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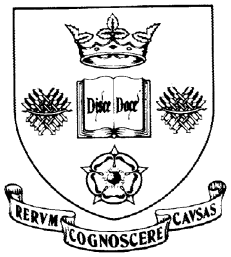

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Financial Constraints, Innovation Performance and Sectoral Disaggregation

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Abstract

How do the effects of financial constraints on innovation performance vary by sector and firm characteristics? This paper uses innovation survey data from eleven European countries to examine the heterogeneity of these effects. So far, there has been a lack of cross-country micro-level studies exploring the effects of financial constraints on innovation performance in Western Europe and only little research about the variability of such effects between the broad sectors of production and services. Our results suggest that the impact of direct measures of financial barriers differs in production and services sectors, and also by the firm's export orientation. In particular, financial constraints appear to have more pronounced negative effects in the production sector than in the services sector. Among different types of firms, the response to financial constraints seems to be stronger for non-exporters.

JEL classification: L1; L2; O1; O3
Keywords: financial constraints; innovation

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1 Introduction

There is ample evidence in the economics literature that achieving sustained long-term productivity and economic growth is intrinsically linked to research and development (R&D) and innovation investment (Coe & Helpman, 1995; Cainelli *et al.*, 2006; Coe *et al.*, 2009). Due to informational asymmetries with external investors and uncertain and lagged returns, this type of investment is considered to be particulary sensitive to financial constraints (Himmelberg & Petersen, 1994; Hall, 2002). The available empirical evidence, however, is not as conclusive as one might expect. Some studies provide evidence that financial frictions have a strong negative effect upon innovation (Mulkay *et al.*, 2000; Aghion *et al.*, 2008; Ouyang, 2011), while some others find the opposite effect (Harhoff, 1998; Bond *et al.*, 2005). A common feature of earlier studies on this topic, particulary of those that show a positive relationship between financial constraints and various innovation indicators, is that they measure the former using the sensitivity of investments to internally generated cash flows. Kaplan & Zingales (1997), and more recently Campello *et al.* (2010), argue in favour of a direct survey-based measure of financial constraints, demonstrating that traditional cash-flow indicators fail to identify meaningful patterns in the data; for example, because of positive correlation with expected profits. Another problem associated with the study of obstacles to innovation is the presence of bias arising from the endogeneity of the financial constraints variable and survey sampling issues. Recent papers that use direct indicators based on firm's own assessments and address such econometric problems (see Savignac, 2008; Gorodnichenko & Schnitzer, 2012; Hottenrott & Peters, 2012) point to significant negative effects of financial barriers on the propensity of firms to engage in innovation[1].

Although the aforementioned literature has provided important insights, the tests implemented consider mainly one country or a group of countries with similar characteristics and involve a relatively small number of firms[2]. The shortage of systematic studies based on cross-country data renders it difficult to conclude that the reported effects are a universal phenomenon. In addition, many existing studies on this topic focus on exploring the causal effect of financial constraints on R&D investment. For example, Brown *et al.* (2012) find strong evidence that financing constraints drive R&D below the socially optimal levels. While R&D has strengths as a measure of innovation, it is an input (not the output) in the innovation process, and as suggested by (Griffith *et al.*, 2006), it does not take account of the productivity or the effectiveness of effort. Furthermore, public R&D and public financial support at different stages of the innovation process may sometimes even replace the firm's own R&D investment (David *et al.*, 2000; Clausen, 2009). Therefore, considering the effects on direct measures of innovation output can complement the findings of these studies and contribute to a better assessment of the overall impact of financing difficulties on innovation performance. Finally, the existing literature tells us little about the cross-sectoral variability of such effects. Since the level of firms' financial distress is heterogeneous across different sectors (Silva & Carreira, 2010), an accurate analysis of the impact of financial barriers on innovation performance should also take into account the considerable differences between the aggregate production and services sectors. The presence of distinct sectoral differences in the response to financial constraints takes on particular importance in the European context, where the share of manufacturing in employment and value added has decreased over the past decades and economies have shifted towards services (Brandes, 2008). Moreover, an enquiry

[1] See Czarnitzki & Hottenrott (2010) for an overview of the empirical literature.

[2] A negative relation between financial constraints and innovation has been shown, for example, in French manufacturing firms (Savignac, 2008), in German manufacturing firms (Hottenrott & Peters, 2012), in Portuguese firms (Silva & Carreira, 2012), and in a panel of transition economies (Männasoo & Meriküll, 2011; Gorodnichenko & Schnitzer, 2012).

in this direction sheds light on the channels through which better access to external finance can foster innovation activity and lead to higher productivity and economic growth.

The present article addresses these issues using European-comparable firm-level data from the Community Innovation Surveys (CIS). In particular, it contributes to the literature in two main aspects. First, we explore the relationship between direct measures of financial constraints and innovation performance using data from a large number of firms in both Western and Eastern European countries. Second, we examine whether these effects depend on firm characteristics and vary between the broad sectors of production and services. To avoid the spurious positive correlation due to firms not wishing to innovate (and thus without financial obstacles to innovation), we restrict the sample to include only the potentially innovative firms[3] (to be referred to as "innovative firms" from now on) and consider the effects on the propensity to have high innovation performance (high share in sales of innovative products[4]) rather than the propensity to engage in innovation activities. In addition, we tackle the endogeneity problem by estimating the probability of having high innovation performance and the likelihood to face financial constraints simultaneously using recursive-mixed-process estimators (Roodman, 2009).

Two basic results emerge from our empirical analysis. First, the lack of appropriate sources of finance is an important hampering factor to innovation performance across European countries. Specifically, the existence of financial constraints reduces the likelihood to have high innovation performance by 15-20%. These effects do not seem to be driven by the inclusion of Eastern European countries in our sample nor to be sensitive to the definition used for the outcome variable. Second, the role of financial constraints appears to be stronger and statistically more robust among innovative firms in the production sector than in the services sector. Within industries and especially within the production sector, innovative firms that do not engage in exporting activities appear to experience the greatest problems.

The paper proceeds as follows: Section 2 discusses the theoretical background and the related empirical literature on the relationship between financial constraints and innovation; Section 3 describes the data used; Section 4 outlines the empirical model specification and the econometric techniques applied; Sections 5 and 6 report the estimation results and investigate their robustness; Section 7 concludes and discusses the policy implications.

2 Literature Review

2.1 Theoretical predictions

In their seminal paper, Modigliani & Miller (1958) state that in perfect capital markets characterized by no taxes, no bankruptcy costs and no asymmetric information, investment decisions are indifferent to capital structure. However, since such conditions do not generally hold and information asymmetries influence lending and investment decisions, the costs of different kinds of capital may vary by type of investment (Meyer & Kuh, 1957; Leland & Pyle, 1977; Myers & Majluf, 1984). Investment in R&D and other innovation inputs, compared to physical assets, is likely to be more affected by financial factors (Himmelberg & Petersen, 1994; Hall, 2002; Hall & Lerner, 2010) because it requires large sunk costs (Alderson & Betker, 1996) and produces intangible assets that can be difficult to use as collateral for external borrowing (Williamson, 1988; Alderson & Betker, 1996). Furthermore, investment in innovation projects

[3]Following Savignac (2008), potentially innovative firms are the firms that wish to innovate. Specifically, the corresponding sample includes: (i) the firms that report product (good or service) or process innovation, (ii) the firms that report ongoing or abandoned innovation activities, or (iii) the firms that report obstacles to innovation. The excluded firms are those that are not interested in innovation; that is, the non-innovative firms and those that do not report obstacles on innovation.

[4]Mohnen & Röller (2005) refer to this variable as the "intensity of innovation".

is characterized by high degree of information asymmetries that drive the investors or lenders to ask for a higher rate of return than in the case of investments in physical assets. As stressed by Myers & Majluf (1984), although information asymmetries matter for external financing of all types of investments, they are particularly significant in limiting financing of innovation investments due to the complexity and specificity of the innovation process.

In a standard Dixit-Stiglitz type monopolistic competition framework, financial constraints have been shown to have an adverse effect on the incentive to innovate, as they lower the difference between the firm's post- and pre-innovation profits. Gorodnichenko & Schnitzer (2012), for instance, develop a stylized model that highlights the interaction between financial constraints and innovation activities and produces two clear, testable predictions. First, the stronger the internal financial constraints (due to a negative liquidity shock), the lower is the investment in innovation or knowledge creation activities in general. Second, the more severe the external financial constraints (that is, the larger the cost of external finance), the more pronounced is the impact of a negative liquidity shock on innovation. In other words, although firms tend to use internal funds to finance innovation projects (Hottenrott & Peters, 2012), the cost of external finance may also play a role for the innovation incentive, since it can affect the firms's production cost and overall profitability.

2.2 Explaining variation across firm-groups and industries

To the extent that firms can be classified into groups with low and high financial costs, the importance of financial factors in constraining innovation activity may vary according to firm-level characteristics. An obvious consideration is that bigger companies are less restricted than smaller firms (see Carpenter & Petersen, 2002; Gorodnichenko & Schnitzer, 2012). This may reflect that large companies have more resources to innovate and can benefit from economics of scale in R&D and marketing. Specifically, it may be more difficult for small firms, than for larger firms, to either raise outside finance (due to more severe problems of information asymmetries) or provide internally generated funds for the financing of an innovation project of a given size. In addition, for smaller newer firms there may be no track record to base a case for funding and there may be fewer realisable assets to use as collateral (Canepa & Stoneman, 2003, 2008). Another possible distinction is between firms that engage in exporting activities and those that do not. It is well known that exporters tend to be larger and more well-known, and thus, they may enjoy better relations with external investors or lenders. Also, exporters need to have relatively high productivity levels to be able to cover the substantial sunk costs of exporting (Melitz, 2003; Helpman *et al.*, 2004; Wagner, 2007). Finally, firms that belong to an enterprise group may be less financially constrained than firms that do not, since they have better access to internal funds and can rely more upon bank credit given their relatively lower default risk.

Differences with respect to sector-level characteristics may also exist, even though the relevant theoretical predictions are not clear-cut. Dahlstrand & Cetindamar (2000), for instance, point out that firms in services industries are more capable of self-financing and of using fewer bank loans than those in production industries. This might be driven by the fact that services firms, on average, require a lower initial investment (lower sunk costs) and have to attain a lower minimum efficient scale than production firms (Silva & Carreira, 2010). In addition, innovation in services industries may require less external financing than in production industries as the latter is more dependent on large scale and costly R&D labs (Gallouj & Weinstein, 1997). On the other hand, firms in the services sector tend to be smaller and less physical-assets intensive, and hence, as already mentioned, they cannot provide as much collateral for external borrowing[5].

[5]Debt holders such as banks prefer physical and redeployable assets as security for their loans since they

Empirical studies that that look into such variations include Ughetto (2008) and Hottenrott & Peters (2012) who show that external financial constraints are more binding for R&D and innovation of small firms. Likewise, Scellato (2007), using dynamic panel data analysis, finds that financing barriers affect more strongly the patenting activities of small enterprises. Canepa & Stoneman (2003) provide evidence that higher-risk, newer and less profitable industries are more likely to experience financial constraints in their innovation activities, whereas Gorodnichenko & Schnitzer (2012), find that these impacts are more pronounced in domestic-owned firms (compared to multinationals) and in firms that operate in services industries[6]. Although this recent empirical research points to certain directions, further work along these lines (that considers cross-country data, employs alternative innovation measures and puts more emphasis on sectoral-level differences) is needed. The present article seeks to do this.

3 Data

We employ cross-country micro-level data from the fourth Community Innovation Survey (CIS4) which covers the period 2002 to 2004. This survey is executed by national statistical offices throughout the European Union (EU) and in Norway and Iceland according to the EU-wide definitions of the Oslo Manual. The countries considered in our study are: Bulgaria, Czech Republic, Estonia, France, Italy, Norway, Portugal, Romania, Slovakia, Spain, Sweden. The rationale for the choice of these eleven countries is twofold: first, they all have information on the dependent and key explanatory variables used in our empirical model; second, they report a sufficiently large number of innovative firms and provide data for firms in both production and services sectors. Unfortunately, for three large countries (namely, France, Italy and Spain) the information required to carry out the same empirical analysis using data from the next CIS wave (CIS2006 with observation period 2004 to 2006) is not available[7]. Hence, while we use CIS2006 data for robustness checks, our analysis relies primarily on CIS4 for which the sample size is very large and enables a more detailed firm-level and industry-level comparison. Due to the confidential character of the CIS micro-data, our empirical investigation has been carried out in the SAFE Center at the premises of Eurostat in Luxembourg (in accordance with the confidentiality requirements of Eurostat). In this way, we also avoid the possibility of micro-aggregation bias associated with the use of the publicly available micro-aggregated CIS data (Mohnen & Röller, 2005).

The CIS has a number of advantages relative to data sets employed in previous studies. First, it provides direct self-reported measures of firms' financial constraints and innovation, and thus, we do not need to rely on indirect proxies. Second, it is the only data source that contains cross-country information on innovation activities in Western European countries. Third, it is based on a common survey questionnaire and methodology and includes data on a large number of firms and a broad range of industries, which makes the corresponding data set suitable for cross-industry and cross-country comparison. Fourth, it entails information on both internal and external financial constraints, which allows us to identify the channels through which financing barriers may affect innovation. In order to construct instrumental variables for our measures of financial constraints, we also employ data from Amadeus: a comprehensive database containing comparable financial information for millions of companies across Europe. Our CIS4-based sample, which results from merging these two sources,

can be liquidated in case of project failure or bankruptcy (Hottenrott & Peters, 2012).

[6]It must be stressed that Gorodnichenko & Schnitzer (2012) use data from emerging market economies in Central and Eastern Europe, where the services sector has been underdeveloped.

[7]The CIS2008 (with observation period 2006 to 2008) is also not considered here as the CIS2008 questionnaire does not include questions on factors hampering innovation activities. This is a result of the decision to only ask some questions (for which responses change slowly over time) every four years instead of every two years.

contains about 40,000 innovative firms, out of which about 29,500 are from Western countries (see Table A.1).

4 Empirical Strategy

One distinctive characteristic of the CIS questionnaire is that it begins by asking all firms for some general information and whether they have innovation activities (completed, ongoing, or abandoned) or face any obstacles to innovation. Then, only the firms that provide positive responses to these questions (that is, the firms that wish to innovate) are requested to answer a large number of additional questions, such as those on public financial support, information sources and cooperation. In the last part of the questionnaire, all surveyed firms are asked about financial and non-financial constraints to innovation. As pointed out by Savignac (2008), questioning the firms that do not wish to innovate, and hence do not meet any financial constraints, about such constraints may lead to a positive correlation between the two variables. To avoid this problem, we restrict the sample to include only the firms that wish to innovate and consider the impact of financial constraints on relative innovation performance rather than the propensity to innovate[8]. This is similar to the approach followed by Brown *et al.* (2012), who concentrate their analysis on R&D reporting firms.

As already stated, another econometric problem associated with the study of obstacles to innovation is the endogeneity of the financial constraints variable. This endogeneity may arise because both financial constraints and innovation patterns may be affected by common elements of unobservable heterogeneity; for example, by firm-specific risk factors, such as the uncertainty associated with the output of an innovation project, or the lack of information about the time needed to bring an innovation project onto the market (Savignac, 2008; Männasoo & Meriküll, 2011). To address this problem, we estimate the probability of having high innovation performance and the likelihood to face financial constraints simultaneously using a two-equation system as follows:

$$\text{'Innovation Success'}_{insc} = \Phi\{\alpha\text{'Financial Constraints'}_{insc} + \beta\mathbf{X}_{insc} + \lambda_n + \eta_s + \psi_c + \varepsilon_1\} \quad (1)$$

$$\text{'Financial Constraints'}_{insc} = \Phi\{\gamma\mathbf{Y}_{sc} + \mu_n + \varepsilon_2\} \quad (2)$$

$$\begin{pmatrix}\varepsilon_1\\ \varepsilon_2\end{pmatrix} \sim N\left\{\begin{pmatrix}0\\ 0\end{pmatrix}, \begin{bmatrix}1 & \rho\\ \rho & 1\end{bmatrix}\right\}$$

where 'Innovation Success' is a dummy variable that equals one if the firm's turnover from newly introduced or significantly modified goods or services is higher than 20% of total turnover[9] (the full sample's 75^{th} percentile value); 'Financial Constraints' (the main variable of interest) is a dummy variable that equals one if the firm reports that the lack of finance (from either internal or external sources) is highly important in hampering its innovation activities (in terms of leading to delay, abandonment or not starting innovation projects); Φ denotes the cumulative distribution function of a standard normally distributed random variable; $\mathbf{X}$ is a vector of control variables; $\mathbf{Y}$ is a vector of instruments; ε_1 and ε_2 are the error terms (assumed to be independently and identically distributed as bivariate normal); i, n, s, c index firm, size group, industry and country. The control variables in Eq. (1) include the traditional determinants of innovation used in innovation production functions (see Crépon

[8]Notice that the CIS provides limited information for the sample of firms not wishing to innovate, and thus, estimating first the impact of financial constraints on the propensity to innovate (using a two stage approach) is not possible.

[9]As a measure of the commercial success of innovation, this variable outperforms simple indicators coding engagement in some kind of innovation activity (Mohnen & Röller, 2005; Mairesse & Mohnen, 2010).

et al., 1998; Mohnen & Röller, 2005; Griffith *et al.*, 2006; Lööf & Heshmati, 2006; Mairesse & Mohnen, 2010); that is, an indicator of whether the firm had some cooperative arrangements on innovation activities during the surveyed period ('Cooperation'), a categorical variable reflecting different sources of information for innovation[10] ('External Search'), a measure of the appropriability conditions that the firm faces ('Formal Protection'), and indicators of whether the firm engages in R&D ('R&D'), has exporting activities ('Export'), and is part of an enterprise group ('Group'). To capture unobserved heterogeneity, we also include size (λ_n), industry (η_s) and country (ψ_c) fixed effects. Detailed variable definitions are given in Table A.2. The cross correlation matrix for all regression variables is displayed in Table A.3.

We estimate Eqs. (1) and (2) by conditional recursive mixed process (cmp) estimators using the procedure developed by Roodman (2009), which is suitable for a large family of multi-equation systems where the dependent variable of each equation may have different format (for example, binary, categorial, and bounded and unbounded continuous). This approach takes into account both simultaneity and endogeneity risks, and produces consistent estimates for recursive systems in which all endogenous variable appear on the right-hand-side as observed. Since our model is a recursive process (imposed by the instrumentation strategy), consisting of one structural equation ('Innovation Success' equation) and one reduced-form equation ('Financial Constraints' equation), the analysis is essentially a limited information maximum likelihood (LIML) estimator. The advantage with this approach, as opposed to two-stage least squares and related linear methods, is the gain in efficiency as it takes into account the covariances of the errors and uses the information about the limited nature of the reduced-form dependent variable (Anderson, 2005; Roodman, 2009). In the special case where both dependent variables are binary (as above), the model is fundamentally a bivariate probit model with endogenous dummy regressor[11]. The correlation coefficient ρ between ε_1 and ε_2 accounts for the possible existence of omitted or unobserved factors that affect simultaneously the probability of successful innovation and the likelihood to face financial constraints.

The consistency of this method depends on the validity of instruments, which in turn, relies on two conditions. First, the instruments must be determinants of facing financial constraints. Second, they must not be correlated with the unobserved factors that may affect the propensity to have high innovation performance. It is easy to show that the first condition is satisfied: the estimated coefficients on the instruments must have the expected sign and be statistically significant at conventional levels of significance in all models. To make sure that the second condition is fulfilled, we propose using variables which affect the firm's innovation performance only through the financial constraints indicator. Industry-level proxies of financing structure and economic performance appear to be good instruments, since they can influence the amount of internal funds and the attractiveness of firms to external investors but cannot influence the firm's innovation performance directly. Hence, in addition to size (μ_n) specific effects, we focus on four industry-level variables[12]. In particular, vector $\mathbf{Y}$ in Eq. (2) includes cross-country

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

[11] Bhattacharya *et al.* (2006) present simulations that suggest that bivariate probit is more robust than instrumental variable techniques to non-normality of the error terms. Furthermore, Chiburis *et al.* (2011) show that when treatment probabilities are low and when sample sizes are below 5000, the confidence intervals of the instrumental variable estimates are too large for any meaningful hypothesis testing; in contrast, bivariate probit confidence intervals are much smaller. Recursive bivariate probit models have previously been applied in studies about the effects of financial constraints on the propensity to engage in R&D or to innovate: for example, in Männasoo & Meriküll (2011) for transition economies, in Piga & Atzeni (2007) for Italy and in Savignac (2008) for France.

[12] Since the conditional recursive mixed process estimator is a maximum likelihood estimator, it differs from linear instrumental variable techniques in not necessarily including exogenous regressors (included instruments) from the second stage in the first stage. However, as mentioned in Section 6, adding the variables 'Cooperation', 'External Search' and 'Formal Protection' to Eq. (2) yields very similar results.

industry averages of 'Public Support', measured by the number of different types of sources of public funding for innovation, 'Collateral', measured by the logarithm of tangible assets, 'Financial Debt', measured by the gearing ratio, and 'Profitability', measured by the operating cash flow ratio[13]. Following the theoretical predictions, we expect that more profitable, less public funding dependent industries are less likely to experience financial constraints (due to larger amount of internal funds), whereas more risky industries and those with fewer realisable assets are more likely to be financially constrained (due to more difficult access to external funds). To test the validity of the aforementioned instruments, we perform the Sargan-Hansen test for over-identifying restrictions in linear LIML models. Even though there is no theoretical evidence to suggest that the assumptions necessary to perform this test are satisfied in the bivariate probit with endogenous dummy regressor, previous empirical studies argue that this is actually the best available diagnostic (Evans & Schwab, 1995; Yörük, 2009).

Notice that in order to ensure that the sample is representative of the relevant population of firms in each country, all regressions are weighted by country sampling weights. These weights correspond to the inverse of the probability of selection; that is, the total population of firms divided by the total number of surveyed firms in each country.

5 Main Findings

We start by estimating Eq. (1) for the full sample of innovative firms using a univariate probit model (see column (1) of Table 1). As a first point, we can notice that the traditional determinants of innovation performance (included in vector **X**) have the expected positive sign and are statistically significant at the 1% confidence level. Specifically, the results suggest that cooperation, formal protection and engagement in R&D increase the probability of having high innovation performance by 7%, 7% and 9% respectively. These estimates are similar to those found in papers considering the Crépon *et al.* (1998)'s three-stage model or other models on the innovation value chain in European countries (see OECD, 2009; Roper *et al.*, 2008). Consistent with the literature on "open innovation" (Chesbrough, 2003; Dahlander & Gann, 2010; Love *et al.*, 2011) and the causal effects of exporting (Salomon & Shaver, 2005; Damijan *et al.*, 2008; Vahter, 2011), we also find that external knowledge sourcing and export orientation play an important role: adding a new type of external knowledge linkage and having exporting activities are both associated with 2% higher probability to be in the group of most successful innovators. Turning now to our variable of interest ('Financial Constraints'), we can see that it has a surprising positive and highly statistically significant impact on innovation performance. This lends support to the endogeneity argument and the need for a two-equation model: ignoring the endogeneity of the financial constraints variable may render the estimates of a univariate probit equation biased and inconsistent.

Column (2) of Table 1 presents the results of a bivariate probit estimation where the financial constraints variable is instrumented using the specification of Eq. (2). The evidence obtained validates the above statement: once the endogeneity bias is corrected, we find a negative (but statistically insignificant) relationship between financial constraints and innovation performance while all other estimates remain virtually unchanged. Moreover, the Wald-test of independent equations conclusively rejects the null hypothesis that the error terms are not positively correlated, confirming the appropriateness of this approach. As pointed out in Section 2, the impact of financial constraints is expected to be more pronounced for firms that do not belong to an enterprise group and for firms that do not engage in exporting activities. To

[13] 'Collateral', 'Financial Debt' and 'Profitability' are constructed using the cross-country 3-year average of the corresponding firm-level variables based on Amadeus data for the periods 2002 to 2004 (for CIS4) and 2004 to 2006 (for CIS2006). To ensure that the industry-level measures are not sensitive to extreme values, all firm-level variables are first winsorized at 1% and 99%.

test these predictions, we re-estimate specification (2) for these two firm groups. The results, displayed in columns (3) and (4), indicate stronger effects for non-exporters: the coefficient on 'Financial Constraints' has the expected negative sign in both specifications, but appears to be statistically significant in the non-exporters equation only. Qualitatively, the corresponding estimate suggests that the likelihood to have high innovation performance is 16% lower for non-exporters who face financial constraints. These findings do not seem to be just a phenomenon of countries with relatively lower level of economic development. As shown in columns (5)-(7), excluding the five Eastern European countries from our sample (namely, Bulgaria, Czech Republic, Estonia, Romania and Slovakia) yields very similar results, both economically and statistically. It must be stressed that in all specifications of Table 1 (as well as in those of the subsequent Tables), the instruments have the desirable properties; that is, they are strong determinants of a firm's financial barriers and are uncorrelated with the error term of the innovation success equation (the p-value of the over-identifying restriction test is, with the exception of column (5), above any standard significance level)[14].

< Insert Table 1 here >

To investigate possible cross-sector heterogeneity of such causal effects, we partition the full sample of innovative firms into production and services industries[15] and re-estimate the regression package of Table 1. Table 2 presents the results for production industries, while Table 3 for services industries. Two regularities stand out. First, the causal effect of financial constraints on innovation performance is stronger and statistically more robust in production than in market services (see column (2) of Table 2 and Table 3). Second, within the two sectors and particularly within the production sector, firms that do not belong to an enterprise group and those that do not have exporting activities are more sensitive to financial constraints (see columns (3) and (4) of Table 2 and Table 3). Specifically, in production, the estimated reduction in the probability of having high innovation performance due to the presence of financial constraints is quite large (21% for the full sample, 23% for the sub-sample of non-group firms and 27% for the sub-sample of non-exporters) and is statistically significant in all specifications. In contrast, in market services, the corresponding marginal effect is relatively small (1% for the full sample, 5% for the sub-sample of non-group firms and 12% for the sub-sample of non-exporters) and fails to reach statistical significance. Our results persist when we restrict our analysis to include only the six Western European countries (see columns (5)-(7) of Table 2 and Table 3). These sectoral variations are consistent with previous studies documenting that services industries are less dependent on costly innovation inputs and more capable of raising external and internal funds (Gallouj & Weinstein, 1997; Dahlstrand & Cetindamar, 2000). This may be due to the fact that production firms have a higher efficiency scale and face higher sunk costs compared to services firms (Silva & Carreira, 2010). It is worth noting that the difference in the mean value of "share of sales with new products" between production and market services is not statistically significant, implying that the weaker response for services industries is not driven by a potentially lower propensity to engage in product innovation (as opposed to other innovation activities, such as organizational innovation).

< Insert Table 2 and Table 3 here >

[14] When we replace the industry-level public support variable with its firm-level counterpart, the Hansen-Sargan test rejects the hypothesis that the instruments are correctly specified, confirming the validity of our chosen instrument structure.

[15] Production industries include: manufacturing (2-digit NACE code D); mining and quarrying (C); electricity, gas and water supply (E); construction (F). Market services industries include: wholesale and retail trade, repair of motor vehicles, personal and household goods (G); hotels and restaurants (H); transport, storage and communication (I); financial intermediation (J); real estate, renting and business activities (K).

Are the reported findings sensitive to alternative definitions of the outcome variable? To answer this question, we use as threshold for high innovation performance the value that corresponds to the full samples' median of "share of sales with new products", instead of the 75% percentile, and re-run the regressions of Table 1, Table 2 and Table 3. Rows (1)-(3) of Table 4 summarize the results on the financial constraints variable[16] when we consider the 75% percentile as threshold value for coding highly innovative firms, while rows (4)-(6) when we consider the median as alternative threshold value. Overall, re-coding the 'Innovation Success' variable generates estimates which are similar to our baseline estimates (reported in the previous two paragraphs) and leads to the same conclusions.

< Insert Table 4 here >

As mentioned in Section 2, information asymmetries and the intangible nature of assets created by innovation projects increase the cost of external fund raising for such investments. To this end, firms, first and foremost, use internal funds to finance innovation projects as compared to external debt (Leland & Pyle, 1977; Bhattacharya & Ritter, 1983; Hall, 1990, 1992; Himmelberg & Petersen, 1994; Bougheas *et al.*, 2003; Czarnitzki & Hottenrott, 2011). This, in turn, implies that firms with limited internal funds are more likely to be constrained in their innovation performance, as they may have to leave some of their innovation projects on the shelf (Hottenrott & Peters, 2012). This conjecture is supported by our results: when we re-define the 'Financial Constraints' variable to capture lack of finance from internal sources, we find a monotonous increase in the responsiveness to financial constraints both in the full sample of innovative firms and the sub-samples of production and market services (see rows (7)-(9) of Table 4). Specifically, the estimated coefficients on 'Financial Constraints' and the associated marginal effects appear to be larger in absolute value, compared to those in rows (1)-(3), and to reach statistical significance also in the case of non-group firms (in the full sample) and non-exporters (in the sample of services industries). The stronger response for non-group firms probably reflects the fact that it is easier for firms that belong to an enterprise group to borrow funds internally; for example, from a mother company. As expected, implementing the same tests using lack of finance from external sources as determinant of financial constraints, produces weaker causal effects: the estimated coefficient on 'Financial Constraints' is statistically significant only for non-exporters in production industries (see rows (10)-(12)). Notice that the chosen instruments behave in the predicted way across these new specifications; that is, 'Profitability' appears to be stronger determinant of internal financial constraints, whereas 'Collateral' and 'Financial Debt' appear to be stronger determinants of external financial constraints.

6 Robustness Tests

As already stated, the conditional recursive mixed procedure (Roodman, 2009) works for a large class of simultaneous-equation systems where the equations can have different kinds of dependent variables. Thus, in order to further explore the sensitivity of our results to the definition used for the outcome variable, we treat 'Innovation Success' as a continuous variable and re-estimate Eqs. (1) and (2) following the same procedure. Even though using the informational content of "share of sales with new products" may allow us to identify causal effects on the intensity of innovation, shortcomings in the distribution and range limits of this

[16] For brevity and comparability, Table 4 and Table 5 display only the results on our variable of interest. The estimated coefficients on the remaining control variables and instruments are very similar to those reported in the baseline specifications and do not change the inferences drawn from earlier findings.

variable[17] point to its subjective nature and suggest that we should perhaps not draw too strong conclusions based on its continuous variations (see also Mairesse & Mohnen, 2010). Nevertheless, replacing the binary indicator with its continuous counterpart, does not change significantly our key results (see rows (1)-(3) of Table 5). Once again, we find that production industries exhibit significant sensitivity (both economic and statistical) to financial constraints and that this sensitivity is relatively more pronounced in the sub-sample of non-exporters.

< Insert Table 5 here >

An important issue concerns the presence of the R&D variable in our model. Financial constraints may affect the firm's decision to engage in R&D, or the intensity with which the firm undertakes R&D, and thus, including both variables among the determinants of innovation success may pose collinearity threats. Although this problem is significantly mitigated by focusing our analysis on the sample of innovative firms[18], we do exclude 'R&D' from the set of controls in Eq. (1) and test the robustness of our results. As shown in rows (4)-(6) of Table 5, the corresponding estimated coefficients, p-values and marginal effects are remarkably similar to those of the baseline specifications. In another robustness check, we examine whether our findings are sensitive to the inclusion/exclusion of particular industries. Excluding the non-manufacturing industries (utilities, mining and quarrying and construction) from the aggregate production sector, leaves our results quantitatively and qualitatively unaffected (see rows (7)-(9)). On the other hand, excluding the financial intermediation industries from the aggregate services sector generates relatively stronger causal effects in this sector, especially in the sub-sample of non-exporters (see rows (10)-(12)).

To explore the sensitivity of our results to different time samples, we replicate our empirical analysis using pooled data from CIS4 and CIS2006; that is, we add data from CIS2006 for eight out of the eleven CIS4 sampled countries. Despite the obvious problems with this approach (such as, including firms that were surveyed in both waves), the results obtained confirm our key findings: stronger response to financial constraints for production industries and more pronounced effects for firms with no exporting activities (see rows (13)-(15) of Table 5). Finally, we experiment with different instruments. Specifically, we examine how our results change when we exclude the variable 'Public Support' from Eq. (2), and when we add the variables 'Cooperation', 'External Search' and 'Formal Protection' to Eq. (2). Overall, estimates based on these alternative sets of instruments (available upon request) are similar to our baseline estimates.

7 Conclusions

This paper contributes to the literature in two main aspects. First, we use data from 40,000 innovative firms in both Western and Eastern European countries and provide evidence that a binding financial constraint is strongly negatively related to innovation performance. The estimates suggest that innovative firms facing financial constraints, especially those with limited internal funds, have 15-20% lower probability to be in the group of most successful innovators. Second, we show that the responsiveness to such constraints differs between production and services sectors, and also by the firm's export status. Specifically, we find that: (i) innovative

[17] In particular, this variable: (i) has values that tend to be rounded (for example, 10%, 15%, 20%); (ii) has a highly skewed distribution with a large mass of firms reporting zero innovative sales; (iii) may be plagued by outliers, as some countries have a surprisingly large number of firms reporting a high percentage of innovative sales (even 100%). Notice that the normality assumption is rejected even we we exclude the 0% and 100% shares of innovative sales.

[18] The correlation coefficient between 'Financial Constraints' and 'R&D' falls from 0.27 to 0.09 when we consider the sample of innovative firms.

firms in production industries are significantly and robustly more sensitive to financial frictions than those in services industries; (ii) within sectors, financial frictions are particularly detrimental for innovative firms with no exporting activities.

From a policy point of view, our results emphasize the role of financial constraints as one of the principal driving forces behind low innovation performance for a significant portion of firms. Therefore, policies aiming at enhancing access to external finance[19] can have a strong positive impact on innovation intensity in firms with limited internal funds, which may lead to a more rapid development of new goods and services, and higher economic growth. Policy initiatives can also involve improving information systems and strengthening investor protection to alleviate information asymmetries between lenders and firms, as well as providing fiscal incentives (such as R&D tax incentives) and funding support for innovation-related collaboration across firms and between firms and technological institutions. The finding that the importance of financial constraints varies with firm characteristics points also to another conclusion: for any innovation policy program to be effective it is vital not to rely on uniform R&D and innovation support measures, but to provide programs that support different firms in different ways. Policies aimed especially at the most constrained firms (for example, non-exporters) are likely to yield the strongest benefits. On the other hand, the finding that innovation sensitivity to financial frictions varies across sectors contributes to a better understanding of sectoral heterogeneities, and provides micro-foundations for interpretation of different effects on productivity and economic growth. In particular, financial frictions affecting more strongly innovation performance in production industries (compared to services industries) can account for possible productivity gaps between the two sectors and be seen as one of the factors that cause different responses to financial crises (see Efthyvoulou, 2012). Hence, establishing better mechanisms of how the occurrence of financial crises affects firm-level and sectoral-level innovation performance (for instance, using data from the most recent waves of the CIS that cover the post-2007 period) is an important task for future research. According to Brandes (2008), the glory time for manufacturing as steering engine for Europe's economy and provider of massive employment is over, and the structural change towards services is likely to continue over the next decades. Thus, alleviating the adverse effects of financial frictions on innovation performance can have a substantial impact on slowing down the relative decline of manufacturing in Europe - which is a key policy goal for EU policymakers.

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[19] Examples of such policies include efforts to improve accounting standards and craft regulations that permit firms to list on equity markets at an earlier stage (see Brown *et al.*, 2012).

the SERVICEGAP meeting in Mannheim, and seminars at the University of Birmingham and the University of Sheffield. Finally, the authors are grateful to Eurostat for granting access to the CIS non anonymised micro-data. The usual disclaimer applies.

A Appendix

A.1 Community Innovation Surveys

- We consider that a firm had innovation activities during the surveyed period if it answered positively to at least one of the following: (1) introduced new or significantly improved products (good or services) with respect to its capabilities, such as improved software, user friendliness, components or sub-systems; (2) introduced new or significantly improved process, distribution, method, or support activity for its goods or services; (3) had any ongoing innovation activities; (4) faced obstacles to innovation (seriously delayed, prevented to be started, or abandoned innovation projects or activities).

- The key question about financial constraints to innovation is the following: "During the surveyed period, how important were the following factors for hampering your innovation activities or projects or influencing a decision not to innovate?". We focus on two factors: lack of funds within the enterprise group (internal financial constraints); lack of funds from outside the enterprise (external financial constraints). The answer choices are: (a) factor of high importance; (b) factor of medium importance; (c) factor of low importance; (d) factor not experienced. We consider a firm to be financially constrained if it answered that the lack of finance (either from internal of external sources) was highly important in hampering its innovation activities or projects (in terms of leading to delay, abandonment or not starting innovation projects); that is, answer (a).

A.2 Tables

Table A.1: Statistics for CIS4 firms

	All Countries (11)	Western Countries (6)
Number of firms	121806	73004
Number of innovative firms	39939	29513
Report impact[a] on innovation activities	18252 (45.7%)	13167 (44.6%)
Due to lack of internal/external finance	6595 (16.5%)	4572 (15.5%)

[a] Impact refers to serious delay, abandonment or not starting innovation projects. The sample of Western European countries includes France, Italy, Norway, Portugal, Spain and Sweden, whereas the sample of Eastern European countries includes Bulgaria, Czech Republic, Estonia, Romania and Slovakia.

Table A.2: Description of variables for innovative firms

Variable Name	Definition	Mean	Std. Dev.
Innovation Success	0-1 dummy variable, =1 if the turnover from newly introduced or significantly modified goods or services ("share of sales with new products") is higher than 20% of total turnover (the full sample's 75^{th} percentile value)	0.25	0.43
Financial Constraints	0-1 dummy variable, =1 if the firm reports that the lack of finance (from either internal or external sources) is highly important in hampering its innovation activities	0.17	0.37
Cooperation	0-1 dummy variable, =1 if the firm has some cooperative arrangements on innovation activities	0.33	0.47
External Search	number of highly important sources of knowledge or information for innovation (ranges from 0 to 10)	1.47	1.51
Formal Protection	0-1 dummy variable, =1 if the firm uses design pattern, trademarks, or copyright to protect inventions or innovations	0.33	0.47
R&D	0-1 dummy variable, =1 if the firm reports engagement in R&D activities	0.62	0.49
Export	0-1 dummy variable, =1 if the firm sells goods or services in other countries	0.55	0.50
Group	0-1 dummy variable, =1 if the firm is part of a firm group (two or more legally-defined firms under common ownership)	0.42	0.49
Public Support	number of sources of public financial support for innovation (ranges from 0 to 3: local, national, EU); industry-level average	0.13	0.08
Collateral	= log(tangible assets); industry-level average	6.67	0.85
Financial Debt	= ((non current liabilities+loans)/shareholders funds)∗100; industry-level average	104.77	41.18
Profitability	= (cash flow/operating revenue)∗100; industry-level average	6.86	5.55
Size Dummies	set of size 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 (NACE 2-digit level)		

Table A.3: Cross correlation matrix for regression variables

	Innovation Success	Financial Constraints	Cooperation	External Search	Formal Protection	R&D	Export	Group	Public Support	Collateral	Financial Debt	Profitab.
Innovation Success	1.00											
Financial Constraints	0.06	1.00										
Cooperation	0.08	0.07	1.00									
External Search	0.12	0.07	0.15	1.00								
Formal Protection	0.06	0.05	0.18	0.14	1.00							
R&D	0.05	0.09	0.26	0.10	0.24	1.00						
Export	0.05	0.03	0.15	0.08	0.21	0.23	1.00					
Group	-0.05	-0.05	0.22	0.01	0.18	0.20	0.19	1.00				
Public Support	0.12	0.07	0.13	0.06	0.12	0.25	0.22	0.05	1.00			
Collateral	-0.05	-0.05	0.03	-0.05	0.01	0.09	0.15	0.07	0.19	1.00		
Financial Debt	-0.08	-0.03	-0.17	-0.10	-0.10	-0.04	-0.09	-0.10	-0.24	0.29	1.00	
Profitability	-0.05	-0.04	0.05	0.03	-0.01	0.02	-0.10	0.08	-0.16	0.02	0.01	1.00

Table 1: Bivariate probit model: all industries

	Probit	Bivariate probit - All Countries						Bivariate probit - 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)	
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)	
Financial Debt		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	
Error Correlation Test[a]		2.06*		0.73		5.81***		0.43		0.05		2.35*	
		[0.08]		[0.20]		[0.00]		[0.26]		[0.41]		[0.06]	
Over-identification Test[b]		5.90		4.62		1.71		6.89*		4.46		2.84	
		[0.12]		[0.20]		[0.42]		[0.08]		[0.22]		[0.42]	
Number of Firms	39939	39939		23112		18084		29513		15461		12709	

Columns report estimated coefficients and associated marginal effects (evaluated at mean values). Robust p-values in parentheses. Regressions are weighted by country sampling weights. ***,**,* Statistically significant at the 1%, 5% and 10% confidence level respectively. [a] Reports the Wald test statistic [p-value], where H_0: $\rho \leq 0$. [b] Reports the Sargan-Hansen test statistic [p-value], where H_0: over-identifying restrictions are valid. The Sargan-Hansen test is implemented in linear LIML models. The variables in the financial constraints equation are taken in their standard normalised form with zero mean and standard deviation one.

Table 2: Bivariate probit model: production industries

	Probit	Bivariate probit - All Countries						Bivariate probit - 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)	
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)	
Financial Debt		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	
Error Correlation Test[a]		5.94***		4.10**		3.06**		5.14**		7.55***		27.04***	
		[0.00]		[0.02]		[0.04]		[0.01]		[0.00]		[0.00]	
Over-identification Test[b]		3.82		0.27		1.27		7.97**		0.49		5.04	
		[0.28]		[0.87]		[0.74]		[0.04]		[0.92]		[0.17]	
Number of Firms	25373	25373		15216		9149		18241		9918		6044	

See notes for Table 1

Table 3: Bivariate probit model: services industries

	Probit	Bivariate probit - All Countries						Bivariate probit - 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)	
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)	
Financial Debt		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	
Error Correlation Test[a]		0.07		0.24		3.26**		0.20		0.08		1.68*	
		[0.39]		[0.31]		[0.04]		[0.67]		[0.39]		[0.09]	
Over-identification Test[b]		0.25		0.51		0.00		7.80*		2.38		3.22	
		[0.88]		[0.77]		[0.99]		[0.05]		[0.30]		[0.20]	
Number of Firms	14566	14566		7896		8935		11272		5543		6665	

See notes for Table 1

Table 4: Summary of results on the financial constraints variable

	Sample		Coefficient	$P>\|z\|$	dy/dx	No of firms
Threshold for 'Innovation Success': the full sample's 75^{th} percentile of "share of sales with new products"; 'Financial Constraints': lack of finance from either internal or external sources						
(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)	Services 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
Threshold for 'Innovation Success': the full sample's 50^{th} percentile (median) of "share of sales with new products"; 'Financial Constraints': lack of finance from either internal or external sources						
	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)	Services 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
Threshold for 'Innovation Success': the full sample's 75^{th} percentile of "share of sales with new products"; 'Financial Constraints': lack of finance from internal sources						
	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)	Services 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
Threshold for 'Innovation Success': the full sample's 75^{th} percentile of "share of sales with new products"; 'Financial Constraints': lack of finance from external sources						
	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)	Services 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

Columns report estimated coefficients, robust p-values and associated marginal effects (evaluated at mean values). ***,**,* Statistically significant at the 1%, 5% and 10% confidence level respectively.

Table 5: Robustness tests

Treat 'Innovation Success' as continuous						
	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)	Services Industries	All Firms	0.15	0.37		14566
		Non-Group	0.05	0.59		7896
		Non-Exporters	0.01	0.93		8935
Exclude 'R&D' from the list of controls						
	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)	Services 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 the aggregate production sector						
	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)	Services 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 the aggregate services sector						
	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)	Services 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 eight 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)	Services 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

See notes for Table 4

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