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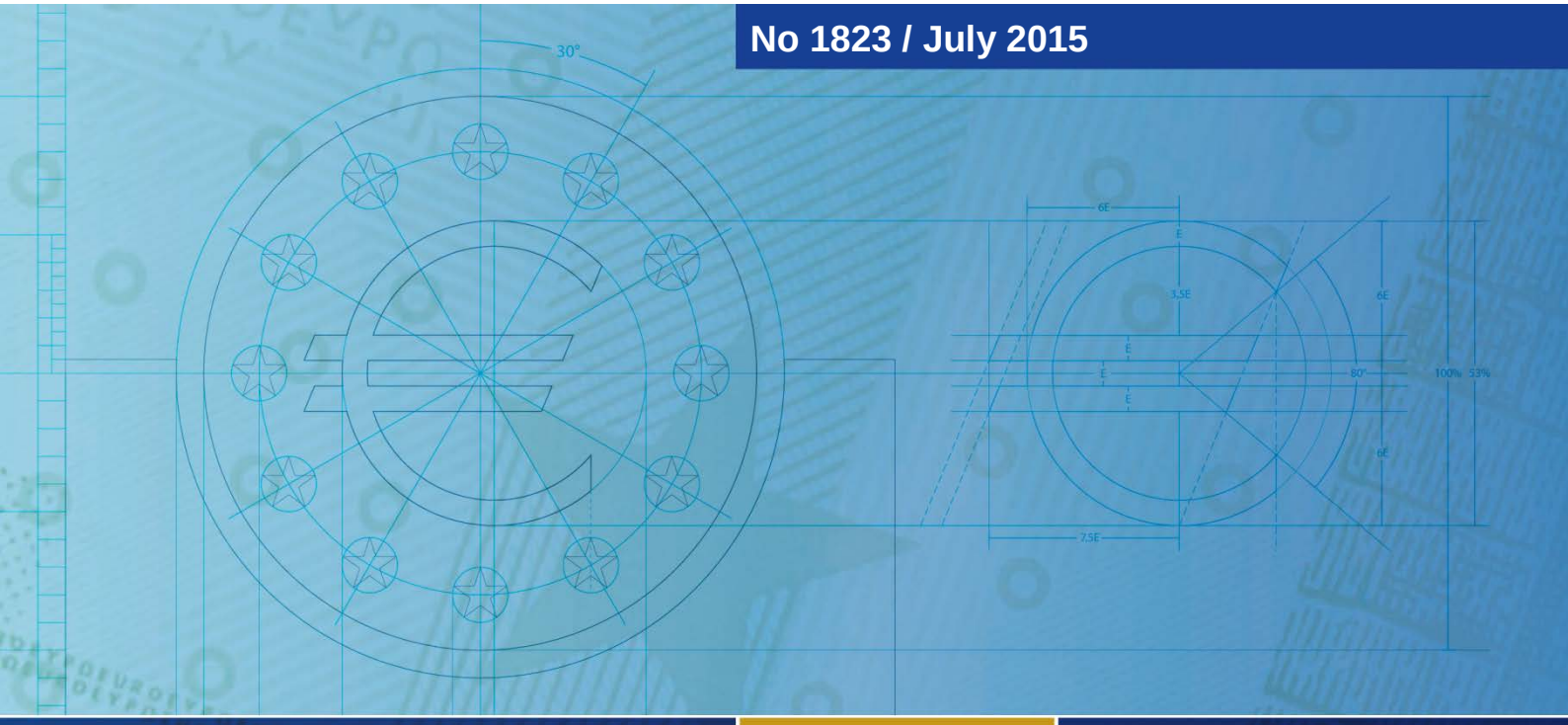
Financial constraints and productivity: evidence from euro area companies



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Abstract

We study the relation between firms financial structure, access to external finance and labor productivity using a unique dataset of firm-level data for several euro area countries during the period 1995-2011. The empirical strategy is twofold. First we build a synthetic indicator of financial constraints using an a-priori classification based on specific firm characteristics and various measures of financial pressure. Therefore we augment a firm-level production equation with our indicator to estimate the direct impact of access to finance to firm-level productivity. We find negative and significant effects in the majority of countries and industries, with marginal impacts considerably higher in industries that innovate the most, like "Energy, Gas and Water Supply" and "R&D, Communication and Information". Counter-factual exercises show that, as opposed to Germany and Netherlands, countries like Italy and Portugal are the most affected by financial constraints, with an estimated loss of around 21% of their labor productivity. In addition, each country would gain on average between one and two percent of their labor productivity by expanding the access to finance of small firms to that of the average large firm.

Keywords: financial constraints, productivity, SMEs, cross-country, sectoral analysis
JEL Classification: D24, G32, O16.

Non Technical Summary

This paper aims to provide new evidence on the link between financial variables and productivity. While it is widely documented that firms financing decisions are crucial in determining investment decisions, few studies analyze in detail how the financial position of a firm and the access to external finance determine firm′ performance in terms of value added generated and productivity. Moreover the empirical evidence on the link between financial constraints and labor productivity at microeconomic level is mixed and mostly confined to either single countries or to few specific production sectors. Our paper goes a step further as it takes a multi-country dimension in the investigation of this link by looking at a large sample of enterprises in eight euro area countries (Belgium, Germany, Spain, Finland, France, Italy, Netherlands and Portugal) and for a time span that takes into account the impact of two financial crisis and economic recessions (1995-2011). We contribute to the existing literature by following a twofold empirical strategy. First we developed an indicator of financial constraints at firm level and second we included this indicator to a firm-level production equation to assess the direct impact of access to finance to firm-level productivity. In the first step we construct an indicator of firm-specific financial constraints based on a classification scheme of firms financing conditions, taking into account information derived from balance sheet and profit and loss accounts. We distinguish between absolutely constrained, relatively constrained and unconstrained firms according to different scenarios based on the relation among total investment, financing gap, financial debt, equity issuance and average interest payment on debt compared to the rate charged in the local credit market. Then, we relate this index to specific firm characteristics, which are extensively used in the literature to proxy financial constraints, such as age, size and sector and some additional measures of financial pressure, and using a non-linear estimation, we predict for each firm in our sample the probability of belonging to one of the aforementioned ranking. In the second part of our empirical analysis, we measure the reaction of firm-level productivity to the probability of accessing external finance as measure by our predicted index. Our results show that financial constraints do significantly lower productivity in the majority of sectors across countries and the impact is heterogeneous across sectors. From a cross-country perspective, Italy and Portugal are the most affected by financial constraints, while Germany and Netherlands are the most immune.

"...in times of severe financial constraints, there is no other choice than to address the structural losses in competitiveness in an urgent and decisive manner."
M.Draghi, at the colloquium "Les défis de la compétitivité", Paris, 13 March 2012

1 Introduction

Do financial constraints affect firm-level labour productivity? In the literature it's widely accepted that firms financing decisions are crucial in determining investment decisions, and that the existence of frictions in accessing external sources of finance (due for instance to the existence of credit risk or information asymmetries) significantly affects the ability of management of exploiting productive investment opportunities.[1] However the empirical evidence on the link between financial constraints and labor productivity at microeconomic level is mixed and mostly confined to either single countries or to few specific production sectors.

Part of the literature reports positive and significant estimates for the effect of financial constraints on long-term productivity-enhancing investments and real value added. For instance, Gatti and Love (2008) use data from a cross-section of Bulgarian firms to study whether having larger access to credit lines or to overdraft facilities foster productivity and find credit to be positively and strongly associated with TFP. Butler and Cornaggia (2011) use county-level data of US mid-western states farmers during the period 2000-2006 to study the productivity response of an exogeneous shift in demand for corn in areas with different access to finance and find that production increased the most in those areas with relatively strong access to finance. Chen and Guariglia (2013) exploits a panel of Chinese manufacturing firms over the period 2001-2007 to investigate the link between cash flow and firm-level productivity and find that TFP is strongly constrained by the availability of firms′ internal finance. Levine and Warusawitharana (2014) find a strong positive relationship between debt growth and future productivity growth for a broad set of firms in four European countries. On the other hand, Moreno-Badia and Slootmaekers (2009) use Estonian firm-level data covering the period 1997-2005 and find that a number of proxies for financial constraints do not have any impact on productivity for most sectors. Similarly, Nunes et al. (2007) apply a quantile approach to a panel data of 162 Portuguese firms between 1999 and 2003 and show that leverage tends to negatively af-

[1] For a theoretical study on the channels linking credit conditions and long-term productivity losses, see, among the others, Aghion et al. (2005) and Moll (2014). For a macro-level empirical analysis on the role of financial development in fostering economic growth, see Levine (1997), Beck et al. (2000) and Khan and Senhadji (2003).

fect labour productivity in firms with relatively low labour productivity. Using data from the 2007 World Bank Enterprise Survey, Mwangi (2014) report a negative but insignificant effect of access to credit on firm productivity for a sample of micro and small enterprises in Kenya.

Within this debate, this paper aims at providing new insights and evidence on the relation between firms financial structure, access to external finance and measures of firm-level productivity. To this extent, we exploit a unique panel of firm-level data, tracking eight euro area countries (Belgium, Germany, Spain, Finland, France, Italy, Netherlands and Portugal) and nine broad economic sectors (Accommodation and Food Service, Construction, Energy, Communication, Manufacturing, Retail trade, Wholesale trade, Transports and Other Business Service) during the period 1995-2011. The sample is derived from the Bureau van Dijk-*Amadeus* database which collects accounting data of non-financial corporations across Europe. Compared to previous contributions, this paper takes a multi-country dimension as it investigates the role of financial constraints on real value added and productivity looking at a sample of enterprises in several European countries and for a time span that takes into account the impacts of two financial crisis and economic recessions.[2]

One of the biggest issues facing empirical works in this literature is to objectify financial constraints and to construct a clean measurement, as they are empirically not observable.[3] Moreover, because access to finance and productivity are endogenously determined as equilibrium outcomes, a further hurdle is a clear identification of the causal direction of impact. To this regard, we conduct our analysis adopting a novel empirical strategy. First we build a firm-level indicator of financial constraints and second we apply this indicator to a production equation to assess the direct impact of financial constraints on productivity. As first step, we construct a semi-parametric index of firm-specific financial constraints, as originally developed by Pal and Ferrando (2010). This indicator is based on a classification scheme of firms′ financing conditions, taking into account information derived from balance sheets and profit and loss accounts. We distinguish between absolutely constrained, relatively constrained and unconstrained firms according to different scenarios based on the relation among total investment, financing gap, financial debt, equity issuance and average interest payment on debt compared to the rate charged in the local credit market. The index gives us some hints on the heterogeneity in financial constraints across firms and euro area countries. To obtain a synthetic value, we relate our indicator to a number of specific firm-level characteristics, like age, size and cash holding, which are extensively used in the literature to proxy financial constraints, and we use a ordered probit estimation to predict the probability of belonging to one of the aforementioned

[2]To the best of our knowledge, this is the first paper trying to study the role of access to finance in enhancing labour productivity using such large panel of firm-level data.

[3]See Silva and Carreira (2012) for a survey of works related to firm-level financial constraints.

groups for each firm in the sample. The resulting predicted index, i.e. a continuous variable with higher values associated with more constrained firms, will represent our core measure of financial constraints: differently from the existing literature, this index takes into consideration a broader set of firm-level factors affecting access to external source of finance, rather than a single proxy. In the second part of the analysis, we estimate the reaction of companies′ labour productivity to financial constraints. Acknowledging the presence of endogeneity in assessing the causal impact, we exploit the nature of our index of financial constraints, which by construction is an additional state variable in the firm-level production function (together with capital stock) and we modify the Wooldridge-Levinsohn-Petrin methodology to accordingly account for that.[4] We use panel generalized method of moments of Arellano and Bond (1991) and Blundell and Bond (1998) to estimate a firm-level production function equation which directly includes our index of financial constraints as one of the regressors, assuming productivity to evolve as a first-order autoregressive process. To provide robustness, we carry out this estimation for each country and sector separately while controlling for time-effects.

Our main findings are the following ones. Financial constraints do lower productivity in most sectors across countries: in the great majority of the estimations, the direct impact of financial constraints is statistically and economically significant. The coefficient estimates are significantly higher in industries that innovate the most, like "Energy, Gas and Water Supply" and "R&D, Communication and Information", while turn to be lower in "Construction and Real Estate", a sector that have benefited more than others from low interest rates along the period 2001-2007. From a cross-country perspective, Italy and Portugal are the most affected by financial constraints, with an estimated counter-factual loss in their average labor productivity of about 21% due to limited access to finance; Germany and Netherlands are the most immune countries, with counter-factual losses of around 11 and 15 percent. In addition, each country would gain on average between one and two percent of their labor productivity by expanding the access to finance of small firms to that of the average large firm. All these results are robust to a number of robustness checks, including alternative econometric specifications, and to several sub-samples.

This paper relates to a number of literature. First, it contributes to the literature that tries to detect and measure the degree of financial constraints from a firm-level perspective. Since the ICFS (investment cash-flow sensitivity) measure proposed by Fazzari et al. (1988), the debate over the consistency in measuring financial constraints has been vivid and has resulted to an extensive empirical work related to this topic. Among the others, the Kaplan and Zingales (KZ) index of financial constraints (Lamont et al., 2001), the CCFS (cash flow sensitivity of

[4] See Fernandes (2007) for a similar application on the effect of trade policies on productivity gains for Colombian manufacturing plants.

cash) index (Almeida et al. 2004), the Whited and Wu (WW) index of constraints (Whited and Wu, 2006), the size-age (SA) index recently advanced by Hadlock and Pierce (2010) and a variety of different criteria based on firm characteristics have been proposed and tested. Differently from the majority of the existing contributions, and in line with Musso and Schiavo (2008), we do not focus on single proxies but we build our indicator upon an *a-priori* discrete-range firm classification and obtain a synthetic value using a ordered probit estimation. Thus, we attempt to estimate the response of firm-level productivity to the likelihood of accessing external finance, as measured by our index. To this extent, this paper relates to the empirical literature that looks explicitly at the impact of financial constraints on firm behavior and measures of performance. A number of contributions have shown that financial constraints and liquidity constraints affect the decision to engage in R&D investment (Bond et al., 2005, and Mancusi and Vezzulli, 2010); that financing frictions have an impact on corporate investment and that the inability to access external source of funding can cause firms to bypass profitable investment opportunities (Almeida and Campello, 2007); that more constrained firms during the global financial crisis of 2008 planned deeper cuts in tech spending, employment, and capital spending (Campello et al., 2010); that financial constraints act as a barrier to export participation (Bellone et al., 2010, Silva and Carreira, 2011). We collocate our paper within this literature by focusing on the effect of financial constraints on labor productivity, and we show that, everything else equal, limited access to finance significantly dampens firm-level real value added in most of the countries and sectors. Finally, our paper contributes to the policy debate on the spillover effects from the financial sector on the real economy and on the implications for policy makers to foster long-term investment and growth in the economy.[5] The remainder of the paper is organized as follows. In Section 2 we describes the dataset. In Section 3 we introduce the classification scheme used to detect financial constraints and we derive a synthetic indicator that will be included in the production function equation. In Sections 4 we describe the empirical strategy used to estimate the impact of financial constraints on productivity. In Section 5 we report the core results of the paper and we discuss a number of robustness checks. We conclude in Section 6.

[5] At the 71st Plenary Meeting of the Group of Thirty (May, 2014), the ECB Vice-president Victor Costancio pointed out how moderate growth still remains a challenge for the euro area countries, where, on average, investment rate is about 20% below its long run mean that came to the end with the financial crisis of 2008. More recently, a report from the ECB CompNet (2015) have documented how the recent financial crisis have dampened firm level-total factor productivity through a decreased access to credit and finance.

2 The Data

For the construction of our sample we use the entire universe of *Amadeus* for accounting data (both balance sheets and income statements).[6] Typically one annual release of *Amadeus* covers at most the preceding ten accounting years of each firm. Further, *Amadeus* removes a firm after at least five years of no reporting data. In order to eliminate this potential survivorship bias, we compile our database by collecting accounting information from each annual release retrospectively so that we can have the complete history of data for all firms across the entire sample period.

The original dataset contains end-of-year accounting information for the period 1991-2011. We drop the first three years because of poor coverage and we lose another year of observations to compute some of our variables, such as sales growth. We eliminate observations when there are inputting mistakes (e.g. negative total assets) and focus our analysis on nine broad non-financial industries: 1) Accommodation and food; 2) Construction and real estate; 3) Electricity, gas and water supply 4) Information, communication and R&D; 5) Manufacturing; 6) Other business activities, 7) Retail trade; 8) Transportation and storage and 9) Wholesale trade. We keep firms with at least three years of observations, so to minimize selection bias and to have enough information to build our proxy of financial constraints status. To eliminate outliers, we winsorize all variables at the top and bottom 1% of their distribution within each country, sector and year. After performing our data filtering, we end up with an unbalanced panel of 1022638 firms and 5543569 firm-year observations over the 1995-2011 period.[7] The final sample contains eight euro area countries (Belgium, Finland, France, Germany, Italy, Netherlands, Portugal, and Spain). Table 1 reports the coverage of our sample. Two fifth of the total sample are made up of Spanish firms and together with French and Italian firms represent 86% of the entire sample. One advantage of *Amadeus* is the wide incidence of small and medium-sized enterprises (SMEs): they represent on average the overwhelming majority of our sample when we consider firms with less than 250 employees. In terms of the EC definition, based not only on the number of employees but also on turnover and assets, our sample contains at least 50%

[6] *Amadeus*, one of the products provided by Bureau van Dijk, is a comprehensive, pan-European database containing accounting information for both publicly traded and privately held companies. Bureau van Dijk collects accounting information from a variety of sources and it further harmonizes the financial accounts to allow accurate cross-country comparisons. Although *Amadeus* includes companies regardless of their size, limited coverage may still occur because the degree of company accounts filing and publication requirements differ between countries. This is particularly the case for Germany, where many firms choose not to file detailed annual reports and instead pay the small non-reporting fine. See ECB (2013), Ferrando et al. (2014) and Levine and Warusawitharana (2014).

[7] After the final cleaning and considering only firms reporting non missing figures for employees in their financial statements, we end up with around 30% of firms which are present for less than 3 years.

of SMEs.[8] Firm age considerably varies across countries: the average age of firms in our sample is 16 years, with Dutch firms being much more older than the average (around 34 years old) and Spanish firms younger (around 13 years old). In Appendix A we report descriptive statistics for a comprehensive set of variables included in the analysis. Overall, all the statistics are in line with the evidence provided in by the ECB (2013) which refer to a larger dataset for the whole euro area.

Insert Table 1 about here

3 Detecting financial constraints

A firm-level *a-priori* classification

Financial constraints are empirically not observable. As there are no specific items on the balance sheets of firms that could tell whether a firm is financially constrained, several avenues have been suggested in the literature, attempting to identify and to measure financial constraints.[9] In this paper we follow the literature that gives importance to "a-priori classification" based on firms financial conditions. Notably, we follow and refine the approach of Pal and Ferrando (2010)[10] by applying a classification scheme based on information from the balance sheet and profit and loss accounts for the sample of firms we described in the previous section. The advantage of this classification is that it takes into consideration a set of variables and their interrelations within some scenarios, allowing us to attach to firms different degrees of financial constraints accordingly. The classification permits us to overcome the usual criticism related to the choice of single a-priori indicators of financial constraints (Musso and Schiavo, 2008). Table 4 reports the classification revisited from Pal-Ferrando (2010).

Insert Table 2 about here

In Table 2 we distinguish between absolutely constrained, relatively constrained and unconstrained firms. Absolutely constrained firms are those that cannot get external finance,

[8] See http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/index.htm. Micro firms have fewer than ten workers and turnover or assets of less than €2 millions. The corresponding figures for small firms are 50 workers and turnover or assets of less than €10 millions, and for medium-sized firms 250 workers, turnover of less than *50* millions and assets of less than €43 millions. Above these cut-off points, firms are classified as large.

[9] See Silva and Carreira (2012) and Farre-Mensa and Ljungqvist (2013) for a survey.

[10] A similar classification was proposed by Vermeulen (2002).

relatively constrained are those that can access only expensive external sources and unconstrained firms are those that get new debt financing and pay, on average, the lowest financing costs available on the market. We construct our scenarios based on the interrelation of total investment, financing gap (defined as fixed investment plus the change in the net increase in working capital minus cash flow), financial debt and issuance of new shares obtained in the given year, and average interest payments on debt relative to interest rates charged in the local credit market. The underlying idea is that if firms face financing gaps, they need to find other sources besides their current cash flow. Firms are considered to be unconstrained when they make use of external sources of finance facing favorable conditions, i.e. they can increase their leverage whenever it is needed with low financing costs relative to market conditions (*case 2*). We expect that the demand for financial debt decreases as its cost increases. Those firms that can get only expensive credits tend to use less external finance relative to the unconstrained firms and we consider those firms as constrained in relative sense (*case 3*). And finally, we consider constrained in absolute sense those firms that despite of the financing gap do not get any credit or additional capital from the stock market (*cases 6*). In the case of liquidation of assets (investment is negative) our classification allows us to distinguish between the case of absolutely constrained firms (*case 5*) from the case when firms are unconstrained (*case 1*), based on their relation to external finance, given from changes in total debt and issuance of new shares of equity. However, it is not certain if their investment is constrained by reimbursement or if they do not invest because of the lack of profitable investment opportunities. Therefore, we choose to include these firms among the constrained ones whenever data on changes in total debt and share issuance are missing. When the financing gap is negative, indicating that the firms' total investment is lower than the current cash flow, firm are considered financially unconstrained in case they are still increasing their total investment (*case 0*). Under case 4 we include firms that finance their investment not through credit but through the new share issuance, which is more costly due to the presence of asymmetric information.

The second column in Table 2 reports the percentages of firm/year observations according to the classification. Around 21% of observations belong to absolutely financially constrained firms while almost 33% of firm-year observations are classified as unconstrained. The remaining 46% of observations in our sample fall in the category relatively constrained: around 30% are firms that get expensive credits and 16% increase their shareholder funds to finance their investment. Table 3 includes the percentages of firms with different degrees of financial access across countries: based on our classification, in each country a share ranging between 10% and 20% of sampled firms are on average financially constrained in absolute terms. The largest fractions of absolutely constrained firms are in Italy, Spain and France while it is more likely to find Belgian, Finnish and Dutch firms among the least constrained ones.

Insert Table 3 about here

Financially constraints affect firms persistently over time. In Table 4, we present the transition matrix for the a-priori indicator, obtained by computing the average share of firms flowing each year from one category to the others. Starting form the last row, 33.2% of firms observation that were signaled as absolutely constrained in a given year remained such also the subsequent year; around 40% move to the category relatively constrained while the remaining 26.5% become unconstrained in absolute terms. About 41% of firms that are absolutely unconstrained remain such also in the year after while 36.4% are classified as relatively unconstrained after a year. The transition matrix suggests the following evidence. On the one hand, about 50% of firms belonging to a certain category at a given point in time, remains in the same category in the next period, signaling the presence of a persistent component in financial constraints at firm-level. On the other hand, access to finance displays a non-negligible time-varying component, as almost 50% of firms is likely to flow to different categories between two consecutive periods. As for firms′ specific characteristics, according to different measures of size, being these either the EC definition or a measure based on the distribution of real total assets, the share of absolutely constrained is around 20% for micro and small firms and around 16% for large firms (Table 7). This evidence is in line with the literature that shows how smaller firms are more likely to suffer limited access to finance compared to larger business.[11] Less clear is the relation between age and financial constraints: while mature firms (larger than 5 year old) are on average more unconstrained compared to younger firms (the share of unconstrained firms among the oldest cohort is equal to 33% of the total, against 27% for the young ones), a much larger share of older firms is also absolutely constrained (around 22%) compared to young enterprises (16%). Finally, as for a sectoral classification, industries like "Information Communication and R&D" and "Retail stands" out as the most financially constrained, with about 22% of absolutely constrained firms out of their total (Table 5), while "Accommodation and Food" displays the highest share of unconstrained firms (42%).

Insert Tables 4-5 about here

A firm-level measure of financial constraints

As noted by Musso and Schiavo (2008), using a number of different scenarios to classify firms′ *ex-ante* financial status allows to overcome the weaknesses related to the use of a single variable. The main drawbacks faced to identify financial constraints with a single variable are 1) the fact

[11] See Carpenter and Petersen (2002) and Beck et al. (2008) on the role of size.

that most of the chosen criteria are almost time-invariant, whereas it's likely that firms switch between being constrained or unconstrained depending on the overall credit conditions, on the investment opportunities faced by the firm and on idiosyncratic shocks, and 2) the fact that single proxies span financial constraints on a unique dimension, as it were a phenomenon that is either in place or not, without allowing for heterogeneous degrees in accessing finance. On the other hand, an index relying on information coming from multiple sources is likely to carry out a great deal of mis-measurement errors. We try to address this limitation by refining our proxy of financial constraints as follow. We use the index based on the a-priori classification to estimate an ordered Probit regression and calculate the conditional probability of firms being in one of the three categories. To do so, we control for a number of additional firms′ characteristics, like firms′ size, age, geographical location, industry specialization and some indicators of financial pressure. Thus we obtain our synthetic index of financial constraints by computing the predicted outcome from the regression.

For firm i, at time t, we specify the following latent model:

$$y^*_{it} = X_{it}\beta + c_i + u_{it} \tag{1}$$

where y^*_{it} is an unobserved measure of being financially constrained which depends on a set of observed regressors X_{it}, unobserved firm-level characteristics c_i, possibly correlated with X_{it}, and a strictly exogenous disturbance u_{it} (assumed to be distributed as a standard normal.). Letting a_0 and a_1, with $a_1 \geq a_0$, be two unknown threshold parameters defined between 0 and 1, we will assume firm to be unconstrained for very low y^*_{it}, while becoming relatively constrained for $y^*_{it} > a_0$ and absolutely constrained for $y^*_{it} > a_1$. Defining:

$$y_{it} = j \quad if \quad y^*_{it} \in [a_{j-1}, a_j] \tag{2}$$

we can obtain the conditional distribution of y_{it}, given X_{it} and c_i, by computing each response probability as:

$$\begin{aligned} Pr(y_{it} = 0) &= Pr(y^*_{it} \leq a_0) = F(a_0 - X_{it}\beta + c_i) \\ Pr(y_{it} = 1) = Pr(a_0 < y^*_{it} \leq a_1) &= F(a_1 - X_{it}\beta + c_i) - F(a_0 - X_{it}\beta + c_i) \\ Pr(y_{it} = 2) &= Pr(y^*_{it} > a_1) = 1 - F(a_1 - X_{it}\beta + c_i) \end{aligned} \tag{3}$$

where F is a standard normal c.d.f. Our baseline regression includes among the regressors X_{it} the following variables: financial leverage, interest payment burden and cash holding. All these variables are lagged of one period in order to reduce simultaneity between firms′ decisions on investment and production and financial decisions. We include also a size dummy based on the EC classification to distinguish between micro, small, medium and large firms, firms age and some interacting terms between cash and size and cash and age, time dummies to control for the business cycle, sectoral and country dummies. Finally, to control for possible correlation between unobserved firms' characteristics c_i and any of the observable variables, we follow Chamberlain (1980)[12] by assuming c_i to be conditional distributed as a normal, with mean equal to $\gamma_0+\gamma_1\bar{X}_i$ and variance σ_c^2, where $\bar{X}_i$ is the time-average of the included regressors. We therefore add this set of time-invariant observables in equation (1) as a set of controls so to estimate the effect of changing X_{it} while holding the time average fixed.

Insert Table 6 about here

Table 6 displays the estimated results. All the estimations are based on random ordered Probit using the a-priori index (with three outcomes) as dependent variable; standard errors are robust and clustered at firm level. We report the outcome of the estimation for our baseline specification (column 1) and, to check for robustness, for several subsets of the sample. The coefficient on financial leverage is always positive and statistically significant across different specifications, pointing to the fact that firms with higher debt ratios are most likely to be financially constrained as it could be difficult or costly for them to find new debt. This is also confirmed by the positive coefficient estimates on the interest payment burden. Larger cash holding reduces the likelihood of being financially constrained, highlighting the importance for non-financial companies to hold internal resources for precautionary motive. Firm size and its interaction with age are significant and negatively related to our measure of financial constraints. These findings are in line with previous results in the literature and indicate that capital market imperfections play an important role and mainly affect SMEs and young firms. Several stylized facts explain why small firms face higher financing obstacles.[13] The financial structure of small-sized firms is more reliant on bank loans, a result of asymmetric information due to lack of credit information, and a short operating track record makes more difficult to them to access alternative source of financing (Berger and Udell, 2006). Smaller-sized firms are more frequently affected by credit rationing than large firms (Baas and Schrooten, 2006) as banks perceive them riskier, in terms of probability of default and opaqueness of their

[12] See also Wooldridge (2012).

[13] See for instance Berger and Udell (2003), Rauh (2006), Fee et al. (2009) or Hadlock and Pierce (2010).

information (Beck and De La Torre, 2007). As firms become larger and older the amount of cash to assets decrease among less constrained firms: cash holding seems to work better in younger and smaller firms as eventual buffer against limited access to finance.

Column 2 of Table 6 displays an alternative specification of the baseline regression, where we introduced additional dummies on the percentiles of liquidity to check for thresholds effects. Table 6 columns 3-6 report estimates for different sub-samples. If we compare the estimations before and after the crisis (columns 3 and 4), on the one hand cash holding is not anymore significant in predicting financial constraints, on the other hand, the impacts of interest payment burden and financial leverage slightly decline. For small and micro firms, which represent the majority of firms on our sample, financial leverage is a signal of financially fragility, which becomes even more important for firms that are unprofitable (columns 5 and 6).

To obtain a single synthetic index, we compute the predicted outcome from the ordered Probit estimation of the baseline specification (column 1, Table 7), and we use it as our final measure of financial constraints at firm-level. For given firm i at time t, the indicator of financial constraints FCI_{it} is constructed as:

$$FCI_{it} = \sum_{j \in \{0,1,2\}} j\hat{Pr}(y_{it} = j), \quad i = 1...N \quad t = 1...T \tag{4}$$

where $\hat{Pr}(y_{it} = j)$ are the time-varying firm-level predicted probabilities of belonging in one of the three afore-mentioned categories j of financial constraints. Figure 1 shows the development of our predicted indicator across countries over time. Two regularities could be inferred. First, the ranking of countries seems to be stable during the time span and it remains unchanged during the crisis. Dutch, German and Finnish firms always scored the lowest value on average, as opposed to Spain, Portugal and Italy, who have been persistently the most constrained countries. Second, after a long period of mild stability, the score jumped considerably up in 2008. In the last years of analysis the index has slightly declined, though remaining high from a historical perspective. To provide robustness, in Appendix B we compare our synthetic indicator with the a-priori classification index (presented before) and with the ICC indicator of financial constraint calculated for the ECB-CompNet database using data from the Survey of Access to Finance for Enterprises (SAFE)[14]. In addition we break down the

[14]The Survey of Access to Finance for Enterprises covers micro, small, medium-sized and large firms and it provides evidence on the financing conditions faced by SMEs compared with those of large firms during the previous six months. In addition to a breakdown into firm size classes, it provides evidence across branches of economic activity, euro area countries, firm age, financial autonomy of the firms, and ownership of the firms. Part of the survey is run by the ECB every six months to assess the latest developments of the financing conditions of firms in the euro area. The more comprehensive survey, run together with the European Commission, was

index of financial constraints by selected percentiles and we report a number firms′ financial characteristics and indicators for each category.

Insert Figure 1 about here

Financial Constraints and Labor Productivity

Constrains in accessing external finance can cause fragility in the financial structure of companies, and this is likely to translate, everything else equal, into a reduced ability of undertaking productive investments and other profitable activities. To the extent that access to finance can restrain from generating additional real-value added per worker, in Table 7 we report a number of statistics for financial constraints and labor productivity at different level of disaggregation, for each country in the sample. Our measure of real labor productivity is computed as the natural log of firm real value added divided by total employment. This measure should be considered as a proxy for labor productivity, since employment can only account for the extensive margin of labor supply (a better proxy would be real value added over total hours) and country-sector output deflators are used to deflate value added instead of firm-specific deflators.

Insert Table 7 about here

The data suggest a number of evidence. First, more financially constrained countries are likely to have lower average labor productivity: compared to Germany and Netherlands, countries like Spain, Italy and Portugal report relatively higher financial imbalances and experience a substantially lower productivity. Second, within every countries, firms suffering a more limited access to finance report lower average labor productivity: as we move to the right tail of the distribution of our index FCI_{it}, average productivity slows down. In addition, as opposed to financial constraints, labor productivity increases with firm-size within each country, a finding that has been documented, among the others, by Haltiwanger et al. (1999) for U.S. and by Pagano and Schivardi (2000) for European companies. This evidence has been linked to 1) the higher capacity of large firms of attracting more skilled workers, consistent with models of sorting and matching in the labor market and with models of human capital accumulation, where higher educated workers make the firm more productive, 2) a greater incentive for larger firms of engaging in R&D activities, as they could be applied to sufficiently large productions, so to exploit economies of scale and scope, and 3) the better ability of financing fixed cost and

initially conducted every two years, i.e. in 2009:H1, 2011:H1 and 2013:H1. As from the wave 2014:H1, the extended survey is run on an annual base.

subsequent expenditure of productive investments, as larger firms feature larger average cash flows, larger cash hoarding and better access to external source of finance. Finally, focusing on each specific industry, in Table 8 we report the unconditional correlations between the index of financial constraints and the measure labor productivity. In 60 cases out of 72, the coefficients are negative and statistically different than zero at 5% of significance level. The 12 remaining case (5 of whom are positive) are not statistically significant and are mostly clustered in Netherlands (4 cases) and Germany (3 cases) and in the "Construction and real estate" sector.

Financial constraints seem to go together with reduced labor productivity along many dimensions. This motivates us to exploit a more formal empirical strategy in the next section.

4 Empirical Strategy

In order to assess the impact of financial constraints to firm-level productivity, we follow a similar procedure as that proposed in Fernandes (2007). We modify the semi-parametric approaches described in Wooldridge (2009) and Petrin and Levinsohn (2004) including our index of financial constraints as a proxy variable (together with capital and intermediate inputs) for the unobserved productivity process. To do so, for each firm belonging to a given country/sector pair, we consider the following firm-level production function equation:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_l k_{it} + \beta_f FCI_{it} + d_t + \Omega_{it} + \epsilon_{it}, \quad i = 1...N \quad t = 1...T \tag{5}$$

where i and t are respectively the cross-sectional (firm-level) and the time dimension.[15] In this specification, y_{it} denotes the natural log of real value added, l_{it} is the log of labor inputs, k_{it} is the log of real capital inputs, FCI_{it} is the measure of financial constraints and d_t are time dummies. As described in section 3, FCI_{it} is by construction a prediction based upon a set of controls observed at the end of time $t-1$, which are taken by each firms as given (together with the initial period capital stock) at time t. This makes our index a further state variable when firms take operative decisions about investment and labor inputs. Finally, the sequences $(\Omega_{it} : t = 1...T)$ and $(\epsilon_{it} : t = 1...T)$ describe, respectively, a firm-level time sequence of cross-sectional productivity shocks which are observed by firms before any input decisions take place (and possibly correlated with them), but are unobserved by econometricians, and a firm-level time sequence of cross-sectional random productivity shocks. Following Olley and Pakes (1996) and Levinsohn and Petrin (2004), we make use of (log) real intermediate inputs,

[15] Conditioning each production equation at a country/sector level implies that all firms in the same sector, within a given country, have the same marginal returns on inputs.

m_{it}, as a variable to correct for the simultaneity bias arising between labor choice and unobserved productivity innovation. Therefore, under invertibility assumptions[16], we can express the unobserved productivity shocks as a function of capital inputs, intermediate inputs and degree of financial constraints,

$$\Omega_{it} = g(k_{it}, FCI_{it}, m_{it}), \quad i = 1...N \quad t = 1...T \tag{6}$$

and, under the assumption of contemporaneous exogeneity of ϵ_{it}, we can write the final regression equation as:

$$\mathbb{E}(y_{it}|k_{it}, FCI_{it}, m_{it}) = \beta_l \mathbb{E}(l_{it}|k_{it}, FCI_{it}, m_{it}) + \Phi(k_{it}, FCI_{it}, m_{it}), \quad i = 1...N \quad t = 1...T \tag{7}$$

where:

$$\Phi(k_{it}, FCI_{it}, m_{it}) = \beta_0 + \beta_k k_{it} + \beta_f FCI_{it} + g(k_{it}, FCI_{it}, m_{it}), \quad i = 1...N \quad t = 1...T \tag{8}$$

As in Moreno-Badia and Slootmaeker (2009), since $g(.)$ is allowed to have a general functional form and since both capital inputs and our index of financial constraints enter the function $\Phi(.)$ (directly and indirectly, by the function $g(.)$), this specification does not provide with a correct identification for parameters β_k, β_l and β_f. We therefore impose a number of additional assumptions enabling us to estimate β_k, β_l and β_f together. Following Olley and Pakes (1996), we restrict the process $(\epsilon_{it} : t = 1...T)$ to be conditionally mean independent of current and past inputs. Second, we restrict the dynamics of unobserved productivity shocks $(\Omega_{it} : t = 1...T)$ to follow a First order Markov process, i.e. $\Omega_{it} = \mathbb{E}(\Omega_{it}|\Omega_{it-1}) + \eta_{it}$, with $\mathbb{E}(\epsilon_{it}\eta_{it}) = 0 \ \forall i, t$. Under these assumptions, the necessary condition to identify the coefficients attached to capital and financial constraints is that both respond with a lag to productivity innovation, leading to following moment conditions:[17]

[16] See Levinsohn and Petrin (2004) for a discussion about this assumption.

[17] These two moment conditions are the same as the ones used by Moreno-Badia and Slootmaeker (2009) in their identification strategy and are based on the idea that "investors may ration credit to firms based on their information set in t-1" (pag.16). This is consistent with the way our index of financial constraints is constructed (see Section 3).

$$\begin{aligned} \mathbb{E}(\epsilon_{it} + \eta_{it}|k_{it}) = 0, \quad i = 1...N \quad t = 1...T \\ \mathbb{E}(\epsilon_{it} + \eta_{it}|FCI_{it}) = 0, \quad i = 1...N \quad t = 1...T \end{aligned} \tag{9}$$

In the same fashion of Wooldridge (2009), these three conditions allow us to deal with non-fundamentalness in the identification of β_f, β_l and β_f. In order to estimate the production function equation (7), we approximate the unspecified function $g(.)$ using a third order polynomial with full set of interactions among the state variables. We include this polynomial into a first-stage regression, linear in labor l_{it}:

$$y_{it} = \beta_l l_{it} + \Phi(k_{it}, FCI_{it}, m_{it}) + d_t + \epsilon_{it} + \eta_{it} \tag{10}$$

and we use OLS to obtain $\hat{\beta}_l$ for each country and sector. Therefore we use GMM to obtain $\hat{\beta}_k$ and $\hat{\beta}_f$, exploiting a number of over-identifying restrictions given by the following vector of expectations:

$$\mathbb{E}(\upsilon_{it} Z_{it}) = 0, \quad i = 1...N \quad t = 1...T \tag{11}$$

where $\upsilon_{it} = \epsilon_{it} + \eta_{it}$ and $Z_{it} = (k_{it}, FCI_{it}, k_{it-1}, FCO_{it-1}, m_{ti-1}, l_{it-1})'$. So defined, $\hat{\beta}_k$ and $\hat{\beta}_f$ are the global minimizers of the following objective function:

$$V(\beta_k, \beta_f) \propto \left(\sum_{i=1}^{N} \sum_{t=T_{i0}}^{T_{i1}} Z_{it} \hat{\upsilon_{it}} \right)' W_Z \left(\sum_{i=1}^{N} \sum_{t=T_{i0}}^{T_{i1}} Z_{it} \hat{\upsilon_{it}} \right) \tag{12}$$

where N is the cross-sectional dimension of firms, T_{i0} and T_{i1} are the second and the last period a given firm i is observed, $\hat{\upsilon_{it}}$ is the residual of the first-stage regression and W_Z is a weighting matrix of dimension $|Z|$x$|Z|$.

5 The Impact of Financial Constraints on Labor Productivity

Table 9 reports the core estimates for the marginal effects of financial constraints on productivity, β_f.[18] Standard errors (in brackets) are computed using the robust variance covariance

[18] Though not reported in the paper, estimates of β_l and β_k are available upon request.

matrix. We use the total number of employees to proxy labor inputs l_{it}, total fixed assets to proxy capital stock k_{it} and material and energy cost as proxy of intermediate inputs m_{it}. We construct value added y_{it} as the difference between operative turnover (expressed in euros) and intermediate inputs. Nominal variables are deflated using country-sectoral output deflators.

Insert Table 9 about here

In line with what Gatti and Love (2008) and Chen and Guariglia (2013) report for Bulgarian and Chinese firms, we do find that financial constraints lower productivity in the majority of cases. The marginal impacts are higher in sectors like "Energy, Gas and Water Supply" and "R&D, Communication and Information". This result is in line with Aghion et al. (2005) and Savignac (2007), who find that being financially constrained significantly reduces the likelihood of firms of investing in R&D and other innovating activities. The estimated coefficients are not surprisingly lower in "Construction and Real Estate", a sector that have benefited more than others from low interest rates and easier access to credit along the period 2001-2007, confirming part of the evidence in Moreno-Badia and Slootmaekers (2009). From a cross-country perspective, Germany and Finland are the least marginally affected by financial constraints: for each sector, the estimated coefficients are on average lower (in absolute value) compared to all the other countries in the sample.

The point estimates allow us to recover the counter-factual distribution of labor productivity under free access to finance; meaning, the distribution of firm-specific productivity that would arise if each firm did face no financial constraints along their life-span. To do so, we first compute the firm specific loss in real-value added multiplying the estimated marginal impact (at country/sectoral level) by the firm-level score of financial constraints. We then add the estimated loss to the observed firms′ real value-added and obtain a counter-factual labor productivity dividing the latter by the relative number of employees. Figure 2 plots the kernel estimates of actual (blue line) and counter-factual (red line) density of (log) labor productivity for each countries.[19]. By construction, the absence of financial constraints determines a clear right-ward shift in the distribution of labor productivity, since all the core estimates of marginal effects are negative and bounded away from zero. As means and medians dramatically improve, the counter-factual distributions get also slightly narrowed, showing less dispersion than the actual one. Table 10 reports a number of measures of dispersion in productivity: all of them are smaller in the counter-factual case. This points to the intuition that firms in the lower tail of the distribution are those who benefit the most from free access to finance. As reported in section 3, financially constrained companies are likely to be the most fragile and the least

[19]The kernel densities are estimated using 50 points in the support and the optimal smoothing parameter.

productive ones: alleviating the higher cost borne by these firms would let them catch up to the more productive ones.

In addition, we use the point estimates to compute the realized loss in labor productivity for the average firm in each country. For a given country, we first compute the loss faced by the average firm in every industry and then we aggregate, weighting each observation by their relative sectoral real value added. The first block in Table 11 reports the estimated losses. Italy and Portugal faced the highest percentage losses, with values ranging between 21% and 22% of their labor productivity, followed by Belgium, France and Spain, with values around 19%. Germany and Netherlands are the least affected, with an estimated loss of about 11 and 15 percent respectively. This result reinforces our hypothesis: distortions in the credit allocations depress firm-level productivity. Better-functioning economic environments, like those in Germany and Netherlands (as the share of unconstrained firms suggests) are likely to facilitate the financial system to channel resources towards the most rewarding and profitable activities, promoting and fostering the structural transformations of the economy triggered by innovative investments. Economic environments characterized by more imbalances, like those in the peripheral countries of the euro area (as highlighted by the large share of absolutely constrained firms), create additional obstacles to the efficient allocation of resources, with the consequence of distorting investment decisions, lowering value added and growth.

Insert Tables 10-11 about here

The second and the third blocks of Table 11 report the outcomes of two further counterfactual exercises. In the first exercise we take a cross-country perspective and we ask what would be the average loss in labor productivity faced by firms in our sample if all had the same access to finance as the average firm in Germany does. In most countries this would produce a non-negligible gain in labor productivity, going from around one percent, as for Belgium and Spain, to (or more than) 2%, as for Italy and Portugal. However, not all countries would benefit from that: Dutch and Finnish firms would be on average worse off, as they experienced better access to finance than German firms but were subject to larger marginal impacts. In the last exercise, we look within each country to quantify the size effect of financial constraints on productivity. We compute the counter-factual gain that firms in our sample would face if all had the same access to finance as the average large firm in their respective country does. The score of financial constraints is on average higher in smaller-sized companies, reflecting difficulties in accessing external source of finance compared to large firms: equating the burden of financial constraints across different sizes to that of the average large companies would make each country suffer, on average, a smaller loss and increase, on average, real value added and productivity.

Robustness Checks

In this section, we show and discuss robustness of our results. To check whether them depend on the choice of the identifying moment conditions, we report the marginal effects obtained under perfect identification, i.e. $Z_{it} = (k_{it-1}, FC_{it-1})'$, and by extending the number of instruments to eight, i.e. $Z_{it} = (k_{it}, FC_{it}, k_{it-1}, FC_{it-1}, m_{it-1}, l_{it-1}, m_{it-2}, l_{it-2})'$. The main results are robust upon different selection of the exogenous instruments: estimated coefficients are always negative and significant and display similar magnitudes.

Insert Table 12-13 about here

Finally, we report the estimates for several selected sub-samples (Tables 14-16). To isolate non-linear effects of size, we only look at micro and small plants, following the EC definition. Excluding Netherlands, for which the estimations could not be performed due to the small amount of observations available, almost all the coefficient estimates are negative and significantly different than zero: this outcome extends to every country but Germany, for which the estimates are statistically not significant in five case out of nine, mostly due to the little sample size. This result is in line with the empirical evidence describing the limited access to formal sources of external finance as a key factor in shaping growth and business expansion of small and medium enterprises.[20] To reduce possible selection bias arising from entry-exit dynamics, we limit our analysis to only those firms that stay in the sample for 5 consecutive years. In addition, we restrain our sample to only those firms with positive investment rates, to get rid of possible bias coming from profitable opportunity selection. None of these restrictions alter our results. All these confirm that higher financial constraints are likely to determine larger and significant differences in firms-level productivity, everything else equal.

Insert Table 14-16 about here

6 Conclusions

This paper aims to provide new evidence on the link between financial constraints and labor productivity. To our knowledge, it is one of the first time that such analysis is conducted using a large dataset of firm-level data for an extensive number of euro area countries (Belgium, Germany, Spain, Finland, France, Italy, Netherlands and Portugal) during the period 1995-2011. We followed a twofold empirical strategy. First we developed an indicator of financial constraints at firm level and second we included this indicator to a firm-level production equation

[20] See for instance Beck and Demirguc-Kunt (2006) for a survey on SMEs and access to finance.

to assess the direct impact of access to finance to firm-level productivity. Our results show that financial constraints do significantly lower productivity in the majority of sectors across countries: the marginal impacts appear to be significantly higher in sectors that innovate the most, like "Energy, Gas and Water Supply" and "R&D, Communication and Information". Counter-factual exercises show that countries like Italy and Portugal are the most affected by financial constraints, with an estimated loss of around 21% of their labor productivity due to limited access to finance, as opposed to Germany and Netherlands, whose estimated losses are no more than 15%. In addition, each country would benefit a gain in the average labor productivity between one and two percent by extending the access to finance to small firms. These results are robust to a number of robustness checks, including the use of alternative econometric specifications, as well as to a number of sub-samples.

From a policy perspective, economical and institutional setting that feature large information frictions between firms and their lenders, and contributes to jeopardize the financial structures of companies, are likely to induce a distribution of firm-level productivity tilted towards the left-hand side and with larger dispersion. Our findings suggest that removing barriers and constraints in accessing external finance, and all those financial frictions that small and medium enterprises face when they take operative decisions, would probably be an effective way of enhancing real value added, stimulating productivity and thus contributing to overall economic growth. As surveyed by Beck and Dermirguc-Kunt (2006), both firm-level and industry-level studies suggest that small firms do relatively better compared to large firms in countries with better-developed institutions. This remarks the importance of achieving a more efficient functioning of credit and capital markets in order to alleviate the burden of financial constraints borne by small, but potentially highly-profitable, companies and to ensure the correct channeling of resources to productive units. Energy supply, Communication, Information and Research and Developments seems to be the economic activities that most would benefit from relaxing financial constraints. A vast literature has documented the tight link between the likelihood of engaging R&D investment, financial constraints and productivity: our results confirm that reducing the high costs of capital and extending access to different source of external capitals would enable these companies to catch up to the technological frontiers, with significant benefits in terms larger value added per worker generated.

Our results might be subject to some caveats. First, sample data might not be representative of the whole population of firms in countries like Germany and the Netherlands, for which the coverage is not as rich as for Spain, Italy and France (especially in terms of micro firms, i.e. firms with less than 10 employees). Second, the analysis does not explicitly address the effect of financial constraints on firm survival: reduced access to finance is likely to increase the likelihood of firm exit by decreasing real value added generated, hence pushing productivity below a certain

threshold. However, because only those firms who actually survived are observed in the sample, the estimates are likely to be downward biased providing with a lower bounds for the impact of financial constraints on productivity. Finally, though our synthetic indicator is consistent with the evidence provided by the survey data on access to finance, it can still fail to some extent in capturing all the dimensions along which firms face financial constraints. Validating our measure with a theoretical background represents a further avenue of investigation.

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TABLE 1 - Sample Characteristics by country

	Countries								
	Belgium	**Germany**	**Spain**	**Finland**	**France**	**Italy**	**Netherlands**	**Portugal**	**Total**
No. of Observations	125799	98915	2175980	197712	1540697	1052450	33048	317968	5542569
No. of Firms	14419	27117	339066	36554	285884	221414	5935	92249	1022638
Size (head counts):									
Mean	114	1078	32	67	62	57	1051	28	191
Median	35	89	9	8	8	14	144	7	10
Size (log of real total assets):									
Mean	8.83	9.52	6.36	6.46	6.49	7.82	10.08	5.93	6.78
No. SMEs ($\leq$ 250 employees)	13731	22485	337184	36001	282908	218989	4740	91702	1007740
% **Total**	95	83	99	98	99	99	8	99	99
No. SMEs (EC definition)	12348	18026	176356	15393	124856	134949	3974	37718	523620
% **Total**	86	66	52	42	44	61	67	41	51
Age: Mean	25	28	13	17	17	19	34	16	16

Note: This table provides some sample characteristics. The sample includes all non-financial firms in eight euro area countries with accounting information for at least three years over the period 1995-2011. All firms are reporting their number of employees in the dataset.

TABLE 2 - Classification scheme

Financing Conditions	% Total	Total Investment	Financing Gap	Changes Total Debt	Issuance New Share	Interest Payments
			Absolutely Constrained			
6	5.3	≥ 0	≥ 0	≤ 0	≤ 0	-
5	15.7	< 0	< 0	≤ 0	-	-
			Relatively Constrained			
4	16	≥ 0	≥ 0	≤ 0	> 0	-
3	30.6	≥ 0	≥ 0	> 0	-	$\geq MIR_{ct}$
			Unconstrained			
2	7.4	≥ 0	≥ 0	> 0	-	$\leq MIR_{ct}$
1	3.6	< 0	< 0	> 0	> 0	-
0	21.4	≥ 0	< 0	-	-	-

Note: This table reports the seven scenarios of the classification scheme used to detect and measure the degree of firm-level financial constraint.

TABLE 3 - Classification scheme by countries

	Belgium	Germany	Spain	Finland	France	Italy	Netherlands	Portugal
				Unconstrained				
0	22.8	24.2	19.6	32.1	25.9	16.7	30.8	16.5
1	4.9	1.4	3.9	5.9	3.4	2.5	1.8	4.2
2	8.5	9.2	8.5	6.1	4.7	7.4	4.9	16.2
				Relatively Constrained				
3	31.3	30.3	28.9	32.5	30.1	33.2	37.8	34.4
4	13.2	16.1	18.6	8.5	12.8	18.2	11.2	11.8
				Absolutely Constrained				
5	14.7	10.6	15.1	10.6	17.3	16.6	9.8	13.1
6	4.7	8.2	5.4	4.3	5.8	5.4	3.8	3.8

Note: This table presents the percentages of firm-year observations according to the classification scheme proposed in Table III.

TABLE 4 - Transition matrix.

	F.C. Index$_{t+1}$		
F.C. Index$_t$	**U**	**R**	**A**
U	41.4	36.4	22.1
R	25.8	50.8	23.4
A	26.5	40.3	33.2

Note: This table displays the average percentage of firms-year observations that moved from time t to time $t+1$ to another category.

TABLE 5.a - Classification scheme by firms characteristics

	FC Index$_t$		
Age	**U**	**R**	**A**
less $<$ 5 years	27.3	56.3	16.3
more or equal 5 years	32.9	45.0	22.1
Size (EC Definition)	**U**	**R**	**A**
Micro	31.9	45.2	22.9
Small	32.0	48.1	19.9
Medium	31.3	50.4	18.4
Large	33.5	49.7	16.8
Size (Real Total Assets)	**U**	**R**	**A**
Small	31.8	46.7	21.5
Medium	31.8	49.6	18.6
Large	34.2	49.0	16.8

Note: This table shows the percentage of firm-year observations across age and two measures of size: the first is based on the EC definition and the second on the distribution of real total assets where small firms are those below the 25th percentile, medium those between 45 and 55th percentile and large greater than 75th percentile.

TABLE 5.b - Classification scheme by economic sectors

	FC Index$_t$		
Industries	**U**	**R**	**A**
Accommodation and Food	42.5	36.2	21.3
Construction and Real Estate	28.4	49.7	21.8
Electricity, gas and water supply	36.1	47.0	16.9
Information and R%D	31.7	46.3	22.0
Manufacturing	31.4	48.3	20.4
Other business activities	33.3	45.4	21.3
Retail trade	35.1	43.1	21.8
Transportation and storage	32.3	48.1	19.6
Wholesale trade	29.7	49.1	21.2

Note: This table shows the percentage of firm-year observations across economic industries.

TABLE 6 - Probit Estimations

Dependent Variable: FC Index$_t$						
	Full sample	**Full Sample**	**Pre-crisis (1995-2007)**	**Crisis (2008-2011)**	**Small Firms**	**Unprofitable Firms**
Financial Leverage$_{t-1}$	0.924***	1.254***	0.990**	0.921***	1.024***	1.188***
	(0.006)	(0.006)	(0.008)	(0.011)	(0.006)	(0.009)
Debt Burden$_{t-1}$	0.078***	0.109***	0.125***	0.086***	0.084***	0.087***
	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)
Cash Holding$_{t-1}$	-0.482***	-0.280***	-0.150***	0.037	-0.129***	-0.051**
	(0.017)	(0.016)	(0.020)	(0.031)	(0.018)	(0.025)
Size$_{t-1}$	-0.053***	-0.053***	-0.007	-0.029***	-0.006*	-0.005
	(0.004)	(0.004)	(0.004)	(0.006)	(0.004)	(0.005)
Age$_{t-1}$	0.007**	0.002***	0.005***	0.000	0.005***	0.006***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Size$_{t-1}$Age$_{t-1}$	-0.001***	-0.001***	-0.000***	-0.001	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash Holding$_{t-1}$Size$_{t-1}$	0.076***	0.030**	0.056***	-0.079	-0.001	-0.087***
	(0.009)	(0.009)	(0.011)	(0.018)	(0.011)	(0.014)
Cash Holding$_{t-1}$Age$_{t-1}$	0.006***	0.005***	0.007***	0.006	0.009***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Liquidity dummies	No	Yes	No	No	No	No
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
Sectoral dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3520382	3520382	2199693	930810	3007934	1364553
Log-likelihood	-3673091	-6154456	-3829779	-1632864	-5259833	-2383815
Pseudo R^2	0.024	0.019	0.017	0.018	0.017	0.017

*Note: All the estimations are based on Random Ordered Probit, corrected through the Chamberlain method, using the a-priori index (with three outcomes) as dependent variable; standard errors are robust and clustered at firm level. *** p-value<0.01, ** p-value<0.05, * p-value<0.1.*

TABLE 7 - Labor Productivity and Financial Constraints.

	Belgium		Germany		Spain		Finland	
	F.C.I.	**L.P.**	**F.C.I.**	**L.P.**	**F.C.I.**	**L.P.**	**F.C.I.**	**L.P.**
Mean	0.98	4.32	0.93	4.30	1.00	3.45	0.90	3.82
Median	0.95	4.23	0.91	4.21	0.98	3.41	0.87	3.81
Std	0.16	0.60	0.16	0.66	0.17	0.58	0.17	0.53
	France		**Italy**		**Netherlands**		**Portugal**	
	F.C.I.	**L.P.**	**F.C.I.**	**L.P.**	**F.C.I.**	**L.P.**	**F.C.I.**	**L.P.**
Mean	0.93	3.85	1.03	3.86	0.82	4.34	0.98	2.88
Median	0.90	3.79	1.02	3.81	0.78	4.22	0.96	2.83
Std	0.16	0.48	0.16	0.56	0.18	0.71	0.19	0.64

Note: This table reports summary statistics for (log) labor productivity and index of financial constraints across countries.

TABLE 7 (continued) - Labor Productivity and Financial Constraints.

	Belgium		Germany		Spain		Finland	
	F.C.I.	**L.P.**	**F.C.I.**	**L.P.**	**F.C.I.**	**L.P.**	**F.C.I.**	**L.P.**
<p25	0.87	4.39	0.84	4.35	0.90	3.56	0.79	3.91
∈ (p45-p55)	(0.929-0.96)	4.28	(0.897-0.982)	4.29	(0.967-1.004)	3.49	(0.856-0.889)	3.85
>p75	1.04	4.34	1.01	4.29	1.10	3.36	0.98	3.82
	France		**Italy**		**Netherlands**		**Portugal**	
	F.C.I.	**L.P.**	**F.C.I.**	**L.P.**	**F.C.I.**	**L.P.**	**F.C.I.**	**L.P.**
<p25	0.83	3.87	0.94	3.97	0.72	4.41	0.86	2.95
∈ (p45-p55)	(0.883-0.914)	3.82	(1.00-1.03)	3.82	(0.78-0.821)	4.39	(0.922-0.961)	2.93
>p75	1.01	3.75	1.13	3.73	0.92	4.36	1.07	2.82

Note: This table reports different percentiles of financial constraint index and the associated average (log) labor productivity for each country.

TABLE 7 (continued) - Labor Productivity and Financial Constraints.

Size		Belgium		Germany		Spain		Finland	
		F.C.I.	**L.P.**	**F.C.I.**	**L.P.**	**F.C.I.**	**L.P.**	**F.C.I.**	**L.P.**
Small	**Mean**	1.00	4.35	0.95	4.31	1.01	3.42	0.91	3.80
	Median	0.97	4.27	0.93	4.19	0.99	3.38	0.88	3.79
	Std	0.17	0.58	0.16	0.76	0.17	0.56	0.18	0.52
Medium	**Mean**	0.95	4.26	0.91	4.35	0.95	3.71	0.83	3.98
	Median	0.93	4.16	0.90	4.23	0.93	3.70	0.81	3.92
	Std	0.15	0.59	0.16	0.67	0.15	0.65	0.14	0.58
Large	**Mean**	0.94	4.40	0.90	4.26	0.93	3.86	0.83	4.06
	Median	0.92	4.27	0.88	4.20	0.91	3.90	0.81	3.98
	Std	0.16	0.69	0.15	0.61	0.16	0.75	0.15	0.63

		France		Italy		Netherlands		Portugal	
		F.C.I.	**L.P.**	**F.C.I.**	**L.P.**	**F.C.I.**	**L.P.**	**F.C.I.**	**L.P.**
Small	**Mean**	0.94	3.80	1.06	3.80	0.95	4.29	0.99	2.84
	Median	0.91	3.77	1.03	3.78	0.91	4.22	0.96	2.79
	Std	0.16	0.48	0.17	0.55	0.20	0.76	0.19	0.62
Medium	**Mean**	0.89	3.86	1.01	3.99	0.83	4.40	0.97	3.21
	Median	0.87	3.80	0.99	3.90	0.79	4.29	0.94	3.17
	Std	0.14	0.52	0.15	0.54	0.18	0.65	0.18	0.64
Large	**Mean**	0.86	4.00	1.00	4.04	0.78	4.31	0.95	3.49
	Median	0.84	3.93	0.98	4.00	0.75	4.17	0.93	3.48
	Std	0.13	0.61	0.15	0.63	0.16	0.73	0.18	0.78

Note: This table reports the average (log) labor productivity (weighted by sector) and the average financial constraint index across different class sizes (EC definition) for each country.

TABLE 8 - Correlations between Financial Constraints and Labour Productivity

	Accommodation and Food Activities	Construction and Real Estate	Energy, Gas and Water Supply	Information, Communication R&D	Manufacturing	Other Business Activities	Retail Trade	Transport and Storage	Wholesale Trade
Belgium	-0.0034	0.0893	-0.0839**	-0.2079**	-0.1649**	0.2428	-0.1526**	-0.0946**	-0.1566**
Germany	-0.0918	0.0599	-0.0812**	-0.0772**	-0.1735**	-0.0544**	-0.0413	-0.0939**	-0.1154**
Spain	-0.2040**	-0.1278**	-0.2179**	-0.2317**	-0.2588**	-0.1164**	-0.2151**	-0.2315**	-0.2003**
Finland	-0.1359**	-0.0828**	0.1874	-0.2425**	-0.1421**	-0.1857**	-0.2424**	-0.0886**	-0.2315**
France	-0.1535**	-0.1304**	-0.1460**	-0.1831**	-0.2076**	-0.0666**	-0.2228**	-0.1778**	-0.2371**
Italy	-0.3168**	-0.1125**	-0.2112**	-0.1712**	-0.2730**	-0.1348**	-0.2572**	-0.2404**	-0.2459**
Netherlands	-0.1797**	0.0225	-0.1275**	-0.0388	-0.1430**	-0.0131	-0.0485	-0.1371**	-0.0933**
Portugal	-0.2117**	0.0306	-0.1619**	-0.3001**	-0.1783**	-0.1162**	-0.2567**	-0.2032**	-0.1674**

*Note: Two stars implies statistical significance at 0.05 level. ** p-value<0.05*

TABLE 9 - Marginal Impacts of Financial Constraints on Productivity across different Countries and Sectors

	Accommodation and Food Activities	Construction and Real Estate	Energy, Gas and Water Supply	Information, Communication R&D	Manufacturing	Other Business Activities	Retail Trade	Transport and Storage	Wholesale Trade
Belgium	-0.619***	-0.719***	-1.231***	-1.026***	-0.884***	-0.779***	-0.905***	-0.715***	-0.941***
	(0.089)	(0.055)	(0.133)	(0.103)	(0.033)	(0.087)	(0.098)	(0.068)	(0.036)
Germany	-0.132***	-0.266***	-0.415***	-0.680***	-0.492***	-0.508***	-0.314***	-0.418***	-0.461***
	(0.275)	(0.061)	(0.115)	(0.147)	(0.044)	(0.079)	(0.146)	(0.091)	(0.070)
Spain	-0.521***	-0.374***	-0.871***	-0.855***	-0.718***	-0.594***	-0.464***	-0.679***	-0.632***
	(0.017)	(0.014)	(0.075)	(0.041)	(0.008)	(0.021)	(0.014)	(0.021)	(0.009)
Finland	-0.417***	-0.551***	-0.422***	-0.640***	-0.828***	-0.516***	-0.631***	-0.603***	-0.984***
	(0.089)	(0.057)	(0.102)	(0.127)	(0.043)	(0.104)	(0.060)	(0.067)	(0.060)
France	-0.437***	-0.602***	-0.900***	-0.798***	-0.803***	-0.894***	-0.765***	-0.546***	-0.764***
	(0.024)	(0.016)	(0.098)	(0.072)	(0.013)	(0.061)	(0.019)	(0.024)	(0.013)
Italy	-0.721***	-0.467***	-1.078***	-0.829***	-0.860***	-0.813***	-0.543***	-0.775***	-0.768***
	(0.037)	(0.020)	(0.070)	(0.045)	(0.008)	(0.038)	(0.023)	(0.030)	(0.012)
Netherlands	-0.220***	-0.744***	-0.919***	-1.695***	-0.579***	-1.122***	-0.398***	-0.980***	-0.892***
	(0.209)	(0.110)	(0.183)	(0.165)	(0.069)	(0.155)	(0.095)	(0.180)	(0.089)
Portugal	-0.479***	-0.215***	-1.432***	-0.952***	-0.555***	-0.605***	-0.536***	-0.746***	-0.529***
	(0.051)	(0.043)	(0.233)	(0.140)	(0.026)	(0.066)	(0.036)	(0.085)	(0.029)

Note: The estimations are performed by country and sector, using the whole sample dataset. The marginal impacts of financial constraints are calculated by extending Levinsohn-Petrin (2006) and Wooldridge (2009) methodologies for the estimation of firm-level production function. We estimate the model through GMM using six over-identifying moment condition, i.e. $Z_{it} = (k_{it}, FCI_{it}, k_{it-1}, FCI_{it-1}, m_{it-1}, l_{it-1})'$. *Though not reported, all regressions include also time dummies. Standard Deviations (in brackets) are computed from the robust variance-covariance matrix. *** p-value*< 0.01, *** p-value*< 0.05, ** p-value*< 0.1

TABLE 10 - Actual and Counter-factual Measures of Productivity Dispersion

Measure	Distribution	Belgium	Germany	Spain	Finland	France	Italy	Netherlands	Portugal
$90^{th}/10^{th}$	**Actual**	1.370	1.455	1.484	1.385	1.354	1.380	1.406	1.723
	Counter-factual	1.308	1.402	1.414	1.331	1.305	1.327	1.375	1.657
$75^{th}/25^{th}$	**Actual**	1.169	1.193	1.219	1.170	1.160	1.164	1.162	1.330
	Counter-factual	1.142	1.175	1.196	1.152	1.141	1.145	1.155	1.307
$50^{th}/10^{th}$	**Actual**	1.142	1.174	1.217	1.186	1.160	1.173	1.148	1.318
	Counter-factual	1.122	1.167	1.191	1.156	1.137	1.158	1.145	1.303
$90^{th}/50^{th}$	**Actual**	1.200	1.239	1.219	1.168	1.167	1.176	1.225	1.307
	Counter-factual	1.166	1.201	1.187	1.152	1.148	1.146	1.201	1.272
Gini	**Actual**	0.073	0.084	0.091	0.075	0.069	0.076	0.083	0.123
	Counter-factual	0.061	0.075	0.079	0.066	0.061	0.066	0.076	0.112

Note: This table reports different measures of dispersions for the actual and the counter-factual distribution of (log) labor productivity for each country.

TABLE 11 - Average Loss in Productivity and Counter-Factual.

Average Loss	Belgium	Germany	Spain	Finland	France	Italy	Netherlands	Portugal
Actual Loss	-0.84	-0.46	-0.65	-0.63	-0.75	-0.81	-0.67	-0.68
%	-19.52	-10.94	-18.29	-16.37	-19.13	-20.77	-15.68	-21.26
Counter Loss 1	-0.79	-0.46	-0.59	-0.65	-0.74	-0.71	-0.76	-0.60
%	-18.45	-10.94	-16.80	-16.88	-18.94	-18.29	-17.51	-19.11
Differential 1	0.04	-	0.05	-0.02	0.01	0.10	-0.08	0.09
%	1.07	-	1.49	-0.51	0.18	2.48	-1.83	2.20
Counter Loss 2	-0.81	-0.45	-0.60	-0.59	-0.69	-0.78	-0.66	-0.65
%	-18.92	-10.71	-17.10	-15.38	-17.61	-19.96	-15.1	-20.49
Differential Loss 2	0.03	0.02	0.04	0.04	0.06	0.03	0.07	0.04
%	0.66	0.29	1.22	1.05	1.56	0.85	1.60	0.83

Note: The first block of this table reports the cross-country average loss (weighted by sectors) in log labor productivity due to limited access to finance. The second block reports the counter-factual weighted average loss if the firms of each country had the same average access to finance as the average German firm. The last block reports the cross-country average counter-factual loss (weighted by sectors) if the firms of each country had the same average access to finance as the average LARGE firm in the relative country.

TABLE 12 - Marginal Impacts of Financial Constraints on Productivity: Robustness Check 1.

	Accommodation and Food Activities	Construction and Real Estate	Energy, Gas and Water Supply	Information, Communication R&D	Manufacturing	Other Business Activities	Retail Trade	Transport and Storage	Wholesale Trade
Belgium	-0.623***	-0.721***	-1.228***	-1.029***	-0.886***	-0.778***	-0.901***	-0.717***	-0.943***
	(0.101)	(0.055)	(0.135)	(0.104)	(0.033)	(0.089)	(0.098)	(0.070)	(0.036)
Germany	-0.284***	-0.274***	-0.448***	-0.670***	-0.484***	-0.506***	-0.365***	-0.369***	-0.423***
	(0.180)	(0.061)	(0.127)	(0.154)	(0.042)	(0.079)	(0.138)	(0.084)	(0.067)
Spain	-0.523***	-0.381***	-0.852***	-0.843***	-0.710***	-0.597***	-0.456***	-0.669***	-0.622***
	(0.016)	(0.013)	(0.072)	(0.040)	(0.008)	(0.021)	(0.014)	(0.021)	(0.009)
Finland	-0.500***	-0.502***	-0.509***	-0.584***	-0.862***	-0.610***	-0.657***	-0.556***	-0.935***
	(0.083)	(0.053)	(0.101)	(0.119)	(0.029)	(0.083)	(0.056)	(0.061)	(0.042)
France	-0.440***	-0.595***	-0.931***	-0.888***	-0.806***	-0.826***	-0.753***	-0.555***	-0.754***
	(0.023)	(0.015)	(0.088)	(0.054)	(0.012)	(0.030)	(0.018)	(0.023)	(0.012)
Italy	-0.664***	-0.473***	-1.070***	-0.802***	-0.854***	-0.785***	-0.514***	-0.753***	-0.756***
	(0.030)	(0.018)	(0.065)	(0.041)	(0.008)	(0.034)	(0.021)	(0.029)	(0.012)
Netherlands	-0.225***	-0.711***	-0.924***	-1.706***	-0.559***	-1.128***	-0.410***	-0.923***	-0.888***
	(0.190)	(0.109)	(0.207)	(0.166)	(0.069)	(0.154)	(0.096)	(0.184)	(0.088)
Portugal	-0.478***	-0.220***	-1.430***	-0.951***	-0.558***	-0.607***	-0.535***	-0.743***	-0.531***
	(0.051)	(0.043)	(0.237)	(0.141)	(0.026)	(0.066)	(0.036)	(0.085)	(0.029)

Note: The estimations are performed by country and sector, using the whole sample dataset. The marginal impacts of financial constraints are calculated by extending Levinsohn-Petrin (2006) and Wooldridge (2009) methodologies for the estimation of firm-level production function. We estimate the model through GMM using four over-identifying moment condition, i.e. $Z_{it} = (k_{it}, FCI_{it}, k_{it-1}, FCI_{it-1})'$. *Though not reported, all regressions include also time dummies. Standard Deviations (in brackets) are computed from the robust variance-covariance matrix. *** p-value*< 0.01, *** p-value*< 0.05, ** p-value*< 0.1

TABLE 13 - Marginal Impacts of Financial Constraints on Productivity: Robustness Check 2.

	Accommodation and Food Activities	Construction and Real Estate	Energy, Gas and Water Supply	Information, Communication R&D	Manufacturing	Other Business Activities	Retail Trade	Transport and Storage	Wholesale Trade
Belgium	-0.660***	-0.719***	-1.252***	-1.024***	-0.885***	-0.876***	-0.876***	-0.733***	-0.945***
	(0.081)	(0.055)	(0.133)	(0.103)	(0.034)	(0.086)	(0.097)	(0.069)	(0.036)
Germany	-0.269***	-0.210***	-0.402***	-0.610***	-0.481***	-0.503***	-0.249***	-0.427***	-0.451***
	(0.501)	(0.066)	(0.126)	(0.156)	(0.049)	(0.079)	(0.153)	(0.100)	(0.073)
Spain	-0.532***	-0.360***	-0.921***	-0.840***	-0.724***	-0.576***	-0.470***	-0.678***	-0.646***
	(0.017)	(0.014)	(0.079)	(0.041)	(0.009)	(0.022)	(0.014)	(0.022)	(0.010)
Finland	-0.415***	-0.594***	-0.473***	-0.681***	-0.886***	-0.616***	-0.596***	-0.463***	-0.952***
	(0.093)	(0.062)	(0.102)	(0.142)	(0.032)	(0.100)	(0.068)	(0.104)	(0.046)
France	-0.441***	-0.618v	-0.926***	-0.818***	-0.810***	-0.852***	-0.779***	-0.540***	-0.770***
	(0.024)	(0.016)	(0.104)	(0.071)	(0.013)	(0.031)	(0.019)	(0.023)	(0.013)
Italy	-0.644***	-0.465***	-1.083***	-0.791***	-0.865***	-0.829***	-0.530***	-0.790***	-0.769***
	(0.040)	(0.021)	(0.073)	(0.048)	(0.008)	(0.040)	(0.025)	(0.031)	(0.012)
Netherlands	-0.286***	-0.762***	-1.016***	-1.774***	-0.602***	-1.129***	-0.325***	-1.049***	-0.874***
	(0.281)	(0.118)	(0.193)	(0.166)	(0.070)	(0.154)	(0.095)	(0.187)	(0.095)
Portugal	-0.444***	-0.232***	-1.414***	-0.951***	-0.547***	-0.602***	-0.533***	-0.765***	-0.529***
	(0.050)	(0.043)	(0.234)	(0.136)	(0.026)	(0.066)	(0.036)	(0.085)	(0.029)

Note: The estimations are performed by country and sector, using the whole sample dataset. The marginal impacts of financial constraints are calculated by extending Levinsohn-Petrin (2006) and Wooldridge (2009) methodologies for the estimation of firm-level production function. We estimate the model through GMM using eigth over-identifying moment condition, i.e. $Z_{it} = (k_{it}, FCI_{it}, k_{it-1}, FCI_{it-1}, m_{it-1}l_{it-1}m_{it-2}l_{it-2})'$. *Though not reported, all regressions include also time dummies. Standard Deviations (in brackets) are computed from the robust variance-covariance matrix. *** p-value< 0.01, ** p-value< 0.05, * p-value< 0.1*

TABLE 14 - Marginal Impacts of Financial Constraints on Productivity: Robustness Check 3.

	Accommodation and Food Activities	Construction and Real Estate	Energy, Gas and Water Supply	Information, Communication R&D	Manufacturing	Other Business Activities	Retail Trade	Transport and Storage	Wholesale Trade
Belgium	-0.782***	-0.948***	-0.870***	-0.945***	-1.135***	-1.066***	-0.744***	-0.586***	-1.052***
	(0.095)	(0.094)	(0.190)	(0.142)	(0.054)	(0.135)	(0.142)	(0.127)	(0.040)
Germany	-0.183	-0.313***	0.081	1.402	-0.658***	-1.357***	-0.280	-0.980	-0.485**
	(0.549)	(0.122)	(1.259)	(6.973)	(0.183)	(0.592)	(0.308)	(0.748)	(0.288)
Spain	-0.497***	-0.390***	-0.840***	-0.754***	-0.635***	-0.585***	-0.449***	-0.637***	-0.593***
	(0.018)	(0.014)	(0.089)	(0.045)	(0.009)	(0.023)	(0.014)	(0.023)	(0.010)
Finland	-0.394***	-0.582***	-0.474***	-0.680***	-0.790***	-0.466***	-0.533***	-0.652***	-0.971***
	(0.095)	(0.059)	(0.164)	(0.167)	(0.056)	(0.171)	(0.111)	(0.071)	(0.048)
France	-0.453***	-0.638***	-1.113***	-0.957***	-0.768***	-0.840***	-0.789***	-0.583***	-0.790***
	(0.025)	(0.018)	(0.094)	(0.062)	(0.015)	(0.034)	(0.020)	(0.027)	(0.014)
Italy	-0.724***	-0.423***	-1.069***	-0.755***	-0.789***	-0.813***	-0.524***	-0.783***	-0.725***
	(0.040)	(0.022)	(0.083)	(0.053)	(0.010)	(0.046)	(0.026)	(0.036)	(0.013)
Netherlands	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Portugal	-0.283	-0.214***	-1.473***	-0.578	-0.513***	-0.709***	-0.518***	-0.544***	-0.508***
	(0.160)	(0.047)	(0.366)	(1.449)	(0.031)	(0.094)	(0.037)	(0.165)	(0.031)

Note: The estimations are performed by country and sector, using a sub-sample of only small firms (EC definition). The marginal impacts of financial constraints are calculated by extending Levinsohn-Petrin (2006) and Wooldridge (2009) methodologies for the estimation of firm-level production function. We estimate the model through GMM using six over-identifying moment condition, i.e. $Z_{it} = (k_{it}, FCI_{it}, k_{it-1}, FCI_{it-1}, m_{it-1}l_{it-1})'$. *Though not reported, all regressions include also time dummies. Standard Deviations (in brackets) are computed from the robust variance-covariance matrix. *** p-value< 0.01, ** p-value< 0.05, * p-value< 0.1*

TABLE 15 - Marginal Impacts of Financial Constraints on Productivity: Robustness Check 4.

	Accommodation and Food Activities	Construction and Real Estate	Energy, Gas and Water Supply	Information, Communication R&D	Manufacturing	Other Business Activities	Retail Trade	Transport and Storage	Wholesale Trade
Belgium	-0.745***	-0.707***	-1.046***	-1.121***	-0.885***	-0.722***	-0.959***	-0.638***	-0.964***
	(0.086)	(0.055)	(0.139)	(0.125)	(0.036)	(0.090)	(0.103)	(0.064)	(0.037)
Germany	-0.693***	-0.217***	-0.430***	-0.674***	-0.447***	-0.554***	-0.138	-0.483***	-0.416***
	(0.315)	(0.066)	(0.111)	(0.182)	(0.046)	(0.083)	(0.167)	(0.092)	(0.076)
Spain	-0.533***	-0.378***	-0.744***	-0.906***	-0.728***	-0.608***	-0.447***	-0.634***	-0.622***
	(0.018)	(0.015)	(0.079)	(0.042)	(0.009)	(0.024)	(0.015)	(0.023)	(0.010)
Finland	-0.480***	-0.504***	-0.399***	-0.558***	-0.843***	-0.415***	-0.476***	-0.555***	-0.913***
	(0.089)	(0.063)	(0.097)	(0.122)	(0.044)	(0.117)	(0.117)	(0.072)	(0.065)
France	-0.461***	-0.583***	-0.861***	-0.882***	-0.833***	-0.841***	-0.732***	-0.564***	-0.725***
	(0.029)	(0.018)	(0.114)	(0.091)	(0.014)	(0.036)	(0.021)	(0.028)	(0.014)
Italy	-0.682***	-0.473***	-1.002***	-0.813***	-0.851***	-0.760***	-0.470***	-0.757***	-0.752***
	(0.042)	(0.022)	(0.075)	(0.053)	(0.009)	(0.043)	(0.026)	(0.032)	(0.013)
Netherlands	-0.012	-0.339***	-0.996***	-1.581***	-0.521***	-0.981***	-0.108	-0.756***	-0.864***
	(0.284)	(0.109)	(0.173)	(0.151)	(0.068)	(0.178)	(0.100)	(0.168)	(0.106)
Portugal	-0.404***	-0.330***	-1.792***	-0.939***	-0.594***	-0.597***	-0.629***	-0.785***	-0.482***
	(0.080)	(0.069)	(0.249)	(0.246)	(0.039)	(0.099)	(0.057)	(0.139)	(0.043)

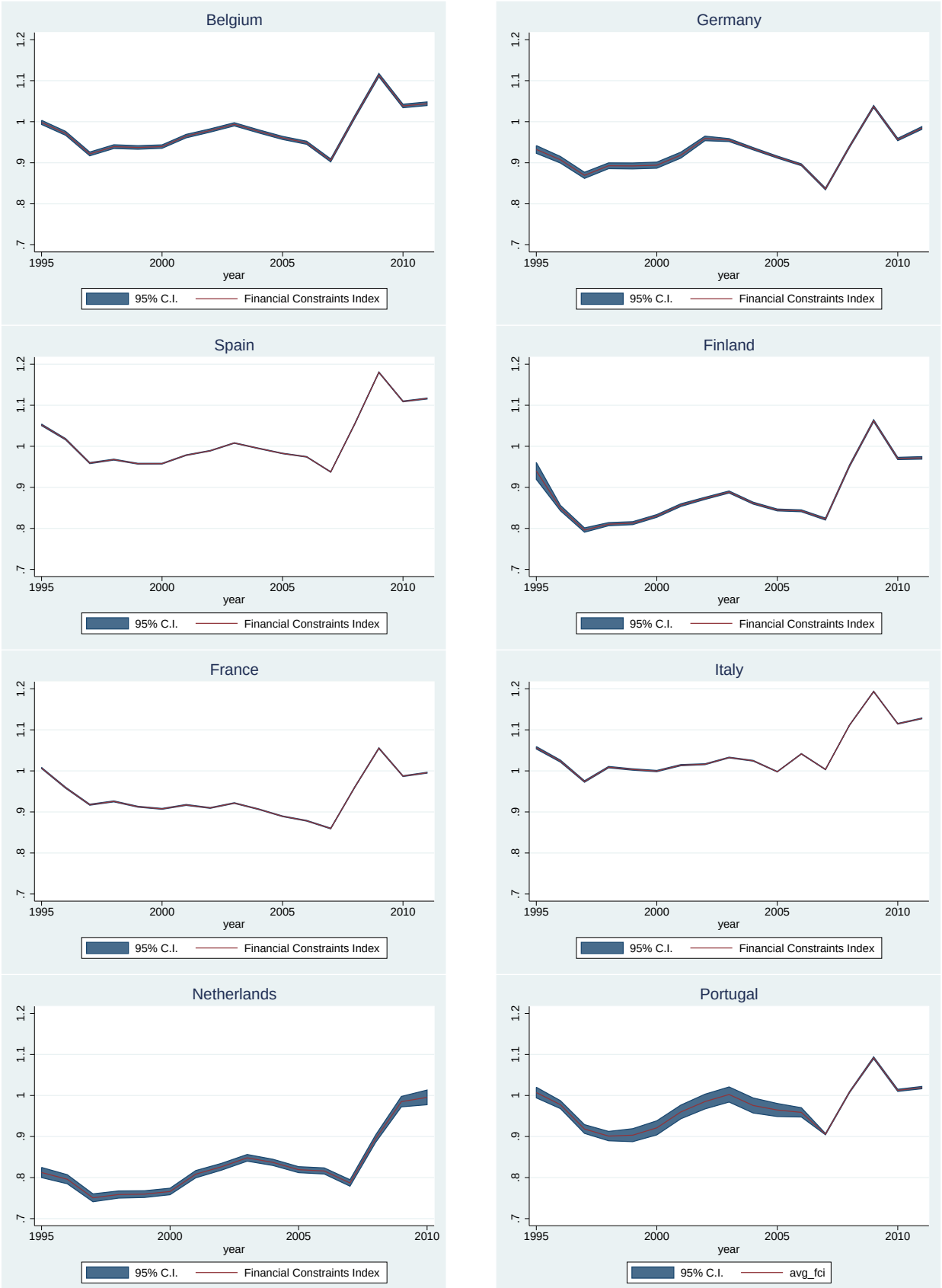
Note: The estimations are performed by country and sector, using a sub-sample of only those firms being in our dataset for AT LEAST 5 consecutive years. The marginal impacts of financial constraints are calculated by extending Levinsohn-Petrin (2006) and Wooldridge (2009) methodologies for the estimation of firm-level production function. We estimate the model through GMM using six over-identifying moment condition, i.e. $Z_{it} = (k_{it}, FCI_{it}, k_{it-1}, FCI_{it-1}, m_{it-1}l_{it-1})'$. *Though not reported, all regressions include also time dummies. Standard Deviations (in brackets) are computed from the robust variance-covariance matrix. *** p-value< 0.01, ** p-value< 0.05, * p-value< 0.1*

TABLE 16 - Marginal Impacts of Financial Constraints on Productivity: Robustness Check 5.

	Accommodation and Food Activities	Construction and Real Estate	Energy, Gas and Water Supply	Information, Communication R&D	Manufacturing	Other Business Activities	Retail Trade	Transport and Storage	Wholesale Trade
Belgium	-0.641***	-0.677***	-1.171***	-0.943***	-0.897***	-0.707***	-0.872***	-0.682***	-0.943***
	(0.091)	(0.055)	(0.141)	(0.106)	(0.034)	(0.089)	(0.101)	(0.061)	(0.037)
Germany	-0.023	-0.205***	-0.401***	-0.671***	-0.511***	-0.482***	-0.294	-0.421***	-0.448***
	(0.266)	(0.063)	(0.116)	(0.151)	(0.044)	(0.082)	(0.148)	(0.094)	(0.074)
Spain	-0.517***	-0.356***	-0.882***	-0.863***	-0.723***	-0.600***	-0.472***	-0.662***	-0.636***
	(0.018)	(0.015)	(0.079)	(0.043)	(0.009)	(0.023)	(0.015)	(0.022)	(0.010)
Finland	-0.456***	-0.509***	-0.504***	-0.585***	-0.848***	-0.467***	-0.561***	-0.564***	-0.929***
	(0.100)	(0.061)	(0.100)	(0.124)	(0.045)	(0.108)	(0.066)	(0.072)	(0.061)
France	-0.430***	-0.596***	-0.953***	-0.826***	-0.805***	-0.881***	-0.749***	-0.559***	-0.757***
	(0.025)	(0.017)	(0.104)	(0.076)	(0.013)	(0.065)	(0.021)	(0.024)	(0.013)
Italy	-0.717***	-0.485***	-1.107***	-0.845***	-0.856***	-0.817***	-0.528***	-0.780***	-0.759***
	(0.038)	(0.020)	(0.072)	(0.046)	(0.008)	(0.038)	(0.024)	(0.031)	(0.012)
Netherlands	-0.168	-0.368***	-0.723***	-1.031***	-0.541***	-1.071***	-0.451***	-0.651***	-0.871***
	(0.186)	(0.115)	(0.178)	(0.169)	(0.063)	(0.170)	(0.092)	(0.182)	(0.094)
Portugal	-0.496***	-0.213***	-1.162***	-1.077***	-0.589***	-0.559***	-0.544***	-0.745***	-0.531***
	(0.055)	(0.047)	(0.292)	(0.159)	(0.027)	(0.071)	(0.041)	(0.096)	(0.033)

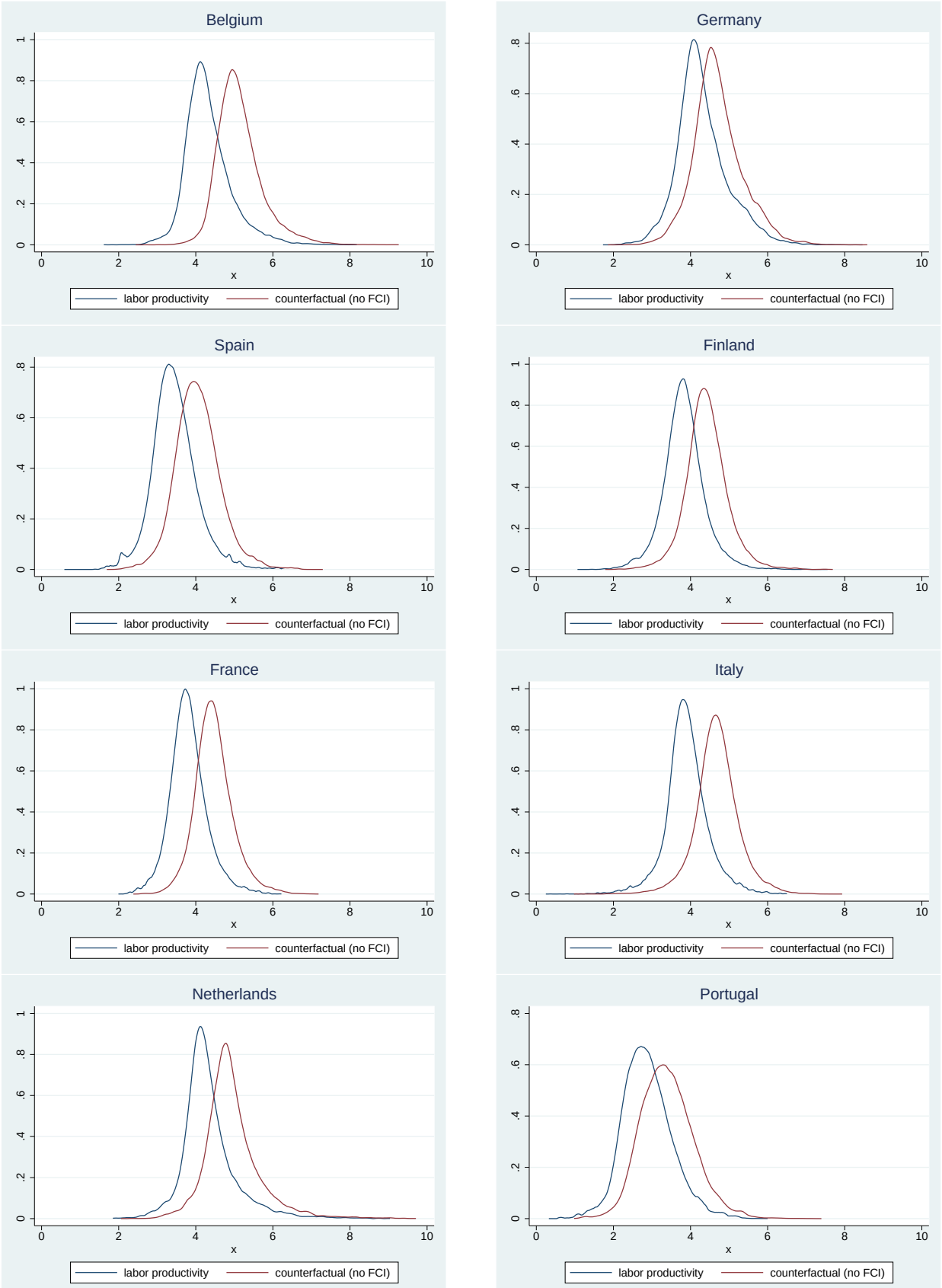
Note: The estimations are performed by country and sector, using a sub-sample of only those firms with a STRICTLY POSITIVE investment rate. The marginal impacts of financial constraints are calculated by extending Levinsohn-Petrin (2006) and Wooldridge (2009) methodologies for the estimation of firm-level production function. We estimate the model through GMM using six over-identifying moment condition, i.e. $Z_{it} = (k_{it}, FCI_{it}, k_{it-1}, FCI_{it-1}, m_{it-1}l_{it-1})'$. *Though not reported, all regressions include also time dummies. Standard Deviations (in brackets) are computed from the robust variance-covariance matrix. *** p-value*< 0.01, *** p-value*< 0.05, ** p-value*< 0.1

Figure 1 - Financial constraints across countries



Note: This figure displays the evolution of the predicted index of financial constraints (obtained from the baseline Probit regression) aggregated by country, over time.

Figure 2 - Labor Productivity Distribution and Counter-factual.



Note: This figure displays the actual kernel densities (blue line) of (log) labor productivity and the counter-factual density (red line) under no financial constraints. Both densities are estimated using 50 points in the support and the optimal smoothing parameter.

Appendix A

Descriptive Statistics

We report descriptive statistics of all variables included in our analysis. European firms in our sample have an average investment rate (defined as the change in tangible fixed assets plus depreciation over fixed assets of the beginning of the year) of around 31%; Italian and Belgian firms show the highest level of investment rate, Spanish and Portuguese firms have the lowest one. On average, sampled firms hold around 15% of their total assets in cash and cash equivalents (Finnish and French firms hoard the highest amount relatively to their total assets) and their sales grow at a rate of around 8% per year. From the liability side, financial leverage (defined as the sum of short-term loans and long-term debt over total assets) is on average 16%: German, Portuguese and Finnish firms show the highest level of leverage, as opposed to French and Dutch firms. Looking at the financial pressure on firms, German firms are in a better position to service their debt although they are the most levered companies in our sample: both the interest payments burden (defined as the ratio of interest payments to earnings before interest, taxes, depreciation and amortization plus financial revenues) and the overall interest rate paid for their total debt are on average the lowest in the sample, amounting respectively to 26% and 9%. The data show also substantial cross-country heterogeneity in production efficiency. In Table 3 we report mean, median and standard deviation of labor productivity, computed as the ratio of firm-level real value added over number of employees. Real value added is constructed as the difference between operative turnover and intermediate inputs (expressed both in euros), deflated using country-sectoral output deflators. Intermediate inputs are proxied by material and energy costs. Significant differences arise both between and within countries. On average, Germany and the Netherlands feature the highest average and median levels, with values that are roughly in line with the empirical findings of Bartelsman et al. (2013) and with the evidence provided by Lopez-Garcia et al. (2015). On the opposite, Spain and Portugal stand as the least productive countries. From a sectoral perspective, companies whose business involves either "Information, Communication and R&D" or "Energy, Gas and Water Supply" activities are able to produce, on average, greater real value added per number of employee, highlighting the ability for firms that innovate the most of generating larger surplus. Overall, our descriptive statistics are in line with those in the analysis by the ECB (2013) which refer to a larger dataset for the whole Euro-area.

TABLE 1 - Descriptive statistics

		Variables								
Countries		Investment Rate	Cash Holding	Cash Flow	Sales Growth	Profitability	Leverage	Maturity	Interest Payment Burden	Interest Paid
Belgium	Mean	0.33	0.12	0.09	0.06	0.11	0.2	0.6	0.3	0.1
	Median	0.21	0.06	0.08	0.04	0.1	0.15	0.7	0.13	0.07
	St.dev.	0.39	0.15	0.1	0.26	0.12	0.2	0.39	0.41	0.12
Germany	Mean	0.28	0.11	0.09	0.06	0.13	0.26	0.76	0.26	0.09
	Median	0.17	0.05	0.08	0.03	0.11	0.2	0.94	0.14	0.06
	St.dev.	0.35	0.15	0.1	0.24	0.14	0.24	0.32	0.31	0.11
Spain	Mean	0.27	0.15	0.08	0.09	0.09	0.17	0.85	0.35	0.14
	Median	0.12	0.08	0.07	0.04	0.09	0.1	1	0.18	0.08
	St.dev.	0.41	0.17	0.1	0.39	0.14	0.2	0.29	0.41	0.17
Finland	Mean	0.32	0.2	0.16	0.1	0.2	0.21	0.75	0.22	0.1
	Median	0.18	0.13	0.15	0.05	0.19	0.16	0.81	0.08	0.07
	St.dev.	0.44	0.2	0.15	0.34	0.19	0.21	0.27	0.33	0.12
France	Mean	0.34	0.2	0.1	0.06	0.12	0.11	0.31	0.23	0.18
	Median	0.19	0.14	0.09	0.03	0.11	0.05	0	0.09	0.11
	St.dev.	0.43	0.2	0.12	0.25	0.14	0.14	0.4	0.32	0.19
Italy	Mean	0.36	0.08	0.06	0.07	0.1	0.17	0.28	0.33	0.12
	Median	0.22	0.03	0.05	0.04	0.09	0.1	0.12	0.2	0.08
	St.dev.	0.44	0.12	0.08	0.31	0.1	0.19	0.33	0.4	0.13
Netherlands	Mean	0.3	0.11	0.11	0.08	0.12	0.12	0.42	0.32	0.13
	Median	0.2	0.05	0.1	0.05	0.11	0	0.41	0.15	0.08
	St.dev.	0.36	0.15	0.1	0.26	0.14	0.17	0.37	0.42	0.14
Portugal	Mean	0.25	0.14	0.07	0.06	0.09	0.21	0.53	0.39	0.13
	Median	0.09	0.07	0.07	0.02	0.08	0.16	0.64	0.19	0.08
	St.dev.	0.41	0.19	0.13	0.37	0.14	0.22	0.44	0.47	0.15
TOTAL	Mean	0.31	0.15	0.08	0.08	0.11	0.16	0.55	0.31	0.14
	Median	0.16	0.08	0.07	0.04	0.09	0.09	0.67	0.15	0.08
	St.dev.	0.42	0.17	0.11	0.33	0.14	0.19	0.44	0.39	0.17

Note: This table reports summary statistics at country level of the variables included in the construction of the measure of financial constraints and in the financing constraints and productivity models. All variables are winsorized at the 1st and 99th percentiles of their distribution within each country and sector across time.

TABLE 2 - Labor Productivity by Countries and Sectors: Descriptive Statistics.

	Belgium			Germany			Spain			Finland		
	Mean	Median	St.Dev.	Mean	Median	St.Dev.	Mean	Median	St.Dev.	Mean	Median	St.Dev.
Accommodation and Food	4.04	3.98	0.51	3.43	3.52	0.54	3.15	3.15	0.51	3.38	3.42	0.51
Construction and Real Estate	4.28	4.03	0.75	4.72	4.79	0.91	3.55	3.44	0.68	3.85	3.81	0.55
Electricity, gas and water supply	4.62	4.5	0.77	4.75	4.72	0.57	3.96	3.8	0.91	4.49	4.43	0.68
Information and R&D	4.43	4.37	0.58	4.4	4.4	0.59	3.52	3.51	0.63	3.92	3.95	0.6
Manufacturing	4.22	4.16	0.51	4.14	4.13	0.44	3.43	3.41	0.53	3.78	3.78	0.47
Other business activities	4.45	4.32	0.78	4.22	4.19	0.65	3.45	3.43	0.63	3.83	3.85	0.55
Retail trade	4.08	4.04	0.51	3.76	3.75	0.56	3.2	3.19	0.5	3.63	3.64	0.45
Transportation and storage	4.38	4.25	0.58	4.04	3.99	0.54	3.6	3.61	0.53	3.83	3.85	0.45
Wholesale trade	4.42	4.34	0.54	4.22	4.15	0.57	3.52	3.48	0.56	3.98	3.95	0.54
	France			**Italy**			**Netherlands**			**Portugal**		
	Mean	Median	St.Dev.	Mean	Median	St.Dev.	Mean	Median	St.Dev.	Mean	Median	St.Dev.
Accommodation and Food	3.59	3.58	0.48	3.44	3.51	0.72	3.97	3.96	0.91	2.42	2.41	0.53
Construction and Real Estate	3.83	3.78	0.47	3.89	3.86	0.63	4.46	4.25	0.86	2.75	2.65	0.71
Electricity, gas and water supply	4.03	3.97	0.59	4.25	4.15	0.75	5.04	5.07	0.76	3.84	3.72	1.08
Information and R&D	4.06	4.03	0.6	3.86	3.81	0.6	4.32	4.23	0.68	3.32	3.3	0.73
Manufacturing	3.76	3.73	0.44	3.9	3.87	0.49	4.27	4.21	0.58	2.79	2.75	0.59
Other business activities	3.98	3.99	0.58	3.82	3.8	0.66	4.26	4.17	0.81	2.96	2.92	0.65
Retail trade	3.67	3.65	0.46	3.72	3.73	0.53	3.81	3.76	0.6	2.8	2.78	0.63
Transportation and storage	3.77	3.73	0.42	3.93	3.95	0.59	4.4	4.18	0.91	3.12	3.13	0.63
Wholesale trade	3.89	3.84	0.48	4.04	4	0.55	4.37	4.26	0.66	2.18	1.95	0.96

Note: The measure of labor productivity is computed by taking the ratio of the firm-level real value added (deflated by sectoral-country specific deflator.) over the number of firm-employees. In this table, we report the statistics for the log of the ratio.

Appendix B
Comparison of Financial Constraints Indexes

In this section, we compare the two indicators of financial constraints we have introduced, meaning, the score based on the a-priori classification and the predicted index from the Probit estimation, with an indicator derived from survey data. In particular, we consider the new indicator of credit constraints (ICC) calculated for the CompNet database.[1] The ICC is constructed using the information derived from a firm-level survey (Survey of Access to Finance for Enterprises) regularly conducted by the ECB-EC since 2009. From the survey data it is possible to construct an index indicating whether firms are credit constrained, according to whether they report that: 1) their loan applications were rejected; 2) only a limited amount was granted; 3) they themselves rejected the loan offer because the borrowing costs were too high; 4) they did not apply for a loan for fear of rejection (i.e. discouraged borrowers). The survey-based index is regressed on a set of financial indicators (financial leverage, financial pressure, profit margin, collateral and cash holdings) to estimate the probability of a firm to be credit constrained given the financial situation and characteristics (like size and sectors). In a third step, the estimated coefficients are applied out-of-sample for the period before 2009, in order to construct backward the time series of the index. More importantly, the CompNet methodology is based on specific thresholds, always derived from the survey data, that are used to calibrate the new index with the aim of deriving the percentages of credit constrained firms across countries over time.[2][3] We have applied the same thresholds to our two indexes of financial constraints in order to compare them with the ICC. Figure A reports the three indexes across countries since 1995. In all countries, the indicator based on the a-priori classification reports consistently higher percentages of financially constrained firms. Differently from the ICC indicator, the a-priori indicator cannot exploit the information on whether firms indeed applied for external funds or whether they have been objectively rejected. Moreover, it cannot control for interactions between the financial position of firms and other characteristics used in the literature to signal financial constraints, such as size or structural differences related to

[1] See Ferrando et al. (2015), "Assessing the financial and financing conditions of enterprises in Europe: the Financial Module in CompNet", ECB-WP, No. 1836.

[2] $SAFEscore = -1.88 + 0.71finlev + 0.28debtburden - 0.51profitability - 0.21tangible - 1.20cashholding - 0.05ln(totalassets)$. The analysis is run from the second quarter of 2010 till the first quarter of 2013 and for seven Euro-area countries: Belgium, Germany, Finland, France, Italy and Portugal.

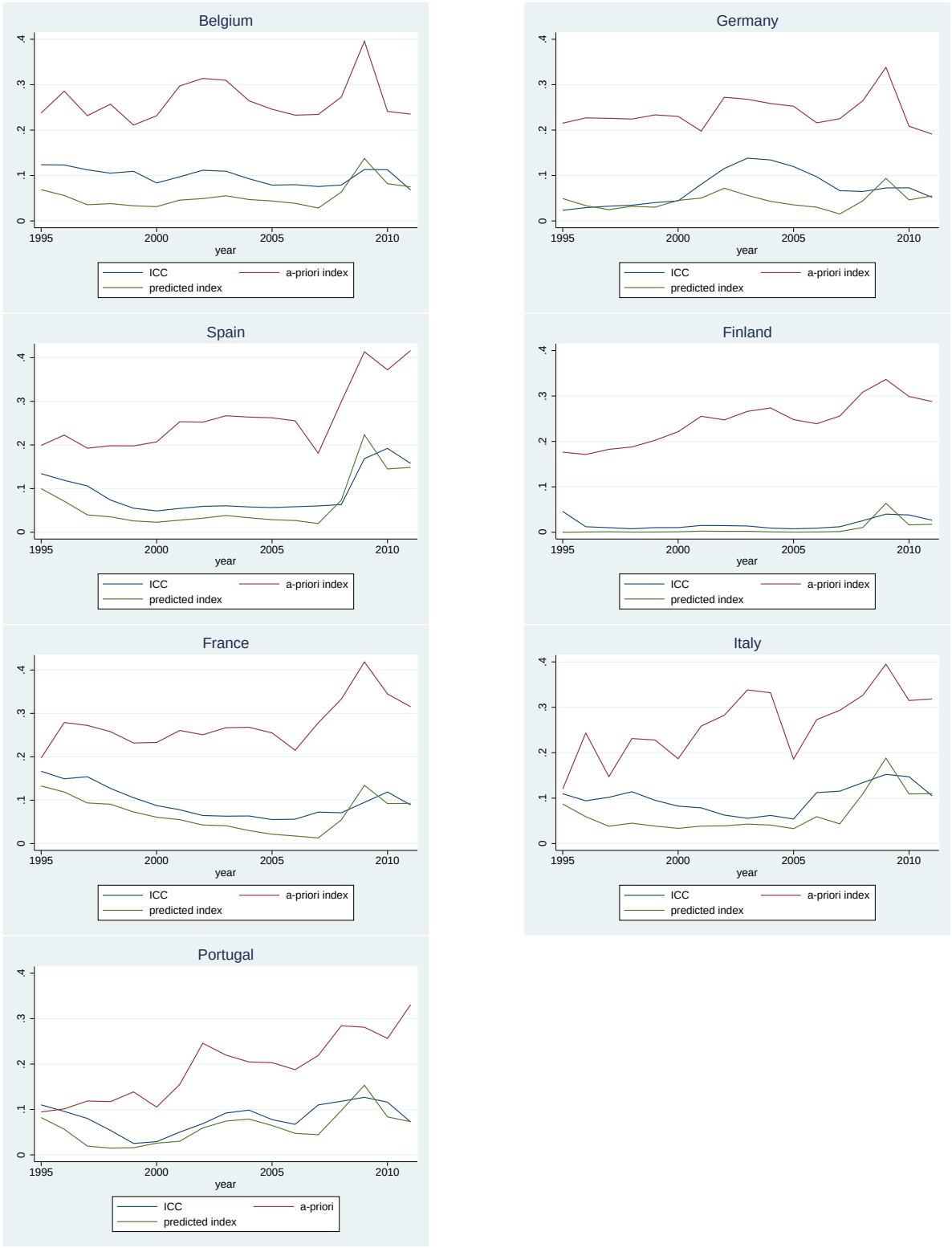
[3] In order to define the country thresholds, CompNet uses the percentage of credit constrained firms in the economy calculated directly from the SAFE survey. For each year, constrained firms are identified as those with a value of the SAFE score greater than the threshold. The ICC indicator will be equal to 1 for them and zero otherwise.

the economic sector. On the other hand, the ICC is closer to the predicted indicator and this reinforces our view that it is necessary to go beyond the a-priori classification in order to detect financially constrained firms.

Firms′ characteristics and financial constraints.

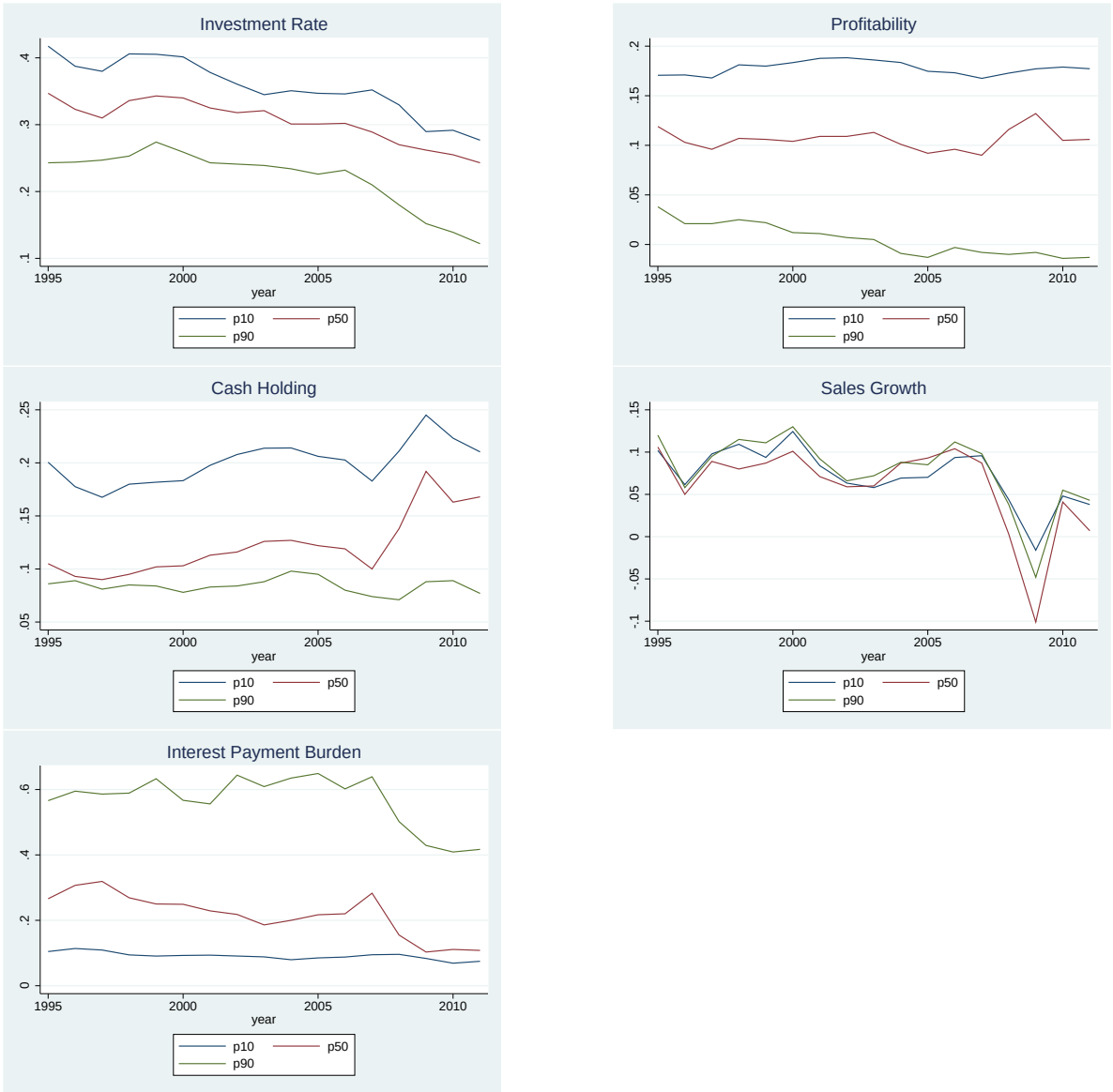
In this section, we use the synthetic indicator developed in section 3 to compare the developments over time of a number of firms characteristics conditional on different degrees of financial constraints. As the predicted index is a continuous variable, we split the sample into the three categories. The first category includes firms for which the predicted index is below the 10th percentile (the p10 line in Figure 2). According to the results of our ordered Probit specification, these are firms that are not financially constrained. The second group includes firms whose predicted index takes values around the median (the p50 line in Figure 4, which comprises values between the 45th and the 55th percentile). These firms should be more constrained than the p10 group but less constrained than those with values above the 90th percentile (p90 in Figure 2). Starting from the upper left side of Figure 2, we see that firms facing the highest level of financial constraints are investing less, indicating their difficulties in acceding external finances. This is in line with the evidence given by Whited and Wu (2004) and Carpenter et al. (1998), who show that constrained firms are more likely to give up profitable investment projects because of insufficient funds. By contrast, the largest share of investment is undertaken by unconstrained firms, which are on average the most profitable over time, where profitability is measured by the ratio of earnings before taxes and over total assets. By construction, unconstrained firms keep more cash in their balances. As suggested in Pal and Ferrando (2009), this could be the results of a financial system where most of the non-financial companies get external source of finance through financial intermediation instead of capital markets, as it is the case in Europe. In this setting, liquid assets might help firm to reduce the burden from penalty cost for delayed repayments of the interest rates. Looking at the growth rate of sales, which is often used in the literature to detect financial health, our predicted measure is not giving a clear picture. Firms′ sales growth rates across different percentiles of financial constraints are moving closely together over time, with no significant difference. Nonetheless, they are still correlated with the business cycle, showing a strong drop in 2009 and a mild recovery since then. In our sample, constrained firms face relatively higher interest payment burden. These are firms that in order to continue to invest have to finance themselves at unfavorable conditions. This positive relationship might be driven by the high costs of financing induced by high leverage ratios: as high leverage is likely to increase the risk of bankruptcy, this has to be compensated by higher financing costs.

Figure 1 - Financial constraints: the ICC index, the a-priori index and the predicted indicator (% of absolutely constrained firms)



Note: This figure reports the percentage of constrained firms using three alternative measures of financial constraints. The first is the ICC index, which is an index based on a combination of survey data and financial statements (CompNet database). The second is the a-priori index which is based on the classification scheme in Table 3. The third index is based on the Probit regression presented in Table 7, column 1. For all of them, the same thresholds are used to define the percentages of constrained firms across time and countries. The thresholds are originally calculated for the ICC index in the CompNet database. The ICC index is not available for the Netherlands.

Figure 2 - Financial indicators at different degrees of financial constraints.



Note: This figure displays the financial indicators for firms with different levels of financial constraints, based on the predicted index. P10 refers to firms below the 10th percentile, P50 refers to firms between 45th and 55th percentile, P90 refers to firms above the 90th percentile of financial constraints.

Appendix C

Definition and construction of row variables

All variables used in this paper are in real terms. Sales, turnover and value added are deflated using time-varying country-sectoral output deflators (source: Eurostat). Intermediate inputs are deflated by the intermediate inputs deflator. Financial variables (assets, liabilities and investment) are deflated with the gross capital formation price index.

- **Total fixed assets**: Tangible, intangible and other fixed assets
- **Other current assets**: Current assets - Trade debtors - Total inventories.
- **Total assets**: Total fixed assets + current assets.
- **Cash and cash equivalents**: Cash and balances at banks.
- **Cash holding**: Cash and cash equivalent over total assets.
- **Cash flow**: Net income + depreciation + extraordinary income.
- **Depreciation**: Depreciation on intangible assets and tangible assets.
- **Investment Rate**: Change in tangible fixed assets plus depreciation over fixed assets at the beginning of the period.
- **Sales Growth**: Annual growth rate of sales.
- **Liquidity**: Current assets - current assets stock over current liabilities.
- **Inventories**: Total inventories and consumable biological assets.
- **Capital stock**: Total fixed assets.
- **Working Capital**: Current assets - current liabilities over total assets.
- **Financing Gap**: Fixed Investment plus change in the net increase in working capital minus cash flow.
- **Financial Leverage**: Ratio of financial debt to total assets, where financial debt includes non-current liabilities (long term debt) and current liabilities (loans) and total assets is the sum of fixed and current assets.
- **Interest paid**: Interest on financial debts + other financial expenses.

- **Debt Burden**: Ratio of interest payments to earning before interest, taxes, depreciation and amortization plus financial revenues.
- **Profitability**: Ratio of earnings before interest, taxes and depreciation to total assets.
- **Size**: Continuous measure of firm size, measured by total assets, expressed in real values.
- **Age**: Continuous measure of firm age, measured by the ge of the firm at the beginning of period t, based on the entry date in the registry .
- **Turnover**: Total Sales.
- **Value Added**: Turnover - intermediate inputs
- **Number of employees**: Total employment, full-time and part-time
- **Labor productivity**: Real value added over number of employees.

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