Knowledge Protection Capabilities and their Effects on Knowledge Creation and Exploitation in High- and Low-tech Environments

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Motivation

Knowledge protection strategies

- Formal
- Strategic

Knowledge protection strategies effects

- Exploitation
- Resource creation

Country environment

- High tech country
- Medium-low tech country

Knowledge protection strategies

Knowledge protection strategy	Formal	Strategic
Major forms	Patents, copyrights, trademarks, industrial design	Secrecy, lead time, complex design, complementarities
Basis of knowledge protection	Law	Prevention of spillovers
Process	Formal application to official agency	Organisation
Costs of protection	Substantial time and resource commitments	Flexible element of organizational design
Embodiment of protection	Tangible	Intangible
Type of suitable knowledge	Easy to codify, large group of potential users, low costs/high risks of imitation, product innovations	All forms of knowledge
Limitations to effectiveness	Knowledge disclosure enables “inventing around”	Knowledge embodied in products on the markets, personnel turnover

Synthesis primarily based on Encaoua et al. (2006), Harabi (1995), Laursen and Salter (2005), Porter Liebeskind (1997), Saviotti (1998), Arundel and Kabla (1998), Gallini, (2002)

Knowledge protection strategies effects

- Management has strong incentives to protect the results so that the firm's investments in knowledge creation activities do not become available to other firms (Arrow, 1962)
- Firms are not passive actors when it comes to protecting their knowledge

- Knowledge protection strategies enable firms to exploit the knowledge and appropriate the economic returns from their investments into knowledge production (Levin et al., 1985; Mansfield, 1986; Liebeskind, 1996)
- It also creates incentives for management to invest into the creation of new knowledge, since it can reduce uncertainty (Freel, 2005)

Hypotheses

Hypothesis 1 Formal knowledge protection capabilities have a greater impact on the firm's investment into knowledge creation than strategic knowledge protection methods in high and low-tech industries

Hypothesis 2a: In industries with less technological opportunities, strategic knowledge protection capabilities enable firms to exploit their knowledge more successfully than formal knowledge protection capabilities.

Hypothesis 2b: In industries with more technological opportunities, formal knowledge protection capabilities enable firms to exploit their knowledge more successfully than strategic knowledge protection capabilities.

Country environment

- The choice of combined knowledge protection strategies is not independent from the host country environment
- The legal settings for intellectual property rights differ significantly across countries due to diversity in economic development and trade policy (Yang and Kuo, 2008)
- The restrictiveness of a firm knowledge protection strategy will depend upon the challenges and opportunities of the host country (Aharonson et al., 2007)
- Most of the studies are focused on high-tech countries and the international comparisons are scarce

Hypotheses

Hypothesis 3a: In countries with less technological opportunities, strategic knowledge protection capabilities enable firms to exploit their knowledge more successfully than formal knowledge protection capabilities.

Hypothesis 3b: In countries with more technological opportunities, formal knowledge protection capabilities enable firms to exploit their knowledge more successfully than strategic knowledge protection capabilities.

Empirical study

Community Innovation Survey

- Guiding principles of the Oslo Innovation Manual and executed under the supervision of Eurostat

Advantages

- Deals directly with heads of R&D departments or innovation management
- Looks at innovation in a broad perspective, and not only at the adoption of one specific technological innovation (e.g. computers)
- Captures innovation activities other than simply R&D expenditures
- Provides information about innovations beyond that linked to patent applications

Empirical study

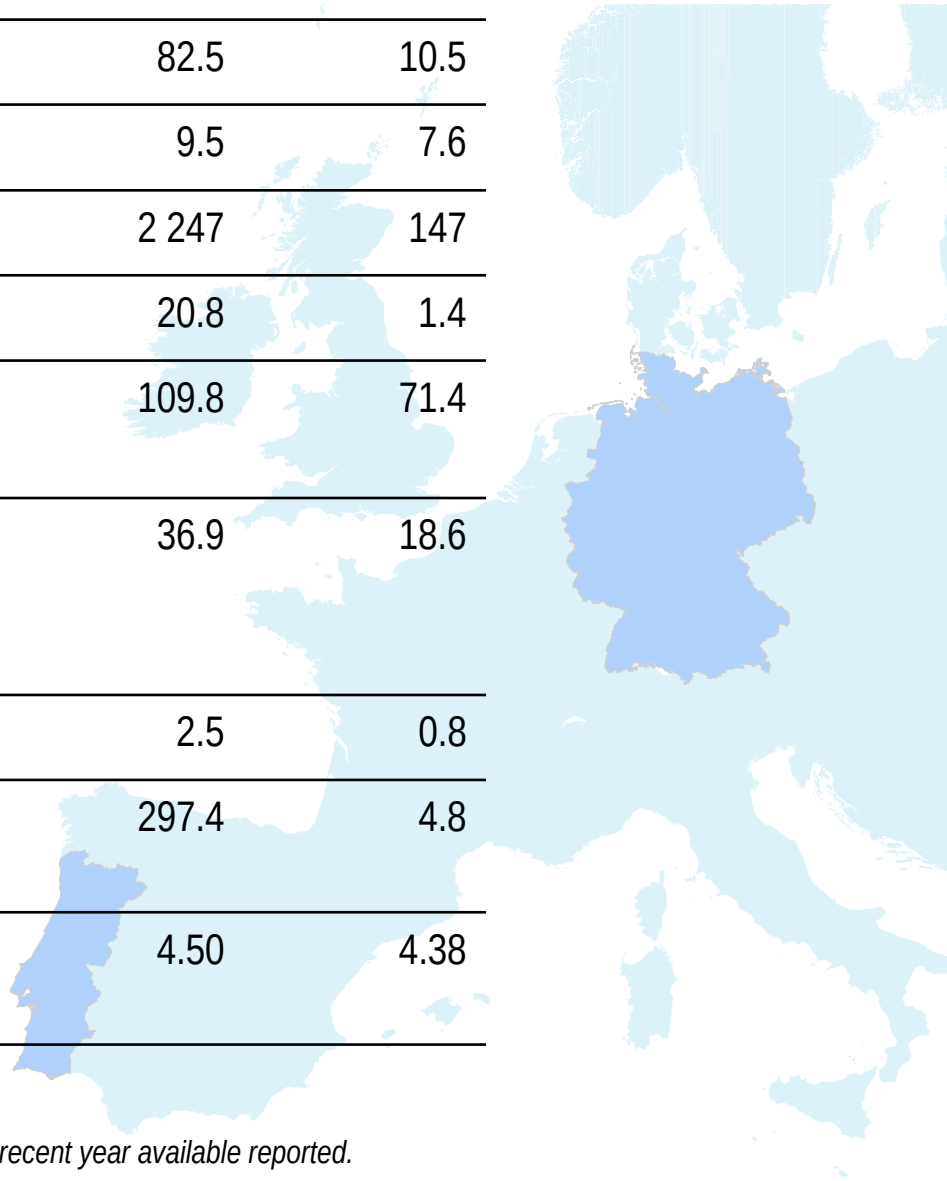
Community Innovation Survey III (CIS III) 2001

- Firm and innovation characteristics
- Quality management at firm, industry and country level
- Questionnaire and methodology harmonized across the countries

Opportunity

- Coverage of knowledge protection strategies
- Cross country comparison: Portugal – Germany
- Broad coverage
  - Portugal: 755 observations
  - Germany: 889 observations

	Germany	Portugal
Total Population *(Mio.)*	82.5	10.5
Unemployment rate *(%)*	9.5	7.6
GDP at current market prices, *(EUR 1 000 Mio.)*	2 247	147
GDP at current market prices, *Share of EU-25 (%)*	20.8	1.4
GDP per capita at current market prices (PPS), *(EU-25 = 100)*	109.8	71.4
Human resources in science and technology for all sectors, People working in a S&T occupation, *(% of total employment)*	36.9	18.6
Gross domestic expenditure on R&D, *(% of GDP)*	2.5	0.8
Patent applications to the European Patent Office, EPO *(number of applications per million inhabitants)*	297.4	4.8
Index of patent rights (5 = highest patent right protection) (Park, 2008)	4.50	4.38



Source: Eurostat (2007): Europe in figures - Eurostat yearbook 2006-07. Most recent year available reported.

Factor Analysis

Principal component factor analyses on firm's usage of seven knowledge protection mechanisms which are directly derived from Laursen and Salter (2005): Patenting, design patterns, trademarks, copyrights, secrecy, lead time and complex design

In both countries lead-time, complex design and secrecy form one factor of knowledge protection capabilities - strategic knowledge protection

In Portugal, patenting, design patterns, trademarks and copyrights, form a separate factor (formal knowledge protection)

Two factors in Germany: patenting and design patterns vs. copyrights and trademarks

Variables

Dependent variables

- Share of turnover due to new or improved products to market
- Share of turnover invested in intramural R&D

Independent variable

- Knowledge protection scales scored from factor analyses

Control variables

- Firm group with foreign HQ , Domestic group, Export share of sales, Share of empl. with college educ., R&D activities, No of employees, Location in East Germany, Industry level knowledge intensity variables
- R&D index: Industry difference in R&D intensity between host country and rest of OECD countries (Salomon and Byungchae, 2008)
- Industry share of R&D expo. of sales

Method

System of two equations (Tobit)

Exploitation = f (knowled. protection scales; control variables; R&D intensity)

R&D intensity = f (knowled. protection scales; control variables; instruments)

Endogeneity

- The inclusion of firm R&D expenditure amongst the determinants raises a possible endogeneity problem
- The solution adopted was to implement an instrumental variable approach (Instrumental variable tobit model)

Instruments

- Government funding for R&D and continuous R&D activities

	Germany				Portugal			
	R&D expenditures	Sales new to market products	R&D expenditures	Sales new to market products	R&D expenditures	Sales new to market products	R&D expenditures	Sales new to market products
Strategic knowl. prot. (scale)	0.00**	0.03***	0.00	0.03**	0.11	0.07***	-0.02	0.07***
	(0.00)	(0.01)	(0.00)	(0.01)	(0.09)	(0.01)	(0.10)	(0.01)
Patents/design pattern knowl. prot. (scale)	0.01***	0.05***	0.00	0.04***				
	(0.00)	(0.01)	(0.00)	(0.01)				
Trademarks/copyrights knowl. prot. (scale)	0.00	0.02**	0.00	0.03**				
	(0.00)	(0.01)	(0.00)	(0.01)				
Formal knowl. Prot. (scale)					0.02	0.04**	0.06	0.03**
					(0.09)	(0.01)	(0.10)	(0.02)
Industry R&D index 1998	0.00	-0.01	0.00	-0.01	0.06	-0.08**	0.03	-0.08**
	(0.00)	(0.02)	(0.00)	(0.02)	(0.23)	(0.04)	(0.23)	(0.04)
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Industry share of R&D expo. of sales (ratio)	0.16*	-1.05**	0.21**	-1.06**	0.20**	-0.03	0.15	-0.03
	(0.09)	(0.44)	(0.09)	(0.47)	(0.10)	(0.02)	(0.11)	(0.02)
Share of empl. with college educ. (ratio)	0.05***	-0.03	0.05***	-0.02	2.69***	-0.13	2.77***	-0.14
	(0.01)	(0.06)	(0.01)	(0.07)	(0.66)	(0.13)	(0.66)	(0.13)
Government funding for R&D (d)	0.02***		0.02***		0.39**		0.38**	
	(0.00)		(0.00)		(0.19)		(0.19)	
Continuous R&D activities	0.03***		0.02***		1.57***		1.55***	
	(0.00)		(0.00)		(0.21)		(0.21)	
Share R&D exp. of sales (ratio)		1.78***		1.79***		0.06***		0.06***
		(0.59)		(0.64)		(0.02)		(0.02)
Interact.: Indu. R&D * Strategic			0.19***	-0.23			0.16***	-0.26
			(0.06)	(0.33)			(0.06)	(1.304
Interact.: Indu. R&D * Patents, design pat.			0.34***	0.09				
			(0.06)	(0.39)				
Interact.: Indu. R&D * Tradem., copyr.			0.04	-0.30				
			(0.06)	(0.28)				
Interact.: Indu. R&D * Formal							-0.05	-0.32
							(0.06)	(0.93)
Pseudo R2								
N	889	889	889	889	755	755	755	755
LR/Wald chi2		116.13		122.42		68.65		69.02
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

H1

H3b

H3a

H2

H2

* p<0.10, ** p<0.05, *** p<0.01

Discussion and Conclusions

Countries with lower technological opportunities

- Traditional distinction between formal and strategic knowledge protection
- knowledge protection capabilities only have impact on the exploitation of innovation opportunities
- Effects from formal and strategic capabilities are not significantly different
- Managers are not sensitive to knowledge protection opportunities in their input decisions

Countries with higher technological opportunities

- Additional copyright protection strategy
- Knowledge protection strategies have impact on both exploitation and creation of innovation opportunities
- Patent-based and strategic knowledge protection capabilities are equally important for input decisions
- Patent-based knowledge protection capabilities are most important for exploitation

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