Innovative Performance and Financial Constraints: Firm-level Evidence from European Countries

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Abstract

How do the effects of financial constraints on innovation vary by sector and firm characteristics? This paper uses innovation survey data from 11 European countries to examine the heterogeneity of these effects. So far, there has been a lack of cross-country micro level studies investigating the effects of financial constraints on innovation in Western Europe and only little research about the differences of the effects in production and services sectors. We estimate recursive mixed process models based on firm-level innovation survey data from European countries and endeavour to account for the endogeneity of financial constraints. Our results clearly point out that the effects of direct measures of financial barriers differ in services and production sectors, and also by export orientation of the firm. Financial constraints have much stronger negative effects in production sector. Among different types of firms, financial constraints affect innovation performance most strongly in the case of non-exporters.

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1. Introduction

Financial constraints are expected to be more severe for investments in R&D and other innovation inputs than for physical investment because their specific features increase the risk and reinforce the informational asymmetries with external investors (Hall, 2002; Himmelberg and Petersen 1994). Empirical analysis of the determinants of innovation based on firm-level innovation data that does not account for endogeneity of financial constraints has often found counterintuitive results. There appears to be positive correlation between innovation barriers (including financial constraints) and various innovation indicators (Lööf and Heshmati 2006, OECD 2009, Crépon et al. 1998). This means that more innovative firms are often more likely to report obstacles to their innovation process. However, recent examples of careful econometric studies that endeavour to account for the endogeneity of financing constraints, e.g. by Hottenrott and Peters (2011) or Gorodnichenko and Schnitzer (2012), usually find significant negative impact on firm's propensity to innovate or invest in R&D.

We contribute to the literature, firstly, by studying the relationship between direct measures of financial constraints and innovation performance in both services and production sector. Secondly, our study is a first one that covers also a number of different countries in Western Europe. Previous cross-country micro level research on this topic has concentrated on data from transition economies (e.g. Gorodnichenko and Schnitzer 2012, Männasoo and Meriküll 2011). The countries included in our analysis include both Western and Central and Eastern European economies: Sweden, Norway, France, Italy, Spain, Portugal, Czech Republic, Slovakia, Estonia, Bulgaria and Romania. Our baseline empirical specifications use data from the fourth (2002-2004) and as a robustness test also from the fifth (years 2004-2006) wave of the European Community Innovation Survey (CIS).

In estimating the effects of financial constraints, we have endeavoured to account for their endogeneity with respect to innovation by using several industry level instruments that are not sensitive to firm level shocks and unobserved heterogeneity in general at firm level. Therefore these are likely to be exogenous and valid instrumental variables for identifying the firm level effects of financial constraints. We explore the impact of financial constraints on the innovation success of a firm relative to the rest of firms, using recursive bivariate probit system (using also the mixed process modelling approach developed in Roodman 2009).

The majority of earlier empirical papers about the role of financial constraints in innovation have concentrated on the effects in production sector, on a case study of a single country, and often on analysis of a single cross section firm-level dataset (e.g. Savignac 2008, Hottenrott and Peters 2011). There is a shortage of research investigating the heterogeneity of the effects of financial constraints across industries, time periods, country groups and types of firms.

We show that the effects of financial constraints differ in services and production sectors. Innovation in services sector may require less (external) financing because there innovation process is often less formal R&D-oriented (Gallouj and Weinstein 1997) and more dependent on innovation inputs (e.g. knowledge linkages with clients) that rely less on access to external financing (Dahlstrand and Cetindamer 2000). This is confirmed in our analysis. We find clear evidence that the role of financial constraints is significantly stronger among firms in the production sector. Within an industry and especially within the production sector, the binding role of financial constraints on innovation is significantly stronger for non-exporters than for exporters. The sign and magnitude of the effects is not driven by the inclusion of the Central and Eastern European countries, as the results based on the sample of Western Europe and all 11 available European countries are rather similar.

2. Financial Constraints and Innovation

Financial constraints are likely to matter more for investments in R&D and other innovation inputs than for physical investment (Hall 2002, Himmelberg and Petersen, 1994, Hall and Lerner 2010). This has to do with the specific nature of investments in R&D and innovation (Hall and Lerner 2010). Investments in innovation inputs require large sunk costs (e.g. Alderson and Betker 1996) and produce intangible assets that can be difficult to use as collateral for external borrowing (Williamson 1988, Alderson and Betker 1996). In addition, innovation investments are characterized by significant information asymmetries that drive the investors to ask for higher rate of return than in the case of investments in physical assets. Although information asymmetries matter for external financing of all types of investments (Meyer and Kuh 1957, Myers and Majluf 1984), they are especially significant in limiting financing of innovation investments, due to the complexity and specificity of innovation process.

There are several reasons why the role of financial constraints may be different in production and services sectors. Innovation in services may require less external financing because their innovation process is often less R&D-dependent (Gallouj and Weinstein 1997) and therefore also less dependent on access to external financing (Dahlstrand and Cetindamer 2000). Nevertheless, firms in services sector are likely to be on average smaller than firms in manufacturing industry or the production sector in general. Small firms cannot provide as much collateral for external borrowing, and are therefore, on average, more likely to face barriers for external financing of investments. The difference in size-structure of the sectors might result in stronger binding role of financial barriers in services than in the production sector. In the case of firms of similar size, production firms may find it easier to provide collateral for a loan, as they are more physical-assets intensive than enterprises in services sectors.

Financial constraints to investments and to investments in R&D may play a different role for exporters and non-exporters or multinationals and domestic owned firms. It is well known that exporters tend to be larger and they need to have relatively high productivity to be able to cover sunk costs of exporting (e.g. Helpman et al. 2005, Melitz 2003, Wagner 2007). Similarly, only the most productive firms are able to internationalize through FDI, as only they are able to cover the substantial sunk costs of FDI that are even higher than the ones associated with export entry (Helpman et al. 2005). Larger and more productive firms tend to be also less financially constrained than others (e.g. Carpenter and Petersen 2002). Also, firms that belong to an enterprise group find it easier to get internal financing for their innovation activities and may be more able to ensure financing from external lenders (they have more collateral, etc.).

The heterogeneous producer trade model of Chaney (2005), which has added financial constraints to the standard Melitz (2003) monopolistic competition model of international trade, predicts that financially constrained firms are less likely to be able to cover the sunk costs of export entry and therefore are less likely to export. The stronger financial barriers of domestic market oriented firms are most likely to affect also their investments in innovation inputs (esp. R&D) and therefore their innovation performance.

The existing empirical literature is not fully conclusive about the effects of financial constraints on innovation or R&D. Some studies provide evidence that financial and credit constraints have a strong adverse effect upon innovation (Mulkay et al. 2000; Aghion et al. 2008; Ouyang 2011), while some others fail to reach the same conclusion (Harhoff 1998, Bond et al. 1999). A common characteristic of many earlier studies of the literature was that they measured financial constraints using the sensitivity of investments to internally generated cash flows.

Kaplan and Zingales (1997), and more recently Campello et al. (2010), argue in favour of a direct survey-based measure of financial constraints, demonstrating that traditional constraint measures fail to identify meaningful patterns in their dataset: for example, due to positive correlation with expected profits. To avoid such significant interpretation problems, a recent tendency in the literature has been to employ survey data on innovation activities and financial constraints of firms (Savignac 2008, Gorodnichenko and Schnitzer 2012). The recent papers that account for endogeneity of direct measures of financial barriers[3] and common sample selection problems point mainly to significant negative effects of financial barriers on the propensity of firms to engage in innovation. See Czarnitzki and Hottenrott (2010) for an overview of the empirical literature.

There is still a shortage of research looking in detail into the heterogeneity of the effects. Notably, the effects of financial constraints are likely to depend a lot on the sector, macroeconomic environment, size and other characteristics of the firm. Papers that look into the heterogeneity of effects include Hottenrott and Peters (2011), Canepa and Stoneman (2008) and Ughetto (2008), who show how constraints to external financing are more binding for R&D and innovation of small firms. Gorodnichenko and Schnitzer (2012) find in the case of transition economies that constraints to external financing have stronger negative effects on propensity to innovate in services, rather than in manufacturing and on newer firms and domestic owned firms (compared to multinationals). They also show that the effects of financial constraints are stronger among less developed transition economies.

[3] For example, Savignac (2008) employs a direct, qualitative indicator for financial constraints derived from a French specific survey for manufacturing firms, Gorodnichenko and Schnitzer (2010) use data from the Business Environment and Enterprise Performance Survey (BEEPS) of a large number of transition economies.

3. Data and Methods

We use cross-country micro level data from the European Community Innovation Surveys: from the CIS4 (2002-2004) and CIS2006 (2004-2006) surveys. In addition, several of our sector level (2-digit NACE level) instruments for financial constraints are calculated based on the Amadeus firm level dataset and merged with the CIS datasets. Most of our regression analysis relies on the CIS4. We test the robustness of our econometric analysis using a combined sample of CIS4 and CIS2006.

The 11 Western and Eastern European countries covered in our study of CIS4 data are: Sweden, Norway, France, Italy, Spain, Portugal, Czech Republic, Slovakia, Estonia, Bulgaria and Romania.[4] We use CIS2006 only for a robustness test, as we cannot employ in that case a similar large set of countries as in CIS4. In the case of Spain, Italy and France, information from manufacturing and services sector that is needed to estimate our model was unfortunately not available in the CIS2006.[5]

CIS has a number of advantages relative to other types of firm level datasets used in previous research. First, it is the only data source that has comparable cross-country information needed to estimate the effects of financial constraints in Western European countries. Second, CIS collects direct self-reported measures of firms' financial constraints and innovation, so that we do not need to rely on indirect proxies. Third, it provides information on a large number of firms and a broad range of industries, which makes the dataset suitable for cross-industry and cross-country comparison. Fourth, it is designed on the basis of a harmonized questionnaire with the goal of maintaining continuity over time and comparability across countries. Fifth, it makes a distinction

[4] We include only these European countries to our sample, which collected CIS innovation survey data for both manufacturing and services sector firms and which have information of our key explanatory variable(s) and all other controls in our model.

[5] Note that CIS2008 (2006-2008) has been excluded from our analysis as it does not include questions about financial constraints, or any other hampering factors of innovation process.

between financing from internal and external sources, which allows us to determine whether the effects of different types of financing barriers differ and whether they vary across industries.

Our analysis concentrates on the sample of innovators. These are defined here as firms that report i) product or process innovation or ii) ongoing or abandoned innovation activities in the CIS.[6] In our cross-country CIS4 we have about 40,000 observations available for regression analysis, of which about 29,500 are from Western European countries.

An important distinction with other related studies is that we investigate the effects of financing barriers on relative innovation performance of a firm, relative to other innovative firms. Unlike in Savignac (2008) or Gorodnichenko and Schnitzer (2012), our results do not provide evidence about the effects on firm's propensity to innovate or propensity to invest in R&D. We cannot estimate the effects on propensity to innovate, as the CIS4 and CIS2006 do not include data on financial constraints and some other of our control variables for the sample of non-innovative firms.

Our measure of relative innovation performance is a firm level dummy that is equal to 1 if firm's sales from new and modified goods or services are higher than 20 per cent. This is the threshold value to define 'highly innovative firms' in this paper, it is equal to the 75th percentile of the indicator of commercial success of innovation—'share (%) of new and modified products in sales'—in the 11 countries that we include from CIS4. As a measure of the commercial success of firm's innovation it has advantages over simple dummy indicators of presence of some type of innovation (Mairesse and Mohnen 2011).[7]

[6] We include also 5 firms to our CIS4-based sample that do not report innovation, but report obstacles to innovation. This is similar to the approach of Savignac (2008) based on French innovation data, who concentrated on analysis of sample of 'potential innovators'.

[7] As a robustness test we define the threshold level for 'highly innovative firms' also as a median of all firms' share of new and modified goods and services in the CIS4 and check whether the results are qualitatively different. In another robustness test we have also investigated the effects of financial constraints on the continuous measure of share (%) of innovative sales. However, the relative measure of innovation success may be preferred over the

Our key explanatory variable ' financial constraints' takes value 1 if the firm reports highly important financial constraints in its innovation process (either high constraints to internal or external financing of innovation, or both).

The empirical analysis involves the following broad steps:

i) We estimate the probability of having highly successful innovation and the likelihood to face financial constraints simultaneously using a recursive bivariate probit model[8] (a recursive-mixed-process model, Roodman, 2009). We use sector level instrumental variables to identify the effects of financial constraints. This allows for construction of a recursive system of equations, estimated using the limited information ML (LIML) estimator;

ii) Examine whether the effects vary between production and services; whether they depend on firm characteristics;

iii) Test the sensitivity and robustness of results by: (a) excluding certain industries; (b) using alternative measures of innovation success (employing different recursive-mixed-process models), investigating separately the effects of internal and external financial constraints.

Our recursive model consists of two equations with binary endogenous variables:

$$\begin{cases} y_{1i} = \beta_1 x_{1i} + \varepsilon_{1i} \\ y_{2i} = \beta_2 x_{2i} + \lambda_{2i} y_{1i} + \varepsilon_{2i} \end{cases} \quad (1)$$

continuous one. As Mairessse and Mohnen (2011) point out: "share in total sales due to new products, has, values that tend to be rounded (10%, 20%, 35%, etc) , showing the subjective nature of the variable and suggesting that perhaps we should not make too much out of its continuous variations".

[8] Recursive bivariate probit model has been previously applied in studies about effects of financial constraints on R&D and propensity of innovation: for example, in Savignac (2008) in France, Männasoo and Meriküll (2011) based on BEEPs data of transition economies, Piga and Atzeni (2007) in Italy.

where y_{1i} is the binary indicator of presence of highly important financial constraints (*i* denotes firm), y_{2i} denotes the likelihood of being highly innovative firm (having share of innovative sales above the 75th percentile value of the cross country sample in CIS4). The error terms ε_{1i} and ε_{2i} are assumed to be jointly normally distributed with zero mean and unit variance. The model allows for correlation between the error terms in the two stages of the model. If this correlation $\rho = 0$, then two separate probit models can be estimated instead of the bivariate recursive probit. Note that the model assumes that relative innovation performance y_{2i} is not included as an endogenous variable in the financial constraints equation.

Other controls x_{2i} in innovation performance equation include the standard variables used in estimating the innovation production function (e.g. as outlined in Crépon et al. 1998, Lööf and Heshmati 2006, Mairesse and Mohnen 2011). Definitions of all variables in the model are given in detail in Annex in Table 6. x_{2i} includes indicators of: firm size groups (6 different size groups); exporter dummy; indicator whether firm belongs to an enterprise group or not; R&D dummy[9]; indicator showing whether firm has innovation related co-operation activities outside the firm; number of different types of knowledge sources[10] that the firm uses in its innovation process (taking values 0-10). Also, innovation performance equation includes 2-digit NACE sector level industry dummies and country dummies as controls, to account for the sector-specific and country-specific determinants of innovation performance.

In order to identify the effects of financial constraints we need valid and strong instrumental variable(s) that affect financial constraints of a firm. They need to be exogenous, need to affect innovation of firms only through the financial constraints indicator. We use various sector level

[9] As a robustness test we estimate the model also without the R&D dummy among other controls.

[10] The knowledge sources include: knowledge from within the enterprise group, from clients, suppliers, competitors, consultants, universities, research institutions, conferences, professional associations, scientific journals.

average financial indicators here for that purpose. Sector level average determinants of financial barriers are potentially good instruments as they can be seen as exogenous from firm's viewpoint, at 2-digit NACE level they are not likely to be affected by the individual firm's own performance or other characteristics. The 2-digit NACE sector level instruments include log of average size of the collateral, gearing ratio (see Table 6 for detailed definitions), cash flow margin, number of different types of sources of public funding for innovation (from the EU, national and local level). Most of these, except the public funding indicator, are calculated separately for each country, based on firm level information from the Amadeus dataset, using data from 2002-2004 (for CIS4) and 2004-2006 (for CIS2006). Firms in sectors that have on average larger collateral, lower gearing, higher profitability and lower reliance on public funding, are likely to be less financially constrained.[11]

In many previous papers, cash flow margin at firm level or other cash flow based indicators have been used as an indicator of financial constraints of the firm (e.g. Bond et al. 1999). Here we use the sector level average cash flow-to-sales indicator to identify the effect of firm level financial constraints. We argue that this variable should affect especially the CIS-based indicator of internal financial constraints. Comparison whether its correlation with internal constraints is stronger than with external financing constraints is also an indirect goodness test of this instrumental variable.

4. Main Findings

In this section, we present the main results of our recursive bivariate probit model. The baseline results for both stages of the recursive bivariate probit model are shown in Table 1. The table

[11] In addition we include firm level size dummies in the financial constraints equation, as size is likely to be one central determinant of financial barriers that a firm faces.

reports both the coefficients of the (recursive bivariate) probit model and the corresponding marginal effects, both in the case of the sample of all available 11 European countries and separately for the sample of 6 Western European countries. Note that all regressions are weighted by country sampling weights.

In the first column of Table 1 we report the standard probit model that does not account for the potential endogeneity of financial constraints. Previously, OECD (2009) study estimated a Crépon et al. (1998) type 3-stage model of innovation process separately for 18 different European countries and included indicators of barriers to innovation in the innovation production function simply as uninstrumented controls. They found that in most of these countries the innovation barriers were positively correlated with innovation propensity. The probit model in Column (1) shows similar correlation with our indicator of 'relative innovation performance' in the case of the sample of innovators in our CIS4 cross country micro level dataset. This seemingly counterintuitive result suggests that it is crucial to account for the endogeneity of financial constraints. There may be (firm level) unobserved heterogeneity that affects both the financial constraints and innovation success of the firm.

Table 1 here

The next Columns (2-13) in Tables 1-3 take the endogeneity of constraints into account. As clearly evident from Table 1 and the next regression tables (Table 2 and 3), our instrumental variables are strongly correlated with firm's financial barriers. This holds in the case of full sample of 11 countries, Western European economies, and also in the case of separate analysis of the production (Table 2) and services sector (Table 3). Higher average sector level collateral, and

cash flow margin (an indicator of profitability) are associated with less likelihood that a firm in that sector faces high financial constraints. This is exactly as expected. In addition, we find that larger number of different types of public funding or higher gearing ratio in a sector predict stronger financial constraints of the firms in the same industry. Larger diversity of external public funding may indicate sectors more suffering from financial constraints that are more targeted by public innovation support. We also found that smaller firms face stronger financial constraints, as previously shown also in Czarnitzki and Hottenrott (2011).

The positive correlation between innovation constraints and innovation disappears once we account for the endogeneity of financing barriers. The coefficient of the financial constraints dummy has consistently negative sign in different samples (see Tables 1-4). However, in the case of the sample of firms from all sectors (Table 1), this negative effect is statistically significant only among non-exporters. Domestic market oriented firms are much more affected by financing barriers in their innovation process than exporters, even after accounting for differences in size, sector and several other firm-level characteristics.

Among non-exporters, high financial constraints are associated, on average, with 16 per cent lower probability of being 'highly innovative firm'. In terms of magnitude, this result is very similar in the sample of all studied European countries and the sample of Western European countries. Other control variables in the innovation equation in the recursive bivariate probit model have the expected signs. Co-operation with other firms is associated with higher innovation performance. Firms with formal IP protection have about 7 and firms with R&D have 9 per cent higher propensity to belong to the group of highly innovative firms. These results are similar to the ones found in papers estimating either the Crépon, Duguet, Mairesse (1998) 3-stage model of the innovation process or other models of the innovation value chain in European

countries (e.g. OECD 2009, Roper et al. 2008). As could be expected based on literature on 'open innovation' (Chesbrough 2003, Dahlander and Gann 2010), external knowledge sourcing plays an important role in innovation. Adding one new type of external knowledge linkage is associated with about 2 per cent higher propensity to be highly innovative. Also, exporters have stronger innovation performance, as shown previously for example in more detail in analysis of causal effects of exporting in Salomon and Shaver (2005) or Damijan et al. (2010).

As a next step we investigate the effects of financing barriers separately in production and market services sectors (Tables 2 and 3). As evident from Column 3 in Table 2, firms in production sector that have high financial constraints will have about 21 per cent lower propensity to have 'high innovation performance' than the rest of production firms. In Western Europe the corresponding figure is again almost exactly the same, -22 per cent. Both in the case of all 11 countries and only the 6 Western European ones (France, Italy, Spain, Portugal, Sweden, Norway), the effects of financial constraints appear to be stronger for these production firms that do not belong to an enterprise group or do not export. In the sub-sample of non-group firms (in the sample of all 11 countries), having high financial constraints results in 23 per cent lower propensity to have high innovation performance. In the case of non-exporters the corresponding marginal effect of financial barriers is 27 per cent lower propensity to have high innovation performance. The error correlation coefficient of the two stages in the bivariate probit indicates that the two equations are related. It is important to account for the endogeneity of financial constraints.

Tables 2 and 3 here

A strong difference emerges if we compare the production and services sectors. The effect of financial constraints is much stronger among the production firms (Table 2). In the case of services firms (Table 3), the effects of financial constraints were not statistically significant in the main specification of our bivariate probit model. This difference between production and services holds also in the case of the non-group and domestic market oriented firms. (Note that the sign of the constraints dummy is still negative in Table 3). The instruments perform remarkably well also in separate analysis of production and services sector. Sector level variables are still rather good predictors of presence of financial barriers at firm level.

Table 4 shows some of the key sensitivity tests of our results. The qualitative findings about differences between production and services, between the sample of Western European and all 11 available European countries or between non-exporters and exporters are robust to the modifications of the dependent variable: if we use the median of 'share of new or modified goods and services in sales' instead of the 75th percentile as the threshold level for defining the 'highly innovative firms'. The choice of the particular threshold level for defining the 'highly innovative firms' is not driving our main qualitative conclusions.

Table 4 here

An important result concerns the different role of internal and external financial constraints. Marginal effects in lower two panels of Table 4 indicate that the effects are markedly different in the case of internal and external financial constraints. The main effect of financial constraints in our sample of 11 European countries appears to be driven by internal financial constraints. Once we estimate separately the effect of internal financing constraints, we find also some evidence of

effects of financing constraints in a sub-sample of services firms: among domestic market oriented services firms. We note that the importance of different sector level instruments varies for the binary indicators of internal and external constraints. Gearing ratio at sector level has stronger association with firm level external financing constraints. Cash flow margin at sector level has stronger association with firm level indicator of internal financial constraints. This is exactly what one could expect in the case of these two sector level variables, this result increases our trust in the validity of the instruments used.

5. Robustness Tests

We perform number of additional robustness tests of the key findings in Table 4, as shown in Table 5. First, we estimate a version of recursive mixed process models (as developed in Roodman 2009), where the first stage in the recursive model is the same as before in Eq. (1): a probit model of propensity to have high financial constraints in innovation process. However, the innovation stage in the model is now estimated with a continuous (left censored) dependent variable y_{2i}: 'log (1 + the share of new or modified goods and services in sales)'. The detailed outline of recursive mixed process models is available in Roodman (2009).

An obvious advantage of using the continuous innovation performance variable as the key dependent variable instead of a dummy variable of relative innovation performance is that we can observe the effects of financial constraints on the intensity of innovation performance of innovators. We exploit the available variation of data and do not restrict ourselves to a binary indicator. However, as mentioned already briefly in the data section, there are significant problems with this type of variables in the CIS and similar surveys (as outlined also in Mairesse and Mohnen 2010, Gorodnichenko and Schnitzer 2012). We prefer using our baseline measure

of a dummy of relative innovation performance to the 'continuous' variable of innovative sales. The distribution of the continuous innovation performance variable is highly skewed in our sample, because of a large mass of firms reporting zero innovative sales, the variable is not normally distributed even if one excludes the 0% and 100% shares of innovative sales, the values between 0 and 100 tend to be rounded to values like 10%, 20%, 30%, etc. Also, our continuous measure may be plagued by outliers, as some countries have surprisingly high number of firms with even 100% of innovative sales in CIS4 (esp. Spain). Previously, typically a Tobit model has been used to estimate an innovation production function with such continuous (censored) dependent variable (e.g. OECD 2009). However, due to these problems, Tobit is not likely to be a suitable approach in our analysis.

Nevertheless, if we estimate the model in Eq. (1) with continuous innovation performance as the key endogenous variable, then the qualitative results about the sign and mostly also the significance of the effects confirm the previous results from Tables 1-3. An exception is that now there is no evidence of a significant effect on non-group firms in production industries and non-exporters in the full sample of all sectors. We find that in production industries high financial constraints are associated with 10 percentage points lower share of new and modified products in sales (a proxy for innovation performance) of a firm. This effect is slightly stronger among firms that sell their goods only to domestic market. Again, we do not find significant effects in services sector.

Table 5 here

A potential criticism of the main specification in this paper could be that we include the R&D dummy among other controls while we estimate the effects of financial barriers on innovation. Certainly, financial constraints can affect not only the intensity of innovation but also propensity to invest in R&D. However, R&D is a key input in innovation process and the key variable used in any estimation of the innovation production function (see Mairesse Mohnen 2011 for an overview). We do not include the level or intensity of R&D expenditure in the model as a control: so, we allow for effects of financial constraints in our analysis to function through intensity of R&D. If we omit R&D dummy from the set of controls, the marginal effect of financial constraints does not change much (compare the corresponding marginal effects in Tables 4 and 5).

In addition, our key conclusions in from Tables 1-3 remain the same if we estimate the effects only in the sample of manufacturing firms, excluding all other production sectors, like utilities, mining and quarrying and construction sector. However, the exclusion of financial sector from our sample of all industries and service industries affects the results. Once the financial sector is excluded from analysis, we find some statistically significant negative effects of financial constraints on non-exporting services firms. Last but not least, we check the robustness of the key findings using pooled data of CIS4 and CIS2006 surveys. In the lowest panel of Table 5, we add CIS2006 data of 8 countries (excluding Spain, Italy and France due to data issues) to the CIS4 and estimate the same recursive bivariate probit model as before, this time with a separate dummy for CIS2006 observations. The qualitative key results showing stronger effects among non-exporters and stronger effects in production sector than in services stay robust to this additional test.

6. Conclusions

The first main contribution of this paper to the innovation literature is studying how the effects of financial constraints on relative innovation performance of innovators differ in production and services sector. Second, we show evidence of these effects using comparable firm level innovation survey data from a number of Western European economies. Most of the previous empirical studies of effects of financial constraints on innovation have concentrated either on a country case study or use cross-country firm level data from transition economies.

The results of this paper clearly point out that the effects of financial constraints differ in services and production sector, and also by export orientation of the firm. The barriers have much stronger negative effects in production sector. We find that the consequence of high financial constraints for a firm in production sector is on average 21 per cent lower probability to have 'high innovation performance' (i.e. to have the share of new products in its sales above the 75th percentile threshold level of the variable in our sample of innovators).

These results confirm the view that innovation in services sector may require less (external) financing, probably because their innovation process is less reliant on investments in large-scale and costly formal R&D (Gallouj and Weinstein 1997) and more dependent on innovation inputs that rely less on access to external financing (Dahlstrand and Cetindamer 2000).

Notably, the key findings based on the sample of Western European countries and all studied 11 European countries are rather similar. A general conclusion based on the CIS4 (and CIS2006) data from Europe is that financial constraints affect innovation performance most strongly among non-exporters.[12] A common problem in empirical analysis of the effects of barriers to innovation is their endogeneity. We address the endogeneity of our indicators of financial

[12] This is in accordance with the theoretical predictions from the heterogeneous producer trade model of Chaney (2005) that there is negative correlation between the financial constraints and export orientation of firms.

barriers in estimating the recursive bivariate probit models. The sector level instrumental variables that we use turn out to be good predictors of financial constraints, both in the case of barriers to internal and external financing of innovation, and also in all sub-samples used in the analysis. Our results go beyond simple analysis of correlations. Obviously, the results depend on the validity of the instruments used. The crucial exclusion assumption is that our sector level instruments affect the relative innovation performance of firms only through financial constraints. Future research may benefit from using natural experiment framework to identify the effects of financial constraints.

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Annex. Data Sources and Definitions

- We use data from two sources: European Community Innovation Survey (CIS) and Amadeus firm level dataset of financial indicators of European firms. Firm level data is all from CIS4 (2003-2004) and CIS2006 (2004-2008) innovation surveys. Most of the sector level (2-digit NACE level) instrumental variables in the financial constraints equation are calculated from the Amadeus dataset and then merged with firm level CIS surveys.
- Production sectors: Manufacturing (NACE code D); Mining and quarrying (C), Electricity, gas and water supply (E), Construction (F).
- Services sectors: Wholesale and retail trade; repair of motor vehicles, personal and household goods (G), Hotels and restaurants (H), Transport,s torage abd communication (I), Financial intermediation (J), Real estate, renting and business activities (K).
- 11 Western and Eastern European countries covered in our study of CIS4 data are: Spain, France, Italy, Portugal, Sweden, Norway, Bulgaria, Romania, Czech Republic, Slovakia and Estonia. We include these European countries into analysis which collect CIS innovation survey data for both production and services sector firms and which have information of our key explanatory variable(s) and all other controls in the bivariate probit model.
- 8 Western and Eastern European countries covered in our study of CIS2006 data are: Portugal, Sweden, Norway, Bulgaria, Romania, Czech Republic, Slovakia and Estonia.
- As a robustness test, we estimate our model in Eq. (1) based on the combined CIS4 and CIS2006 data of European countries. The suitable data for estimating the model for both production and services sector of Spain, Italy and France was unfortunately not available

in CIS2006. The recursive bivariate probit model estimated based on the pooled dataset of the 2 surveys included also a period dummy variable for the CIS2006 period (2004-2006).

- Potential innovators: firms that have either product, process, and firms that report any factors hampering innovation (cost, financing, lack of information about markets, lack of skilled personnel, among others). The sample used for regression analysis is based on the 'potential innovators'. For other firms we do not observe information from CIS for all the variables needed to estimate the effects of financial constraints.
- The key question about financial barriers of innovation process in CIS4 and CIS2006 surveys is the following: "During the years 2002-2004 (2004-2006 in CIS2006), how important were the following factors for hampering your innovation activities or projects or influencing a decision not to innovate?" The two factors that we concentrate on are:

i) lack of funds within the enterprise group (internal financial constraints);

ii) lack of funds from outside the enterprise (external financial constraints).

The answer choices were: a) factor not experienced, b) factor of high importance, c) factor of medium importance, d) factor of low importance. We define an indicator of internal (external) financial constraints that takes value 1 if a firm reported that it has seriously delayed, abandoned or not started projects because of high internal (external) financial constraints, 0 otherwise. Next, we define a general indicator of financial constraints that is equal to 1 if firm experienced high internal or external financial constraints. This is the key indicator of financial constraints in our model.

Table 1: Bivariate Probit Model - All Industries

	Probit	Biprobit - All Countries						Biprobit - Western Countries					
	All	All Firms		Non-Group		Non-Exporters		All		Non-Group		Non-Exporters	
	Coef.	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Equation for innovation success													
Financial Constraints	0.06***	-0.42	-0.13	-0.40	-0.13	-0.62**	-0.16	-0.30	-0.08	-0.12	-0.03	-0.91**	-0.18
	(0.00)	(0.18)		(0.43)		(0.02)		(0.57)		(0.88)		(0.05)	
Cooperation	0.21***	0.20***	0.07	0.22***	0.08	0.20***	0.06	0.20***	0.06	0.22***	0.07	0.21***	0.06
	(0.00)	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
External Search	0.06***	0.06***	0.02	0.06***	0.02	0.06***	0.02	0.06***	0.02	0.06***	0.02	0.05***	0.01
	(0.00)	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Formal Protection	0.21***	0.21***	0.07	0.17***	0.06	0.22***	0.07	0.21***	0.07	0.17***	0.05	0.19***	0.06
	(0.00)	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
R & D	0.27***	0.27***	0.09	0.27***	0.09	0.20***	0.06	0.26***	0.07	0.26***	0.08	0.17***	0.05
	(0.00)	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Exports	0.07***	0.07***	0.02	0.11***	0.04			0.07***	0.02	0.11***	0.03		
	(0.00)	(0.00)		(0.00)				(0.00)		(0.00)			
Group	0.02	0.02	0.01			0.06**	0.02	0.02	0.01			0.07**	0.02
	(0.21)	(0.23)				(0.03)		(0.32)				(0.03)	
Size Dummies	YES	YES		YES		YES		YES		YES		YES	
Industry Dummies	YES	YES		YES		YES		YES		YES		YES	
Country Dummies	YES	YES		YES		YES		YES		YES		YES	
Equation for financial constraints													
Public Support		0.14***		0.16***		0.14***		0.15***		0.17***		0.15***	
		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Collateral		-0.09***		-0.12***		-0.09***		-0.07***		-0.12***		-0.08***	
		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Gearing		0.05***		0.08***		0.10***		0.05***		0.10***		0.13***	
		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Profitability		-0.07***		-0.06***		-0.07***		-0.06***		-0.04**		-0.06***	
		(0.00)		(0.00)		(0.00)		(0.00)		(0.04)		(0.00)	
Size Dummies		YES		YES		YES		YES		YES		YES	
Number of Firms	39939	39939		23112		18084		29513		15461		12709	
Number of Countries	11	11		11		11		6		6		6	
Error Correlation		0.28		0.26		0.43***		0.20		0.10		0.65	

Robust p-values in parentheses. Regressions are weighted by country sampling weights. ***,**,* Statistically significant at the 1%, 5% and 10% confidence level respectively.

Table 2: Bivariate Probit Model - Production Industries

	Probit	Biprobit - All Countries						Biprobit - Western Countries					
	All	All Firms		Non-Group		Non-Exporters		All		Non-Group		Non-Exporters	
	Coef.	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Equation for innovation success													
Financial Constraints	0.04	-0.74***	-0.21	-0.81**	-0.23	-1.19***	-0.27	-0.94***	-0.22	-1.12***	-0.26	-1.42***	-0.26
	(0.12)	(0.00)		(0.02)		(0.00)		(0.00)		(0.00)		(0.05)	
Cooperation	0.17***	0.17***	0.06	0.21***	0.07	0.13***	0.04	0.16***	0.05	0.20***	0.06	0.12***	0.04
	(0.00)	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
External Search	0.06***	0.06***	0.02	0.06***	0.02	0.05***	0.02	0.05***	0.02	0.05***	0.02	0.03***	0.01
	(0.00)	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Formal Protection	0.21***	0.20***	0.07	0.15***	0.05	0.25***	0.08	0.20***	0.06	0.13***	0.04	0.16***	0.05
	(0.00)	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
R & D	0.31***	0.30***	0.10	0.29***	0.10	0.19***	0.06	0.27***	0.08	0.26***	0.08	0.15***	0.05
	(0.00)	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Exports	0.06**	0.06**	0.02	0.10***	0.03			0.05*	0.02	0.09***	0.03		
	(0.01)	(0.01)		(0.00)				(0.06)		(0.00)			
Group	0.02	0.02	0.01			0.06	0.02	0.01	0.01			0.02	0.01
	(0.37)	(0.40)				(0.20)		(0.79)				(0.48)	
Size Dummies	YES	YES		YES		YES		YES		YES		YES	
Industry Dummies	YES	YES		YES		YES		YES		YES		YES	
Country Dummies	YES	YES		YES		YES		YES		YES		YES	
Equation for financial constraints													
Public Support		0.11***		0.14***		0.15***		0.10***		0.10***		0.10***	
		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Collateral		-0.12***		-0.12***		-0.09***		-0.04**		-0.02		-0.02	
		(0.00)		(0.00)		(0.00)		(0.03)		(0.45)		(0.51)	
Gearing		0.04***		0.07***		0.11***		0.05***		0.10***		0.16***	
		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Profitability		-0.10***		-0.13***		-0.12***		-0.17***		-0.25***		-0.15***	
		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Size Dummies		YES		YES		YES		YES		YES		YES	
Number of Firms	25373	25373		15216		9149		18241		9918		6044	
Number of Countries	11	11		11		11		6		6		6	
Error Correlation		0.48**		0.55**		0.99*		0.64**		0.84***		2.95***	

Robust p-values in parentheses. Regressions are weighted by country sampling weights. ***,**,* Statistically significant at the 1%, 5% and 10% confidence level respectively.

Table 3: Bivariate Probit Model - Service Industries

	Probit	Biprobit - All Countries						Biprobit - Western Countries					
	All	All Firms		Non-Group		Non-Exporters		All		Non-Group		Non-Exporters	
	Coef.	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Equation for innovation success													
Financial Constraints	0.08**	-0.01	-0.01	-0.16	-0.05	-0.43	-0.12	0.25	0.08	-0.07	-0.02	-0.41	-0.10
	(0.03)	(0.98)		(0.74)		(0.12)		(0.49)		(0.91)		(0.28)	
Cooperation	0.25***	0.25***	0.08	0.23***	0.07	0.24***	0.08	0.25***	0.08	0.23***	0.07	0.26***	0.08
	(0.00)	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
External Search	0.06***	0.06***	0.02	0.06***	0.02	0.06***	0.02	0.05***	0.02	0.05***	0.02	0.06***	0.02
	(0.00)	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Formal Protection	0.21***	0.21***	0.07	0.20***	0.07	0.18***	0.06	0.22***	0.06	0.20***	0.06	0.18***	0.05
	(0.00)	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
R & D	0.23***	0.23***	0.07	0.22***	0.08	0.19***	0.06	0.23***	0.07	0.21***	0.06	0.17***	0.05
	(0.00)	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Exports	0.09***	0.09***	0.03	0.12***	0.04			0.09***	0.03	0.12***	0.04		
	(0.00)	(0.00)		(0.00)				(0.00)		(0.00)			
Group	0.03	0.03	0.01			0.06*	0.02	0.04	0.01			0.08*	0.02
	(0.33)	(0.33)				(0.09)		(0.23)				(0.48)	
Size Dummies	YES	YES		YES		YES		YES		YES		YES	
Industry Dummies	YES	YES		YES		YES		YES		YES		YES	
Country Dummies	YES	YES		YES		YES		YES		YES		YES	
Equation for financial constraints													
Public Support		0.15***		0.16***		0.13***		0.20***		0.21***		0.18***	
		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Collateral		-0.07***		-0.17***		-0.11***		0.03		-0.10**		-0.04	
		(0.00)		(0.00)		(0.00)		(0.90)		(0.02)		(0.25)	
Gearing		0.05***		0.11***		0.09***		0.03		0.09***		0.08***	
		(0.00)		(0.00)		(0.00)		(0.11)		(0.00)		(0.00)	
Profitability		-0.05***		-0.04*		-0.05***		-0.04***		-0.03		-0.05***	
		(0.00)		(0.06)		(0.00)		(0.00)		(0.16)		(0.00)	
Size Dummies		YES		YES		YES		YES		YES		YES	
Number of Firms	14566	14566		7896		8935		11272		5543		6665	
Number of Countries	11	11		11		11		6		6		6	
Error Correlation		0.05		0.13		0.31*		-0.09		0.10		0.30	

Robust p-values in parentheses. Regressions are weighted by country sampling weights. ***,**,* Statistically significant at the 1%, 5% and 10% confidence level respectively.

Table 4: Summary of results on the financial constraints variable

Dependent variable: relative innovation success (75^{th} percentile); Independent variable: financial constraints						
	Sample		Coefficient	$P>\|z\|$	dy/dx	No of firms
(1)	All Industries	All Firms	-0.42	0.18	-0.13	39939
		Non-Group	-0.40	0.43	-0.13	23112
		Non-Exporters	-0.62**	0.02	-0.16	18084
(2)	Production Industries	All Firms	-0.74***	0.00	-0.21	25373
		Non-Group	-0.81**	0.02	-0.23	15216
		Non-Exporters	-1.19***	0.00	-0.27	9149
(3)	Service Industries	All Firms	-0.01	0.98	-0.01	14566
		Non-Group	-0.16	0.74	-0.05	7896
		Non-Exporters	-0.43	0.12	-0.12	8935
Dependent variable: relative innovation success (50^{th} percentile); Independent variable: financial constraints						
	Sample		Coefficient	$P>\|z\|$	dy/dx	No of firms
(4)	All Industries	All Firms	-0.23	0.39	-0.09	39939
		Non-Group	-0.26	0.67	-0.10	23112
		Non-Exporters	-0.36	0.14	-0.14	18084
(5)	Production Industries	All Firms	-0.60***	0.00	-0.23	25373
		Non-Group	-0.63*	0.05	-0.25	15216
		Non-Exporters	-0.69**	0.02	-0.25	9149
(6)	Service Industries	All Firms	0.17	0.65	0.07	14566
		Non-Group	-0.05	0.93	-0.02	7896
		Non-Exporters	-0.17	0.55	-0.07	8935
Dependent variable: relative innovation success (75^{th} percentile); Independent variable: internal financial constraints						
	Sample		Coefficient	$P>\|z\|$	dy/dx	No of firms
(7)	All Industries	All Firms	-0.50	0.14	-0.14	39939
		Non-Group	-0.94***	0.00	-0.25	23112
		Non-Exporters	-0.82***	0.00	-0.20	18084
(8)	Production Industries	All Firms	-0.92***	0.00	-0.24	25373
		Non-Group	-1.14***	0.00	-0.29	15216
		Non-Exporters	-1.27***	0.00	-0.27	9149
(9)	Service Industries	All Firms	-0.11	0.77	-0.03	14566
		Non-Group	-0.53	0.20	-0.16	7896
		Non-Exporters	-0.63**	0.03	-0.16	8935
Dependent variable: relative innovation success (75^{th} percentile); Independent variable: external financial constraints						
	Sample		Coefficient	$P>\|z\|$	dy/dx	No of firms
(10)	All Industries	All Firms	-0.46	0.15	-0.13	39939
		Non-Group	0.07	0.85	0.03	23112
		Non-Exporters	-0.50	0.17	-0.13	18084
(11)	Production Industries	All Firms	-0.50	0.11	-0.15	25373
		Non-Group	-0.09	0.85	-0.03	15216
		Non-Exporters	-0.97**	0.02	-0.22	9149
(12)	Service Industries	All Firms	0.16	0.71	0.05	14566
		Non-Group	0.22	0.64	0.08	7896
		Non-Exporters	-0.07	0.85	-0.02	8935

Robust p-values in parentheses. Regressions are weighted by country sampling weights. ***,**,* Statistically significant at the 1%, 5% and 10% confidence level respectively.

Table 5: Robustness Tests

Treat innovation success as a continuous variable						
	Sample		Coefficient	$P>\|z\|$		No of firms
(1)	All Industries	All Firms	0.01	0.98		39939
		Non-Group	0.01	0.90		23112
		Non-Exporters	-0.04	0.39		18084
(2)	Production Industries	All Firms	-0.08**	0.04		25373
		Non-Group	-0.06	0.28		15216
		Non-Exporters	-0.10*	0.07		9149
(3)	Service Industries	All Firms	0.15	0.37		14566
		Non-Group	0.05	0.59		7896
		Non-Exporters	0.01	0.93		8935
Omit the R&D dummy variable						
	Sample		Coefficient	$P>\|z\|$	dy/dx	No of firms
(4)	All Industries	All Firms	-0.38	0.20	-0.12	39939
		Non-Group	-0.33	0.39	-0.11	23112
		Non-Exporters	-0.62**	0.02	-0.16	18084
(5)	Production Industries	All Firms	-0.64**	0.02	-0.18	25373
		Non-Group	-0.72**	0.03	-0.21	15216
		Non-Exporters	-1.04***	0.00	-0.25	9149
(6)	Service Industries	All Firms	-0.01	0.99	-0.01	14566
		Non-Group	-0.13	0.75	-0.04	7896
		Non-Exporters	-0.44	0.13	-0.12	8935
Exclude Non-Manufacturing Industries from Production Industries						
	Sample		Coefficient	$P>\|z\|$	dy/dx	No of firms
(7)	All Industries	All Firms	-0.41	0.27	-0.13	37046
		Non-Group	-0.44	0.47	-0.15	21319
		Non-Exporters	-0.61**	0.03	-0.17	15698
(8)	Production Industries	All Firms	-0.69*	0.09	-0.21	22480
		Non-Group	-0.89**	0.02	-0.26	13423
		Non-Exporters	-1.07***	0.00	-0.28	6763
(9)	Service Industries	All Firms	-0.01	0.98	-0.01	14566
		Non-Group	-0.16	0.74	-0.05	7896
		Non-Exporters	-0.43	0.12	-0.12	8935
Exclude Financial Intermediation Industries from Service Industries						
	Sample		Coefficient	$P>\|z\|$	dy/dx	No of firms
(10)	All Industries	All Firms	-0.88***	0.00	-0.24	38482
		Non-Group	-0.72*	0.08	-0.21	22636
		Non-Exporters	-1.07***	0.00	-0.26	16884
(11)	Production Industries	All Firms	-0.74***	0.00	-0.21	25373
		Non-Group	-0.81**	0.02	-0.23	15216
		Non-Exporters	-1.19***	0.00	-0.27	9149
(12)	Service Industries	All Firms	0.34	0.56	0.12	13109
		Non-Group	-0.19	0.79	-0.07	7420
		Non-Exporters	-0.83**	0.03	-0.21	7735
Add data from CIS2006 for 8 countries						
	Sample		Coefficient	$P>\|z\|$	dy/dx	No of firms
(13)	All Industries	All Firms	-0.30	0.21	-0.10	55526
		Non-Group	-0.09	0.86	-0.03	32712
		Non-Exporters	-0.47*	0.06	-0.14	25432
(14)	Production Industries	All Firms	-0.43*	0.09	-0.14	35433
		Non-Group	-0.50	0.39	-0.16	21514
		Non-Exporters	-1.00***	0.00	-0.26	13100
(15)	Service Industries	All Firms	0.04	0.89	0.01	20093
		Non-Group	0.02	0.96	0.01	11198
		Non-Exporters	-0.24	0.36	-0.07	12332

Robust p-values in parentheses. Regressions are weighted by country sampling weights. ***,**,* Statistically significant at the 1%, 5% and 10% confidence level respectively.

Table 6: Definition of Variables

Variable	Description
Innovation Success	=1 if the turnover from newly introduced goods or service innovations is higher than 20% of total turnover (75^{th} percentile)
Financial Constraints	=1 if the firm faces obstacles to innovation and reports highly important financial constraints (either internal or external)
Cooperation	=1 if the firm has some cooperative arrangements on innovation activities
External Search	number of highly important sources of knowledge or information for innovation (ranges from 0 to 10)
Formal Protection	=1 if the firm uses design pattern, trademarks, or copyright to protect inventions or innovations
R & D	=1 if the firm reports engagement in R&D activities
Export	=1 if the firm sells goods or services in other countries
Group	=1 if the firm is part of a firm group (two or more legally-defined firms under common ownership)
Public Support	number of sources of public financial support for innovation (ranges from 0 to 3: local, national, EU); industry-level, normalised
Collateral	= log(tangible assets); industry-level, normalised
Gearing	= ((non current liabilities+loans)/shareholders funds)∗100; industry-level, normalised
Profitability	= (cash flow/operating revenue)∗100; industry-level, normalised
Size Dummies	set of industry dummies according to the firm's number of employees (categories are <20, 20-49, 50-99, 100-249, 250-999, >1000)
Industry Dummies	set of industry dummies according to the firm's main business activities