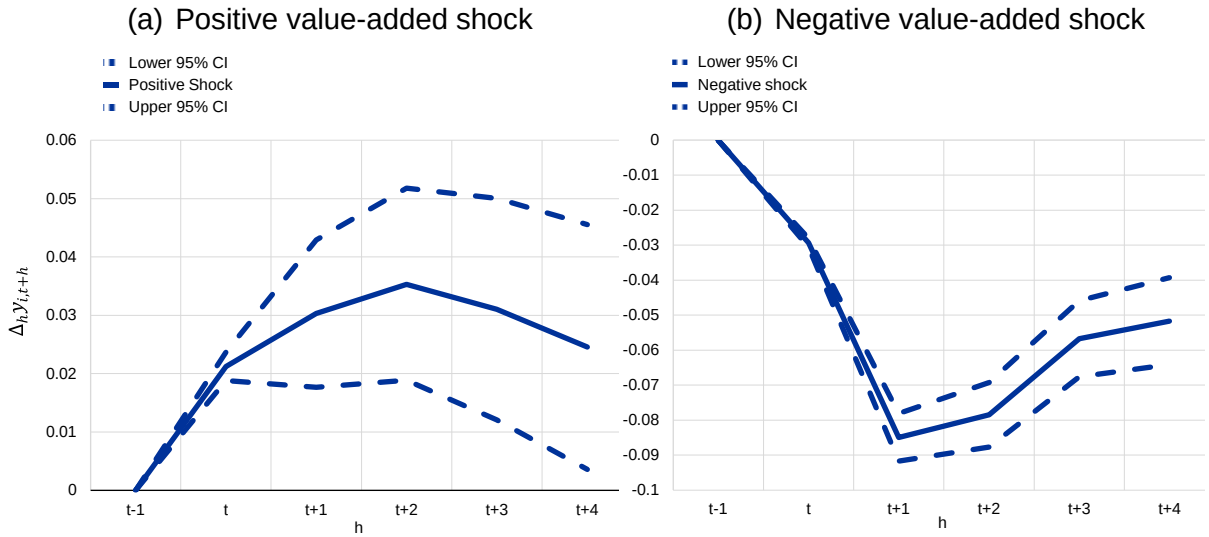
with $h = 0, \ \ldots, 4 \ and \ \Delta_h \, y_{i,t+h} \equiv \frac{K_{t+h} - K_{t-1}}{K_{t-1}}$, with K_t being tangible fixed assets. The two shock variables,ε_{N_t} and ε_{P_t}, are dummy variables that capture negative or positive shocks to economic activity, respectively, with $\varepsilon_{N_t}(\varepsilon_{P_t})$ equalling one if the two-digit sector value added growth is inferior to (exceeds) the country-sector-specific average historical (2005-2018) value-added growth by 1.5 standard deviations (see Tables A4 and A5 for summary statistics of value-added growth). The choice of magnitude of the shock is based on two criteria: i) our shock variable should capture only the largest changes in value added; and ii) there should be sufficient variability across countries, years and sectors. In Table A6 we show three different options considered and their respective impact on the number of firms affected by a shock in each year. The choice of 1.5 standard deviations from the average reflects the optimisation of the above criteria.

The vector of control variables, $\boldsymbol{X}_{i,t-1}$, and the fixed effects structure follow equation (1). Standard errors are clustered at the firm-level to account for time dependence of individual-level standard errors, following Jordà (2005) and Jordà et al. (2015).

Figure 4 shows the estimated impulse-response function. Investment peaks two years after a positive shock and troughs one year after a negative shock. The impact of a negative shock on investment is twice as strong in absolute terms than the corresponding effect for positive shocks. Four years after the shock, tangible capital has decreased by more than five percent in case of a negative shock while it has increased by 2.5 percent after a positive economic shock.[2]

[2] For the specification with firm fixed effects, see Figure A4 in the Appendix.

Figure 4 – Baseline model of investment without debt bins



Note: This figure shows the impulse response functions for the response of cumulative net tangible fixed asset growth following a positive (panel a) and a negative (panel b) activity shock. A positive (negative) shock to economic activity is defined by a rise (fall) in the two-digit sector value added growth that exceeds its country-sector-specific historical average by 1.5 standard deviations. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level.

In the following step, we extend equation (2) to investigate the impact of positive and negative activity shocks on investment depending on firm leverage. Specifically, the equation, estimated by OLS, is as follows:

$$\Delta_h y_{i,t+h} = \alpha + \psi_1 \varepsilon_{P_t} + \psi_2 \varepsilon_{N_t} + \boldsymbol{\beta} \sum_{l \in Debt\ Bin} \mathrm{D}_{l_{i,t-1}} + \boldsymbol{\gamma_1} \sum_{l \in Debt\ Bin} \mathrm{D}_{l_{i,\,t-1}} \times \varepsilon_{P_{i,t}} + \boldsymbol{\gamma_2} \sum_{l \in Debt\ Bin} \mathrm{D}_{l_{i,\,t-1}} \times \varepsilon_{N_{i,\,t}} + \boldsymbol{\Omega X}_{i,\,t-1} + Country_i + Sector_i + Year_i + u_{i,t+h} \quad (3)$$

with $h = 0, \ldots, 4$ and $\Delta_h\, y_{i,t+h} \equiv \frac{K_{t+h} - K_{t-1}}{K_{t-1}}$, with K_t being tangible fixed assets.

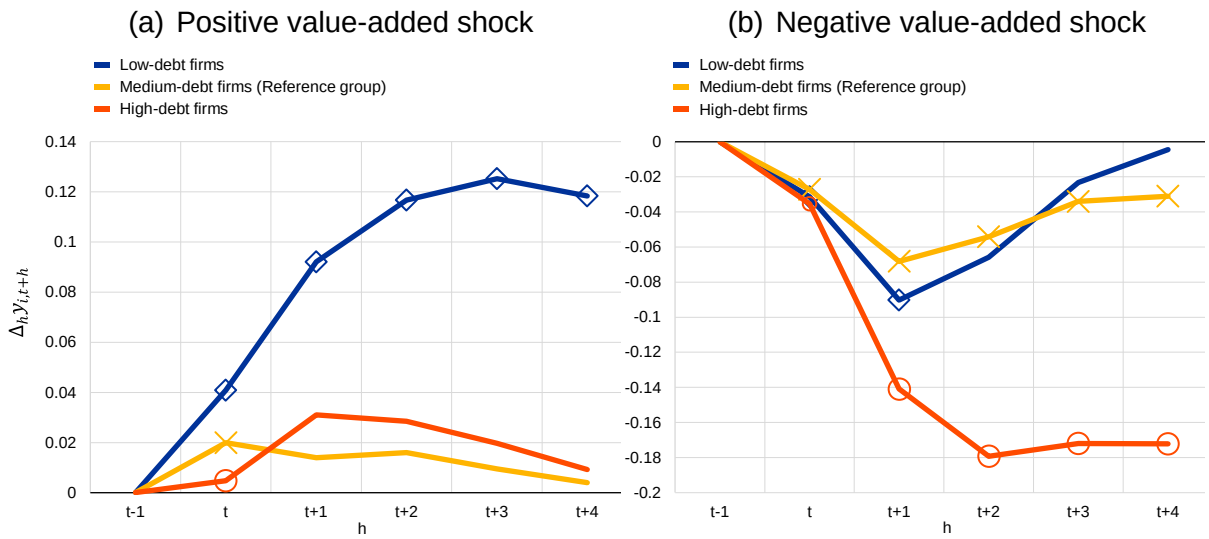
Similar to equation (1), we include dummy variables for low-, medium-, and high-debt firms, which we interact with the value-added shocks to analyse the impact of leverage on firm's investment response in the post-shock period.

The coefficients of interest are $\psi_1, \psi_2, \boldsymbol{\gamma_1}$ and $\boldsymbol{\gamma_2}$. The first two inform about the direct effects of positive and negative value-added shocks on investment of medium-debt firms (the reference group). The coefficients $\boldsymbol{\gamma_1}$ and $\boldsymbol{\gamma_2}$ show whether the investment impact of shocks is significantly different for high- and low-debt firms respectively, relative to medium-debt firms.

The impulse responses in Figure 5 provide evidence that firms' debt ratio strongly influences the investment response after both positive and negative activity shocks. In the four years after

a positive activity shock, low-debt firms increase capital expenditure by 12 percent. By contrast, high- and medium-debt firms record only a short-lived increase in investment, with tangible assets reverting to their initial levels four years after the shock. This indicates that while firms with moderate debt levels potentially make use of unused borrowing capacities to engage in further investment, high debt liabilities depress investment activity in a prolonged manner.

Figure 5 – Baseline model of investment with debt bins



Notes: This figure shows the impulse response functions for the response of cumulative net tangible fixed assets growth following a positive (panel a) and negative (panel b) activity shock. A positive (negative) shock to economic activity is defined by a rise (fall) in the two-digit sector value added growth that exceeds its country-sector-specific historical average by 1.5 standard deviations. Low debt firms are defined as firms in the bottom 20th percentile of the debt ratio distribution, medium-debt firms are firms between the 20th and the 80th percentile and high debt firms are firms standing above the 80th percentile of this distribution. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level. A cross represents a statistically significant coefficient different from zero at 90% confidence. Diamonds and circles represent statistically significant coefficients (90% confidence) vis-à-vis the reference group.

After a negative shock, the capital stock of high debt firms shrinks by almost one fifth after four years. By contrast, low- and medium-debt firms suffer only an initial drop in capital that is almost fully recovered after four years. In principle, one explanation for the more resilient response of low- and medium-debt firms could be that low- and medium-debt firms have larger cash holdings to withstand the shock. However, the above findings are confirmed when we replace in equation (3) gross debt with net debt, defined as gross debt minus cash holdings (Figure A5).

Note that these estimates suffer from a possible survivorship bias, and therefore represent a lower bound, given that they only capture the impact along the intensive margin, but excludes the possible impacts due to the exit of high-leveraged firms from the market.

3.2. Effect of firm size and country

In the next step, we explore whether our above findings hold across firm sizes and country groups.

We start with firm size differences, distinguishing between i) micro, ii) small and medium and iii) large firms. Large firms are those with more than EUR 43 million in total assets; small and medium firms are those whose total assets exceed EUR 2 million but do not exceed EUR 43 million; and micro firms have total assets of no more than EUR 2 million.[3]

We build on equation (2) and add a three-way interaction between activity shock, debt bin and size-class. The equation then becomes:

$$\begin{aligned}\Delta_h y_{i,t+h} = \alpha + \psi_1 \varepsilon_{P_t} + \psi_2 \varepsilon_{N_t} + \boldsymbol{\beta} \sum_{l \in Debt\ Bin} \mathrm{D}_{l_{i,t-1}} + \boldsymbol{\gamma_1} \sum_{l \in Debt\ Bin} \mathrm{D}_{l_{i,\,t-1}} \times \varepsilon_{P_{i,t}} \\ + \boldsymbol{\gamma_2} \sum_{l \in Debt\ Bin} \mathrm{D}_{l_{i,\,t-1}} \times \varepsilon_{N_{i,\,t}} \\ + \boldsymbol{\phi} \sum_{k \in Size\ Class} \mathrm{S}_{k_{i,t-1}} + \boldsymbol{\theta_1} \sum_{k \in Size\ Class} \sum_{l \in Debt\ Bin} \mathrm{D}_{l_{i,\,t-1}} \times S_{k_{i,t-1}} \times \varepsilon_{P_{i,t}} \\ + \boldsymbol{\theta_2} \sum_{k \in Size\ Class} \sum_{l \in Debt\ Bin} \mathrm{D}_{l_{i,\,t-1}} \times S_{k_{i,t-1}} \times \varepsilon_{N_{i,t}} + \boldsymbol{\Omega X}_{i,\,t-1} + Country_i + Sector_i \\ + Year_i + u_{i,t+h} \end{aligned} \tag{3}$$

where $Size\ Class \in \{\text{Small and Medium, Large}\}$ and $Debt\ Bin \in \{\text{Low-debt, High-debt}\}$.

As we are mostly interested in the implications of the COVID-19 crisis, we focus in the following on negative shocks. The results for positive shock are in the appendix (Figures A6 to A8).

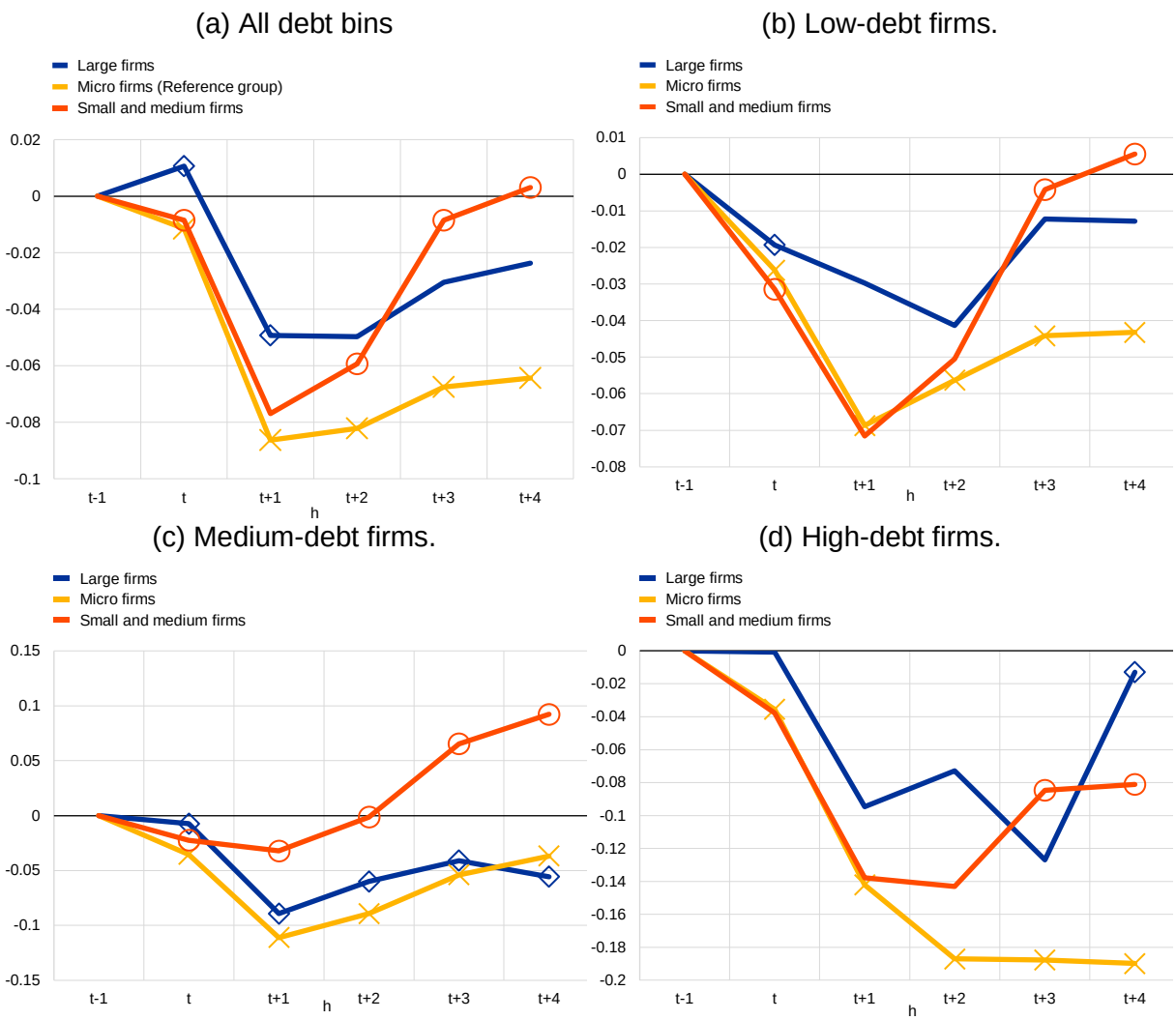
We estimate equation (3) first without and then with taking into account the debt ratio of firms in different size classes. This allows us to disentangle the impact of size from that of the debt ratio in the firm's investment response. The idea is to understand how firms across the size distribution react to activity shocks, and if these reactions depend on debt levels.

From panel a) in Figure 6, it becomes evident that micro firms drive the aggregate results of Figures 4 and 5. The capital stock of micro firms decreases by 6 percent in the four years following a negative shock. The corresponding reactions of small and medium firms as well as large firms are non-negligible but more muted. The differences between micro firms and their peers are even more pronounced when restricting the sample to high debt firms. Highly-

[3] This definition is closely aligned with EU classification but uses only the asset criterion due to data availability reasons. See Official Journal of the European Union – "Commission Recommendation of 6 May 2003 concerning the definition of micro, small, and medium-sized enterprises"

indebted micro firms reduce their capital by close to one fifth in the four years after a shock, which compares to some eight percent in the case of small and medium-sized firms and less than two percent for large firms.

Figure 6 – Baseline model by firm size



Notes: This figure shows the impulse response functions for the response of cumulative net tangible fixed assets growth following a negative activity shock. A negative shock to economic activity is defined by a fall in the two-digit sector value added growth that exceeds its country-sector-specific historical average by 1.5 standard deviations. Low debt firms are defined as firms in the bottom 20th percentile of the debt ratio distribution, medium-debt firms are firms between the 20th and the 80th percentile and high debt firms are firms standing above the 80th percentile of this distribution. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level. A cross represents a statistically significant coefficient different from zero at 90% confidence. Diamonds and circles represent statistically significant coefficients (90% confidence) vis-à-vis the reference group. Micro firms are those with total assets lower than EUR 2m; small and medium firms are those with total assets larger than EUR 2m and lower than EUR 43m; large firms are those with total assets exceeding EUR 43m.

In the following, we analyse cross-country differences in the investment response to negative activity shocks. We split our sample in three country groups based on geographical considerations and re-estimate equation (2) for each region. The three groups are Northern and Central European economies (Austria, Belgium, Germany, France, Ireland, Netherlands and Finland), Southern European economies (Greece, Spain, Italy and Portugal) and Eastern European economies (Estonia, Slovenia and Slovakia).

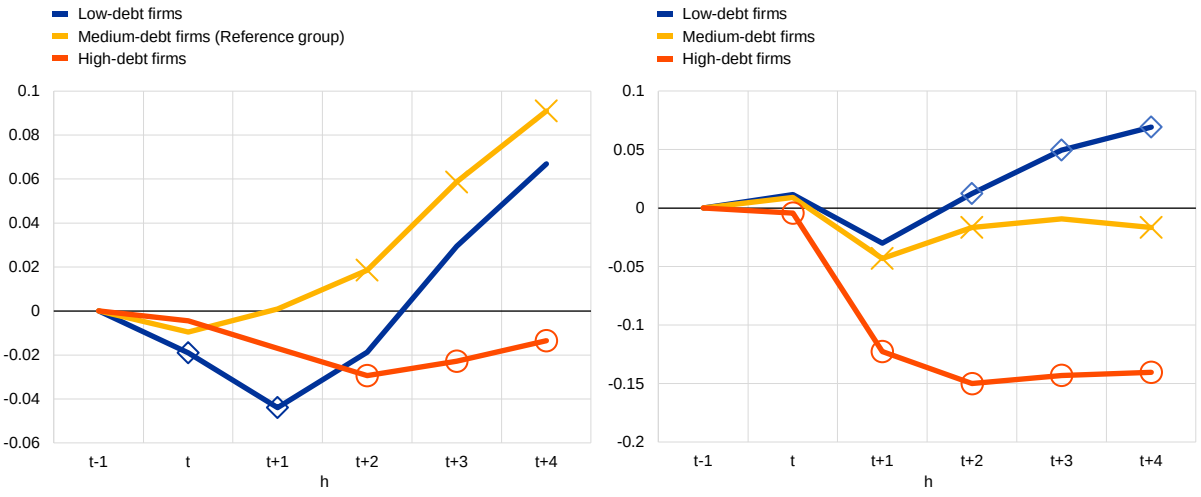
There are significant differences across countries in terms of the magnitude and persistence of the investment effects after a negative shock. High debt firms in Southern and Eastern European countries record a more pronounced and protracted fall in investment than their peers in Northern and Central Europe (Figure 7).

This suggests an interesting link to the literature on zombie firms, defined as non-viable but still operating firms with high levels of debt and negative profitability. There is evidence that zombie firms are more relevant in Southern European than in Northern Europe (Adalet McGowan et al. 2017) which is, inter alia, associated with the role of distressed banks that roll over loans to non-viable firms rather than writing them off in a gamble for resurrection (Storz et al. 2017, Andrews and Petroulakis 2019). Such evergreening of loans is not associated with the financing of new capital. Instead, as shown by Banerjee and Hofmann (2022), zombie firms record lower investment than non-zombie firms.

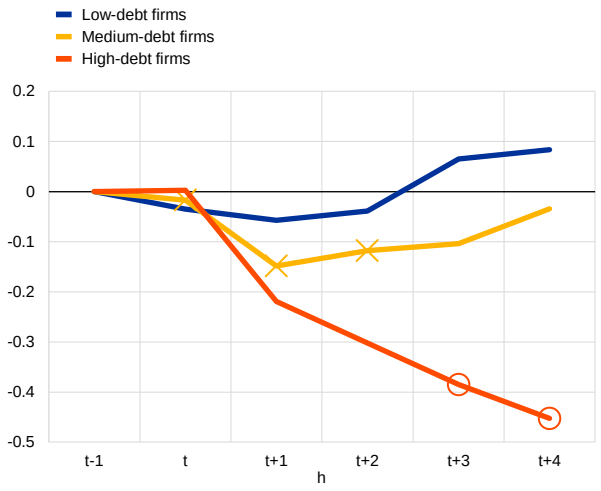
Figure 7 – Baseline model by country groups

(a) Northern and Central European countries.

(b) Southern European countries.



(c) Eastern European countries

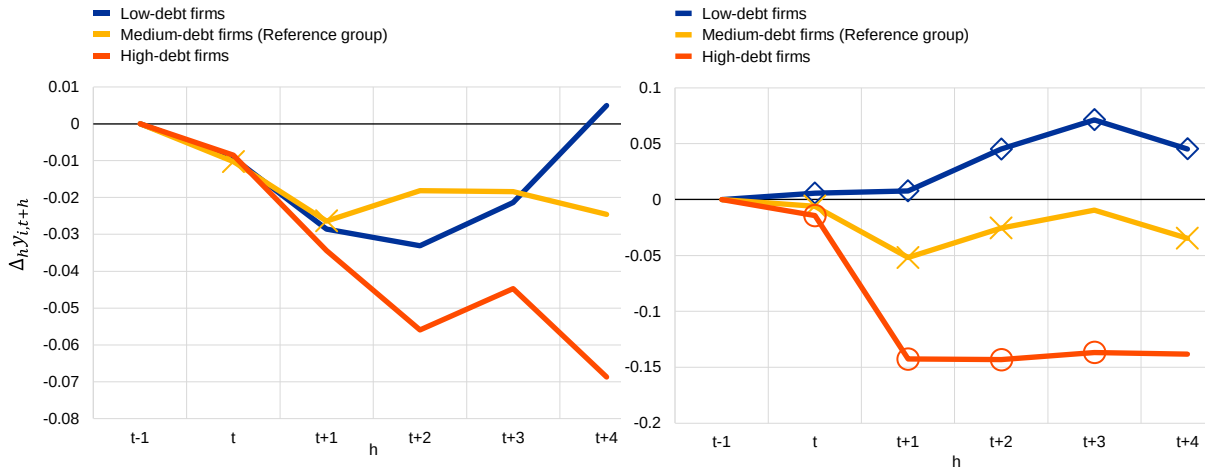


Notes: The figure shows the impulse response functions for the response of cumulative net tangible fixed assets growth following a negative activity shock. A negative shock to economic activity is defined by a fall in the two-digit sector value added growth that exceeds its country-sector-specific historical average by 1.5 standard deviations. Low debt firms are defined as firms in the bottom 20th percentile of the debt ratio distribution, medium-debt firms are firms between the 20th and the 80th percentile and high debt firms are firms standing above the 80th percentile of this distribution. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level. A cross represents a statistically significant coefficient different from zero at 90% confidence. Diamonds and circles represent statistically significant coefficients (90% confidence) vis-à-vis the reference group. A cross represents a statistically significant coefficient different from zero at 90% confidence. Northern and Central European countries: AT, BE, DE, FR, IE, NL and FI. Southern European countries: EL, ES, IT and PT. Eastern European countries: EE, SI and SK.

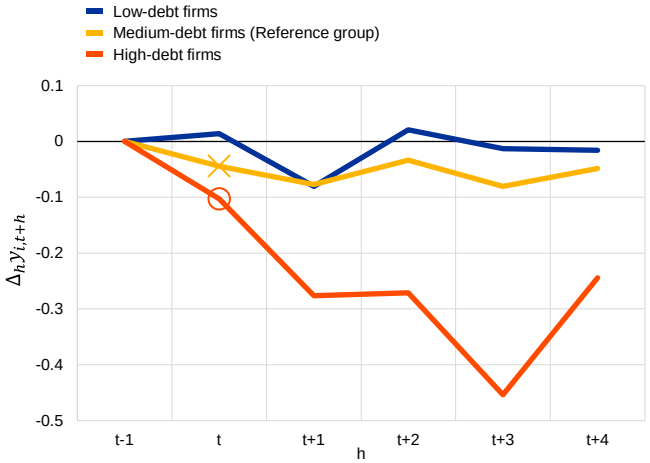
Another explanation could be that the firm composition in Southern and Eastern European countries is biased towards smaller, more financially distressed companies (Table A7). The depressed investment activity of highly indebted firms in Southern and Eastern European countries could stem from a higher share of micro firms in these countries. To better understand if the cross-country differences in investment are driven by differences in firm size, we rerun equation (2) without micro firms for all country groups. The results suggest that regional differences shrink somewhat if micro firms are excluded (Figure 8). This notwithstanding, Southern European countries still record a much more depressed investment response to an activity shock for high-debt firms than for firms with low or medium debt. This suggest that not only firm size but also other structural features are important to explain cross-country differences.

Figure 8 – Baseline model by country group and without micro firms

(a) Northern and Central European countries. (b) Southern European countries



(c) Eastern European countries



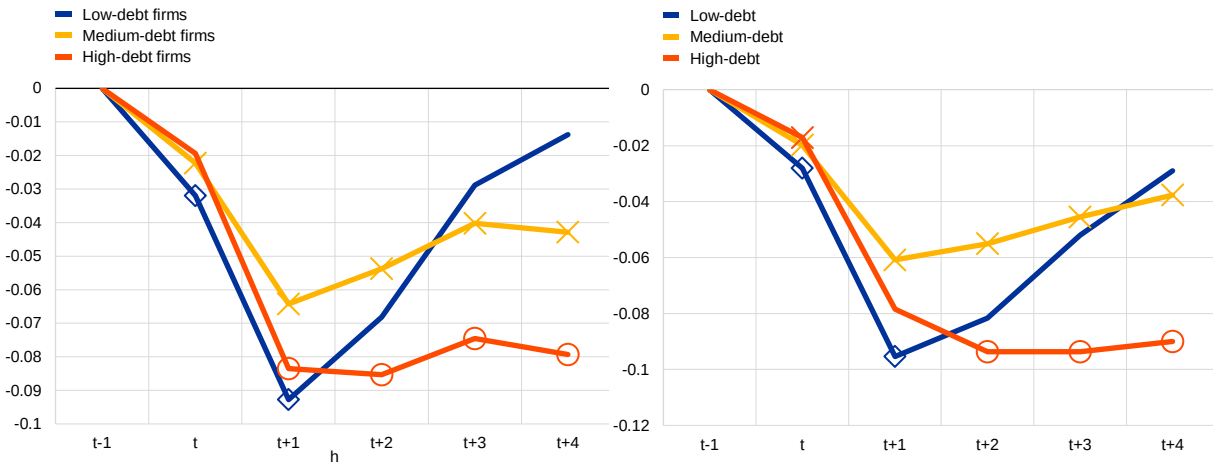
Notes: This figure shows the impulse response functions for the response of cumulative net tangible fixed assets growth following a negative activity shock. A negative shock to economic activity is defined by a fall in the two-digit sector value added growth that exceeds its country-sector-specific historical average by 1.5 standard deviations. Low debt firms are defined as firms in the bottom 20th percentile of the debt ratio distribution, medium-debt firms are firms between the 20th and the 80th percentile and high debt firms are firms standing above the 80th percentile of this distribution. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level. A cross represents a statistically significant coefficient different from zero at 90% confidence. Diamonds and circles represent statistically significant coefficients (90% confidence) vis-à-vis the reference group. Northern and Central European countries: AT, BE, DE, FR, IE, NL and FI. Southern European countries: EL, ES, IT and PT. Eastern European countries: EE, SI and SK.

3.3. Sensitivity analysis

This section analyses the robustness of our main findings to alternative definitions of investment and a different computation of the activity shock.

We first discuss the robustness of our results to other types of investment. Specifically, we replace net tangible fixed assets in equation (2) with a) net total fixed assets, and b) gross total fixed assets. Furthermore, we provide in the appendix results using intangible fixed assets (see Figure A9).

Figure 9 – Alternative investment definition (negative shock)



(a) net total investment (b) gross total investment

Notes: This figure shows the impulse response functions for the response of cumulative net fixed assets growth (panel a) and gross total investment (panel b) following a negative activity shock. A negative shock to economic activity is defined by a fall in the two-digit sector value added growth that exceeds its country-sector-specific historical average by 1.5 standard deviations. Low debt firms are defined as firms in the bottom 20th percentile of the debt ratio distribution, medium-debt firms are firms between the 20th and the 80th percentile and high debt firms are firms standing above the 80th percentile of this distribution. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level. A cross represents a statistically significant coefficient different from zero at 90% confidence. Diamonds and circles represent statistically significant coefficients (90% confidence) vis-à-vis the reference group.

In both cases, results are similar to the baseline, with high-debt firms showing the most protracted negative investment reaction. The initial investment response of low-debt firms is more adverse than in the baseline, however these firms' investment recovers the fastest, returning almost to their previous capital level at t+4, similar to the baseline. (See Figure A10 in the appendix for the investment response to a positive shock.)

One concern with our baseline specification might be that the link between value added and investment might not be straightforward as investment could lead to periods of high or low value-added growth. While in equation (2) we lag all our control variables for this purpose, it cannot be taken for granted that our shocks, ε_P and ε_N are uncorrelated with the error term.

To address these endogeneity concerns, we propose in this section an alternative definition of activity shocks that captures the exogenous cyclical variation of a sector using input-output

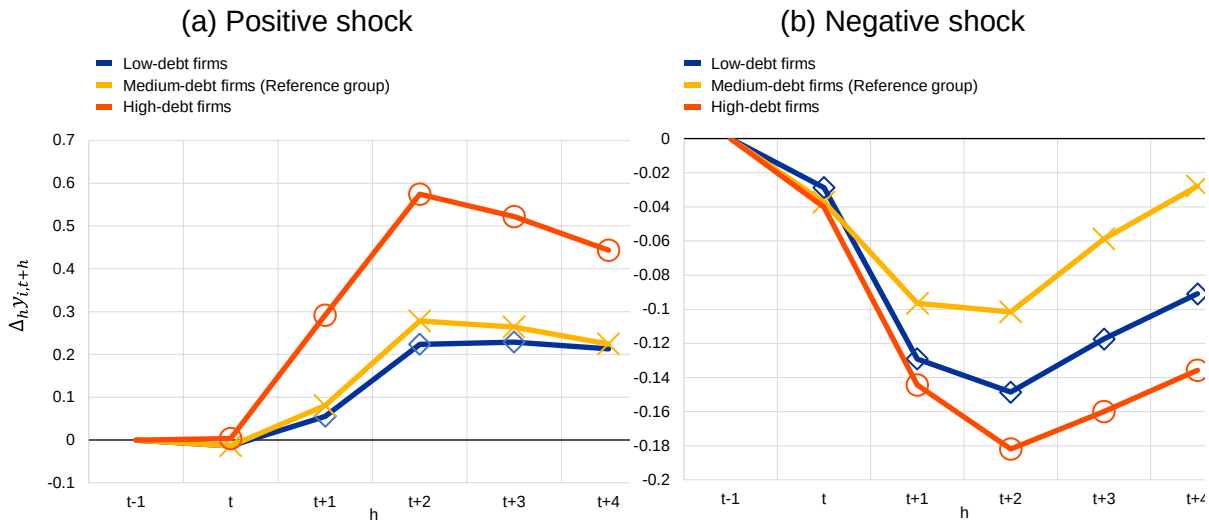
tables (see Shea 1993 and applied in Bartelsman, Caballero, and Lyons 1994 and Bartelsman, Lopez-Garcia, and Presidente 2018). We identify exogenous changes in the cyclical position of a sector by calculating changes in downstream sectors' demand for each ISIC Revision 4 sector using the OECD's Inter-Country Input-Output tables (OECD 2021). In line with the literature, and to address potential endogeneity concerns, we remove any downstream sector that contributes more than one percent to a given sector's inputs.[4]

As such, the total demand for sector i is given by

$$Total\ Demand_i = \sum_{j \in J} Intermediate\ Demand_{j,i} + Final\ Expenditure_i \qquad (4)$$

where J is the set of sectors that do not contribute with more than 1% to sector i's inputs. The subscript j,i indicates that sector j demands from sector i.

Figure 10 – Alternative activity shock



Notes: This figure shows the impulse response functions for the response of cumulative net tangible fixed assets growth following a positive (panel a) and negative (panel b) activity shock. A positive (negative) shock to economic activity is defined by a rise (fall) in the sector's demand that exceeds its country-sector-specific historical average by 1.5 standard deviation. Demand is defined by the output of a given sector to its downstream sectors. Low debt firms are defined as firms in the bottom 20th percentile of the debt ratio distribution, medium-debt firms are firms between the 20th and the 80th percentile and high debt firms are firms standing above the 80th percentile of this distribution. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level. A cross represents a statistically significant coefficient different from zero at 90% confidence. Diamonds and circles represent statistically significant coefficients (90% confidence) vis-à-vis the reference group.

[4] Note that the sectoral disaggregation of this measure is less granular than our baseline measure. This implies that we need to pool several sectors together and lose information on the cyclical position of each sector. For this reason, we do not use the approach described in this section as our main measure.

Equation (4) allows to define yearly changes in total demand for each country-sector and thus provides an indicator of exogenous changes in sector demand. We then define our activity shocks as above. A positive (negative) shock occurs whenever demand exceeds (falls below) 1.5 standard deviation from the country-sector's historical (2005-2018) average. Finally, we run equation (2) using these alternative shocks. The results in Figure 10 highlight the robustness of the findings. While investment decreases across all types of firms, high-debt firms record the strongest and most sustained decline.

4. Implications for the recovery from the COVID-19 pandemic

The above findings can be applied to provide a tentative assessment on the medium-term impact of the COVID-19 shock on corporate investment. The COVID-19 shock led to a drop in euro area value added of around 6.5% from 2019 to 2020. This compares with a drop in value-added of 5.3% during the global financial crisis from 2008 to 2009.

We base our calculation of the potential investment impact of the COVID-19 shock on equation (2), but redefine negative and positive activity shocks, now labelled φ_N and φ_P, as the standardised annual change in sector value-added.

$$\Delta_h y_{i,t+h} = \alpha + \psi_1 \varphi_{P_t} + \psi_2 \varphi_{N_t} + \boldsymbol{\beta} \sum_{l \in Debt\ Bin} \mathrm{D}_{l_{i,t-1}} + \boldsymbol{\gamma_1} \sum_{l \in Debt\ Bin} \mathrm{D}_{l_{i,\,t-1}} \times \varphi_{P_{i,t}} + \boldsymbol{\gamma_2} \sum_{l \in Debt\ Bin} \mathrm{D}_{l_{i,\,t-1}} \times \varphi_{N_{i,\,t}} + \boldsymbol{\Omega X}_{i,\,t-1} + Country_i + Sector_i + Year_i + u_{i,t+h} \quad (5)$$

This definition allows us to extract the elasticity of a one standard deviation change in value-added on investment. Table 4 shows the resulting elasticities by firm type for period $t+4$. After running this regression and obtaining the elasticities, $\boldsymbol{\gamma_1}$ and $\boldsymbol{\gamma_2}$, we apply the normalised change in value-added in 2020[5] to these elasticities.

Table 4 – Investment elasticities to COVID shock

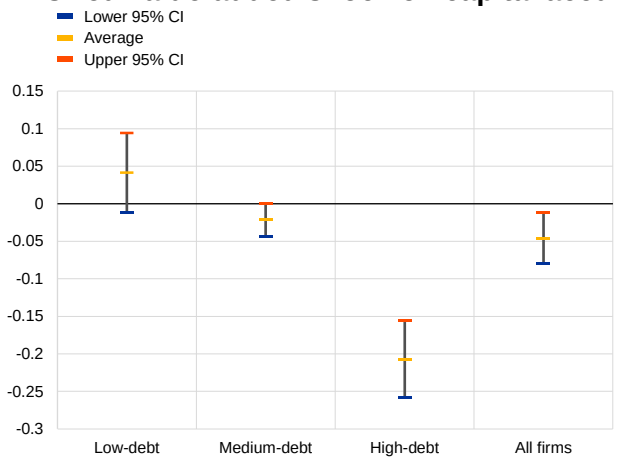
Dep. variable: $\boldsymbol{\Delta y_{t+4}}$	Lower 95% CI	Average	Upper 95% CI
$\boldsymbol{\varphi_{N_t}} \times \mathrm{D}_{\text{Low-debt}_{\boldsymbol{t-1}}}$	-0.0048	0.0132	0.0302
$\boldsymbol{\varphi_{N_t}} \times \mathrm{D}_{\text{Medium-debt}_{\boldsymbol{t-1}}}$	-0.0140	-0.0069	0.0002
$\boldsymbol{\varphi_{N_t}} \times \mathrm{D}_{\text{High-debt}_{\boldsymbol{t-1}}}$	-0.0828	-0.0666	-0.0503

Note: The elasticities are calculated based on equation (5).

[5] According to Eurostat national account data, and taking value-added data from 1995 to 2020, the standardised annual change in value-added in 2020 was 3.11 standard deviations.

Figure 11 shows the range of results which suggest a decrease in capital for all firms of around 5% by 2024 compared to 2019. The drop stems mostly from the large fall in investment of high-debt firms, which are estimated to reduce their capital by one fifth over this period. By contrast, low-debt firms show a stronger resilience to the shock and increase their capital.

Figure 11 –COVID-sized value-added shock on capital accumulation in 2024



Notes: Results based on equation (5) and investment elasticities of Table 4.

Overall, these computations should be interpreted with caution due to their rather mechanical nature. In particular, this exercise does not explicitly consider general equilibrium issues, such as the impact of economic policies in laying the ground for the recovery, changes in the distribution of debt across firms, or other factors that might influence the post-COVID-19 investment path, including those related to the Russian war in Ukraine. Note also that equation (5) does not account for the rising debt ratio as a result of the pandemic but conditions on the initial debt ratio.

5. Conclusions

This paper provides new evidence on the relationship between corporate debt and investment. Based on firm-level data for fourteen euro area countries, our empirical analysis shows that high leverage impedes investment in the years following a large economic contraction. The negative investment impact of high leverage is highly robust across different specifications. It is observed for micro and, to a lower extent, for small and medium firms (which amount to 99 percent of firms in our weighted sample). Large firms are more resilient to economic shocks, suggesting that financial constraints related to debt overhang play a less important role for large firms.

We also find considerable cross-country heterogeneity. Highly indebted firms in Southern and Eastern Europe record significantly lower investment after a negative economic shock than their peers in Northern Europe. Our results are largely unaffected if we use alternative definitions of investment and are also qualitatively similar if we apply different computation of economic shocks.

Our findings suggest that high corporate leverage could deter investment in the years after the COVID-19 shock. A failure to address the high leverage of micro, small and medium sized firm could negatively affect the capacity of the corporate sector to pursue the large-scale investment needs over coming years, related inter alia to promote the green and digital transitions, increase energy security, and support more diversified supply chains. The strains on firm balance sheets put a premium on policies that promote larger equity buffers in the corporate sector. Governments would need to ensure timely debt restructurings for viable firms, and the implementation of efficient liquidation procedures to address concerns about debt overhang and to ensure that resources are not misallocated to unviable firms (Nicoletti et al. 2022).

Our analysis does not take a stance on whether the negative impact of high debt on investment is due to demand or supply effects. The literature identifying the role of credit conditions on firm investment suggests that banking shocks to the supply of credit can have large effects on corporate investment (Amiti and Weinstein 2013). Our finding that investment decisions by large firms are less restrained by high leverage suggests that large firms have better access to alternative financing sources and are thus less vulnerable to adverse effects of bank shocks on investment. From a structural point of view, diversification across alternative sources of financing could thus make an important contribution for SMEs to the resilience of investment against real shocks.

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Appendix

Construction of the dataset

We performed the following balance sheet tests to account for data irregularities, largely drawing on Gopinath et. al (2017).

- Drop observations for which the ratio between total liabilities and total assets is above 1.02 or below 0.98.
- Drop observations for which tangible, intangible or total fixed assets are below zero.
- Drop observations for which tangible fixed assets exceed total fixed assets.
- Drop observations for which the sum of tangible, intangible and other fixed assets exceeds total fixed assets by more than 20%.
- Drop observations for which the ratio of employees per million assets and sales per million assets falls above the 99.9th percentile or below the 0.1st percentile.
- Whenever a variable was missing for a given firm and year, but lagged and forward values were available, the missing value was imputed by the average of the forward and lagged value. The same procedure was applied if the gap was of two years.

Table A1 – Coverage relative to Eurostat

	Number of firms	Total fixed assets
AT	56%	90%
BE	54%	84%
DE	35%	69%
EE	20%	43%
ES	30%	65%
FI	22%	50%
FR	36%	60%
GR	9%	53%
IE	8%	46%
IT	43%	64%
NL	12%	80%
PT	92%	93%
SI	27%	55%
SK	43%	35%

Source: ORBIS-iBACH and Eurostat
Note: The total fixed asset series were extracted by one-digit NACE Rev.2 sectors from Eurostat's National Accounts (Eurostat Annual National Accounts – Breakdowns of non-financial assets by type, industry and sector – Cross-classification of fixed assets by industry and by assets (stocks)). Since Eurostat only provides current and previous year replacement costs, a volume series was constructed using chain-linking. To complete the dataset, EUKLEMS 2019 data on real capital was used (https://euklems.eu/). Due to the lack of coverage for Portugal in both of these datasets, data for Portugal was taken from the OECD's STAN 2020 edition (https://www.oecd.org/sti/ind/stanstructuralanalysisdatabase.htm). Remaining missing values were interpolated.

Table A2 – Distribution of Total Fixed Assets in sample and Eurostat

	Manufacturing			Utilities & Construction			Trade & Transport		
	Unweighted Sample	Weighted Sample	Eurostat	Unweighted Sample	Weighted Sample	Eurostat	Unweighted Sample	Weighted Sample	Eurostat
AT	18.3%	24.1%	23.9%	30.0%	22.7%	22.8%	28.4%	31.2%	31.4%
BE	16.0%	25.1%	25.7%	21.7%	15.4%	15.3%	35.4%	39.18%	38.8%
DE	27.3%	30.2%	30.4%	24.8%	20.3%	20.5%	24.1%	24.5%	24.2%
EE	17.5%	23.1%	22.9%	38.7%	27.1%	26.9%	31.7%	32.0%	31.9%
ES	21.3%	17.7%	18.2%	31.0%	40.5%	39.1%	26.1%	25.5%	25.8%
FI	24.2%	40.3%	40.4%	40.8%	24.5%	24.5%	19.9%	20.2%	20.2%
FR	30.9%	28.0%	28.3%	18.2%	19.2%	19.3%	26.7%	21.7%	21.6%
GR	24.4%	13.5%	13.6%	10.6%	18.4%	18.3%	40.2%	40.9%	40.6%
IE	22.3%	16.8%	25.5%	12.0%	16.7%	16.8%	16.4%	20.4%	20.5%
IT	30.6%	28.1%	28.1%	23.8%	20.1%	20.1%	28.7%	30.0%	30.1%
NL	41.4%	31.4%	31.7%	15.8%	18.4%	18.7%	18.8%	28.7%	28.9%
PT	25.0%	20.9%	21.1%	24.7%	23.7%	24.3%	30.9%	33.6%	32.6%
SI	29.6%	31.6%	31.8%	17.6%	21.5%	21.4%	37.4%	29.3%	29.0%
SK	28.5%	34.4%	33.8%	24.5%	35.6%	35.8%	32.7%	19.0%	19.5%

	Accommodation			Information and communication			Professional and administrative services		
	Unweighted Sample	Weighted Sample	Eurostat	Unweighted Sample	Weighted Sample	Eurostat	Unweighted Sample	Weighted Sample	Eurostat
AT	4.1%	5.9%	6.1%	3.9%	4.9%	4.9%	14.3%	11.1%	10.9%
BE	3.4%	2.4%	2.4%	7.6%	4.5%	4.4%	15.9%	13.4%	13.4%
DE	0.9%	1.9%	1.9%	4.5%	5.9%	5.7%	18.4%	17.1%	17.2%
EE	3.3%	2.3%	2.3%	1.6%	5.4%	5.5%	7.3%	10.1%	10.3%
ES	6.8%	3.2%	3.3%	6.4%	6.6%	6.7%	8.3%	6.6%	6.9%
FI	1.8%	1.5%	1.5%	5.5%	6.9%	6.9%	7.9%	6.6%	6.5%
FR	4.3%	3.3%	3.3%	7.3%	8.9%	8.8%	12.7%	18.9%	18.8%
GR	14.2%	8.3%	8.5%	5.4%	12.8%	13.0%	5.3%	6.1%	6.0%
IE	3.1%	2.9%	3.1%	5.7%	18.5%	18.0%	41.1%	24.7%	33.4%
IT	5.5%	6.3%	6.3%	5.3%	5.6%	5.6%	6.1%	9.9%	9.8%
NL	1.2%	1.5%	1.5%	11.9%	8.4%	8.2%	11.5%	11.6%	11.0%
PT	9.3%	8.4%	8.5%	4.7%	7.9%	7.9%	5.5%	5.6%	5.6%
SI	4.5%	4.9%	5.0%	5.6%	5.8%	5.7%	5.3%	6.7%	7.1%
SK	2.9%	1.6%	1.6%	2.7%	5.2%	5.3%	8.8%	4.2%	4.1%

Source: ORBIS-iBACH and Eurostat
Note: To remove astronomical weights, we keep only country-year and two-digit sector cells with more than ten firms represented in our dataset.

Table A3 – Distribution of firm weights

	Min	P10	P50	P90	Max	Average
Weights	0.67	1.05	2.11	4.19	182.77	2.50

Source: ORBIS-iBACH and ECB calculations.

Table A4 – Distribution of value-added growth

	Min	P50	Average	Max	SD
2006	-52.84%	4.07%	5.66%	148.46%	13.46
2007	-64.09%	4.23%	6.22%	143.29%	12.8
2008	-96.08%	0.24%	0.93%	137.56%	16.28
2009	-78.98%	-7.89%	-8.26%	364.29%	23.47
2010	-70.07%	2.67%	5.09%	310.71%	21.83
2011	-86.03%	1.18%	1.37%	102.48%	14.68
2012	-70.84%	-1.61%	-0.83%	371.84%	19.02

2013	-166.03%	-0.22%	-0.87%	149.38%	15.06
2014	-113.39%	1.7%	2.81%	245.07%	17.80
2015	-899.76%	1.4%	1.41%	431.34%	40.07
2016	-92.31%	1.67%	2.31%	148.83%	12.30
2017	-750.00%	3.72%	4.29%	705.35%	41.28
2018	-42.93%	2.47%	3.40%	400.00%	17.97

Source: Eurostat.

Table A5 – Average value-added growth across country groups

	Northern and Central	Southern	Eastern
2006	2.81%	4.23%	7.57%
2007	7.66%	4.76%	7.40%
2008	0.29%	-1.56%	3.80%
2009	-5.74%	-6.75%	-13.71%
2010	3.02%	0.56%	10.21%
2011	1.99%	-2.49%	4.04%
2012	2.62%	-3.93%	8.55%
2013	-0.57%	1.58%	-1.44%
2014	1.68%	1.65%	-7.36%
2015	1.94%	0.65%	4.47%
2016	0.71%	2.01%	2.00%
2017	5.11%	4.40%	8.65%
2018	5.02%	3.21%	14.24%

Source: Eurostat.
Note: Unweighted average across countries and sectors. Northern and Central European countries – AT, BE, DE, FI, FR, IE, NL; Southern European countries – ES, GR, IT, PT; Eastern European countries – EE, SI, SK.

Table A6 – Share of firms affected by shocks

	Mild shock		Medium shock		Severe shock	
	Positive	Negative	Positive	Negative	Positive	Negative
2006	24%	6%	9%	3%	3%	1%
2007	24%	4%	10%	1%	4%	1%
2008	10%	15%	5%	6%	1%	2%
2009	4%	62%	2%	45%	1%	27%
2010	26%	13%	13%	5%	6%	2%
2011	15%	12%	7%	4%	2%	1%
2012	7%	22%	3%	8%	2%	2%
2013	7%	18%	2%	5%	1%	1%
2014	11%	8%	4%	3%	2%	1%
2015	12%	10%	5%	4%	2%	1%
2016	10%	6%	4%	2%	2%	1%
2017	21%	4%	8%	2%	3%	0%
2018	14%	6%	5%	2%	3%	1%

Source: ORBIS-iBACH
Note: The shock variables are defined as dummy variables which equal one whenever a positive or negative shock occurs. The table shows the percentage of observations in each year for which the dummy is one. The mild shock is one whenever the value added growth of the sector is more (less) than 1 standard deviations from the historical average; the medium shock is defined in terms of 1.5 standard deviations from the historical average; and the severe shock is one whenever the value added growth of the sector is 2 standard deviations from the historical average.

Table A7 – Distribution of firms by size-class

	Micro firms	Small firms	Medium firms	Large firms
Northern and Central	90.6%	7.9%	1.3%	0.2%
Southern	94.8%	4.5%	0.6%	0.1%
Eastern	95.5%	3.6%	0.7%	0.2%

Source: Eurostat Structural Business Statistics
Note: Northern and Central European countries – AT, BE, DE, FI, FR, IE, NL; Southern European countries – ES, GR, IT, PT; Eastern European countries – EE, SI, SK.

Figure A1 – Debt ratio and investment by sector

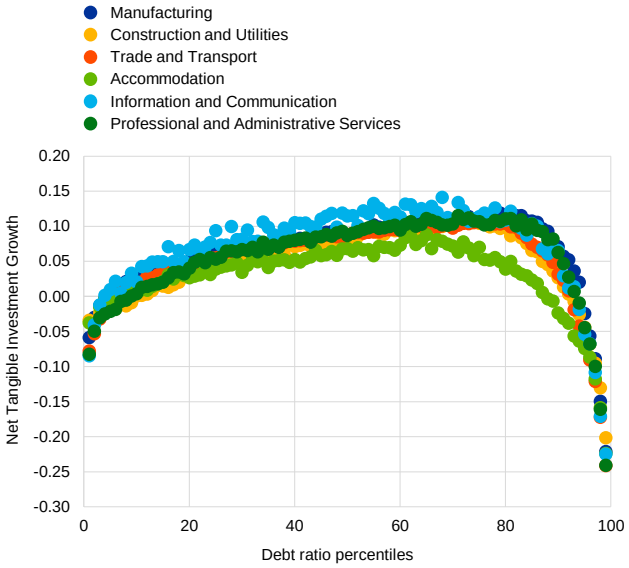
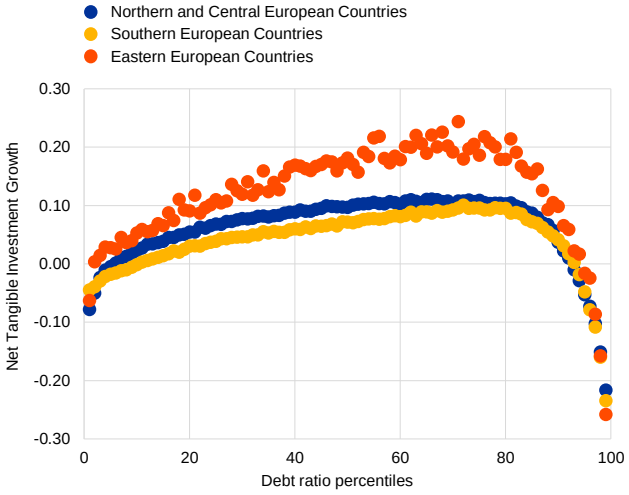
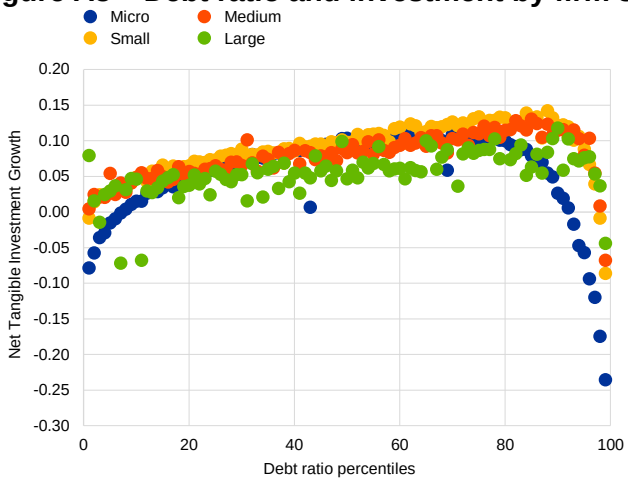


Figure A2 – Debt ratio and investment by region



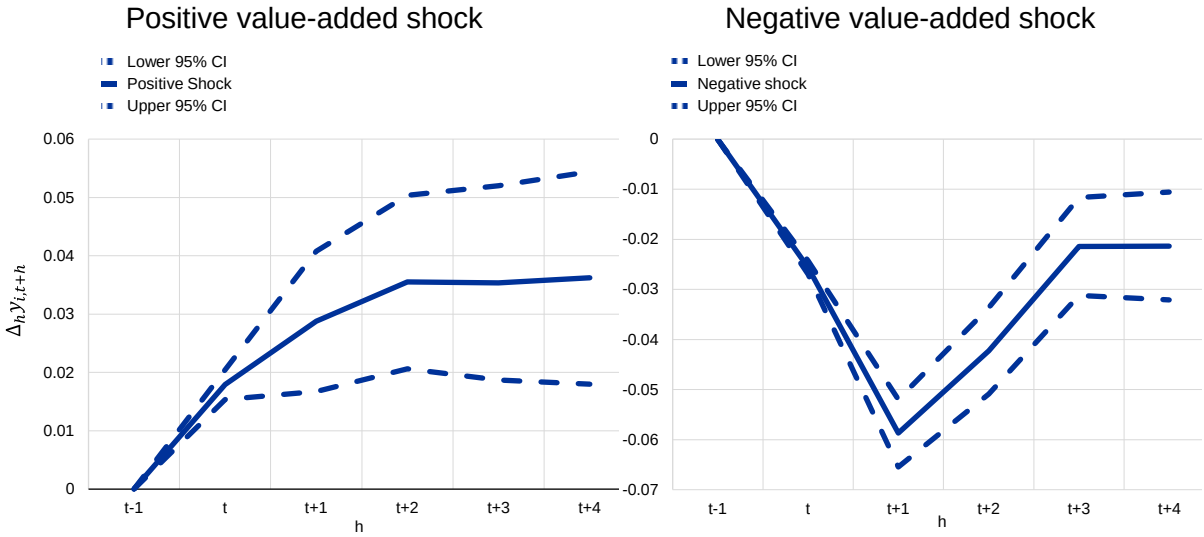
Note: Northern and Central European countries: AT, BE, DE, FR, IE, NL and FI. Southern European countries: EL, ES, IT and PT. Eastern European countries: EE, SI and SK.

Figure A3 – Debt ratio and investment by firm size



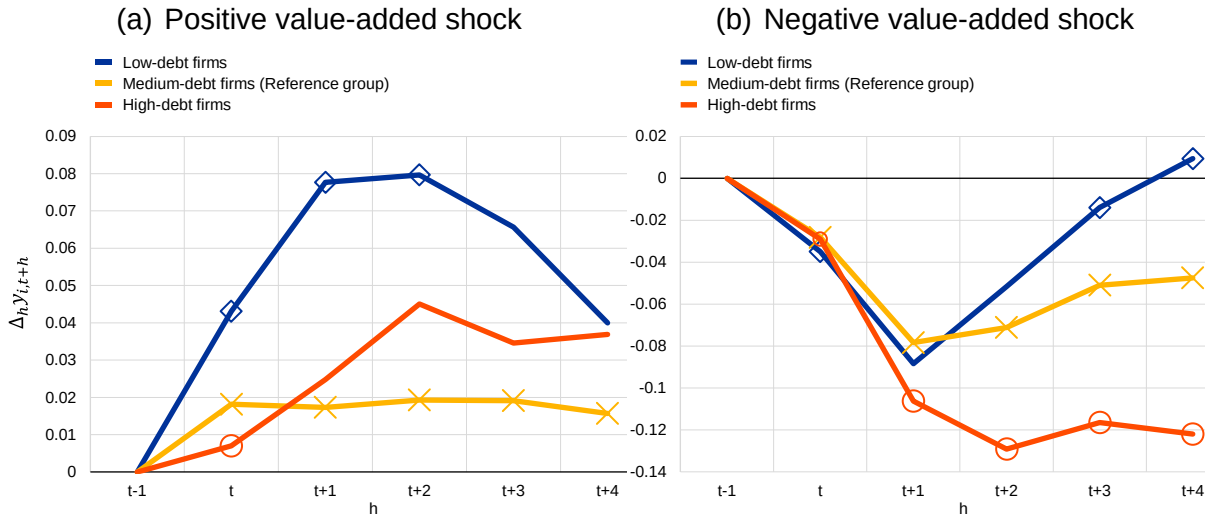
Note: Micro firms are those with Total Assets lower than EUR 2m; Small and Medium firms are those with Total Assets larger than EUR 2m and lower than EUR 43m; Large firms are those with Total Assets larger than EUR 43m.

Figure A4 – Baseline with firm fixed effects



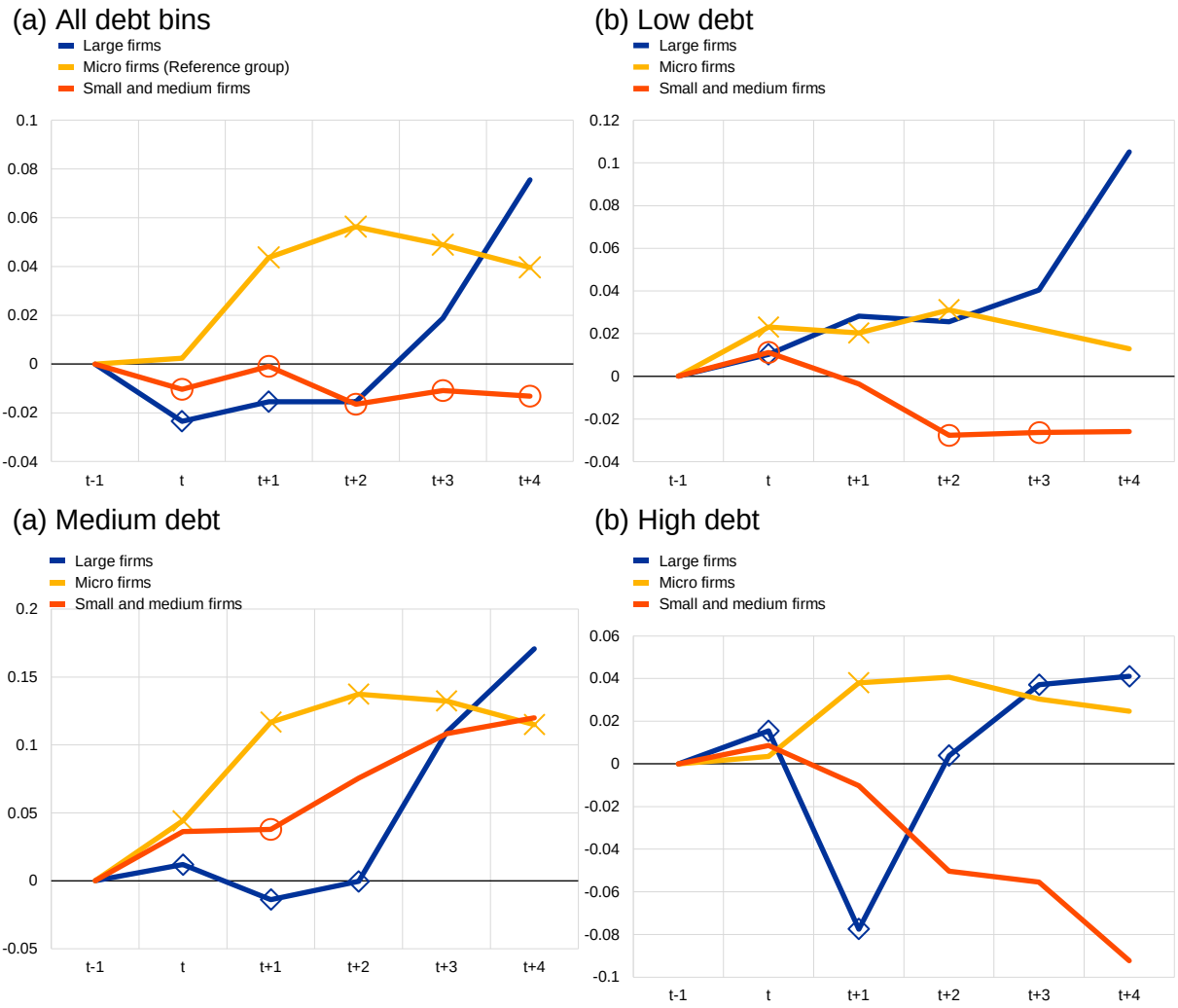
Notes: This figure shows the impulse response functions for the response of cumulative net tangible fixed asset growth following a positive (panel a) and a negative (panel b) activity shock. A positive (negative) shock to economic activity is defined by a rise (fall) in the two-digit sector value added growth that exceeds its country-sector-specific historical average by 1.5 standard deviations. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level.

Figure A5 – Net debt



Notes: Net-debt is defined as debt minus cash holdings over total assets. A cross represents a statistically significant coefficient different from zero at 90% confidence. Diamonds and circles represent statistically significant coefficients (90% confidence) vis-à-vis the reference group.

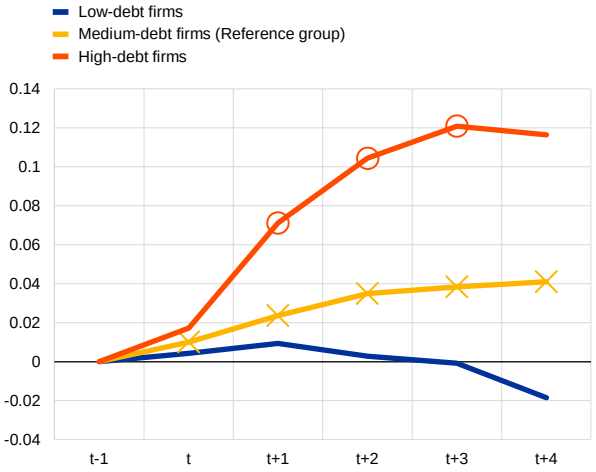
Figure A6 – Positive value-added shocks by firm size



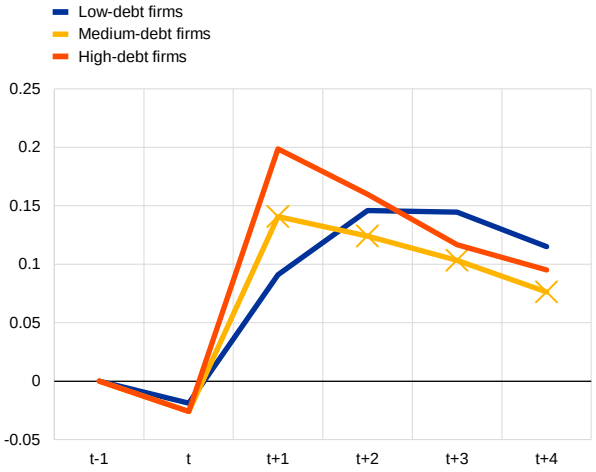
Notes: This figure shows the impulse response functions for the response of cumulative net tangible fixed assets growth following a positive activity shock. A positive shock to economic activity is defined by a rise in the two-digit sector value added growth that exceeds its country-sector-specific historical average by 1.5 standard deviations. Low debt firms are defined as firms in the bottom 20th percentile of the debt ratio distribution, medium-debt firms are firms between the 20th and the 80th percentile and high debt firms are firms standing above the 80th percentile of this distribution. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level. A cross represents a statistically significant coefficient different from zero at 90% confidence. Diamonds and circles represent statistically significant coefficients (90% confidence) vis-à-vis the reference group. Micro firms are those with Total Assets lower than EUR 2m; Small and Medium firms are those with Total Assets larger than EUR 2m and lower than EUR 43m; Large firms are those with Total Assets larger than EUR 43m.

Figure A7 – Positive value-added shock by region

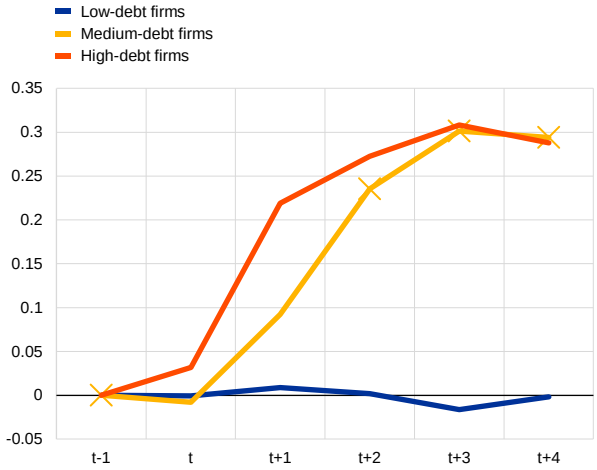
(a) Northern and Central European countries.



(b) Southern European countries.



(c) Eastern European countries.

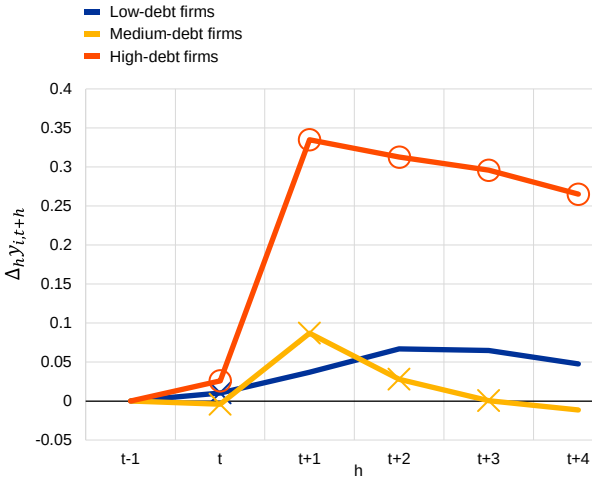


Notes: This figure shows the impulse response functions for the response of cumulative net tangible fixed assets growth following a positive activity shock. A positive shock to economic activity is defined by a rise (fall) in the two-digit sector value added growth that exceeds its country-sector-specific historical average by 1.5 standard deviations. Low debt firms are defined as firms in the bottom 20th percentile of the debt ratio distribution, medium-debt firms are firms between the 20th and the 80th percentile and high debt firms are firms standing above the 80th percentile of this distribution. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level. A cross represents a statistically significant coefficient different from zero at 90% confidence. Diamonds and circles represent statistically significant coefficients (90% confidence) vis-à-vis the reference group. Northern and Central European countries: AT, BE, DE, FR, IE, NL and FI. Southern European countries: EL, ES, IT and PT. Eastern European countries: EE, SI and SK.

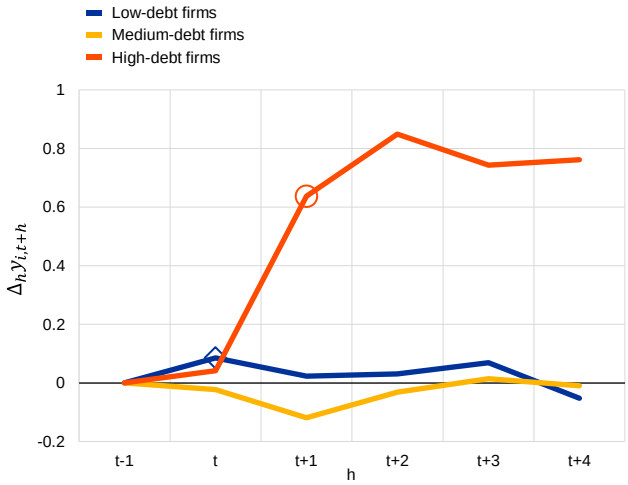
Figure A8 – Positive value-added shocks by region and without micro firms

(a) Northern and Central European countries

(b) Southern European countries

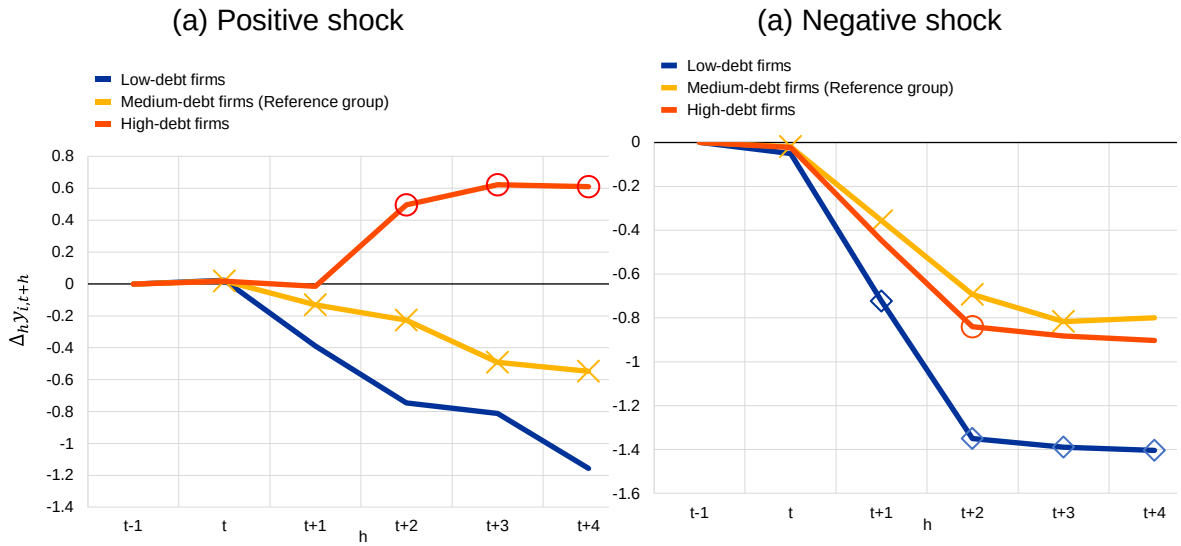


(c) Eastern European countries



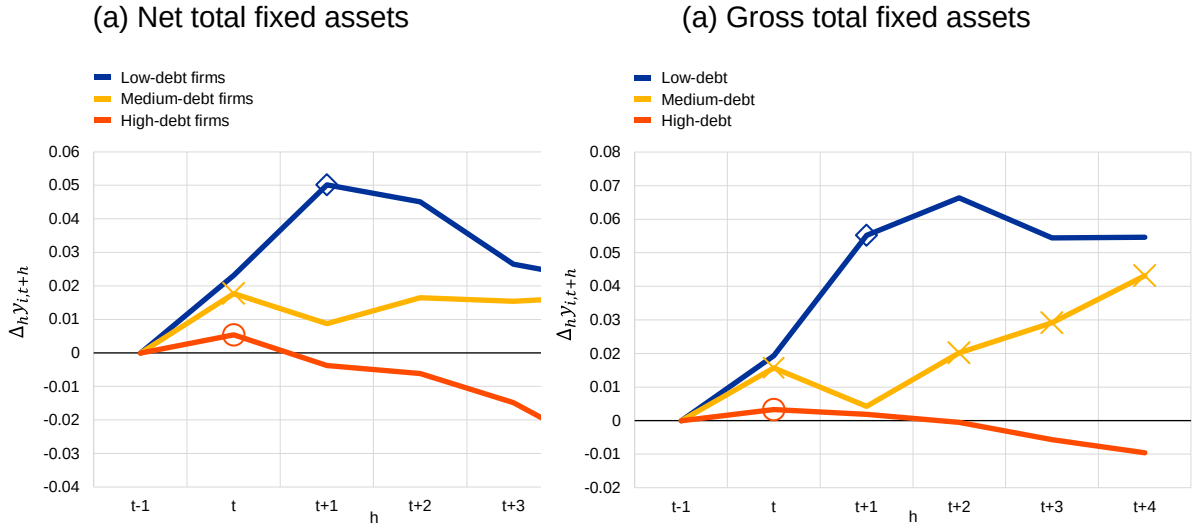
Notes: This figure shows the impulse response functions for the response of cumulative net tangible fixed assets growth following a positive activity shock. A positive shock to economic activity is defined by a rise (fall) in the two-digit sector value added growth that exceeds its country-sector-specific historical average by 1.5 standard deviations. Low debt firms are defined as firms in the bottom 20th percentile of the debt ratio distribution, medium-debt firms are firms between the 20th and the 80th percentile and high debt firms are firms standing above the 80th percentile of this distribution. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level. A cross represents a statistically significant coefficient different from zero at 90% confidence. Diamonds and circles represent statistically significant coefficients (90% confidence) vis-à-vis the reference group. Northern and Central European countries: AT, BE, DE, FR, IE, NL and FI. Southern European countries: EL, ES, IT and PT. Eastern European countries: EE, SI and SK. Micro firms are excluded from the sample.

Figure A9 – Intangible investment



Notes: This figure shows the impulse response functions for the response of cumulative net intangible fixed assets growth following a positive (panel a) and negative (panel b) activity shock. A positive (negative) shock to economic activity is defined by a rise (fall) in the two-digit sector value added growth that exceeds its country-sector-specific historical average by 1.5 standard deviations. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level. A cross represents a statistically significant coefficient different from zero at 90% confidence. Diamonds and circles represent statistically significant coefficients (90% confidence) vis-à-vis the reference group.

Figure A10 – Alternative investment definitions (positive shock)



Notes: This figure shows the impulse response functions for the response of cumulative net total fixed assets growth (panel 1) and gross total assets growth (panel b) following a positive activity shock. A positive shock to economic activity is defined by a rise in the two-digit sector value added growth that exceeds its countrysector-specific historical average by 1.5 standard deviations. The impulse response functions are estimated using the local projection approach by Jordà (2005). Standard errors are clustered at the firm level. A cross represents a statistically significant coefficient different from zero at 90% confidence. Diamonds and circles represent statistically significant coefficients (90% confidence) vis-à-vis the reference group.

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Views and conclusions expressed in this paper are those of the authors alone and cannot be attributed to the European Central Bank.

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