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Abstract

Using a representative sample of European firms, 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 as a share of fixed assets by 2.9 to 4.5 percent and investment in training per employee by 1.8 to 2.5 percent. We document that lower investment in training reduces productivity, and show that firms facing tighter financing constraints cut back the investment in training and tangible assets less than the investment in R&D and software and data.

Keywords: training, financing constraints, Europe
JEL Codes: J24

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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, as in an economic environment characterized by globalization, population ageing and technological progress it is necessary to constantly update the skills of the workforce, and firms have a key role in financing lifelong learning.

From an aggregate perspective, under-investment in training may occur because of externalities, i.e. the investing firm does not take into account that other firms and the economy at large could benefit from the investment in training (see for instance Lynch, 1994, and Bassanini et al, 2007). Individual firms under-invest due to factors affecting the expected marginal benefits of training, including hold up problems,[1] employee poaching and high staff turnover.

Financing constraints may also explain under-investment. When capital markets are not perfect, firms may not be able 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.[2]

The negative correlation between financing constraints and investment in training is documented by Figure 1, which shows the country-specific share of firms reporting that they are financially constrained and investment in training as share on fixed assets for the 27 EU member States and the UK during 2015-2017. Needless to say, correlation does not mean causation.

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 of these constraints on employers' investment in employee training. In the only study we are aware of, Popov, 2014, uses data from the

[1] The hold-up problem refers to situations where, when the investment in training is done, workers may capture part of the benefits by threatening to leave the firm.
[2] 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.

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 to bank credit in particular, is associated with significantly lower investment in on-the-job training.

We contribute to this literature in two directions. First, we use firm-level data drawn from the European Investment Bank (EIB) Investment Survey (EIBIS). Unlike Popov, 2014, our sample does not include only transition economies but consists of all the 27 EU member States and the UK, which differ in their systems of financial intermediation in spite of the harmonised regulatory framework. Second, we match EIBIS survey data with administrative data on the financial statements of firms from the Bureau Van Dijk Orbis database to 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. This approach helps us to address both reverse causality and measurement error, and relies on the idea that self-reported constraints in survey data are more credible when they are backed up by hard financial data.

We estimate the effect of the financing constraints index on investment in training (as a share of fixed assets or per employee) and find that, on average, a 10 percent increase in the index reduces the share of training investment on fixed assets by 2.9 to 4.5 percent, depending on the estimation method, and investment in training per employee by 1.8 to 2.5 percent. We also show that the elasticity of investment in training as a share of fixed assets and per employee with respect to the financing constraints index are much higher in Southern Europe (-1.115 and -0.301 respectively) than in Central and Eastern Europe (-0.154 and -0.221) and Western and Northern Europe (-0.199 and -0.114). Since Southern European firms tend to rely more on external finance than other European firms, they may find it more difficult to substitute external with internal finance when financing constraints increase.

By curbing investment in training, financing constraints can negatively affect the productivity of firms.[3] We estimate that reducing the financing constraints index from its European sample average in 2017 (0.050) to the average prevailing in Germany (0.033) – a 34 percent reduction – would increase investment in training per employee by 6.1 to 8.5 percent and output per head by 2 to 2.7 percent, a non-negligible amount.

This reduction would also increase investment in training as a share of fixed assets from 2.5 (the European mean in 2017) to 2.74/2.88, still significantly below the German share (3.18 percent). This back of the envelope exercise suggests that the cross–country differences in financing constraints can only partially explain the observed differences in investment in training across European economies, which are also driven by other factors, including the heterogeneity of economic institutions, industrial structure, innovation activities and relative supply of skills (Bassanini et al, 2007).

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 investment in training 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 describes the results. Conclusions follow.

1. Literature review

When training is entirely general and the labour market is perfectly competitive, we know from Becker, 1964, that the worker should pay for it. In this case, the financial constraints of firms do not matter. In practice, however, such constraints are likely to matter as training often includes firm–specific components, which are paid by firms. In addition, firms pay for general training when labour markets are imperfectly competitive (see Acemoglu and Pischke, 1999).

[3] One exception is if the bulk of training expenses are considered as non-monetary benefits that firms give to their employees. In that case, training has a consumption value rather than a benefit to productivity.

In a world of frictionless financial intermediation, a firm's financial structure does not affect its market value and firms' 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.[4] Any investment 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; Breunig et al, 2020) and human capital (Popov, 2014). By affecting investment, credit rationing can also impact on firm productivity (Ferrando and Ruggieri, 2018).

A large empirical literature has examined 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 the use of cash flow is the Kaplan–Zingales (KZ) index (Farre-Mensa and Ljungqvist, 2015), which relies on the qualitative measure of financing constraints

[4] 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).

developed by Kaplan and Zingales, 1997.[5] To capture firms' ability to finance investment, Lamont et al, 2001, regress this qualitative 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 then 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 employers' 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 with the production function

[5] Kaplan and Zingales define a firm as financially constrained if the costs of external funds preclude the firm from making an investment it would have undertaken had internal funds been available. In general, the firms they classify as unconstrained or less constrained have relatively large amounts of liquid assets and net worth. See Kaplan and Zingales, 1997, for further discussion.

$Y = AK^{\beta}(L^{e})^{\alpha}$, 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. Let *FC* be a continuous measure of the intensity of these constraints, which 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).

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 (or investment in training) per employee is $\frac{\mu}{2}\tau^{2}$.[6] 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

$$\frac{\partial \Pi_{i}}{\partial K_{i}} = 0 \Rightarrow \beta A_{i}K_{i}^{\beta-1}(1+\tau_{i})^{\alpha}L_{i}^{\alpha} = c_{i} \qquad (2)$$

$$\frac{\partial \Pi_{i}}{\partial L_{i}} = 0 \Rightarrow \alpha A_{i}K_{i}^{\beta}(1+\tau_{i})^{\alpha}L_{i}^{\alpha-1} = w_{i} + \frac{\mu}{2}\tau_{i}^{2} \qquad (3)$$

$$\frac{\partial \Pi_{i}}{\partial \tau_{i}} = 0 \Rightarrow \alpha A_{i}K_{i}^{\beta}(1+\tau_{i})^{\alpha-1}L_{i}^{\alpha} = \mu\tau_{i}L_{i} \qquad (4)$$

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

[6] The assumption that training costs are convex in training is standard in this literature. See for instance Acemoglu and Pischke, 1999.

$$\mu\tau_i = w_i - \frac{\mu}{2}\ \tau_i^2 \tag{5}$$

Differentiating equation (5) with respect to *FC* we obtain[7]

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

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

Taking the logarithm of the first order conditions for the capital stock and employment (equations (2) and (3)), we also obtain

$$lnK = \varphi_K + \frac{\alpha}{\Delta}\tau - \frac{1-\alpha}{\Delta}\ lnc - \frac{\alpha}{\Delta}\frac{\mu\tau^2}{2w} - \frac{\alpha}{\Delta}lnw \tag{7}$$

$$lnL = \varphi_L + \frac{\alpha}{\Delta}\tau - \frac{1-\beta}{\Delta}\ lnw - \frac{1-\beta}{\Delta}\frac{\mu\tau^2}{2w} - \frac{\beta}{\Delta}lnc \tag{8}$$

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

The effect of financing constraints on employment is given by

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

which is negative because $\frac{\partial\tau}{\partial FC} < 0$ and $\frac{\partial \ln c}{\partial FC} > 0$. Higher financing constraints reduce employment when investment in training per employee decreases and the cost of capital increases with financial constraints.

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

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

Using equation (5), we can establish that the term within square brackets is negative. Hence, higher financing constraints reduce training expenditure per employee because $\frac{\partial\mu}{\partial FC} > 0$. Finally, define $TK = \frac{\mu}{2}\tau^2 L/K_{t-1}$ as investment in training as a share

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

of 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 three waves of the EIB Investment Survey (EIBIS), covering the financial years 2015 to 2017. EIBIS is administered each year to the senior managers or financial directors of a representative sample of firms in each of the 27 EU member states and in the UK. 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.[8]

We combine EIBIS with accounting data from Bureau van Dijk's Orbis database.[9] The financial and balance-sheet information in Orbis originates from business registers collected by local chambers of commerce to fulfil legal and administrative 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.

EIBIS covers firms in sectors C (Manufacturing) to J (Information and Communication) of the NACE classification.[10] 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

[8] 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.

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

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

2017 (and 22,633 firm-year observations over the three years).

Information on investment in training 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; [11] (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 process improvements.[12]

We define the training share *TK* as the ratio of investment in training 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.[13] As shown in Table 1, median and mean *TK* in 2017 were equal to 0.5 and 2.5 percent of fixed assets respectively (with standard deviation 6.9). The table also reports for the same year median and average investment in training per employee, which were equal to 107 and 211 euro respectively. Investment in training corresponded on average to 2.8 percent of the wage bill. Figure 2 shows that the average share *TK* in 2017 was highest in Luxemburg, France and Ireland and lowest in Poland and Greece.

Unfortunately, our data do not include information on the share of employees who received training. According to Eurostat's Continuous Vocational Training Survey, this share was equal to 40.8 percent in 2015.[14] Applying this share to our data would suggest that average investment in training per trained employee in 2017 was 517 euro (or 211/0.408).

The median and mean share of total investment in (lagged) fixed assets (*IK*) in 2017

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[11] By considering only monetary outlays, this definition does not take into account the opportunity costs of training (i.e. foregone productivity).

[12] 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 reporting no training in 2015. 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 – we find that the correlation between the two measures is relatively high, at 0.66.

[13] Since fixed assets refer to the previous year, we multiply the training share *TK* by the ratio of lagged to current output prices. We have also experimented with alternative definitions of training, including log(1 + investment) and found that the results are qualitatively similar.

[14] The share refers to continuous vocational training and therefore excludes initial training and apprenticeships.

were equal to 16.8 and 53.4 percent respectively. The relatively high mean is driven by 12 percent of firms in the sample having a value of *IK* above 100 percent.[15] The bulk of total investment was spent on tangible assets (mean share: 37.7 percent), much more than on research and development (5.6 percent), software and data (5.5 percent) and training (2.5 percent).

4. The index of financing constraints

EIBIS includes a measure of actual financing constraints (*AC*), which is based on the most recent loan application of the firm. It 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 takes value one, and zero otherwise.[16] It is a direct measure of financing constraints that relies on the actual experience in applying for a loan, trade credit or other external financing tools (Ferrando and Mulier, 2015a).[17]

In 2017, 5 percent of firms in our sample reported to be financially constrained (AC=1) (see Table 2). Figure 3 shows the distribution of average *AC* by country in that year. Typically, firms in Western and Northern Europe are less likely to be financially constrained than their peers in Central and Eastern Europe. Among Southern European countries, firms in Greece seem to be especially financially constrained. The percentage of firms with actual financial constraints is higher among firms with 5 to 49 employees (7.8 percent) than among firms with more than 50 employees (3.5

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[15] The share of firms with IK above 100 percent is largest for small firms (16.7 percent), highest in the information and communication sector (24.7 percent) and in Luxemburg (27.3 percent) and the Netherlands (23.5 percent).

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

[17] EIBIS also asks the firms to report whether they consider that the availability of external finance is a major obstacle, a minor obstacle or not an obstacle to investment at all. While the measure *AC* is based on the actual experience of the firm in the most recent application for external finance, the alternative measure relies on a general perception of the respondent (see Ferrando and Mulier, 2015a). We thus only use the AC measure in this study.

percent), highest in the construction sector (6.3 percent) and lowest in the transport sector (3.7 percent).

A study of the effects of financing constraints on investment in training faces three difficulties. The first is reverse causality, running from training to financing 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 financing constraints. Last but not least, self-reported financing constraints are likely to measure true constraints with error, as the measure of financing constraints may not reflect objectively the financial position of firms. For instance, less capable managers 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 in their firm to the credit market (Popov, 2014).

Reverse causality concerns can be alleviated by using measures of lagged rather than current firm-level constraints. However, this approach poses difficulties 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 address reverse causality and measurement error by using 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.[18]

We assume that actual constraints AC are determined as follows

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

where ε is measurement error (assumed to be classical, with zero mean and uncorrelated with the right hand side regressors) and Z an index summarizing the financial situation of the firm in the two previous years (i.e. at time t - s, where s = 1,2). We estimate the index Z using four financial indicators: a) the debt to total assets ratio (*leverage*); b) the ratio of current assets to current liabilities and the ratio of cash to total

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

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[19] to derive from them the index Z using principal component analysis.[20]

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 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, size, foreign ownership, and institutional factors that are country, time and sector specific. For instance, older firms are more likely to have successful track records and to entertain repeated interactions with lenders (Ferrando and Mulier, 2015a). As to size, small firms often have a lower amount of collateral relative to their liabilities and are more likely to be credit constrained. 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 thus include in the vector X firm size and firm age, subsidiary status, foreign ownership, country by year as well as sector fixed effects.

We estimate Eq. (12) using a linear probability model. Table 3 reports the results and shows that, as expected, actual constraints AC decline with the index Z, 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 the predicted value

[19] 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.

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

of AC, $FCI_{it} = X_{it}\hat{\theta} + Z_{it-s}\hat{\gamma}$.[21] The underlying intuition is that, if a firm declares to be financially constrained, this should appear in its financial accounts as 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.[22]

Figure 4 shows that there is a positive and high correlation across countries between the share of firms in each country with actual financing constraints (AC) and the country–specific average index of financing constraints (FCI). Figure 5 instead shows that the FCI index and investment in training as a share of fixed assets are negatively correlated across countries.

Our strategy can address the reverse causality problem, and can also mitigate the measurement error originating from self-assessment. However it does not necessarily account for 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 would be a distorted indicator of actual financing constraints.

We evaluate whether the 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 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

[21] 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 in the paper is very high (0.985). A very similar index is obtained when we estimate equation (12) using a logit specification. The results are available from the authors upon request.

[22] 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.

last row of Table 3, the two bounds are both negative and 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

We investigate the links between the financing constraints index *FCI* and investment activities by estimating the following regression

$$O_{it} = W_{it}\alpha + FCI_{it}\beta + u_{it} \tag{13}$$

where W is a vector of control variables, u is a disturbance term and the outcome variable O includes either (real) investment in training as a share of (lagged) fixed assets or (real) investment in training per employee.[23] As additional outcomes, we also consider investment in research and development (*RK*), investment in software and data (*DK*) and investment in tangible assets (*MK*) as shares of (lagged) fixed assets.

We recognize that optimal investment in training is determined by equalising marginal benefits and marginal costs – see equation (4) – 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.[24] 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, country by year as well as sector fixed effects.

Estimating equation (13) is equivalent to regressing O on W and actual constraints AC, using the index *FCI* as an instrumental variable for AC.[25] A potential concern with our approach is that *FCI* may influence O not only via its effect on AC but also directly. We address this issue by including in the vector W the ratio of debt to fixed assets and

[23] Real investment in training is obtaining by dividing nominal training expenses by the consumer price index, which varies across countries.

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

[25] See the Appendix for details. 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 of 10, indicating that the instrument is not weak.

the ratio of current to fixed assets (averages of first and second lag).[26] The identifying assumption is that, conditional on debt to fixed assets, leverage affects investment in training only by changing financing constraints. In a similar fashion, we assume that, conditional on average returns to equity, current assets and debt, solvency (measured as the ratio of profits to debt) and liquidity (measured by the ratio of cash to assets and by the ratio of current assets to current liabilities) do not directly affect outcome *O*.

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 *O* and the financing constraints index *FCI*, thereby biasing the estimates downwards. We verify whether unobserved heterogeneity affects the sign as well as the size of our estimates by using the Oster test discussed 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 report bootstrap standard errors, which is a valid inference procedure in our setting.

6. Results

6.1 Main findings

We present our baseline estimates in Table 4. The table is organized in four columns. In the first two columns, the outcome is investment in training as a share of fixed assets, *TK*. In the last two columns, it is (real) investment in training per employee. We report OLS estimates in columns (1) and (3) and Tobit estimates in columns (2) and (4). In each column, we also report the estimated coefficients associated with the average lagged return on equity and the average lagged ratio of sales to fixed assets.

[26] 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.

We also use the mean values of the relevant variables to compute the elasticity of each outcome with respect to the financing constraints index, the return on equity and the sales to assets ratio.

We find that an increase in the financing constraints index reduces both investment in training as a share of fixed assets and investment in training per employee. In particular, our estimates indicate that a 10 percent increase in the index reduces the former by 2.9 to 4.5 percent, depending on the estimation method, and the latter by 1.8 to 2.5 percent. We also find evidence of a positive and statistically significant effect both of the return on equity and of the sales to fixed assets ratio on the share *TK*.[27]

As discussed in the previous section, our estimates may be affected by omitted variables. If unobserved heterogeneity is 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. The bounds reported in the bottom part of the table show that this is not the case for any of the two outcomes.

Financial constraints may also affect other investment items. As shown in Table 5, we estimate that a 10 percent increase in the financing constraints index reduces the share of investment in R&D on fixed assets by 5.5 percent, the share of investment in software and data on fixed assets by 7.6 percent and the share of investment in tangible assets by 4.2 percent.[28] These results indicate that European firms facing tighter constraints reduce their investment in training and tangible assets relatively less than their investment in software and data and in R&D. They suggest that the share of training expenses with a consumption rather than a productivity value cannot be too

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[27] As discussed by Solon et al, 2015, 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 investment in training using value added weights and find that the estimated effect of financing constraints are similar to those reported in Table 4, albeit less precise, as one would expect.

[28] The estimated elasticities are evaluated at the sample mean values of the dependent variable and of the financing constraints index. The differences in the coefficients associated with the variable *FCI* are statistically different from zero when we compare training and software, or training and tangible assets, and not statistically different from zero when we compare training and R&D (results based on seemingly unrelated regressions).

important, because otherwise the investment in training should be more rather than less sensitive to financing constraints than other investment types.

6.2 Sensitivities

A causal interpretation of the estimates in Table 4 requires that the treatment (being financially constrained or not) should 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 (see Hainmueller and Xu, 2013).

Since entropy balancing requires a binary treatment, we standardize the financing constraints index for each country and construct a binary variable equal to 1 when the index is – in each country - at or above one standard deviation (about 15 percent of the sample) and to 0 otherwise.[29] We estimate the effect of the binary treatment on investment in training as a share of fixed assets *TK* and investment in training per employee (see Table 6) and find – reassuringly - that the estimated elasticities are similar to those obtained in Table 4 when using the continuous index *FCI*.

We also consider the fact that our working sample includes firms with a share of investment on fixed assets above 100 percent by checking in Table A1 whether removing these firms from the sample would change qualitatively our results. We find that it does not, although we lose precision because the sample is smaller.

6.3 Heterogeneous Effects

The estimates in Table 4 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

[29] The standardized financing constraints index ranges in the full sample between -4.26 and +3.18.

7 reports the results when we group countries in three areas: Western and Northern Europe (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxemburg, Netherlands, Sweden and the UK), Southern 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 investment in training with respect to the financing constraints index is much higher in Southern Europe (-1.115 for TK and -0.301 for training per employee) than in Central and Eastern Europe (-0.154 for TK and -0.221 for training per employee) and Western and Northern Europe (-0.199 for TK and -0.114 for training per employee). 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 activities in Southern Europe, compared to 37 percent in Western and Northern 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 7 also reports our estimates when we allow the parameter β to vary by sector (manufacturing versus services), 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 than in services and tend to be smaller for subsidiary and foreign owned firms.

6.4 The effect of investment in training on productivity

If the investment in training measured in EIBIS survey is mainly a way for firms to provide utility to their employees, it should have no impact on firm productivity.[30] We investigate whether this is the case by estimating a Cobb Douglas production function similar to the one introduced in Section 2: $Y_{it} = A_{it}K_{it}^{\beta}L_{it}^{\alpha}(1+\tau_{it})^{\gamma}\, M_{it}^{\delta}$, where

[30] Recent empirical evidence of the effect of training on productivity includes Konings and Vanormelingen, 2015, and Martins, 2020.

the indices i and t are for the firm and time, Y is output (real sales), K the capital stock, L employment, τ is investment in training per employee, M the cost of materials and A the technical efficiency parameter, unobserved by the analyst but predictable to the firm.[31] Taking logs and appending an error term, we obtain

$$lnY_{it} = c_0 + \alpha lnL_{it} + \beta lnK_{it} + \gamma \ln(1+\tau_{it}) + \delta lnM_{it} + \omega_{it} + \varepsilon_{it} \qquad (14)$$

where c_0 is a constant term, $\omega_{it} = lnA_{it}$ correlates with input decisions, and ε_{it} is an unobservable that is orthogonal to these decisions. Since ω_{it} correlates with optimal inputs, there is an endogeneity problem.

A classical solution to this problem has been proposed by Olley and Pakes, 1996, and is based on the idea that the shock ω_{it} can be eliminated from (14) by substitution if an additional equation exists that monotonically associates an observable variable (i.e. investment) to the shock. In this paper, we follow Levinsohn and Petrin, 2003, and use the cost of materials M as the control variable required to learn about ω_{it}.

Table 8 presents our estimates. The first column refers to the full sample of countries and the remaining three columns considers separately the firms in North and Western Europe, Southern and Eastern Europe (CESEE). There is evidence that investment in training affects productivity, and that this effect is larger in Eastern and Southern Europe than in Northern and Western Europe. Since firms in the last area invest on average more in training than firms in other areas, this is consistent with decreasing marginal returns to training. For the full sample of countries, we estimate that a 10 percent increase in investment in training per employee – which in our data corresponds to about 20 euro – raises firm output by 0.32 percent.

6.5 Simulating the effects on training of changing financial constraints

The relative importance of financing constraints during the period 2015-17 varied across European countries. While the country average value of *FCI* was 0.05, the index ranged from below 0.035 in Austria, Sweden and Germany to above 0.115 in Croatia, Latvia, Hungary, Lithuania and Greece. In this sub-section, we develop the following

[31] Compared to the production function in Section 2, we allow the exponent associated with employment L to differ from the exponent associated with training per employee.

thought experiment: suppose that policies could be put in place such that the index of financing constraints is reduced in each single country to the average level prevailing in Germany. What would be the effect on average investment in training by country?

We perform this back of the envelope exercise by using the estimated elasticities by area reported in Table 7. Table 9 shows in the first column the average index of financing constraints by country during 2015-17, in the second column average investment in training as a share of fixed assets *TK* during the same period, and in the third column the hypothetical share attained, ceteris paribus, if the country-specific financing constraints index were set to the one prevailing in Germany. It turns out that in countries such as Greece, where financing constraints are relatively high and training investment relatively low by European standards, bringing the average *FCI* index down to the German average would increase the share of training from 0.76 to 1.46 percent of fixed assets, an improvement that would significantly reduce the training gap with Germany. The gap, however, would remain large (3.18 versus 1.46 percent). By virtue of this partial convergence, productivity in Greece would increase by 2.57 percent.

Conclusions

Employer investment in employee training varies substantially within the EU. Firms in Central and Eastern Europe and in some Southern European countries are investing much less than firms located in Northern and Western Europe. In this paper, we have investigated whether some of this cross-country variation can be explained by differences in the financing constraints that firms face, which may affect the implementation of their desired investment plans. To address this question, we have combined firm survey data from EIBIS, which covers the 27 EU Member States and the UK, 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 investment in training, expressed either as share of fixed assets or per employee. Our results indicate that a 34 percent reduction in the financing constraints index, bringing the European average down to the German average, would increase the investment in training per employee by 6.1 to 8.5 percent, and firm productivity by 2 to 2.7 percent. These are non-negligible effects.

We have shown that investment in training is less sensitive to financing constraints than investments in software,data and R&D, and about as sensible as investment in tangible assets. There is also evidence that the sensitivity of investment in training to changes in financing constraints is significantly higher in the countries of Southern Europe, where investment is lower than the EU average.

Our simulations indicate that policies that reduce the financing constraints faced by firms can foster employers' investment in training, with positive effects on productivity, but are unlikely to fully close the training gap between European countries. This gap is likely to depend also on differences in economic institutions, industrial structures, innovation activities and the relative supplies of skills.

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Table 1. Descriptive statistics on investment activities in 2017.

Variable	Median	Mean	St. 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 and data / 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	0.277
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 2. Descriptive statistics of main variables in 2017.

Variable	Mean	St. Dev
% of financially constrained firms	0.050	
FCI (financing constraints index)	0.050	0.218
Leverage: average debt to total assets ratio (first and second lag)	0.546	0.211
Liquidity: average current assets to liabilities (first and second lag)	2.156	2.164
Liquidity: average cash to assets (first and second lag)	0.116	0.122
Solvency: average profits to debt (first and second lag)	0.241	0.235
Average return on equity (first and second lag)	0.291	0.219
Average sales / fixed assets (first and second lag)	16.205	20.306
Average capital labour ratio (first and second lag)	44.332	45.690
Average debt / fixed assets (first and second lag)	4.674	6.646
Average current assets / fixed assets (first and second lag)	6.996	10.711
Age: older than 20 years (share of firms)	0.733	
Size: 5 to 49 employees (share of firms)	0.343	
Subsidiary (share of firms)	0.384	
Foreign owned (share of firms)	0.152	

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

Table 3. The effect of the financial situation in the two previous years Z on "actual" constraints *AC*. Linear probability model.

Variable	Coefficient	Standard error
Index *Z* of financial situation in the two previous years	-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	22,633	
Oster bounds for *Z*	[-0.012/-0.010]	

Note: the index Z is obtained from principal component analysis using as ingredients the debt to total assets ratio (first and second lag); the ratio of current assets to current liabilities (first and second lag); the ratio of cash to total assets (first and second lag); the ratio of operating profits to total debt (first and second lag). 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 4. The effect of the financing constraints index *FCI* on investment in training as a share of fixed assets TK and on investment in training per employee. OLS and Tobit estimates.

Variable	Investment in training / Fixed assets OLS (1)	Investment in training / Fixed assets Tobit (2)	Investment in training per employee OLS (3)	Investment in training per employee Tobit (4)
FCI (financing constraints index)	-0.086**	-0.133***	-0.327**	-0.472**
	(0.041)	(0.049)	(0.133)	(0.178)
Average return on equity (lagged)	0.019***	0.022***	0.006	0.008
	(0.002)	(0.003)	(0.006)	(0.009)
Average sales / fixed assets (lagged)*10	0.004***	0.004***	-0.001	-0.002
	(0.001)	(0.001)	(0.001)	(0.002)
Elasticity with respect to *FCI*	-0.287**	-0.445***	-0.175**	-0.248**
Elasticity with respect to *ROE*	0.205***	0.241***	0.010	0.014
Elasticity with respect to sales /fixed assets	0.243***	0.258***	-0.013	-0.020
Oster bounds	[-0.086,-0.091]		[-0.037,-2.167]	
R Squared	0.097	-	0.134	-
Sample size	22,633	22,633	22,633	22,633

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

Table 5. The effect of the financing constraints index *FCI* on investment in other activities. OLS estimates.

Variable	Investment in R&D / Fixed assets	Investment in software and data / Fixed assets	Investment in tangible assets / Fixed assets
FCI (financing constraints index)	-0.272*	-0.476***	-2.187***
	(-0.156	-0.152	-0.75
Average return on equity (lagged)	0.023**	0.035***	0.398***
	-0.009	-0.007	-0.049
Average sales / fixed assets (lagged)*10	-0.003	0.008***	0.075***
	-0.004	-0.003	-0.017
Elasticity with respect to *FCI*	-0.546*	-0.763***	-0.418***
Elasticity with respect to *ROE*	0.149***	0.183***	0.247***
Elasticity with respect to sales /fixed assets	-0.095	0.230**	0.263***
Oster bounds	[-0.137,-0.272]	[-0.476,-0.483]	[-2.187,-2.238]
R Squared	0.048	0.046	0.075
Sample size	22,633	22,633	22,633

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

Table 6. The effect of the binary variable "high FCI" on investment in training. Entropy balancing.

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

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

Table 7. Elasticity of investment in training (as a share of fixed assets) with respect to changes in the financing constraints index FCI. By area, sector, firm size and ownership. OLS estimates.

Group	Investment in training/ fixed assets	Investment in training / employee
Western and Northern Europe (1)	-0.199**	-0.114***
South Europe (2)	-1.115***	-0.301***
CESEE (3)	-0.154	-0.221
p-value Test (1) = (2)	0.000	0.512
p-value Test (1) = (3)	0.815	0.010
p-value Test (2) = (3)	0.000	0.038
Manufacturing (1)	-0.464**	-0.229***
Services (2)	-0.235**	-0.137***
p-value Test (1) = (2)	0.075	0.048
Subsidiary (1)	-0.266***	-0.092***
Not a subsidiary (2)	-0.236	-0.203**
p-value Test (1) = (2)	0.786	0.069
Foreign owned (1)	-0.153**	-0.113***
Not foreign owned (2)	-0.155**	-0.181***
p-value Test (1) = (2)	0.980	0.004

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

Table 8. The effect of investment in training per employee on log output Y. Production function estimates. Method: Levinsohn and Petrin, 2003.

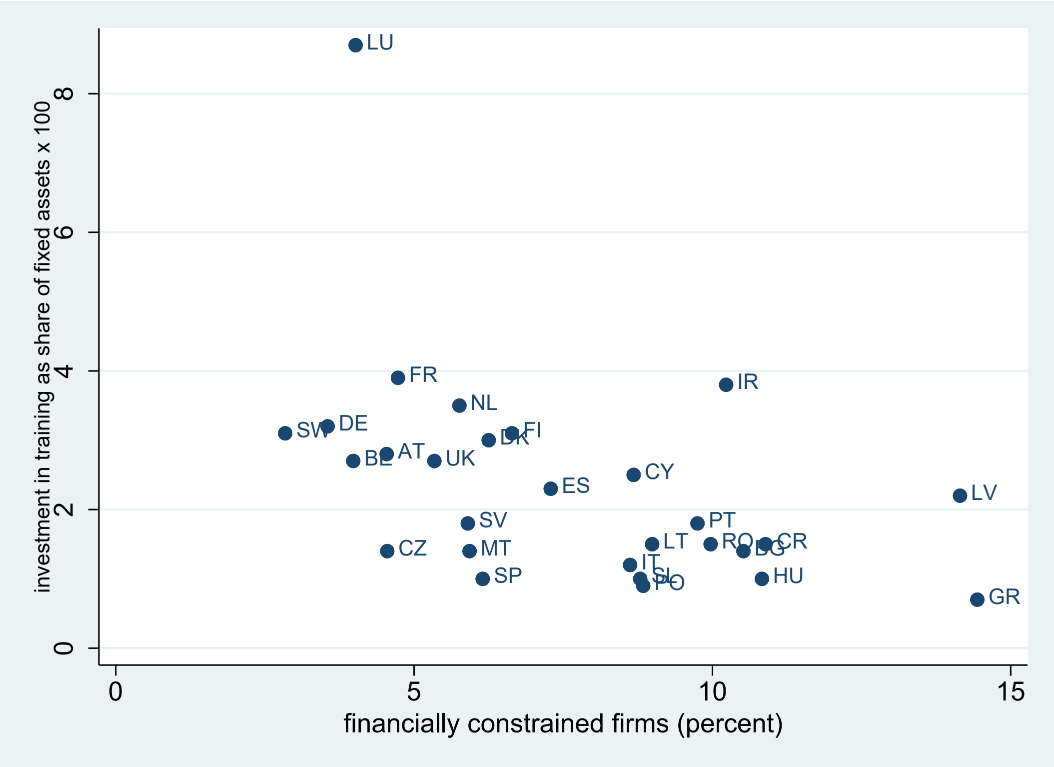
Variable	Full sample	Western and Northern Europe	Southern Europe	Central and Eastern Europe
Log employment	0.381***	0.374***	0.499***	0.464***
	(0.001)	(0.006)	(0.009)	(0.005)
Log fixed assets	0.052***	0.011	0.125***	0.035
	(0.008)	(0.019)	(0.015)	(0.022)
Log material costs	0.386***	0.544***	0.259***	0.341***
	(0.023)	(0.015)	(0.001)	(0.022)
Log(1 + training per employee)	0.032***	0.009***	0.027***	0.048***
	(0.001)	(0.001)	(0.001)	(0.005)
Sample size	18,559	7,436	2,701	8,422

Note: see Table 4. The estimates are based on the routine "prodest" in Stata 16. *, **, *** for statistical significance at the 10, 5 and 1 level of confidence.

Table 9. Simulated TK when FCI is set equal to the value for Germany.

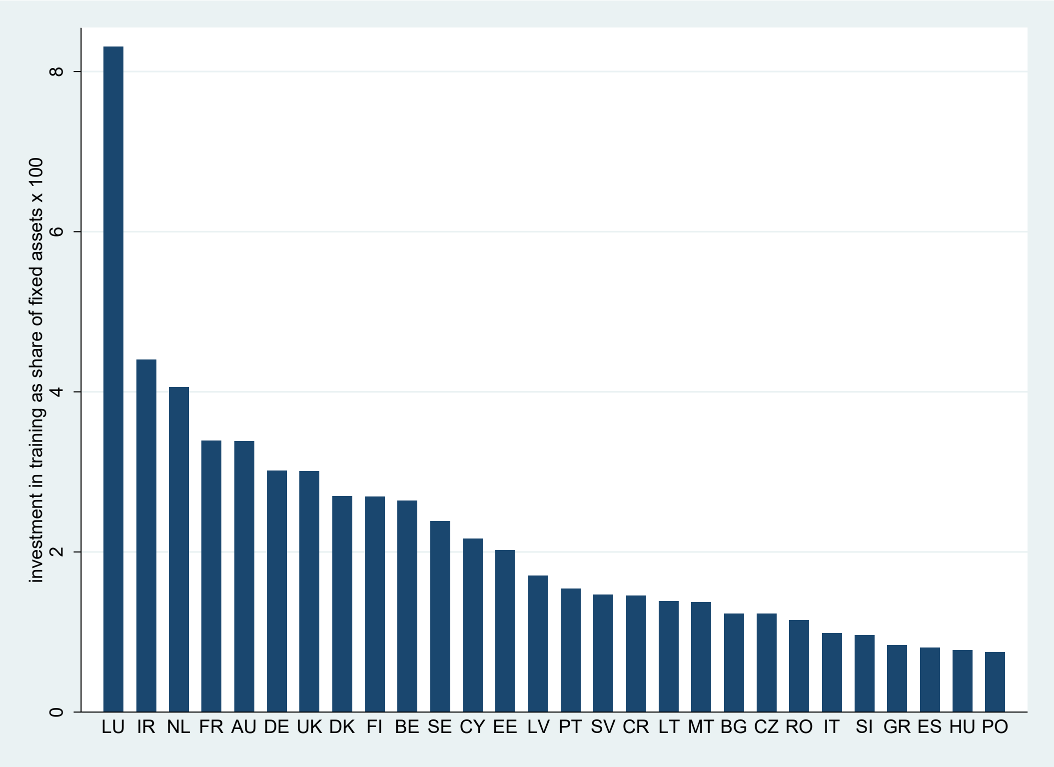
Country	FCI 2015-17	TK (%)	Simulated TK (%)
Austria	0.034	2.76	2.78
Belgium	0.037	2.68	2.75
Bulgaria	0.101	1.40	1.54
Croatia	0.134	1.53	1.71
Cyprus	0.081	2.54	4.23
Czech Republic	0.043	1.35	1.40
Denmark	0.055	3.02	3.27
Estonia	0.090	2.31	2.54
Finland	0.060	3.09	3.37
France	0.036	3.94	4.02
Germany	0.033	3.18	3.18
Greece	0.170	0.76	1.46
Hungary	0.119	1.01	1.12
Ireland	0.094	3.85	4.35
Italy	0.090	1.23	2.10
Latvia	0.128	2.24	2.50
Lithuania	0.120	1.47	1.63
Luxembourg	0.052	8.68	9.31
Malta	0.060	1.37	2.07
Netherlands	0.062	3.50	3.83
Poland	0.104	0.90	1.00
Portugal	0.102	1.76	3.10
Romania	0.093	1.53	1.68
Slovakia	0.083	1.82	1.99
Slovenia	0.079	1.03	1.12
Spain	0.062	0.98	1.51
Sweden	0.018	3.13	3.09
UK	0.042	2.74	2.87

Figure 1. Investment in training as a share of fixed assets and share of financially constrained firms, by country. EIBIS 2017



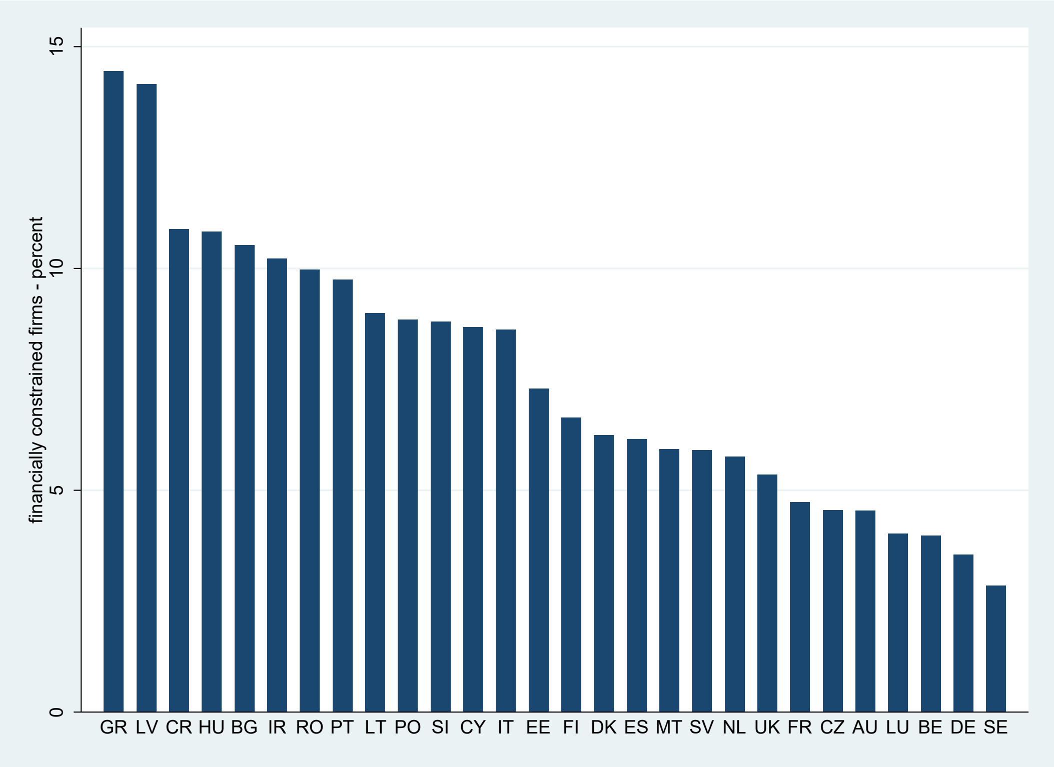
Legend: AT: Austria; BE: Belgium; BG: Bulgaria; CY: Cyprus; CZ: Czech Republic; DE: Germany; DK: Denmark; EE: Estonia; FI: Finland; FR: France; GR: Greece; HR: Croatia; HU: Hungary; IE: Ireland; IT: Italy; LT: Lithuania; LU: Luxembourg; LV: Latvia; MT: Malta; NL: Netherlands; PL: Poland; PT: Portugal;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

Figure 2. Investment in training as share of fixed assets, by country. EIBIS 2017



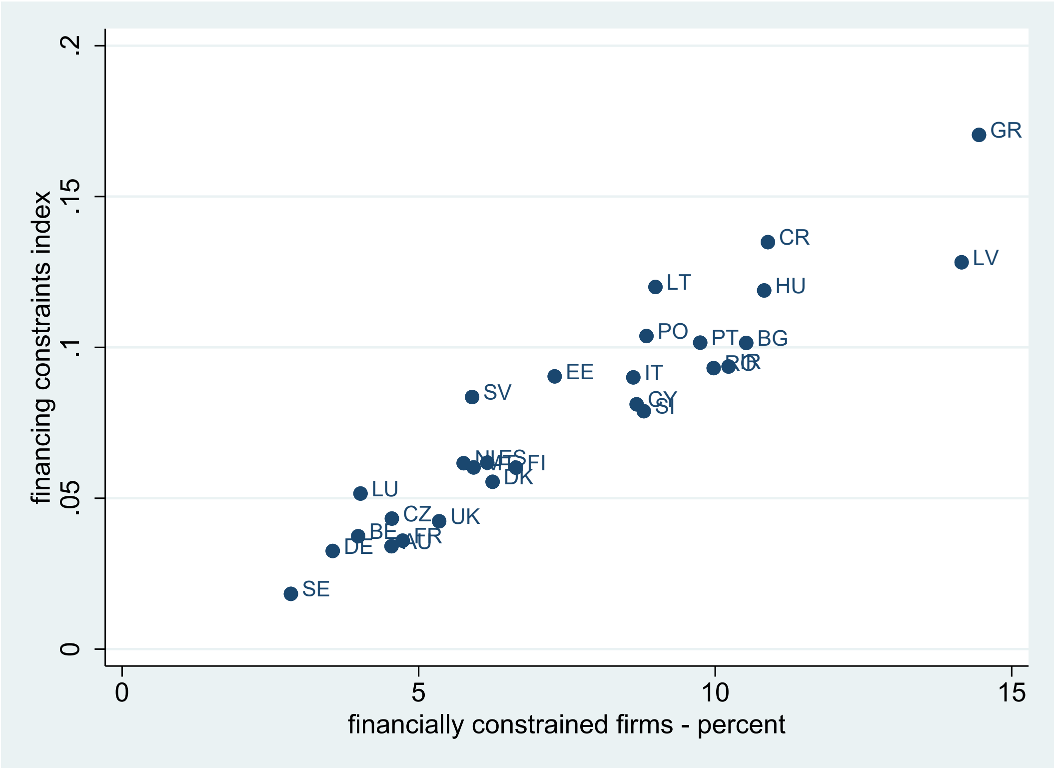
Legend: AT: Austria; BE: Belgium; BG: Bulgaria; CY: Cyprus; CZ: Czech Republic; DE: Germany; DK: Denmark; EE: Estonia; FI: Finland; FR: France; GR: Greece; HR: Croatia; HU: Hungary; IE: Ireland; IT: Italy; LT: Lithuania; LU: Luxembourg; LV: Latvia; MT: Malta; NL: Netherlands; PL: Poland; PT: Portugal;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

Figure 3. Share of financially constrained firms, by country. EIBIS 2017



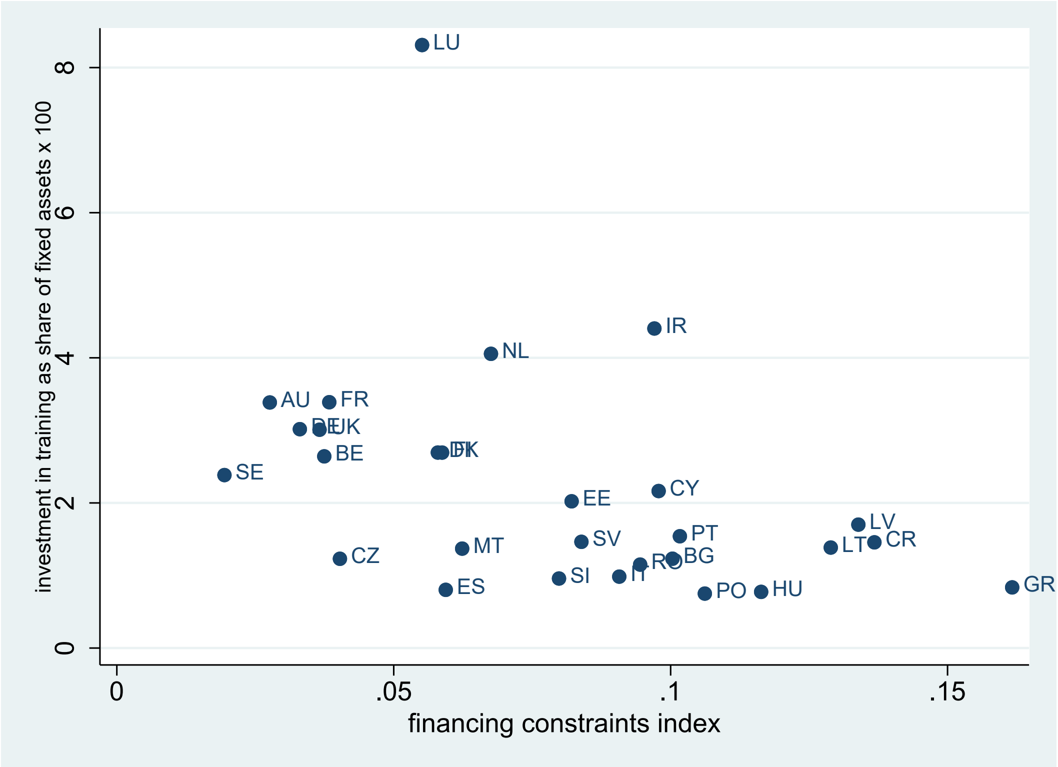
Legend: AT: Austria; BE: Belgium; BG: Bulgaria; CY: Cyprus; CZ: Czech Republic; DE: Germany; DK: Denmark; EE: Estonia; FI: Finland; FR: France; GR: Greece; HR: Croatia; HU: Hungary; IE: Ireland; IT: Italy; LT: Lithuania; LU: Luxembourg; LV: Latvia; MT: Malta; NL: Netherlands; PL: Poland; PT: Portugal;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

Figure 4. 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 5. Investment in training as a share of fixed assets 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 OLS	Investment in training / Fixed assets Tobit	Investment in training per employee OLS	Investment in training per employee Tobit
FCI (financing constraints index)	-0.041*	-0.057*	-0.190*	-0.264*
	(0.021)	(0.032)	(0.105)	(0.159)
Average return on equity (lagged)	0.009***	0.010***	-0.005	-0.009
	(0.002)	(0.002)	(0.007)	(0.011)
Average sales / fixed assets (lagged)*10	0.002***	0.002***	-0.002	-0.003
	(0.000)	(0.001)	(0.002)	(0.002)
Elasticity with respect to *FCI*	-0.245*	-0.335*	-0.106*	-0.109*
Elasticity with respect to *ROE*	0.181***	0.182***	-0.008	-0.012
Elasticity with respect to sales /fixed assets	0.299***	0.228***	-0.016	-0.021
R Squared	0.081	-	0.127	-
Sample size	19,256	19,256	19,256	19,256

Note: see Table 4.

Appendix. FCI as instrumental variable for AC in equation (13)

We obtain *FCI* as the predicted value from regression

$AC = Z\gamma + \omega$

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

$FCI = Z\hat{\gamma} = Z(Z'Z)^{-1}Z'AC$

Next, consider equation (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 instrumental variable 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

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

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