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Intangible differences: Investment during the pandemic and the role of financial constraints

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About the Economics Department
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Contents

Abstract

We use the European Investment Bank Investment Survey (EIBIS) data to analyse the impact of the COVID-19 crisis on firm-level investment in tangible and intangible assets. We find considerable heterogeneity regarding the extent of the reduction of investment in different asset groups – with R&D investment declining the least, and investment in training and in machinery and equipment the most. This can be partly explained by the different income-elasticity of investments. Our results also suggest that financial constraints deterred investment activity both before and after the outbreak of the COVID-19 shock. These financing constraints were binding not only for tangible investment, but also for intangibles such as R&D and training. We find evidence for a higher sensitivity of R&D investments to the COVID-19 shock compared to tangible investments. Strong policy support implemented during the pandemic contributed to alleviating part of the negative impact of COVID-19 by mitigating the increase in the number of financially constrained firms.

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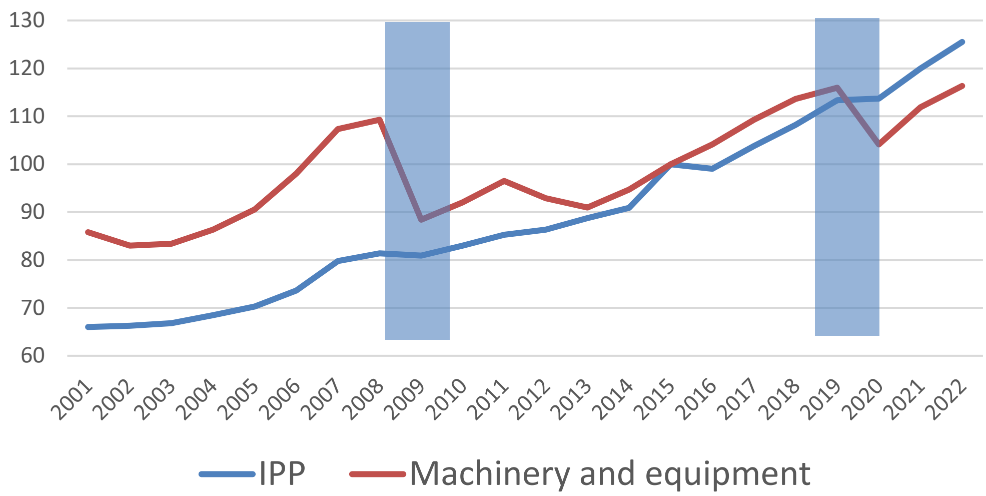
1 Introduction

Under imperfect capital markets, limited access to external finance restricts investment activity (Fazzari et al., 1987; Gómez, 2019). In this context, financial constraints can be more binding for intangible than for tangible investments (Czarnitzki & Hottenrott, 2011; Lim et al., 2020; Peia & Romelli, 2022). Economic shocks can also amplify the detrimental impact of financial constraints on firm investment, depending on asset specificity. There is a vast literature documenting the negative effects of the Global Financial Crisis on investment while taking into account the role of financial constraints (Gaiotti, 2013; Garicano & Steinwender, 2016). However, to the best of our knowledge we are not aware of any empirical evidence on the impact of COVID-19 crisis on investment behaviour for different assets while taking into account the role of financial constraints.

Figure 1 illustrates the evolution of investment in (in)tangible assets in the EU-27 over the past 20 years. Two major trends stand out. First, the relative weight of intangible investments is increasing over time (Haskel & Westlake, 2017). Second, investment in intangibles seems to be more resilient compared to tangible assets in times of crisis, as evidenced by the dynamics during the Global Financial Crisis (GFC) and during the start of the COVID-19 outbreak (the shaded blue areas in the graph) (Altomonte et al., 2022; Corrado et al., 2016; European Commission, 2022; Thum-Thysen et al., 2019).

Figure 1: Investment in Machinery and Equipment and in Intangibles (IPP) in EU27 (excluding Ireland) (chain linked volumes, 2015=100)



Note: Own calculation based on Eurostat's National Accounts data. IPP (intellectual property products) are the intangible assets included in National Accounts. The shaded areas show the GFC and the COVID-19 period.

In this paper, we analyse firm-level investment behaviour in the EU-27 before and after the outbreak of the COVID-19 pandemic. We document and investigate differences in the investment dynamics of six asset categories and the heterogeneous impact of the COVID-19 crisis. To gain a better understanding of the drivers of asset-specific investment dynamics, both in normal and crisis times, we evaluate the impact of financial constraints.

In our empirical framework, we propose an instrumental variable strategy since financial constraints may be endogenous to firm-level investment because of omitted variables (if firms investing in intangibles are more constrained) or reverse causality (higher investment needs might lead firms to experience higher financial constraints). We use indicators of pre-existing financial fragility, namely the lagged cash-ratio and excess financial leverage, as instrumental variables.

The European Investment Bank Investment Survey (EIBIS) provides an ideal data source for our empirical investigation, since it combines firm-level data on specific investment assets, investment obstacles and crisis-related indicators for all 27 EU countries.

Our main results can be summarized as follows. R&D investment declined less than investment in machinery and equipment during the COVID-19 pandemic, which is in line with previous findings for the Global Financial Crisis (e.g. European Commission, 2022). At the same time, other assets show a mixed picture that highlights the heterogeneity within tangible and intangible investment. Compared to investment in machinery and equipment, R&D investment seems to be less hampered by financial constraints before the COVID-19 period. The adverse effect is still slightly milder but becomes much more similar during the COVID-19 pandemic. This finding remains robust using various alternative indicators to proxy financial constraints. Thus, although financial constraints were not more binding for R&D compared to machinery and equipment investments in absolute terms, their importance increased more for R&D during the pandemic.

Overall, our finding suggests that it is important to take asset specificity into account when analysing firm-level investment behaviour, since aggregate categories such as (in)tangible investments can hide large heterogeneity between asset categories. Our results also show that financial constraints are overall detrimental to firm investment. Point estimates of the role of financial constraints show a substantially larger adverse effect on R&D investments during the COVID-19 crisis than before, although the difference is not statistically significant. This is in line with some of the literature finding stronger sensitivity of R&D to credit constraints during crises (e.g. Aghion et al., 2012). Nevertheless, swift policy support avoided a sharp increase in the number of financially constrained firms, thus mitigating the adverse effect of the crisis on investment (Harasztosi et al., 2022). Lastly, our results indicate that the elasticity of investment to income of firms as further crisis propagation mechanism during the pandemic was relatively low for R&D, compared to machinery and equipment, explaining partly the fact that R&D investment fell less compared to investment in machinery and equipment.

The remainder of this paper is organised as follows. Section 2 provides a short overview of the relevant literature. Section 3 discusses the data. Section 4 describes the empirical model and present the main results. We conclude in Section 5.

2 Literature Review

Our paper is related to several strands of the economic literature. To start, we contribute to the large economic literature that links investments into intangible assets to higher productivity growth and economic performance (Adarov & Stehrer, 2019; Bauer et al., 2020; Cincera et al., 2020; Corrado et al., 2016; Roth, 2022; Thum-Thysen et al., 2019) by providing an up-to-date analysis on the dynamics of intangible assets using detailed European firm-level data. In this context, our research also relates to the literature that links intangible investment to economic performance more broadly, e.g. related to innovation (Montresor & Vezzani, 2016) or digitalisation efforts (Corrado et al., 2017; Van Ark, 2016).

There exists a vast literature that documents the detrimental effects of financial constraints on firm investment (e.g. Fazzari et al., 1987). However, it is important to highlight some key difference regarding the financing of tangible and intangible investments. Intangible investments are of a long-term nature and largely irreversible, less sensitive to long-term interest rates (Crouzet & Eberly, 2018; Thum-Thysen et al., 2019) and less influenced by monetary policy (Döttling and Ratnovski, 2020). Intangibles are usually financed by internal sources or equity instead of debt because they cannot be pledged as collateral (Altomonte et al., 2021). As such, financial constraints and their impact may vary across different types of investment.

At the *sectoral* level, access to finance has a larger impact on labour productivity growth in intangible intensive industries, especially if they are more dependent on external finance (Demmou et al., 2019). Financial frictions in intangible sectors have been a barrier to productivity growth, especially in countries that are less financially developed (Demmou et al., 2019). This finding is corroborated by Demmou et al. (2020) using firm-level data.

In a recent paper using EIBIS data, Segol et al. (2021) document that insufficient loan amounts, high lending rates, and more stringent collateral requirements have a detrimental effect on intangible investment. Using EIBIS and an instrumental variable approach, Brunello et al. (2022) show that financing constraints substantially reduce investment in physical capital, but that they have no effect on investment in employee training. Other contributions analyse the detrimental role of financial constraints on R&D (Brown et al., 2012; Hall et al., 2016). For example, financial constraints may be more binding for intangible investments due to stronger informational asymmetries and the related uncertainty regarding valuation (Caggese & Pérez-Orive, 2022).

Our paper also contributes to the literature on the impact of economic crisis on firm investment by analysing the COVID-19 crisis and its impact on firm investment as external shock. As tangible investments are more likely to be financed using external finance, unfavourable credit conditions may have a more direct adverse impact on tangible investment (Ferrando & Preuss, 2018). On the other hand, as tangible assets may be closely linked to the daily operations of firms (e.g. machinery and equipment), their financing may be more essential than the financing of intangible investments, such as R&D.

Several papers focus on the composition of firm investment during crisis times, documenting that intangibles exhibit a higher resilience to crises (Corrado et al., 2016; European Commission, 2022) and that they are less sensitive to fluctuations in aggregate demand than tangible investments (Altomonte et al., 2022; Thum-Thysen et al., 2019). These findings are in line with the evidence for smaller declines in intangible vs tangible assets during the COVID-19 based on National Accounts data (see also Figure 1).[1] In a setting using data on the expected impact of COVID-19 at the start of the pandemic, Coad et al. (2022) focus on the heterogeneous impact of the COVID-19 shock on firm level investment expectations. They show that R&D investors are more likely to be pessimistic about their investment plans as a consequence of the COVID-19 shock compared to non-R&D investors. In a related paper, Teruel et al. (2022) show that the COVID-19 shock pushed firm-level digitalisation activities, in particular driven for firms that were already digital before the crisis.

The impact of financial constraints on firm-level investment may also vary during times of economic crisis. Previous research has found that firms' investment elasticity depends on the availability of bank credit during times of crisis (Gaiotti, 2013). Using a large sample of European firms, Peia and Romelli (2022) focus on R&D investments and find that financially more constrained firms invested less during periods of tight credit supply. This effect is amplified in sectors with high dependence on external finance. Using pre-GFC data, Aghion et al. (2010) show that the R&D investment share in total investment is countercyclical, but more procyclical if credit constraints are binding, and that this effect is magnified for sectors highly dependent on external finance.

Other studies find evidence that points to a relatively *steeper* decline for intangible investment relative to tangible investments in times of crisis and financial vulnerability. Ahn et al. (2020) use cross-country firm level data to show that financially vulnerable firms decreased intangible investment during the Global Financial Crisis (GFC) by more than firms that were not vulnerable. They also find that firms that are more vulnerable cut intangible investment more than tangible investment. Deng & Liu (2021) show that Italian firms, in particular smaller and high-leverage firms, reallocated from intangible towards tangible assets during the sovereign debt crisis in the Euro area.

Duval et al. (2020) argue that the financial crisis had a long-term effect on productivity. They examine firms that suffer from existing pre-crisis financial frictions and vulnerabilities and show that these firms suffer from a significant and persistent drop in total factor productivity (TFP) post-crisis. They conclude that one important channel that underpins this TFP drop is that financially fragile firms cut back on intangible investments, such as R&D investments. One of the potential reasons is the lower capacity to use intangible assets as collateral.

Lopez & Olivella (2018) use a general equilibrium model to illustrate that financial shocks affect the investment mix of (in)tangible investment and tilts the investment ratio towards tangibles. On the other hand, Garicano & Steinwender (2016) find the opposite using Spanish firm level data, i.e. tangible investment declined *more* compared to intangible investment in more credit-constrained firms during the financial crisis. They argue that firms facing credit constraints shift investments from more durable to less durable assets. Our study sheds new light on this issue by using detailed investment data, various financial constraints indicators and the recent impact of the COVID 19 crisis.

To summarise, there is vast evidence that intangible investments play an increasingly important role in a knowledge-based economy. Financial constraints hamper firm-investment, but their impact may vary depending on the underlying asset. Investment behaviour by asset type can be quite different in times of economic crisis. In times of crisis, evidence for the Global Financial Crisis and already available macro data on the COVID crisis suggest that the decline for tangible investment was steeper than for intangible investments. Earlier studies have also pointed out that financial constraints can be especially binding for intangible investments during times of crisis, but the empirical evidence is mixed. As such, this paper aims to address these questions empirically focusing on the COVID-19 crisis.

[1] Difference in the results of studies at the micro- and macro-level could be explained by measurement issues related to intangible assets derived from (non)-national accounts and firm-level data or from issues related to aggregation. See also Van Criekingen et al. (2022).

3 Data and main variables

3.1 European Investment Bank Investment Survey

This paper relies on data of the European Investment Bank Investment Survey (EIBIS), an annual firm-level survey on investment and investment finance covering the EU-27, which is linked at the firm level to ORBIS data on balance sheets and profit and loss accounts. Firms in EIBIS comprise of a representative sample of the business population of non-financial corporations in every EU country – using stratified sampling by country, sector and firm size (Brutscher et al., 2020). The last wave of EIBIS considered in this paper is 2022, which means that most of the financial and economic data from that wave refer to the financial year 2021. ORBIS data linked to EIBIS are available until 2020.

Information on investment activities, our main variables of interest, are based on questions on investment in specific assets in the previous financial year. Six different asset categories are covered: a) land and buildings; b) machinery and equipment; c) research and development; d) software and data; e) training of employees; f) organisational capital. The category of tangible assets comprises categories a-b, intangible assets categories c-f. Firms report their investment asset-by-asset, denominated in euro. We deflated these values using the chain-linked price index of total gross fixed capital formation by country and year (with 2015 as base year). Our empirical analyses use these gross investment values as reported by the firm as our dependent variable of interest.[2]

For our explanatory variables, we focus on the role of financial constraints. There exists a vast literature on how to measure financial constraints (see e.g. the discussion in Asdrubali et al., 2022; Ferrando & Mulier, 2015). One way to identify financial constraints in EIBIS is to use survey responses about binding financial constraints, such as rejection of credit applications or credit conditions that were less favourable than requested by the firm (Segol et al., 2021).

We identify financially constrained firms as those which indicated that availability of finance was a major obstacle to investment.[3] We opted for this baseline indicator as it reflects a broad concept of financial constraints which includes both internal and external financial constraints (as opposed to indicators focusing exclusively on external financing constraints) and it is available for a larger part of our sample (see Table 1). An alternative indicator of financial constraints ("Finance constrained") used for robustness checks is based on firms self-reporting difficulties in accessing external finance. In this case, firms are defined as financially constrained if either i) their application for external finance was rejected; ii) they were discouraged to apply for credit; or iii) they were dissatisfied with the quantity or cost of external finance. As a second alternative indicator, we use expectations regarding external finance. This indicator takes value 1 if a firm expects deterioration of external finance in the next 12 months, and 0 if it does not. As this is a variable based on expectations, it does not show directly *actual* financing constraints.

Table 1: Number of firms, by alternative indicators of financial constraints (pooled between 2015 and 2020)

		Finance constrained	
		No	Yes
Major obstacle	No	50,106	2,856
	Yes	11,407	3,061

[2] We use data on investment flows and we do not have data on asset stocks. Calculating other alternatives is quite limited by the data, e.g. analysing the capital stock for each asset category is not possible due to the lack of data on depreciation rates and the short panel dimension, among others.

[3] We assume that obstacles to investment influenced investment decisions of firms in the last financial year.

We group firms into four firm size categories: micro (less than 10 employees), small (10 to 49 employees), medium (50 to 249 employees) and large (250+ employees). Similarly, we use different categories for firm age: younger than 2 years, between 2 and 5, between 5 and 10, between 10 and 20, and more than 20 years.

We also categorise firms into four big sectors: manufacturing, construction, services and infrastructure based on their NACE Rev. 2 classification.[4]

We use specific variables linked to the COVID-19 pandemic that are only available for the year 2020. We construct an indicator variable "Sales_drop_25" taking value 1 if the firm reported a drop in its sales (turnover) of at least 25%, and 0 otherwise.

We also use financial variables based on the balance sheet available in the ORBIS database. ''Leverage'' is defined as debt over total assets, and we define ''excess leverage'' as an indicator for firms with the top 25% leverage values (pooled over different years). ''Cash ratio'' is defined as cash over total assets. All variables are winsorised at the top 1% percentile.

3.2 Descriptive statistics

For our econometric analysis we use data for the EU-27 for the full range of available years (2015-2021). In terms of country coverage, we focus on firms in the EU-27 and exclude the US and the UK. Our full sample comprises 71335 firm-year observations and 21150 firm-year observations when restricted to including firms with asset level investment data for the current and previous year (see Appendix A0 for further information on the sample).

3.2.1 Investment dynamics

Our two main indicators of investment activity for the empirical analysis are 'log-investment', $\log{(inv_{it}^k + 1)}$ and an indicator of non-zero investment, defined as $I(inv_{it}^k > 0)$ for firm i, financial year t and asset category k. In case of the first indicator, we use logarithms to deal with the skewness of the investment distribution, and we add 1 to deal with the large number of zero investment in our data. The second indicator captures the probability of a firm investing into a specific asset (extensive margin of investment). Any estimated effect on our main indicator ''log-investment'' incorporates the full effect on investment, which is a combination of the intensive and extensive margins.

For the descriptive analysis, we present our indicators of investment activity in the form of average values of log-investment of all firms in a given year and of the share of firms investing in asset k, i.e. firms with positive investment levels. Descriptive statistics using other indicators of investment activity are reported in Appendix A1.

We start with depicting the change of investments of tangible vs intangible investments over time, with a special attention on the dynamics after the start of the COVID-19 crisis in early 2020 (Figure 2). As shown by the left and right panels of Figure 2, the investment dynamic and the share of firms investing fell less in 2020 for intangible investments than for tangible investments, in line with the available macro time-series (see Figure 1).

[4] Manufacturing includes firms in NACE 10 to 32, construction in NACE 41 to 43, services in NACE 45 to 47 and 55 to 56, infrastructure in NACE 35 to 39, 49 to 53, and 58 to 63.

Figure 2: Evolution of investment in tangible and intangible assets (logarithmic change and percentage point change)

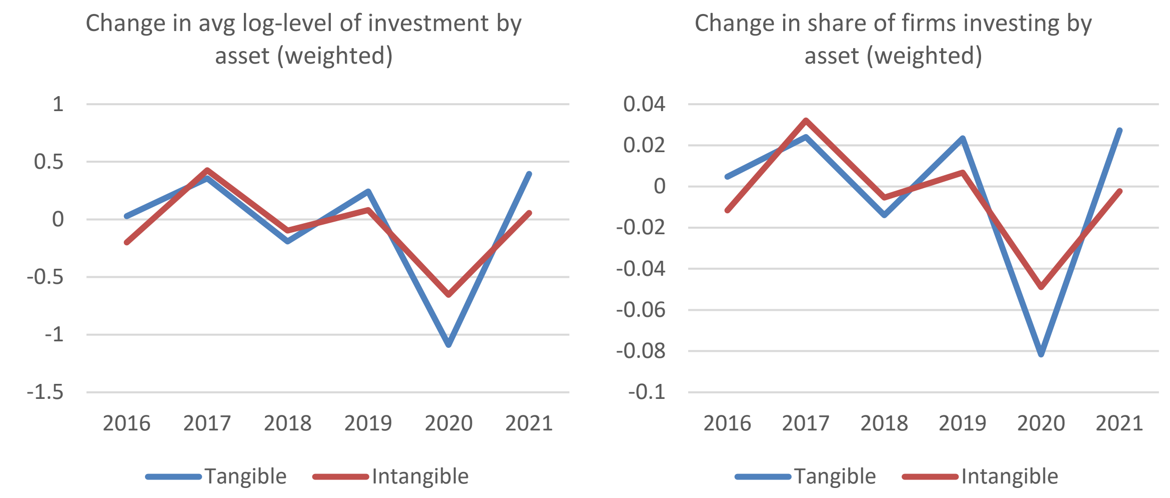
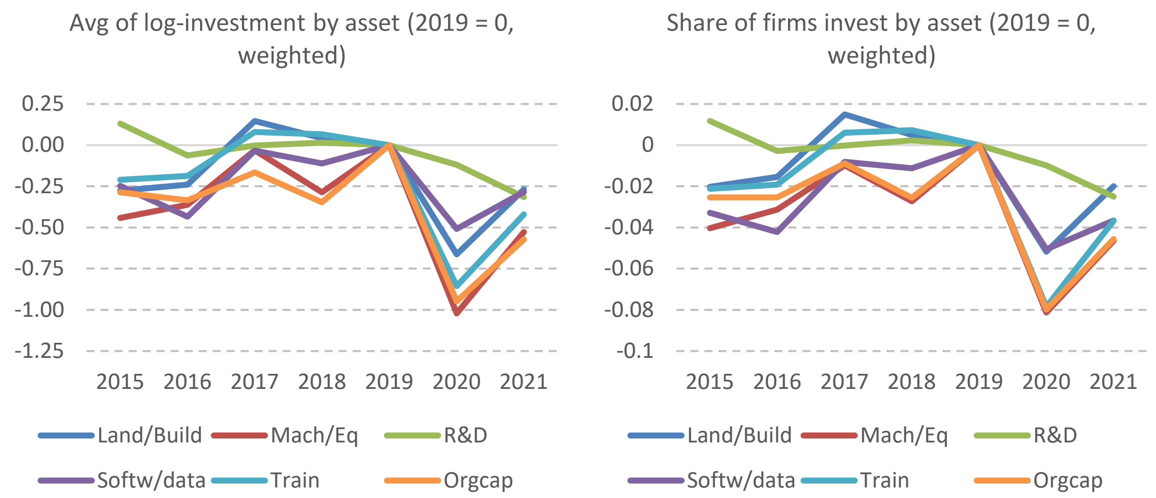


Figure 3: Evolution of investment activity in different asset categories (logarithmic change and percentage point change)



Note: "Land/build"=land and building, "Mach/Eq"=machinery and equipment, "R&D"=research and development, "Softw/data"=software and data, "Train"=employee training, Orgcap"=organisational capital.

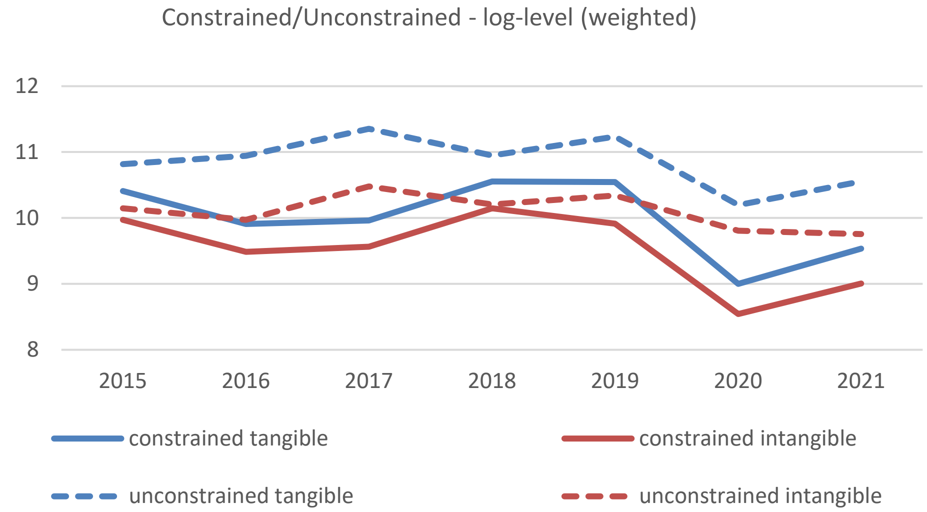
Zooming in into the detailed underlying asset categories (Figure 3), we find that machinery and equipment, organisational capital and employee training declined the most, while R&D and software declined the least in 2020. Interestingly, R&D investment continued to decline in 2021, as opposed to the sharp recovery in the other assets.

Overall, our descriptive statistics show that the impact of COVID-19 on investment behaviour varies with the underlying asset. Differences are large even within the tangible or intangible asset classes. On average, investments in tangible assets, such as machinery and equipment, decreased relatively *more* compared to intangible assets, in particular in comparison to R&D.

3.2.2 The role of financial constraints

We also split the sample using our binary measure of financial constraints. In the following, we will use and describe the indicator for ''availability of finance was regarded as a major obstacle to invest''. The initial COVID-19 shock in 2020 negatively affected investments of both financially constrained and unconstrained firms (Figure 4). However, it influenced investments more severely for financially constrained firms, both in tangible and in intangible assets, evidenced by the widening gap between constrained and unconstrained firms in 2020. Despite the recovery in 2021, the gap remained wider than before the pandemic.

Figure 4: Investment in tangible and intangible assets of financially constrained firms and unconstrained firms (logarithmic change and log-level, respectively)



Note: We define "financially constrained" as firms that report the availability of finance as a major obstacle to investment.

4 Empirical model and results

Our main research question investigates the impact of the COVID-19 crisis on firm-level investment, distinguishing between asset specificity and taking into account the role of financial constraints. We use different regression models to control for potential sample composition effects and other drivers of investment behaviour. We are interested in analysing the different sensitivity of various categories of firm-level investments in the wake of the COVID-19 shock. For the analysis of log-investment, our regression model uses all available financial years in our sample (2015-2021) and pooled OLS:

$$\log\left(1 + inv_{it}^{k}\right) = \beta^{t}\delta_{t} + \lambda X_{it} + \varepsilon_{it}, \qquad (1)$$

For the analysis of the extensive margin (i.e. the probability of investment), we rely on a linear probability model (LPM):

$$I(inv_{\text{it}}^{k} > 0) = \beta^{t}\delta_{t} + \lambda X_{it} + \varepsilon_{it}, \qquad (2)$$

where inv is the investment into asset k of the firm i in year t. We also control in vector X for firm characteristics (firm size, age) and country, industry and time fixed-effects. To highlight the average impact of the COVID-19 crisis on investment activity, we define a COVID-19 indicator taking value 1 for the years 2020 and 2021, and 0 otherwise. $\hat{\beta}^{COVID}$ is the estimated coefficients of the COVID-19 indicator and uses 2019 as the base year (i.e. omitting δ_{2019} from the regression), thus comparing the effects of the COVID-19 period to the last pre-pandemic year, 2019.

In order to investigate the impact of financial constraints and income shocks on investment behaviour, we use different models and indicators. For the sake of consistency, we will outline them in the respective sections 4.2 and 4.3.

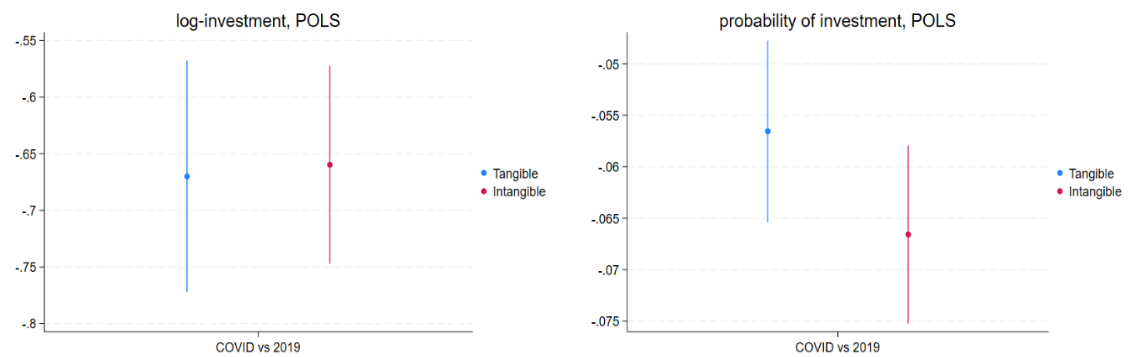
There are several reasons why we chose the pooled OLS as baseline instead of the panel fixed effects estimation. Most importantly, only a limited number of firms are included in more than one wave of the EIBIS survey, leading to a smaller panel sub-sample (see Appendix A0, Table 2). Secondly, some of the variables we use are only available for one particular year (i.e. the 2020 COVID-19 year) and consequently do not allow for panel data methods. Lastly, results from panel fixed effects estimations to control for unobserved firm-specific heterogeneity are reported as robustness checks in Appendix A2.

4.1 Impact of COVID-19 on tangible and intangible investment dynamics

To start our empirical analysis, we investigate whether the COVID-19 shock had a stronger negative impact on tangible or intangible investment. To gain a better understanding of the drivers of investment, we analyse both log-investment and the probability of investing. In a next step, we extend our analysis to investigate the specific subcategories of (in)tangible assets.

In Figure 5, we show graphically the change of average tangible and intangible investment levels during COVID-19 in 2020-2021 compared to 2019, controlling for different firm characteristics. Based on this graph alone, we cannot see a significant difference in the decline of tangible versus intangible investment. Looking at the probability of investment, we find that the decline is larger for intangibles than for tangible assets. However, the difference is not statistically significant. Consequently, analysing the impact of COVID-19 using these coarse aggregates of investment does not yield any discernible difference in investment dynamics.

Figure 5: Estimated impact of COVID on log-investment and on the probability of investment in tangible and intangible assets – pooled OLS estimation



Note: The graphs show estimated coefficients with 95% confidence intervals of the COVID indicator (year 2020 and 2021), with tangible and intangible investment as dependent variables (in log, and for the probability of investment, respectively).

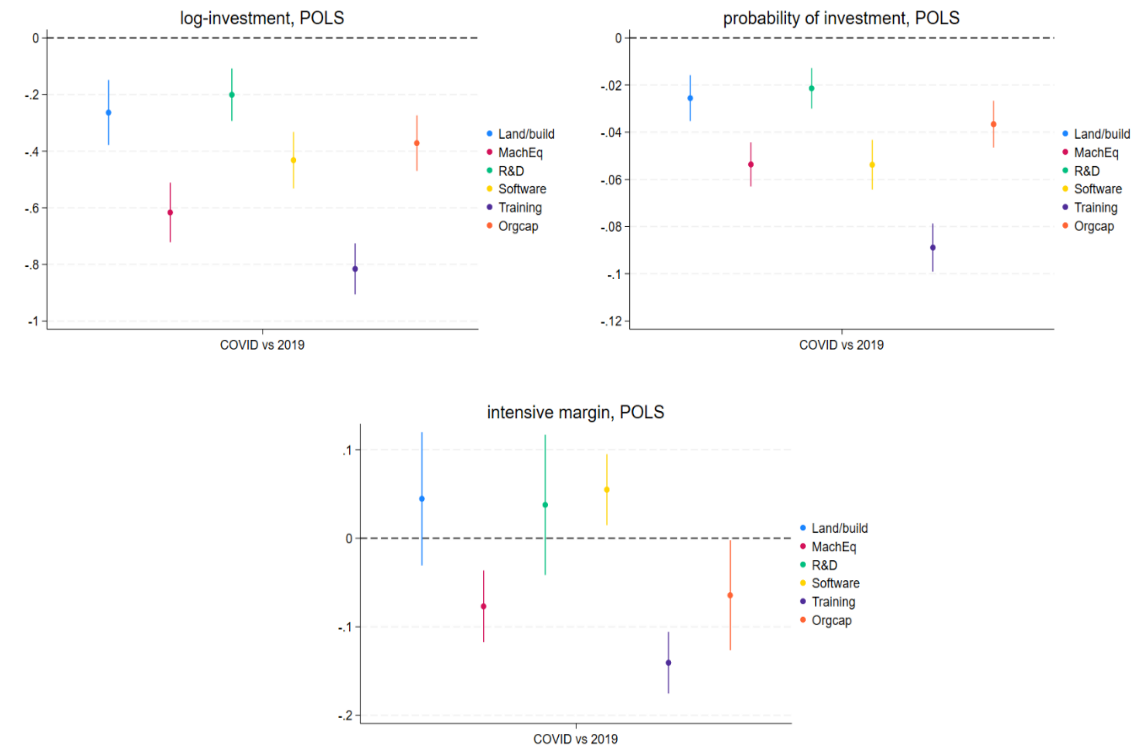
We also estimate equation (1) for specific assets within the category of intangible and tangible assets. These include six distinct groups: for tangibles, land and buildings (Land/build) and machinery and equipment (MachEq); for intangibles, R&D, software, training of employees, and organisation capital (Orgacap).

We report our coefficients of interest in Figure 6. Recall that $\hat{\beta}^{COVID}$ shows the average COVID-19 impact in 2020 and 2021 on investment compared to 2019 as our base year. The left- and right-hand side panels as well as the bottom panel of the graph show the results for log investment, for the probability of investment, and for the intensive margin (i.e. the change in log-investment for firms with nonzero investment) respectively, estimated by pooled OLS (i.e. LPM for the probability of investment).

The results from the regressions show that COVID-19 reduced both the probability and the overall investment for all asset categories, with the smallest impact on investments in R&D, and the largest on employee training – while controlling for firm characteristics (size, age, sector, and country). Despite the milder impact, the decline in R&D is not negligible: COVID-19 decreased R&D investments by 20% and the probability of investing in R&D by 2 percentage points.

Investment in machinery and equipment was severely impacted, with a relatively strong effect for the intensive margin. In case of training, both the extensive and intensive margin plays an important role in the overall investment decline, as the probability of investment declined by around 10 percentage points. The impact on investments in land and buildings, software and organisational capital was smaller.[5] Interestingly, the intensive margin is positive for software, meaning that average investment in software and data actually increased during the pandemic.

Figure 6: Estimated impact of COVID on log-investment, on the probability of investment and on the intensive margin – pooled OLS estimation



Note: The graphs show estimated coefficients with 95% confidence intervals of the COVID-19 dummy (year 2020 and 2021), with different asset categories as dependent variables (in log, and for the probability of investment, respectively).

As robustness checks, we estimated the impact of COVID-19 controlling for linear pre-pandemic trends in investment (Appendix A3). The effect of COVID-19 is quantitatively larger (more negative), but qualitatively similar in terms of the relative effects across different asset categories.

Overall, these results show that focusing on the aggregated investment categories hides significant heterogeneity across specific asset types. We find that R&D investment declined the least among the analysed assets, consistently with the results of Aghion et al. (2012) showing that the share of R&D investment is counter-cyclical. As they also find that financial constraints can overturn counter-cyclicality, we will explore this potential mechanism as one of the different transmission channels in more detail.

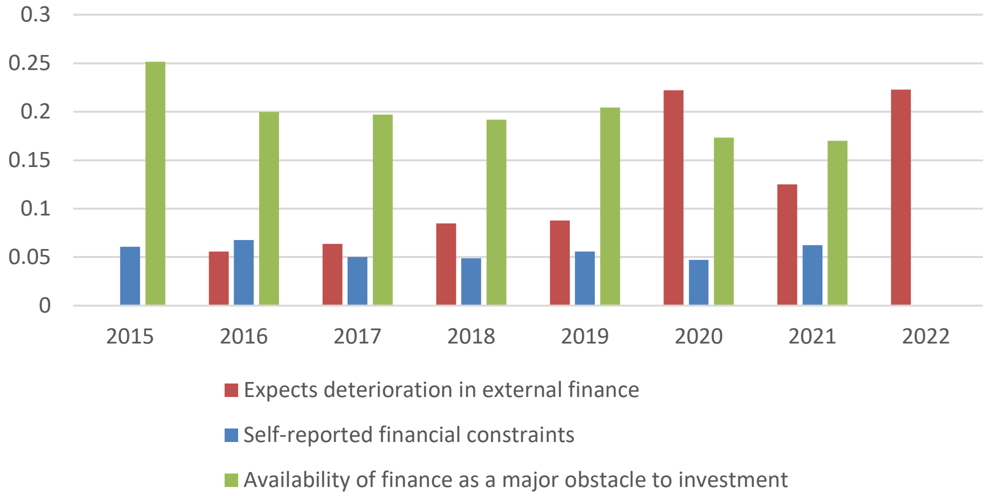
4.2 Intangible investment and financing constraints during the COVID-19 crisis

In this section, we study the impact of financial constraints on intangible and tangible investments during the COVID-19 crisis. Our expectation is that financial constraints have a negative impact on firm investment overall. Furthermore, financial constraints are expected to be more binding for intangible than for tangible investment in times of crisis. However, the generous and swift policy support during the pandemic alleviated the tightening of financial conditions and the deterioration of firms' liquidity and therefore muted the negative impact on

[5] Estimates from the firm fixed effect estimation for log-investment and for the probability of investment are very similar to the pooled OLS results (see Appendix A1, Figure 16). Furthermore, estimates shown in Appendix A1 for other indicators of investment activity (investment/sales, investment/fixed assets) show a similar picture.

investment activity (Harasztosi et al., 2022). Indeed, during the COVID-19 crisis, as an initial reaction, firm pessimism about external finance increased significantly (as reported in 2020) but this did not translate into an increase in the share of financially constrained firms for the year 2020 (Figure 7). The discrepancy between these variables is due to their different nature: expectations about external finance are probably more cyclical and react more quickly than firms' reporting about actual financial constraints.

Figure 7: Share of financially constrained firms by alterative indicators (weighted)



Note: In case of expectations, the year on the x-axis refer to the survey year; for the other two indicators, the year on the x-axis refers to the financial year (the year before the survey year).

4.2.1 Instrumental variable regressions

Introducing financial constraints in our econometric framework raises endogeneity concerns. First, firms intensively investing in intangible assets are more likely to be financially constrained due to limited acceptance of intangible assets as collateral (unobserved heterogeneity). Second, the intention to invest more can lead to a higher probability of being financially constrained, as firms can run into quantity or price constraints for bank loans (i.e. reverse causality).

To tackle endogeneity issues, we propose an instrumental variable approach based on two indicators of pre-existing financial fragility – lagged excess leverage and lagged cash ratio – as instruments for financial constraints.[6] Excess leverage is defined as the top 25% firms in terms of leverage. Our baseline regression equation for estimating the impact of financial constraints on investment is:

$$\log\left(inv_{it}^{k}+1\right)=\phi FC_{it}+\beta^{t}\delta_{t}+\gamma X_{it}+u_{i} \qquad (3)$$

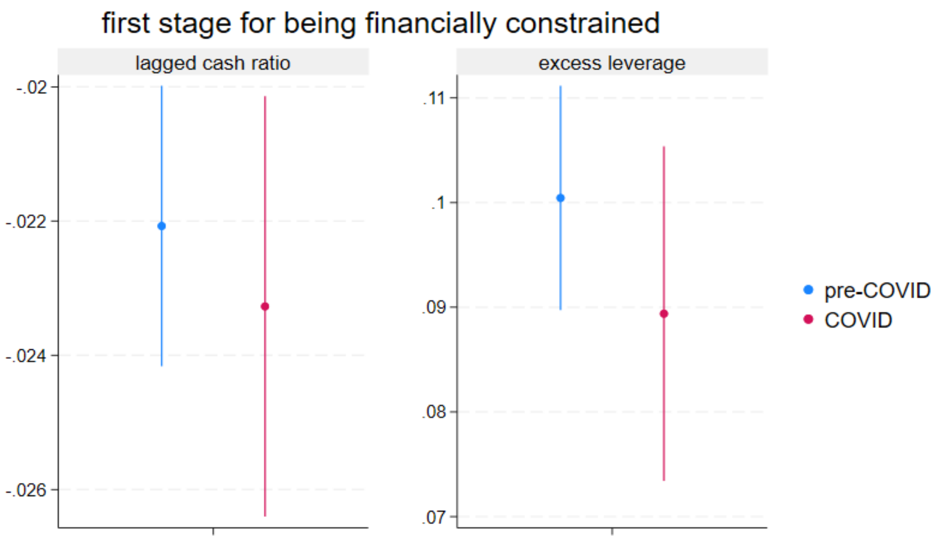
where FC is our indicator of financial constraints for firm i in year t, and X is a vector of firm-level controls, δ_t are time fixed effects. Since our instruments are defined relative to total assets (e.g. leverage is debt over total assets), we also include the logarithm of total assets (lagged) of the firm in X. We estimate equation (3) by 2SLS using country and sector fixed effects. For our main regressions, we use the "availability of finance as a major obstacle" derived from EIBIS as our main indicator for financial constraints, but provide further robustness checks with alternative measures in section 4.2.3.

To explore the association between financial constraints and investment both before and during the COVID-19 crisis, we estimate equation (3) for the years until 2019, and separately for the COVID-19 period (2020 and 2021 pooled), as pooled cross-sectional regressions. Our IV approach is similar to using a financial constraints index like the well-known Altman Z-score (Altman, 1968) as explanatory variable in a simple OLS framework.

[6] Brunello et al. (2022) uses these two variables as measures of financial constraints alongside self-reported constraints of external financing. We try to exclude reverse causality by lagging these variables. We experimented with a proxy of collateral (fixed assets per total assets) as potential instrument but that was insignificant in the first-stage of the instrumental variable regression, as it did not have explanatory power for the presence of financial constraints.

In the first stage regression (Figure 8), both the cash-ratio and excess leverage are correlated with our indicator of financial constraints, after controlling for firm characteristics. As expected, more cash *decreases* (while excess leverage *increases*) the likelihood of being financially constrained. This is equally true for the pre-COVID-19 and for the COVID-19 period, supporting the relevance of our instruments.[7] For the instruments to be valid, we need to assume that they affect investments only through financial constraints.

Figure 8: First stage regression for being financially constrained, pre-COVID and COVID – OLS



Note: The graphs show the estimated coefficient with 95% confidence interval of the cash-ratio and excess leverage variables, with the "availability of finance as a major obstacle" as dependent variable, for the pre-COVID and for the COVID periods (year 2020 and 2021).

Our results of the 2SLS estimations[8] for the impact on log-investment indicate that before COVID-19, land and building, machinery and equipment and software were much more affected by financial constraints than R&D (Figure 9). During COVID-19, the adverse effect of financial constraints became stronger for R&D. Thus, the magnitude of the sensitivity for land and buildings, machinery and equipment and R&D became quite similar in 2020-2021.

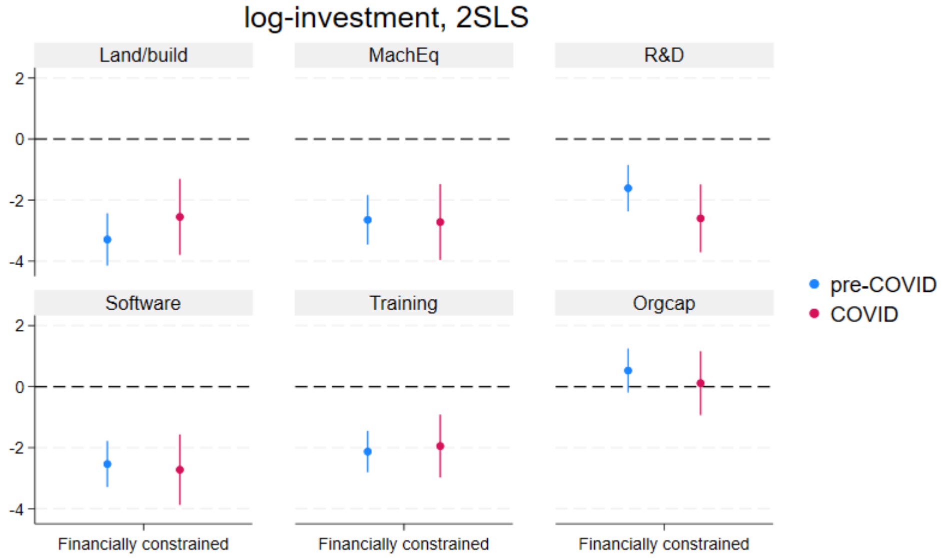
The difference in investment levels between financially constrained and non-constrained firms is large, e.g. in the case of for land and buildings, the estimated coefficient of -3.5 (in logarithm) for the pre-COVID-19 period is equivalent to a 97% difference in investment. For intangibles, such as R&D and training of employee, these estimates are around -2 (in logarithm), equivalent to a 86% lower investment, during the pre-COVID-19 period, which is still very large.[9] These estimates are broadly consistent with findings from Segol et al. (2021), based on the same database for the pre-COVID-19 period using a similar methodology.

[7] The F-statistic from the first-stage of the regression supports the relevance of the instruments. (102.3 for the COVID period, and 604.7 for the pre-COVID period).

[8] OLS estimates are biased upward (see Appendix A2, Figure 17), as evidenced by the statistically significant positive coefficient for R&D and in line with theoretical considerations.

[9] Note that the overall impact of COVID is per se very large, e.g. around -1 (in logarithm) for tangible investments (see section 3.1), which translates into a reduction of -63%.

Figure 9: Impact of being financially constrained on log investment – 2SLS

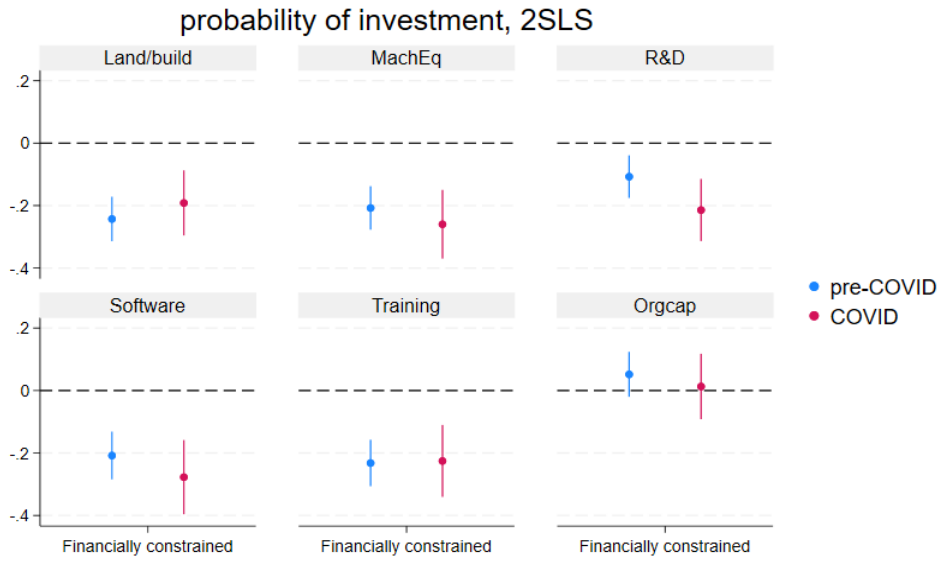


Note: The graph shows the estimated coefficients of the financial constraints indicator ("availability of finance as a major obstacle") for different asset categories and for different periods (before COVID, and during COVID for 2020 and 2021).

*T*he results shown in Figure 10 suggest that the probability of investment for financially constrained firms are substantially lower for all assets than for non-constrained firms, except for organisational capital (with the coefficients being not statistically significant at the 5% level). This confirms that one of the drivers of the differences in investment levels between constrained and non-constrained firms comes from the lower propensity of constrained firms to invest. In other words, financial constraints on investment might deter many firms from investing at all.

Second, we obtain broadly similar results in terms of the ranking of the sensitivity of assets for the full effect and for the extensive margin, both for the time-period before and during COVID-19. Describing the effect on the probability of investing, as depicted in Figure 10, provides a more intuitive interpretation of the quantitative impact of financial constraints. As an example, before the COVID-19 outbreak, financially constrained firms invested into R&D with a 10 percentage points lower probability compared to non-constrained firms. During COVID-19, this difference in investment propensities in R&D between financially constrained and non-constrained firms increased to 20 percentage points.

Figure 10: Impact of being financially constrained on the probability of investing in different asset categories – 2SLS



Note: The graph shows the estimated coefficients of the financial constraints indicator ("availability of finance as a major obstacle") for different assets and for different periods (COVID for 2020 and COVID21 for 2021).

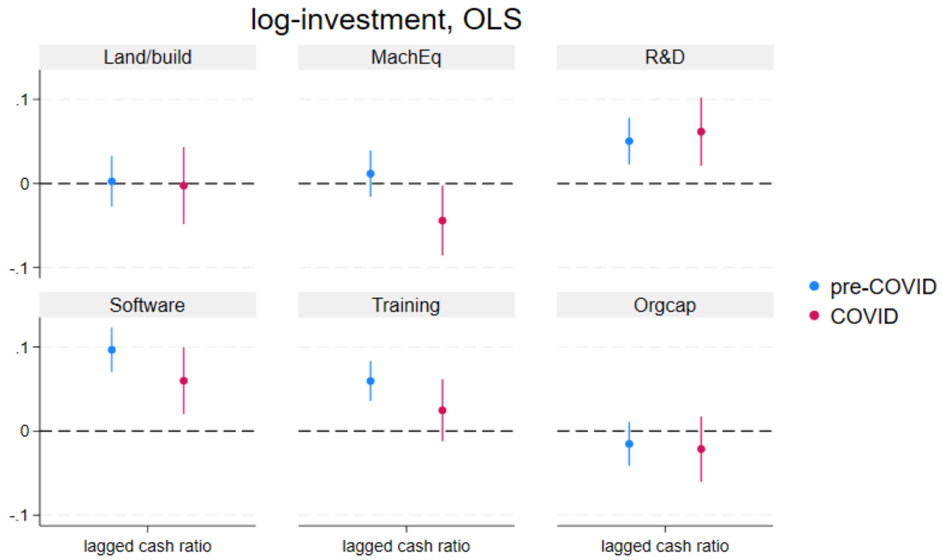
4.2.2 Robustness checks – Reduced form estimations

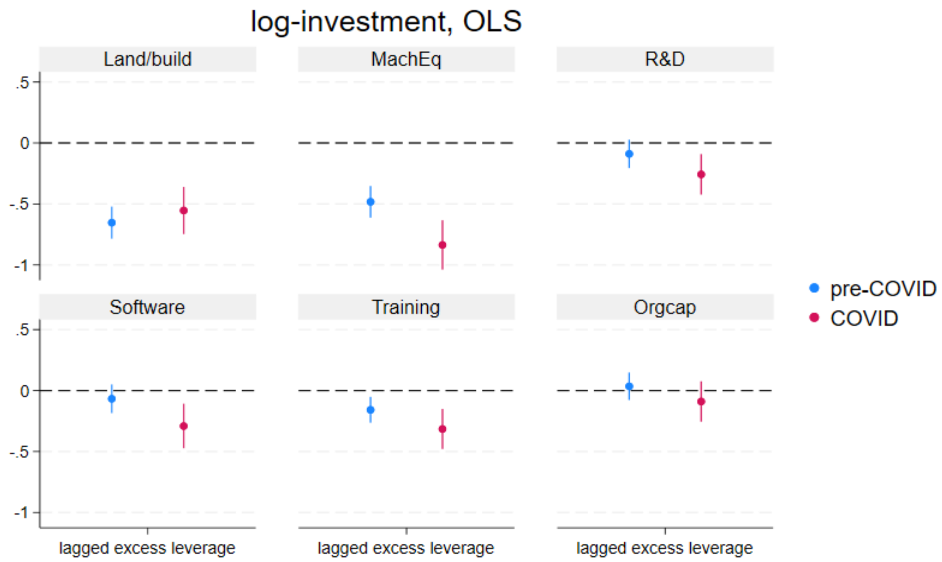
As an alternative to 2SLS, we also estimate the impact of pre-existing financial constraints on investment using a simple OLS with the lagged excess leverage and cash ratio as additional explanatory variables. In this way, we estimate the direct effects of pre-existing financial fragility on investment, without having to assume that these effects operate only through being financial constrained. We run this reduced form regression both for overall investment and the extensive margin separately.

$$\log\left(inv_{it}^{k} + 1\right) = \phi_1 exlev_{it-1} + \phi_2 cashratio_{it-1} + \beta^t \delta_t + \gamma X_{it} + u_i \qquad (5)$$

Our results indicate that excess leverage is (negatively) associated with investment in several types of assets, such as land and buildings, machinery and equipment, R&D, and employee training, and the sensitivity of investment increased during 2020-2021 compared to the pre-COVID-19 period (see Figure 11, lower panel). For cash, we find that it helped investment only in intangible assets, which is consistent with the view that intangibles are mainly financed from internal sources (see Figure 11, upper panel). These findings support the relevance of our instruments used in the 2SLS estimation. The results for the extensive margin, i.e. for the association between the probability of investment and the cash-ratio and excess leverage, are qualitatively similar to the previous results on log-investment (see Figure 20 in Appendix A2).

Figure 11: Association of log-investment to cash and excess leverage, pre-COVID and during the COVID – OLS





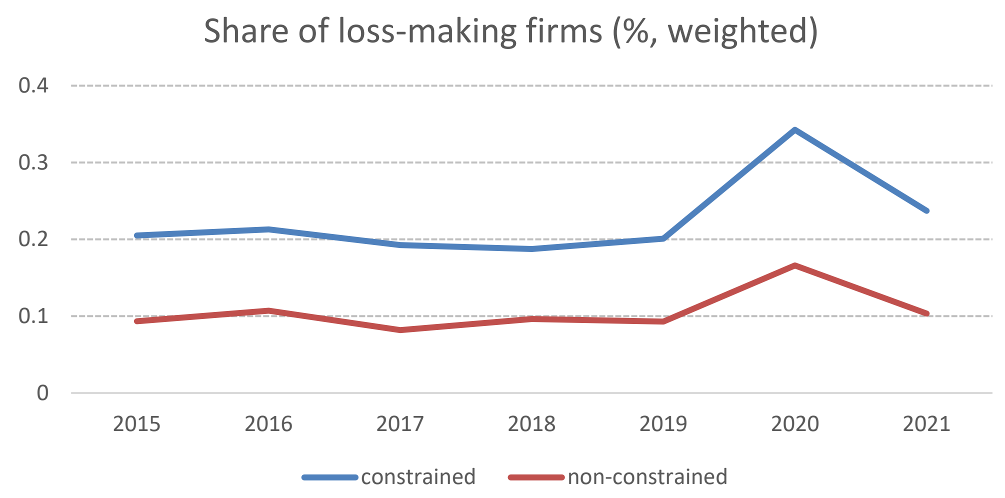
Overall, we find a larger adverse impact on investment during COVID-19 compared to the pre-pandemic period, especially for R&D investments. This result is not entirely surprising, considering that during crisis periods, firms' liquidity position worsens, contributing to lower investment. This may have happened to some extent during COVID-19 despite the generous policy support provided to firms. As indirect evidence, we observe that the profitability situation of firms (measured by the share of loss-making firms) worsened much more in 2020 for financially constrained firms compared to non-constrained firms (Figure 12).[10] Thus, liquidity was probably comparatively tighter for financially constrained firms during COVID-19, contributing to the decline in investment. At the same time, policy support contributed to mute the increase in the number of financially constrained firms.

As we find that financial constraints were seriously binding during the pandemic for various asset categories, including R&D and employee training (which are two key assets for long-term growth), we can speculate on the avoided damages of financial constraints on investment thanks to policy intervention. Based on historical pre-pandemic association of expected deterioration of external finance ("pessimism") and financial constraints (availability of external finance as a major obstacle to investment), we can calculate a hypothetical increase in

[10] Profitability is reported by the firms in EIBIS in each year. Our results are qualitatively similar if we control for size, age, sector and country fixed effects.

the share of financially constrained firms of 5.4 percentage points in case of no policy support. Together with our estimate of FC impact on R&D of -2.6 (in log), it means that policy support might have prevented a further decline in R&D of about 14% in 2020, a non-trivial effect.

Figure 12: Share of loss making firms for financially constrained and non-constrained firms (%, weighted)



Note: Firms reporting availability of finance as a major obstacle to investment are defined as financially constrained

4.2.3 Robustness checks - Alternative indicators for financial constraints

As a robustness check, we repeat the instrumental variable approach with other FC indicators available in EIBIS, e.g. self-reported external financial constraints which are a combination of rejection of application for external finance, discouraged borrowing or price/quantity constraints. Furthermore, we look at the short-term outlook of external finance (expectation of improvement or deterioration in the next 12 months). We included the graphs for these results in Appendix A2.

Our previous 2SLS results are qualitatively similar to the case when we define financial constraints based on self-reported constraints (rejected application for external finance, discouraged borrower, price and quantity constrained), although our baseline results are quantitatively smaller.. Brunello et al. (2022) based on the EIBIS and using a combination of self-reported constraints, leverage and cash-ratio, and employing a different IV strategy, find different elasticities: no impact on training from financial constraints and lower, but a substantial negative impact on physical investments.

We also estimated the same regressions using the short-term outlook about external finance (lagged) as an indicator of being financially constrained (again, see Appendix A2, Figure 19). In this case we find qualitatively different results. Investments are generally less sensitive to pessimism about external finance during COVID than before COVID, and even became insignificant for all intangible assets. This suggests that policy support avoided many pessimistic firms to become financially constrained, in line with the fact that pessimism increased but actual financial constraints (self-reported constraints and finance as major obstacle) did not during the pandemic.

4.2.4 Robustness checks – 2SLS estimation without the cash ratio

The validity of our instruments, excess leverage and cash ratio, is based on the assumption that they affect investment only through financial constraints, and not directly. This assumption might be questioned for the cash ratio on the grounds that cash can be used as a buffer for investment, especially during crises. As our main indicator of financial constraints (finance as major obstacle for investment) also includes obstacles to internal finance, we think that cash buffers as a type of liquidity contribute to less binding financial constraints. To address the potential issue of validity, the results of 2SLS estimations without the cash ratio, i.e. using only excess leverage as instrument are reported in Appendix A2 (Figure 20 and Figure 21, for the log-investment and probability of investment, respectively).

We find that the effect of financial constraints is actually larger (more negative) for the tangible assets while it is more or less the same for the intangibles. In case of cash impacts investment directly (positively), not entirely through financial constraints, we would expect smaller negative effects than in the baseline results, not larger ones. This suggests that the validity of the cash ratio might hold. At the same time the robustness checks show qualitatively the same results as the baseline estimation: we find negative effects before and during COVID, while these negative effects are somewhat stronger during COVID for most of the assets (though not statistically significantly).

4.3 Extension: What is the role of income shocks to firms on (in)tangible investment during COVID-19?

Our analysis has focused on the role of financial constraints during the COVID-19 crisis and their impact on investment behaviour. In this subsection, we investigate the role of income shocks as another crisis transmission channel. Part of the large adverse effect of COVID-19 on investment stems from a big decline in sales of firms during the crisis.[11] A decline in income may affect investment adversely via different channels. One is the accelerator-type relationship between income and investment, i.e. demand affects investment directly (see e.g. Barkbu et al., 2015). In this context, a decline in income might also lead to increased financial constraints due to tighter liquidity.

In line with the evidence in the literature on the smaller sensitivity of intangibles to demand (see e.g. Thum-Thysen et al. (2019), Aghion et al. (2010) and Aghion et al. (2012)), we expect that we will find lower income elasticities to intangible assets compared to tangible assets. Alternatively, we can expect that important heterogeneity within the tangible/intangible asset group is partly explained by these income elasticities.

In our identification strategy, we exploit the fact that during the COVID-19 pandemic, some firms were hit by large income shocks, stemming from the deterioration of demand (and supply) conditions. Although we cannot assume that the large drop in income is completely exogenous (e.g. firms that are more fragile could have suffered a larger drop in income), we can plausibly assume that these declines during COVID-19 did not stem from lower investment during COVID-19. We classify firms into two groups based on whether their sales dropped by at least 25% or not in 2020. As this variable is only available for 2020, we cannot use a standard pooled OLS or fixed-effect panel estimation. Rather, we use a first difference (FD) estimator, thus estimating the change in investment for the two groups between 2019 and 2020, with the difference providing an estimate of the impact of the large income shock for the various assets. For this exercise, we can use only the subsample of firms existing both in 2019 and in 2020 in the EIBIS sample. We estimate the following equation for the FD estimation for overall investment as well as the extensive margin (i.e. the probability of investment) for the year 2020:

$$\Delta \log\left(inv_i^k + 1\right) = \phi drop_i + \lambda X_i + \varepsilon_i, \quad (6)$$

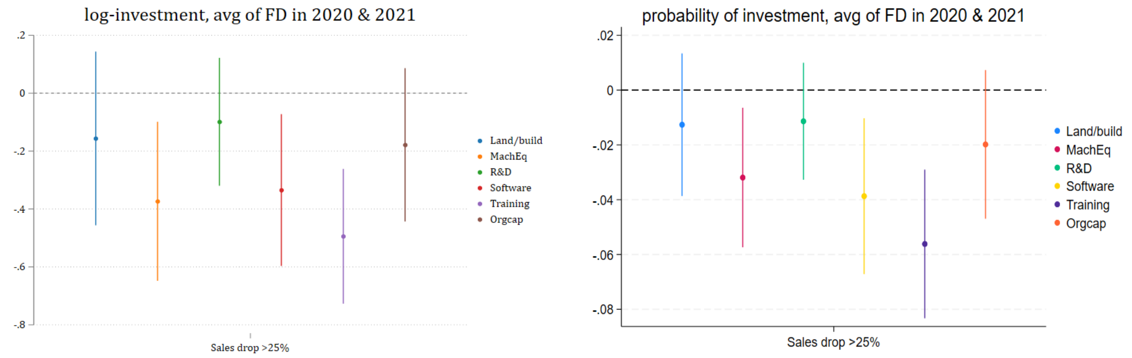
where:

$$drop_i = \begin{cases} 1, \ if\ sales\ dropped\ by\ more\ than\ 25\%\ in\ 2020 \\ 0, \ if\ sales\ did\ not\ drop\ by\ more\ than\ 25\%\ in\ 2020 \end{cases}$$

In this equation, ϕ measures the impact of a large sales drop on investment in asset k in 2020 compared to 2019. X includes firm size and age, as well as country and sector fixed-effects. We could have separately estimated the same equation for 2021, still using the sales drop variable for 2020. Thus, the results would show the impact of the large sales drops on the change in investment between 2020 and 2021. Instead of reporting the results separately for 2020 and for 2021, we pooled the two years together for the estimation.

11 Another important factor could have been the increased uncertainty during COVID-19 (see, e.g. Bernanke, 1983).The analysis of the impact of uncertainty on investment is beyond the scope of this paper.

Figure 13: Estimated impact of a large, at least 25% drop in sales in 2020 on log-investment and on the probability of investment by asset – first difference estimation pooled for 2020 and for 2021



According to our results, an income shock decreases investment and the probability of investment mostly in machinery and equipment, software and training. It decreases investment the least in land/building, in R&D and in organisational capital. Results for the extensive margin (right panel in Figure 13) show an almost identical picture.

The lower sensitivity of R&D and the higher sensitivity of machinery and equipment to the sales drop are in-line with previous findings of the literature on the impact of demand shocks on tangible/intangible investment (Aghion et al., 2010, 2012; Thum-Thysen et al., 2019). Furthermore, the elasticity of investment to the sales shock helps to explain the high decline of machinery and equipment and the low decline of R&D investment during COVID, as seen in section 4.1.2. Employee training also declined significantly during the pandemic despite being an intangible asset. This finding can be associated with difficulties of in-person training during the COVID-19 pandemic due to restrictions to mobility and social distancing rules. Furthermore, software – an intangible asset – was quite sensitive, while land and buildings – a tangible asset – was insensitive to income shocks. One possible hypothesis to explain these differences relates to different costs associated with reversing or stopping an investment. As an example, it might be easier to stop buying software or halt the training of employees rather than to stop on-going constructions or to lay-off R&D scientists[12], which constitutes one of the main ways to stop investing into R&D.

5 Conclusion

This paper addresses two intertwined research questions. Are tangible or intangible assets more resilient in crisis times? What is the impact of financial constraints on investment dynamics? Previous research has established that intangible investment was relatively more resilient compared to tangible investment during the global financial crisis in 2008-2009 (Corrado et al., 2016; European Commission, 2022). According to our results for the latest COVID-19 crisis based on firm level data, we find heterogeneity in the extent of the decline in investment among intangible and tangible assets. R&D investment declined the least in 2020, while investment into training, an intangible asset, and into machinery and equipment, a tangible asset, declined the most. The decline in land and buildings, software and organisational capital was relatively mild. These results come from estimations where we control for firm characteristic (size, age, sector and country), and our findings remain largely the same independently of the estimation method (pooled OLS or firm fixed-effect) or of the dependent variable (log investment, probability of investment). We argue that aggregating different (in)tangible assets into one group can hide significant underlying heterogeneity in specific assets.

When exploring the role of financial constraints in explaining investment behaviour, we find that financial constraints decrease investment in general. This effect was comparatively low for R&D before the COVID-19 crisis. In 2020, the number of financially constrained firms did not grow, likely due to policy support provided to firms, but the role of financial constraints increased for R&D investment. However, this increase between pre-COVID-19 and COVID-19 periods is not statistically significant. The robust finding is that we can observe a strong negative impact of financial constraints on investment during both COVID-19 and pre-COVID-19. From a policy

12 R&D scientists could have benefitted from furlough schemes which might have contributed to this effect.

point of view, our results indicate that strong policy support was vital to mitigate the increase in the number of financially constrained firms, as these constraints presented an obstacle to investment during the COVID-19 crisis into different asset categories, including R&D and employee training, two vital sources for long-term productivity growth.

As regards the investment elasticity to demand, we estimated the response of investment to a large (at least 25%) decrease in sales. We find that employee training, machinery and equipment, and software and data were the most sensitive to income shocks during the COVID-19 crisis, while investment into land and buildings, into R&D, and into organisational capital were the least sensitive to these shocks. Thus, the heterogeneous decline across assets can be partly explained by the different sensitivity of assets to the large decrease in income during the COVID-19 crisis. Notably, the low decline in R&D can be associated to its low sensitivity to income shocks.

Clearly, more research on this topic is warranted. Future research could for instance focus on different and additional propagation channels of the COVID-19 crisis on firm investment, such as uncertainty shocks. Secondly, our research does not allow us to explore whether the temporary fall in investment intensities translates into persistent falls of investment activity, and whether persistence depends on investment (e.g. asset specificity) or firm characteristics. This important question might be addressed using future waves of the EIB Investment Survey.

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Appendix

A.0 Overview of sample

Table 2 shows the number of observations in the EIBIS sample for the EU-27 countries for the time period 2015-2021 for our unbalanced panel of firms. As column 2 shows, the coverage of firms reporting information on asset level investment data is very high. However, the share of panel firms, which are tracked in two consecutive waves (column 4), is close to 40%.

Table 2: Number of observations in EIBIS (excluding the UK and the US)

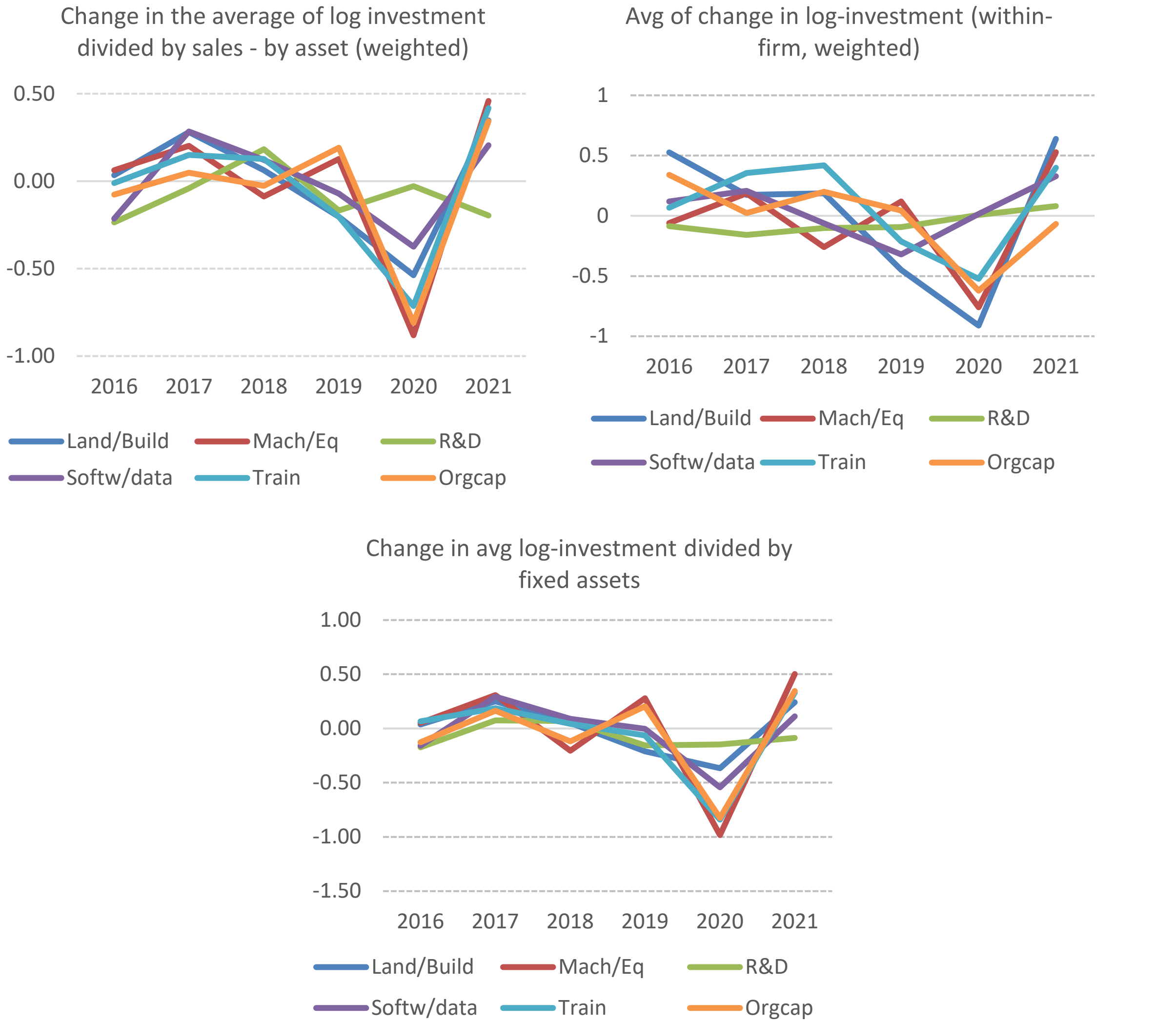
Year	Sample size	With asset level investment data	With asset level investment data for the current and the previous year
2015	11882	10537	0 (0%)
2016	11738	10796	4011 (37%)
2017	11753	10511	4647 (44%)
2018	12071	10255	3973 (39%)
2019	11971	10671	4007 (38%)
2020	11920	10887	4512 (41%)
2021	12021	10851	4573 (42%)
Total	71335	63657	21150 (35%)

Note: Year is the financial year in which firms report their investment activity. Column 3 refers to the number of firms with non-missing data on investment for individual asset categories.

A.1 Using alternative indicators for investment

The following figures depict the evolution of firm investment using different indicators for financial constraints. In particular, the indicator is based on firms self-reported difficulties in accessing external finance with firms defined as financially constrained if either i) their application for external finance was rejected; ii) they were discouraged to apply for external finance; or iii) they were dissatisfied with the quantity or price of external finance.

Figure 14: Evolution of investment in different assets for alternative measures of investment: investment scaled by sales, within-firm change of investment and investment scaled by lagged total fixed assets (log-points)



Note: "Land/build"=land and building, "Mach/Eq"=machinery and equipment, "R&D"=research and development, "Softw/data"=software and data, "Train"=employee training, Orgcap"=organisational capital.

Figure 15: Estimated impact of COVID on alternative measures of investment: investment/sales, investment/fixed assets (in logarithm)

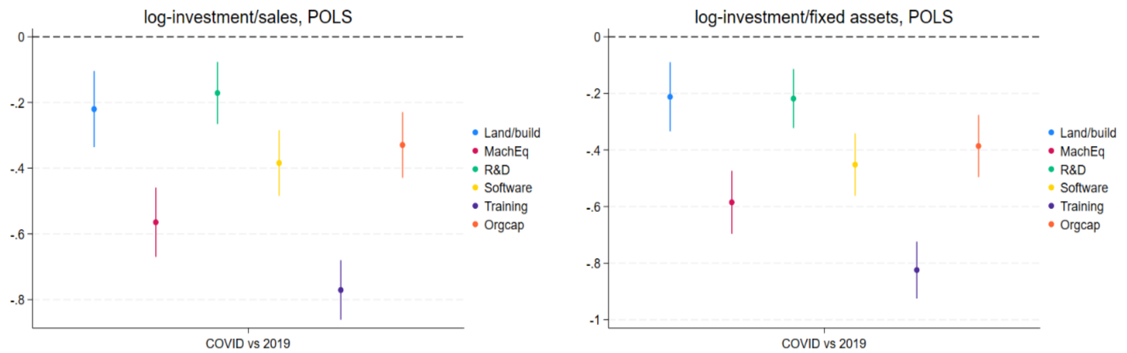
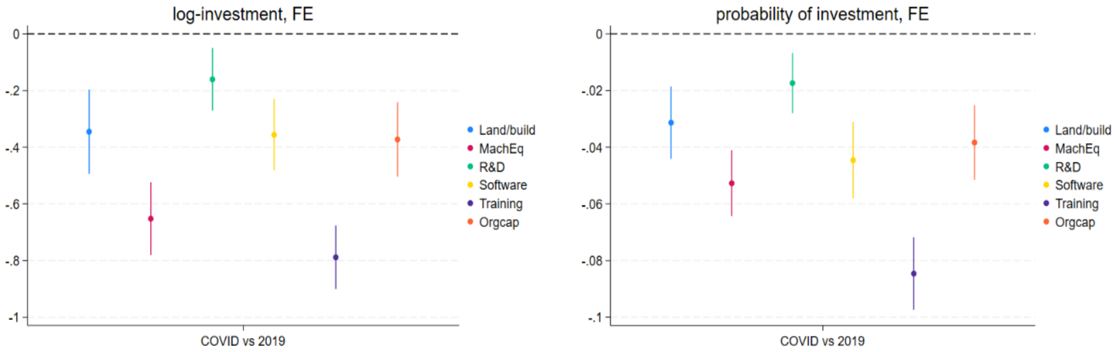
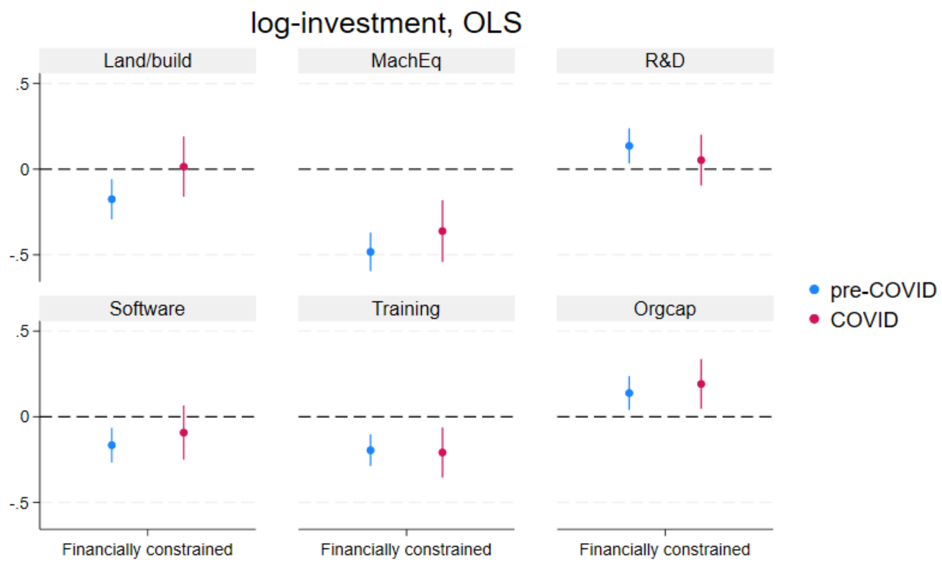


Figure 16: Estimated impact of COVID on investment activity –fixed effect panel estimation



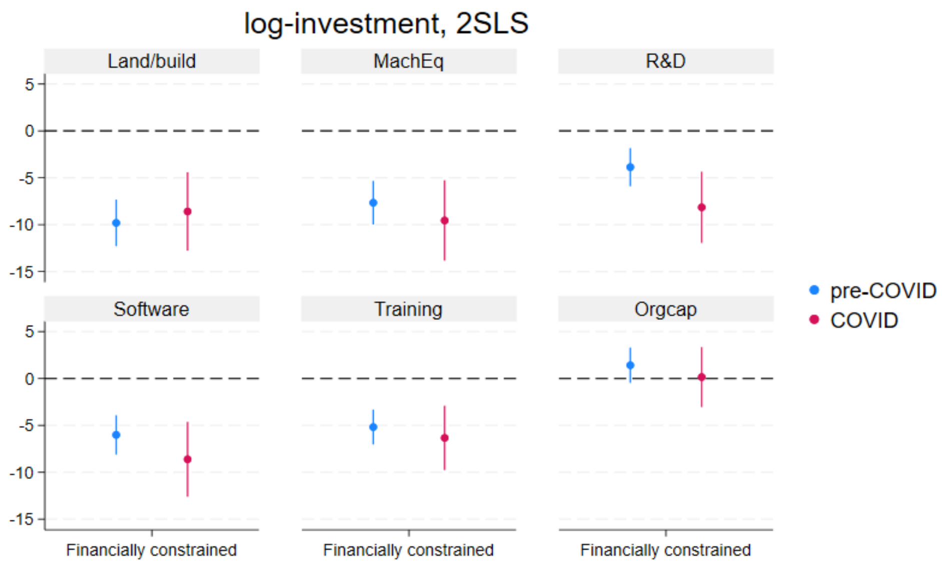
A.2 Robustness checks for the effect of financial constraints

Figure 17: Impact of financial constraint on log-investment, "availability of finance as a major obstacle" as the financial constraints indicator – OLS



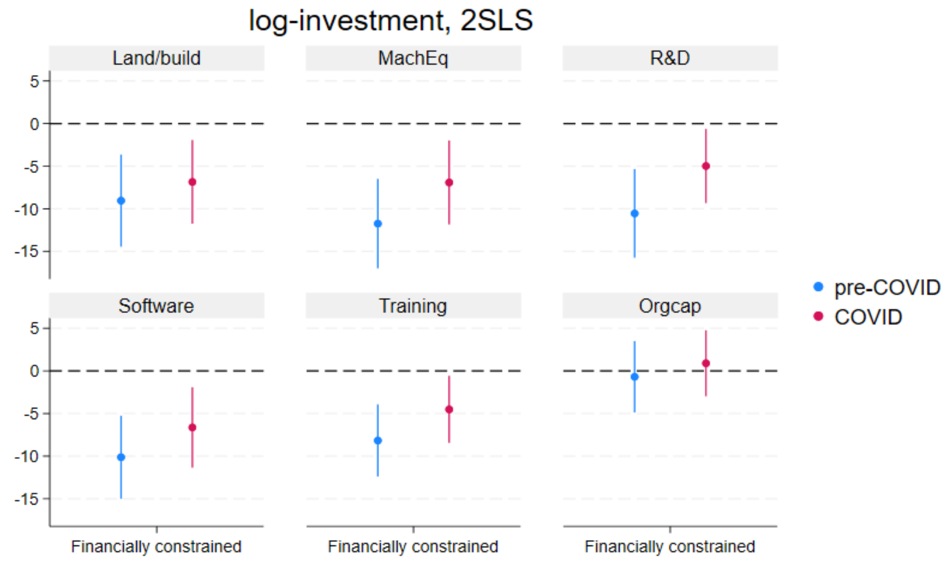
Note: COVID denotes the average impact in 2020-2021.

Figure 18: Impact of financial constraints on log investment, self-reported constraints (rejection, discouraged, price and quantity constrained) – 2SLS



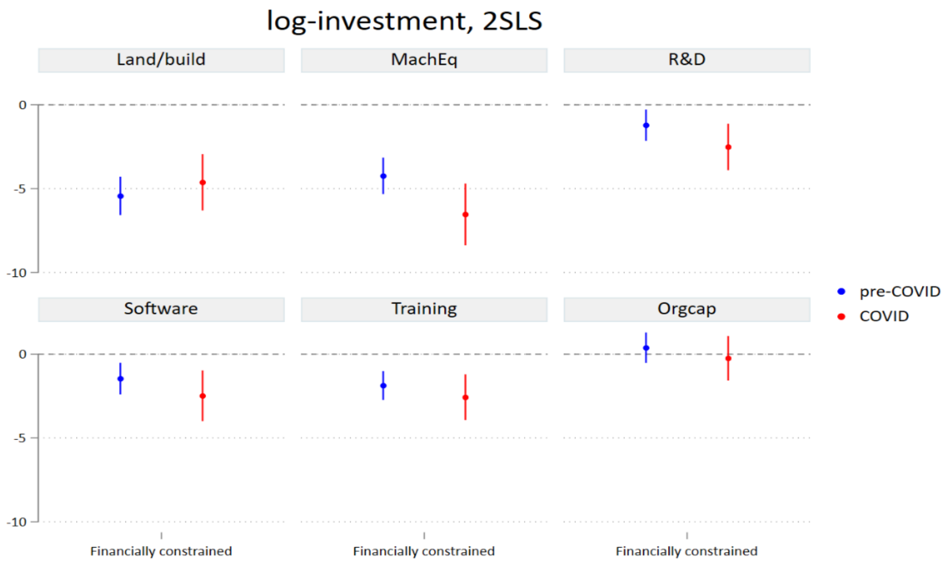
Note: COVID denotes the average impact in 2020-2021.

Figure 19: Impact of financial constraints on log investment, – deterioration expected in external finance (lagged) – 2SLS



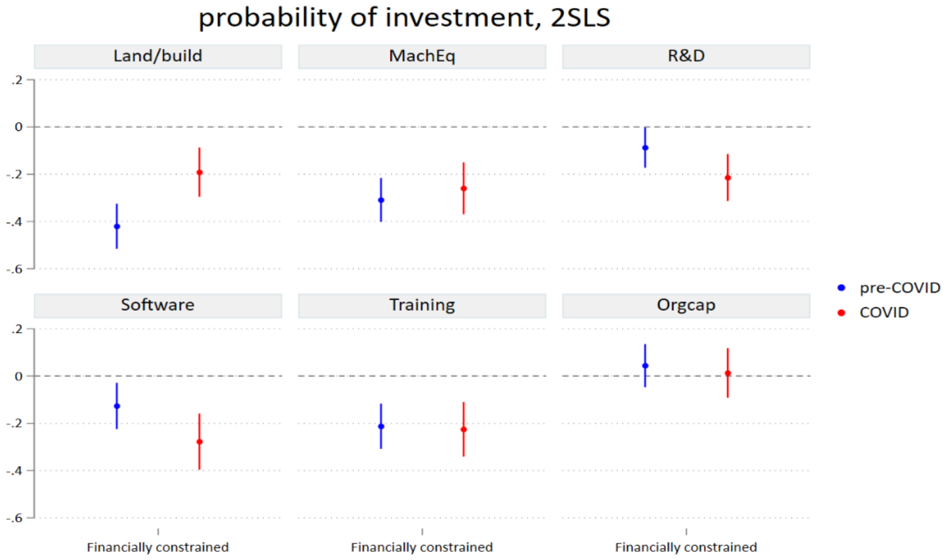
Note: COVID denotes the average impact in 2020-2021.

Figure 20: Impact of financial constraints on log investment, estimation without cash ratio – 2SLS



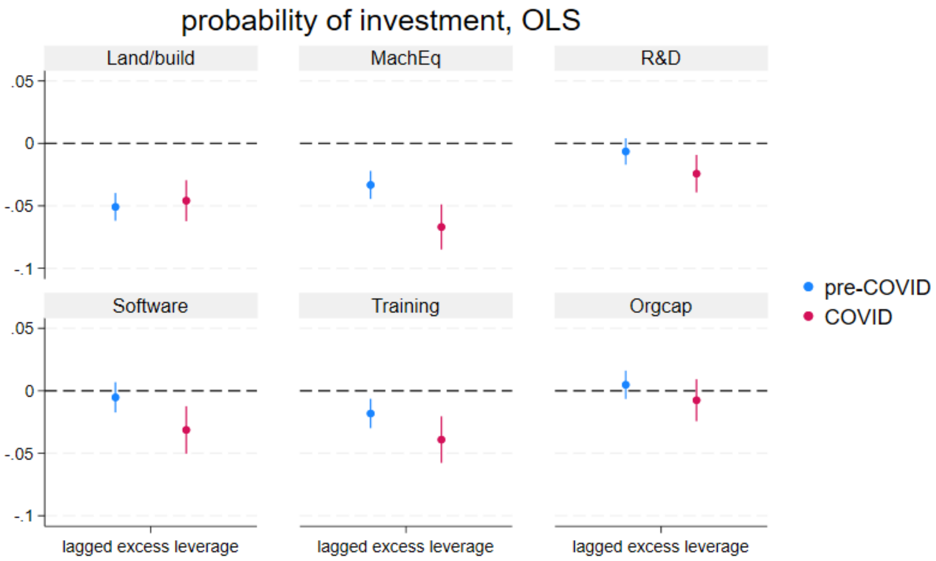
Note: COVID denotes the average impact in 2020-2021.

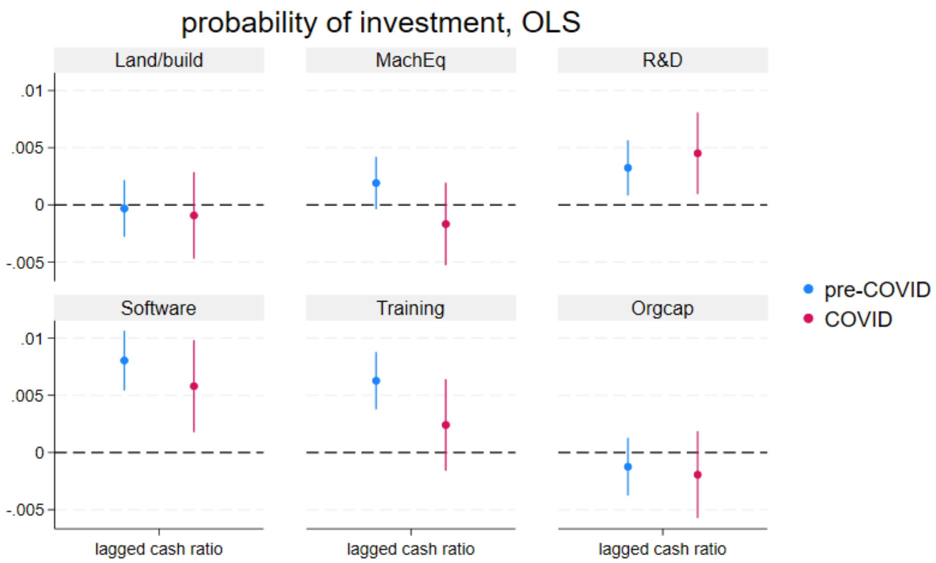
Figure 21: Impact of financial constraints on probability of investment, estimation without cash ratio – 2SLS



Note: COVID denotes the average impact in 2020-2021.

Figure 22: Association of the probability of investment to cash and excess leverage pre-COVID and during the COVID – OLS

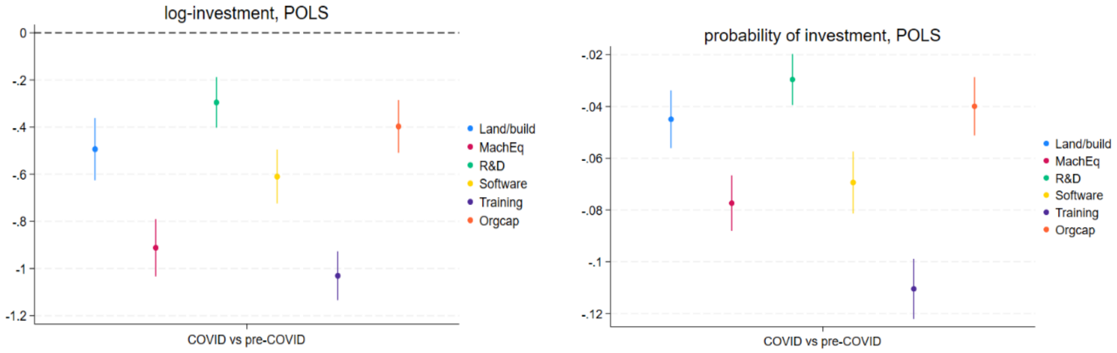




Note: COVID denotes the average impact in 2020-2021.

A.3 COVID-19 impact on investment, controlling for linear trend in pre-pandemic investment

Figure 23: Impact of COVID-19 on investment activity, controlling for a linear trend in investment activity (change in logarithm, and change in probability)



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