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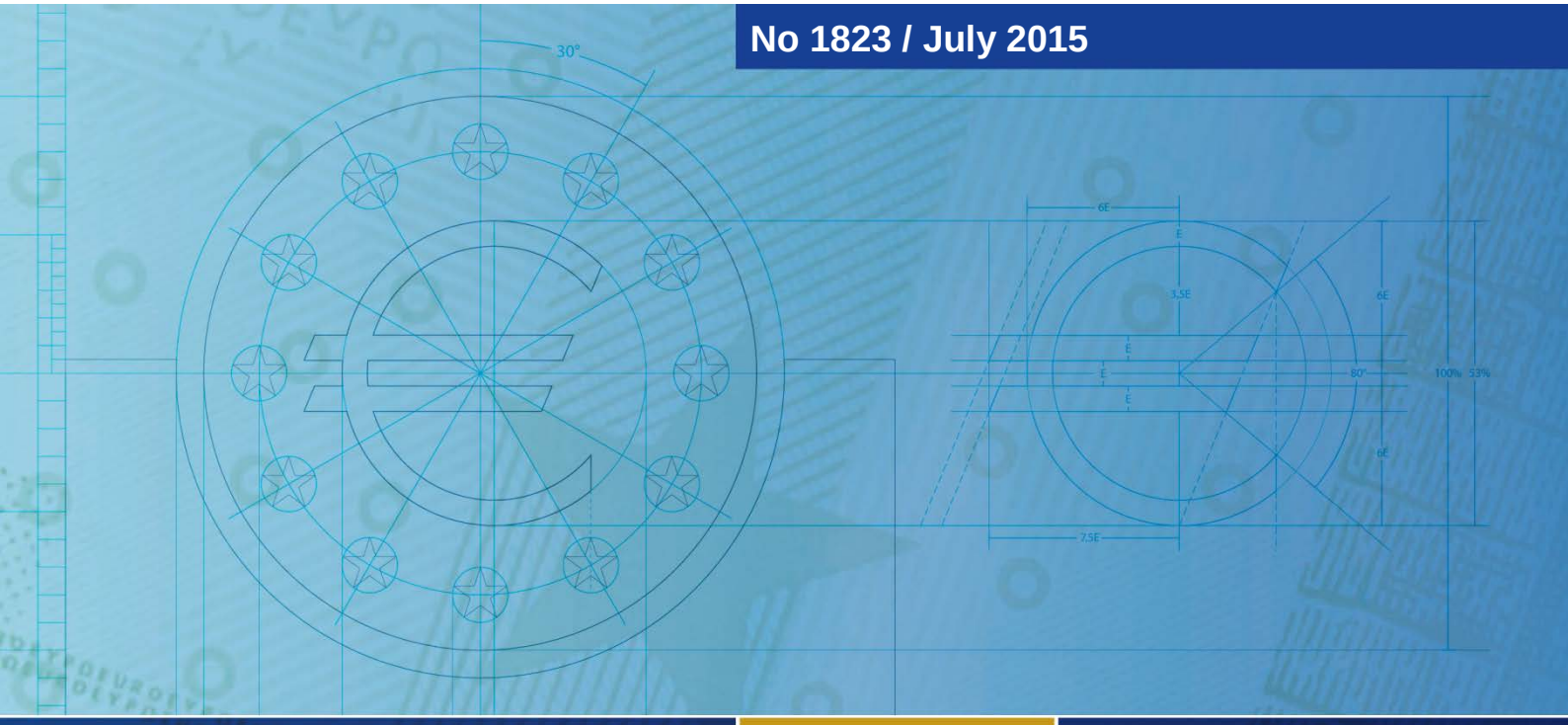
Financial constraints and productivity: evidence from euro area companies



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Abstract

In this paper we consider the relation between firms financial structure, access to external finance and labor productivity using a large dataset of firm-level data for Euro-area countries during the period 1995-2011. Our empirical strategy is twofold. First we develop an indicator of financial constraints at firm level using a classification based on specific firm characteristics and various measures of financial pressure and liquidity. Second we apply this indicator to a firm-level production equation to assess the direct impact of access to finance to firm-level productivity. We estimate the impact of financial constraints on a measure of labor productivity and we find significant and negative effects in the majority of sectors across countries. The impact appears to be significantly higher in sectors like Energy, Gas and Water Supply and R&D, Communication and Information, for small and micro firms, while it is slightly smaller for firms with positive investment rates. From a cross-country perspective, while Germany and Netherlands are the least one, Italy, France, Spain and Portugal are the most affected by financial constraints, with an estimated loss of around 10% of their average real value added due to limited access to finance.

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 funds are key factors to explain its performance in terms of value added generated. Moreover, these studies mostly focus on one-country analysis or do not consider in an explicit way the role of financial constraints. 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 the recent financial crisis (1995-2011). Furthermore, 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 constructed and indicators 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 interrelation 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. Using non-linear estimations, 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 the 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.

...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, President of the ECB, at the colloquium Les dfis de la comptitivit, Paris, 13 March 2012

1 Introduction and brief review of the literature.

In the literature it is widely documented that firms financing decisions become crucial in determining investment decisions, and the existence of frictions in accessing external sources of finance, for instance due to imperfect information, would significantly affect the ability of management of exploiting productive investment opportunities.[1] In this setting, the financial position of a firm and the access to external funds stand out to be key factors to explain its performance in terms of profitability and value added generated.

From an empirical point of view, few papers have analyzed the link between finance and productivity focusing at the firm level decision. Papers like Nunes et al. (2007)[30], Gatti and Love(2008)[19], Moreno-Badia and Slootmaekers (2009)[24], Chen and Guariglia (2013)[11] use firm-level data but they consider single countries. Our paper takes a multi-country dimension as it further investigates this link looking at a sample of enterprises in several Euro-area countries and for a time span that takes into account the impacts of the dot-com bubble and of the recent financial crisis. This allows us to contribute to the policy debate on the spillover effects from the financial sector on the real economy and on the implications for long-term investment and growth in the economy.[2] Though for a smaller time-span and for a more restricted set of countries, Levine and Warusawitharana (2014)[20] analyze the link between the use of external financing and productivity using a similar cross-country perspective.[3] But while they just look at the relation between total factor productivity and debt growth, we focus instead on a measure of financial constraints which takes into consideration a broader set of firm-level factors affecting access to external source of finance.

In particular, in our analysis we consider the relation between firms financial structure, access to external finance and measures of firm-level performance using a unique large dataset of firm-level data for eight Euro-area countries (Belgium, Germany, Spain, Finland, France, Italy, Netherlands and Portugal) and nine broad economic sectors (Accommodation and Food Service, Construction, En-

[1] See Silva and Carreira (2010)[38] for a survey of works related to financial constraints faced by firms.

[2] 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.

[3] Due to data availability, they only consider four countries, meaning France, Italy, Spain and United Kingdom, for a period of time going from 2000 to 2012.

ergy, Communication, Manufacturing, Retail trade, Wholesale trade, Transports and Other Business Service), during the period 1993-2011. The all sample is derived from the Bureau van Dijk-*Amadeus* database which collects accounting data of non-financial corporations across Europe.

To the extent of our analysis, we adopt a novel empirical strategy. First we construct an indicator of financial constraints at firm level and second we apply this indicator to a production equation to assess the direct impact of financial constraints on productivity. As a first step, we apply a semi-parametric index of firm-specific financial constraints, originally developed by Pal and Ferrando (2010)[32]. This 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 interrelation 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. 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 measures of financial pressure. Using a Ordered Probit estimation, we predict for each firm in our sample the probability of belonging to one of the aforementioned ranking. This predicted variable will represent the measure of access to finance that we use to investigate the link between financing constraint and NFCs productivity.

In the second part of our empirical analysis, we attempt to estimate the reaction of firm-level productivity to the probability of accessing external finance. Acknowledging the presence of endogeneity in assessing the causal relationship between these two variables, we exploit the nature of our index of financial constraint, which by construction will be an additional state variable in the firm-level production function, and we modify the Wooldridge-Levinsohn-Petrin methodology to accordingly account for that. [4]

Our paper contributes to the literature that looks explicitly at the impact of financial constraints on productivity. Differently from the evidence in Moreno-Badia and Slootmaekers (2009)[24] on Estonian firms and from the results in Levine and Warusawitharana (2014)[20] on the relationship between financial constraint measures and sensitivity of future TFP growth to debt growth, our analysis show that financial constraints do lower productivity in most sectors across countries: in the majority of the sector-country estimations, the direct impact of financial constraints is statistically and economically significant. The impact appears to be significantly higher in sectors like Energy, Gas and Water Supply and R&D, Communication and Information, for small and micro firms, while they are slightly smaller for firms with positive investment rates. Not surprisingly, estimates of marginal

[4] See Fernandes (2007)[17] for a similar application on the effect of trade policies on productivity gains for Colombian manufacturing plants.

impact turn out to be lower in Construction and Real Estate, a sector that have benefited more than others from low interest rates during the period 2001-2007. From a cross-country perspective, while Germany and Netherlands are the least one, Italy, France and Portugal are the most marginally affected by financial constraints, with losses in their average productivity ranging between 8% and 10% due to limited access to finance. These results are robust to a number of robustness checks, including alternative econometric specifications and several sub-samples.

The remainder of the paper is organized as follows. Section 2 describes the data. Section 3 introduces the classification used to detect financial constraints while in section 4 we derive our measure of financial constraints which will be then used in the productivity analysis. Section 5 performs a comparison of the indicators we have constructed with an index derived from survey data. Section 6 displays some firms characteristics according to their level of financial constraint while in Section 7 we relate our index with a measure of firm-level productivity. In sections 8 and 9 we present the estimation strategy and the empirical results. Section 10 includes a set of robustness checks while section 11 concludes.

2 Data collection and sampling.

For the construction of our sample we use the entire universe of *Amadeus* for accounting data (both balance sheets and income statements).[5] 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 1990-2011. 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 eight non-financial sectors: 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

[5] *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, Marchica and Mura (2014)[15] and Levine and Warusawitharana (2014)[20]).

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 1993-2011 period.[6] 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% of SMEs.[7] In general, there is also a large heterogeneity across countries in terms of age. The average age of firms in our sample is 16 years, with Dutch firms being on average 34 years old and Spanish firms around 13 years.

INSERT HERE TABLE 1

Table 2 reports descriptive statistics of all variables included in our analysis. On average, European firms in our sample have an investment rate of around 31% (defined as the change in tangible fixed assets plus depreciation over fixed assets of the beginning of the year); Italian and Belgian firms show the highest level of investment rate, while Spanish and Portuguese firms have the lowest one. On average, sampled firms hold around 15% of their total assets in cash and cash equivalents (with Finnish and French firms hoarding the highest amount relatively to their total assets) and their sales growth is around 8% per year. As for the liability side, financial leverage (defined as the sum of short-term loans and long-term debt over total assets) is around 16%: German, Portuguese and Finnish firms show the highest level of leverage, as opposed to French and Dutch firms, that have the lowest one. Looking at the financial pressure on firms, it is worth noting that, although they are the most levered companies in our sample, German firms are in a better position to service their debt: 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

[6] 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.

[7] 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.

rate paid for their total debt are on average the lowest in the sample, amounting respectively to 26% and 9%. 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.

INSERT HERE TABLE 2

3 Detecting financial constraints.

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.[8] 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)[32][9] 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[27]). Table 3 reports the classification revisited from Pal-Ferrando (2010)[32]. In the table we distinguish between absolutely constrained, relatively constrained and unconstrained firms. Absolutely constrained firms are those that cannot get external finance, 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

[8] See Silva and Carreira, 2012 [39], for a survey.

[9] A similar classification was proposed by Vermeulen (2002)[40].

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.

INSERT HERE TABLES 3 AND 4

The second column in Table 3 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 4 includes the percentages of firms with different levels of financial constraints across countries. To simplify the descriptive analysis that follows in the next sections we decided to collapse the seven categories to three categories: A absolutely constrained, R relatively constrained and U unconstrained. Figure 1 provides the percentages based on this broad definition. Based on our classification, the largest fraction of least constrained firms are in Belgium, Finland and Netherlands while it is more frequent to find Italian, Spanish and French firms among the most constrained ones.

INSERT FIGURE 1

Interestingly, financially constraints affect firms persistently over time. In Table 5, we present the transition matrix for the broad 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-years observation that were signaled as absolutely constrained 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 were absolutely unconstrained remain such also in the year after while 36.4% are classified as relatively unconstrained after a year. In our sample around 16% of young firms and 22% of mature firms are absolutely constrained while, according to size (being this

either the EC definition or a measure based on the distribution of real total assets), the percentages of absolutely constrained are around 20% for micro and small firms and 16% for large firms (Table 6).

INSERT HERE TABLE 5

INSERT HERE TABLE 6

INSERT HERE TABLE 7

Finally, as for a sectoral classifications, sectors 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 7), while sectors as Accommodation and Food and Electricity and Water Supply display the highest share of unconstrained firms, with fractions equal to, respectively, 42% and 36.1% of their total.

4 A firm-level measure of financial constraints.

Though it can provide interesting insights, the measure developed above can be somehow misleading if used to assess to which extent financial constraint impacts firms performance. The reasons lie on the possible measurement error carried out by our a-priori classification, which abstracts from additional firms' characteristics, like firms size, age and from further aggregate features at sectoral and country level. Disregarding this issue can invalidate our empirical analysis: systematic measurement error can lead to under/over -estimate the degree of financial constraints, and thus the impact on labor productivity. We try to address this limitation by refining our measure of financial constraint 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 firms size, age, geographical location, industry specialization and some indicators of financial pressure.

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 and exogenous disturbance u_{it} (assumed to be distributed as a standard normal.). Letting a_0 and a_1 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:

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

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 status. 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 and any of the observable variable, we follow Chamberlain (1980)[10] 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^2_c, where $\bar{X}_i$ are time-average 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.

Table 8 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 a preliminary specification (column 1), our baseline specification (column 2) 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

[10] See also Wooldridge (2012)[10].

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[11] and indicate that capital market imperfections play an important role and mainly affect SMEs and young firms. In the baseline specification we consider also some interaction to understand better the role of cash holding and in the case of age we see that as firms become older the amount of cash to assets increases among less constrained firms.

INSERT HERE TABLE 8

Column 3 of Table 8 displays an alternative specification of the baseline regression, where we introduced additional dummies on the percentiles of liquidity to check for some thresholds effects. Table 8 columns 4-7 report estimates for different sub-samples. If we compare the estimations before and after the crisis (columns 4 and 5), on the one hand cash holding is not anymore significant in predicting financial constraints; on the other hand, the impact of interest payment burden and financial leverage has slightly declined. For firms with less than 50 employees, which represent the majority of firms on our sample, financial leverage is a signal of being more financially constrained, which becomes even more important for firms that are unprofitable (columns 6 and 7). These results are thus stable across different sub-samples and do not vary when controlling for further indicators such as firm profitability, average debt maturity and inventories over total assets.

Driven by the robustness of the estimation across different specifications, we compute the weighted average of the predicted probabilities of being financially constrained for each of the three outcomes derived from the ordered Probit estimation of the baseline specification (column 2, Table 8), and we use it as our final measure of financial constraints at firm-level. Figure 2 shows the development of our predicted indicator across countries over time. Two regularities could be inferred from the picture. First, the ranking of countries seems to be stable during our sample period and it remains unchanged during the crisis. Dutch, German and Finnish firms display the lowest levels of the index, while Spanish, Portuguese and Italian show the highest ones. Second, after a long period in which the expected index of financial constraints was moving around a range of 0.8 and 1, the index jumped in 2008 up to values between 1.1 and 1.2 in 2009. In the last two years of our analysis the index has declined but it remains high from an historical perspective.

INSERT HERE FIGURE 2

[11] See for instance Berger and Udell (2003)[4], Rauh (2006)[35], Fee et al. (2009)[14] or Hadlock and Pierce (2010)[18].

5 Comparison with alternative measures of financial constraints: the index of credit constraints (ICC).

In this section we perform a comparison of the indicators of financial constrained we have introduced so far, meaning both the index based on the a-priori classification and the predicted index constructed 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 Comp-Net database.[12] The ICC is constructed using the information derived from a firm-level survey (Survey of access to finance for enterprises, SAFE) regularly conducted by the ECB-European Commission since 2009. From the survey data it is possible to construct an index indicating whether firms are credit constrained, i.e. when they reported 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). Then, this 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 its financial situation and characteristics (like size and sectors). In a third step, the estimated coefficients[13] are applied out-of-sample for the period before 2009, in order to construct a time series of the index. More importantly, the Comp-Net methodology uses a specific threshold- always derived from the survey data- to calibrate the new index with the aim of deriving the percentages of credit constrained firms across countries over time.[14]

We have applied the same thresholds to our two indexes of financial constraints in order to compare them with the ICC. Figure 3 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; this could be related to the fact that this indicator reports firms which are mostly financially fragile. Differently from the ICC indicator, the a-priori indicator cannot exploit the information on whether firms indeed applied for external funds and whether they have been objectively rejected. Furthermore, it cannot control for interactions between the financial position of firms and other characteristics detected in the literature to signal financial constraints, such as size or structural differences related to the economic sector. Hence it's not surprising that

[12] See Ferrando and Iudice (2015)[16], Assessing the financial and financing conditions of enterprises in Europe: the Financial Module in Comp-Net, forthcoming.

[13] $SAFEscore = -1.88 + 0.71finlev + 0.28debtburden - 0.51profitability - 0.21tangible - 1.20cashholding - 0.05ln(totalassets)$. 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.

[14] In order to define the country thresholds Comp-Net 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.

this indicator signals higher percentages of financially constrained firms than in the ICC indicator. More interestingly, the ICC is closer to our 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.

INSERT HERE FIGURE 3

6 Firms characteristics and financial constraints.

Using our measure of financial constraints we analyze the developments over time for various firms characteristics across different degree of financial constraints. As the predicted index is a continuous variable we split the sample into the three categories. The first category groups firms for which the predicted index is below the 10th percentile (the p10 line in Figure 4). According to the results of our ordered Probit specification, these are firms that are not financially constrained. The second group includes firms whose values of the predicted index is 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 of those with values above the 90th percentile (p90 in Figure 4).

Starting from the upper left side of Figure 4, 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)[41] and Carpenter et al. (1998)[9], 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 ones over time, where profitability is measured by the ratio of earnings before taxes and over total assets. At the same time these firms keep more cash in their balances. As suggested in Pal and Ferrando (2009)[32], 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 sales growth rates, which are often used in the literature to detect financial health, our predicted measure is not giving a clear picture. Firms' sales are moving closely together over time, with no significant difference across different percentiles of financial constraint. However, they are still following the business cycle, showing a strong drop in 2009 and a mild recovery since then.

In our sample, constrained firms face also a relatively higher interest payment burden over the sample period and they have also relatively high leverage ratios. These are firms that in order to continue to invest have to finance themselves at unfavorable conditions. The possible costs of bankrupt induced by high leverage ratios suggest therefore a positive relationship, in the sense that

higher leverage would increase the bankrupt risk, which has to be compensated by higher financing costs. Furthermore, our measure of financial constraints is indicating that firms with low leverage ratios are among those more financially constraints in the sense that they have insufficient funds to pursue their investment projects.

INSERT HERE FIGURE 4

7 Labor Productivity and Financial Constraints.

In this section we attempt to relate financial constraints and firm-level productivity. In the literature, a number of theoretical contributions have highlighted the negative relation between these two variables. Aghion et al (2005)[2] use a model of growth to show how tighter credit conditions leads to lower long-term productivity-enhancing investments, amplifying income volatility and reducing its average growth rate. Moll (2014)[26] builds a DSGE model to argue how the nature of a productivity shocks can be amplified by financial and credit frictions, resulting either in large long-run productivity losses or in a longer transition of the economy to the steady state. Caggese and Cunat (2013)[7] develop a dynamic industry model to show how financing frictions reduce the ability of firms to finance the fixed costs necessary to start exporting, reducing therefore any aggregate productivity gains that could be induced by a trade liberalization. In our analysis we do not aim to test any of these specific transmission channels; however we adopt the general view of financial constraints as fostering resource mis-allocation[15], impeding productive investments to be undertaken, and therefore reducing firm-level value added. To begin with, Table 9 displays descriptive statistics for a measure of firm-level labor productivity, computed as the ratio of firm-level real value added over number of employees.[16] We report mean, median and standard deviation of the logarithm of labor productivity for each country and sector.

INSERT HERE TABLE 9

Data show a considerable degree of cross-country heterogeneity in labor productivity. Belgium, Germany and the Netherlands naturally arise as the countries with the highest average and median level of labor productivity, with values that are roughly in line with the empirical findings of Bartelsman and Doms (2000)[3]. 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,

[15]For instance, the 2013 Product Market Review of the European Commission reports empirical evidence about the relations between business dynamics and resource allocative efficiency.

[16]Firm-level nominal value added is deflated using time-varying country-sectoral deflators.

greater real value added per number of employee, highlighting the ability for firms that innovate the most of generating a larger surplus. Finally, companies operating either in Retail Sector or in Food and Accommodation are ranked as the least productive. As a further step, we report the correlations coefficients between our broad index of financial constraints and the measure of firm-level productivity adopted. Table 10 displays these correlations for each sector and country, averaged over time.

INSERT HERE TABLE 10

In 60 cases out of 72, the correlation coefficients are negative and statistically different than 0 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. Given this, at first sight we expect to find a negative and significant effect of financial constraints on productivity; in particular, we expect this effect to be significantly larger (in absolute value) in those countries with the highest share of absolutely constrained firms, say Italy, Spain and France, and lower labor productivity. In the next section, we will explore this relation more formally.

8 Estimating a production function augmented with financial constraints.

In order to assess the impact of financial constraints to firm-level productivity, we follow the same procedure as proposed in Fernandes (2007)[17]. We modify the semi-parametric approaches described in Wooldridge (2009)[42] and Petrin and Levinsohn (2004)[34] 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 i in country j, sector s, at time t, we consider the following firm-level production function equation:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_l k_{it} + \beta_f FCI_{it} + d_i + d_t + \Omega_{it} + \epsilon_{it} \quad i = 1...N \quad t = 1...T \tag{4}$$

where i and t are respectively the cross-sectional (firm-level) and the time dimension. In our specification, y_{it} is natural log of value added, l_{it} is the natural log of number of employees k_{it} is the natural log of capital inputs (measured as total fixed assets), FCI_{it} is the measure of financial constraints while d_i and d_t are firm-specific and time dummies.[17] Each variable is expressed in

[17]Since for any of the country-sector pair in the sample we run a different estimation, including country- and sectoral-dummies would make us run into perfect collinearity. Thus we avoid to include them into the production function.

real terms using country-sectoral deflators. As described in section 4, the measure 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)[31] and Petrin and Levinsohn (2004)[34], we make use of intermediate inputs, m_{it}, as a variable to correct for the simultaneity bias arising between labor choice and unobserved productivity innovation. Therefore, we can express the unobserved productivity shocks as a function of capital inputs, intermediate inputs and degree of financial constraints,

$$\Omega_{it} = g(k_{it}, FCI_{it}, m_{it}) \quad t = 1...T \tag{5}$$

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

$$\mathbb{E}(y_{it}|l_{it}, k_{it}, FCI_{it}, m_{it}) = \beta_l l_{it} + \Phi(k_{it}, FCI_{it}, m_{it}) + d_i + d_t \quad t = 1...T \tag{6}$$

where:

$$\Phi(k_{it}, FCI_{it}, m_{it}) = \beta_0 + \beta_k k_{it} + \beta_f FCI_{it} + g(k_{it}, FCI_{it}, m_{it}) \quad t = 1...T \tag{7}$$

As in Moreno-Badia and Slootmaeker (2011)[24], since $g(.)$ is allowed to have a general functional form and since both capital inputs and financing constraint index 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. Moreover, since intermediate inputs m_{it} can be assumed to be chosen at the same time as labor inputs l_{it}, the latter might become function of endogenous arguments, $(k_{it}, FCI_{it}, m_{it})$, leading to a non-fundamental identification of β_l. We therefore impose three additional assumptions on the specification of our model which enable us to estimate β_k, β_l and β_f together. Following Olley and Pakes (1999)[31], we restrict the process $(\epsilon_{it} : t = 1...T)$ to be conditionally mean independent of current and past inputs and we restrict the dynamics of unobserved productivity shocks $(\Omega_{it} : t = 1...T)$ to follow a First order Markov process. Finally we assume that

intermediate inputs are chosen before any labor input decision is taken (we will relax this assumption and impose more structure to the specification of our model later in the paper). In the same fashion of Wooldridge (2009)[42], these three conditions allow us to deal with non-fundamentalness in the identification of β_k, β_l and β_f.

9 Estimation and Results.

In order to estimate the production function equation (6), we approximate the unspecified function $g(.)$ using a third order polynomial with full set of interactions among the state variables. We use this polynomial together with capital and index of financial constrained as instrumental variables and we estimate the parameters of interest by applying the Generalized Method of Moments, as developed by Arellano and Bond (1991)[1] and Blundell and Bond (1998)[6]. Table 11 shows the estimates for the marginal effects of financial constraint on productivity, by country and sector. Standard errors (reported in brackets) are computed using the robust variance covariance matrix.

INSERT HERE TABLE 11

In line with what Chen and Guariglia (2013)[11] find for Chinese firms, we do find that financing constraints lower the level productivity in the majority of cases.[18] On the one hand, the marginal effects appear to be significantly different almost in each country and sector, and higher in sectors like Energy, Gas and Water Supply and R&D, Communication and Information. This result seems to confirm Aghion et al. (2007)[2] and Savignac (2007)[36], who find that being financially constrained significantly reduces the likelihood of firms of investing in R&D and other innovating activities. On the other hand, estimates of marginal impact turn out, not surprisingly, to be lower in Construction and Real Estate, a sector that have benefited more than others from low interest rates and higher access to credit along the period 2001-2007, confirming part of the evidence in Moreno-Badia and Slootmaekers (2008)[24]. From a cross-country perspective, while Germany and Finland are the least one, Italy, France and Portugal are the most marginally affected by financial constraints. To have a better sense of the cross-country economic impact of financial constraints, we use the point estimates to compute the average percentage loss in real value added driven by the limited access to finance, for each of 72 cases. To do so we multiply the estimated marginal impact by the average value of financial constraints and divide by the log of real value added. We then aggregate this measure

[18] In 4 cases out of 72, the estimates are not statistically significant at 10% while in 2 cases the estimate is not statistically significant at 5%. From a sectoral perspective, these coefficients are mainly clustered on the sector Accommodation and Foods. From a country perspective, only Belgium, Germany and Netherlands are affected by this outcome.

across sectors, weighting each of them by their relative sectoral real value added. Figure 5 compares the average loss across countries.

INSERT HERE FIGURE 5

Except for the Netherlands, for which the estimated loss is not significantly different than zero, on average each country experienced a significant and positive loss in productivity due to limited access to finance. Italy, France, Spain and Portugal faced the highest percentage losses, with values that range between 8% and 10% of their average productivity, while Germany appears as the least affected, with an estimated loss of about 4%. This result confirms our hypothesis: distortions in the credit and capital allocations depress firm-level productivity. Better-functioning financial system, like those in Germany and Netherlands (as the share of unconstrained firms suggests) are likely to channel resources towards the most rewarding and profitable activities, promoting and fostering the structural transformations of the economy triggered by innovative investments. Bad-functioning financial sectors, like those characterizing the peripheral countries of the Euro area (as highlighted by the share of absolutely constrained firms) refrains from allocating and re-allocating resources efficiently between productive and non-productive firms, with the consequence of distorting investment decision, and lowering potential value added and growth.

10 Robustness Checks and Discussion.

In this section, we show and discuss robustness of our results. To perform our baseline estimation, we assumed that intermediate inputs were chosen before labor inputs, allowing us to use the former as a proxy variable for unobserved productivity shock. However, if this assumption were revealed to be incorrect, simultaneity between firm's choices would invalidate our identification strategy, being based upon the wrong moment conditions. Therefore, as first departure from the main specification, we relax this assumption by assuming that both intermediate and labor input are chosen at the same time. On the one hand, this prevents us to use contemporaneous intermediate inputs to approximate the unobserved productivity shocks: intermediate inputs cease to be a state variable, being indeed chosen simultaneously to labor input. On the other hand, following Wooldridge (2009)[42], we can still make use of lagged labor input and lagged intermediate input (and any function of the latter ones) as instrumental variable in our estimation. We do perform a GMM estimation using capital, index of financial constraint, lagged labor input, lagged intermediate input and our approximation of the unknown function $g(.)$ as IV[19] and we show results in Table 12. The regression outcome

[19]In this case, we still approximate the unknown function $g(.)$ using a third order Taylor expansion; however we can only include with a full set of interactions between capital inputs and the predicted index of financial constraints.

shows that controlling for simultaneity between labor input and intermediate inputs plays a role in our analysis. Point estimates are on average smaller (in absolute value) compared to the baseline model. However, the substance of the baseline regressions stays the same: financial constraints still significantly reduce the level of productivity for the majority of the cases, in each country and sector: in only 6 cases out of 72 we do not observe a significant marginal effect and they are mainly clustered on Germany (2), Netherlands (3) and Belgium (1).

INSERT HERE TABLE 12

Finally, Tables 13-15 show estimates for several selected sub-samples. To reduce any possible selection bias arising from entry-exit dynamics, we restrict our analysis on only those firms that stay in the sample for 5 consecutive years. To isolate the effect of size, we only look at only those plants with less than 50 employees, and, to get rid of possible bias coming from profitable opportunity selection, we confine our sample considering only firms with positive investment rates.

INSERT HERE TABLES 13

INSERT HERE TABLES 14

INSERT HERE TABLES 15

Productivity of small firms is marginally more affected by financial constraint compared to large firms. Excluding those cases where the estimations could not be performed due to the small amount of observations[20], almost all the coefficient estimates are larger in magnitude compared to the baseline estimation. This result mainly applies to Italy, Spain, Portugal and France while it does not extend to Belgium, Germany and Netherlands, for which some of the estimates become statistically not significant, 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.[21] Restricting the analysis to firms with positive investment rate or to firms that are in the sample for 5 consecutive years, does not alter our results. All this confirms therefore that higher financing constraints are likely to determine, everything else equal, larger and significant differences in firms-level productivity.

From a policy perspective, our findings suggest that improving financial and credit institutions and relaxing those constraints that in particular small and medium enterprises face when they take

[20]Four of these eight cases are for the Netherlands, for whom the share of large firms accounts for almost the entire relative sample.

[21]See for instance Beck and Demirguc-Kunt (2006)[5] for a survey on SMEs and access to finance.

operative decisions, would probably be an effective way of stimulating productivity, enhancing investment and thus contributing to overall economic growth. As surveyed by Beck and Dermirguc-Kunt (2006)[5], 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 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 sectors 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 the access to different source of external capitals would enables these companies to catch up to the technological frontiers, with significant benefits in terms larger value added generated.

11 Conclusions.

At the 2014 presentation ceremony of the Schumpeter Award in Vienna, the ECB president Mario Draghi affirmed:

There is some evidence that credit mis-allocation is already occurring in the Euro-area, and it is creating an undesirable, even if only temporary, distortion to the detriment of small firms. [...] If small, innovative firms cannot access finance, it has an important impact on employment and investment.[...] At the same time, young firms have been shown to be much more sensitive to changes in investment opportunities than older firms, meaning that fewer start-ups would probably lead to lower trend productivity growth.

Along the argument traced by Draghi, this paper aims to provide new evidence on the link between financial constraints and 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 across nine broad economic sectors. Our paper contributes to the debate that looks explicitly at the impact of financial constraints on productivity. 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 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 impact appears to be significantly higher in sectors that

innovate the most, like Energy, Gas and Water Supply and R&D, Communication and Information, and for small and micro firms, while they are slightly smaller for firms with positive investment rates. From a cross-country perspective, while Germany and Netherlands are the least one, Italy, France, Spain and Portugal are the most affected by financial constraints, with an estimated loss of around 10% of their average real value added due to limited access to finance. These results are robust to a number of robustness checks, including the use of alternative econometric specifications as well as when the empirical approach is computed with several sub-samples related to the characteristics of firms, such as size and survival bias.

References

[1] **Arellano, M., Bond, S.**, (1991), Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations, *Review of Economic Studies*, Vol. 58, No. 2, pp. 277-297.

[2] **Aghion, P., Angeletos, G-M., Banerjee, A. and Manova, K.**, (2007), Volatility and Growth: Credit Constraints and the Composition of Investment, *mimeograph*, Massachusetts Institute of Technology.

[3] **Bartelsman, E.J., Doms, M.**, (2000), Understanding Productivity: Lessons from Longitudinal Microdata, *Journal of Economic Literature*, Vol. 38, No. 3, pp. 569-594.

[4] **Berger, A. N. and Udell, G. F.**, (2006), A more complete conceptual framework for SME finance, *Journal of Banking and Finance* Vol. 30, pp. 2945-2966.

[5] **Beck, T. and Demirguc-Kunt, A.**, (2006), Small and medium-size enterprises: Access to finance as a growth constraint, *Journal of Banking and Finance*, Vol. 30, pp. 29312943.

[6] **Blundell, R., Bond, S.**, (1998), Initial conditions and moment restrictions in dynamic panel data models, *Journal of Econometrics*, Vol. 87, No. 1, pp. 115-143.

[7] **Caggese, A., Cunat, V.**, (2008), Financing Constraints and Fixed-term Employment Contracts, *The Economic Journal*, Vol. 118, No. 533, pp. 2013-2046.

[8] **Carpenter, R. E., Fazzari, S. M. and Petersen, B. C.**, (1994), Inventory Investment, Internal-finance Fluctuations and the Business-cycle, *Brookings Papers on Economic Activity*, No. 2, pp. 75-138.

[9] **Carpenter, R. E., Fazzari, S. M. and Petersen, B. C.**, (1998), Financing Constraints and Inventory Investment: A Comparative Study with High-frequency Panel Data, *Review of Economics and Statistics*, Vol. 80, No. 4, pp. 513-9.

[10] **Chamberlain, G.**, (1980) Analysis of Covariance with Qualitative Data, *Review of Economic Studies*, Vol. 47, pp. 225-238.

[11] **Chen, M. and Guariglia, A.** (2011), Financial constraints and firm productivity in China: do liquidity and export behavior make a difference?, *University of Nottingham*, .Research paper series, No. 9.

[12] **Fazzari, S. M., Hubbard, R. G. and Petersen, B. C.**, (1988), Financing Constraints and Corporate Investment, *Brookings Papers on Economic Activity*, No. 1, pp. 141-95.

[13] **Fazzari, S. M., and Petersen, B. C.**, (1993), Working Capital and Fixed Investment: New Evidence on Financing Constraints, *The RAND Journal of Economics*, Vol. 24, No. 3, pp. 328-42.

[14] **Fee, C. E., Hardlock, C.J., Pierce, J.R.**, (2009), Investment, financing constraints, and the internal capital markets: evidence from the advertising expenditures of multinational firms,*Review of Financial Studies*, Vol. 22, pp. 2362-2392.

[15] **Ferrando, A., Marchica M.T. and Mura, R.**, (2014) Financial flexibility across the Euro area and the UK, *ECB WP series*, No. 1603.

[16] **Ferrando, A., Iudice M.**, (2015) Assessing the financial and financing conditions of firms in Europe: the Financial Module in CompNet, *ECB WP series*, forthcoming.

[17] **Fernandes A.**, (2007), Trade policy, trade volumes and Plant-level productivity in Colombian Manufacturing Industries, *Journal of Development Economics*, Vol. 71 (No. 2), 294-323.

[18] **Hadlock, C.J. and Pierce, J.R.**, (2010), New evidence on measuring financial constraints: moving beyond the KZ index, *Review of Financial Studies*, Vol. 23, No. 5, pp. 1909-1940.

[19] **Gatti, R. and Love, I.**, (2008), Does Access to Credit Improve Productivity? Evidence from Bulgaria, *Economics of Transition*, Vol. 16, No. 3, pp. 445-65.

[20] **Levine, O. and Warasawitharana, M.**, (2014), Finance and Productivity Growth: Firm-level Evidence, *Finance and Economics DP*, Federal Reserve Board, No. 2014-17.

[21] **Levinsohn, J. and Petrin, A.**, (2003), Estimating Production Functions Using Inputs to Control Unobservables, *Review of Economic Studies*, Vol. 70, No. 2, pp. 317-41.

[22] **Mancusi, M.L. and Vezzulli, A.**, (2010), R&D, Innovation and Liquidity Constraints, Contributed paper for the 2nd Conference on corporate R&D (CONCORD- 2010)

[23] **Manova, K., Wei, S-J, and Zhang, Z.**, (2011), Firm Exports and Multinational Activity under Credit Constraints, *National Bureau of Economic Research*, Working Paper No. 16905.

[24] **Moreno-Badia, M. and Slootmaekers, V.**, (2009), The Missing Link between Financial Constraints and Productivity, *International Monetary Fund*, Working Paper No. WP-09-72.

[25] **Myers, S. C. and Majluf, N. S.**, (1984), Corporate Financing and Investment Decisions When Firms Have Information that Investors Do not Have, *Journal of Financial Economics*, Vol. 13, No. 2, pp. 187-221.

[26] **Moll, B.**, (2014), Productivity Losses from Financial Frictions: Can Self-Financing Undo Capital Misallocation?, *The American Economic Review*, Vol, 104, No. 10, pp. 3186-3221.

[27] **Musso, P. and Schiavo, S.**, (2008), The impact of financial constraints on firm survival and growth, *Journal of Evolutionary Economics*, 1892, pp. 135-149.

[28] **Nickell, S. and Nicolitsas, D.**, (1999), How does Financial Pressure Affect Firms?, *European Economic Review*, Vol. 43, No. 8, pp. 1435-56.

[29] **Nucci, F., Pozzolo, A. F. and Schivardi, F.**, (2005), Is Firms Productivity Related to Its Financial Structure? Evidence from Microeconomic Data, *Rivista di Politica Economica*, No. I-II, pp. 177-98.

[30] **Nunes, P. M., Sequeira, T. N. and Serrasqueiro, Z.**, (2007), Firms Leverage and Labor Productivity: A Quantile Approach in Portuguese Firms, *Applied Economics*, Vol. 39, No. 13-15, pp. 1783-8.

[31] **Olley, G. S. and Pakes, A.**, (1996), The Dynamics of Productivity in the Telecommunications Equipment Industry, *Econometrica*, Vol. 64, No. 6, pp. 1263-97

[32] **Pal, R. and Ferrando, A.**, (2010), Financing constraints and Firms cash policies in the Euro area, *The European Journal of Finance*, Vol. 16, No. 2, pp. 153-171

[33] **Palangkaraya, A., Stierwald, A. and Yong, J.**, (2009), Is Firm Productivity Related to Size and Age? The Case of Large Australian Firms, *Journal of Industry, Competition and Trade*, Vol. 9, No. 2, pp. 167-95.

[34] **Petrin, A., Poi, B. P. and Levinsohn, J.**, (2004), Production Function Estimation in Stata Using Input to Control for Unobservables, *The Stata Journal*, Vol. 4, No. 2, pp. 113-23

[35] **Rauh, J. D.**, (2006), Investment and Financing constraints: Evidence from the funding of corporate pension plans, *Journal of Finance*, Vol. 61, pp. 3371.

[36] **Savignac F.**, (2008), Impact of Financial Constraint on Innovation: What can be learned from a direct measure?, *Econ. Innov. New Technology*, Vol. 17, No. 6, pp. 553-569

[37] **Schiantarelli, F. and Sembenelli, A.**, (1997), The Maturity Structure of Debt-Determinants and Effects on Firms Performance: Evidence from the United Kingdom and Italy, *The World Bank*, Policy Research Working Paper, WPS-1699.

[38] **Silva, F. and Carreira, C.**, (2010), No Deep Pockets: Some Stylized Empirical Results On Firms Financial Constraint., *Journal of Economic Survey*, Vol. 24, No. 4, pp. 731-753

[39] **Silva, F. and Carreira, C.**, (2012), Measuring firms financial constraints: a rough guide, *Notas Economicas*, Vol. 36, pp. 23-46.

[40] **Vermeulen, P.**, (2002), Investment and Financing constraints: what does the data tell?, EIFC Working Paper No.25.

[41] **Whited, T. and Wu G.**, (2004), Financial constraints risk, *The Review of Financial Studies*, Vol. 19, No.2, pp. 531-559.

[42] **Wooldridge, J.M.**, (2009), On estimating firm level production function using proxy variables to control for unobservables, *Economic Letters*, Vol. 104, No. 3, pp. 112-114

[43] **Wooldridge, J.M.**, (2012), Econometric Analysis of Cross Section and Panel Data, MIT Press, second edition.

TABLE I - Sample Characteristics by country.

This table provides some sample characteristics. The sample includes all non-financial firms in eight Euro countries with accounting information for at least three years over the period 1993-2011. All firms are reporting their number of employees in the dataset.

	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
%	0.95	0.83	0.99	0.98	0.99	0.99	0.8	0.99	0.99
No. SMEs (EC definition)	12348	18026	176356	15393	124856	134949	3974	37718	523620
%	0.86	0.66	0.52	0.42	0.44	0.61	0.67	0.41	0.51
Age: Mean	25	28	13	17	17	19	34	16	16

TABLE II - Summary statistics.

This table reports summary statistics at country level of the variables included in the construction of the measure of financing 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.

		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

TABLE III - Classification scheme to detect financially constrained firms.

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	-	-	-

TABLE IV - Classification scheme by countries.

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

	Belgium	Germany	Spain	Finland	France	Italy	Netherlands	Portugal	Total
				Unconstrained					
0	22.8	24.2	19.6	32.1	25.9	16.7	30.8	16.5	21.4
1	4.9	1.4	3.9	5.9	3.4	2.5	1.8	4.2	3.6
2	8.5	9.2	8.5	6.1	4.7	7.4	4.9	16.2	7.4
				Relatively Constrained					
3	31.3	30.3	28.9	32.5	30.1	33.2	37.8	34.4	30.6
4	13.2	16.1	18.6	8.5	12.8	18.2	11.2	11.8	16
				Absolutely Constrained					
5	14.7	10.6	15.1	10.6	17.3	16.6	9.8	13.1	15.7
6	4.7	8.2	5.4	4.3	5.8	5.4	3.8	3.8	5.4

TABLE V - Transition matrix.

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

	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

TABLE VI - Classification scheme by firms characteristics.

The 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.

	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

TABLE VII - Classification scheme by economic sectors.

The table shows the percentage of firm-year observations across economic industries.

	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

TABLE VIII - Probit Estimations.

All the estimations are based on Random Ordered Probit, corrected with 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.

	Dependent Variable: FC Index$_t$.									
	Full sample	**Full sample**	**Full Sample**	**Pre-crisis (1995-2007)**	**Crisis (2008-2011)**	**Small Firms**	**Unprofitable Firms**	**Full** sample	**Full sample**	**Full sample**
Financial Leverage$_{t-1}$	0.922***	0.924***	1.254***	0.990**	0.921***	1.024***	1.188***	0.937***	0.942***	0.978***
	(0.006)	(0.006)	(0.006)	(0.008)	(0.011)	(0.006)	(0.009)	(0.006)	(0.006)	(0.007)
Debt Burden$_{t-1}$	0.077***	0.078***	0.109***	0.125***	0.086***	0.084***	0.087***	0.023***	0.022***	0.024***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)
Cash Holding$_{t-1}$	-0.279***	-0.482***	-0.280***	-0.150***	0.037	-0.129***	-0.051**	-0.457***	-0.429***	-0.379**
	(0.007)	(0.017)	(0.016)	(0.020)	(0.031)	(0.018)	(0.025)	0.016	(0.016)	(0.021)
Size$_{t-1}$	-0.007***	-0.053***	-0.053***	-0.007	-0.029***	-0.006*	-0.005	0.023***	0.022***	0.005
	(0.002)	(0.004)	(0.004)	(0.004)	(0.006)	(0.004)	(0.005)	(0.003)	(0.003)	(0.003)
Age$_{t-1}$	0.007***	0.007**	0.002***	0.005***	0.000	0.005***	0.006***	0.014***	0.013***	0.008***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
Size$_{t-1}$**Age**$_{t-1}$		-0.001	-0.001***	-0.000***	-0.001	-0.001***	-0.001***	-0.002***	-0.002***	-0.001***
		(0.000)	(0.000)	(0.000)	(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***	0.07***	0.068***	0.093***
		(0.009)	(0.009)	(0.011)	(0.018)	(0.011)	(0.014)	(0.009)	(0.009)	(0.011)
Cash Holding$_{t-1}$**Age**$_{t-1}$		0.006***	0.005***	0.007***	0.006	0.009***	0.009***	0.004***	0 .004***	0.0003***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Profitability$_{t-1}$								-0.335***	-0.331***	-0.446***
								(0.008)	(0.008)	(0.010)
Inventories$_{t-1}$									0.119***	0.158***
									(0.008)	(0.010)
Debt Maturity$_{t-1}$										0.023***
										(0.003)
Liquidity dummies	No	No	Yes	No	No	No	No	No	No	No
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sectoral dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3520382	3520382	3520382	2199693	930810	3007934	1364553	3520382	3504254	2670579
Log-likelihood	-3673744	-3673091	-6154456	-3829779	-1632864	-5259833	-2383815	-3649680	-3649680	-2719544
Pseudo R^2	0.023	0.024	0.019	0.017	0.018	0.017	0.017	0.0300	0.0301	0.0353

TABLE IX - Labor Productivity by countries and sectors: Descriptive Statistics.

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.

	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

TABLE X - Correlations between Financial Constraint and Real Value Added over Number of Employees.

Two stars imply significance at 0.05 level.

	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**

TABLE XI - Marginal Impacts of Financial Constraint on Productivity across different Countries and Sectors.

The estimations are performed by country and sector, using the whole sample dataset. The marginal impacts of Financing Constraint are calculated by extending Wooldridge (2009) and Levinsohn-Petrin (2006) methodologies for the estimation of firm-level production function. We include our predicted Index of financial constraint among the proxy variables used to control for unobserved productivity, together with BOTH Capital and Intermediate Inputs, and we consider a third order Taylor expansion with the full set of interactions between these three state variables. R -squared statistics are not available for the modified Levinsohn-Petrin estimation. 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 .

	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	-0.41**	-0.59***	-0.20**	-1.01***	-0.88***	-0.59***	-1.00***	-0.70***	-0.94***
	(-0.2)	(-0.13)	(-0.08)	(-0.322)	(-0.06)	(-0.18)	(-0.19)	(-0.12)	(-0.07)
Germany	-0.06	-0.23***	-0.52***	-0.55***	-0.47***	-0.47***	-0.30**	-0.34***	-0.45***
	(-0.24)	(-0.08)	(-0.11)	(-0.17)	(-0.04)	(-0.08)	(-0.13)	(-0.12)	(-0.07)
Spain	-0.52***	-0.27***	-0.84***	-0.81***	-0.71***	-0.58***	-0.47***	-0.65***	-0.63***
	(-0.03)	(-0.02)	(-0.12)	(-0.07)	(-0.01)	(-0.03)	(-0.03)	(-0.03)	(-0.02)
Finland	-0.43***	-0.49***	-0.42***	-0.68***	-0.83***	-0.56***	-0.71***	-0.50***	-0.99***
	(-0.1)	(-0.05)	(-0.14)	(-0.14)	(-0.04)	(-0.09)	(-0.1)	(-0.06)	(-0.07)
France	-0.44***	-0.59***	-0.91***	-0.82***	-0.83***	-0.77***	-0.78***	-0.55***	-0.76***
	(-0.03)	(-0.02)	(-0.1)	(-0.08)	(-0.02)	(-0.04)	(-0.03)	(-0.04)	(-0.02)
Italy	-0.66***	-0.50***	-1.17***	-0.84***	-0.90***	-0.79***	-0.56***	-0.77***	-0.79***
	(-0.05)	(-0.03)	(-0.09)	(-0.06)	(-0.01)	(-0.05)	(-0.04)	(-0.05)	(-0.02)
Netherlands	-0.6	-0.59*	-0.4	-0.57***	-0.56***	-0.84***	-0.41	-0.72*	-0.91***
	(-1.46)	(-0.32)	(-0.31)	(-0.12)	(-0.13)	(-0.25)	(-0.41)	(-0.37)	(-0.14)
Portugal	-0.46***	-0.23***	-1.44***	-1.02***	-0.58***	-0.60***	-0.56***	-0.75***	-0.56***
	(-0.06)	(-0.05)	(-0.38)	(-0.25)	(-0.04)	(-0.07)	(-0.06)	(-0.1)	(-0.06)

TABLE XII - Marginal Impacts of Financial Constraint on Productivity: Robustness check 1.

The estimations are performed by country and sector, using the whole sample dataset. The marginal impacts of Financing Constraint are calculated by extending Wooldridge (2009) and Levinsohn-Petrin (2006) methodologies for the estimation of firm-level production function. We include our predicted Index of financial constraint among the proxy variables used to control for unobserved productivity, together with Capital Inputs ONLY, assuming intermediate and labor inputs are chosen at the same time. We consider a third order Taylor expansion with the full set of interactions between these two state variables. R -squared statistics are not available for the modified Levinsohn-Petrin estimation. 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 .

	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	-0.46*	-0.55***	-0.17***	-1.05***	-0.82***	-0.54***	-0.94***	-0.53***	-0.90***
	(-0.24)	(-0.1)	(-0.04)	(-0.2)	(-0.05)	(-0.15)	(-0.19)	(-0.11)	(-0.06)
Germany	-0.4	-0.21***	-0.67***	-0.78***	-0.45***	-0.50***	-0.21	-0.65***	-0.41***
	(-0.29)	(-0.09)	(-0.11)	(-0.19)	(-0.05)	(-0.08)	(-0.16)	(-0.12)	(-0.07)
Spain	-0.53***	-0.36***	-0.80***	-0.77***	-0.72***	-0.45***	-0.48***	-0.52***	-0.51***
	(-0.02)	(-0.02)	(-0.12)	(-0.07)	(-0.02)	(-0.03)	(-0.03)	(-0.03)	(-0.02)
Finland	-0.47***	-0.37***	-0.49***	-0.57***	-0.78***	-0.36***	-0.67***	-0.40***	-0.65***
	(-0.12)	(-0.06)	(-0.16)	(-0.15)	(-0.04)	(-0.1)	(-0.09)	(-0.06)	(-0.08)
France	-0.48***	-0.56***	-0.88***	-0.82***	-0.80***	-0.63***	-0.79***	-0.42***	-0.71***
	(-0.03)	(-0.02)	(-0.11)	(-0.09)	(-0.02)	(-0.04)	(-0.03)	(-0.04)	(-0.02)
Italy	-0.68***	-0.46***	-1.19***	-0.78***	-0.90***	-0.74***	-0.52***	-0.75***	-0.73***
	(-0.05)	(-0.03)	(-0.01)	(-0.07)	(-0.02)	(-0.06)	(-0.04)	(-0.05)	(-0.03)
Netherlands	-0.5	-0.35	-0.84***	-0.58***	-0.57***	-0.81***	-0.66*	-0.78***	-0.81***
	(-0.68)	(-0.28)	(-0.36)	(-0.14)	(-0.12)	(-0.27)	(-0.39)	(-0.31)	(-0.15)
Portugal	-0.47***	-0.04	-2.05***	-0.98***	-0.56***	-0.39***	-0.58***	-0.60***	-0.57***
	(-0.06)	(-0.05)	(-0.4)	(-0.2)	(-0.04)	(-0.08)	(-0.06)	(-0.12)	(-0.06)

TABLE XIII - Marginal Impacts of Financial Constraint on Productivity: Robustness check 2.

The estimations are performed by country and sector, using a sub-sample of only those firms with LESS than 50 employees (Micro and Small Firms). The marginal impacts of Financing Constraint are calculated by extending Wooldridge (2009) and Levinsohn-Petrin (2006) methodologies for the estimation of firm-level production function. We include our predicted Index of financial constraint among the proxy variables used to control for unobserved productivity, together with BOTH Capital and Intermediate Inputs, and we consider a third order Taylor expansion with the full set of interactions between these three state variables. R -squared statistics are not available for the modified Levinsohn-Petrin estimation. 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.

	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	-0.07	-0.89***	n.a.	n.a.	-0.98***	-0.32	-0.58**	-0.85***	-0.98***
	(-0.3)	(-0.17)			(-0.09)	(-0.24)	(-0.27)	(-0.18)	(-0.07)
Germany	n.a.	-0.3	-0.57	-1.92	-0.55***	-0.47	-0.61	-1.43*	-1.10***
		(-0.22)	(-0.41)	(-1.17)	(-0.21)	(-0.59)	(-0.43)	(-0.86)	(-0.2)
Spain	-0.60***	-0.40***	-1.23***	-1.03***	-0.80***	-0.91***	-0.72***	-0.85***	-0.77***
	(-0.03)	(-0.02)	(-0.16)	(-0.07)	(-0.02)	(-0.03)	(-0.02)	(-0.03)	(-0.02)
Finland	-0.57***	-0.77***	-0.2	-1.24***	-1.02***	-1.09***	-0.90***	-0.98***	-1.11***
	(-0.14)	(-0.08)	(-0.28)	(-0.21)	(-0.07)	(-0.14)	(-0.09)	(-0.1)	(-0.08)
France	-0.65***	-0.66***	-1.09***	-1.27***	-0.97***	-0.90***	-1.05***	-0.72***	-1.01***
	(-0.03)	(-0.02)	(-0.14)	(-0.1)	(-0.03)	(-0.05)	(-0.03)	(-0.04)	(-0.02)
Italy	-0.87***	-0.45***	-1.42	-1.11***	-0.97***	-0.92***	-0.63***	-0.85***	-0.77***
	(-0.07)	(-0.04)	(-0.13	(-0.08)	(-0.02)	(-0.07)	(-0.04)	(-0.06)	(-0.02)
Netherlands	n.a.	0.01	n.a.	n.a.	-0.82	n.a.	n.a.	0.06	-1.07**
		(-1.81)			(-1.94)			(-2.34)	(-0.46)
Portugal	-0.60***	-0.17***	-1.67***	-1.18***	-0.70***	-0.69***	-0.75***	-0.99***	-0.72***
	(-0.06)	(-0.05)	(-0.39)	(-0.17)	(-0.04)	(-0.07)	(-0.05)	(-0.12)	(-0.04)

TABLE XIV - Marginal Impacts of Financial Constraint on Productivity: Robustness check 3.

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 Financing Constraint are calculated by extending Wooldridge (2009)[?] and Levinsohn-Petrin (2006) methodologies for the estimation of firm-level production function. We include our predicted Index of financial constraint among the proxy variables used to control for unobserved productivity, together with BOTH Capital and Intermediate Inputs, and we consider a third order Taylor expansion with the full set of interactions between these three state variables. R -squared statistics are not available for the modified Levinsohn-Petrin estimation. 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.

	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	-0.41*	-0.81***	n.a.	n.a.	-0.85***	-0.26*	-0.95***	-0.75***	-0.90***
	(-0.22)	(-0.1)			(-0.06)	(-0.15)	(-0.24)	(-0.13)	(-0.06)
Germany	0.28	-0.35**	-0.60*	-1.12***	-0.83***	-0.89***	-0.45*	-0.13	-1.10***
	(-1.81)	(-0.16)	(-0.33)	(-0.35)	(-0.08)	(-0.13)	(-0.26)	(-0.29)	(-0.16)
Spain	-0.60***	-0.43***	-1.11***	-1.06***	-0.84***	-0.92***	-0.67***	-0.80***	-0.74***
	(-0.03)	(-0.024)	(-0.15)	(-0.07)	(-0.02)	(-0.04)	(-0.03)	(-0.04)	(-0.018)
Finland	-0.62***	-0.68***	-0.53*	-1.08***	-0.97***	-0.78***	-0.91***	-0.77***	-0.97***
	(-0.17)	(-0.09)	(-0.28)	(-0.21)	(-0.05)	(-0.13)	(-0.1)	(-0.12)	(-0.08)
France	-0.63***	-0.56***	-0.89***	-1.32***	-0.96***	-0.91***	-0.97***	-0.60***	-0.90***
	(-0.04)	(-0.03)	(-0.15)	(-0.1)	(-0.02)	(-0.06)	(-0.04)	(-0.04)	(-0.02)
Italy	-0.77***	-0.49***	-1.17***	-1.16***	-0.99***	-0.86***	-0.57***	-0.77***	-0.77***
	(-0.08)	(-0.04)	(-0.12)	(-0.09)	(-0.02)	(-0.08)	(-0.05)	(-0.06)	(-0.03)
Netherlands	-1.78	-0.85***	-0.93	n.a.	-1.08***	n.a.	-0.39	-0.5	-1.11***
	(-1.1)	(-0.17)	(-0.59)		(-0.12)		(-0.36)	(-0.32)	(-0.17)
Portugal	-0.51***	-0.20**	-1.60***	-0.79***	-0.64***	-0.63***	-0.73***	-1.09***	-0.55***
	(-0.08)	(-0.08)	(-0.42)	(-0.27)	(-0.04)	(-0.1)	(-0.07)	(-0.15)	(-0.06)

TABLE XV - Marginal Impacts of Financial Constraint on Productivity: Robustness check 4.

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 Financing Constraint are calculated by extending Wooldridge (2009)and Levinsohn-Petrin (2006) methodologies for the estimation of firm-level production function. We include our predicted Index of financial constraint among the proxy variables used to control for unobserved productivity, together with BOTH Capital and Intermediate Inputs, and we consider a third order Taylor expansion with the full set of interactions between these three state variables. R -squared statistics are not available for the modified Levinsohn-Petrin estimation. 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.

	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	-0.25	-0.73***	n.a.	n.a.	-0.86***	-0.35**	-1.01***	-0.83***	-0.93***
	(-0.19)	(-0.1)			(-0.06)	(-0.14)	(-0.25)	(-0.13)	(-0.06)
Germany	-0.45	-0.19	-0.58**	-1.24***	-0.84***	-0.81***	-0.60***	-0.23	-1.01***
	(-0.35)	(-0.12)	(-0.26)	(-0.27)	(-0.07)	(-0.12)	(-0.21)	(-0.22)	(-0.11)
Spain	-0.60***	-0.38***	-1.24***	-1.15***	-0.85***	-0.89***	-0.72***	-0.84***	-0.79***
	(-0.03)	(-0.02)	(-0.13)	(-0.07)	(-0.01)	(-0.03)	(-0.03)	(-0.04)	(-0.02)
Finland	-0.62***	-0.74***	-0.61**	-0.95***	-0.99***	-0.92***	-0.88***	-0.89***	-0.97***
	(-0.17)	(-0.08)	(-0.24)	(-0.18)	(-0.05)	(-0.14)	(-0.11)	(-0.1)	(-0.08)
France	-0.62***	-0.63***	-1.02***	-1.29***	-0.99***	-0.88***	-1.03***	-0.65***	-0.95***
	(-0.04)	(-0.03)	(-0.14)	(-0.08)	(-0.02)	(-0.04)	(-0.03)	(-0.04)	(-0.02)
Italy	-0.85***	-0.49***	-1.32***	-1.13***	-1.00***	-0.93***	-0.62***	-0.80***	-0.79***
	(-0.06)	(-0.04)	(-0.11)	(-0.07)	(-0.01)	(-0.06)	(-0.04)	(-0.05)	(-0.02)
Netherlands	-0.87	-0.78***	-1.17	n.a.	-1.07***	n.a.	-0.23	-0.62	-1.26***
	(-1.49)	(-0.2)	(-0.82)		(-0.12)		(-0.34)	(-0.39)	(-0.16)
Portugal	-0.69***	-0.18***	-1.67***	-1.22***	-0.73***	-0.66***	-0.79***	-1.03***	-0.72***
	(-0.06)	(-0.06)	(-0.41)	(-0.17)	(-0.04)	(-0.08)	(-0.06)	(-0.13)	(-0.04)

Figure 1 - Financial Constraints across countries.

The figure displays the percentages of firm-year observations according to the classification scheme proposed in Table 3 but collapsed into three categories: U unconstrained; R relatively constrained and A absolutely constrained.

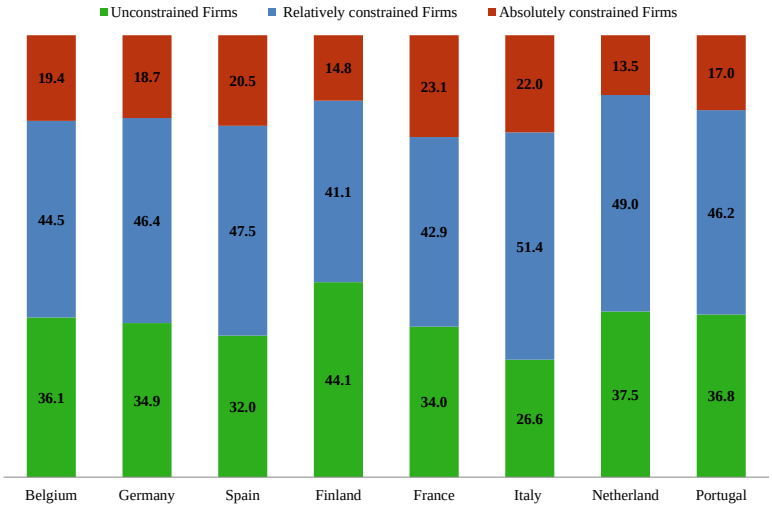


Figure 2 - Financial Constraints over time.

The figure displays the evolution of the predicted index of financial constraint (obtained from the baseline Probit regression) for different countries across time.

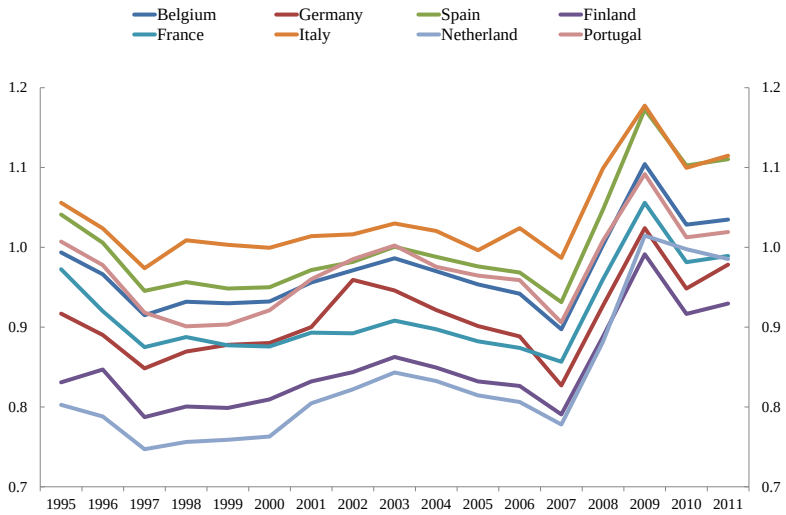
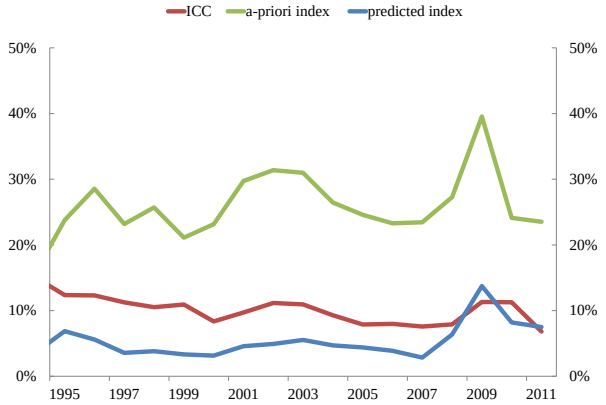


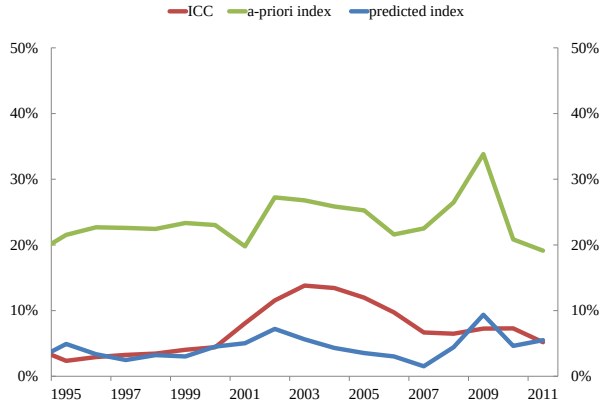
Figure 3 - Financial constrained firms: the ICC index, the a-priori index and the predicted indicator (percentages)

The 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 one is the a-priori index which is based on the classification scheme in Table III. The third index is based on the Probit analysis presented in Table 8, column 2. The three indexes are using the same thresholds to define the percentages of constrained firms across time and countries. This threshold is originally calculated for the ICC index in the CompNet database. The ICC index is not available for the Netherlands.

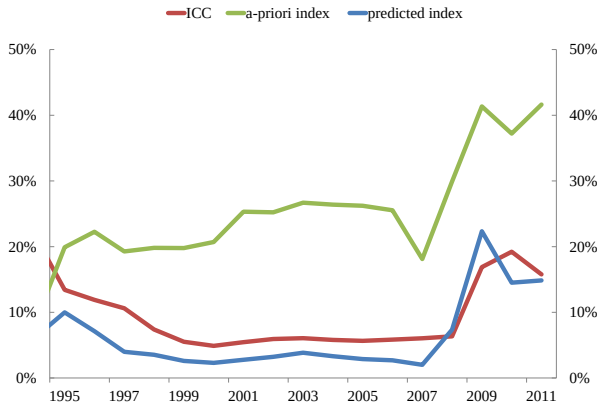
Belgium



Germany



Spain



Finland

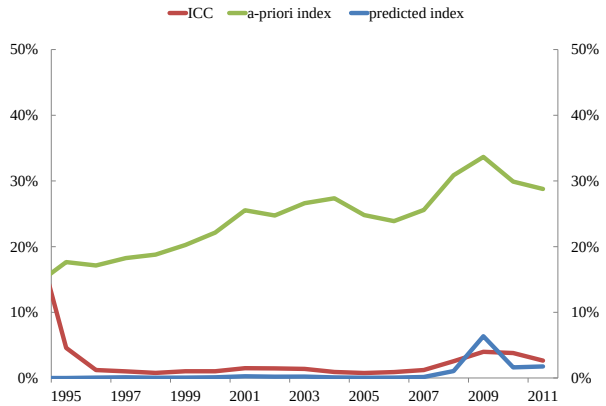
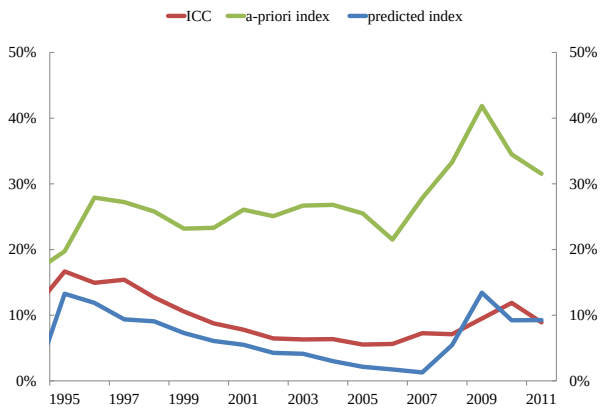


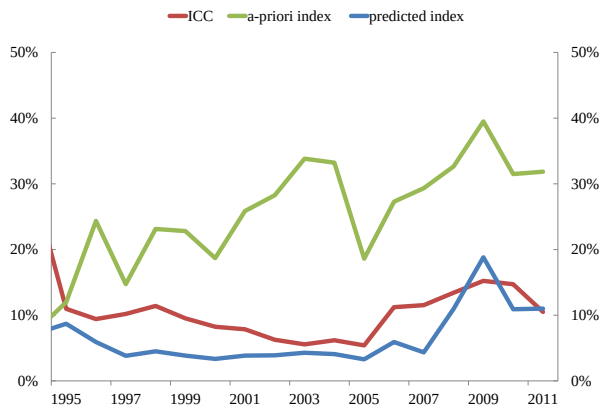
Figure 3 (continued) - Financial constrained firms: the ICC index, the a-priori index and the predicted indicator (percentages)

The 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 one is the a-priori index which is based on the classification scheme in Table III. The third index is based on the Probit analysis presented in Table 8, column 2. The three indexes are using the same thresholds to define the percentages of constrained firms across time and countries. This threshold is originally calculated for the ICC index in the CompNet database. The ICC index is not available for the Netherlands.

France



Italy



Portugal

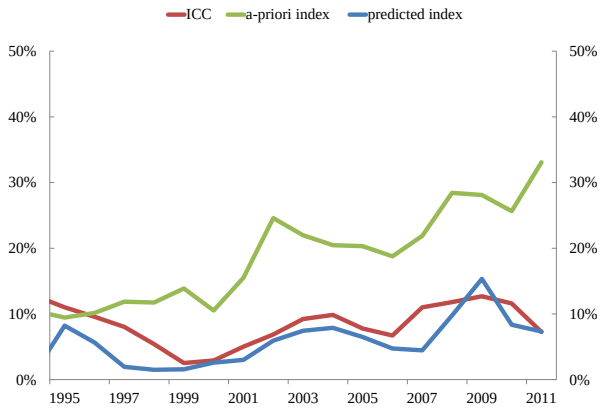
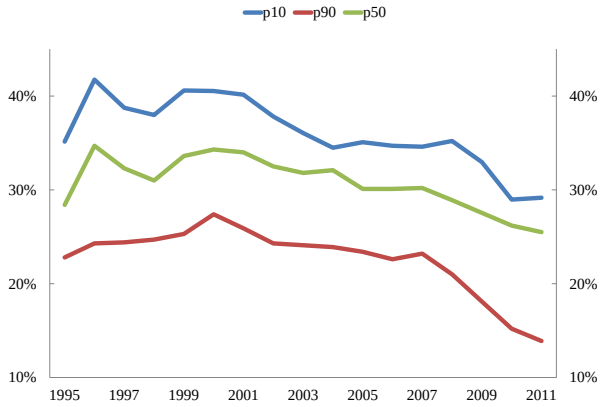


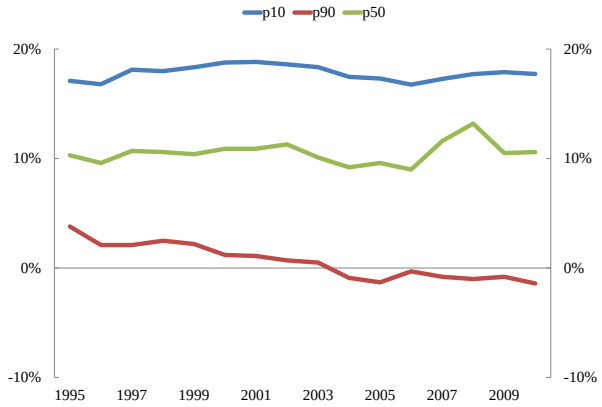
Figure 4 - Financial indicators for different degrees of financial constraints

The Figure displays financial indicators for firms with different levels of financial constraints, based on the predicted index where p10 are firms below the 10th percentile, p50 those between 45 and 55th percentile and p90 greater than 90th percentile.

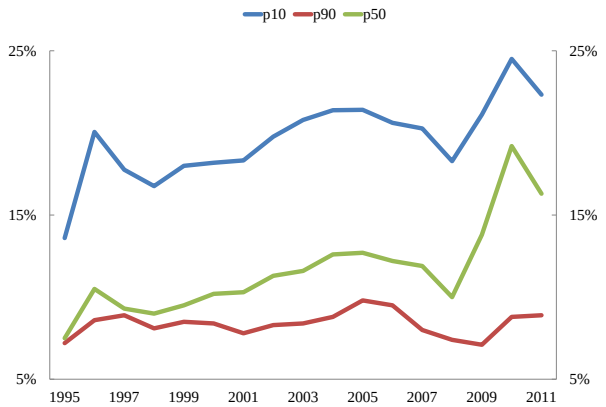
Investment Rate



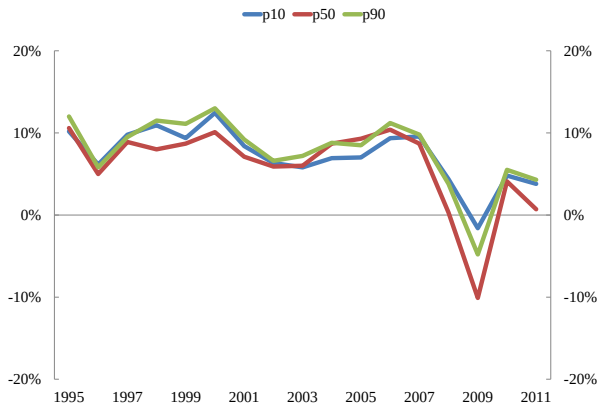
Profitability



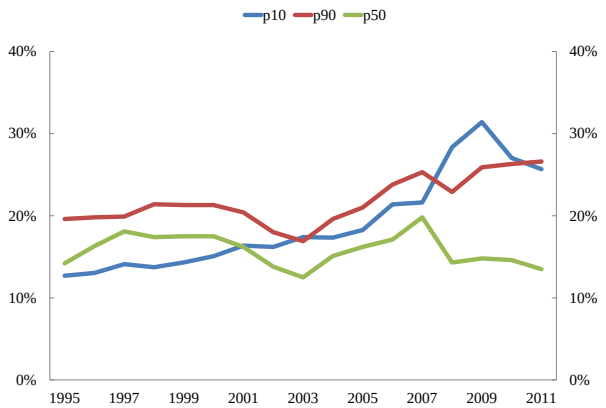
Cash Holding



Sales Growth



Leverage



Interest Payment Burden

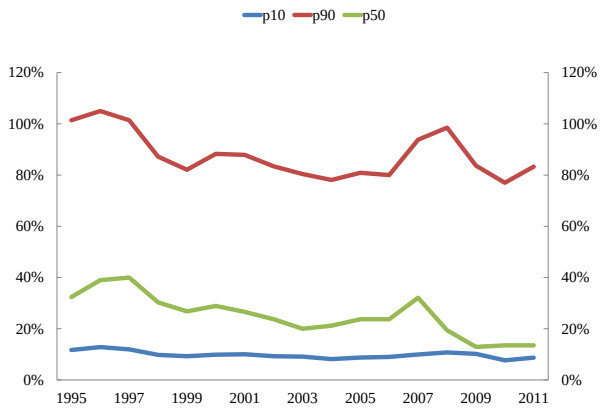
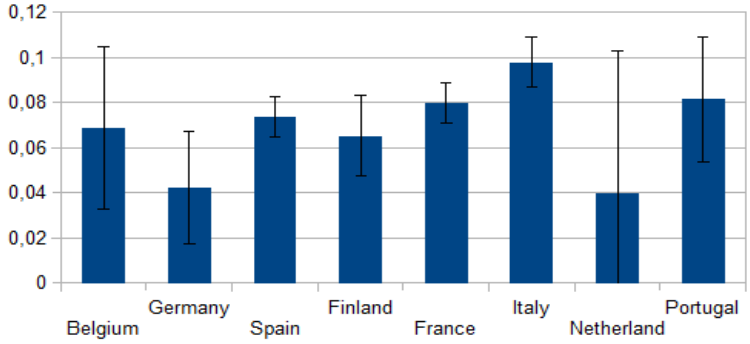


Figure 5 - Estimates of Productivity Loss across countries

Confidence bands are at 95% significance level



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