Financing Constraints and Employee Training

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Abstract

Using a representative sample of firms in the 28 EU Member states, we study whether and to what extent financing constraints affect employers' decision to invest in employee training. We combine survey data on investment activities with administrative data on financial statements to develop an index of financing constraints. We estimate that a 10 percent increase in this index reduces investment in training (expressed as share of fixed assets) by 2.9 to 4.5 percent. We show that European firms facing tighter financing constraints not only reduce their total investment but also alter its composition by cutting back the investment in training and tangible assets less than the investment in software and data and R&D.

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Introduction

About one in five companies in the EU report to have invested too little in the training of their workforce in 2017 (EIB, 2018). This is a source of concern because of the need to update the skills of the workforce in an economic environment characterized by globalization, population ageing and technological progress and of the key role played by firms in financing lifelong learning.

Firms under-invest due to factors affecting the expected marginal benefits of training. These include the hold-up problem, i.e. after the investment is done workers may capture part of the benefits by threatening to leave, poaching, staff turnover and the presence of externalities – for example when the investing firm does not take into account in its decisions the fact that other firms could benefit from the investment in training (see for instance Lynch, 1994, and Bassanini et al, 2007).

Under-investment may also occur because of financing constraints. When capital markets are not perfect, firms may be limited in their ability to invest as much as planned because they have difficulties in accessing external funds or because these funds are excessively costly. The costs of raising external finance are typically higher for firms with high leverage, low liquidity and solvency.[1]

While there is a large empirical literature on the effects of financing constraints on investment decisions (see Hubbard, 1998, for an early survey), less research has been done to investigate the effects on investment in training, which affects the human capital of employees and has important implications for the development of skills

[1] Leverage measures the debt position of firms, liquidity describes the degree to which an asset can be quickly bought or sold and solvency measures an enterprise's ability to meet its debt obligations.

within firms. In the only study we are aware of, Popov, 2014, uses data from the 2005 "Business Environment and Enterprise Performance Survey" (BEEPS) on 8,265 small and medium sized enterprises belonging to 25 transition economies and finds that lack of access to finance in general, and of bank credit in particular, is associated with significantly lower investment in on-the-job training.

We contribute to this literature in two main directions. First, we use firm-level data drawn from the EIB Investment Survey (EIBIS), which cover firms in the 28 EU Member States. Unlike Popov, 2014, our sample of countries thus includes both the transition economies of Central and Eastern Europe and the developed economies of Western Europe, which differ in their systems of financial intermediation in spite of the harmonised regulatory framework.

Second, we match survey data of EIBIS with administrative data on the financial statements of firms (from the ORBIS Bureau Van Dijk database) and develop an index of financing constraints that uses information from both sources of data – self-reported financing constraints from EIBIS and lagged indicators of leverage, liquidity and solvency from ORBIS. Our approach, which addresses both reverse causality and measurement error, relies on the idea that self-reported constraints are more credible when they are backed up by hard financial data.

We estimate the effect of the financing constraints index on training investment (as a share of fixed assets or per employee) and compare it with the effect on (i) total investment; (ii) investment in research and development, including the acquisition of intellectual property; (iii) investment in software, data and IT network; (iv) investment

in tangible assets (land, business buildings and infrastructure, machinery and equipment).

We find that a 10 percent increase in the financing constraints index reduces investment in training (as a share of fixed assets) by 2.9 to 4.5 percent, depending on the empirical specification, investment in R&D by 5.4 to 13.8 percent, investment in software and data by 7.6 to 9.10 percent, investment in tangible assets by 4.2 to 5.3 percent and total investment by 4.4 to 4.8 percent. These results indicate that European firms facing tighter financing constraints not only reduce their total investment but also alter its composition by cutting back the investment in training and tangible assets less than the investment in software and data and R&D.

To gauge the size of the estimated effects, we ask what would be the impact on average training investment in Portugal of reducing the financing constraints index in that country from its average level (0.102) to the level prevailing in Germany (0.032). We find that this drastic change (-68.6 percent) would increase average investment in training in Portugal from 1.8 to 2.2/2.4 percent of fixed assets, still much lower than the average level in Germany (3.2). The training gap would be further reduced by additional 0.2 percentage points, according to our estimates, if Portuguese firms were as profitable as German firms.

We conclude that cross–country differences in financing constraints account for an important share of the observed differences in training investment across European economies, which are also driven by the heterogeneity of profitability, economic institutions, industrial structure, innovation activities and the relative supply of skills (Bassanini et al, 2007). Policies that successfully address these constraints are likely to

pay off in terms of higher training investment but are unlikely to be sufficient to eliminate the observed within-Europe variation in employer provided training.

The remainder of this paper is organised as follows. Section 1 briefly reviews the relevant literature. Section 2 introduces an illustrative model that highlights the relationship between financing constraints and training investment by firms. Section 3 presents the data. Section 4 discusses the relationship between reported financing constraints and the financial situation of firms to derive the financing constraints index. Section 5 introduces the empirical strategy and Section 6 illustrates the results. Conclusions follow.

1. Literature review

In a world of frictionless financial intermediation, a firm's financial structure does not affect its market value and real firm decisions, motivated by the maximization of shareholders' claims, are independent of financial factors (Modigliani and Miller, 1958). However, there are a number of reasons why financial intermediation is not frictionless. These include taxes, transaction costs and information asymmetries (between lenders and borrowers and/or between managers and shareholders), which make external sources of finance more expensive than internal finance.

When markets are characterised by information asymmetries, external finance is available only on less favourable terms in capital markets or is not available at all. Under such circumstances, investment spending is constrained by the shortage of internal funds (Fazzari et al, 1988) and credit rationing may occur.[2] Any investment

[2] We define credit rationing as the case in which economic agents "…would not receive a loan even if they offered to pay a higher interest rate" (Stiglitz and Weiss, 1981, p.395).

activity can potentially be adversely affected by a rise in borrowing costs – including investment in employment (Nickell and Nicolitsas, 1999; Boeri, Garibaldi and Moen, 2017) and human capital (Popov, 2014).

A large empirical literature has examined the validity of these predictions and, in a broader sense, the existence of financing constraints arising from informational asymmetries and agency problems (see Hubbard, 1998, for a survey). Much of this literature has relied on firm-level data and reduced-form investment models featuring costly external finance and controlling, at least in part, for current and expected shifts in product demand.

In a seminal contribution, Fazzari et al, 1988, regress investment on Tobin's Q and the ratio of cash-flow to capital as a proxy of financing constraints. The problem with using cash-flow, however, is that it is closely related to operating profits and to the marginal product of capital and therefore measures "…investment opportunities rather than, or in addition to, measuring the availability of internal funds…" (Love, 2001, p.9).

An alternative to cash-flow is the Kaplan–Zingales (KZ) index (Farre-Mensa and Ljungqvist, 2015), which relies on the qualitative measure of financing constraints developed by Kaplan and Zingales, 1997. Lamont et al, 2001, regress this measure on five readily available accounting variables: cash flow to total capital, market-to-book ratio, leverage (debt to total capital), dividends to total capital, and cash holdings to total capital. They use the estimated regression coefficients to construct the KZ index, which loads positively on the market-to book ratio and leverage and negatively on

cash-flow, dividends and cash holdings. A higher value of this index suggests that a firm is facing tighter financing constraints.

Another measure of financing constraints used in the literature is based on the replies to direct questions asking whether firms were denied credit or did not apply for it in the first place fearing that they would be rejected. Studies using self-reported constraints include Beck et al, 2005; Campello et al, 2010; Popov, 2014 and Ferrando and Mulier, 2015a. In a recent paper, Garcia-Posada Gomez, 2018, uses data from a large panel of small and medium-sized enterprises in 12 European countries for the period 2014-2016. He measures credit constraints by combining the following information: a) a firm's application to external financing was rejected; b) a firm only received a limited part of what it applied for; c) a firm refused the lender's proposal for external financing because borrowing costs were too high; d) a firm did not apply for external financing because it feared its application would be rejected. He finds that credit constraints, both in bank financing and other financing (e.g. trade credit), have strong negative effects on investment in fixed assets.

2. An illustrative model

In this section, we introduce a simple model that illustrates the relationship between financing constraints and investment in employee training. Consider an economy populated by identical firms employing homogeneous workers. Production requires technology, capital and employment. Individual productivity is enhanced by training. Each firm in this economy operates the technology $Y = AK^{\beta}(L^{e})^{\alpha}$, where Y is output, A is the level of technology, K the capital stock and L^{e} is labour in efficiency units.

Following Bassanini and Brunello, 2011, labour in efficiency units is defined as

$L^e = L(1+\tau)$, where L is employment and τ is average training per employee. We assume that $\Delta = 1-\alpha-\beta > 0$, i.e. decreasing returns to scale with respect to capital and labour. Product prices are set in the international market and normalised to 1.

Firms in this economy use debt as a source of external finance. The effective cost of borrowing rises with leverage and decreases with liquidity and solvency, because the interest rate paid on loans is affected (Bond and Meghir, 1994). Applications for credit by firms with high leverage or low liquidity and solvency may be rejected, generating financing constraints (FC). These constraints affect both the cost of capital *c* and the cost of training μ by increasing the cost of raising external finance (Carpenter and Petersen, 2002). They could also affect wages *w* (Milanez, 2012), as firms with low working capital can cut wages, but we exclude this possibility here.

Each firm maximizes profits with respect to capital K, employment L and training per employee τ. The costs of labour and capital are *w* and *c*, and the cost of training per employee is $\frac{\mu}{2}\tau^2$.[3] The real profits of firm *i* are

$$\Pi_i = A_i K_i^{\beta}(1+\tau_i)^{\alpha} L_i^{\alpha} - wL_i - c_i K_i - \frac{\mu}{2}\tau_i^2 L_i \qquad (1)$$

The first order conditions necessary for an internal maximum are

$$\frac{\partial \Pi_i}{\partial K_i} = 0 \Rightarrow \beta A_i K_i^{\beta-1}(1+\tau_i)^{\alpha} L_i^{\alpha} = c_i \qquad (2)$$

$$\frac{\partial \Pi_i}{\partial L_i} = 0 \Rightarrow \alpha A_i K_i^{\beta}(1+\tau_i)^{\alpha} L_i^{\alpha-1} = w_i + \frac{\mu}{2}\tau_i^2 \qquad (3)$$

$$\frac{\partial \Pi_i}{\partial \tau_i} = 0 \Rightarrow \alpha A_i K_i^{\beta}(1+\tau_i)^{\alpha-1} L_i^{\alpha} = \mu \tau_i L_i \qquad (4)$$

[3] The assumption that training costs are convex in training is standard in this literature.

Conditions (3) and (4) can be combined to yield

$$\mu\tau_i = w_i - \frac{\mu}{2}\ \tau_i^2 \qquad (5)$$

Differentiating equation (5) with respect to FC we obtain[4]

$$\frac{\partial \tau}{\partial FC} = -\frac{w}{\mu^2(1+\tau)}\frac{\partial \mu}{\partial FC} \qquad (6)$$

Proposition 1. $\frac{\partial \tau}{\partial FC} < 0$ *if* $\frac{\partial \mu}{\partial FC} > 0$. *Higher financing constraints reduce training per employee if they increase the marginal cost of training.*

Using the first order conditions for employment and the capital stock, we also obtain

$$lnL = \varphi_L + \frac{\alpha}{\Delta}\tau - \frac{1-\beta}{\Delta}\ lnw - \frac{1-\beta}{\Delta}\ \frac{\mu\tau^2}{2w} - \frac{\beta}{\Delta} lnc \qquad (7)$$

$$lnK = \varphi_K + \frac{\alpha}{\Delta}\tau - \frac{1-\alpha}{\Delta}\ lnc - \frac{\alpha}{\Delta}\ \frac{\mu\tau^2}{2w} - \frac{\alpha}{\Delta} lnw \qquad (8)$$

where ϕ are constant terms and we have used the approximation $x = \ln(1+x)$.

The effect of financing constraints on employment is given by

$$\frac{\partial L}{\partial FC} = \frac{\alpha}{\Delta}\frac{\partial \tau}{\partial FC} - \frac{\beta}{\Delta}\frac{\partial \ln c}{\partial FC} - \frac{1-\beta}{\Delta}\left[\frac{\tau^2}{2w} + \frac{\tau}{\mu(\tau+1)}\right]\frac{\partial \mu}{\partial FC} < 0 \qquad (9)$$

which is negative because $\frac{\partial \tau}{\partial FC} < 0$ and $\frac{\partial \ln c}{\partial FC} > 0$.

Proposition 2. *Higher financing constraints reduce employment when training per employee decreases with financial constraints and the costs of capital increase with financial constraints.*

The effect of financing constraints on training per employee $\frac{\mu}{2}\tau_i^2$ is given by

$$\frac{\partial\left(\mu\tau^2/2\right)}{\partial FC} = \frac{\tau}{2}\left[\tau - \frac{2w}{\mu(\tau+1)}\right]\frac{\partial \mu}{\partial FC} \qquad (10)$$

Using equation (5) we can establish that the term in the square brackets is negative. Hence, higher financing constraints reduce training expenditure per employee

[4] We ignore the subscript *i* in the rest of the section to simplify notation.

because $\frac{\partial \mu}{\partial FC} > 0$. Finally, define $TK = \frac{\mu}{2}\tau^2 L/K_{-1}$ as the share of training investment on the lagged capital stock. The effect of tighter financing constraints on TK is negative because

$$\frac{\partial lnTK}{\partial FC} = \frac{\partial ln\left(\frac{\mu}{2}\tau^2\right)}{\partial FC} + \frac{\partial lnL}{\partial FC} < 0 \qquad (11)$$

3. Data

We use firm-level data on investment in training and self-reported financing constraints from the waves 2016 to 2018 of the EIB Investment Survey (EIBIS). Starting in 2016, EIBIS is administered each year to the senior managers or financial directors of a representative sample of firms in the 28 EU member states. The survey covers firms with at least five employees, with both full-time and part-time employees being counted as one employee and employees working less than twelve hours per week being excluded.[5] The information collected in EIBIS refers to the previous financial year (e.g. the data for the 2016 wave refers to the fiscal year 2015).

We combine EIBIS with accounting data from Bureau van Dijk's ORBIS database.[6] The financial and balance-sheet information in ORBIS originates from business registers collected by local chambers of commerce to fulfil legal and administrative

[5]The sampling methodology is described in Ipsos, 2017. The sample is stratified disproportionally by country, sector and size class, and stratified proportionally by region within the country. Ipsos constructed weights to reweight the sample and make it representative of the population reported by the Structural Business Statistics (SBS) in Eurostat. Brutscher and Coali, 2019, provide evidence on the representativeness of EIBIS data for the business population of interest.

[6] See Kalemli-Ozcan et al., 2015, for a detailed analysis of the advantages and disadvantages of using ORBIS data on firms in Europe.

requirements and is relayed to Bureau van Dijk via different information providers. Bureau van Dijk prepares the public data from administrative sources and arranges them in a standard format (derived from the most common formats used for the presentation of business accounts in Europe) to facilitate comparisons across firms in different countries.

We retain only firms in sectors C (Manufacturing) to J (Information and Communication) of the NACE classification.[7] For each country and wave, we trim continuous variables in our data by removing observations above the 99th percentile of the distribution, resulting in a final working sample of 7,414 firms in financial year 2017 (and 22,633 firm-year observations over the three years).

Information on training investment is based on the responses to a question in EIBIS asking how much did the business invest – in the relevant financial year - in: (i) training of employees; (ii) research and development (including the acquisition of intellectual property); (iii) software, data and IT network; (iv) tangible assets (land, business buildings and infrastructure, and machinery and equipment) and (v) other activities, including organisation and business improvements. By considering only monetary outlays, this definition does not take into account the opportunity costs of training (i.e. foregone productivity).

We compare the information on employer-provided training in EIBIS with data of the Continuing Vocational Training Survey (CVTS), an employer survey carried out by Eurostat every five years, by focusing on the country-specific average share of firms

[7] We therefore include also firms operating in energy, construction, wholesale trade, transport and accommodation.

reporting no training in 2015. We find that, in spite of the differences in the definition of training - EIBIS includes all the training the employer pays for, while CVTS considers only planned training and excludes apprenticeships – the correlation between the two measures is relatively high, at 0.66.

We define the training share *TK* as the ratio of training investment in year *t* (from EIBIS) to the stock of fixed assets in year *t-1* (from ORBIS) and proceed in a similar fashion for the other investment items.[8] As shown in Table 1a, the median and mean *TK* were equal in 2017 to 0.5 and 2.5 percent respectively (with standard deviation 6.9). The table also reports median and average training investment per employee, which were equal to 0.107 and 0.211 thousand euro respectively. Figure 1 shows that the average share *TK* in 2017 was highest in Luxemburg, France and Ireland and lowest in Poland and Greece.

The median and mean share of total investment in (lagged) fixed assets (*IK*) in 2017 were equal to 16.8 and 53.4 percent respectively. The relatively high mean is driven by 12% of firms in the sample having a value of *IK* above 1: this share is largest for small firms (16.7 percent), highest in the information and communication sector (24.7%) and in Luxemburg (27.3 percent) and the Netherlands (23.5 percent). The bulk of total investment was spent on tangible assets (mean share *IK*: 37.7 percent), much more than on research and development (5.6 percent), software and data (5.5 percent) and training (2.5 percent).

[8] Since fixed assets refer to the previous year, we multiply the training share TK by the ratio of lagged to current output prices.

There are two measures of financing constraints in EIBIS: "actual" financing constraints and "perceived" financing constraints. They are both directly reported by the firms. The measure of actual financing constraints (AC) combines four indicators: i) quantity constrained (the firm is unsatisfied with the amount of external finance obtained); ii) rejected (the firm has seen its request for external financing rejected); iii) price constrained (the firm decided not to seek any external financing because of excessive costs); iv) discouraged (the firm decided not to seek any external financing due to the concern of being rejected). Each indicator is a binary variable equal to one if the firm reports a positive answer and to zero otherwise. The binary variable AC takes value one if any of these four indicators take value one, and zero otherwise.[9]

The second measure, "perceived" financing constraints, is a binary variable equal to one if the availability of finance is considered by the firm a major obstacle to its investment activities, and to zero otherwise. While the measure AC is based on the actual experience of the firm in the most recent application for external finance, the second measure relies on the perception of the respondent (see Ferrando and Mulier, 2015a).

Nevertheless, neither measure may reflect objectively the financial position of firms. For instance, less capable managers of inefficient firms may report higher constraints – by claiming to have been rejected or discouraged from applying for funding – in an effort to shift the blame of inefficiency to the credit market (Popov, 2014). Since we expect this problem to be less relevant for measure AC, which relies on the actual

[9] About 63 percent of firms reporting actual financing constraints were rejected in their application for external finance.

experience in applying for a loan, trade credit or other external financing tools (Ferrando and Mulier, 2015a), we shall focus hereafter on this indicator.

In 2017, 5 percent of firms reported to have been affected by actual financing constraints (see Table 1b). Figure 2 shows the distribution of average *AC* by country in that year. Typically, firms in the countries of West and North Europe are less likely to be financially constrained than their peers in the countries of Eastern Europe. Greece, among Southern European countries, is especially exposed. The percentage of firms with actual financial constraints is highest among firms with 5 to 49 employees (7.8 percent) and lowest among firms with more than 50 employees (3.5 percent), highest in the construction sector (6.3 percent) and lowest in the transport sector (3.7 percent).

4. The index of financing constraints

A study of the effects of financing constraints on training investment faces three difficulties. The first is reverse causality, running from training to constraints. For instance, firms with poor records in training and other investment may have difficulties accessing external finance. The second is unobserved heterogeneity, which may drive both training and constraints. Last but not least, self-reported financing constraints are likely to measure true constraints with error.

Reverse causality concerns can be alleviated by using measures of lagged rather than current firm-level constraints. However, this approach is problematic with the data at hand, because only 61.1 percent of the firms in the working sample are observed in two consecutive years between 2015 and 2017. We use data from ORBIS, which provide information on the lagged financial situation of all the firms in the sample, to

develop a financing constraints index, in line with previous work by Kaplan and Zingales, 1997, and Lamont et al, 2001.[10]

We assume that actual constraints AC are determined as follows

$$AC_{it} = X_{it}\theta + Z_{i,t-s}\gamma + \varepsilon_{it} \quad (12)$$

where ε is measurement error (assumed to be classical, with zero mean and uncorrelated with the right hand side regressors) and Z is an index summarizing the financial situation of the firm in the two previous years (i.e. at time t-s, where s=1,2) that we measure with four indicators: a) the debt to assets ratio (leverage); b) the ratio of current assets to current liabilities and the ratio of cash to total assets (liquidity); c) the ratio of operating profits to total debt (solvency). We take the average of the first and second lag of these ratios[11] and extract from them the index Z using principal component analysis.[12]

We find that the index Z is positively correlated with solvency (correlation: 0.725) and liquidity (correlation: 0.679 with the ratio of current assets to current liabilities and 0.558 with the ratio of cash to total assets), and negatively correlated with leverage (correlation: -0.730). These results are in line with the literature (e.g., Kaplan and Zingales 1997; Lamont et al, 2001): a higher value of Z indicates that the firm is more

[10] Compared to these authors, who only consider listed firms, we use data for both listed and unlisted firms.

[11] Throughout the analysis, we deal with missing values in binary variables by defining for each variable an indicator variable for missing data and by replacing missing values with zero. For continuous variables, we impute missing values using the averages (of firms with no missing data) by country, sector and firm size.

[12] We select the eigenvector associated to the single eigenvalue higher than 1.

solvent, liquid and has lower leverage, and is therefore less likely to face financing constraints when applying for external finance.

We expect the measure of actual financing constraints AC to also depend on firm characteristics such as age - older firms are more likely to have successful track records and to entertain repeated interactions with lenders (Ferrando and Mulier, 2015a); size - small firms have a small amount of collateral relative to their liabilities and are more likely to be credit constrained; ownership – whether the firm is a subsidiary or foreign owned, and institutional factors that are country, time and sector specific. Foreign owned companies may raise external finance in another country (e.g. the country of the majority owner), and financial flows from the parent company can compensate subsidiaries for the limited access to the local financial market. We therefore include in the vector X firm size and firm age, subsidiary status, foreign ownership, country by year as well as sector fixed effects.

Table 2 reports the estimates of equation (12) and show that actual constraints AC decline with the index Z (as expected) and are lower for larger and older firms, and for firms which are either foreign owned or subsidiaries of other firms. Equation (12) thus decomposes self-reported constraints AC into a component which reflects financial and other characteristics of the firm and measurement error. We define the financing constraints index as $FCI_{it} = X_{it}\hat{\theta} + Z_{it-s}\hat{\gamma}$, using the predicted value from the regression.[13] The underlying intuition is that, if a firm declares to be financially

[13] The financing constraints index *FCI* is virtually identical if we instead regress AC in equation (12) not on Z but on the four indicators constituting it. The correlation between this index and the one computed

constrained, this should show up in its financial accounts, in terms of higher leverage, lower liquidity and solvency. By taking predicted values, we retain from actual constraints AC the component that is systematically related to the financial situation of firms and eliminate (classical) measurement error.[14]

Figure 3 shows that there is a positive and high correlation across countries between the share of firms with actual financing constraints (AC) in each country and the index of financing constraints (FCI). Figure 4 instead shows that the FCI index and the share of training investment on fixed assets are negatively correlated across countries.

Although our strategy can get us around the reverse causality problem, it does not necessarily address the possibility that the index Z and the binary indicator of actual financing constraints AC are both driven by omitted variables, for example unobserved managerial ability. If this is the case, the financing constraints index FCI is a distorted indicator of actual financing constraints. We evaluate whether omitted variable bias is important in our estimates of equation (12) using a test proposed by Oster (Oster, 2019).

The test establishes bounds to the true value of parameters under two polar cases. In the first case, there are no un-observables and equation (12) is correctly specified. We

in the paper is very high, at 0.985. We also estimated equation (12) using a logit specification and this would also produce a very similar index. The results are available from the authors upon request.

[14] The weighted mean of leverage is 0.552 for firms with no self-reported financing constraints ($AC = 0$) and 0.594 for constrained firms ($AC = 1$). The weighted mean of solvency is 0.238 for the former and 0.207 for the latter; the weighted mean of the cash to assets ratio and the ratio of current assets to current liabilities is 0.114 and 2.212 for unconstrained firms and 0.087 and 1.952 for constrained firms. Finally, the weighted mean of the FCI index is 0.055 for unconstrained firms and 0.083 for constrained firms.

denote as $\hat{R}$ the estimated R squared. In the second case, there are un-observables but both observables and un-observables are equally related to the treatment. When un-observables are included, we conservatively assume that the R squared is equal to $R_{max} = \min(1.3\hat{R}, 1)$. If zero can be excluded from the bounding set delimited by these two polar cases, accounting for un-observables does not change the direction of our estimates. As shown in the last row of Table 2, the two bounds are both negative: the range, which excludes zero, is small (-0.012, -0.010), suggesting that, even if an omitted variables bias cannot be ruled out a priori, it is likely to be negligible.

5. Empirical approach

To explore the links between the financing constraints index *FCI* and investment activities, we estimate the following regression

$$Y_{it} = W_{it}\alpha + FCI_{it}\beta + u_{it} \qquad (13)$$

where *W* is a vector of control variables, *u* is a disturbance term. The outcome variable *Y* includes either training investment (*TK*), total investment (*IK*), investment in research and development (*RK*), investment in software and data (*DK*) or investment in tangible assets (*MK*). Each variable is computed as share of lagged fixed assets. As alternative outcome variable *Y*, we also consider training investment per employee.

We take into account that optimal investment in training is determined by equalising marginal benefits and marginal costs – see equation (4) above – by including in the vector *W* the returns on equity, measured as operating profits over shareholders' funds (average of first and second lag), and sales over fixed assets (average of first and

second lag). Both variables capture shifts in marginal benefits.[15] The vector *W* also includes the capital labour ratio (average of first and second lag) and the variables in the vector *X* discussed in the previous section – firm size and firm age, subsidiary status and foreign ownership, the interactions of country and year as well as sector fixed effects.

Estimating equation (13) is equivalent to regressing *Y* on *W* and actual constraints *AC*, using the index *FCI* as an instrumental variable for *AC*.[16] A potential concern with our approach is that *FCI* may influence *Y* not only via its effect on *AC* but also directly. We address this issue by including in vector *W* the ratio of the stock of firm debt to fixed assets and the ratio of current assets to fixed assets (averages of first and second lag).[17] The identifying assumption is that, conditional on debt to fixed assets, leverage affects training investment only by changing financing constraints. In a similar fashion, we assume that, conditional on average returns to equity, solvency (measured as the ratio of profits to debt) does not affect directly the outcomes, and that, conditional on current assets and debt, liquidity (measured by the ratio of cash to assets and by the ratio of current assets to current liabilities) is excludable as a separate

[15] See Hubbard, 1998, and Carpenter and Pedersen, 2002, on the importance of controlling for shifts in marginal benefits.

[16] See the Appendix for a proof. The "first stage" regression of *AC* on *FCI* yields a coefficient equal to 0.89 (with standard error 0.174). The *F*-test statistic for the inclusion of *FCI* in this regression is equal to 26.5, well above the rule of thumb criterion (10), indicating that the instrument is not weak.

[17] Ferrando and Mulier, 2015b, argue that a high level of debt, which may signal potential problems in the financial situation of the firms, also indicates that the firm has enjoyed wide access to external finance, which may also affect investment decisions.

variable from equation (13).

An additional concern with equation (13) – already discussed for equation (12) – is that unobserved heterogeneity – for instance, managerial ability – could affect both the outcome variable Y and the financing constraints index *FCI*, thereby biasing the estimates. We verify whether unobserved heterogeneity affects the sign as well as the size of our estimates by using the Oster test introduced in the previous section.

We estimate equation (13) using both a linear and a Tobit specification, which takes into account that the dependent variable contains several zeros. Since many firms appear more than once in the sample, we cluster standard errors at the level of the firm. In addition, because the index of financing constraints *FCI* is a generated variable, we bootstrap standard errors, which is a valid inference procedure in this setting.[18]

6. Results

6.1 Main findings

We present our baseline estimates in Table 3. The table is organized in five columns. The first column considers training investment *TK*, the second column looks at total investment *IK*, and columns three to five are for other types of investment. We find that firms that are more finance constrained (have a higher value of the financing constraints index) invest less. In particular, our estimates indicate that a 10 percent increase in the index reduces total investment by 4.4 percent, investment in training

[18]We estimate equation (13) for each investment type separately. Seemingly unrelated regressions, which allow for the contemporaneous correlation across equations, yield very similar results that are available from the authors upon request.

by 2.9 percent, investment in R&D by 5.5 percent, investment in software and data by 7.6 percent and investment in tangible assets by 4.2 percent.[19] These results suggest that European firms facing tighter constraints not only reduce their total investment but also alter its composition by reducing investment in training and tangible assets relatively less than investment in software and data and in R&D.[20]

Investment in training is somewhat less sensitive to variations in the returns on equity and in the ratio of sales to fixed assets (elasticities: 0.205 and 0.243 respectively) than investment in tangible assets (elasticities: 0.247 and 0.263 respectively), and more sensitive to changes in these variables than investment in software and data and in R&D.

These estimates may be affected by omitted variables. If un-observed heterogeneity were important to the point of changing the qualitative thrust of our results, we should find that the bounds defined by Oster tests contain zero in their range, and that the lower and upper bound have different signs. As shown in Table 4, this happens only when the dependent variable is investment in R&D, where the range for the estimates is -0.272 to 0.001.

[19] The estimated elasticities are evaluated at the sample mean values of the dependent variable and of the financing constraints index.

[20] As discussed by Solon et al, 2013, it is not clear a priori whether weighting the firms in the sample is required when estimating causal effects. We re-run our estimates for training and total investment using value added weights and find that the estimated effect of financing constraints are similar to those reported in columns (1) and (2) of Table 3, albeit less precise, as one would expect.

With the exception of this type of investment, we find that the bounds computed by accounting for un-observables and assuming that both un-observables and observables are equally related to the treatment are larger in absolute terms than the bounds that ignore un-observables. If we consider as "true" effects those that account for un-observables, we interpret these findings as suggesting that the estimated elasticities in Table 3 are lower bounds of the "true" effects.

Since self-reported actual constraints AC measure true constraints with error, we expect that the estimates obtained by replacing FCI with AC in equation (13) will be affected by attenuation bias. When the true value of parameter β is negative, the bias is positive and the estimated coefficients tend to zero.[21] Table A1 confirms that this is the case.

6.2 Sensitivities

The estimates in Table 3 are based on a linear specification. Since investment in training has many zeroes (about 30 percent of the total), we also use a Tobit specification and present the results in Table 5. The table confirms the qualitative findings in Table 3 and shows that the estimated elasticities are generally larger than in the linear model. In particular, we find that a 10 percent increase in the financing constraints index reduces investment in training by 4.45 and total investment by 4.78 percent.

[21] Using a simplified version of equation (13), , i.e. without other explanatory variables W - $Y = FCI\beta + \varepsilon$ – and the relationship between AC and FCI - $AC = FCI + \mu$, the bias is given by $plim\ \hat{\beta} - \beta = -\frac{\sigma_{\mu}^2}{\sigma_{FC}^2}\beta > 0$.

Our working sample includes firms with an investment to fixed assets ratio above 1. We verify in Table A2 whether removing these firms from the sample would change our results and find that they generally do not. We also estimate the effects of the financing constraints index on training investment per employee, using both a linear and a Tobit specification (Table 6) and find that a 10 percent increase in the index reduces training per employee by 1.76 to 2.48 percent.

A causal interpretation of our results requires that the treatment (being financially constrained or not) be as good as randomly allocated across firms. When this is the case, observables in the treatment and control samples are balanced. We attain this by using entropy balancing, a re-weighting scheme that specifies for each selected covariate a set of balance constraints to equalize the moments of the covariate distribution between the treatment and the reweighted control group. We then estimate average treatment effects by standard regressions using re-weighted data (Hainmueller and Xu, 2013).

Since the treatment must be binary, we standardize the financing constraints index for each country and construct a binary variable equal to 1 if the index is at or above one standard deviation (about 15 percent of the sample) and 0 otherwise. We estimate the effect of the binary treatment on training investment *TK*, total investment *IK* and training investment per employee (see Table 7) and find that the estimated elasticities are similar to those obtained in Table 3 using the continuous index *FCI*.

6.3 Heterogeneous Effects

The estimates in Table 3 rely on the assumption that the elasticity of investment in training to changes in the financing constraints index is constant across areas, sectors

and firm sizes. We investigate whether this is the case by allowing the key parameter β in equation (13) to vary across areas, sectors, firm size and ownership (foreign or domestic), while maintaining all the other parameters invariant across models. Table 8 reports the results when we group countries in three areas: West and North Europe (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxemburg, Netherlands, Sweden and the UK), South Europe (Cyprus, Greece, Italy, Malta, Portugal and Spain) and Central and Eastern Europe (Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia).

We find that the elasticity of training investment with respect to the financing constraints index is highest in South Europe (-1.115) and lowest in Central and Eastern Europe (-0.154), with West and North Europe (-0.199) closer to the latter. Furthermore, the difference in estimated elasticities between South Europe and the other two areas is statistically significant at the conventional level. A candidate explanation of this finding is that Southern European firms rely on external finance more than other European firms: according to the EIBIS survey, external finance accounted for 43.3 percent of the funds used between 2015 and 2017 for investment purposes in Southern Europe, compared to 37 percent in West and North Europe and to 29.5 percent in Central and Eastern Europe. This higher reliance implies that firms located in Southern Europe may find it more difficult than other firms to substitute external with internal finance when financing constraints increase.

Table 8 also reports the estimates when we allow the parameter β to vary by sector (manufacturing versus services), firm size (firms with less than 250 employees and

larger firms), ownership (foreign or domestic) and subsidiary status. We find that the impact of financing constraints on investment in training is higher in the manufacturing sector (elasticity: -0.464) than in services (elasticity: -0.235). However, the estimates do not vary significantly with firm size, ownership or subsidiary status.

Conclusions

Employer investment in employee training varies substantially within the EU, with firms in Central and East Europe and in some South Europe countries investing much less than firms located in West and North Europe. In this paper, we have investigated whether some of this variation can be explained by differences in the importance of financing constraints that affect the implementation of desired investment plans. To address this question, we have combined firm survey data from EIBIS, which covers all 28 EU Member States, with administrative data based on the financial statements of firms from the ORBIS database.

We have constructed a financing constraints index (*FCI*) that circumvents reverse causality, addresses measurement error and focuses on the component of self-reported constraints that is backed up by financial difficulties, captured by high leverage, low liquidity and low solvency. We have estimated the impact of this index on training investment, expressed either as share of fixed assets or per employee. We have found that a 10 percent reduction in the financing constraints index increases investment in training (expressed as share of fixed assets) by 2.9 to 4.5 percent, a sizeable effect.

Our results also show that investment in training is less sensitive to financing constraints than investments in software and data and R&D, and about as sensible as

investment in tangible assets. There is also evidence that the sensitivity of training investment to changes in financing constraints is significantly higher in the countries of Southern Europe, where training investment is lower than the EU average.

The relative weight of financing constraints during the period 2015-17 exhibits important variation across the 28 EU Members. While the country average value of *FCI* was equal to 0.05, the index ranged from below 0.035 in Austria, Sweden and Germany to above 0.120 in Croatia, Latvia, Lithuania and Greece. In countries such as Greece, where training is very low by European standards, bringing the average FCI index down to the EU mean would imply reducing it by 70.6 percent.

Assuming that this could be done, what would be the impact on average investment in training in Greece? Our area-specific estimates suggest that it would increase significantly, from 0.7 to 1.3, but remain well below average investment in training in the 28 EU members, which stands at 2.5 percent of fixed assets.

This simple exercise points out that policies that reduce the financing constraints faced by firms are important to support investment in training by employers, but are unlikely to be sufficient to close the gap between European countries with relatively low and relatively high investment in training. This gap most likely depends also on differences in the profitability of firms as well as on heterogeneous economic institutions, industrial structures, innovation activities and relative supplies of skills.

References

Bassanini, A., and G. Brunello (2011). Barriers to entry, deregulation and workplace training: A theoretical model with evidence from Europe. *European Economic Review*, 55(8), 1152-1176.

Bassanini, A., A. Booth, G. Brunello, M. De Paola and E. Leuven (2007). Workplace training in Europe, in *Education and Training in Europe*, G. Brunello, P. Garibaldi and E. Wasmer (eds.), Oxford: Oxford University Press.

Beck, T., A. Demirgüç-Kunt, L. Laeven and V. Maksimovic (2005). Financial and legal constraints to firm growth: Does firm size matter? *Journal of Finance*, 60(1), 137-177.

Boeri, T, P. Garibaldi and E. Moen (2018). Financial constraints in search equilibrium: Mortensen Pissarides meet Holmstrom and Tirole. *Labour Economics*, 50, 144-155.

Bond, S., and C. Meghir (1994). Financial constraints and company investment. *Fiscal Studies*, 15(2), 1-18.

Brutscher, P.-B., and A. Coali (2019). EIB Group survey on investment and investment finance – A data quality assessment. EIB Working Paper No. 2019/12.

Campello, M., J.R. Graham and C.R. Harvey (2010). The real effects of financial constraints: Evidence from a financial crisis," *Journal of Financial Economics*, 97(3), 470-487.

Carpenter, R.E., and B.C. Petersen (2002). Is the growth of small firms constrained by internal finance? *Review of Economics and Statistics*, 84(2), 298-309.

EIB (2018). *Investment Report 2018/19: Retooling Europe's Economy*, D. Revoltella, P. de Lima and A. Kolev (eds.), Luxembourg: European Investment Bank.

Farre-Mensa, J., and A. Ljungquist (2016). Do measures of financial constraints measure financial constraints? *Review of Financial Studies*, 29(2), 271-308.

Fazzari, S,M., R.G. Hubbard, B.C. Pedersen, A.S. Blinder and J.M. Poterba (1988). Financing constraints and corporate investment. *Brookings Papers on Economic Activity*, 1988(1), 141-206.

Ferrando, A., and K. Mulier (2015a). Firms' financing constraints. Do perceptions match the actual situation? *The Economic and Social Review*, 46(1), 87-117.

Ferrando, A., and K. Mulier (2015b). The real effects of credit constraints: evidence from discouraged borrowers in the euro area. ECB Working Paper No. 1842.

Garcia-Posada Gomez, M. (2018). Credit constraints, firm investment and growth: Evidence from survey data. ECB Working Paper No. 2126.

Hubbard, R.G. (1998). Capital-market imperfections and investment, *Journal of Economic Literature*, 36(1), 193-225.

Ipsos (2017). EIB Group survey on investment and investment finance, Technical report. Luxembourg: European Investment Bank.

Kalemli-Ozcan, S., B. Sorensen, C. Villegas-Sanchez, V. Volosovych, and S. Yesiltas (2015). How to construct nationally representative firm level data from the Orbis global database. NBER Working Paper No. 21558.

Kaplan, S.N., and L. Zingales (1997). Do investment cash flow sensitivities provide useful measures of financing constraints? *Quarterly Journal of Economics*, 112(1), 169-215.

Lamont, O., C. Polk and J. Saaá-Requejo (2001). Financial constraints and stock returns. *Review of Financial Studies*, 14(2), 529-554.

Love, I. (2001). Financial development and financing constraints: International evidence from the structural investment model. World Bank Policy Research Working Paper No. 2694.

Lynch, L., (1994), *Training and the Private Sector*, NBER Comparative Labor Market Series.

Milanez, A. (2012). The human capital cost of financing constraints. Unpublished manuscript.

Modigliani, F., and M.H. Miller (1958). The cost of capital, corporation finance and the theory of investment. *American Economic Review*, 48(3), 261-297.

Nickell, S., and D. Nicolitsas (1999). How does financial pressure affect firms? *European Economic Review*, 43(8), 1435-1456.

Oster, E. (2019). Unobservable Selection and Coefficient Stability: Theory and Evidence. *Journal of Business & Economic Statistics*, 37(2), 187-204.

Popov, A. (2014). Credit constraints and investment in human capital: Training evidence from transition economies. *Journal of Financial Intermediation*, 23(1), 76-100.

Solon, G., Haider, S and Wooldridge, J. (2013), What are we Weighting For?, NBER Working Papers 18859

Stiglitz, J.E., and A. Weiss (1981). Credit rationing in markets with imperfect information. *American Economic Review*, 71(3), 393-410.

Table 1a. Investment activities in 2017. Descriptive statistics.

Variable	Median	Mean	Standard Dev.
Investment in training / lagged fixed assets	0.005	0.025	0.069
Investment in R&D / lagged fixed assets	0	0.056	0.39
Investment in software / lagged fixed assets	0.005	0.055	0.319
Investment in tangibles / lagged fixed assets	0.099	0.377	0.971
Total investment / lagged fixed assets	0.168	0.534	1.209
Investment in training / employees (thousand euro)	0.107	0.211	0.279
Investment in training / wage bill	0.004	0.007	0.009

Note: Each variable is weighted with value added weights provided by EIBIS to obtain values that are representative of the business population.

Table 1b. Descriptive statistics of main variables. Year 2017

Variable	Mean	Standard Dev
"Actual" financing constraints *AC*	0.050	
FCI (financing constraints index)	0.050	0.218
Liquidity: average working capital (first and second lag)	2.156	2.164
Leverage: average debt assets ratio (first and second lag)	0.546	0.211
Solvency: average profits to debt (first and second lag)	0.241	0.235
Liquidity: average cash to assets (first and second lag)	0.116	0.122
Average capital labour ratio (first and second lag)	44.332	45.690
Average sales to fixed assets (first and second lag)	16.205	20.306
Average current assets to fixed assets (first and sec. lag)	6.996	10.711
Average debt to fixed assets (first and second lag)	4.674	6.646
Average returns to equity (first and second lag)	0.291	0.219
Foreign owned (percent)	0.152	
Age: older than 20 years (percent)	0.733	
Subsidiary (percent)	0.384	
Size: % firms with 5 to 49 employees	0.343	

Note: Each variable is weighted with value added weights provided by EIBIS to obtain values that are representative of the business population.

Table 2. The effect of the financial situation in the two previous years Z on "actual" constraints *AC*. Linear probability model.

Variable	Coefficient	Standard error
Index of financial situation in the two previous years *Z*	-0.012***	0.001
Firm size (omitted category: 5 to 49)		
50-249 employees	-0.022***	0.004
250+ employees	-0.026***	0.007
Firm age (omitted category: less than 5 years)		
5-9 years	-0.016	0.011
10-19 years	-0.041***	0.01
20+ years	-0.042***	0.01
Subsidiary	-0.038***	0.005
Foreign ownership	-0.015**	0.007
R Squared	0.032	
Sample size	22633	
Oster bounds for *Z*	[-0.012/-0.010]	

Note: The regression includes country by year as well as sector fixed effects and indicator variables for missing values. Standard errors are clustered by firm. *, **, *** for statistical significance at the 10, 5 and 1 level of confidence.

Table 3. The effect of the financing constraints index *FCI* on investment in training and other activities. OLS estimates.

Variable	Investment in training / Fixed assets	Total investment / Fixed assets	Investment in R&D / Fixed assets	Investment in software and data / Fixed assets	Investment in tangible assets / Fixed assets
FCI (financing constraints index)	-0.086**	-3.059***	-0.272*	-0.476***	-2.187***
	(-0.041)	(-0.851)	(-0.156	-0.152	-0.75
Average return on equity (lagged)	0.019***	0.504***	0.023**	0.035***	0.398***
	(-0.002)	(-0.047)	-0.009	-0.007	-0.049
Average sales / fixed assets (lagged)*10	0.004***	0.085***	-0.003	0.008***	0.075***
	(-0.001)	(-0.022)	-0.004	-0.003	-0.017
Elasticity with respect to *FCI*	-0.287**	-0.436***	-0.546*	-0.763***	-0.418***
Elasticity with respect to *ROE*	0.205***	0.232***	0.149***	0.183***	0.247***
Elasticity with respect to sales to assets	0.243***	0.220***	-0.095	0.230**	0.263***
R Squared	0.097	0.091	0.048	0.046	0.075
Sample size	22,633	22,633	22,633	22,633	22,633

Note: All regressions include controls for the capital / labour ratio (lagged), firm age, firm size, foreign ownership, subsidiary status, country by year as well as sector fixed effects and dummies for: labour market regulations, business regulations and labour shortages as major obstacles to investment, missing variables, average current assets over fixed assets and average debt over fixed assets. Bootstrapped standard errors (within parentheses) are clustered by firm. *, **, *** for statistical significance at the 10, 5 and 1 level of confidence.

Table 4. Parameter bounds defined by the Oster test.

Variable	Parameter bounds
Training investment / fixed assets	[-0.087, -0.086]
Investment / fixed assets	[-3.243,-3.059]
R&D investment / fixed assets	[-0.272, 0.001]
Digital investment / fixed assets	[-0.504, -0.476]
Equipment investment / fixed assets	[-2.408, -2.187]

Note: Additional covariates include country by time, sector, firm size, firm age and ownership fixed effects.

Table 5. The effect of the financing constraints index FCI on investment in training and other activities. Tobit estimates.

Variable	Investment in training / Fixed assets	Total investment / Fixed assets	Investment in R&D / Fixed assets	Investment in software and data / Fixed assets	Investment in tangible assets / Fixed assets
FCI (financing constraints index)	-0.133***	-3.377***	-0.689	-0.550**	-2.787***
	(0.049)	(0.885)	(0.512)	(0.231)	(0.922)
Average return on equity (lagged)	0.022***	0.506***	0.049*	0.042***	0.418***
	(0.003)	(0.052)	(0.029)	(0.009)	(0.048)
Average sales / fixed assets (lagged)*10	0.004***	0.083***	-0.011	0.010**	0.075***
	(0.001)	(0.024)	(0.012)	(0.004)	(0.019)
Elasticity with respect to *FCI*	-0.445***	-0.478***	-1.379	-0.910**	-0.528***
Elasticity with respect to *ROE*	0.241***	0.234***	0.326*	0.229***	0.258***
Elasticity with respect to sales to fixed assets	0.258***	0.215***	-0.408	0.308**	0.261***
Sample size	22,633	22,633	22,633	22,633	22,633

Note: See Table 3.

Table 6. The effect of the financing constraints index *FCI* on investment in training per employee. OLS and Tobit estimates

Variable	Training investment / Employee Linear model	Training investment / Employee Tobit model
FCI (financing constraints index)	-0.329**	-0.472**
	(0.129)	(0.178)
Average return on equity (lagged)	0.006	0.008
	(0.006)	(0.009)
Average sales / fixed assets (lagged)*10	-0.001	-0.002
	(0.001)	(0.002)
Elasticity with respect to *FCI*	-0.176**	-0.248**
Elasticity with respect to *ROE*	0.010	0.014
Elasticity with respect to sales to assets	-0.013	-0.020
Sample size	22,633	22,633

Note: See Table 3.

Table 7. The effect of a high level in the financing constraints indicator *FCI* (high *FCI* – binary variable) on investment in training and total investment. Entropy balancing.

Variable	Training investment / Fixed Assets	Total investment / Fixed Assets	Training investment / Employee
High *FCI* (binary variable)	-0.010*	-0.240**	-0.031***
	(0.006)	(0.102)	(0.011)
Average return on equity (lagged)	0.011*	0.545***	-0.009
	(0.006)	(0.186)	(0.014)
Average sales / fixed assets (lagged)*10	0.006***	0.143***	-0.003*
	(0.001)	(0.042)	(0.002)
Elasticity with respect to FCI Dummy	-0.391*	-0.384**	-0.185***
Elasticity with respect to *ROE*	0.120*	0.251***	-0.016
Elasticity with respect to sales to assets	0.374***	0.371***	-0.029*
Sample size	22,633	22.633	22,633

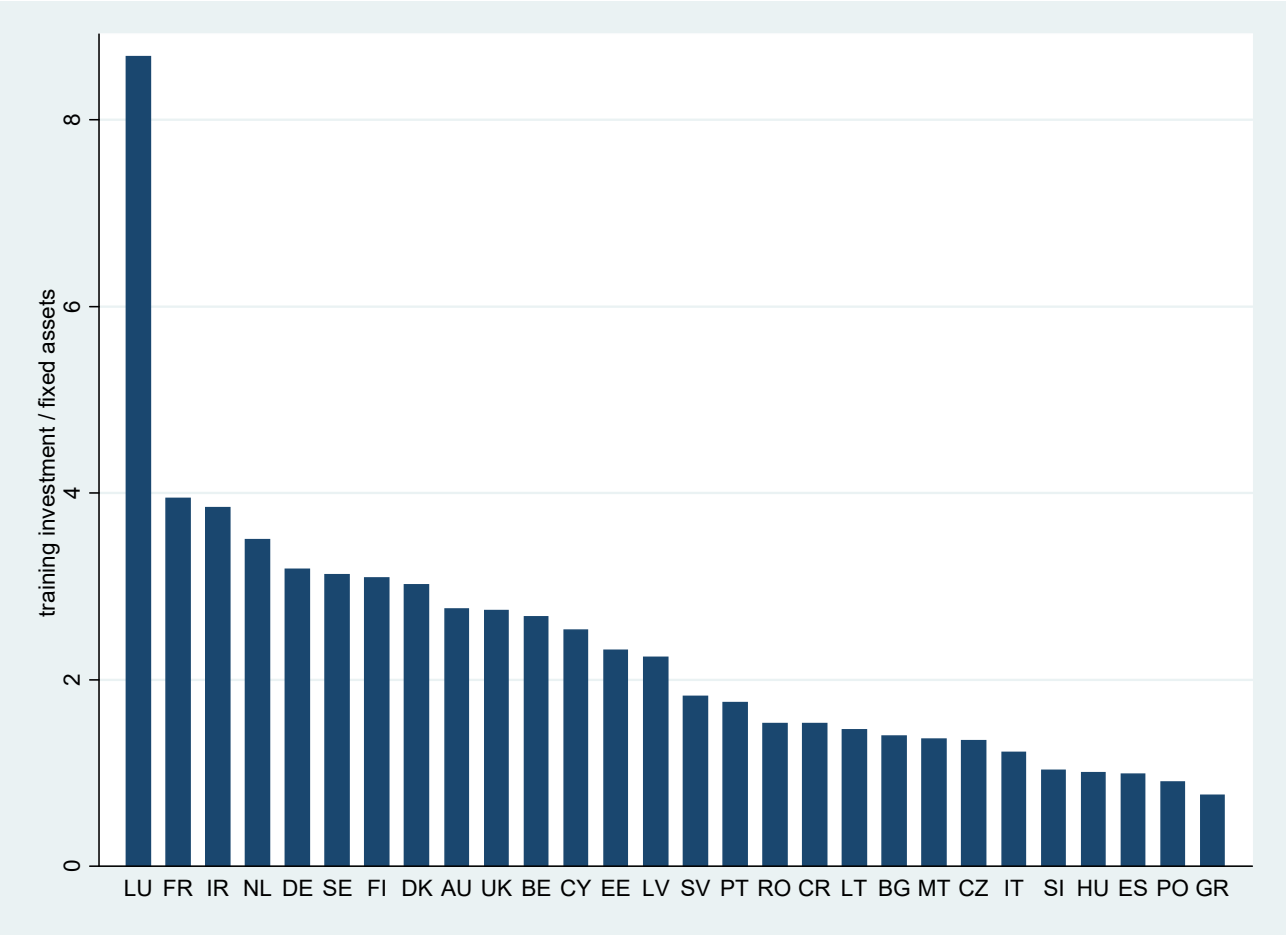
Note: See Table 3.

Table 8. Elasticity of training investment with respect to changes in the financing constraints index FCI. By area, sector, firm size and ownership. OLS estimates.

Group	Training investment / Fixed Assets
West and North Europe (1)	-0.199**
South Europe (2)	-1.115***
CESEE (3)	-0.154
p-value Test (1) = (2)	0.000
p-value Test (1) = (3)	0.815
p-value Test (2) = (3)	0.000
Manufacturing (1)	-0.464**
Services (2)	-0.235**
p-value Test (1) = (2)	0.075
Size: 5-249 (1)	-0.281**
Size: 250 plus (2)	-0.357***
p-value Test (1) = (2)	0.916
Foreign owned (1)	-0.153**
Not foreign owned (2)	-0.155**
p-value Test (1) = (2)	0.980
Subsidiary (1)	-0.266***
Not a subsidiary (2)	-0.236
p-value Test (1) = (2)	0.786

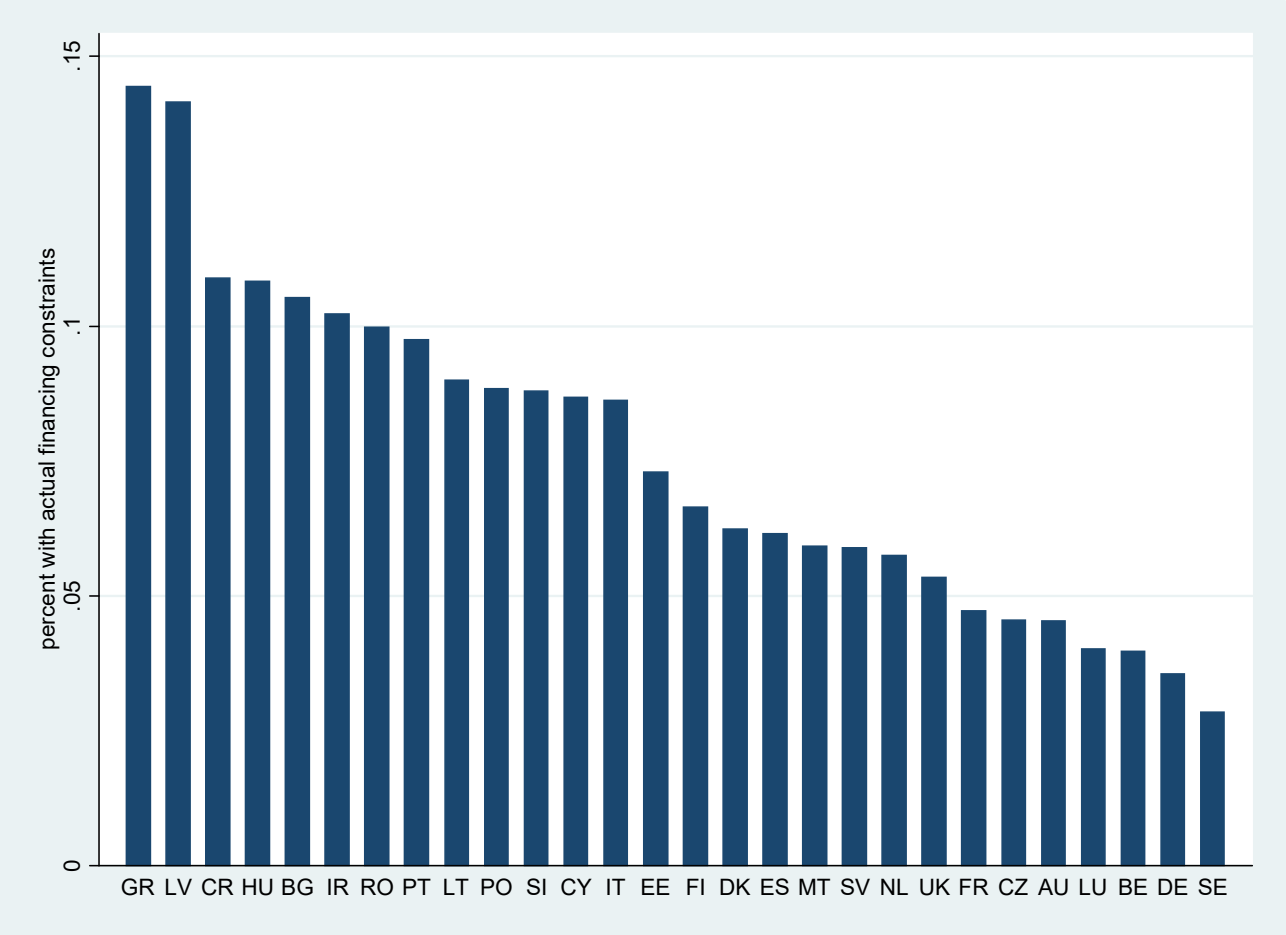
Note: See Table 3.

Figure 1. Average share of training investment on fixed assets (x100), by country. EIBIS 2017



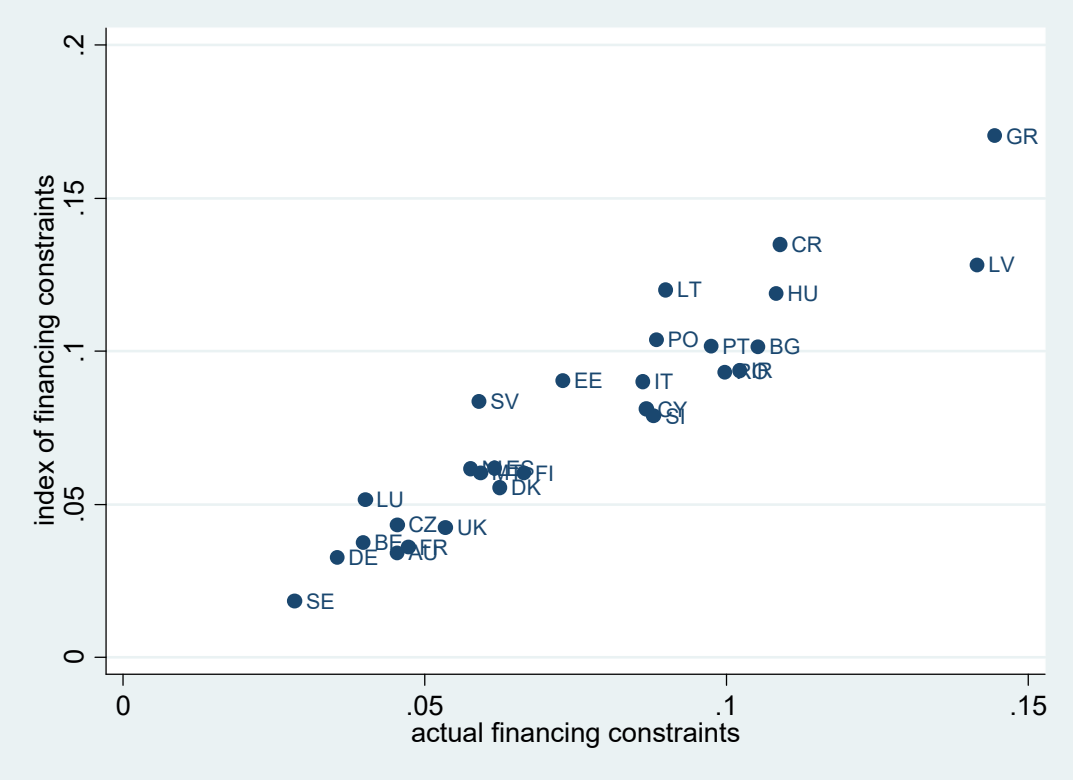
Legend: AT: Austria; BE: Belgium; BG: Bulgaria; CY: Cyprus; CZ: Czech Republic; DE: Germany; DK: Denmark; EE: Estonia; FI: Finland; FR: France; GR: Greece; HR: Croatia; HU: Hungary; IE: Ireland; IT: Italy; LT: Lithuania; LU: Luxembourg; LV: Latvia; MT: Malta; NL: Netherlands; PL: Poland; PT: Portugal; RO: Romania; SE: Sweden; SI: Slovenia; SK: Slovakia; ES: Spain; UK: United Kingdom.

Figure 2. Average share of financially constrained firms, by country. EIBIS 2017



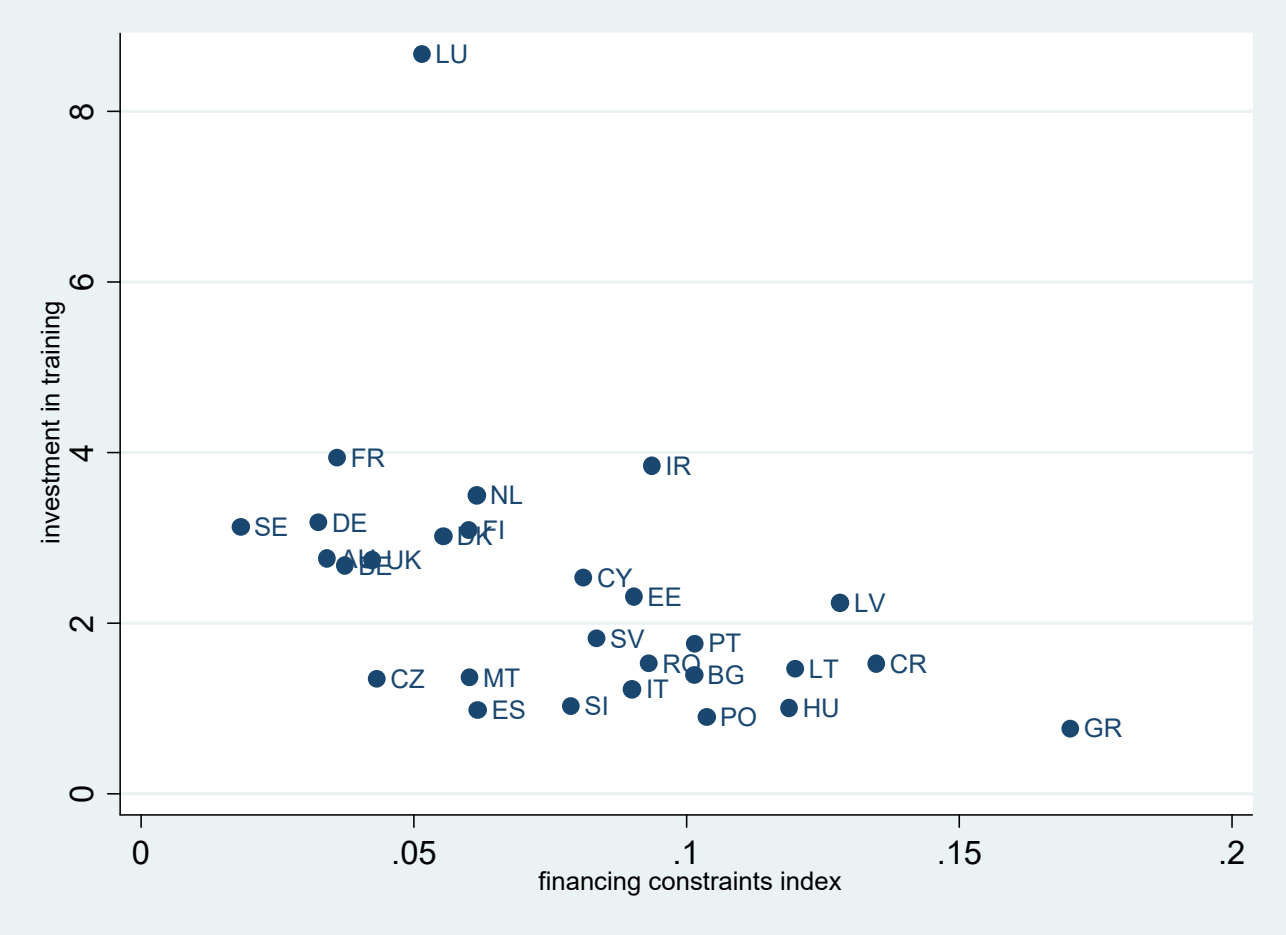
Legend: AT: Austria; BE: Belgium; BG: Bulgaria; CY: Cyprus; CZ: Czech Republic; DE: Germany; DK: Denmark; EE: Estonia; FI: Finland; FR: France; GR: Greece; HR: Croatia; HU: Hungary; IE: Ireland; IT: Italy; LT: Lithuania; LU: Luxembourg; LV: Latvia; MT: Malta; NL: Netherlands; PL: Poland; PT: Portugal; RO: Romania; SE: Sweden; SI: Slovenia; SK: Slovakia; ES: Spain; UK: United Kingdom.

Figure 3. Average share of financially constrained firms and average financing constraints index, by country. EIBIS 2017



Legend: AT: Austria; BE: Belgium; BG: Bulgaria; CY: Cyprus; CZ: Czech Republic; DE: Germany; DK: Denmark; EE: Estonia; FI: Finland; FR: France; GR: Greece; HR: Croatia; HU: Hungary; IE: Ireland; IT: Italy; LT: Lithuania; LU: Luxembourg; LV: Latvia; MT: Malta; NL: Netherlands; PL: Poland; PT: Portugal; RO: Romania; SE: Sweden; SI: Slovenia; SK: Slovakia; ES: Spain; UK: United Kingdom.

Figure 4. Average training investment and average financing constraints index, by country. EIBIS 2017



Legend: AT: Austria; BE: Belgium; BG: Bulgaria; CY: Cyprus; CZ: Czech Republic; DE: Germany; DK: Denmark; EE: Estonia; FI: Finland; FR: France; GR: Greece; HR: Croatia; HU: Hungary; IE: Ireland; IT: Italy; LT: Lithuania; LU: Luxembourg; LV: Latvia; MT: Malta; NL: Netherlands; PL: Poland; PT: Portugal; RO: Romania; SE: Sweden; SI: Slovenia; SK: Slovakia; ES: Spain; UK: United Kingdom.

Appendix

Table A1. The effect of the financing constraints index *FCI* on investment in training and other activities. Only firms with IK below 1. OLS estimates.

Variable	Investment in training / Fixed assets	Total investment / Fixed assets	Investment in R&D / Fixed assets	Investment in software and data / Fixed assets	Investment in tangible assets / Fixed assets
FCI	-0.041*	-0.544***	-0.022	-0.075**	-0.441***
	(0.021)	(0.147)	(0.025)	(0.031)	(0.109)
Average return on equity (lagged)	0.009***	0.070***	0.004*	0.010***	0.041***
	(0.002)	(0.008)	(0.002)	(0.002)	(0.006)
Average sales / fixed assets (lagged)*10	0.002***	0.003*	-0.001**	0.030***	-0.001
	(0.000)	(0.002)	(0.000)	(0.009)	(0.001)
Elasticity with respect to *FCI*	-0.245*	-0.228***	-0.149	-0.298***	-0.261***
Elasticity with respect to *ROE*	0.181***	0.103***	0.125**	0.140***	0.084***
Elasticity with respect to sales to assets	0.299***	0.037***	-0.141***	0.266**	-0.004
R Squared	0.081	0.072	0.056	0.057	0.057
Sample size	19,256	19,256	19,256	19,256	19,256

Note: See Table 3

Table A2. The effect of the financing constraints index *FCI* on investment in training and other activities. Only firms with the ratio IK<1.

Variables	Investment in training / Fixed assets	Investment / Fixed assets	Investment in R&D / Fixed assets	Investment in software and data / Fixed assets	Investment in tangible assets / Fixed assets
FCI (financing constraints index)	-0.041*	-0.544***	-0.022	-0.075**	-0.441***
	(0.021)	(0.147)	(0.025)	(0.031)	(0.109)
Average return on equity (lagged)	0.009***	0.070***	0.004*	0.010***	0.041***
	(0.002)	(0.008)	(0.002)	(0.002)	(0.006)
Average sales / fixed assets (lagged)*10	0.002***	0.003*	-0.001**	0.030***	-0.001
	(0.000)	(0.002)	(0.000)	(0.009)	(0.001)
Elasticity with respect to FCI	-0.245*	-0.228***	-0.149	-0.298***	-0.261***
Sample size	19,256	19,256	19,256	19,256	19,256

Appendix. FCI as instrument for AC in Eq. (13)

We have obtained FCI as the predicted value from regression

$AC = Z\gamma + \omega$

where in this appendix the vector Z includes also X in Eq. (12). Therefore

$FCI = Z\hat{\gamma} = Z(Z'Z)^{-1}Z'AC$. Next, consider Eq. (13)

$Y = W\alpha + FCI\beta + u$

Under the assumption that $FCI'u = 0$, the OLS estimate of β is

$\hat{\beta} = (FCI'FCI)^{-1}FCI'Y - (FCI'FCI)^{-1}FCI'W\alpha$

Since $FCI = Z\hat{\gamma} = Z(Z'Z)^{-1}Z'AC$, we can re-write $\hat{\beta}$ as follows

$\hat{\beta} = (AC'Z(Z'Z)^{-1}Z'Z(Z'Z)^{-1}Z'AC)^{-1}AC'Z(Z'Z)^{-1}Z'Y -$

$(AC'Z(Z'Z)^{-1}Z'Z(Z'Z)^{-1}Z'AC)^{-1}AC'Z(Z'Z)^{-1}Z'W\alpha$

or

$\hat{\beta} = (AC'Z(Z'Z)^{-1}Z'AC)^{-1}AC'Z(Z'Z)^{-1}Z'Y - (AC'Z(Z'Z)^{-1}Z'AC)^{-1}AC'Z(Z'Z)^{-1}Z'W\alpha$

We could have estimated instead

$Y = W\alpha + AC\beta + \varepsilon$

using FCI as instrument for AC. Pre-multiplying the above expression by FCI' we obtain

$\tilde{\beta} = (FCI'AC)^{-1}FCI'Y - (FCI'AC)^{-1}FCI'W\alpha$

which can be written as

$\tilde{\beta} = (AC'Z(Z'Z)^{-1}Z'AC)^{-1}AC'Z(Z'Z)^{-1}Z'Y - (AC'Z(Z'Z)^{-1}Z'AC)^{-1}AC'Z(Z'Z)^{-1}Z'W\alpha$