



Copenhagen
Business School
HANDELSHØJSKOLEN

The Paradox of Openness

Appropriability and the Use of External Sources of Knowledge for Innovation

Keld Laursen

DRUID, Department of Industrial Economics and Strategy Copenhagen
Business School

<http://www.druid.dk/laursen/>

E-mail: kl.ivs@cbs.dk

Ammon Salter

Tanaka Business School, Imperial College London

E-mail: a.salter@imperial.ac.uk

Presentation prepared for the All-Academy Symposium “Open Innovation: Empirical Research on Locating and Incorporating External Innovations”, August 9, 2005, 2:30 p.m. (Session #1064) at the Academy of Management Conference 2005, August 5-10, Honolulu, Hawaii, USA

Aim



**Copenhagen
Business School**
HANDELSHØJSKOLEN

- **Issues**
 - To explore the factors that shape how open firms are to external sources of knowledge in their innovative activities.
 - We suggest that there are four lines of analysis that can help to develop a conceptual framework for the study of the determinants of openness:
 - Appropriability strategy (the paradox of openness)
 - Absorptive capacity
 - Knowledge intensive startups
 - Technological opportunity conditions

Aim



**Copenhagen
Business School**
HANDELSHØJSKOLEN

- Data
 - UK Innovation Survey 2001 with 2304 manufacturing firms
 - Method – descriptive analysis and zero-inflated binomial regressions



Previous work (i)

- The early Schumpeterian model of the lone entrepreneur bringing innovations to markets has been superseded...
- ...by a rich picture of different actors working together in iterative process of trial and error to bring about the successful commercial exploitation of a new idea
- These newer models of innovation have highlighted the that the innovators rely heavily on their interaction with lead users, between different functional departments within the firm and with a range of institutions inside the broader innovation system



Previous work (ii)

- A recent example: Chesbrough (2003):
 - The advantages that firm's gain from internal R&D expenditure have declined.
 - Accordingly, many innovative firms now spend little on R&D
 - Yet they are able to successfully innovate by drawing in knowledge and expertise from wide range of external sources.
- However, previous research has made limited attempts to address the contingencies and strategies that condition the ability of firms to be open to external sources of innovation.



Copenhagen
Business School
HANDELSHØJSKOLEN

Openness meets appropriability: complements, not substitutes



*meets
the*



Conceptual background



Copenhagen
Business School
HANDELSHØJSKOLEN

- The paradox of openness
 - In order to gain from formal and informal knowledge trading, firms need to protect their knowledge and innovations to some extent (Gans & Stern, 2003).
 - As such, using an appropriability strategy and being open to external sources of innovation go hand in hand: firms need to disclose some knowledge to be able to gain from being open to external sources of innovation, but firms also need to protect some of the knowledge to gain from the exchange.
 - Nevertheless, at some point, a strong emphasis on appropriability will lead firms to be less open as their fear theft or leakage forces them to limit their exposure to external sources.

Hypotheses



Copenhagen
Business School
HANDELSHØJSKOLEN

- H1. The tightness of the overall appropriability strategy of firms is curvilinearly (taking an inverted U-shape) related to the degree of openness to external sources of innovation ^L
- H2. The level of human capital of firms is positively related to the degree of openness to external sources of innovation
- H3. Startups with a high level of human capital are less open to external sources of innovation
- H4. The higher the technological opportunities offered by the industry in which firms are operating, the higher the degree of openness to external sources of innovation

Data



Copenhagen
Business School
HANDELSHØJSKOLEN

- UK CIS 3 - 2001
- 2304 manufacturing firms across 13 different broad industries
- General and sectoral patterns
- 17 different sources of innovation (we use 16 in this paper)
- Detailed information on expenditure and degrees of innovativeness

Sources of information and knowledge for innovation activities in UK manufacturing firms, year 2000 (n=2304).



Type	Knowledge source	Not used/ low use	Medium use/ High use
		Percentages	
Market	Suppliers of equipment, materials, components or software	51	49
	Clients or customers	55	45
	Competitors	73	27
	Consultants	84	16
	Commercial laboratories/ R&D enterprises	91	9
Institutional	Universities or other higher education institutes	89	11
	Government research organizations	96	4
	Other public sector e .g. business links, Government Offices	92	8
	Private research institutes	96	4
Other	Professional conferences, meetings	85	15
	Trade associations	79	21
	Technical/trade press, computer databases	73	27
	Fairs, exhibitions	70	30
Specialized	Technical standards	64	36
	Health and safety standards and regulations	61	39
	Environmental standards and regulations	65	35
Average		77	22

Openness by industry



	No. of firms	No. of startups w. less than 250 employees	Openness mean	Degree/employee mean	Tech. opp. Mean	Appropriability mean
Food, drink & tobacco	180	6	3.69	7.22	0.13	3.28
Textiles	135	13	2.64	5.47	0.10	3.56
Wood	128	7	3.23	4.08	0.10	3.70
Paper and printing	203	12	3.43	14.73	0.47	2.03
Chemicals	101	3	4.81	24.50	3.00	7.84
Plastics	120	1	3.62	7.41	0.63	5.52
Non-metallic minerals	62	4	3.61	6.56	0.21	5.00
Basic metals	51	0	3.88	5.12	0.15	3.29
Fabric. metal products	249	11	2.90	7.51	0.12	2.31
Machinery	183	6	4.70	11.89	0.68	5.85
Electrical	393	14	4.49	16.29	1.41	6.00
Transport	223	13	4.23	9.65	0.36	4.96
Other	276	27	3.26	6.70	0.33	4.12
Average			3.73	9.78	0.59	4.42
Total number	2304	117				

Zero-inflated binomial regressions – measures



**Copenhagen
Business School**
HANDELSHØJSKOLEN

- **Dependent variable**
 - The degree of openness (0-16 possible sources)
- **Independent key variables**
 - Appropriability strategy (0-18 – six underlying methods)
 - The proportion of employees with a degree
 - Start-up interacted with the proportion of employees with a degree
- **Independent control variables**
 - Log of firm size (employment)
 - 13 industry dummies

Descriptive stats



**Copenhagen
Business School**
HANDELSHØJSKOLEN

Variable	Mean	Std. Dev.	Min	Max	1.	2.	3.	4.	5.
1. Openness	3.76	3.63	0	16					
2. Appropriability strategy	4.40	5.12	0	18	0.464 ***				
3. Share employees with a degree	10.43	18.31	0	100	0.158 ***	0.200 ***			
4. Small startups	0.05	0.22	0	1	-0.071 ***	-0.058 **	0.026		
5. Industry average R&D intensity	0.62	0.77	0.05	6.13	0.139 ***	0.194 ***	0.240 ***	-0.023	
6. Number of employees (log)	4.17	1.39	0	8.97	0.270 ***	0.343 ***	0.056 **	-0.146 ***	0.093 ***

Zero-inflated negative binomial regression, explaining external Openness to sources of innovation across UK manufacturing firms



**Copenhagen
Business School**
HANDELSHØJSKOLEN

Independent variables	Model 1		Model 2	
	Coeff.	Std. Err.	Coeff.	Std. Err.
Appropriability strategy	0.063 ***	0.011	0.071 ***	0.011
Appropriability strategy squared	-0.001 †	0.001	-0.002 **	0.001
Share of employees with a degree	0.003 **	0.001		
R&D intensity			-0.001	0.004
Startup	0.011	0.103	-0.030	0.082
Startup x Degree/employees	-0.010 *	0.004		
Startups x R&D intensity			-0.051 †	0.028
Industry average R&D intensity	0.134 **	0.044	0.109 *	0.043
Number of employees (log)	0.064 ***	0.013	0.063 ***	0.012
Food, drink & tobacco	0.222 **	0.080	0.175 *	0.077
Textiles	-0.092	0.094	-0.069	0.090
Wood	0.152	0.093	0.147 †	0.086
Paper and printing	0.216 **	0.079	0.273 ***	0.074
Chemicals	-0.248 †	0.147	-0.132	0.141
Plastics	0.028	0.093	0.077	0.089
Non-metallic minerals	0.096	0.119	0.040	0.117
Basic metals	0.293 *	0.122	0.313 **	0.119
Fabric. metal products	0.147 †	0.078	0.147 *	0.074
Machinery	0.203 **	0.076	0.207 **	0.073
Electrical	0.018	0.081	0.077	0.077
Transport	0.198 **	0.073	0.195 **	0.068
Other	Benchmark		Benchmark	
Constant	0.769 ***	0.083	0.775 ***	0.079
No. of obs	2304		2706	
Zero obs	633		775	
Log likelihood	-5318.96		-6213.57	
Chi-square	328.72 ***		351.33 ***	

† $p < .10$; * $p < .05$;
** $p < .01$; *** $p < .001$



Conclusions

- Openness to sources of knowledge for innovation is contingent on:
 - The firm's appropriability strategy and (broad) absorptive capacity
 - The environment in terms of imperatives for newly founded firms and technological opportunity conditions



Future research

- Analyzing external search within each individual knowledge channel (such as users, suppliers, universities etc.)
- Looking at how the level of complexity of an innovation shapes the way firms search for new innovation opportunities.
- Attempt to understand changes in innovative search over time.