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Subsidies, financial constraints and firm  
innovative activities in developing economies

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# **Subsidies, financial constraints and firm innovative activities in developing economies**

**Simona Mateut\***

## **Abstract**

This paper extends the investigation on the relationship between public subsidies and innovation to firms in developing economies. The analysis merges the innovation subsidy literature with the stream focusing on financial constraints for innovation. Innovation is defined broadly to include the introduction of new products or services and the upgrade of existing ones, which is relevant for developing economies. The results obtained using a range of econometric techniques and alternative measures of financial constraints suggest a positive correlation between public subsidies and the innovative activities of 11,998 firms across thirty Eastern Europe and Central Asia countries.

*JEL:* O3, L26, G3

*Keywords:* innovation, subsidies, financial constraints

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## 1. Introduction

Innovation is regarded as an important driving element of firm level productivity, competitiveness and sustainable economic growth. Equally largely accepted is the view that innovative activities are difficult to finance due to imperfect capital markets. A large strand of literature highlights that firm innovative activities are likely to be more severely affected by financial constraints than fixed capital investment due to the higher complexity, specificity and degree of uncertainty characterising innovation projects. Studies in this literature stream have focused on the role played by internal finance (Himmelberg and Petersen, 1994, Mulkey et al., 2001), cost and availability of external funding (Hall, 2002, Brown et al., 2012), and overall country financial development (Hsu et al., 2014) for R&D investment.

As a response to market failures, government intervention via subsidies has become common practice to support private innovative activities in most industrialised countries. Subsequently, another strand of literature has developed to investigate whether subsidies have additional effects and do not merely replace private investment in R&D. Hall and Lerner (2010) find limited evidence to support the effectiveness of US government programmes, but other studies based on European countries data conclude that public subsidies are linked with increased firm innovative activities.<sup>1</sup>

This study investigates the impact of public subsidies on the innovative activities of firms operating in less developed economies. As financing constraints are likely to be more binding in these countries, this analysis bridges the two strands of the literature by focusing on whether subsidies have additional effects on firm innovative activities while controlling for firm financial strength. The cross-country data set drawn from the *Business Environment and Enterprise Performance Survey* (BEEPS) provides rich information on innovation and finance for 11,998 enterprises in thirty countries of Eastern Europe and Central Asia. Instead of focusing on R&D expenditure, which may or may not result in innovative activities, this study defines firm innovation broadly to include the introduction of new products/services and upgrading an existing product line/service, which is of great relevance for firms in developing countries. Gorodnichenko and Schnitzer (2013) and Ayyagari et al. (2011) use similarly defined firm innovation indicators and focus on the role of financial factors without considering subsidies. With few exceptions (e.g. Aerts and Schmidt, 2008, Hyttinen and Toivanen, 2005), the R&D subsidy literature contrasts the innovative behaviour of subsidised

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<sup>1</sup> See, for instance, evidence in Almus and Czarnitzki (2003) for East Germany, Aerts and Schmidt (2008), Czarnitzki and Lopes-Bento (2013) for Germany and Flanders, Colombo et al. (2011) for Italy, and Takalo et al. (2013a) for Finland.

and unsubsidised firms without taking into account their financial strength. Focusing on the recent financial crisis, Paunov (2012) assesses the impact of access to both public and private external funding on the innovation performance of firms in eight Latin American countries.

Detailed information in the BEEPS survey allows us to construct several alternative indicators of firm financial strength based on objective measures of internal financial resources, access to and use of external funding, as well as responses regarding the difficulty of access to external finance, which could be an obstacle to firm development and operations. The robustness of the empirical results is tested by a wide variety of empirical techniques including ordinary probit and instrumental variables as standard in the financial constraints and innovation literature, the newly developed special regressor estimator, as well as treatment effects and propensity score matching as customary in the R&D subsidy literature. The analysis suggests a positive relationship between firms' innovation and receipt of public subsidies, and the link seems to be stronger for financially constrained firms. This finding implies that subsidies play an important role for firm innovative activities in emerging economies, which are likely to be characterised by less developed financial markets. Even though innovation is more in the form of new-to-firm innovation (i.e. imitation), this is as important for facilitating growth in these countries as new-to-world innovations.<sup>2</sup>

The rest of the paper is structured as follows. Section 2 briefly reviews the two strands of the literature this paper is related to. Section 3 outlines the empirical strategy. Section 4 presents the data and gives some summary statistics. Section 5 reports the empirical results and the final section concludes.

## **2. Literature review**

This section reviews the two strands of the innovation literature: one focusing on firm financial strength and the other investigating the role of public subsidies. Finally, it mentions the few papers controlling for both firm financial strength and availability of public subsidies.

### *2.1 Financial constraints and innovation*

The importance of binding financial constraints for firm innovative activities has long been acknowledged in the literature. Following the seminal paper by Fazzari et al. (1988), several papers accept a positive statistical significant relationship between R&D expenditure and firm wealth as evidence that firm wealth relaxes financing constraints. Among others,

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<sup>2</sup> Acemoglu et al. (2006) argue that innovation becomes more important relative to imitation only when the country approaches the world technology frontier.

Himmelberg and Petersen (1994) and Mulkey et al. (2001) focus on the impact of cash flow on firms R&D investment. However, Kaplan and Zingales (2000) challenged this approach on the grounds that investment cash flow sensitivities need not increase monotonically with financial constraints and that investment opportunities may not be sufficiently controlled for.

Kim and Weisbach (2008) suggest equity plays an important role in raising capital for R&D spending. Brown and Petersen (2009) and Brown et al. (2012) confirm the linkage between stock issues and R&D investment of US and European firms, respectively. Using data for 32 countries, Hsu et al. (2012) show that overall market capitalization encourages innovation productivity (as measured by patenting).

Debt finance may not be the preferred source for financing innovation due to the high complexity, specificity, degree of uncertainty, and limited collateral value characterising innovation projects.<sup>3</sup> Hall (2002) reports that R&D-intensive firms normally exhibit lower debt ratios than firms engaging less in R&D. Similarly, Brown et al. (2012) find weak debt finance effects on the R&D investment of US quoted firms. On the contrary, Ayyagari et al. (2011) find a positive relationship between access to external financing, most likely bank financing, and the extent of firm innovation in developing economies.

Recent studies suggested various ways to circumvent the drawbacks related with cash flow as a measure of internal resources. Czarnitzki and Hottenrott (2011a and 2011b) replace cash flow with the empirical price-cost margin. Other studies use survey data regarding cost and availability of finance to construct direct measures of financial constraints. For example, Canepa and Stoneman (2008) link (lack of) availability of finance with the likelihood that firms from high tech industries and small firms in the UK report a project being abandoned or delayed. Hajivassiliou and Savignac (2011) study whether French firms' innovative projects were delayed, abandoned or non-started due to one of the following reasons: unavailability of new financing, searching and waiting for new financing, too high cost of finance. Using responses to questions on how severe an obstacle is access to and cost of external funding for business operations, Gorodnichenko and Schnitzer (2013) show that firms' decisions to invest in innovative activities are sensitive to financial frictions. Aghion et al. (2012) propose a payment incident variable as an indicator of firm credit constraints. They find that French firms R&D investment is negatively correlated with supplier overdue payments and the effect is stronger in sectors more dependent on external finance.

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<sup>3</sup> Another source for financing innovation activities (in developed markets) is venture capital (Cochrane, 2005).

## *2.2 Subsidies and innovation*

The impact of public subsidies on firm innovation has attracted much interest in the literature. Overall, the empirical literature concludes against public subsidies completely crowding-out private investment. Despite finding crowding-out effects, Wallsten (2000) cannot reject the hypothesis that the grants from the US Small Business Innovation Research (SBIR) program allowed firms to continue their R&D activities at a constant level rather than cutting back. A series of papers use cross-sectional survey data for European countries and conduct a treatment effect analysis. Evidence that public support stimulates private R&D investment is found for firms in East Germany (Almus and Czarnitzki, 2003), Finland (Czarnitzki et al., 2007), Flanders and Germany (Aerts and Schmidt, 2008, Czarnitzki and Lopes-Bento, 2013, 2014, Hottenrott and Lopes-Bento, 2014).

Colombo et al. (2011) use panel data on 247 new technology-based Italian firms and find that only subsidies provided on a competitive basis have large positive effects on firm TFP growth. In a similar approach, Girma et al. (2007) show that only grants that support productivity enhancing activities increase total factor productivity of Irish plants.

Takalo et al. (2013a) model the subsidy application and R&D investment decisions of the firm and also the subsidy granting decision of the public agency in charge of the program to estimate the expected welfare effects of targeted R&D subsidies using project level data from Finland. Distinguishing between research and development grants, Hottenrott et al. (2014) find evidence of both direct and cross-scheme effects and the magnitude of the treatment effects depends on firm size and age.

## *2.3 Subsidies, financial constraints and innovation*

A handful of papers take into account capital market imperfections when studying the effects of public policy on firm innovation. Hyytinen and Toivanen (2005) use Finnish SMEs data to show that government funding disproportionately affected the R&D expenditure of firms from industries dependent on external finance. Aerts and Schmidt (2008) control for firm financial strength (cash flow for Flanders and a four-point Likert scale for Germany) and reject the crowding out hypothesis in their samples.

Takalo et al. (2013b) model the interaction between public and private financiers of firm R&D and show that higher costs of external finance increase (decrease) the optimal subsidy rate at the extensive (intensive) margin. Finding evidence of subsidy additionality crucially depends on the size of subsidy spillover effects. Czarnitzki et al. (2015) model the behaviour of firms in four alternative scenarios: a subsidy regime, a tax credit policy, no

public support, and a European-wide agency deciding on subsidies. Using project level data for Flanders, Germany, and Finland, their study finds larger welfare effects from an EU innovation policy due to cross-country spillovers.

While the subsidy literature focuses on developed economies, Paunov (2012) analyses firms' innovation performance during the financial crisis in eight Latin American countries. Controlling for access to external funding, Paunov (2012) shows that manufacturing firms with access to public funding were less likely to discontinue innovation projects in 2008-09.

### 3. Empirical strategy

Our empirical strategy bridges the analysis in the firm financial strength stream (e.g., Gorodnichenko and Schnitzer, 2013, and Ayyagari et al., 2010), with the approach in the R&D subsidy literature (e.g., Aerts and Schmidt, 2008, Czarnitzki and Lopes-Bento, 2013), to account for the role of public subsidies on firm innovative activities. The baseline empirical model specifies firm innovative activities as a function of subsidies received, firm financial strength, firm R&D effort and other controls:

$$\mathbf{Innovate}_i = \Phi(\mathbf{Subsidy}_i, \mathbf{FS}_i, \mathbf{R\&D}_i, \mathbf{X}_i) \quad (1)$$

where  $i$  indexes firms. The dependent variable,  $\mathbf{Innovate}_i$  is a generic dichotomous variable equal to 1 if the firm reports an innovative activity, 0 otherwise.  $\mathbf{Subsidy}_i$  indicates receipt of a subsidy;  $\mathbf{FS}_i$  measures firm financial strength and  $\mathbf{R\&D}_i$  records whether the firm invested in R&D.  $\mathbf{X}_i$  is the set of regressors thought to affect firm innovative activities. Detailed description of the variables is provided in the data section below.

Benefitting from rich firm financial information, this study uses both direct measures of financial constraints reported by firms (similar to Aghion et al., 2012, and Gorodnichenko and Schnitzer, 2013), and accounting data based indicators for access to external funding (like Ayyagari et al., 2011, and Paunov, 2012), and for availability of internal finance (as in Czarnitzki and Hottenrott, 2011a). Using alternative measures facilitates comparison with the literature and helps reduce concerns about the appropriateness of the financial constraints indicators used in this study.

The multivariate analysis starts with the estimation of simple probit models. An instrumental variable approach (both probit and a special regressor) deals with potential concerns regarding endogeneity of financial variables. A matching estimator addresses the potential sample selection bias in receiving subsidies, as routinely done by the subsidies strand of the innovation literature. Even though it does not establish a causal relationship,

through the variety of controls and estimation techniques, this study assesses the links between innovation, public subsidies, firm financial health and input in innovation.

#### ***4. Data and summary statistics***

##### ***4.1 Sample***

The data used in this study is drawn from the *Business Environment and Enterprise Performance Survey* (BEEPS), a joint initiative of the European Bank for Reconstruction and Development (EBRD) and the World Bank. BEEPS is a particularly rich data set covering a broad range of business environment topics including innovation, access to finance, trade, competition, and performance measures. The cross-sectional analysis in this study uses the fourth round of the survey, 2009 BEEPS.<sup>4</sup> Starting with 2008, the survey underwent changes in the questionnaire and methodology which aimed to improve cross-country comparability and to make it compatible with the Enterprise Surveys the World Bank has been implementing in other regions of the world since 2006. Earlier rounds of BEEPS have been used by Gorodnichenko and Schnitzer (2013), Popov (2013), Hanedar et al. (2014), while Ayyagari et al. (2011) use the 2006 World Bank Enterprise Surveys.

Since 2008, the survey universe consist of the majority of manufacturing sectors (excluding extraction), retail trade, construction, and most services sectors (wholesale, hotels, restaurants, transport, storage, communications, IT).<sup>5</sup> Only registered companies with at least 5 employees are eligible for interview but there are no restrictions on firm age. Firms with 100% government / state ownership are no longer eligible to participate. In contrast to previous rounds of BEEPS, there are no additional requirements on the ownership, exporter status, location or years in operation of the establishment. Starting with the fourth round, BEEPS uses three instruments: the manufacturing, the retail, and the core (residual sectors) questionnaire. Although many questions overlap, some are asked only to one type of business (e.g., retail firms are not asked questions about capacity utilisation).

BEEPS strive to provide a representative sample of a country's private sector in terms of economic sectors, firm size and region distribution. The 2009 BEEPS covered 11,998 firms in thirty countries of Eastern Europe and Central Asia. Appendix Table A1 provides the structure of the sample by country (Panel A) and by main economic sectors (Panel B).

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<sup>4</sup> The survey was first undertaken in 1999-2000, and was followed by subsequent rounds in 2002, 2004-2005 and 2008-2009. Data for the fifth round, 2012-2013, became available in January 2015.

<sup>5</sup> This corresponds to firms classified with ISIC Rev 3.1 codes 15-37, 45, 50-52, 55, 60-64, and 72. Prior to 2008, the survey universe consisted of industry and most service sectors. This corresponded to firms classified with ISIC Rev 3.1 codes 10-14, 15-37, 45, 50-52, 55, 60-64, 70-74, 92.1-92.4 and 93.



A. *Innovative activities*. The generic outcome variable *Innovate* denotes, alternatively, several variables derived from questions regarding firm innovative activities. *New product* is a binary variable equal to 1 if the firm answered “yes” (0 if it answered “no”) to the following question: “In the last three years, has this establishment introduced new products or services?”. *Upgrade* is constructed similarly if the firm upgraded an existing product line or service in the previous three years. The BEEPS questions align closely with the definition in the Oslo Manual (OECD, 2005) developed by OECD and Eurostat for innovation surveys. Gorodnichenko and Schnitzer (2013) analyse similarly defined variables using earlier rounds of BEEPS. In their UK SMEs analysis, Lee et al. (2015) also define innovators as those firms which have introduced a new product in the previous 12 months.

Even though 2009 BEEPS does not include information regarding the introduction of new technologies, *NewProduct* and *Upgrade* provide a good reflection of firm innovation in the BEEPS sample since these are the most common innovative activities undertaken by firms in developing economies. Ayyagari et al. (2011) identify eight firm innovative activities using responses to similar questions in the Enterprise Surveys of the World Bank and observe that a higher percentage of firms are more actively engaged in core innovation (introduced a new product line, upgraded existing product lines) than in other innovative activities.

Additionally, BEEPS 2009 asks businesses whether they have contracted with other companies (outsourced) activities previously performed in-house or have discontinued at least one product or service in the last three years. Responses to these questions are coded 1-0 (yes-no) to create two more variables, *Outsource* and *Discontinued*. Only manufacturing firms are asked the question on outsourcing. On the contrary, all firms are asked whether they discontinued at least one product line or service in the last three years. One could argue though that this is not a measure of innovation but rather a measure of firm flexibility and dynamism (Ayyagari et al., 2011). Notwithstanding their weaknesses, these two variables are used to complement the firm innovation analysis in additional tests.

Besides information about the outcome of innovative activities, the survey provides data on whether firms had any (in-house or outsourced) R&D expenditure in 2007. Even though R&D expenditure does not necessarily lead to innovation, it provides a good measure of firm innovation input.<sup>6</sup> Given the skewness of the R&D expenditure distribution and the large proportion of zero values, I use an indicator rather than the volume of R&D spending.

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<sup>6</sup> Other papers, e.g. Aerts and Schmidt (2008) and Czarnitzki and Lopes-Bento (2013), use information on the firms’ patent stock instead. While patent data is accurately measured, it has other weaknesses: it measures inventions rather than innovations; firms often use measures other than patents to protect their innovations; the tendency to patent varies across countries and industries.

The variable **R&D**, set equal to 1 if the firm spent a positive amount on R&D expenditure, 0 otherwise, captures firm effort in innovative activities.

*B. Subsidies.* The next crucial survey data used is information on whether the firm has received any subsidies in the last three years. The BEEPS question mentions several possible sources of subsidies, namely from the national, regional, or local governments and European Union sources. However, it does not distinguish among them and does not report amounts of subsidies. The analysis can therefore only investigate whether receipt (or not) of subsidies is linked with firm innovation. **Subsidy** takes value 1 if the firm has received any subsidies from any source, 0 otherwise.

*C. Financial strength.* BEEPS 2009 collects a host of information regarding firms' current and past financial situation. For instance, using survey responses, two variables gauge firm current access to external finance. **CreditLine** takes value 1 if the firm had a line of credit or a loan from a financial institution, and 0 otherwise. Similarly, **Overdraft** is coded 1/0 if the firm had an overdraft facility at the time of the interview.

Firms are also asked to estimate the proportion of funds from various sources used to finance purchases of fixed assets over fiscal year 2007. **BankLoan** is coded 1/0 if the firm borrowed from private or state-owned banks to fund purchases of fixed assets. Firms which did not purchase any fixed assets in 2007 were not asked this question. Ayyagari et al. (2011) use a similarly defined variable to show that access to bank financing is positively associated with the extent of innovation undertaken by firms in developing economies.

Instead of access to external funding, internal finance availability may proxy firm financial strength. Following Czarnitzki and Hottenrott (2011a and 2011b), to circumvent the problems related with the use of cash flow, availability of internal resources is measured by the price-cost margin calculated as  $PCM = (sales - labour\ and\ material\ costs + \delta\ R\&D\ expenditure) / sales$ . The labour and material cost shares of the R&D expenditure ( $\delta = 0.93$ ) are added back into PCM in order to measure internally available funds during the year irrespective of the actual decision on R&D investment.

Besides measures of actual use of (external and internal) finance, BEEPS reports respondents' opinions on what are their major obstacles to firm growth and performance. The first direct measure of financial constraints, **FC1** is set equal to 1 if firms choose access to finance as their current biggest obstacle, and equal to 0 if they choose any of the other 14 possible answers. The second proxy is based on the five ordered responses to a separate question regarding firms' access to finance (which includes availability and cost, interest rates, fees and collateral requirements). **FC2** takes value 1 if the firm considers access to

finance either a ‘major’ or a ‘very severe’ obstacle, and value 0 if access to finance represents either ‘no obstacle’, a ‘minor’ or a ‘moderate’ obstacle to current operations. Alternatively, *Access* is defined as an ordered variable taking five values (0/4) corresponding to how severe (‘no obstacle’, ‘minor’, ‘moderate’, ‘major’, ‘very severe’) an obstacle is access to finance.<sup>7</sup>

Finally, *Overdue* is defined 1/0 if the firm has overdue payments by more than 90 days. It is similar in nature to the overdue payments to suppliers indicator proposed by Aghion et al. (2012) as a measure of firm financial constraints. While earlier rounds allowed separation of overdue payments into four categories (utilities, taxes, employees and material input suppliers), the fourth round of BEEPS used here reports information only about overdue payments to utilities or taxes.

*D. Controls.* The analysis includes several control variables likely to impact on whether a firm undertakes innovative activities. Consistent with the literature, the logarithm of the number of employees (*EMP*) and its squared term (*EMP2*) allow for a potential non-linear size effect. *Age*, calculated as the logarithm of the number of years since the company was formally registered, controls for two possible effects. On the one hand, older firms may have accumulated knowledge and may therefore be more likely to innovate. On the other hand, older firms may have developed routines and may be more rigid and less likely to engage in innovative activities.

The survey includes several questions about market characteristics and the degree of competition in the market. It is generally accepted that foreign competition and exporting status impact firm behaviour. Accordingly, all regressions control for whether the firm engages in export markets (*Export*) and whether it has majority foreign capital (*Foreign*). Some models take into account whether the respondents are part of a larger firm (*Group*).

Firms are asked directly how important domestic competitors, foreign competitors, and customers, were in affecting their decisions to develop new products or services and markets. Using the four-ordered responses, three measures (*Pres\_dcomp*, *Pres\_fcomp*, *Pres\_cust*) are coded 1 if the firm answers ‘fairly important’ or ‘very important’, and 0 if it answers ‘not at all important’ or ‘slightly important’, regarding the pressure exerted by domestic competitors, foreign competitors, and customers, respectively.<sup>8</sup>

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<sup>7</sup> Using earlier rounds of BEEPS, Gorodnichenko and Schnitzer (2013) construct two proxies for self-reported financial constraints: *Difficulty of Access to External Finance* and *Cost of External Finance*. See section 5.2 Self-reported financial constraints for more details.

<sup>8</sup> Using the 2003 Mannheim Innovation Survey, Cappelli et al. (2014) find that pressure from competitors matter for imitation, while customers and research institutions deliver valuable knowledge for sales with market novelties, and there are no significant spillover effects from suppliers.

Additional detailed information is available in the manufacturing firms' questionnaire. For instance, with reference to year 2007, the survey provides information about the number of competitors (*Compet*) grouped into four categories: 1 (no competitors), 2 (one competitor), 3 (2-5 competitors), and 4 (more than 5 competitors). *Market* = 1/2/3 indicates whether the firm's main product market is local, national or international. For all surveyed firms, *City* is an ordinal variable taking five values corresponding to the population size of the city where the firm is located (1-capital city, and 5-town with population less than 50,000). There is data on firm capacity utilization (*CU*), capital intensity (*CapIntens*), defined as the net book value of machinery, vehicles, and equipment relative to permanent full-time employees in 2007, and whether the firm imported material inputs or supplies (*Importinp*). A firm's ability to innovate depends to a large extent on the knowledge base of its employees, which can be measured through formal training provided to its full-time employees (*Training*).

Controls for economic sector are included either by separating firms in manufacturing (distinguishing between producers of specialised and standardised goods), construction, retail, wholesale, and services, or by adding two-digit industry indicators.

#### 4.2 Summary statistics

Table 1 Panel A summarizes, by country, the proportions of firms that undertook different innovative activities over the three years prior to the survey. Irrespective of country, the most common innovative activity is upgrading an existing product, followed by the introduction of a new product or service. On average, the proportion of firms that upgraded an existing product or service (73.3%) is roughly three times larger than the percentage of firms that outsourced an activity (25.8%) or discontinued an existing product or service (24.3%). Slightly more than half the firms introduced a new product (54.1%) in the last three years. These raw descriptive statistics support the use of *NewProduct* and *Upgrade* as the main indicators of firm innovative activities in this study, and are consistent with the numbers calculated by Ayyagari et al. (2011) using the 2006 World Bank Enterprise Survey.

Looking at the proportions across countries, Lithuanian and Slovenian firms seem to be the most innovative. In Lithuania, 91.2% of firms have upgraded a product or service and 69.8% of firms introduced a new product or service in recent years, which compares well with the proportions for Slovenia (90.8% upgraded and 74.5% introduced new products). At the other extreme, Uzbek firms are the least innovative across all categories (23% upgraded and 37.4% introduced new products). At the same time, Uzbekistan stands out as the country

with the lowest proportion of firms (2.5%) that spent a positive amount on R&D activities in 2007, which is ten times lower than the sample average (24.6%).

Panel B of Table 1 presents additional statistics (mean, standard deviation and number of observations) aggregated according to whether firms operate in an EU member state. There are statistically significant differences in firm innovativeness across the two country groups. Not surprisingly, and consistent with the idea that firms in less developed economies engage mainly in imitation, firms in EU countries are more likely to introduce a new product / service while the average proportion of firms upgrading an existing product / service is higher in non-EU countries. Nevertheless, the standard deviations for the innovation indicators are large and conceal the fact that firms in some non-EU countries (e.g. Russia and Armenia) are more innovative than firms within some EU countries (e.g. Bulgaria). The striking difference across the two country groups regards, however, the proportion of firms that report receipt of public subsidies: 16.2% for firms in EU countries relative to 5.7% in non-EU countries, with Croatia (26.6%) and Armenia (0.8%) at the two extremes.

Table 2 reports the sample statistics of the variables measuring firm financial strength (Panel A). Slightly less than half of the surveyed firms had access to a credit line or loan from a financial institution (47.8%) or to an overdraft facility (45.1%) at the time of the interview. Bank loans were the funding source used by about 40% of the firms that purchased fixed assets in 2007. Looking at internal liquidity reveals that the price-cost margin is on average 36.5%. This is slightly higher than the averages reported by Czarnitzki and Hottenrott (2011) for their sample of German firms (27% and 30% for firms undertaking routine R&D and cutting-edge R&D, respectively).

Finally, the self-reported measures of financial constraints suggest that on average 27% of firms consider access to finance either a very severe or a major obstacle to their current business operations. However, among the different possible obstacles to their establishment's operation, only 17% of firms rank access to finance as their major obstacle. About 7% of firms experience payments overdue by more than 90 days with utilities or taxes.

Panel B shows that the vast majority (64.8%) of the sample firms are classified as small. While there is large variation in terms of number of employees (ranging from 1 to 100,000), 90.7% of firms have less than 250 employees. About a quarter of firms export their goods directly or indirectly, and roughly 7% of firms have majority foreign capital. The average firm age is 16 years but the large standard deviation suggests the sample contains a mixture of very young and old firms. The other controls are self-reported measures of degree of competition in the product market and, for manufacturing firms only, different measures of

capital utilisation and productivity. These statistics suggest that domestic agents, customers and competitors alike, put pressure on firms to innovate, while foreign competitors play a much lesser role. On average, firms operate close to three quarters of their full capacity. Nearly 40% of firms provided training to their full-time permanent employees in 2007.

Table 3 presents simple correlation coefficients. The positive correlations between the alternative measures of firm innovation are statistically significant at the 5% level and the strongest relationship is between the two main dependent variables *NewProduct* and *Upgrade* (Panel A). Better firm financial strength and receipt of subsidies are associated with increased innovation (Panel B). The coefficients in Panel C suggest that larger and older firms are more innovative. Similarly, innovative firms are likely to export, have foreign capital, belong to a group and provide training to their employees. According to Panel D, more intense competition is associated with increased firm innovation.

## **5. Empirical results**

### *5.1 Baseline results*

The empirical analysis begins by estimating the probability that firm  $i$  undertakes an innovative activity. Table 4 reports marginal effects calculated at mean values and robust standard errors clustered at the country level. The baseline model includes non-linear firm size effects and controls for export participation, foreign capital, and country fixed effects. The results suggest that large firms are more likely to introduce new products and services (Panel A) but there seems to be a non-linear relationship between firm size and the likelihood that the firm upgrades an existing product or service (Panel B). Both export participation and presence of foreign capital exert large and significant effects on firm innovative activities.

The results suggest a positive and significant correlation between subsidies and firm innovative activities. Looking across panels, subsidies have a larger impact on the likelihood of introducing new products or services (Panel A) than on the likelihood of upgrading an existing product or service (Panel B). This finding holds when the estimation controls for R&D effort and / or firm financial strength (captured by *CreditLine*). The marginal effects suggest that a major determinant of firm innovative activities over the period 2007-2009 is firms' engagement in R&D activities in the fiscal year 2007. Finally, a standard control in the R&D subsidy literature *Group* (i.e. respondent belongs to a larger firm) does not appear to significantly affect firm innovative activities in this sample.

All Table 4 specifications capture firm financial strength by *CreditLine*, an indicator that the respondent has a line of credit or a loan from a financial institution. Table 5 uses

alternative measures for firm financial strength. Access to external funding is measured by availability of an overdraft facility (columns 2 and 7) or by the use of bank loans to purchase fixed assets in 2007 (columns 3 and 8). Internal finance strength is proxied by the price-cost margin (columns 4 and 9) as in Czarnitzki and Hottenrott (2011a and 2011b). All measures of firm financial strength are positively correlated with the likelihood of innovative activities. One interesting observation is that internal funding seems to matter more than external funding for the decision to upgrade an existing product line or service. Importantly, subsidies always exert a sizeable positive effect on firm innovative activities even when controlling for firm financial strength.

*Market characteristic.* The analysis focuses next on the relationship between firm innovativeness and market characteristics. One can argue that the intensity of competition in the product market is the device that gives firms an incentive to innovate. Besides exporting status and foreign capital, the empirical analysis considers now other measures of product market competition including the number of competitors (*Compet*), the population size of the city where the firm is located (*City* = 1/5 with 1 for capital, 5 for towns with less than 50,000 people), whether the firm uses imported inputs (*Importinp*), the main product market in the previous year (*Market* = 1-local, 2-national, 3-international), and the importance of various factors affecting firms' decisions to develop new products and services.

Overall, the results in Table 6 suggest that competition is positively associated with increased innovation. For instance, there is a positive and significant correlation between the number of competitors and the two indicators of firm innovation. Firms located in larger cities are more likely to upgrade existing products but there seems to be no association between city size and the likelihood of introducing new products. Using imported inputs positively correlates with the probability of engaging in both innovative activities. Firms which sold their products on more competitive markets (national and international) are more likely to introduce new products and this result holds even when there is allowance for the type of agent affecting firms' decisions to innovate (column 6). It seems that firms' decisions to introduce new products are due to pressure from domestic competitors and customers.

*Additional checks.* Table 7 collects results obtained from further robustness checks. The first columns in both panels investigate whether certain economic sectors are more innovative than others. These results suggest that, while our previous findings hold, firms in construction and services sectors are less likely to innovate than firms producing standardised manufacturing goods (column 1) or than all manufacturers taken together (column 2). Restricting the sample to manufacturers only (column 3) does not alter the significant

positive association between subsidies and firm innovation. The last three columns in both panels are based on the manufacturers sample and control for capacity utilisation, capital intensity, and training provided to full-time employees in 2007. Capacity utilisation is positively associated with the likelihood of upgrading existing products while capital intensity (the net book value of machinery, vehicles, and equipment relative to the number of permanent full-time employees) is positively correlated with the likelihood of introducing new products. There is evidence of a significant positive association between human capital (as measured by formal training provided to firms' permanent full-time employees) and firm innovation. The marginal effects calculated at the means are large: 13.5% for introducing new products and 9.4% for upgrading existing ones.

### 5.2 Self-reported financial constraints

This section uses self-reported measures of financial constraints instead of balance sheet data regarding use of (external or internal) funding. The main indicator is *FC1*, coded 1/0, if firms report access to finance as the major obstacle to their business operations. Alternatively, *FC2* indicates that firms find access to finance either a major or a very severe obstacle to their current business operations (1/0). *Access* takes values 0-4 corresponding to the possible responses ('no obstacle', 'minor', 'moderate', 'major', 'very severe' obstacle) to the same question regarding access to finance (which includes availability and cost, interest rates, fees and collateral requirements). Gorodnichenko and Schnitzer (2013) construct two similar financial constraints measures using earlier rounds of BEEPS<sup>9</sup> and suggest using an instrumental variable approach to address the possibility that innovating firms are more likely to face financial constraints than firms that do not innovate.<sup>10</sup>

To allow rough comparison with previous studies, Table A2 in the appendix reports IV probit estimates for the three self-reported financial constraints measures. All estimations include country fixed effects, cluster standard errors at country level, and use the instrument *Overdue*, defined 1/0 if firms report payments overdue by more than 90 days with utilities or taxes.<sup>11</sup> The estimates suggest that financially constrained firms are less likely to innovate.

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<sup>9</sup> Their variables *Difficulty of Access to External Finance* and *Cost of External Finance* take four values (0/3) corresponding to whether access to finance and, respectively, cost of external finance are considered 'no obstacle', 'minor', 'moderate' or 'major obstacle' for the operation and growth of the business. The BEEPS 2009 question refers to access to finance, which includes availability and cost, interest rates, fees and collateral requirements, and allows for five possible answers (adding 'very severe' as a possible response).

<sup>10</sup> Ayyagari et al. (2011) use an IV procedure as robustness check.

<sup>11</sup> Aghion et al. (2012) propose a payment incident variable (if the firm fails to pay its trade creditors) as an indicator of firm credit constraints. Similar to this, the instrument used by Gorodnichenko and Schnitzer (2013) is overdue payments to suppliers, which unfortunately is not available in BEEPS 2009.



Importantly, as in the simple probit estimations, subsidies are still positively and significantly associated with firm innovation.

These estimates should be interpreted with care. The IV probit estimator requires that the endogenous regressors are continuous, while the three self-reported financial constraints variables are either dichotomous (*FC1*, *FC2*) or take discrete values (*Access*). I address this issue in two ways. Firstly, similar to Aghion et al. (2012), I use the overdue payments incidence as an indicator of firm financial constraints instead of using it as an instrument. Consistent with the other results reported in Table 5 for alternative measures of firm financial strength, the estimates in columns 5 and 10 suggest that firms which have overdue payments are less likely to introduce new products or to upgrade existing ones.

Secondly, I employ the special regressor estimator proposed by Lewbel (2010).<sup>12</sup> The advantage over the IV probit is that the special regressor can handle binary choice models with discrete or limited endogenous regressors. The method relies on a particular 'special regressor' that is exogenous and appears additively in the model. The special regressor must be continuously distributed, with a large support so that it can take on a wide range of values and, ideally, it should have thick tails. Firm age (demeaned) is used as the special regressor since it is exogenously determined, continuously distributed, and as shown previously in the data section, likely to be correlated with firm innovativeness.<sup>13</sup>

Table 8 reports marginal effects obtained with the special regressor estimator when financial constraints are gauged by *FC1* (access to finance is the major obstacle to current business operations). The estimator specifies the heteroskedastic form of the model should be estimated and allows for two specifications: the standard kernel density (odd columns) and the sorted data density of Lewbel and Schennach (2007) in even columns. Marginal effects and bootstrapped standard errors (100 replications) are calculated for the two main dependent variables *NewProduct* and *Upgrade*. While this method requires strong restrictions on one variable, the special regressor age, it provides useful robustness checks against alternative estimators. The marginal effects in columns 1-2 in both panels support the previous findings that *Subsidies* are positively associated with firm innovation.

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<sup>12</sup> The estimation uses the `sspecialreg` command developed in Stata by Baum (2012).

<sup>13</sup> Dong and Lewbel (2014) use age as the special regressor in their analysis of individual decision to migrate from one US state to another.

### 5.3 Matching techniques

Given the secondary survey data used in this study, it is difficult to establish a causal relationship between receipt of subsidies and firm innovation. This would entail showing the counterfactual that had the firm not received any subsidies, it would not have been able to innovate. Subsidized firms may have put more effort into innovative activities than non-subsidized firms even in the absence of the subsidies. As common in the literature on the evaluation of R&D subsidies, this section uses a propensity score matching technique to compare the actual outcome of subsidised firms with their potential outcome in case of not receiving a subsidy. Matching techniques aim to construct a sample counterpart for the treated (i.e. subsidised) firms' outcomes had they not been treated by using an average of the outcomes of similar firms that were not treated. Similarity between firms is based on estimated treatment probabilities, known as propensity scores. A treated firm is matched to the nearest non-treated firm in the control group in terms of propensity scores for the given set of observable characteristics. Under the matching assumption, the only remaining difference between the two groups is the actual treatment effect.

Table 9 reports the average subsidy effect on the subsidised firms where matching is performed using the *teffects psmatch* command in Stata.<sup>14</sup> The columns labelled ATET give the estimated impact of receiving a subsidy on the likelihood of undertaking innovative activities (*Newprod* and *Upgrade*) for subsidised firms. As expected, subsidies have a larger impact on the likelihood of introducing new products and services than on the probability of upgrading existing ones, which depends mostly on internal funding.

The rows report the model (variables) used to perform the matching. For instance, in Panel A model 1, subsidised firms are matched with non-subsidised firms similar in terms of size, export participation and foreign capital. The numbers reported imply that subsidies increase the likelihood of subsidised firms to introduce new products (column 1) and to upgrade existing products (column 4) by 12.7% and 9%, respectively. The subsequent models add variables to the matching procedure: R&D effort (model 2), access to a credit line (model 3), both R&D effort and use of a credit line in model 4. The average treatment effects on the subsidised firms are economically and statistically significant. The smallest coefficients, though significant, are obtained when similarity between treated and untreated firms conditions on the establishment being part of a larger firm (models 5) or operating in the same two-digit industry (model 7). The similarity between subsidised and non-subsidised

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<sup>14</sup> The advantage of this command is that it takes into account the fact that propensity scores are estimated rather than known when calculating standard errors.

firms takes into account the country where firms operate from model 8 onwards and market characteristics such as the number of competitors in the domestic market (model 8) or the firm's main market (models 9 - 10).

Panel B reports average treatment effects on the subsidised firms when the matching procedure is model 10 replacing credit line with alternative financial variables. These results suggest that subsidies have a positive significant impact on the innovative activities of subsidised firms irrespective of the variable used to measure firm financial strength.

#### *5.4 Subsidy effects for financially constrained firms*

Throughout the analysis it appears that financially stronger firms and firms receiving subsidies are more likely to innovate. This section attempts to investigate whether subsidies ameliorate firms' financial strength, or in other words, whether subsidies have larger effects on the innovative activities of financially constrained firms.

Panel C of Table 9 presents the results for the treatment effects analysis conducted for separate sub-samples of firms. Matching is performed according to firms' size (including non-linear term), export participation, foreign capital, R&D input, economic sector, and country. Firstly, the average treatment effect on the subsidised firms is calculated separately according to whether or not firms consider access to finance as the biggest obstacle to their current business operations (rows 1-2, respectively). Secondly, firms are split according to whether (or not) they operate in an EU member state (rows 3 and 4). The implicit assumption here is that firms in Non-EU member countries are more likely to be financially constrained. Finally, the last two rows report results for firms in Non-EU countries separated according to self-reported financial constraints. The numbers reported in Panel C suggest that subsidies have a larger impact on the innovative activities of financially constrained firms. Subsidies are associated with more firm innovation in both EU and Non-EU countries, but the average treatment effects are slightly larger for the latter group in terms of introducing new products.

Columns 3-6 in Table 8 report marginal effects obtained with the special regressor, using EU membership to split the sample, for *NewProducts* (Panel A) and *Upgrade* (Panel B). Consistent with the previous average treatment effects, the positive subsidy effects on firm innovation seem to be mainly driven by firms in Non-EU countries.

Finally, Table 10 reports marginal effects obtained with the standard probit estimator on the whole sample and separately according to country EU membership. All specifications control for economic sector and country effects, and add *Subsidy* interacted with *Overdue* as an indicator of firm financial constraints. If the interaction term is significant and has the

opposite sign to the coefficient associated with the financial variable, one can conclude that subsidies alleviate financial constraints. Subsidies seem to have larger direct effects on the innovative activities of EU firms, but at the same time they have a strong indirect effect via reducing financial constraints for firms in the Non-EU sample.

Overall, the results obtained with the four estimation approaches suggest a positive relationship between public subsidies and firm innovation as measured by the introduction of new products and services and the upgrade of existing ones. As a final robustness check, the whole analysis is done when the innovative indicators are replaced with *Outsource* and *Discont* (results not reported). While there seem to be positive subsidy effects in the case of outsourcing activities, however, there is weak evidence supporting a link between public subsidies and firms discontinuing an existing product or service.

## **6. Conclusions**

This paper investigates the relationship between public subsidies and the innovative activities of roughly 12,000 firms across thirty countries in Eastern Europe and Central Asia. It extends the literature on innovation subsidies by addressing this question in the context of developing economies. As in Ayyagari et al. (2011), innovation activities are defined broadly to include the introduction of new products or services and the upgrade of existing ones, which is of particular relevance for developing economies. Using detailed firm level data collected by the *Business Environment and Enterprise Performance Survey* (BEEPS) in the 2009 round, this paper bridges two strands of the innovation literature: the strand focusing on the role of subsidies and the stream highlighting financial constraints. While most studies omit to control for the financial strength of firms when they look at the impact of subsidies on firm innovative activities, this paper uses alternative indicators of access to internal financial resources, external funding, and self-reported measures of financial constraints. Using a range of econometric techniques including a standard probit model, instrumental variables (probit and special regressor) and treatment effects, this study finds a positive correlation between receipt of public subsidies and the innovative activities of firms in developing economies. Moreover, the analysis finds some evidence suggesting that the positive link is stronger for firms more likely to be financially constrained. Given the importance of innovation for economic growth and the fact that firm innovation, in developing countries in particular, is likely to be constrained by financial factors (Gorodnichenko and Schnitzer, 2013) this finding suggests public intervention is necessary to prevent developing economies lag even further behind industrialised economies.

## References:

- Acemoglu, D., Aghion, P., Zilibotti, F., 2006. Distance to frontier, selection, and economic growth, *Journal of the European Economic Association* 4, 37-74
- Aerts, K., Schmidt, T., 2008. Two for the price of one? Additionality effects of R&D subsidies: A comparison between Flanders and Germany. *Research Policy* 37, 806-822
- Aghion, P., Askenazy, P., Cette, G., Berman, N., Eymard, L., 2012. Credit constraints and the cyclicity of R&D investment: Evidence from France. *Journal of the European Economic Association* 10, 1001–1024
- Almus, M., Czarnitzki, D., 2003. The effects of public R&D subsidies on firms' innovation activities: The case of Eastern Germany. *Journal of Business and Economic Statistics* 21, 226–236
- Ayyagari, M., Demirguc-Kunt, A., Maksimovic, V., 2011. Firm innovation in emerging markets: The roles of governance and finance, *Journal of Financial and Quantitative Analysis* 46, 1545-80
- Baum, C.F., 2012. `specialreg`: Stata module to estimate binary choice model with discrete endogenous regressor via special regressor method. <http://ideas.repec.org/c/boc/bocode/s457546.html>
- Brown, J.R., Martinsson, G., Petersen, B.C., 2012. Do financing constraints matter for R&D? *European Economic Review* 56, 1512–1529
- Brown, J.R., Petersen, B.C., 2009. Why has the investment-cash flow sensitivity declined so sharply? Rising R&D and equity market developments. *Journal of Banking and Finance* 33, 971–984
- Canepa, A., Stoneman, P., 2008. Financial constraints to innovation in the UK: evidence from CIS2 and CIS3, *Oxford Economic Papers* 60, 711–730
- Cappelli, R., Czarnitzki, D., Kraft, K., 2014. Sources of spillovers for imitation and innovation. *Research Policy* 43, 115-120
- Cochrane, J.H., 2005. The risk and return of venture capital. *Journal of Financial Economics* 75, 3–52
- Colombo, M.G., Grilli, L., Murtinu, S., 2011. R&D Subsidies and the performance of high-tech start-ups. *Economics Letters* 112, 97-99
- Czarnitzki, D., Ebersberger, B., Fier, A., 2007. The relationship between R&D collaboration, subsidies and R&D performance: Empirical evidence from Finland and Germany, *Journal of Applied Econometrics* 22, 1347-1366
- Czarnitzki, D., Hottenrott, H., 2011a. Financial constraints: Routine versus cutting-edge R&D investment. *Journal of Economics & Management Strategy* 20, 121-157
- Czarnitzki, D., Hottenrott, H., 2011b. R&D investment and financing constraints of small and medium-sized firms, *Small Business Economics* 36, 65–83
- Czarnitzki, D., Huergo, E., Köhler, M., Mohnen, P., Pacher, S., Takalo, T., Toivanen, O., 2015. Welfare effects of European R&D support policies, mimeograph, <http://simpatic.eu/events/>
- Czarnitzki, D., Lopes-Bento, C., 2013. Value for money? New microeconomic evidence on public R&D grants in Flanders. *Research Policy* 42, 76-89
- Czarnitzki, D., Lopes-Bento, C., 2014. Evaluation of public R&D policies: A cross-country comparison. *World Review of Science, Technology and Sustainable Development* 9, 254-282
- Dong, Y., Lewbel, A., 2014. A simple estimator for binary choice models with endogenous regressors. *Econometric Reviews* forthcoming
- Girma, S., Görg, H., Strobl, E., 2007. The effect of government grants on plant level productivity. *Economics Letters* 94, 439–444.

- Gorodnichenko, Y., Schnitzer, M., 2013. Financial constraints and innovation: Why poor countries don't catch up. *Journal of the European Economic Association* 11, 1115-1152
- Hall, B.H., 2002. The financing of research and development. *Oxford Review of Economic Policy* 18, 35-51
- Hall, B.H., Lerner, J., 2010. The financing of R&D and innovation. In Hall, B. and Rosemberg, N. (Eds.), *Handbook of the Economics of Innovation*. Elsevier-North Holland.
- Hanedar, E.Y., Broccardo, E., Bazzana, F., 2014. Collateral requirements of SMEs: The evidence from less-developed countries, *Journal of Banking and Finance* 38, 106-121
- Himmelberg, C.P., Petersen, B.C., 1994. R&D and internal finance: A panel study of small firms in high-tech industries. *The Review of Economics and Statistics* 76, 38-51
- Hottenrott, H., Lopes-Bento, C., 2014. (International) R&D collaboration and SMEs: The effectiveness of targeted public R&D support schemes. *Research Policy* 43, 1055-1066
- Hottenrott, H., Lopes-Bento, C., Veugelers, R., 2014. Direct and cross-scheme effects in a research and development subsidy program, DICE Discussion Paper, No. 152
- Hsu, P.-H., Tian, X., Xu, Y., 2014. Financial development and innovation: Cross-country evidence. *Journal of Financial Economics* 112, 116-135
- Hyytinen, A., Toivanen, O., 2005. Do financial constraints hold back innovation and growth? Evidence on the role of public policy, *Research Policy* 24, 1385-1403
- Kaplan, S.N., Zingales, L., 1997. Do investment-cash flow sensitivities provide useful measures of financing constraints? *Quarterly Journal of Economics* 112, 169-215
- Kim, W., Weisbach, M.S., 2008. Motivations for public equity offers: An international perspective. *Journal of Financial Economics* 87, 281-307
- Lee, N., Sameen, H., Cowling, M., 2015. Access to finance for innovative SMEs since the financial crisis. *Research Policy* 44, 370-380
- Lewbel, A., 2000. Semiparametric qualitative response model estimation with unknown heteroskedasticity or instrumental variables. *Journal of Econometrics* 97, 145-177
- Lewbel, A., Schennach, S., 2007. A simple ordered data estimator for inverse density weighted functions. *Journal of Econometrics* 136, 189-211.
- Mulkay, B., Hall, B.H., Mairesse, J., 2001. Firm level investment and R&D in France and the United States: A comparison. In Deutsche Bundesbank (Ed.), *Investing today for the world of tomorrow: Studies on the investment process in Europe*, Heidelberg: Springer Berlin, 229-73
- Paunov, C., 2012. The global crisis and firms' investments in innovation. *Research Policy* 41, 24-35
- Popov, A., 2013. Credit constraints and investment in human capital: Training evidence from transition economies, *Journal of Financial Intermediation* 23, 76-100
- Takalo, T., Tanayama, T., Toivanen, O., 2013a. Estimating the benefits of targeted R&D subsidies, *The Review of Economics and Statistics* 95, 255-272
- Takalo, T., Tanayama, T., Toivanen, O., 2013b. Market failures and the additional effects of public support to private R&D: Theory and empirical implications, *International Journal of Industrial Organization* 31, 634-642
- Wallsten, S.J., 2000. The effects of government-industry R&D programs on private R&D: the case Small Business Innovation Research Program, *RAND Journal of Economics* 31, 82-100

**Table 1. Panel A. Indicators of firm innovative activity**

Country	NewProduct	Upgrade	Outsource	Discont	R&D	Subsidy
Albania	0.414	0.701	0.115	0.109	0.305	0.018
Belarus	0.696	0.907	0.200	0.342	0.198	0.041
Georgia	0.349	0.749	0.182	0.152	0.134	0.041
Tajikistan	0.517	0.793	0.207	0.162	0.120	0.050
Turkey	0.448	0.598	0.269	0.217	0.273	0.090
Ukraine	0.568	0.770	0.234	0.245	0.198	0.024
Uzbekistan	0.230	0.374	0.217	0.133	0.025	0.025
Russia	0.644	0.861	0.288	0.300	0.328	0.068
Poland	0.581	0.601	0.311	0.161	0.211	0.135
Romania	0.464	0.522	0.128	0.218	0.258	0.111
Serbia	0.621	0.751	0.389	0.245	0.331	0.075
Kazakhstan	0.453	0.753	0.181	0.156	0.117	0.035
Moldova	0.533	0.660	0.151	0.275	0.274	0.070
Bosnia and Herzegovina	0.599	0.810	0.213	0.196	0.468	0.144
Azerbaijan	0.442	0.742	0.261	0.226	0.082	0.037
FYR Macedonia	0.597	0.766	0.243	0.164	0.413	0.038
Armenia	0.614	0.753	0.354	0.288	0.219	0.008
Kyrgyz Republic	0.462	0.685	0.174	0.193	0.149	0.077
Mongolia	0.680	0.845	0.220	0.246	0.227	0.088
Estonia	0.641	0.780	0.478	0.429	0.359	0.187
Kosovo under UNSCR 1244	0.549	0.869	0.052	0.382	0.264	0.041
Czech Republic	0.622	0.720	0.356	0.301	0.282	0.240
Hungary	0.426	0.745	0.225	0.259	0.175	0.196
Latvia	0.605	0.893	0.281	0.387	0.181	0.141
Lithuania	0.698	0.912	0.464	0.447	0.239	0.170
Slovak Republic	0.526	0.703	0.259	0.242	0.151	0.165
Slovenia	0.745	0.908	0.392	0.324	0.411	0.252
Bulgaria	0.423	0.586	0.196	0.147	0.285	0.038
Croatia	0.658	0.761	0.338	0.312	0.519	0.266
Montenegro	0.534	0.609	0.294	0.113	0.246	0.027
<b>Total</b>	<b>0.541</b>	<b>0.733</b>	<b>0.258</b>	<b>0.243</b>	<b>0.246</b>	<b>0.087</b>

**Table 1. Panel B. EU country membership**

		NewProduct	Upgrade	Outsource	Discont	R&D	Subsidy
Non-EU	Mean	0.531	0.741	0.245	0.230	0.239	0.057
	SD	0.499	0.438	0.430	0.421	0.426	0.232
	No firms	8532	8482	3786	8470	8493	8447
EU	Mean	0.568	0.712	0.298	0.277	0.264	0.162
	SD	0.495	0.453	0.458	0.448	0.441	0.368
	No firms	3398	3374	1161	3376	3378	3373
Total	Mean	0.541	0.733	0.258	0.243	0.246	0.087
	SD	0.498	0.442	0.437	0.429	0.431	0.281
	No firms	11930	11856	4947	11846	11871	11820



**Table2. Summary statistics**

**Panel A. Financial strength variables**

variable	N	mean	sd	min	max
<i>CreditLine</i>	11853	0.478	0.500	0	1
<i>Overdraft</i>	11116	0.451	0.498	0	1
<i>BankLoan</i>	6819	0.397	0.489	0	1
<i>PCM</i>	3369	0.365	0.306	-1	0.999
<i>FC1</i>	10745	0.172	0.377	0	1
<i>FC2</i>	11535	0.271	0.445	0	1
<i>Access</i>	11535	1.568	1.356	0	4
<i>Overdue</i>	11916	0.072	0.258	0	1

**Panel B. Controls**

variable	N	mean	sd	min	max
<i>EMP</i>	11880	126.850	1,076.128	1	100,000
<i>Small</i>	11880	0.648	0.478	0	1
<i>SME</i>	11880	0.907	0.291	0	1
<i>Age</i>	11750	16.603	15.797	1	184
<i>Exporter</i>	11998	0.264	0.441	0	1
<i>Foreign</i>	11861	0.069	0.253	0	1
<i>Group</i>	11998	0.107	0.309	0	1
<i>Compet</i>	3892	3.380	0.883	1	4
<i>Market</i>	4991	1.838	0.702	1	3
<i>Pres_domcomp</i>	11831	0.623	0.485	0	1
<i>Pres_fcomp</i>	11594	0.365	0.482	0	1
<i>Pres_customer</i>	11724	0.608	0.488	0	1
<i>CU</i>	4634	0.735	0.236	0	1
<i>Importinp</i>	4738	0.326	0.369	0	1
<i>Training</i>	4937	0.395	0.489	0	1

**Table 3. Pairwise correlations**

**Panel A. Correlations among innovation measures**

	<i>NewProduct</i>	<i>Upgrade</i>	<i>Outsource</i>	<i>Discont</i>
<i>Upgrade</i>	0.434*			
<i>Outsource</i>	0.158*	0.143*		
<i>Discont</i>	0.246*	0.171*	0.158*	
<i>R&amp;D</i>	0.303*	0.230*	0.203*	0.125*

**Panel B. Correlations between innovation measures, subsidy and firm financial strength**

	<i>NewProduct</i>	<i>Upgrade</i>	<i>Subsidy</i>	<i>CreditLine</i>	<i>Overdraft</i>	<i>Bank</i>
<i>Subsidy</i>	0.094*	0.069*				
<i>CreditLine</i>	0.141*	0.087*	0.135*			
<i>Overdraft</i>	0.103*	0.075*	0.082*	0.313*		
<i>BankLoan</i>	0.057*	0.046*	0.097*	0.480*	0.181*	
<i>PCM</i>	0.050*	0.049*	0.020	0.009	0.061*	-0.004

**Panel C. Correlations between innovation measures and firm characteristics**

	<i>NewProduct</i>	<i>Upgrade</i>	<i>EMP</i>	<i>SME</i>	<i>Age</i>	<i>Exporter</i>	<i>Foreign</i>	<i>Group</i>	<i>CU</i>
<i>EMP</i>	0.031*	0.016							
<i>SME</i>	-0.072*	-0.058*	-0.230*						
<i>Age</i>	0.034*	0.016	0.081*	-0.242*					
<i>Exporter</i>	0.143*	0.082*	0.062*	-0.186*	0.147*				
<i>Foreign</i>	0.069*	0.043*	0.038*	-0.129*	-0.012	0.147*			
<i>Group</i>	0.059*	0.032*	0.036*	-0.101*	0.046*	0.055*	0.202*		
<i>CU</i>	-0.004	0.065*	0.046*	-0.057*	-0.078*	0.046*	0.055*	0.032*	
<i>Training</i>	0.243*	0.181*	0.118*	-0.176*	0.089*	0.202*	0.085*	0.109*	0.008

**Panel D. Correlations between innovation measures and market competition**

	<i>NewProduct</i>	<i>Upgrade</i>	<i>Compet</i>	<i>Market</i>	<i>Importinp</i>	<i>Pres_domc omp</i>	<i>Pres_fcomp</i>
<i>Compet</i>	0.083*	0.042*					
<i>Market</i>	0.044*	0.043*	0.097*				
<i>Importinp</i>	0.132*	0.131*	0.040*	0.224*			
<i>Pres_domcomp</i>	0.056*	0.043*	0.258*	-0.123*	-0.065*		
<i>Pres_fcomp</i>	0.083*	0.064*	0.086*	0.237*	0.152*	0.226*	
<i>Pres_customer</i>	0.089*	0.034*	0.162*	0.026	0.002	0.371*	0.261*

**Table 4. Baseline results**

**Panel A. Dependent variable NewProduct**

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>EMP</i>	0.043*** (0.014)	0.041*** (0.015)	0.033** (0.014)	0.032** (0.014)	0.031** (0.015)	0.030** (0.015)	0.022 (0.014)	0.022 (0.014)
<i>EMP2</i>	-0.002 (0.002)	-0.002 (0.002)	-0.003 (0.002)	-0.003 (0.002)	-0.001 (0.002)	-0.002 (0.002)	-0.002 (0.002)	-0.003 (0.002)
<i>Exporter</i>	0.132*** (0.015)	0.127*** (0.015)	0.090*** (0.014)	0.092*** (0.014)	0.124*** (0.015)	0.119*** (0.014)	0.084*** (0.013)	0.084*** (0.013)
<i>Foreign</i>	0.079*** (0.022)	0.083*** (0.023)	0.092*** (0.024)	0.090*** (0.023)	0.088*** (0.023)	0.091*** (0.024)	0.098*** (0.024)	0.091*** (0.025)
<i>Subsidy</i>		0.116*** (0.019)	0.084*** (0.018)			0.107*** (0.019)	0.077*** (0.019)	0.076*** (0.019)
<i>R&amp;D</i>			0.324*** (0.015)	0.326*** (0.015)			0.319*** (0.016)	0.318*** (0.016)
<i>CreditLine</i>					0.100*** (0.014)	0.096*** (0.014)	0.084*** (0.013)	0.085*** (0.013)
<i>Group</i>								0.037* (0.019)
Observations	11,708	11,569	11,495	11,616	11,606	11,482	11,414	11,414
Pseudo Rsq	0.0551	0.0579	0.109	0.108	0.0608	0.0632	0.113	0.113

**Panel B. Dependent variable Upgrade**

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>EMP</i>	0.076*** (0.014)	0.074*** (0.014)	0.070*** (0.013)	0.070*** (0.013)	0.070*** (0.013)	0.067*** (0.013)	0.064*** (0.013)	0.064*** (0.013)
<i>EMP2</i>	-0.007*** (0.002)	-0.007*** (0.002)	-0.007*** (0.002)	-0.007*** (0.002)	-0.006*** (0.002)	-0.006*** (0.002)	-0.007*** (0.002)	-0.007*** (0.002)
<i>Exporter</i>	0.071*** (0.013)	0.067*** (0.013)	0.041*** (0.013)	0.043*** (0.013)	0.065*** (0.014)	0.062*** (0.013)	0.037*** (0.014)	0.037*** (0.014)
<i>Foreign</i>	0.042** (0.016)	0.042** (0.017)	0.043*** (0.016)	0.044*** (0.016)	0.047*** (0.017)	0.047*** (0.017)	0.047*** (0.017)	0.047*** (0.017)
<i>Subsidy</i>		0.082*** (0.022)	0.058*** (0.022)			0.077*** (0.023)	0.054** (0.023)	0.054** (0.023)
<i>R&amp;D</i>			0.217*** (0.010)	0.219*** (0.011)			0.215*** (0.010)	0.215*** (0.011)
<i>CreditLine</i>					0.052*** (0.012)	0.049*** (0.012)	0.038*** (0.011)	0.038*** (0.011)
<i>Group</i>								-0.002 (0.021)
Observations	11,635	11,501	11,424	11,542	11,534	11,415	11,344	11,344
Pseudo Rsq	0.0804	0.0816	0.122	0.122	0.0833	0.0842	0.123	0.123

**Note:** The table reports marginal effects calculated at the mean. All specifications include country fixed effects. Robust standard errors clustered at country level in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 5. Firm financial strength measures**

VARIABLES	NewProduct					Upgrade				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>EMP</i>	0.024 (0.015)	0.029** (0.015)	-0.023 (0.019)	0.059** (0.028)	0.036** (0.015)	0.064*** (0.014)	0.064*** (0.014)	0.020 (0.015)	0.103*** (0.023)	0.071*** (0.014)
<i>EMP2</i>	-0.003 (0.002)	-0.003* (0.002)	0.002 (0.002)	-0.006* (0.003)	-0.003* (0.002)	-0.007*** (0.002)	-0.007*** (0.002)	-0.002 (0.002)	-0.011*** (0.003)	-0.008*** (0.002)
<i>Exporter</i>	0.087*** (0.013)	0.093*** (0.014)	0.078*** (0.016)	0.061** (0.029)	0.094*** (0.014)	0.040*** (0.013)	0.041*** (0.014)	0.036*** (0.011)	0.029 (0.022)	0.044*** (0.013)
<i>Foreign</i>	0.089*** (0.025)	0.080*** (0.027)	0.064*** (0.023)	-0.014 (0.032)	0.081*** (0.025)	0.049*** (0.017)	0.052*** (0.018)	0.019 (0.015)	0.007 (0.027)	0.044*** (0.017)
<i>Subsidy</i>	0.080*** (0.018)	0.095*** (0.017)	0.062*** (0.016)	0.099*** (0.025)	0.087*** (0.017)	0.054** (0.022)	0.068*** (0.021)	0.039** (0.017)	0.080*** (0.021)	0.060*** (0.021)
<i>R&amp;D</i>	0.318*** (0.016)	0.322*** (0.015)	0.258*** (0.016)	0.314*** (0.018)	0.322*** (0.015)	0.215*** (0.011)	0.216*** (0.012)	0.165*** (0.009)	0.192*** (0.015)	0.216*** (0.011)
<i>Group</i>	0.039** (0.018)	0.038** (0.017)	0.050*** (0.017)	0.022 (0.028)	0.036** (0.018)	0.001 (0.022)	-0.005 (0.022)	-0.002 (0.018)	0.023 (0.023)	0.001 (0.022)
<i>Age</i>	-0.003 (0.010)	0.000 (0.011)	0.003 (0.012)	-0.005 (0.018)	-0.003 (0.010)	0.001 (0.009)	0.001 (0.010)	0.006 (0.009)	-0.025* (0.015)	0.004 (0.009)
<i>CreditLine</i>	0.086*** (0.013)					0.038*** (0.011)				
<i>Overdraft</i>		0.056*** (0.013)					0.045*** (0.013)			
<i>BankLoan</i>			0.035** (0.014)					0.013 (0.009)		
<i>PCM</i>				0.051** (0.025)					0.053*** (0.020)	
<i>Overdue</i>					-0.042* (0.021)					-0.095*** (0.024)
Observations	11,229	10,541	6,469	3,278	11,256	11,160	10,474	6,444	3,272	11,187
Pseudo Rsq	0.113	0.115	0.0903	0.132	0.110	0.124	0.127	0.121	0.142	0.124

**Note:** The table reports marginal effects calculated at the mean. All specifications include country fixed effects. Robust standard errors clustered at country level in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 6. Innovation and product market competition****Panel A. NewProduct**

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
<i>EMP</i>	0.074*** (0.020)	0.025* (0.014)	0.068*** (0.023)	0.046*** (0.015)	0.020 (0.015)	0.049*** (0.017)
<i>EMP2</i>	-0.009*** (0.003)	-0.003 (0.002)	-0.008** (0.004)	-0.005** (0.002)	-0.002 (0.002)	-0.005** (0.002)
<i>Exporter</i>	0.125*** (0.025)	0.087*** (0.013)	0.110*** (0.025)	0.098*** (0.028)	0.090*** (0.013)	0.101*** (0.030)
<i>Foreign</i>	0.078** (0.037)	0.090*** (0.024)	0.067** (0.034)	0.017 (0.029)	0.107*** (0.024)	0.035 (0.028)
<i>CreditLine</i>	0.107*** (0.021)	0.087*** (0.013)	0.104*** (0.019)	0.084*** (0.016)	0.079*** (0.013)	0.076*** (0.016)
<i>Subsidy</i>	0.060** (0.025)	0.084*** (0.017)	0.057** (0.025)	0.084*** (0.020)	0.088*** (0.018)	0.091*** (0.020)
<i>R&amp;D</i>	0.315*** (0.015)	0.316*** (0.015)	0.306*** (0.014)	0.330*** (0.015)	0.313*** (0.016)	0.330*** (0.015)
<i>Age</i>	0.011 (0.014)	-0.003 (0.010)	0.016 (0.014)	0.003 (0.014)	-0.004 (0.010)	0.002 (0.013)
<i>Compet</i>	0.044*** (0.016)		0.037*** (0.013)			
<i>City</i>		-0.012 (0.008)				
<i>Importinp</i>			0.153*** (0.027)			
<i>Market</i>				-0.052*** (0.014)		-0.052*** (0.013)
<i>Pres_domcomp</i>					0.044*** (0.010)	0.040** (0.018)
<i>Pres_fcomp</i>					0.012 (0.013)	0.006 (0.017)
<i>Pres_customer</i>					0.056*** (0.012)	0.040* (0.022)
Observations	3,675	11,229	3,534	4,680	10,737	4,500
Pseudo Rsq	0.151	0.114	0.159	0.139	0.118	0.144

**Note:** The table reports marginal effects calculated at the mean. All specifications include country fixed effects. Robust standard errors clustered at country level in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Panel B. Upgrade**

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
<i>EMP</i>	0.089*** (0.023)	0.064*** (0.014)	0.087*** (0.025)	0.085*** (0.021)	0.063*** (0.014)	0.082*** (0.020)
<i>EMP2</i>	-0.010*** (0.002)	-0.007*** (0.002)	-0.009*** (0.003)	-0.009*** (0.002)	-0.007*** (0.002)	-0.009*** (0.002)
<i>Exporter</i>	0.060*** (0.019)	0.040*** (0.014)	0.048** (0.019)	0.046** (0.020)	0.040*** (0.013)	0.050** (0.020)
<i>Foreign</i>	0.004 (0.030)	0.045*** (0.016)	-0.013 (0.033)	0.003 (0.021)	0.054*** (0.016)	0.014 (0.023)
<i>CreditLine</i>	0.037*** (0.014)	0.039*** (0.011)	0.038*** (0.015)	0.032** (0.013)	0.035*** (0.012)	0.032** (0.014)
<i>Subsidy</i>	0.070*** (0.025)	0.056** (0.022)	0.069*** (0.025)	0.076*** (0.022)	0.059*** (0.021)	0.081*** (0.020)
<i>R&amp;D</i>	0.197*** (0.018)	0.213*** (0.011)	0.193*** (0.017)	0.198*** (0.014)	0.209*** (0.011)	0.192*** (0.014)
<i>Age</i>	-0.016** (0.008)	0.002 (0.009)	-0.019** (0.010)	-0.013 (0.011)	0.002 (0.009)	-0.015 (0.010)
<i>Compet</i>	0.026** (0.010)		0.027** (0.011)			
<i>City</i>		-0.009** (0.004)				
<i>Importinp</i>			0.108*** (0.025)			
<i>Market</i>				-0.009 (0.009)		-0.013 (0.011)
<i>Pres_domcomp</i>					0.037*** (0.011)	0.029* (0.015)
<i>Pres_fcomp</i>					0.020 (0.013)	0.026* (0.016)
<i>Pres_customer</i>					0.028*** (0.011)	0.019 (0.014)
Observations	3,664	11,160	3,523	4,668	10,675	4,487
Pseudo Rsq	0.136	0.125	0.145	0.136	0.129	0.142

**Note:** The table reports marginal effects calculated at the mean. All specifications include country fixed effects. Robust standard errors clustered at country level in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 7. Additional results**

**Panel A. NewProduct**

VARIABLES	(1) <i>v Stand</i>	(2) <i>v Manuf</i>	(3) <i>if Manuf</i>	(4) <i>CU</i>	(5) <i>CapIntens</i>	(6) <i>Training</i>
<i>EMP</i>	0.038*** (0.014)	0.040*** (0.015)	0.025* (0.014)	0.035** (0.017)	0.047** (0.023)	0.021 (0.015)
<i>EMP2</i>	-0.003* (0.002)	-0.003* (0.002)	-0.003 (0.002)	-0.004* (0.002)	-0.006* (0.003)	-0.004* (0.002)
<i>Exporter</i>	0.071*** (0.014)	0.075*** (0.014)	0.066*** (0.023)	0.063** (0.025)	0.058* (0.030)	0.066*** (0.025)
<i>Foreign</i>	0.076*** (0.023)	0.073*** (0.024)	0.010 (0.027)	0.001 (0.033)	0.020 (0.033)	0.001 (0.030)
<i>CreditLine</i>	0.080*** (0.014)	0.079*** (0.013)	0.073*** (0.015)	0.081*** (0.016)	0.084*** (0.017)	0.078*** (0.015)
<i>Subsidy</i>	0.070*** (0.019)	0.074*** (0.018)	0.071*** (0.020)	0.092*** (0.019)	0.094*** (0.024)	0.079*** (0.021)
<i>R&amp;D</i>	0.321*** (0.016)	0.322*** (0.016)	0.326*** (0.017)	0.321*** (0.015)	0.323*** (0.019)	0.307*** (0.016)
<i>Group</i>	0.025 (0.019)	0.028 (0.019)	0.029 (0.020)	0.020 (0.022)		
<i>Diff</i>	0.039* (0.024)					
<i>Construct</i>	-0.196*** (0.020)	-0.212*** (0.020)				
<i>Retail</i>	0.041** (0.019)	0.026 (0.018)				
<i>Wholesale</i>	0.069*** (0.018)	0.052*** (0.018)				
<i>Services</i>	-0.093*** (0.022)	-0.109*** (0.019)				
<i>Age</i>		-0.004 (0.010)	0.008 (0.015)	0.005 (0.016)	0.011 (0.017)	0.007 (0.014)
<i>CU</i>				-0.052 (0.042)		
<i>CapIntens</i>					0.001*** (0.000)	
<i>Training</i>						0.135*** (0.016)
Observations	11,267	11,092	4,992	4,376	3,343	4,665
Pseudo Rsq	0.127	0.127	0.134	0.136	0.137	0.149

**Note:** The table reports marginal effects calculated at the means and robust standard errors clustered at country level (in parentheses). All specifications include country fixed effects. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Panel B. Upgrade**

VARIABLES	(1) <i>v Stand</i>	(2) <i>v Manuf</i>	(3) <i>if Manuf</i>	(4) <i>CU</i>	(5) <i>CapIntens</i>	(6) <i>Training</i>
<i>EMP</i>	0.070*** (0.012)	0.069*** (0.013)	0.072*** (0.017)	0.082*** (0.020)	0.099*** (0.021)	0.074*** (0.021)
<i>EMP2</i>	-0.007*** (0.002)	-0.007*** (0.002)	-0.008*** (0.002)	-0.009*** (0.002)	-0.011*** (0.003)	-0.009*** (0.002)
<i>Exporter</i>	0.035** (0.014)	0.038*** (0.014)	0.048** (0.019)	0.034* (0.020)	0.041* (0.023)	0.038** (0.020)
<i>Foreign</i>	0.040** (0.016)	0.042*** (0.016)	0.004 (0.019)	0.001 (0.025)	0.019 (0.021)	-0.006 (0.021)
<i>CreditLine</i>	0.034*** (0.011)	0.033*** (0.011)	0.033** (0.014)	0.034*** (0.012)	0.022 (0.014)	0.027** (0.013)
<i>Subsidy</i>	0.050** (0.022)	0.050** (0.022)	0.074*** (0.021)	0.084*** (0.020)	0.069*** (0.023)	0.072*** (0.022)
<i>R&amp;D</i>	0.211*** (0.010)	0.213*** (0.011)	0.199*** (0.013)	0.196*** (0.013)	0.195*** (0.014)	0.182*** (0.014)
<i>Group</i>	-0.003 (0.020)	-0.000 (0.021)	-0.016 (0.027)	0.013 (0.023)		
<i>Differentiated</i>	0.042*** (0.015)					
<i>Construct</i>	-0.041* (0.023)	-0.060*** (0.022)				
<i>Retail</i>	0.031** (0.016)	0.016 (0.017)				
<i>Wholesale</i>	0.002 (0.019)	-0.014 (0.020)				
<i>Services</i>	-0.029 (0.020)	-0.045** (0.019)				
<i>Age</i>		0.000 (0.009)	-0.004 (0.013)	-0.013 (0.011)	-0.009 (0.014)	-0.014 (0.010)
<i>CU</i>				0.098*** (0.018)		
<i>CapIntens</i>					-0.000 (0.000)	
<i>Training</i>						0.094*** (0.012)
Observations	11,198	11,024	4,979	4,366	3,338	4,654
Pseudo Rsq	0.125	0.125	0.132	0.141	0.139	0.145

**Note:** The table reports marginal effects calculated at the means and robust standard errors clustered at country level (in parentheses). All specifications include country fixed effects. \*\*\* p<0.01, \*\*p<0.05, \* p<0.



**Table 8. Special regressor marginal effects**

**Panel A. NewProduct**

	All sample		Non-EU		EU	
	(1) kdens	(2) sortdens	(3) kdens	(4) sortdens	(5) kdens	(6) sortdens
<i>EMP</i>	-0.073*** (0.015)	-0.068*** (0.021)	-0.055*** (0.020)	-0.045* (0.023)	-0.033 (0.024)	-0.040 (0.036)
<i>EMP2</i>	0.006*** (0.002)	0.006** (0.003)	0.005* (0.002)	0.004 (0.003)	0.002 (0.003)	0.002 (0.005)
<i>Exporter</i>	0.023* (0.013)	0.022 (0.014)	0.017 (0.015)	0.016 (0.016)	0.047** (0.024)	0.062** (0.030)
<i>Foreign</i>	-0.003 (0.026)	-0.006 (0.033)	-0.002 (0.025)	-0.006 (0.032)	0.072** (0.034)	0.078* (0.041)
<i>R&amp;D</i>	0.105*** (0.016)	0.095*** (0.017)	0.081*** (0.018)	0.077*** (0.023)	0.079*** (0.030)	0.120*** (0.035)
<i>Subsidy</i>	0.043** (0.017)	0.043** (0.021)	0.060** (0.026)	0.060** (0.028)	0.035 (0.022)	0.044 (0.030)
<i>FCI</i>	-0.915*** (0.217)	-0.812*** (0.267)	-0.758*** (0.170)	-0.696*** (0.219)	0.149 (0.426)	0.017 (0.502)
<i>Age~</i>	0.004*** (0.001)	0.005*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	0.007*** (0.002)	0.010*** (0.002)
Observations	10,037	10,037	7,269	7,269	2,768	2,768

**Panel B. Upgrade**

	All sample		Non-EU		EU	
	(1) kdens	(2) sortdens	(3) kdens	(4) sortdens	(5) kdens	(6) sortdens
<i>EMP</i>	-0.027*** (0.007)	-0.025*** (0.009)	-0.025*** (0.009)	-0.024** (0.012)	-0.012 (0.019)	-0.011 (0.028)
<i>EMP2</i>	0.003*** (0.001)	0.002** (0.001)	0.002*** (0.001)	0.002* (0.001)	0.002 (0.003)	0.001 (0.004)
<i>Exporter</i>	0.001 (0.005)	0.001 (0.007)	0.001 (0.005)	0.001 (0.006)	0.031** (0.015)	0.041* (0.025)
<i>Foreign</i>	-0.012 (0.009)	-0.013 (0.011)	-0.006 (0.008)	-0.002 (0.010)	0.012 (0.029)	0.010 (0.043)
<i>R&amp;D</i>	0.026*** (0.009)	0.028** (0.012)	0.021** (0.010)	0.019* (0.011)	0.036* (0.019)	0.053* (0.031)
<i>Subsidy</i>	0.014* (0.008)	0.014 (0.009)	0.025** (0.010)	0.028** (0.013)	0.022 (0.019)	0.022 (0.024)
<i>FCI</i>	-0.427*** (0.091)	-0.464*** (0.121)	-0.334*** (0.096)	-0.337*** (0.120)	-0.130 (0.338)	-0.408 (0.432)
<i>Age~</i>	0.002*** (0.001)	0.002*** (0.001)	0.001** (0.001)	0.001*** (0.000)	0.007*** (0.002)	0.009*** (0.002)
Observations	9,976	9,976	7,216	7,216	2,760	2,760

**Note:** The table reports marginal effects obtained with the special regressor estimator and bootstrapped standard errors in parentheses (100 replications) for the dependent variables *NewProduct* (Panel A) and *Upgrade* (Panel B). Two specifications of the density estimator are used: the kernel density in columns 1, 3 and 5, and the sorted data density in columns 2, 4 and 6. The special regressor *Age~* (firm age demeaned) is exogenous, continuously distributed, and likely to be correlated with firm innovativeness. *FCI* is 1 if access to finance is either a major or a very serious obstacle to current business operations, 0 otherwise. Economic sector controls are included but not reported. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 9.****Panel A. Propensity score matching - Average subsidy effects on subsidised firms**

Model	Variables	<i>NewProduct</i>				<i>Upgrade</i>			
		ATET	RSE	P> z	Obs	ATET	RSE	P> z	Obs
1	<i>Emp Emp<sup>2</sup> Export Foreign</i>	0.127	0.017	0.000	11,569	0.090	0.014	0.000	11,501
2	<i>(1) + R&amp;D</i>	0.088	0.017	0.000	11,495	0.056	0.015	0.000	11,424
3	<i>(1) + CreditLine</i>	0.096	0.017	0.000	11,482	0.072	0.015	0.000	11,415
4	<i>(1) + R&amp;D + CreditLine</i>	0.080	0.017	0.000	11,414	0.054	0.015	0.000	11,344
5	<i>(4) + Group</i>	0.064	0.018	0.000	11,414	0.065	0.015	0.000	11,344
6	<i>(4) + Country</i>	0.094	0.021	0.000	11,414	0.047	0.017	0.005	11,344
7	<i>(4) + Ind (two-digit)</i>	0.070	0.020	0.000	11,267	0.035	0.016	0.028	11,344
8	<i>(6) + Compet</i>	0.079	0.033	0.017	3,738	0.061	0.028	0.026	3,727
9	<i>(2) + CreditLine+Country+Market</i>	0.082	0.028	0.003	4,764	0.071	0.025	0.004	4,751
10	<i>(9) + Ind</i>	0.089	0.030	0.003	4,717	0.080	0.024	0.001	4,705

**Note:** The table reports the average subsidy (treatment) effects on the subsidised firms (ATET), robust standard errors (RSE), probabilities, and number of observations.

**Panel B. Average treatment effects - different financial strength measures**

Model	Financial variable	<i>NewProduct</i>				<i>Upgrade</i>			
		ATET	RSE	P> z	Obs	ATET	RSE	P> z	Obs
1	<i>Overdraft</i>	0.079	0.028	0.005	4,435	0.130	0.027	0.000	4,424
2	<i>BankLoan</i>	0.083	0.032	0.009	2,804	0.047	0.024	0.052	2,802
3	<i>PCM</i>	0.132	0.035	0.000	3,294	0.059	0.029	0.043	3,288
4	<i>Overdue</i>	0.088	0.029	0.002	4,725	0.074	0.024	0.002	4,713
5	<i>FC1</i>	0.057	0.029	0.051	4,305	0.094	0.027	0.000	4,295
6	<i>FC2</i>	0.072	0.029	0.015	4,600	0.100	0.025	0.000	4,589
7	<i>Access</i>	0.086	0.030	0.004	4,600	0.104	0.026	0.001	4,589

**Note:** Matching is performed as in model 10 in Panel A (i.e. using the variables *Emp*, *Emp<sup>2</sup>*, *Export*, *Foreign*, *R&D*, *Country*, *Market*, *Ind*) but replaces *CreditLine* with alternative financial strength variables. The table reports the average subsidy (treatment) effects on the subsidised firms (ATET), robust standard errors (RSE), probabilities, and number of observations.

**Panel C. Average treatment effects - separate samples according to financial constraints**

Model	Sample	<i>NewProduct</i>				<i>Upgrade</i>			
		ATET	RSE	P> z	Obs	ATET	RSE	P> z	Obs
1	<i>FCI=1</i>	0.144	0.048	0.003	1,759	0.075	0.045	0.098	1,746
2	<i>FCI=0</i>	0.046	0.026	0.076	8,462	0.023	0.020	0.252	8,412
3	<i>Non-EU</i>	0.097	0.028	0.001	8,191	0.021	0.025	0.400	8,136
4	<i>EU</i>	0.084	0.032	0.008	3,150	0.051	0.026	0.044	3,135
5	<i>Non-EU &amp; FCI=1</i>	0.110	0.061	0.068	1,377	-0.002	0.056	0.971	1,368
6	<i>Non-EU &amp; FCI=0</i>	0.040	0.037	0.289	6,022	0.020	0.030	0.511	5,977

**Note:** Firms are matched on the variables *Emp*, *Emp2*, *Export*, *Foreign*, *R&D*, *Country*, and economic sector (standardised manufacturing is the reference category). Samples are split according to access to finance is the biggest obstacle to firms' current business operations ( $FCI = 1/0$ ); the country in which the firm operates is a EU member. The table reports the average subsidy (treatment) effects on the subsidised firms (ATET), robust standard errors (RSE), probabilities, and number of observations.

**Table 10. Interaction terms - probit marginal effects**

	<i>NewProduct</i>			<i>Upgrade</i>		
	All sample	Non-EU	EU	All sample	Non-EU	EU
	(1)	(2)	(3)	(4)	(5)	(6)
<i>EMP</i>	0.051*** (0.015)	0.056*** (0.015)	0.041 (0.033)	0.076*** (0.013)	0.067*** (0.012)	0.076*** (0.027)
<i>EMP2</i>	-0.004** (0.002)	-0.005** (0.002)	-0.003 (0.004)	-0.008*** (0.002)	-0.007*** (0.002)	-0.005 (0.004)
<i>Exporter</i>	0.081*** (0.015)	0.089*** (0.014)	0.065* (0.035)	0.041*** (0.014)	0.056*** (0.015)	0.003 (0.020)
<i>Foreign</i>	0.068*** (0.024)	0.065** (0.029)	0.081** (0.040)	0.039** (0.016)	0.028 (0.021)	0.053** (0.024)
<i>R&amp;D</i>	0.325*** (0.015)	0.330*** (0.017)	0.309*** (0.033)	0.212*** (0.010)	0.204*** (0.010)	0.226*** (0.025)
<i>Group</i>	0.025 (0.019)	0.039* (0.024)	-0.013 (0.024)	-0.000 (0.021)	0.012 (0.027)	-0.039 (0.032)
<i>Age</i>	-0.004 (0.010)	-0.003 (0.012)	-0.007 (0.022)	0.003 (0.009)	0.003 (0.010)	0.017 (0.018)
<i>Subsidy</i>	0.074*** (0.018)	0.063* (0.033)	0.091*** (0.018)	0.050** (0.022)	0.032 (0.033)	0.063* (0.034)
<i>Overdue</i>	-0.046** (0.023)	-0.064** (0.028)	0.015 (0.032)	-0.099*** (0.026)	-0.118*** (0.031)	-0.030 (0.038)
<i>Overdue*Subsidy</i>	0.088 (0.054)	0.200*** (0.053)	-0.084 (0.061)	0.070** (0.035)	0.121*** (0.034)	-0.040 (0.074)
Observations	11,114	8,029	3,085	11,046	7,975	3,071
Pseudo Rsq	0.125	0.123	0.129	0.127	0.114	0.170

**Note:** The table reports marginal effects calculated at the means and robust standard errors clustered at country level (in parentheses). All specifications include country and economic sector fixed effects. \*\*\* p<0.01, \*\*p<0.05, \* p<0.

## Data Appendix

### Variable definitions

#### *Innovative activities*

**NewProduct** = 1 if the firm has introduced new products or services in the last three years (i.e. over the period 2007-2009), 0 otherwise.

**Upgrade** = 1 if the firm has upgraded an existing product line or service in the last three years, 0 otherwise

**Outsource** = 1 if, in the last three years, the firm has contracted with other companies (outsourced) activities previously performed in-house, 0 otherwise

**Discontinued** = 1 if the firm has discontinued at least one product line or service in the last three years, 0 otherwise

**R&D** = 1 if, in fiscal year 2007, the firm spent a positive amount on research and development activities, either in-house or contracted with other companies (outsourced), 0 otherwise.

**Subsidy** = 1 if the firm has received any subsidies from the national, regional or local governments or European Union sources over the last three years, 0 otherwise

#### *Financial strength*

**Credit line** = 1 if the firm has a credit line or loan from a financial institution, 0 otherwise

**Overdraft** = 1 if the firm has an overdraft facility, 0 otherwise

**BankLoan** = 1 if the firm borrowed from private or state-owned banks to purchase fixed assets in 2007, 0 otherwise. Firms have to estimate the proportion of their total purchases of fixed assets that was financed from each of the following sources: a) internal funds or retained earnings; b) owners' contribution or issued new equity shares; c) borrowed from private banks; d) borrowed from state-owned banks; e) purchases on credit from suppliers and advances from customers; f) other (moneylenders, friends, relatives, non-banking financial institutions, etc.). These proportions add up to 100%. Firms which did not purchase any fixed assets were not asked this question.

**PCM** = the price-cost margin is calculated for year 2007 as  $(\text{sales} - \text{annual cost of labour} - \text{annual cost of raw materials and intermediate goods used in production} + \delta \cdot \text{R\&D expenditure}) / \text{sales}$ . The labour and material cost shares of the R&D expenditure ( $\delta = 0.93$ ) are added back into PCM in order to measure internally available funds irrespective of the actual decision on R&D investment.

**Overdue** = 1 if firms have overdue payments by more than 90 days with either utilities or taxes, 0 otherwise.

#### *Self-reported financial constraints*

**FC1** = 1 if firms choose access to finance as their current biggest obstacle, 0 otherwise.

**FC2** = 1 if firms consider access to finance (which includes availability and cost, interest rates, fees and collateral requirements) either a 'major' or a 'very severe' obstacle, and 0 if access to finance represents either 'no obstacle', a 'minor' or a 'moderate' obstacle to current operations.

**Access** = ordered variable taking values 0-4 corresponding to how severe an obstacle ('no obstacle', 'minor', 'moderate', 'major', 'very severe') is access to finance for the firm's current operations

#### *Firm characteristics*

**Emp** = number of permanent full-time employees at the end of last fiscal year (logarithm)

**Foreign** = 1/0 if the primary owner (majority capital) is a foreign individual, company or organization

**Exporter** = 1/0 if the firm had any export sales (directly or indirectly) in 2007

**Age** = number of years since the firm was established

**CU** = capacity utilisation, output produced as a proportion of the maximum output possible if using all facilities available in 2007

**CapIntens** = capital intensity is the net book value (after depreciation) of machinery, vehicles, and equipment relative to the number of permanent full-time employees in 2007

**Training** = 1 if the firm had any formal training programs for its permanent, full-time employees in 2007, 0 otherwise

#### *Market characteristics*

**Compet** = ordered variable indicating the number of competitors in the domestic market with values 1 (no competitors), 2 (one competitor), 3 (2-5 competitors), and 4 (more than 5 competitors).

**Market** = the market where the main product is mostly sold with values 1 for local, 2 for national and 3 for international market

**City** = ordered variable indicating size of locality where firm operates; 1 - capital city; 2 - population over 1 million; 3 - over 250,000 to 1million; 4 - 50,000 to 250,000; 5 - less than 50,000 population

**Importinp** = proportion of material inputs or supplies of foreign origin relative to total inputs purchased in 2007

#### *Pressure to innovate measures*

Are constructed based on answers to the question “How important are each of the following factors in affecting decisions to develop new products or services and markets?”. Spontaneous answers ‘I don’t know’ are discarded.

**Pres\_domcomp** = 1 if answer ‘very important’ or ‘fairly important’, 0 if answer “not at all important’, ‘slightly important’. The question refers to domestic competitors.

**Pres\_fcomp** = 1 if answer ‘very important’ or ‘fairly important’, 0 if answer “not at all important’, ‘slightly important’. The question refers to foreign competitors.

**Pres\_customer** = 1 if answer ‘very important’ or ‘fairly important’, 0 if answer “not at all important’, ‘slightly important’. The question refers to customers.

**Manufacturing** = 1/0 if the firm produces manufacturing goods (UN ISIC Rev. 3.1 codes 15-37).

Following Rauch (1999), manufacturing products can be categorised into differentiated (specialised) or standardized.

**Differentiated** = 1/0 if the manufacturing firm produces differentiated goods (UN ISIC Rev. 3.1 codes 22, 25, 28-36).

**Standardized** = 1/0 if the manufacturing firm produces standardized goods (UN ISIC Rev. 3.1 codes 15-21, 23, 24, 26, 27, 37).

**Construction** = 1 for firms operating in construction (UN ISIC Rev. 3.1 code 45), 0 otherwise.

**Retail** = 1 for firms operating in UN ISIC Rev. 3.1 code 50 and 52, 0 otherwise.

**Wholesale** = 1 for firms operating in UN ISIC Rev. 3.1 code 51, 0 otherwise.

**Services** = 1 for firms operating in non-financial service industries, 0 otherwise.

**Table A1.**

The table presents the number (and proportion) of firms in each country surveyed in Panel A. The statistics in Panel B refer to firms grouped according to their main economic activity.

<b>Panel A. Country</b>	<b>Freq.</b>	<b>Percent</b>	<b>Cum.</b>
Albania	175	1.46	1.46
Belarus	273	2.28	3.73
Georgia	373	3.11	6.84
Tajikistan	360	3.00	9.84
Turkey	1,152	9.60	19.44
Ukraine	851	7.09	26.54
Uzbekistan	366	3.05	29.59
Russia	1,256	10.47	40.06
Poland	533	4.44	44.50
Romania	541	4.51	49.01
Serbia	388	3.23	52.24
Kazakhstan	544	4.53	56.78
Moldova	363	3.03	59.80
Bosnia and Herzegovina	361	3.01	62.81
Azerbaijan	380	3.17	65.98
FYR Macedonia	366	3.05	69.03
Armenia	374	3.12	72.15
Kyrgyz Republic	235	1.96	74.10
Mongolia	362	3.02	77.12
Estonia	273	2.28	79.40
Kosovo under UNSCR 1244	270	2.25	81.65
Czech Republic	250	2.08	83.73
Hungary	291	2.43	86.16
Latvia	271	2.26	88.41
Lithuania	276	2.30	90.72
Slovak Republic	275	2.29	93.01
Slovenia	276	2.30	95.31
Bulgaria	288	2.40	97.71
Croatia	159	1.33	99.03
Montenegro	116	0.97	100.00
<b>Total</b>	<b>11,998</b>	<b>100.00</b>	

<b>Panel B. Economic sector</b>	<b>Freq.</b>	<b>Percent</b>	<b>Cum.</b>
Manufacturing	5,508	45.91	45.91
Construction	1,049	8.74	54.65
Retail	3,123	26.03	80.68
Wholesale	1,031	8.59	89.27
Services	1,287	10.73	100.00
<b>Total</b>	<b>11,998</b>	<b>100.00</b>	

**Table A2. IV probit estimates**

VARIABLES	<i>NewProduct</i>			<i>Upgrade</i>		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>EMP</i>	0.047 (0.036)	0.080** (0.036)	0.092*** (0.035)	0.098** (0.047)	0.113** (0.050)	0.150*** (0.049)
<i>EMP2</i>	-0.003 (0.005)	-0.009** (0.004)	-0.010** (0.005)	-0.009 (0.006)	-0.013** (0.006)	-0.017*** (0.006)
<i>Exporter</i>	0.217*** (0.049)	0.206*** (0.047)	0.233*** (0.039)	0.093** (0.039)	0.086** (0.042)	0.134*** (0.040)
<i>Foreign</i>	0.137 (0.086)	0.158** (0.079)	0.138* (0.084)	-0.015 (0.065)	0.036 (0.063)	-0.009 (0.076)
<i>Subsidy</i>	0.213*** (0.048)	0.202*** (0.051)	0.219*** (0.045)	0.184*** (0.053)	0.126** (0.062)	0.159** (0.063)
<i>R&amp;D</i>	0.774*** (0.125)	0.838*** (0.093)	0.860*** (0.061)	0.457*** (0.107)	0.604*** (0.133)	0.666*** (0.115)
<i>Group</i>	0.057 (0.052)	0.033 (0.056)	0.039 (0.054)	-0.055 (0.043)	-0.091* (0.052)	-0.097* (0.057)
<i>Age</i>	0.003 (0.029)	0.001 (0.026)	-0.006 (0.023)	0.035 (0.022)	0.021 (0.021)	0.008 (0.020)
<i>FC1</i>	-1.390** (0.691)			-2.290*** (0.259)		
<i>FC2</i>		-0.985* (0.542)			-1.825*** (0.233)	
<i>Access</i>			-0.263* (0.144)			-0.540*** (0.085)
<i>Overdue</i>	0.066*** (0.016)	0.097*** (0.028)	0.382*** (0.085)	0.067*** (0.016)	0.098*** (0.028)	0.384*** (0.084)
Observations	10,138	10,856	10,856	10,076	10,793	10,793
Chi2(1)	2.73	2.76	3.46	17.85	12.45	13.99
Prob	0.0983	0.0964	0.628	0.000	0.000	0.000

**Note:** The table reports iv probit coefficients and robust standard errors clustered at country level (in parentheses). *FC1* is 1 if access to finance is either a major or a very serious obstacle to current business operations, 0 otherwise; *Access* takes values 0-4 corresponding to how severe an obstacle ('no obstacle', 'minor', 'moderate', 'major', 'very severe') is access to finance for the firm's current operations; *FC2* is equal to 1 if firms' access to finance as their current biggest obstacle, 0 otherwise. *Overdue* is the instrument used for all the self-reported financial constraints indicators. All specifications include country fixed effects. The last row reports the estimates obtained in the first stage regression. Chi2 (1) and Prob denote the chi-squared statistic / probability for the Wald test of instrument exogeneity. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1