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

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Outline of our study

- **Motivation:**

1. Shortage of studies about differences of effects of financial constraints on innovation in services and manufacturing sector

2. Lack of cross-country micro level studies of these effects in Western Europe

- **What does this paper do?**

Investigates effects of financial constraints in production and services sector, endeavours to account for endogeneity of financial constraints. Compares the results from Western Europe with the rest of Europe

- **How? Recursive bivariate probit, recursive mixed process models (Roodman 2009), based on firm level data from CIS4 and CIS2006 from European countries**

Background: literature on financial constraints and innovation

- Financial constraints are expected to be more severe for R&D and innovation than for physical investment (Himmelberg and Petersen, 1994; Hall, 2002)
- **Specificity of investments in innovation inputs (incl. shortage of collateral); information asymmetries**
- **Recent studies employ direct qualitative indicators of financial constraints using survey data** (Savignac, 2008; Gorodnichenko & Schnitzer, 2012)
- Need to account for **endogeneity** of financial constraints; both financial constraints and innovation patterns are likely to be affected by common elements of unobservable heterogeneity
- **Firms that account for this are more likely to find significant negative effects of financial constraints**
- There is still shortage of studies looking in detail into the heterogeneity of effects across sectors, types of firms, time periods, countries

Effects in production and services sector

- **The effects of financial contraints on innovation may differ in production and services sectors**
- **Innovation in services may require less external financing because their innovation process is often less R&D-dependent** (Gallouj and Weinstein 1997) **and therefore also less dependent on access to external financing → innovation process of services firms may be less affected by financial contraints**
- BUT, firms in services sector are often on average smaller: smaller firms are more financially contrained. Also, fims in manufacturing sector find it easier to collateralize borrowing from external creditors (Gorodnichenko and Schnitzer 2012)
- Financial constraints to investments and to investments in R&D may play a different role for exporters and non-exporters or multinationals and domestic owned firms

Data

- Data from Community Innovation Surveys: from the **CIS4** (2002-2004) and **CIS2006** (2004-2006)
- 11 European countries covered in our study are: **Sweden, Norway, France, Italy, Spain, Portugal, Czech Republic, Slovakia, Estonia, Bulgaria and Romania**
- Firm level data, estimation at the SAFE centre at Eurostat
- Sector level (2-digit or 3-digit NACE level) instruments for financial constraints are calculated based on the Amadeus firm level dataset and merged with the CIS datasets.
- Advantages of CIS: comparable data across countries, covers services
- Note: we concentrate on sample of innovators, in most of the specifications we look at the effects on relative innovation performance of innovators

Key variables

- **Innovation performance:**

Our main measure of **relative innovation performance** is a firm level dummy that is equal to 1 if firm's sales from new and modified goods or services are higher than 20 per cent. This is the threshold value to define 'highly innovative firms' in this paper, it is equal to the 75th percentile of the indicator of commercial success of innovation—'share (%) of new and modified products and services in sales'—in the 11 countries that we include from CIS4.

- **Note: robustness tests also with a continuous measure of innovation performance.**
- **Financial constraints:**

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

Empirical approach

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

Financial constraints eq.: $y_{1i} = \beta_1 x_{1i} + \varepsilon_{1i}$

Innovation eq.: $y_{2i} = \beta_2 x_{2i} + \lambda_{2i} y_{1i} + \varepsilon_{2i}$

- Examine whether the effects vary between production and services; whether they depend on firm characteristics;
- Test the sensitivity and robustness of results by: (a) excluding certain industries; (b) using alternative measures of innovation success (employing different recursive-mixed-process models), investigating separately the effects of internal and external financial constraints.

Table A.1: Description of Variables

Variable Name	Definition	Mean	Std. Dev.
Innovation Success	0-1 dummy variable, =1 if the turnover from newly introduced goods or service innovations is higher than 20% of total turnover (75^{th} percentile)	0.25	0.43
Financial Constraints	0-1 dummy variable, =1 if the firm faces obstacles to innovation and reports highly important financial constraints (either internal or external)	0.17	0.37
Cooperation	0-1 dummy variable, =1 if the firm has some cooperative arrangements on innovation activities	0.33	0.47
External Search	number of highly important sources of knowledge or information for innovation (ranges from 0 to 10)	1.47	1.51
Formal Protection	0-1 dummy variable, =1 if the firm uses design pattern, trademarks, or copyright to protect inventions or innovations	0.33	0.47
R&D	0-1 dummy variable, =1 if the firm reports engagement in R&D activities	0.62	0.49
Export	0-1 dummy variable, =1 if the firm sells goods or services in other countries	0.55	0.50
Group	0-1 dummy variable, =1 if the firm is part of a firm group (two or more legally-defined firms under common ownership)	0.42	0.49
Public Support	number of sources of public financial support for innovation (ranges from 0 to 3: local, national, EU); industry-level average,	0.13	0.08
Collateral	= log(tangible assets); industry-level average, normalised[a]	6.67	0.85
Gearing	= ((non current liabilities+loans)/shareholders funds)∗100; industry-level average,	104.77	41.18
Profitability	= (cash flow/operating revenue)∗100; industry-level average,	6.86	5.55
Size Dummies	set of industry dummies according to the firm's number of employees (categories are <20, 20-49, 50-99, 100-249, 250-		

Production sector, 11 European countries

	Probit	Biprobit - All Countries					
	All	All Firms		Non-Group		Non-Exporters	
	Coef.	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Equation for innovation success							
Financial Constraints	0.04	-0.74***	-0.21	-0.81**	-0.23	-1.19***	-0.27
	(0.12)	(0.00)		(0.02)		(0.00)	
Cooperation	0.17***	0.17***	0.06	0.21***	0.07	0.13***	0.04
	(0.00)	(0.00)		(0.00)		(0.00)	
External Search	0.06***	0.06***	0.02	0.06***	0.02	0.05***	0.02
	(0.00)	(0.00)		(0.00)		(0.00)	
Formal Protection	0.21***	0.20***	0.07	0.15***	0.05	0.25***	0.08
	(0.00)	(0.00)		(0.00)		(0.00)	
R&D	0.31***	0.30***	0.10	0.29***	0.10	0.19***	0.06
	(0.00)	(0.00)		(0.00)		(0.00)	
Exports	0.06**	0.06**	0.02	0.10***	0.03		
	(0.01)	(0.01)		(0.00)			
Group	0.02	0.02	0.01			0.06	0.02
	(0.37)	(0.40)				(0.20)	
Size Dummies	YES	YES		YES		YES	
Industry Dummies	YES	YES		YES		YES	
Country Dummies	YES	YES		YES		YES	
Equation for financial constraints							
Public Support		0.11***		0.14***		0.15***	
		(0.00)		(0.00)		(0.00)	
Collateral		-0.12***		-0.12***		-0.09***	
		(0.00)		(0.00)		(0.00)	
Gearing		0.04***		0.07***		0.11***	
		(0.00)		(0.00)		(0.00)	
Profitability		-0.10***		-0.13***		-0.12***	
		(0.00)		(0.00)		(0.00)	
Size Dummies		YES		YES		YES	
Error Correlation Test[a]		5.94***		4.10**		3.06**	
		[0.00]		[0.02]		[0.04]	
Overidentification Test[b]		3.82		0.27		1.27	
		[0.28]		[0.87]		[0.74]	
Number of Firms	25373	25373		15216		9149	

Production sector, Western Europe

	Biprobit - Western Countries					
	All		Non-Group		Non-Exporters	
	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx
	(8)	(9)	(10)	(11)	(12)	(13)
Equation for innovation succ						
Financial Constraints	-0.94***	-0.22	-1.12***	-0.26	-1.42***	-0.26
	(0.00)		(0.00)		(0.05)	
Cooperation	0.16***	0.05	0.20***	0.06	0.12***	0.04
	(0.00)		(0.00)		(0.00)	
External Search	0.05***	0.02	0.05***	0.02	0.03***	0.01
	(0.00)		(0.00)		(0.00)	
Formal Protection	0.20***	0.06	0.13***	0.04	0.16***	0.05
	(0.00)		(0.00)		(0.00)	
R&D	0.27***	0.08	0.26***	0.08	0.15***	0.05
	(0.00)		(0.00)		(0.00)	
Exports	0.05*	0.02	0.09***	0.03		
	(0.06)		(0.00)			
Group	0.01	0.01			0.02	0.01
	(0.79)				(0.48)	
Size Dummies	YES		YES		YES	
Industry Dummies	YES		YES		YES	
Country Dummies	YES		YES		YES	
Equation for financial constr						
Public Support	0.10***		0.10***		0.10***	
	(0.00)		(0.00)		(0.00)	
Collateral	-0.04**		-0.02		-0.02	
	(0.03)		(0.45)		(0.51)	
Gearing	0.05***		0.10***		0.16***	
	(0.00)		(0.00)		(0.00)	
Profitability	-0.17***		-0.25***		-0.15***	
	(0.00)		(0.00)		(0.00)	
Size Dummies	YES		YES		YES	
Error Correlation Test[a]	5.14**		7.55***		27.04***	
	[0.01]		[0.00]		[0.00]	
Overidentification Test[b]	7.97**		0.49		5.04	
	[0.04]		[0.92]		[0.17]	
Number of Firms	18241		9918		6044	

Dependent variable: relative innovation success (75^{th} percentile); Independent variable: financial constraints

	Sample		Coefficient	$P > \|z\|$	dy/dx	No of firms
(1)	All Industries	All Firms	-0.42	0.18	-0.13	39939
		Non-Group	-0.40	0.43	-0.13	23112
		Non-Exporters	-0.62**	0.02	-0.16	18084
(2)	Production Industries	All Firms	-0.74***	0.00	-0.21	25373
		Non-Group	-0.81**	0.02	-0.23	15216
		Non-Exporters	-1.19***	0.00	-0.27	9149
(3)	Service Industries	All Firms	-0.01	0.98	-0.01	14566
		Non-Group	-0.16	0.74	-0.05	7896
		Non-Exporters	-0.43	0.12	-0.12	8935

Dependent variable: relative innovation success (50^{th} percentile); Independent variable: financial constraints

	Sample		Coefficient	$P > \|z\|$	dy/dx	No of firms
(4)	All Industries	All Firms	-0.23	0.39	-0.09	39939
		Non-Group	-0.26	0.67	-0.10	23112
		Non-Exporters	-0.36	0.14	-0.14	18084
(5)	Production Industries	All Firms	-0.60***	0.00	-0.23	25373
		Non-Group	-0.63*	0.05	-0.25	15216
		Non-Exporters	-0.69**	0.02	-0.25	9149
(6)	Service Industries	All Firms	0.17	0.65	0.07	14566
		Non-Group	-0.05	0.93	-0.02	7896
		Non-Exporters	-0.17	0.55	-0.07	8935

Dependent variable: relative innovation success (75^{th} percentile); Independent variable: internal financial constraints

	Sample		Coefficient	$P > \|z\|$	dy/dx	No of firms
(7)	All Industries	All Firms	-0.50	0.14	-0.14	39939
		Non-Group	-0.94***	0.00	-0.25	23112
		Non-Exporters	-0.82***	0.00	-0.20	18084
(8)	Production Industries	All Firms	-0.92***	0.00	-0.24	25373
		Non-Group	-1.14***	0.00	-0.29	15216
		Non-Exporters	-1.27***	0.00	-0.27	9149
(9)	Service Industries	All Firms	-0.11	0.77	-0.03	14566
		Non-Group	-0.53	0.20	-0.16	7896
		Non-Exporters	-0.63**	0.03	-0.16	8935

Robustness tests

	Sample		Coefficient	$P > \|z\|$	dy/dx	No of firms
Treat innovation success as a continuous variable						
(1)	All Industries	All Firms	0.01	0.98		39939
		Non-Group	0.01	0.90		23112
		Non-Exporters	-0.04	0.39		18084
(2)	Production Industries	All Firms	-0.08**	0.04		25373
		Non-Group	-0.06	0.28		15216
		Non-Exporters	-0.10*	0.07		9149
(3)	Service Industries	All Firms	0.15	0.37		14566
		Non-Group	0.05	0.59		7896
		Non-Exporters	0.01	0.93		8935
Omit the R&D dummy variable						
	Sample		Coefficient	$P > \|z\|$	dy/dx	No of firms
(4)	All Industries	All Firms	-0.38	0.20	-0.12	39939
		Non-Group	-0.33	0.39	-0.11	23112
		Non-Exporters	-0.62**	0.02	-0.16	18084
(5)	Production Industries	All Firms	-0.64**	0.02	-0.18	25373
		Non-Group	-0.72**	0.03	-0.21	15216
		Non-Exporters	-1.04***	0.00	-0.25	9149
(6)	Service Industries	All Firms	-0.01	0.99	-0.01	14566
		Non-Group	-0.13	0.75	-0.04	7896
		Non-Exporters	-0.44	0.13	-0.12	8935
Exclude Non-Manufacturing Industries from Production Industries						
	Sample		Coefficient	$P > \|z\|$	dy/dx	No of firms
(7)	All Industries	All Firms	-0.41	0.27	-0.13	37046
		Non-Group	-0.44	0.47	-0.15	21319
		Non-Exporters	-0.61**	0.03	-0.17	15698
(8)	Production Industries	All Firms	-0.69*	0.09	-0.21	22480
		Non-Group	-0.89**	0.02	-0.26	13423
		Non-Exporters	-1.07***	0.00	-0.28	6763
(9)	Service Industries	All Firms	-0.01	0.98	-0.01	14566
		Non-Group	-0.16	0.74	-0.05	7896
		Non-Exporters	-0.43	0.12	-0.12	8935

Conclusions

- Evidence of negative effects of financial constraints on innovation performance, based on 11 European countries, incl. 6 Western European countries
- **Financial barriers have much stronger negative effects in production sector in Europe than in services.**
- **Financial constraints affect innovation performance most strongly among non-exporters**
- **Effects similar in Western Europe and the full sample of 11 countries**
- We find that the consequence of high financial constraints for a firm in production sector is on average 21 per cent lower probability to have 'high innovation performance' (i.e. to have the share of new products in its sales above the 75th percentile threshold level of the variable in our sample of innovators).
- **EXTENSIONS**: effects in knowledge intensive services (KIS) and non-KIS sector; better identification of causal effects (exogenous shocks)