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How do demand fluctuations and credit constraints affect R&D? Evidence from Central, Southern and Eastern Europe

Kadri Männasoo and Jaanika Meriküll*

Abstract

The opportunity cost approach suggesting a countervailing cyclical effect between R&D and short-term investments is the subject of theoretical and empirical debate. We extend the discussion by investigating the impact of demand fluctuations and credit constraints on firms' R&D in ten new EU member states from Central, Southern and Eastern Europe (CSEE). Using membership of the OECD as a proxy for the country's level of development we find more counter-cyclicality amongst the firms in non-OECD CSEE countries, while a similar but somewhat less accentuated counter-cyclical pattern of R&D behaviour emerges in the more advanced OECD-CSEE countries. Surprisingly, any adverse effect from credit constraints on firm's engagement in R&D is largely absent in CSEE countries.

JEL Code: G31, E32, O30, O52

Keywords: R&D cyclicality, demand shocks, credit constraints, Central and Eastern Europe

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Non-technical summary

The enlargment of the European Union by twelve member states, including ten transition countries from Central, Southern and Eastern Europe (CSEE), raised expectations of more stable and enduring development.[1] The newly-joined economies have, however, experienced a rather turbulent period with episodes of rapid growth followed by severe distress in the aftermath of the global financial crisis of 2008/2009. Following the distress, the struggle for improved competitiveness and sustained growth remains a primary concern for the region.

According to economic theory, R&D is vital for economic growth. R&D is seen as a productivity enhancing investment, which leads to new products and improved technologies. Moreover R&D creates positive spillovers, such as efficiency gains, which are not fully compensated by private returns. In consequence, R&D benefits from a number of supportive policy measures in many countries.

The recent literature on volatility and growth suggests that temporary fluctuations have further implications for a country's long-term growth through the incentives given to investors. Productivity enhancing investments such as R&D play a major role here. Uncertain and lagged returns from R&D make it subject to opportunity cost considerations as investors prefer high-liquidity, short-term production when the economy is at its peak, since the opportunity costs of productivity enhancing R&D are high. An adverse demand shock has the opposite effect and motivates entrepreneurs to invest in R&D as "the opportunity cost in terms of forgone current production is low" (Aghion and Howitt, 2009). As a result, R&D follows a countercyclical pattern, but this will be the case only to the extent of limits on firm's access to credit. Under credit constraints the R&D of firms will be pro-cyclical when there is a negative shock, since there will be shortage of both internal and external funding. R&D cyclicality remains a subject of theoretical and empirical debates however, with mixed evidence revealed from country, industry or firm-level analyses.

Given this background, the aim of the current paper is to examine how the R&D of firms depends on demand fluctuations and credit constraints in the ten new EU member countries from the CSEE region. In order to address the heterogenity within the CSEE sample, we divide it into two country groups based on membership of the Organisation for Economic Co-operation and Development (OECD)[2]. This gives us six countries: the Czech Republik, Estonia,

[1] Malta and Cyprus, unlike other countries, which joined EU in 2004 and 2007, do not share the common history of centrally planned economies.

[2] Members of the OECD as at 1 January 2011.

Hungary, Poland, Slovakia and Slovenia that belong to the OECD members group and the other four countries: Bulgaria, Latvia, Lihtuania and Romania in the OECD non-members group. This way the analysis enables to control for the importance of a country's level of advancement in determining the cyclicality of R&D and the implications for credit constraints.

We use the World Bank/EBRD Business Environment and Enterprice Performace survey (BEEPs) rounds 2002, 2005 and 2008/2009 for empirical analysis. This dataset contains direct self-reported measures of firms' credit frictions and R&D along with a number of indicators for firms' demographics and performance. Eurostat industry-level statistics have been used for compiling exogenous demand fluctuation variables. We control for three different demand proxies, which show the annual growth in value added, in number of employees and in turnover. The main variables of interest, firms' R&D and credit constraints, are defined respectively as the likelihood of a firm conducting R&D and its propensity to be credit constrained. All firms that are dependent on external funding, but have been rejected by lenders or discouraged from borrowing are defined as credit contrained. The rest of the firms, those whose need for external credit has been met or who do not need external funding, are defined as unconstrained.

The simultaneous estimation procedure — a recursive probit model — has been used to account for the co-determined relationship between R&D and credit constraints.

Our results provide support for the counter-cyclicality argument of R&D as suggested by the opportunity cost approach in theory. We observe strong counter-cyclicality in respect of demand fluctuations amongst the firms operating in the non-OECD CSEE countries. A similar, but somewhat less accentuated counter-cyclical pattern of R&D behaviour is observed in more advanced OECD CSEE countries. The impact of credit constraints on R&D remained insignificant for the OECD group, while a counter-intuitive positive effect on R&D emerged in the non-OECD4 sample. The rationale behind this seemingly questionable result is that credit contraints obviously have no relevance for firms not dependent on external finance or firms operating in countries with a poor supply of venture capital or long-term credit.

In conclusion, we have shown the heterogeneity in R&D cyclicality amongst the ten new CSEE EU member countries, highligting the growing importance of more sustainable R&D in narrowing the technological and productivity gap with the leading economies.

Contents

1. Introduction

The last two decades on the road to convergence have seen episodes of remarkable growth in the Central, Southern and Eastern European (CSEE) economies, but also severe downturns of a magnitude far exceeding that of the slowdowns in mature economies. The global financial crisis has made these vulnerabilities even more evident. However the countries in the CSEE region have significant diversity in terms of their technological advancement and financial sector development. Six of the ten new CSEE EU member countries — the Czech Republic, Hungary, Estonia, Poland, Slovakia and Slovenia — are members of the OECD, while the other four — Latvia, Lihtuania, Bulgaria and Romania — are still knocking on the door.

Modern theories on endogenous growth and the Schumpeterian growth theory in particular stress the importance of innovation, R&D and knowledge creation for long-term sustainable growth [3]. The so-called cleansing mechanism or the "virtue of bad times" in the Schumpeterian view of business cycles suggests that recessions help to correct for inefficiencies whilst forcing firms to focus on a productivity enhancing agenda. An opportunity cost effect comes in here as long-term innovation activity gains priority over short-term capital investments in a recession. The counter-cyclical nature of innovation is an appealing property. Evening out some of the cyclical volatility enables an economy to navigate towards a more balanced development path. However, the counter-cyclicality argument for long-term productivity enhancing investments will apply only as long as firms' access to credit is not limited. This is hardly the case whenever the firm is hit by an adverse (idiosyncratic or aggregate) shock. A negative shock has an effect on firm's current earnings, reducing the availability of internal funds and undermining the firm's capacity to borrow or raise external funds in general. This means that the extent to which credit constraints bind depends on whether the firm faces an upturn or downturn on the market.

The aim of the current paper is to look at how the likelihood of a firm undertaking R&D is affected by fluctuating demand and credit constraints. We divide the ten new EU member states from Central, Southern and Eastern Europe into two groups based on their OECD membership status in order to see whether the level of advancement of the countries matters in how demand fluctuations and credit constraints impact the likelihood of a firm conducting R&D.

The paper is organized as follows. Section 2 provides a literature survey

[3] See Aghion and Howitt (1992), for a theoretical model and, Sylwester (2001) for an empirical survey.

discussing the cyclicality of R&D and the main arguments behind the pro- and counter-cyclicality hypotheses. Section 3 elaborates how the concept of credit constraints intervene to the R&D cyclicality story. In section 4 we describe the methodology used to take into account the interdependence of the R&D and credit constraints; present the data and the results on the OECD6 and non-OECD4 countries. Section 5 concludes.

2. The cyclicality of R&D

The avenue of research that investigates the impact of volatility on growth has moved to the forefront in the research agenda (Francois and Lloyd-Ellis (2009)). The influential model proposed by Aghion et al. (2010) or AABM, starts with the distinction between short-term capital investments and long-term productivity enhancing investments such as R&D. The argument is made that in the absense of credit constraints, long-term growth enhancing investments behave in a countrercyclical manner. The intuition behind this is straightforward and pertains to opportunity cost effect. In simple terms, as lower demand makes the return on short-term investments lower in recessions, the opportunity cost of long-term productivity-enhancing investments also becomes lower. This implies that it is more profitable to invest in short-term production with high-level productivity when the economy is at its peak and the firm is facing positive demand than in long-term R&D, which involves an uncertainty component and delay in returns. An adverse productivity shock, in contrast, motivates business leaders to invest in long-term R&D as the opportunity cost in terms of forgone current production is low. The theory is appealing in terms of social welfare as reallocating a proportion of R&D expenditures from booms to recessions would allow the economy to grow at a lower resource cost Barlevy (2007).

Aghion et al. (2010), however claim that under sufficiently tight credit constraints the long-term investments become pro-cyclical, leading to both "lower mean growth and amplified volatility". Their model identifies a propagating mechanism that credit constraints have on the cyclical composition of investment. In particular, there is a wedge that reflects the probability of failure determined by the allocation of investments between the short and long run. This wedge is countercyclical, decreasing in booms and increasing in recessions. The intuition is that a negative shock will leave firms short of internal resources and will limit their access to external funds. Hence, the probability of failure increases and the shift from long-term to short-term investments simply improves the liquitity available over the next period.

Barlevy (2007) proposes an opposing theory claiming that R&D expenditures behave in a pro-cyclical manner contrary to the opportunity cost argument. According to his model, "the bigger the ratio of profits in booms to their value in recessions", the more R&D will be biased towards boom. For this to be true requires that profits be more pro-cyclical than the cost of R&D. He also shows that industries with more pro-cyclical profits as proxied by stock values tend to have more pro-cyclical R&D growth. A number of examples from earlier literature are given in Barlevy (2007), which confirm pro-cyclical behavior of R&D.

Indeed, the empirical evidence has not given consistent support to either of the R&D counter- or pro-cyclicality arguments. From a study of long-term relationships in US aggregate data, Rafferty (2003) demonstrates pro-cyclical and asymmetric patterns of firm-financed R&D. He claims that increased after-tax cash flows rise R&D expenditures and that more R&D has been lost during recessions than gained during expansions with business cycles having a negative net effect on aggregate R&D. The evidence from an annual panel of 20 US manufacturing industries over 1958–1998 Ouyang (2007) indicates a more mixed result with pro-cyclical R&D responding asymmetrically and negatively to demand shocks. In the follow-up paper by Ouyang (2010) she constructs a model which suggests that R&D appears counter-cyclical with low credit constraints, but pro-cyclical with sufficiently high credit constraints, whereas mixed cyclicality is displayed for a moderate degree of credit constraints. Her theory also claims that the Schumpeterian virtue of bad times holds only if "the marginal opportunity cost of R&D dominates over the marginal expected return".

Aghion et al. (2005) and Aghion et al. (2010) also provide support for their model. Based on an annual panel of 21 OECD countries over the 1960–2000 period, the analysis shows that long-term growth-enhancing investments respond less to positive exogenous shocks in countries with more developed financial sectors. The evidence from the AABM model is however limited. Aghion et al. (2008) have also provided firm-level evidence for their model using a panel dataset covering 13,000 French firms over the period 1980–2000. They use a proxy variable called "payment incident" (a record of payment failure in a blacklist, which affects firms' access to new credit) in order to measure credit contraints. They show a stronger positive correlation between sales and R&D spending in more credit-constrained firms. Also the credit-constrained firms suffer more from demand volatility with an asymmetric effect on R&D investments, which become more harmed in slumps than they are encouraged in booms. Along similar lines Bovha-Padilla et al. (2009) conduct a panel study on Slovenian firms for the period 1996–2002 and observe the pro-cyclicality of R&D investments in credit constrained firms, but note that

the effect disappears in less financially dependent firms which have access to parent company funding or government subsidies.

Ulku (2004) investigates the effect of R&D on innovation and sustainable economic growth in 20 OECD and 10 non-OECD countries, concluding that a positive, significant relationship between R&D and innovation was only found for OECD countries with large markets. The positive impact of innovation on per capita GDP was however significant in both OECD and non-OECD countries.

3. Credit frictions

Theoretical literature on growth, business cycles and firm investment behavior is increasingly more concerned with imperfect capital markets. The asymmetric information problem and uncertain and lagged returns make R&D investments particularly sensitive to credit constraints[4].

The impact of credit constraints on firm performance is predominantly negative. Recent evidence presented by Campello et al. (2010) on the global financial crisis of 2008/2009 shows that constrained firms in the US, Europe, and Asia witnessed deeper cuts in employment, technology and capital spending. Their study also interestingly points up the issue that constrained firms drew more heavily on lines of credit in order to frontload funds in fear of restricted access to credit in the future. Savignac (2008), Aghion et al. (2008), Ouyang (2007), Ouyang (2010) and others have found strong support for the argument that financial and credit constraints have an adverse effect on R&D and innovation. Badia and Slootmaekers (2008) study on the relationship between productivity and financial constraints in Estonia and conclude that unlike in all other industries financial constraints had a large negative impact on productivity in the R&D intensive sector.

The reverse relationship, or the impact of R&D intensity upon liquidity constraints, is tested by Piga and Atzeni (2007). Their empirical findings based on a survey of Italian manufacturing firms show that credit constraints depend on the R&D intensity of the firm and that an inverse U-shaped relationship is observed between R&D activity and the probability of a firm being credit constrained. They also note that firms with no R&D are less likely to apply for new credit.

The measures of credit constraints vary across the studies. The unavailabil-

[4]The adverse selection between investors financing R&D and entrepreneurs undertaking R&D has been investigated by Plehn-Dujowich (2009) showing that an increase in the mean skill level enhances growth via greater R&D productivity and investment.

ity of explicit information imposes the limit that indirect measures of financial constraints such as firm size, age, distribution of dividends, credit rating, foreign ownership and so forth prevail in the literature. One typical approach to financial constraints is the measurement of the sensitibvity of investments to internally generated cash flows using the Q-theory and Euler-equation models. A recent survey on issues in the measurement of financial constraints is provided by Hadlock and Pierce (2010), in which they also propose their own novel approach. Hadlock and Pierce (2010) find that firms' age and size alone perform as good predictors of the level of financial constraint.

On the empirical front Ouyang (2007), Ouyang (2010) employs two proxies to capture the financial constraints faced by US manufacturing firms, the firm's liquid assets and its net worth. In her interpretation the first variable reflects the firm's need for external funds, whereas the net worth acts as the collateral for a loan. As mentioned above, Aghion et al. (2008) use a "payment incident" or blacklist record as a proxy variable for picking up credit constraints at firm level.

Campello et al. (2010) however argue in favour of a direct survey-based measure of financial constraints demonstrating that traditional measures of constraints fail to identify meaningful patterns in their sample survey data. In the same vein, Kaplan and Zingales (1997) question the measurement of financial constraints through investment-cash-flow sensitivities, extracting access to credit information from firms' public statements instead. Empirical evidence on the use of direct financial or credit constraint measures is scarce due to limited availability of data. Ayyagari et al. (2008) analysis draws on the World Bank Business Environment Survey [5], from which they capture firm managers' direct responses to perceived financial obstacles. Savignac (2008) also employs the direct, qualitative indicator on financial constraints derived from the survey conducted by the French Ministry of Industry in order to obtain information about the financing conditions of innovative projects of manufacturing firms in France. His arguments in favour of a direct measure for financial constraints are that it avoids the interpretation problems of indirect indicators, such as cash-flows and that it provides specific and new information about the financial problems encountered by firms, whereas accounting variables or the credit rating index reflect the global financial situation of the firm (Savignac (2008)).

[5]The Business Environment survey resembles the Business Environment and Enterprise Performance Survey (BEEPs), the data-source for our empirical analysis.

4. Empirical analysis and results

4.1. Methodology

Our econometric approach departs from recursive bivariate probit model. According to Monfardini and Radice (2008) the bivariate probit model with endogenous dummy is the appropriate inference tool "whenever there are good "a priori" reasons to consider a dependent binary variable to be simultaneously determined with a dichotomous regressor".

Savignac (2008) employs a recursive bivariate probit to estimate how the French firms' propensity to innovate is subject to endogenous financial constraints. Masso and Vahter (2008), Masso et al. (2010), employ a bivariate probit model to estimate the knowledge production function in respect of the product and process innovation of the Estonian firms used in later modelling the linkages between productivity and innovation and the FDI impact on innovation respectively. The credit rationing patterns of R&D intensive firms have been studied with a bivariate probit model by Piga and Atzeni (2007).

In our model the endogenous financial constraint is regressed with the following variables: (1) log of firm age in years since the start of operations in the given country; (2) firm size measured by number of employees; (3) a dummy variable reflecting publicly listed firms; (4) the share of foreign ownership; (5) annual growth in firm real sales; (6) private bank funding in the firm's new fixed investments over the last year, (7) a dummy variable for the presence of 90-day overdue loans; (8) the share of sales sold on credit; (9) an indicator for whether the firm is audited and finally (10) a dummy variable for the existence of state subsidies[6].

The argument in favour of a recursive model is that financial constraints can be considered endogenous to R&D. Not only do the financial constraints have an impact on the likelihood of a firm conducting R&D, but the qualities which distinguish firms engaging in R&D such as skill and technology intensity or competitiveness also make them more attractive for creditors. It follows from this that estimating separately the likelihood of a firm conducting R&D and the likelihood of being financially constrained would lead to inconsistent results. A two-step procedure where predicted values from the financial constraint equation (a selection equation) are fed into the R&D equation (an outcome equation), is potentially inefficient insofar as it does not account for

[6]In comparison Savignac (2008) estimates the financial constraints of firms using the following five measures: (1) the share of the banking debt, (2) the share of the firm's own financing in its total financing resources, (3) a logarithm of tangible assets as a proxy for collateral, (4) the firm's gross operating profit margin ratio and finally (5) the firm's size.

the possible correlation between the disturbance terms of the two equations Greene (1998). Binary models in general are demanding in terms of sample sizes, more so in bivariate binary outcome models Monfardini and Radice (2008).

Considering a recursive system with binary endogenous variables we get:

$$\begin{cases} y_1 = \beta_1 x_1 + \epsilon_1 \\ y_2 = \beta_2 x_2 + \gamma_2 y_1 + \epsilon_2 \end{cases}$$

where y_1 stands for the presence of financial constraints in a reduced form equation and y_2 represents the likelihood of the firm conducting R&D in the structural form equation. x_1 and x_2 denote the exogenous variables explaining respectively the presence of financial constraints and the R&D decision. The errors ϵ_1 and ϵ_2 are jointly normally distributed with zero mean, unit variance and correlation of ρ where $|\rho| > 0$[7]. The correlation between error terms can be interpreted as the correlation between the unobservable explanatory variables of the two equations.

A widespread opinion in the literature is that the parameters of the second equation in structural form are not identified unless the reduced form equation contains at least one variable that is not one of the regressors in the structural form equation. This assertion, stated by Maddala (1983) is contradicted in a more recent paper by Wilde (2000), who show that exclusion restrictions are not needed provided there is one varying exogenous regressor in each equation Monfardini and Radice (2008).

For MLE four probabilities (summing up to 1) are needed, like in a standard bivariate probit model without endogenity, as follows Lee (2010):

$$\begin{aligned} Pr(y_1 = 1, y_2 = 1) &= P(\varepsilon_1 > -\beta_1 x_1, \varepsilon_2 > -\gamma_2 - \beta_2 x_2) \\ Pr(y_1 = 1, y_2 = 0) &= P(\varepsilon_1 > -\beta_1 x_1, \varepsilon_2 < -\gamma_2 - \beta_2 x_2) \\ Pr(y_1 = 0, y_2 = 1) &= P(\varepsilon_1 < -\beta_1 x_1, \varepsilon_2 > -\beta_2 x_2) \\ Pr(y_1 = 0, y_2 = 0) &= P(\varepsilon_1 < -\beta_1 x_1, \varepsilon_2 < -\beta_2 x_2) \end{aligned}$$

As y_1 and y_2 are observed as dichotomous variables, it is necessary to adopt the standard normalisation of the variance of the errors. Given $\sigma_1 = SD(\varepsilon_1)$ and $\sigma_2 = SD(\varepsilon_2)$ the respective standardised probabilities are obtained as functions of $\beta_1/\sigma_1, \gamma_1/\sigma_1, \beta_2/\sigma_2, \rho$ where the last term ρ denotes correlation between the standardised error terms.

$$\begin{aligned} Pr(-\tfrac{\varepsilon_1}{\sigma_1} < \tfrac{\beta_1}{\sigma_1} x_1, -\tfrac{\varepsilon_2}{\sigma_2} < \tfrac{\gamma_2}{\sigma_2} + \tfrac{\beta_2}{\sigma_2} x_2) &= \Psi(\tfrac{\beta_1}{\sigma_1} x_1, \tfrac{\gamma_2}{\sigma_2} + \tfrac{\beta_2}{\sigma_2} x_2; \rho) \\ Pr(-\tfrac{\varepsilon_1}{\sigma_1} < \tfrac{\beta_1}{\sigma_1} x_1, \tfrac{\varepsilon_2}{\sigma_2} < -\tfrac{\gamma_2}{\sigma_2} - \tfrac{\beta_2}{\sigma_2} x_2) &= \Psi(\tfrac{\beta_1}{\sigma_1} x_1, \tfrac{-\gamma_2}{\sigma_2} - \tfrac{\beta_2}{\sigma_2} x_2; -\rho) \\ Pr(\tfrac{\varepsilon_1}{\sigma_1} < -\tfrac{\beta_1}{\sigma_1} x_1, -\tfrac{\varepsilon_2}{\sigma_2} < \tfrac{\beta_2}{\sigma_2} x_2) &= \Psi(-\tfrac{\beta_1}{\sigma_1} x_1, \tfrac{\beta_2}{\sigma_2} x_2; -\rho) \\ Pr(\tfrac{\varepsilon_1}{\sigma_1} < -\tfrac{\beta_1}{\sigma_1} x_1, \tfrac{\varepsilon_2}{\sigma_2} < -\tfrac{\beta_2}{\sigma_2} x_2) &= \Psi(-\tfrac{\beta_1}{\sigma_1} x_1, -\tfrac{\beta_2}{\sigma_2} x_2; \rho) \end{aligned}$$

[7] If $\rho = 0$ two separate probit models can be estimated implying that y_1 is exogenous for the structural form equation.

From here the maximum likelihood is derived as:

$$\sum[y_{1i}y_{2i}ln(\Psi(\frac{\beta_1}{\sigma_1}x_1, \frac{\gamma_2}{\sigma_2}+\frac{\beta_2}{\sigma_2}x_2; \rho)+y_{1i}(1-y_{2i})ln(\Psi(\frac{\beta_1}{\sigma_1}x_1, \frac{-\gamma_2}{\sigma_2}-\frac{\beta_2}{\sigma_2}x_2; -\rho)$$
$$+(1-y_{1i})y_{2i}ln\Psi(-\frac{\beta_1}{\sigma_1}x_1, \frac{\beta_2}{\sigma_2}x_2; -\rho)+(1-y_{1i})1-y_{2i})ln\Psi(-\frac{\beta_1}{\sigma_1}x_1, -\frac{\beta_2}{\sigma_2}x_2; \rho)]$$

4.2. Data

This paper employs the firm-level data from the Business Environment and Enterprise Performance survey (BEEPs) conducted jointly by the EBRD and the World Bank. Three consecutive rounds of BEEPs, 2002, 2005 and 2009, have been employed. The information of the data set used in the current study is collected retrospectively, coming respectively from the years 2001, 2004 and 2007. The sample structure has been designed to be representative of the population of firms in every country. The survey does not cover firms operating in sectors under government regulation and prudential supervision such as banking, electric power, rail transport and water supply. Firms with only one employee or with more than 10,000 employees were also excluded[8]. In addition, we exclude firms with yearly sales below 50,000 euros and firms that have been in operation for less than three years [9].

The BEEPs survey covers a wide set of transition countries, but our analysis focuses on ten of the newer EU member countries: the Czech Republic, Bulgaria, Hungary, Poland, Slovakia, Slovenia, Romania, Estonia, Latvia and Lithuania. We divide the total sample into groups of OECD members and non-members, which alloes us to see how the country's level of development affects the cyclicality of R&D. Table 1 shows that OECD membership is in close correlation with the countries' level of income and R&D expenditures as a share of GDP[10].

The BEEPs survey contains valuable information about the firm-specific factors, including R&D and innovation activities, firm age, size measured by the number of employees, ownership, sales growth, share of sales going for export, employees' skill level, and dependence on and access to external finances. For a description of the variables see Table 2. The R&D activity is measured as a binary variable, indicating whether the firm conducts R&D or not, while the amount of R&D investments done are not known. However, this binary measurement of R&D activity should not affect significantly the effect of credit constraints on R&D as credit constraints affect mostly the likelihood

[8] See BEEPs reports on methodology and observations at http://www.ebrd.com/pages/research/analysis/surveys/beeps.shtml for more details on survey design.

[9] Starting businesses might exhibit dynamics that are not really in line with general patterns at firm or industry level.

[10] Only for Poland is the OECD membership not well correlated with country rankings.

Table 1: Country rankings by aggregate GDP, R&D spending and private credit 2001–2007

Rank	GDP per capita in PPS		Business sector R&D in GDP		Private credit to GDP		Mean Rank
1	Slovenia	18 729	Slovenia	0.88	Estonia	63.2	1.7
2	Czech Republic	16 429	Czech Republic	0.84	Latvia	56.3	3.0
3	Hungary	13 671	Hungary	0.40	Slovenia	48.1	3.3
4	Slovakia	12 971	Estonia	0.36	Hungary	46.3	3.3
5	Estonia	12 829	Slovakia	0.29	Czech Republik	37.4	5.3
6	Lithuania	11 143	Romania	0.22	Bulgaria	36.6	5.7
7	Poland	11 114	Latvia	0.20	Slovakia	36.4	7.3
8	Latvia	10 286	Lithuania	0.17	Lithuania	33.2	8.3
9	Bulgaria	7 743	Poland	0.17	Poland	30.4	8.3
10	Romania	7 543	Bulgaria	0.11	Romania	18.5	8.7

Note: GDP Purchasing Power Standard per inhabitant (Source: Eurostat). Business sector R&D expenditures from GDP (Source: Eurostat). Domestic credit to private sector as share of GDP (Source: World Bank.)

Table 2: Variables Description

NAME	UNIT	DESCRIPTION	SOURCE
RD	[0;1]	1 if firm conducts R&D, 0 otherwise	BEEPs
constrained	[0;1]	1 if firm is constrained, 0 otherwise	BEEPs
age	ln(year)	age in years since company started operations in particular country. For transition countries the beginning year is set to 1987 if reported earlier	BEEPs
size	[0;1]	dummy variable on wheter the company belongs to one of the three size categories: 2–49 employees; 50–250 employees or 250–10 000 employees	BEEPs
dsales	%	Percent change in sales over last three years in real terms	BEEPs
UniGrade	%	A percent of firm workforce having university degree or higher	BEEPs
ExSale	%	share of direct and indirect exports in firm total sales	BEEPs
BankFin	%	Private bank funding in the firm's new fixed investments (land, buildings, machinery, equipment) over the last year	BEEPs
CredSale	%	Proportion of sales sold on credit i.e. paid after delivery	BEEPs
foreign	%	Percent of foreign ownership if foreign share $\geq$50%, zero otherwise	BEEPs
overdue	[0;1]	1 if the firm has 90 day overdue payment (includes tax overdues and overdues on utilities), 0 otherwise	BEEPs
audit	[0;1]	1 if the financial statements reviewed by external auditor, 0 otherwise	BEEPs
subsidies	[0;1]	1 if the firm has been subject to public subsidies from local, national or EU sources	BEEPs
VA	%	Industry level annual growth in real value added	Eurostat
LAB	%	Industry level annual growth of workforce	Eurostat
TURN	%	Industry level annual real sales growth	Eurostat
OECD	[0;1]	1 if firm located in OECD country (standing 1st of January 2011), 0 otherwise	
GDP	PPS	Country-level annual GDP per capita in thousands of purchasing power parity standard units	Eurostat

to undertake R&D and not the level of R&D investment (see Mancusi and Vezzulli (2010) for this finding). Hence, the empirical regularity brought out in the literature section that credit constrained firms lose more R&D during recessions than they gain during the booms (Rafferty (2003) and Aghion et al. (2008)), should also be captured with the binary measure of engagement with R&D activity.

The credit constraint variable is conditioned on two terms, first the dependence of the firm on external finance and secondly its access to finance. Firms which state that they don't need a loan are defined as not dependent on ex-

ternal finance, because access to finance is irrelevant for them. On the other hand those firms that do not have a loan because they claim not to be eligible to apply for one can be treated as discouraged and hence credit constrained. In addition to discouraged firms, firms which have applied for credit, but been turned down by the bank are put in the credit constrained group. See the Table 3.

Table 3: Variable definitions

	DEPENDENT	INDEPENDENT
CONSTRAINED	Loan rejected OR discouraged from applying a loan	Not applicable
UNCONSTRAINED	Has got a loan	Does not need a loan

The demand shock has been proxied by three industry level variables covering year-on-year growth in real value added, employment and real turnover. The set of industries contains: mining and quarring, manufacturing, energy, construction, sales, hotels and restaurants, transport and communication, real estate, and business services. The aggregation level of industries correspond to the NACE Rev.1.1 one-digit level of industries. This means that the industry-level demand proxies are relatively broadly defined, which implies that firms are not likely to have any significant influence on demand, so therefore the industry output variables serve as good proxies for exogenous demand shocks. Another argument that supports our choice of demand proxies is that as supply shocks are more long-term, the yearly changes in output capture mostly changes in demand.

We include cycle variables in our regressions to R&D from the contemporaneous period as there is empirical evidence that the correlation between R&D and economic growth is the strongest at the same period of time (see Walde and Woitek (2004)). Asymmetric demand shock effects are accounted for by decomposing the demand variables into separate variables for positive values showing growth, and negative values showing decline. (For the full set of variables from the data description table used in the current analysis, see Table 2, above).

$$Demand^{+} = \Delta Demand \textit{ if } \Delta Demand > 0, \quad 0 \textit{ otherwise}$$
$$Demand^{-} = \Delta Demand \textit{ if } \Delta Demand < 0, \quad 0 \textit{ otherwise}$$

The econometric analysis in the next section clusters standard errors by country, industry and year. The need for clustering arises because the performance of firms within a particular country and/or industry may be somehow correlated and we are not able to capture all of this correlation with any available set of explanatory variables. Another reason for clustering arises from the inclusion of group level variables (industry demand measured at the level

of country, industry and year) together with firm-level variables in the same regressions. As shown by Moulton (1990) the inclusion of higher level measured variables in the analysis of lower level measured variables may lead to serious underestimation of the standard errors of coefficients. In consequence, we use robust country-industry-year-level clustered standard errors to account for the possible within-group correlation of disturbances in our econometric analysis.

4.3. R&D in more and less advanced CSEE countries

The CSEE countries have witnessed severe episodes of volatility over the past two decades in their struggle for improved international competitiveness. The econometric results reveal exciting cyclical patterns reflecting how R&D responds to demand shock and whether credit constraints matter in firm's R&D decisions.

The estimation outcome (see Table 4) implies that credit constraints, though negative coefficients appear, have no statistically significant impact on R&D by firms in the OECD6-group[11]. Moreover, an anomalous positive and significant relationship emerges between R&D and credit constraints in the non-OECD country-group (see Table 6). This result seems to be counter-intuitive while anticipating that credit constraints should be a bigger obstacle for the less financially integrated non-OECD sample.

However, this result may be affected by the selection bias. As brought up and tested by Savignac (2008) and Mancusi and Vezzulli (2010), there may be a set of firms that are not even "potentially innovative", i.e. nevertheless of the existence of the credit constraints, they would not do R&D anyway. If we neglect this selection issue, we will underestimate the effect of credit constraints on R&D. Another source of selection bias raises from the credit dependence side. There is a large share of firms in the CSEE countries that do not use external financing at all (and this share does not include firms that are discouraged to borrow), $\approx 44\%$ in the OECD and $\approx 46\%$ in the non-OECD samples (see Table 8). These firms cannot have any variability in the credit constraint variable as they will never apply for a loan, while they can be engaged in R&D and finance it by internal funds. If we neglect this selection issue, we will overestimate the effect of credit constraints on R&D.

Savignac (2008) and Mancusi and Vezzulli (2010) test for the selection bias

[11] A single, negative sign for credit constraints, significant at the 10% level, comes up in the total CSEE countries sample regression in appendix Table 9. While the effect is negative but insignificant in the total CSEE countries sample of credit dependent firms, see Table 10 in appendix.

by excluding the firms that are not potential R&D firms (no R&D or innovation projects) and who do not want to get additional financing. They find that correcting for this selection bias rises the negative marginal effect of constraint on R&D from –0.23% to –0.34%. We perform the same selection bias test and find that the subsample of innovative (no R&D project or no product innovation or no process innovation) or credit dependent firms have similar effect of constraints on the propensity to conduct R&D than in the whole sample (the results are available from the authors upon request). This indicates that the selection bias seem not to be the issue here. We perform also additional tests for the selection bias. First, we exclude from the sample firms that are not potential R&D firms (no R&D project or no product innovation or no process innovation), but do not filter in terms of credit dependence. The results are surprisingly similar to the ones of the whole sample, while the coefficient on credit constraint becomes somewhat larger as predicted by the discussion above. Second, we exclude from the sample those firms that do not use external financing, but do not filter in terms of R&D potential. Now the results alter significantly, the effect of credit constraint reduces from around 0.3%–0.5% to around 0.1%–0.3% for the OECD group (see Tables 4 and 5) and becomes negative from 0.2% to –0.1% for the non-OECD group (see Tables 6 and 7).

However insignificant, the marginal effects of constraint on R&D are negative for credit dependent firms in the non-OECD4 as they are in the OECD group. This means that the results for credit dependent firms across both country groups are more similar. According to this empirical evidence credit constraints, though not significant, have more of a negative effect on credit dependent firms or on firms operating in countries with more developed credit markets. Thus, being more reliant on external financing, and possibly also having higher expectations of the availability of credit, makes firms more vulnerable to credit constraints.[12]

Furthermore, the indirect effects from the credit constraint equation are modest, and only the sales and overdue variable has a significant impact on R&D in some of the regressions.

Another difference between OECD and non-OECD groups is that in the OECD sample firms with a higher share of exports in sales are more likely to conduct R&D, whereas no similar relation exists in the non-OECD sample. The firm's knowledge-intensity as measured by the share of highly educated employees has a statistically significant positive impact on the likelihood to

[12]On the other hand in less developed markets where venture capital or long-term credit is hardly available (see Groh and von Liechtenstein (2009) for this evidence), only the most innovative and R&D inclined firms dare to apply for credit and so are more likely to become credit constrained.

conduct R&D only in credit dependent firms in the OECD sample. Interestingly, the foreign ownership variable remains insignificant throughout all estimations, without OECD-membership or credit-dependence making any difference. In contrast, the firm-size variable as measured by the number of employees appears highly significant in all regressions, suggesting that the largest firms with more than 250 employees are those most likely to conduct R&D in CSEE countries. While the indirect effect of firm size via credit constraints is very modest.

Listed firms are more likely to conduct R&D only in the OECD6 countries, and this relation is the strongest for credit dependent firms in the OECD sample. As for the listed variable the direct effect dominates, accompanied by a negative but very low indirect effect.

An important factor accelerating R&D is the firm's sales, which reflect the firm's growth potential and its capacity to generate internal funds. The sales growth elicits a highly significant positive impact on the R&D of firms in the OECD-sample, where both the direct and indirect effects are considerable. The indirect effects show that internal funds relieve credit constraints. In the non-OECD sample however, the indirect effect of sales growht remains negligible and the direct effect dominates. The overall effect of sales growth is insignificant only for credit dependent firms in the non-OECD sample.

The industry level demand fluctuations have a highly significant impact on R&D. Falling industry-level demand is counter-cyclical to R&D, which provides support to the opportunity cost theory. This means that the virtue of bad times proves to be true in CSEE countries, and is valid for both the OECD member countries and for the non-members. On the positive side of the demand shock the evidence is quite modest with mixed signs across the three demand proxies, although, the non-OECD members seem to behave more counter-cyclically on both strands of the demand cycle.

Taken overall, the estimations reveal more counter-cyclicality amongst the non-OECD members, suggesting that the opportunity cost postulate is more valid for firms operating in less advanced markets. Ouyang (2010) theory might provide the explanation. She suggests that there is a trade-off between marginal opportunity cost and marginal expected return from R&D. Arguably the closer the country is to the techonogical frontier, the higher are the expected returns from R&D relative to the opportunity costs. This conjecture however remains a subject for further research.

Table 4: R&D and credit constraints OECD=1, 2001–2007

constrained=1	Value added			Employment			Turnover		
	Overall	Direct	Indirect	Overall	Direct	Indirect	Overall	Direct	Indirect
constrained (d)	–0.539	–0.539		–0.493	–0.493		–0.291	–0.291	
	(0.367)			(0.395)			(0.531)		
lnage	0.037	–0.019	0.056	0.032	–0.021	0.053	0.020	–0.015	0.035
	(0.031)			(0.027)			(0.026)		
empl2to49 (d)	–0.378***	–0.362	–0.016	–0.380***	–0.363	–0.017	–0.362***	–0.345	–0.017
	(0.063)			(0.062)			(0.055)		
empl50to250 (d)	–0.137***	–0.138	0.001	–0.141***	–0.142	0.001	–0.132***	–0.129	–0.003
	(0.047)			(0.045)			(0.037)		
listed (d)	0.081	0.172	–0.091	0.093	0.179	–0.086	0.106*	0.160	–0.054
	(0.060)			(0.060)			(0.058)		
ExSale	0.106**	0.106		0.111**	0.111		0.106**	0.106	
	(0.049)			(0.048)			(0.043)		
foreign	0.027	–0.030	0.057	0.033	–0.023	0.056	0.025	–0.011	0.036
	(0.039)			(0.043)			(0.045)		
UniGrade	0.037	0.037		0.025	0.025		0.038	0.038	
	(0.046)			(0.048)			(0.045)		
dsales	0.178***	0.090	0.088	0.171***	0.090	0.081	0.145***	0.093	0.052
	(0.053)			(0.051)			(0.055)		
demand^-	–2.441**	–2.441		–0.965	–0.965		–3.093*	–3.093	
	(1.224)			(0.731)			(1.667)		
demand^+	–0.182	–0.182		0.236	0.236		0.129	0.129	
	(0.618)			(0.584)			(0.222)		
BankFin	0.061		0.061	0.060	0.060		0.043		0.043
	(0.047)			(0.048)			(0.058)		
overdue (d)	–0.090***		–0.090	–0.088**		–0.088	–0.064		–0.064
	(0.034)			(0.041)			(0.075)		
CredSale	0.033		0.033	0.029		0.029	0.019		0.019
	(0.031)			(0.027)			(0.030)		
audit (d)	0.022		0.022	0.021		0.021	0.010		0.010
	(0.026)			(0.025)			(0.022)		
subsidies (d)	0.087		0.087	0.082		0.082	0.049		0.049
	(0.059)			(0.064)			(0.075)		
Log likelihood	–2.7e+03			–2.7e+03			–2.7e+03		
No of obs.	3394			3394			3394		
rho	0.731			0.695			0.492		
Wald test of rho=0	1.794			1.529			0.496		

Source: authors' calculations on BEEPs data.
*Note: Bivariate probit conditional marginal effects of R&D, reported at constrained=1. Robust, country-sector-survey clustered standard errors in parenthesis. Country, sector dummies included. ***, **, * stand for 1%, 5% and 10% level statistical significance respectively.*

Table 5: R&D and credit constraints OECD=1, credit dependent firms, 2001–2007

constrained=1	Value added			Employment			Turnover		
	Overall	Direct	Indirect	Overall	Direct	Indirect	Overall	Direct	Indirect
constrained (d)	–0.276	–0.276		–0.215	–0.215		–0.135	–0.135	
	(0.292)			(0.281)			(0.246)		
lnage	0.055*	0.002	0.053	0.047	0.002	0.045	0.035	0.002	0.033
	(0.033)			(0.031)			(0.030)		
empl2to49 (d)	–0.335***	–0.305	–0.030	–0.333***	–0.307	–0.026	–0.332***	–0.313	–0.020
	(0.058)			(0.055)			(0.052)		
empl50to250 (d)	–0.123***	–0.116	–0.007	–0.126***	–0.120	–0.006	–0.121***	–0.116	–0.005
	(0.047)			(0.045)			(0.042)		
listed (d)	0.129**	0.184	–0.055	0.142**	0.189	–0.047	0.153**	0.186	–0.033
	(0.065)			(0.063)			(0.061)		
ExSale	0.106**	0.106		0.110**	0.110		0.109**	0.109	
	(0.052)			(0.051)			(0.050)		
foreign	0.018	0.002	0.016	0.027	0.013	0.014	0.027	0.017	0.010
	(0.040)			(0.044)			(0.041)		
UniGrade	0.129***	0.129		0.112**	0.112		0.122***	0.122	
	(0.050)			(0.048)			(0.047)		
dsales	0.138***	0.080	0.058	0.128***	0.079	0.049	0.114***	0.079	0.035
	(0.044)			(0.041)			(0.041)		
demand^-	–3.373***	–3.373		–0.587	–0.587		–3.921**	–3.921	
	(1.271)			(0.900)			(1.743)		
demand^+	-0.059	-0.059		0.208	0.208		0.149	0.149	
	(0.581)			(0.563)			(0.224)		
BankFin	0.109		0.109	0.095		0.095	0.069		0.069
	(0.081)			(0.086)			(0.083)		
overdue (d)	–0.051		–0.051	–0.046		–0.046	–0.034		–0.034
	(0.039)			(0.042)			(0.041)		
CredSale	0.049		0.049	0.041		0.041	0.029		0.029
	(0.045)			(0.042)			(0.037)		
audit (d)	0.021		0.021	0.017		0.017	0.012		0.012
	(0.023)			(0.022)			(0.018)		
subsidies (d)	0.065		0.065	0.055		0.055	0.038		0.038
	(0.056)			(0.056)			(0.049)		
Log likelihood	–2.0e+03			–2.0e+03			–2.0e+03		
No of obs.	2295			2295			2295		
rho	0.477			0.412			0.305		
Wald test of rho=0	1.371			1.057			0.695		

Source: authors' calculations on BEEPs data.
*Note: Bivariate probit conditional marginal effects of R&D, reported at constrained=1. Robust, country-sector-survey clustered standard errors in parenthesis. Country, sector dummies included. ***, **, * stand for 1%, 5% and 10% level statistical significance respectively.*

Table 6: R&D and credit constraints OECD=0, 2001–2007

constrained=1	Value added			Employment			Turnover		
	Overall	Direct	Indirect	Overall	Direct	Indirect	Overall	Direct	Indirect
constrained (d)	0.193***	0.193		0.185***	0.185		0.196***	0.196	
	(0.044)			(0.048)			(0.043)		
lnage	–0.029	0.001	–0.030	–0.001	0.029	–0.030	–0.024	0.015	–0.039
	(0.042)			(0.046)			(0.051)		
empl2to49 (d)	–0.233***	–0.205	–0.028	–0.202***	–0.175	–0.027	–0.241***	–0.208	–0.033
	(0.061)			(0.065)			(0.068)		
empl50to250 (d)	–0.102***	–0.079	–0.023	–0.083*	–0.060	–0.023	–0.104**	–0.075	–0.029
	(0.039)			(0.044)			(0.046)		
listed (d)	0.038	0.060	–0.022	0.045	0.065	–0.020	0.082	0.112	–0.030
	(0.068)			(0.067)			(0.080)		
ExSale	–0.029	–0.029		–0.037	–0.037		–0.022	–0.022	
	(0.044)			(0.043)			(0.046)		
foreign	0.019	0.044	–0.027	0.022	0.044	–0.022	0.019	0.049	–0.030
	(0.042)			(0.042)			(0.048)		
UniGrade	0.080	0.080		0.074	0.074		0.106*	0.106	
	(0.055)			(0.054)			(0.057)		
dsales	0.072*	0.109	–0.037	0.090**	0.125	–0.035	0.075*	0.120	–0.045
	(0.042)			(0.042)			(0.042)		
demand$^-$	–6.397***	–6.397		–2.696*	–2.696		–0.919**	–0.919	
	(1.957)			(1.430)			(0.382)		
demand$^+$	–1.414*	–1.414		–1.295**	–1.295		–0.139	–0.139	
	(0.798)			(0.623)			(0.451)		
BankFin	–0.051		–0.051	–0.046		–0.046	–0.059		–0.059
	(0.060)			(0.056)			(0.054)		
overdue (d)	0.097		0.097	0.088		0.088	0.113*		0.113
	(0.079)			(0.095)			(0.066)		
CredSale	–0.018		–0.018	–0.017		–0.017	–0.020		–0.020
	(0.018)			(0.019)			(0.020)		
audit (d)	0.009		0.009	0.008		0.008	0.014		0.014
	(0.019)			(0.022)			(0.025)		
subsidies (d)	–0.060		–0.060	–0.056		–0.056	–0.067		–0.067
	(0.052)			(0.059)			(0.049)		
Log likelihood	–1.2e+03			–1.2e+03			–1.2e+03		
No of obs.	1619			1619			1619		
rho	–0.584			–0.559			–0.661		
Wald test of rho=0	1.424			0.767			2.769*		

Source: authors' calculations on BEEPs data.
*Note: Bivariate probit conditional marginal effects of R&D, reported at constrained=1. Robust, country-sector-survey clustered standard errors in parenthesis. Country, sector dummies included. ***, **, * stand for 1%, 5% and 10% level statistical significance respectively.*

Table 7: R&D and credit constraints OECD=0, credit dependent firms, 2001–2007

constrained=1	Value added			Employment			Turnover		
	Overall	Direct	Indirect	Overall	Direct	Indirect	Overall	Direct	Indirect
constrained (d)	–0.157	–0.157		–0.174	–0.174		–0.067	–0.067	
	(0.269)			(0.228)			(0.256)		
lnage	–0.019	–0.056	0.037	0.008	–0.029	0.037	–0.005	–0.028	0.023
	(0.048)			(0.049)			(0.052)		
empl2to49 (d)	–0.222***	–0.219	–0.003	–0.203***	–0.199	–0.004	–0.211***	–0.209	–0.002
	(0.054)			(0.050)			(0.055)		
empl50to250 (d)	–0.098**	–0.103	0.005	–0.081**	–0.085	0.004	–0.084**	–0.087	0.003
	(0.040)			(0.038)			(0.040)		
listed (d)	0.013	0.011	.002	0.004	0.002	0.002	0.059	0.058	0.001
	(0.074)			(0.068)			(0.073)		
ExSale	0.014	0.014		–0.004	–0.004		0.016	0.016	
	(0.054)			(0.054)			(0.053)		
foreign	0.042	0.036	0.006	0.043	0.037	0.006	-0.044	0.041	0.003
	(0.053)			(0.050)			(0.053)		
UniGrade	0.079	0.079		0.061	0.061		0.109*	0.109	
	(0.073)			(0.072)			(0.062)		
dsales	0.035	0.007	0.028	0.051	0.022	0.029	0.047	0.029	0.018
	(0.036)			(0.038)			(0.039)		
demand$^-$	–7.569***	–7.569		–3.575**	–3.575		–1.453***	–1.453	
	(2.335)			(1.500)			(0.324)		
demand$^+$	–1.424	–1.424		–1.219	–1.219		–1.453	–1.453	
	(0.873)			(0.752)			(0.379)		
BankFin	0.095		0.095	0.099		0.099	0.060		0.060
	(0.099)			(0.083)			(0.106)		
overdue (d)	–0.054		–0.054	–0.056		–0.056	–0.036		–0.036
	(0.056)			(0.047)			(0.061)		
CredSale	0.032		0.032	0.033		0.033	0.020		0.020
	(0.043)			(0.037)			(0.040)		
audit (d)	0.006		0.006	0.006		0.006	0.003		0.003
	(0.016)			(0.015)			(0.011)		
subsidies (d)	0.048		0.048	0.050		0.050	0.030		0.030
	(0.054)			(0.044)			(0.054)		
Log likelihood	–8.7e+02			–8.7e+02			–8.7e+02		
No of obs.	1075			1075			1075		
rho	0.377			0.392			0.245		
Wald test of rho=0	0.867			1.382			0.324		

Source: authors' calculations on BEEPs data.
*Note: Bivariate probit conditional marginal effects of R&D, reported at constrained=1. Robust, country-sector-survey clustered standard errors in parenthesis. Country, sector dummies included. ***, **, * stand for 1%, 5% and 10% level statistical significance respectively.*

In order to test the robustness of the results we have estimated the differences between more and less advanced countries using interaction terms with two country development proxies, OECD membership and GDP per capita level (see Table 11 and Table 12 in appendix.) The joint estimation with multiple interaction terms between explanatory variables and country development proxies showed that the effect of credit constraints on the likelihood of a firm conducting R&D do not significantly differ across more and less developed country groups. The interaction coefficients with industry demand proxies confirmed that R&D counter-cyclicality falls as the country's level of development rises, as measured by OECD membership or GDP per capita in purchasing power parity (PPP).

5. Summary

In our study we have sought to fill some of the gap between macroeconomic understanding of volatility and long-term growth on the one hand, and the firm-level evidence of productivity enhancing R&D on the other hand. The analysis has provided solid support for the existing literature, highlighting the link between short-term demand fluctuations and long-term growth fostered by productivity enhancing R&D. The firms in the CSEE countries proved to be more inclined to conduct R&D at times of low demand. This evidence is in line with the opportunity cost theory suggesting that recessions force firms to focus on a productivity-enhancing agenda. The comparison of CSEEC countries that are in the OECD and non-members reveals that the opportunity cost driven behavior is more evident in the less advanced non-OECD group of CSEE countries.

The theory proposed by Ouyang (2010) might provide an explanation. Her model suggests that there is a trade-off between marginal opportunity cost and marginal expected return from R&D. Our interpetation is that more advanced economies that are closer to the techonogical frontier are more likely to have a higher expected return from R&D relative to opportunity costs. This conjecture is, however, a subject for further research.

The financial frictions have been accounted for by a simultaneous estimation procedure — a recursive probit model on the R&D and credit constraints of firms. However, the impact of credit constraints on R&D proved insignificant for the OECD group, whereas a counter-intuitive positive effect on R&D emerged in the non-OECD4 sample. The rationale behind this seemingly questionable result is that credit contraints have no bearing for firms operating in countries with a lack of supply of venture capital or long-term credit. We have found that the sales growth of firms has a direct, positive effct on R&D, and also an indirect effect by mitigating the credit constraints on firms.

Firms with a higher share of exports in their sales are more likely to conduct R&D in the OECD sample, whereas no similar relation exists in the non-OECD sample. A firm's knowledge-intensity as measured by the share of highly educated employees only has a highly statistically significant positive impact on the likelihood of it to conducting R&D in credit dependent firms in the OECD sample. Interestingly, the foreign ownership and company age variables remained mostly insignificant, regardless of OECD-membership or credit-dependence. In contrast, the firm-size variable as measured by the number of employees appeared highly significant in all regressions, suggesting that the largest firms, with more than 250 employees, are the ones most likely to conduct R&D in the CSEE region.

The general implications are that the country's level of advancement plays a significant role in how the R&D of firms responds to changing demand, whereas the demand fluctuations seem to be more relevant for the less developed countries. The hypothesis of credit constraints as an important obstacle in firms' R&D engagements was rejected by the model in CSEE countries.

References

AGHION, P., G.-M. ANGELETOS, A. BANERJEE, AND K. MANOVA (2005): "Volatility and Growth: Credit Constraints and Productivity-Enhancing Investment," NBER Working Papers 11349, National Bureau of Economic Research, Inc.

——— (2010): "Volatility and growth: Credit constraints and the composition of investment," *Journal of Monetary Economics*, 57, 246–265.

AGHION, P., P. ASKENAZY, N. BERMAN, G. CETTE, AND L. EYMARD (2008): "Credit Constraints and the Cyclicality of R&D Investment: Evidence from France," Documents de Travail 198, Banque de France.

AGHION, P. AND P. HOWITT (1992): "A Model of Growth through Creative Destruction," *Econometrica*, 60, 323–51.

AYYAGARI, M., A. DEMIRGÜC-KUNT, AND V. MAKSIMOVIC (2008): "How Important Are Financing Constraints? The Role of Finance in the Business Environment," *World Bank Economic Review*, 22, 483–516.

BADIA, M. M. AND V. SLOOTMAEKERS (2008): "The Missing Link Between Financial Constraints and Productivity," LICOS Discussion Papers 20808, LICOS - Centre for Institutions and Economic Performance, K.U.Leuven.

BARLEVY, G. (2007): "On the Cyclicality of Research and Development," *American Economic Review*, 97, 1131–1164.

BOVHA-PADILLA, S., J. P. DAMIJAN, AND J. KONINGS (2009): "Financial Constraints and the Cyclicality of R&D Investment:Evidence from Slovenia," LICOS Discussion Papers 23909, LICOS - Centre for Institutions and Economic Performance, K.U.Leuven.

CAMPELLO, M., J. R. GRAHAM, AND C. R. HARVEY (2010): "The real effects of financial constraints: Evidence from a financial crisis," *Journal of Financial Economics*, 97, 470–487.

FRANCOIS, P. AND H. LLOYD-ELLIS (2009): "Schumpeterian Business Cycles with Pro-Cyclical R&D," *Review of Economic Dynamics*, 12, 567–591.

GREENE, W. H. (1998): "Gender Economic Courses in Liberal Arts Colleges: Further Results," *Journal of Economic Education*, 29, 291–300.

GROH, A. P. AND H. VON LIECHTENSTEIN (2009): "How attractive is central Eastern Europe for risk capital investors?" *Journal of International Money and Finance*, 28, 625–647.

HADLOCK, C. J. AND J. R. PIERCE (2010): "New Evidence on Measuring Financial Constraints: Moving Beyond the KZ Index," *Review of Financial Studies*, 23, 1909–1940.

KAPLAN, S. N. AND L. ZINGALES (1997): "Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints," *The Quarterly Journal of Economics*, 112, 169–215.

LEE, M. (2010): *Micro-Econometrics: Methods of Moments and Limited Dependent Variables*, Springer.

MADDALA, G. (1983): *Limited Dependent and Qualitative Variables in Econo*, Cambridge University Press.

MANCUSI, M. L. AND A. VEZZULLI (2010): "R&D, Innovation and Liquidity Constraints," KITeS Working Papers 030, KITeS, Centre for Knowledge, Internationalization and Technology Studies, Universita' Bocconi, Milano, Italy.

MASSO, J., T. ROOLAHT, AND U. VARBLANE (2010): "Foreign direct investment and innovation in Central and eastern Europe : evidence from Estonia," Bank of Estonia Working Papers wp2010-05, Bank of Estonia.

MASSO, J. AND P. VAHTER (2008): "Technological innovation and productivity in late-transition Estonia: econometric evidence from innovation surveys," *European Journal of Development Research*, 20, 240–261.

MONFARDINI, C. AND R. RADICE (2008): "Testing Exogeneity in the Bivariate Probit Model: A Monte Carlo Study," *Oxford Bulletin of Economics and Statistics*, 70, 271–282.

MOULTON, B. R. (1990): "An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Unit," *The Review of Economics and Statistics*, 72, 334–38.

OUYANG, M. (2007): "On the cyclicality of R&D: disaggregated evidence," Working Paper 0707, Federal Reserve Bank of Cleveland.

——— (2010): "Virtue of Bad Times and Financial Market Frictions," Working Papers 101103, University of California-Irvine, Department of Economics.

PIGA, C. A. AND G. ATZENI (2007): "R&D Investment, Credit Rationing And Sample Selection," *Bulletin of Economic Research*, 59, 149–178.

PLEHN-DUJOWICH, J. M. (2009): "Endogenous growth and adverse selection in entrepreneurship," *Journal of Economic Dynamics and Control*, 33, 1419–1436.

RAFFERTY, M., C. (2003): "Do Business Cycles Influence Long-Run Growth? The Effect of Aggregate Demand on Firm-Financed R&D Expenditures," *Eastern Economic Journal*, 29, 607–617.

SAVIGNAC, F. (2008): "Impact Of Financial Constraints On Innovation: What Can Be Learned From A Direct Measure?" *Economics of Innovation and New Technology*, 17, 553–569.

SYLWESTER, K. (2001): "R&D and Economic Growth," *Knowledge, Technology & Policy*, 13, 71–84.

ULKU, H. (2004): "R&D, Innovation, and Economic Growth: An Empirical Analysis," IMF Working Papers 04/185, International Monetary Fund.

WALDE, K. AND U. WOITEK (2004): "R&D expenditure in G7 countries and the implications for endogenous fluctuations and growth," *Economics Letters*, 82, 91–97.

WILDE, J. (2000): "Identification of multiple equation probit models with endogenous dummy regressors," *Economics Letters*, 69, 309–312.

6. Appendixes

Table 8: Summary statistics

Variable	OECD6			Non-OECD4		
	Mean	Std.Dev.	N	Mean	Std.Dev.	N
RD	0.213	0.41	4534	0.195	0.396	2146
constrained	0.130	0.336	4534	0.120	0.325	2146
dependent	0.661	0.473	4534	0.640	0.480	2146
age	12.747	4.569	4534	11.864	4.381	2146
empl2to49	0.698	0.459	4531	0.632	0.482	2144
empl50to250	0.216	0.411	4531	0.262	0.44	2144
empl250to10000	0.086	0.281	4531	0.105	0.307	2144
dsales	0.134	0.372	4534	0.217	0.462	2146
UniGrade	0.172	0.241	4439	0.215	0.258	2084
listed	0.053	0.224	4534	0.047	0.211	2146
ExSale	0.142	0.272	4529	0.15	0.306	2145
ForOwned	0.129	0.335	4534	0.141	0.348	2146
ForCapShare	0.121	0.308	4523	0.128	0.31	2140
BankFin	0.121	0.265	3485	0.171	0.319	1668
overdue	0.067	0.25	4534	0.078	0.269	2146
CredSale	0.509	0.413	4505	0.477	0.397	2139
audit	0.53	0.499	4534	0.474	0.499	2146
subsidies	0.136	0.343	4534	0.074	0.262	2146
dsales	0.134	0.372	4534	0.217	0.462	2146
VA	0.06	0.053	4534	0.095	0.05	2146
VA^+	0.073	0.042	3991	0.096	0.05	2141
VA^-	–0.033	0.029	543	–0.035	0.013	5
LAB	0.02	0.053	4534	0.043	0.066	2146
LAB^+	0.045	0.042	2974	0.06	0.057	1754
LAB^-	–0.028	0.038	1535	–0.036	0.043	392
TURN	0.103	0.138	4534	0.085	0.108	2015
$TURN^+$	0.118	0.138	4039	0.11	0.079	1817
$TURN^-$	–0.022	0.021	495	–0.142	0.062	198

Source: authors' calculations on BEEPs data.

Note: OECD6 includes Czech Republic, Estonia, Hungary, Poland, Slovakia and Slovenia. Non-OECD4 includes Latvia, Lithuania, Bulgaria and Romania.

Table 9: R&D and credit constraints all CSEE countries, 2001–2007

constrained=1	Value added			Employment			Turnover		
	Overall	Direct	Indirect	Overall	Direct	Indirect	Overall	Direct	Indirect
constrained (d)	–0.588*	–0.588		–0.437	–0.437		–0.409	–0.409	
	(0.356)			(0.505)			(0.582)		
lnage	0.029	–0.025	0.054	0.031	–0.010	0.041	0.025	–0.014	0.039
	(0.026)			(0.023)			(0.024)		
empl2to49 (d)	–0.304***	–0.321	0.017	–0.297***	–0.305	0.008	–0.295***	–0.302	0.007
	(0.047)			(0.048)			(0.047)		
empl50to250 (d)	–0.112***	–0.129	0.017	–0.112***	–0.122	0.010	–0.110***	–0.120	0.010
	(0.033)			(0.031)			(0.030)		
listed (d)	0.091*	0.153	–0.062	0.101**	0.147	–0.046	0.107**	0.150	–0.043
	(0.047)			(0.045)			(0.044)		
ExSale	0.050	0.050		0.052	0.052	0.052	0.056	0.056	
	(0.039)			(0.036)			(0.036)		
foreign	0.049	0.031	–0.012	0.049	0.001	0.048	0.004	0.044	
	(0.031)			(0.037)			(0.039)		
UniGrade	0.053	0.053		0.046	0.046		0.054	0.054	
	(0.037)			(0.037)			(0.037)		
dsales	0.150***	0.075	0.075	0.142***	0.085	0.057	0.133**	0.079	0.054
	(0.044)			(0.049)			(0.052)		
demand$^-$	–1.950*	–1.950		–0.868	–0.868		–0.925**	–0.925	
	(1.052)			(0.615)			(0.360)		
demand$^+$	–0.517	–0.517		–0.373	–0.373		0.066	0.066	
	(0.507)			(0.365)			(0.199)		
BankFin	0.074*		0.074	0.063		0.063	0.059		0.059
	(0.040)			(0.055)			(0.063)		
overdue (d)	–0.090***		–0.090	–0.080		–0.080	–0.077		–0.077
	(0.024)			(0.053)			(0.064)		
CredSale	0.039		0.039	0.029		0.029	0.027		0.027
	(0.033)			(0.033)			(0.035)		
audit (d)	0.028		0.028	0.018		0.018	0.017		0.017
	(0.030)			(0.030)			(0.034)		
subsidies (d)	0.098*		0.098	0.076		0.076	0.071		0.071
	(0.058)			(0.079)			(0.089)		
Log likelihood	–4.0e+03			–4.0e+03			–4.0e+03		
No of obs.	5013			5013			5013		
rho	0.775			0.645			0.616		
Wald test of rho=0	1.808			0.880			0.621		

Source: authors' calculations on BEEPs data.

*Note: Bivariate probit conditional marginal effects of R&D, reported at constrained=1. Robust, country-sector-survey clustered standard errors in parenthesis. Country, sector dummies included. ***, **, * stand for 1%, 5% and 10% level statistical significance respectively.*

Table 10: R&D and credit constraints all CSEE countries, credit dependent firms, 2001–2007

constrained=1	Value added			Employment			Turnover		
	Overall	Direct	Indirect	Overall	Direct	Indirect	Overall	Direct	Indirect
constrained (d)	–0.262	–0.262		–0.216	–0.216		–0.193	–0.193	
	(0.205)			(0.202)			(0.199)		
lnage	0.039	–0.012	0.051	0.040	–0.006	0.046	0.035	–0.007	0.042
	(0.027)			(0.027)			(0.027)		
empl2to49 (d)	–0.285***	–0.267	–0.018	–0.282***	–0.265	–0.017	–0.275***	–0.260	–0.015
	(0.043)			(0.042)			(0.041)		
empl50to250 (d)	–0.103***	–0.103	0.000	–0.104***	–0.103	–0.001	–0.097***	–0.097	–0.000
	(0.034)			(0.033)			(0.032)		
listed (d)	0.100*	0.135	–0.035	0.107**	0.138	–0.031	0.120**	0.148	–0.028
	(0.053)			(0.054)			(0.053)		
ExSale	0.067*	0.067		0.064*	0.064		0.071*	0.071	
	(0.040)			(0.039)			(0.039)		
foreign	0.039	0.024	0.015	0.047	0.033	0.014	0.048	0.036	0.012
	(0.032)			(0.033)			(0.032)		
UniGrade	0.107***	0.107		0.097**	0.097		0.110***	0.110	
	(0.040)			(0.040)			(0.039)		
dsales	0.096***	0.047	0.049	0.093***	0.049	0.044	0.086***	0.046	0.040
	(0.033)			(0.031)			(0.032)		
demand$^-$	–2.814***	–2.814		–0.759	–0.759		–1.544***	–1.544	
	(1.088)			(0.701)			(0.423)		
demand$^+$	–0.374	–0.374		–0.338	–0.338		0.086	0.086	
	(0.455)			(0.387)			(0.190)		
BankFin	0.116*		0.116	0.105		0.105	0.095		0.095
	(0.064)			(0.067)			(0.068)		
overdue (d)	–0.058*		–0.058	–0.053		–0.053	–0.049		–0.049
	(0.032)			(0.034)			(0.034)		
CredSale	0.048		0.048	0.042		0.042	0.038		0.038
	(0.034)			(0.032)			(0.031)		
audit (d)	0.017		0.017	0.015		0.015	0.013		0.013
	(0.016)			(0.015)			(0.014)		
subsidies (d)	0.065		0.065	0.059		0.059	0.052		0.052
	(0.041)			(0.041)			(0.041)		
Log likelihood	–2.9e+03			–2.9e+03			–2.9e+03		
No of obs.	3370			3370			3370		
rho	0.475			0.429			0.395		
Wald test of rho=0	2.712*			2.212			1.866		

Source: authors' calculations on BEEPs data.

*Note: Bivariate probit conditional marginal effects of R&D, reported at constrained=1. Robust, country-sector-survey clustered standard errors in parenthesis. Country, sector dummies included. ***, **, * stand for 1%, 5% and 10% level statistical significance respectively.*

Table 11: R&D, industry demand and credit constraints, interactions with OECD dummy (OECD=1)

RD	Value Added	Employment	Turnover
constrained (d)	–0.394	–0.224	–0.068
	(0.643)	(0.667)	(0.776)
OECD (d)	–0.014	0.101	0.094
	(0.202)	(0.172)	(0.172)
constr*OECD (d)	–0.014	–0.005	–0.011
	(0.061)	(0.059)	(0.060)
lnage	0.001	0.019	0.006
	(0.045)	(0.042)	(0.044)
lnage*OECD	0.035	0.012	0.009
	(0.055)	(0.050)	(0.051)
empl2to49 (d)	–0.211***	–0.190***	–0.201***
	(0.056)	(0.052)	(0.048)
empl2to49*OECD (d)	–0.136*	–0.141**	–0.125*
	(0.072)	(0.069)	(0.073)
empl50to250 (d)	–0.093***	–0.076**	–0.081***
	(0.034)	(0.030)	(0.029)
empl50to250*OECD (d)	–0.053	–0.065	–0.053
	(0.057)	(0.048)	(0.044)
listed (d)	0.081	0.081	0.110
	(0.067)	(0.065)	(0.071)
listed*OECD (d)	0.007	0.021	0.008
	(0.084)	(0.088)	(0.102)
ExSale	–0.049	–0.065	–0.034
	(0.050)	(0.044)	(0.045)
ExSale*OECD	0.171**	0.193***	0.151**
	(0.076)	(0.069)	(0.067)
foreign	0.049	0.046	0.038
	(0.045)	(0.044)	(0.050)
foreign*OECD	–0.027	–0.029	–0.027
	(0.052)	(0.051)	(0.052)
UniGrade	0.089	0.084	0.106**
	(0.059)	(0.058)	(0.051)
UniGrade*OECD	–0.052	–0.061	–0.071
	(0.078)	(0.076)	(0.069)
dsales	0.112*	0.117**	0.101*
	(0.059)	(0.058)	(0.059)
dsales*OECD	0.054	0.029	0.026
	(0.064)	(0.059)	(0.061)
demand$^-$	–3.201	–2.352*	–0.865**
	(2.937)	(1.276)	(0.378)
demand$^+$	–1.379*	–0.806	–0.078
	(0.826)	(0.509)	(0.403)
Dneg*OECD	1.261	1.571	–2.065
	(0.891)	(1.273)	(1.702)
Dpos*OECD	0.953	0.876	0.213
	(2.977)	(0.732)	(0.449)
BankFin	0.066	0.043	0.021
	(0.091)	(0.095)	(0.118)
BankFin*OECD	–0.014	–0.007	–0.002
	(0.073)	(0.046)	(0.024)
overdue (d)	–0.074	–0.054	–0.029
	(0.066)	(0.094)	(0.150)
overdue*OECD (d)	–0.005	–0.001	–0.000
	(0.033)	(0.021)	(0.011)
CredSale	0.027	0.016	0.008
	(0.047)	(0.040)	(0.047)
CredSale*OECD	–0.001	0.000	0.000
	(0.030)	(0.019)	(0.009)
audit (d)	0.014	0.005	0.002
	(0.040)	(0.026)	(0.018)
audit*OECD (d)	0.001	0.002	0.001
	(0.021)	(0.013)	(0.008)
subsidies (d)	0.081	0.051	0.026
	(0.108)	(0.105)	(0.148)
subsidies*OECD (d)	–0.012	–0.009	–0.006
	(0.043)	(0.028)	(0.032)
Log likelihood	–3.9e+03	–3.9e+03	–3.9e+03
No of obs.	5013	5013	5013
rho	0.609	0.422	0.220
Wald test of rho=0	0.508	0.219	0.033

*Source: authors' calculations on BEEPs data. Note: Bivariate probit marginal effects: direct effects on R&D above and indirect effects via credit constraint below. Robust, sector clustered standard errors in parenthesis. Country, sector and year dummies included. ***, **, * stand for 1%, 5% and 10% level statistical significance respectively.*

Table 12: R&D, industry demand and credit constraints, interactions with country's GDP per capita in PPS

RD	Value Added	Employment	Turnover
constrained (d)	–0.575*	–0.256	–0.094
	(0.339)	(0.501)	(0.514)
GDP	–0.047	0.004	0.004
	(0.042)	(0.038)	(0.032)
constr*GDP	–0.004	–0.003	–0.006
	(0.010)	(0.009)	(0.009)
lnage	0.027	0.028	0.001
	(0.025)	(0.023)	(0.024)
lnage*GDP	0.007	0.004	0.005
	(0.008)	(0.008)	(0.008)
empl2to49 (d)	–0.323***	–0.293***	–0.302***
	(0.047)	(0.042)	(0.037)
empl2to49*GDP	–0.031**	–0.027**	–0.019
	(0.014)	(0.013)	(0.012)
empl50to250 (d)	–0.122***	–0.108***	–0.106***
	(0.034)	(0.026)	(0.023)
empl50to250*GDP	–0.021*	–0.019**	–0.016*
	(0.012)	(0.009)	(0.009)
listed (d)	0.088*	0.101**	0.124***
	(0.052)	(0.044)	(0.044)
listed*GDP	–0.003	–0.001	–0.002
	(0.015)	(0.012)	(0.013)
ExSale	0.048	0.047	0.043
	(0.034)	(0.030)	(0.027)
ExSale*GDP	0.028***	0.027***	0.025***
	(0.010)	(0.009)	(0.007)
foreign	0.036	0.029	0.020
	(0.030)	(0.034)	(0.035)
foreign*GDP	–0.013	–0.013	–0.008
	(0.009)	(0.008)	(0.007)
UniGrade	0.059	0.054	0.067**
	(0.038)	(0.035)	(0.033)
UniGrade*GDP	–0.003	–0.004	–0.003
	(0.013)	(0.011)	(0.011)
dsales	0.153***	0.131***	0.096**
	(0.042)	(0.046)	(0.043)
dsales*GDP	0.003	0.000	0.006
	(0.009)	(0.009)	(0.007)
demand$^-$	–2.768***	–0.786	–1.577**
	(1.047)	(0.588)	(0.697)
demand$^+$	–0.476	–0.113	0.187
	(0.502)	(0.395)	(0.193)
Dneg*GDP	0.260*	0.939**	-0.118
	(0.134)	(0.429)	(0.178)
Dpos*GDP	0.339	0.063	0.003
	(0.323)	(0.123)	(0.053)
BankFin	0.077**	0.045	0.025
	(0.039)	(0.064)	(0.075)
BankFin*GDP	–0.015	–0.007	–0.004
	(0.012)	(0.012)	(0.013)
overdue (d)	–0.091***	–0.058	–0.035
	(0.025)	(0.070)	(0.098)
overdue*GDP	0.004	0.003	0.002
	(0.005)	(0.005)	(0.006)
CredSale	0.038	0.018	0.008
	(0.031)	(0.029)	(0.026)
CredSale*GDP	0.007	0.004	0.003
	(0.006)	(0.006)	(0.010)
audit (d)	0.022	0.007	0.002
	(0.023)	(0.018)	(0.012)
audit*GDP	–0.002	–0.001	0.000
	(0.004)	(0.003)	(0.001)
subsidies (d)	0.095*	0.048	0.029
	(0.051)	(0.072)	(0.089)
subsidies*GDP	–0.002	–0.003	–0.003
	(0.009)	(0.005)	(0.008)
Log likelihood	–3.9e+03	–3.9e+03	–3.8e+03
No of obs.	5013	5013	4924
rho	0.768	0.456	0.262
Wald test of rho=0	2.065	0.467	0.112

*Source: authors' calculations on BEEPs data. Note: Bivariate probit marginal effects: direct effects on R&D above and indirect effects via credit constraint below. Robust, sector clustered standard errors in parenthesis. Country, sector and year dummies included. ***, **, * stand for 1%, 5% and 10% level statistical significance respectively.*

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