

**FINANCIAL CONSTRAINTS TO  
INNOVATION IN THE UK AND OTHER  
EUROPEAN COUNTRIES: EVIDENCE  
FROM CIS2 AND CIS3**

**By**

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**Aim:**

Exploring the role of financial factors as constraints to innovation in the UK and the rest of Europe using data from the second and third Community Innovation Surveys (CIS2&CIS3).

**Presentation Plan:**

- References,
- Data description,
- Importance of financial constraints by firm size,
- Importance of financial constraints by country,
- Importance of financial constraints by sector,
- Conclusion

## 2. Reference

Hall (2002) yields the following conclusions:

- Firm is likely to be financially constrained if the firm's R&D investment is observed to be particularly sensitive to cash flow
- Small firms are more likely to be financially constrained.
- Firms in R&D intensive industries face a higher cost of capital
- Anglo Saxon economies, exhibit greater sensitivity of R&D to cash flow than continental economies.

In this paper we address the same issues but using data from the CIS2 and CIS3. Why?

- 1) The CIS surveys concern innovation in its totality and not just R&D
- 2) The CIS data set encompasses all the EU countries and the questionnaire was standardised across those countries.

### **3. THE COMMUNITY INNOVATION SURVEY**

- CIS2-EU: (1994-1996), 15 EU countries included, with aggregated data on industry, country or firm size,
- CIS2-UK: (1994-1996), This data set covers a sample of 2,344 firms with more than 10 employees in sections C-K of the SIC 1992.
- CIS3-UK: (1998-2000), it includes agriculture; fishing and forestry; public administration and defence; education; and health and social work. 8,172 valid responses were received.

#### 4 Ranking of factors hampering innovation:

<i>Factors hampering innovation</i>	<i>Rank CIS2-EU</i>	<i>Rank CIS2-UK 2</i>	<i>Rank CIS3-UK</i>
<i>Excessive perceived economic risks</i>	1	4	3
<i>Innovation costs too high</i>	5	5	1
<i>Lack of appropriate sources of finance</i>	2	-	-
<i>Cost of Finance</i>	-	6	2
<i>Availability of finance</i>	-	3	7
<i>Organisational rigidities</i>	4	9	10
<i>Lack of qualified personnel</i>	3	1	5
<i>Lack of information on technology</i>	8	10	8
<i>Lack of information on markets</i>	9	8	9
<i>Fulfilling regulations, standards</i>	6	7	6
<i>Lack of customer responsiveness</i>	7	2	4

## 5. THE IMPORTANCE OF FINANCIAL CONSTRAINTS BY FIRM SIZE

Let  $p$  be the number of covariates in  $x$ . Consider the outcomes  $0, \dots, k, \dots, m$  recorded in  $Y_i$  (for  $i=1,2$ ), so that

$$\Pr(Y_i = k) = \frac{\exp\left(\sum_{j=0}^p x_{ij} \beta_{jk}\right)}{\sum_{m=0}^3 \exp\left(\sum_{j=0}^p x_{ij} \beta_{jm}\right)}.$$

The relative probability of the outcome  $Y_i = k$  with respect to  $Y_i = 0$  is given by

$$(2) \quad \frac{\Pr(Y_i = k)}{\Pr(Y_i = 0)} = e^{x_{ij} \beta_i^{(k)}},$$

(i.e. relative risk).

**Relative risk ratios of being constrained by the cost of finance: small vs. large firms. CIS3-UK**

<i>Effect</i>	<i>Firm Size</i>	<i>Risk</i>	<i>Std. Err.</i>	<i>z</i>	<i>P&gt; z </i>
<i>Low</i>	<i>Small</i>	0.482 (0.398–0.583)	0.046	-7.51	0.000
<i>Medium</i>	<i>Small</i>	0.675 (0.560–0.817)	0.065	-4.04	0.000
<i>High</i>	<i>Small</i>	1.273 (1.03–1.573)	0.137	2.23	0.025

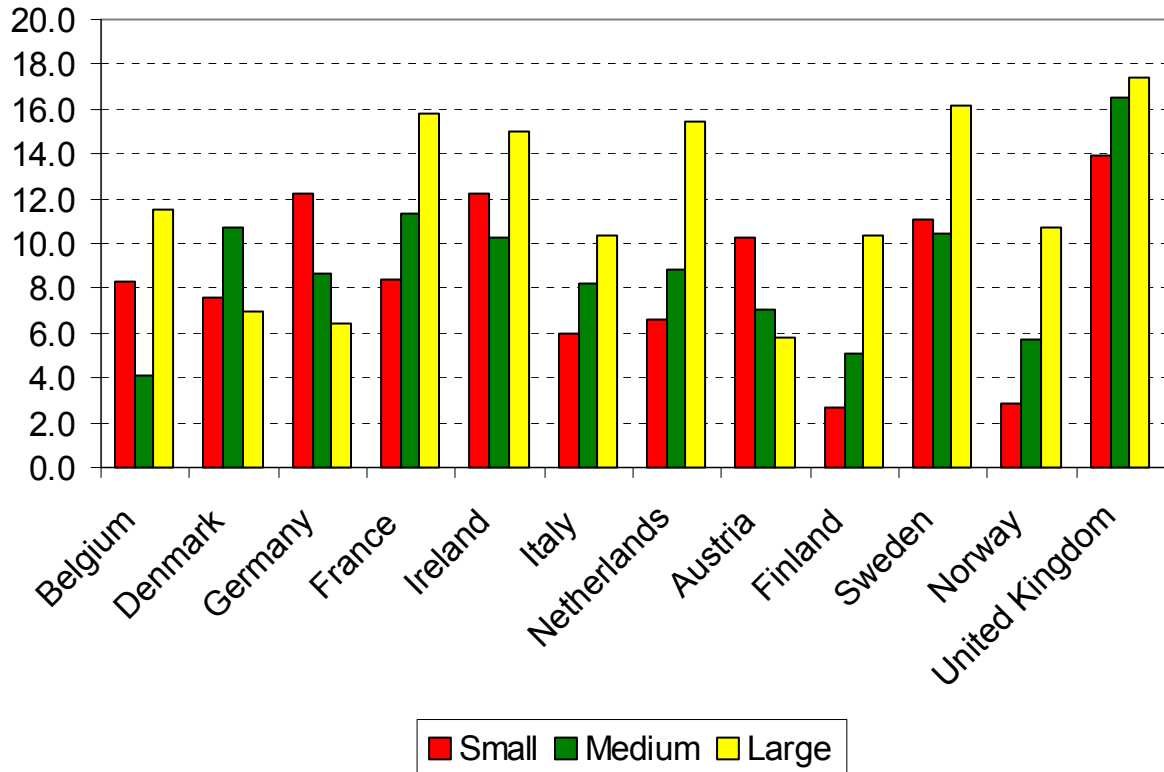
Log likelihood: -4375.8963. Likelihood ratio test:  $\chi^2(3)=9684$  ( $p$ -value=0.000).

**Relative risk ratios of being constrained by lack of finance: small and medium vs. large firms. CIS3-UK**

<i>Effect</i>	<i>Firm Size</i>	<i>Risk</i>	<i>Std. Err.</i>	<i>z</i>	<i>P&gt; z </i>
<i>Low</i>	<i>Small</i>	0.483 (0.382–0.613)	0.058	-6.01	0.000
	<i>Medium</i>	0.599 (0.454–0.791)	0.085	-3.61	0.000
<i>Medium</i>	<i>Small</i>	0.610 (0.471–0.793)	0.08	-3.71	0.000
	<i>Medium</i>	0.738 (0.545–0.999)	0.114	-1.97	0.049
<i>High</i>	<i>Small</i>	1.195 (0.884–1.616)	0.184	1.16	0.250
	<i>Medium</i>	1.05 (0.738–1.485)	0.187	0.26	0.797

Log likelihood: -4313.8618. Likelihood ratio test:  $\chi^2(6) = 57.08$  ( $p$ -value=0.000).

## 6. INTER COUNTRY DIFFERENCES IN THE IMPORTANCE OF FINANCIAL CONSTRAINTS



## Defining

$s_{ij}$  = number of innovating firms in the country  $i$  (for  $i= 1, \dots, 12$ ) and firm class  $j$  (for  $j= 1, \dots, 3$ )

$k_{ij}$  = number of firms who reported financial problems,

Let the responses be  $y_{ij} = \frac{k_{ij}}{s_{ij}}$  so that the  $E(Y_{ij})$

is equal to the probability  $\pi_{ij}$  that a firm experiences financial constraints,

$\pi_{ij}$  is related to  $\eta_{ij} = \alpha_i + \beta_j$  through  $\eta = \log \left\{ \frac{\pi}{(1-\pi)} \right\}$ . So the model we estimated for each firm class is

$$E(Y_{ij}) = \mu_{ij}, \quad \mu_{ij} = \left\{ \frac{\exp(\alpha_i + \beta_j)}{1 + \exp(\alpha_i + \beta_j)} \right\},$$

$$\text{Var}(Y_{ij}) = s^{-1}_{ij} V(\mu_{ij}), \quad V(\mu_{ij}) = \mu_{ij} (1 - \mu_{ij}).$$

The endpoints of the 95% CI estimators have been calculated using

$$\hat{\beta}_{ij} \pm z_{1-\alpha/2} \boxed{SE}^* [\hat{\beta}_{ij}],$$

where

$$\boxed{SE}^*_{\hat{\beta}_{ij}} = \left[ \left( (B-1)^{-1} \sum_{b=1}^B [\hat{\beta}_{ijb}^* - \overline{\hat{\beta}_{ij}^*}] \right)^2 \right]^{1/2},$$

$$\overline{\hat{\beta}_{ij}^*} = B^{-1} \sum_{b=1}^B [\hat{\beta}_{ijb}^*],$$

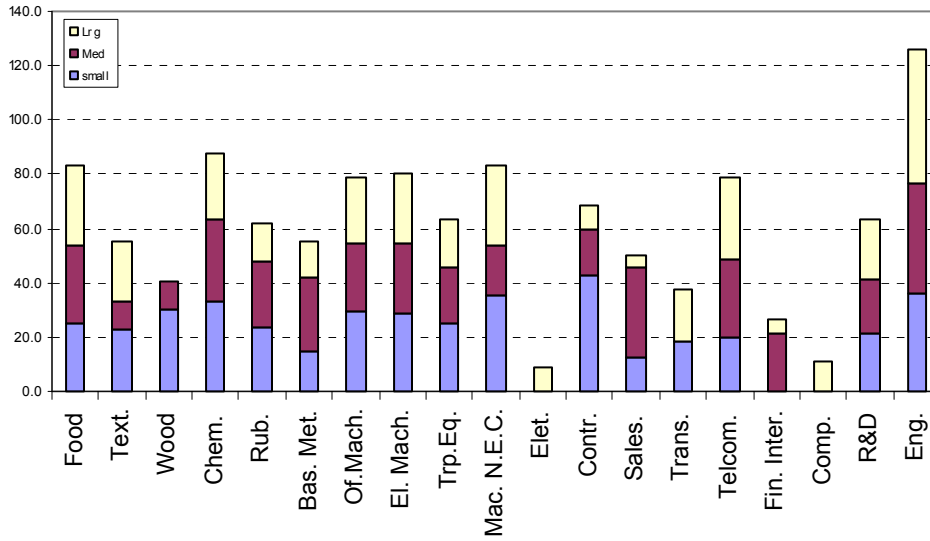
and  $B$  (for  $B=1000$ ) is the number of bootstrap replications. So that

$$CI_{\hat{\beta}_{ij}} = \exp \left\{ \hat{\beta}_{ij} \pm z_{1-\alpha/2} \boxed{SE}^* [\hat{\beta}_{ij}] \right\}.$$

## Comparing UK and the other EU countries, CIS2 - EU:

	<i>All</i>	<i>Small</i>	<i>Medium</i>	<i>Large</i>
<i>Country</i>	<i>Od. Rt.</i> <i>( CI)</i>	<i>Od. Rt.</i> <i>( CI)</i>	<i>Od. Rt.</i> <i>( CI)</i>	<i>Od. Rt.</i> <i>( CI)</i>
<i>Belgium</i>	0.46 (0.23-0.94)	0.59 (0.28-1.23)	0.24 (0.12-0.47)	0.65 (0.47-0.89)
<i>Denmark</i>	0.59 (0.34-0.89)	0.54 (0.33-0.87)	0.64 (0.35-1.16)	0.38 (0.19-0.77)
<i>Germany</i>	0.64 (0.36-1.12)	0.87 (0.48-1.58)	0.51 (0.25-1.02)	0.36 (0.24-0.51)
<i>France</i>	0.65 (0.39-1.06)	0.59 (0.32-1.09)	0.67 (0.42-1.07)	0.90 (0.60-1.35)
<i>Ireland</i>	0.75 (0.47-1.21)	0.87 (0.55-1.38)	0.61 (0.27-1.34)	0.86 (0.62-1.18)
<i>Italy</i>	0.43 (0.22-0.83)	0.42 (0.22-0.814)	0.49 (0.23-0.99)	0.58 (0.34-0.98)
<i>Netherlands</i>	0.52 (0.32-0.83)	0.46 (0.29-0.75)	0.52 (0.29-0.93)	0.88 (0.60-1.28)
<i>Austria</i>	0.55 (0.31-0.97)	0.73 (0.34-1.51)	0.41 (0.27-0.64)	0.32 (0.21-0.48)
<i>Finland</i>	0.27 (0.14-0.51)	0.18 (0.10-0.34)	0.29 (0.13-0.68)	0.58 (0.31-1.07)
<i>Sweden</i>	0.73 (0.45-1.20)	0.79 (0.38-1.63)	0.62 (0.38-0.99)	0.92 (0.54-1.57)
<i>Norway</i>	0.28 (0.17-0.48)	0.20 (0.11-0.36)	0.33 (0.20-0.53)	0.60 (0.41-0.87)
<i>United Kingdom</i>	1 (-)	1 (-)	1 (-)	1 (-)

# 7. FINANCIAL CONSTRAINTS TO INNOVATION: A SECTORAL ANALYSIS.



## Defining

$a_{sj}$  = (for  $s = 1, \dots, s-1$ ) number of innovating firms with “unsuccessful” innovating project in the  $j$ th (for  $s = 1, \dots, 3$ ) class size of the  $s$ th sector,

$b_j$  = number of innovating firms with “unsuccessful” innovating project in the reference size class and sector.

$c_{sj}$  (for  $s = 1, \dots, s-1$ ) = number of innovating firms with “successful” innovating project in the  $j$ th class size and  $s$ th sector,

$d_j$  = number of innovating firms with “successful” innovating project in the reference class size and sector, the relative risk is calculated as

$$(3) \quad \bar{\theta}_{R_{sj}} = \frac{a_{sj}/b_j}{c_{sj}/d_j} = \frac{a_{sj}d_j}{c_{sj}b_j},$$

while the standard errors are calculated as

$$\bar{SE}_{\bar{\theta}_{R_{sj}}} = \sqrt{\left( \frac{1}{a_{sj}} + \frac{1}{b_j} + \frac{1}{c_{sj}} + \frac{1}{d_j} \right)}.$$

**Estimated odds of a lack of availability of finance, by sector and firm size, CIS2-UK.**

		<i>Small</i>	<i>Medium</i>	<i>Large</i>
<i>Manufacturing</i>	<i>Food</i>	2.17 (0.73–3.60)	2.60 (0.66–4.54)	2.73 (1.37–4.09)
	<i>Textiles</i>	1.19 (0.84–2.98)	0.76 (–0.90–2.43)	1.86 (0.23–3.49)
	<i>Wood</i>	2.84 (1.88–3.81)	0.72 (–0.93–2.38)	0
	<i>Chemicals</i>	3.25 (2.19–4.31)	2.79 (1.75–3.82)	2.09 (0.68–3.50)
	<i>Rubber</i>	2.00 (0.79–3.21)	2.08 (1.19–2.97)	1.05 (–0.47–2.57)
	<i>Basic Metals</i>	1.12 (0.10–2.15)	2.04 (1.57–3.30)	1 (–)
	<i>Office Machinery</i>	2.74 (1.82–3.65)	2.17 (1.17–3.17)	2.08 (0.64–3.52)
	<i>Electrical Machinery</i>	2.63 (1.90–3.36)	2.25 (1.54–2.95)	2.26 (0.94–3.58)
	<i>Transport Equipment</i>	2.17 (0.95–3.39)	1.69 (0.77–2.60)	1.39 (0.09–2.88)
	<i>Machinery n.ec.</i>	3.55 (2.48–4.62)	1.44 (0.32–3.21)	2.79 (0.99–4.59)
	<i>Electricity</i>	0	0	0.65 (–1.73–3.03)

	<i>Constructions</i>	0.93 (-0.38-2.24)	1.30 (-1.62-4.22)	0.65 (-1.73-3.03)
<i>Services</i>	<i>Wholesale and Retail Trade</i>	1.50 (0.13-2.87)	3.25 (1.70-4.80)	0.30 (-2.04-2.63)
	<i>Transport</i>	1.63 (-0.17-3.42)	0	1.48 (-0.06-3.02)
	<i>Telecommunications</i>	0	2.60 (1.35-3.85)	0.80 (0.37-1.22)
	<i>Financial Intermediation</i>	0	1.77 (0.38-3.17)	0.33 (-1.34-1.99)
	<i>Computer</i>	0	0	0.81 (-1.59-3.21)
	<i>Engineering</i>	3.71 (2.38-5.05)	1.12 (2.13-6.53)	6.50 (4.20-8.80)

## 8. CONCLUSIONS

- Financial factors rank among the more significant factors that have acted as hindrances to innovation in Europe both in 1994 – 1996 and 1998 – 2000.
- Analysis of the pan European CIS2–EU data set shows that the risk differs across countries.
- The probability of high a tech sector to experience financial constraints is higher than a firm in a low tech sector.
- Overall one may thus conclude that financial factors do impact upon innovative activity in Europe. That impact is more severe in higher tech sectors, for smaller firms and in market based systems.