Innovation Management

Internal and External Technology Acquisition

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IGIER, February 14, 2003

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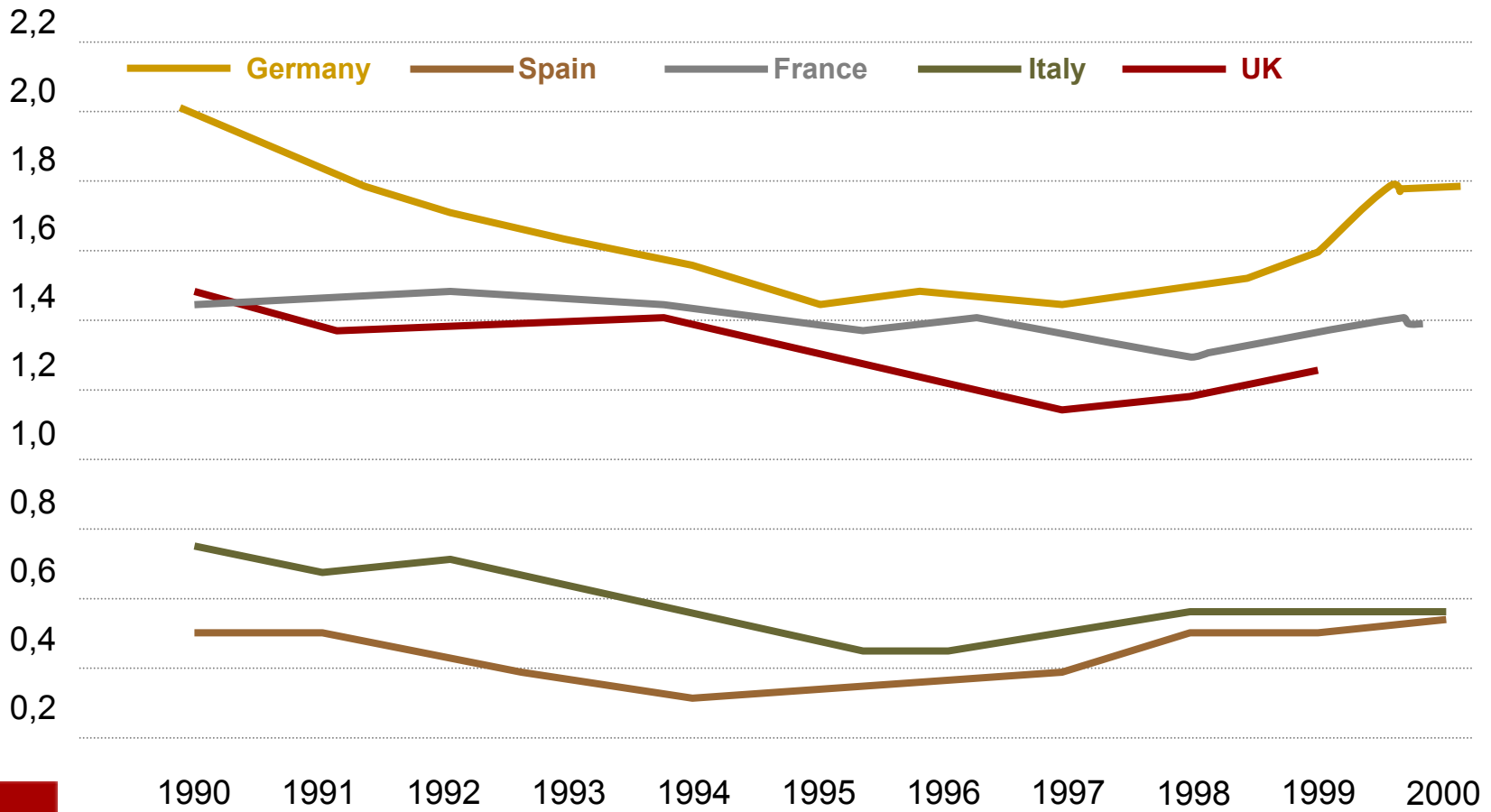
Introduction

- Today even the largest and most technologically self-sufficient organizations require knowledge from beyond their boundaries
- An important task in innovation management is to optimally integrate external knowledge into the firm's innovation process
- Ever increasing demand to improve innovative performance, but…

…no significant increase in innovation expenditures

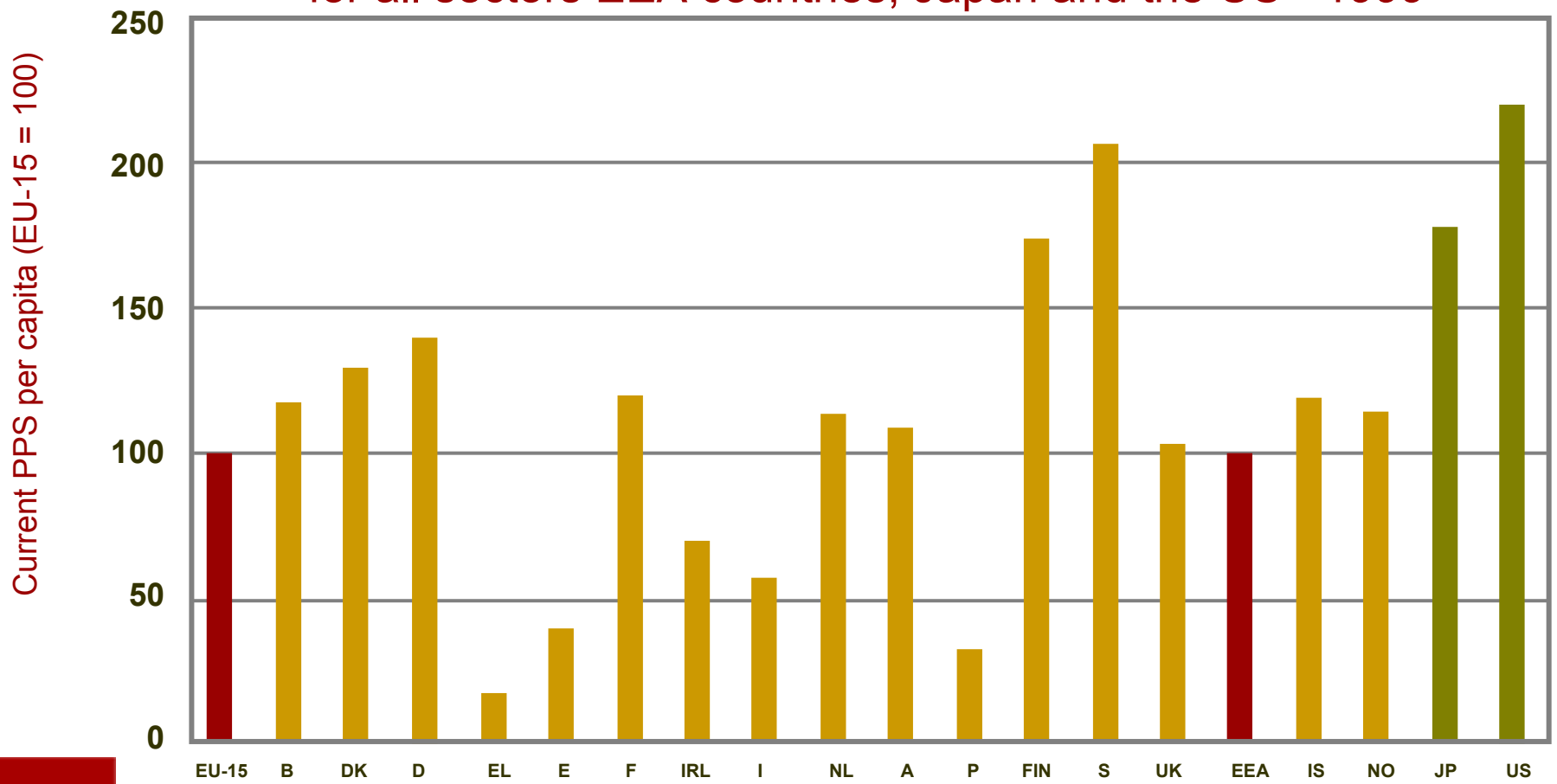
Evolution of Firm R&D expenditures (% GDP)



Source: "Main Science and Technology Indicators" OCDE (2001)

…with significant country specific variation…

Intramural R&D expenditure per capita in current PPS (EU-15 = 100) for all sectors EEA countries, Japan and the US - 1999



Source: Eurostat, OECD, (JP,US)

…and industry variation…

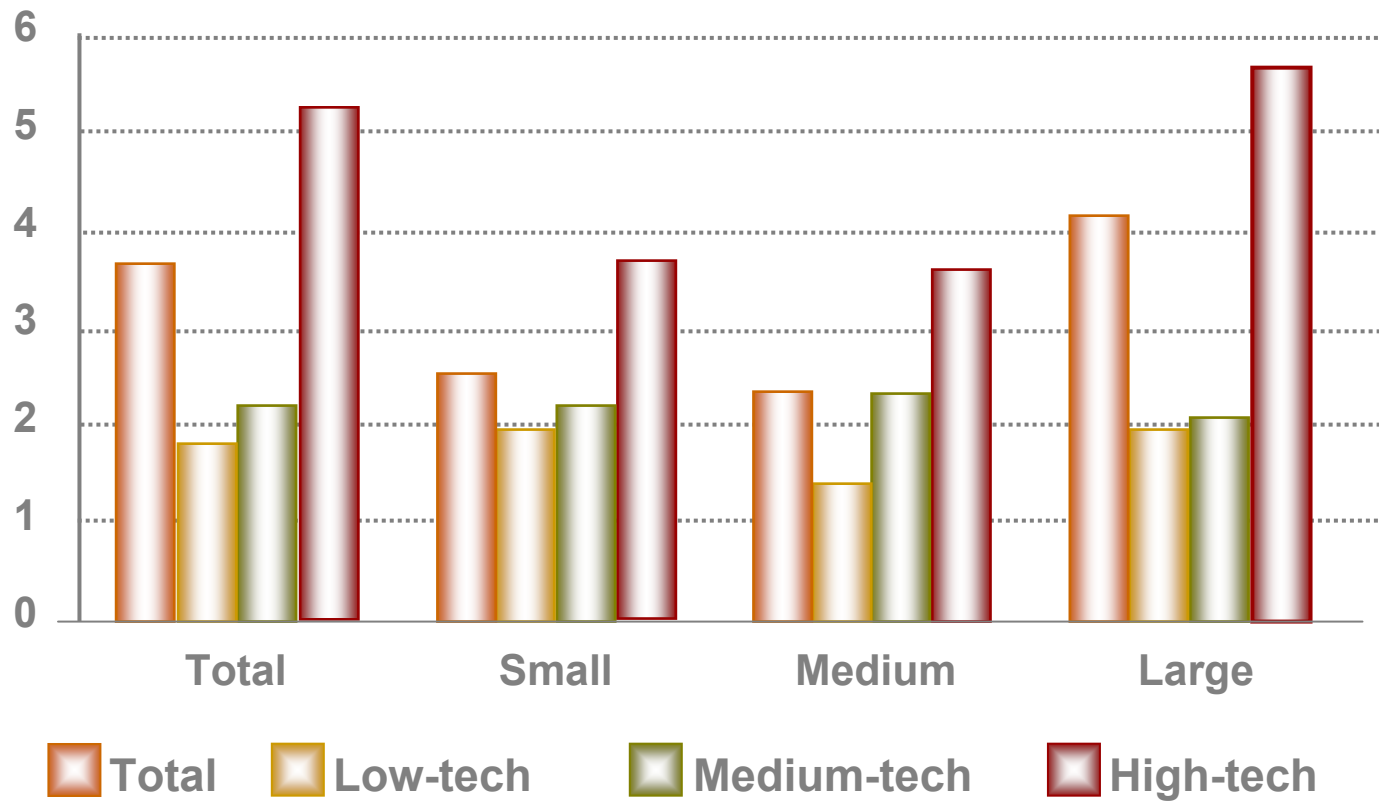
Concentration of innovation expenditure	Concentration of total innovation expenditure within sectors[1]	Innovation intensity		
		All innovators	Largest 1% of innovators	Smallest 99% of innovators
Total Manufacturing	55	3.7	7.3	2.3
Food, beverages & tobacco	37	1.6	3.5	1.2
Textile & leather	23	1.6	8.8	1.3
Wood, pulp & printing	43	2.5	9.8	1.6
Coke & chemicals	45	4.1	10.6	2.7
Rubber & other non-metallic	31	2.7	4.9	2.2
Basic & fabricated metals	52	2.1	2.9	1.6
Machinery & equipment	45	3.8	7.3	2.7
Electrical & optical equipment	71	8.4	11.6	5.1
Transport equipment	65	4.3	6.5	2.7
NEC & recycling	24	2.4	5.8	2.0

[1] Share of the group of 1% of enterprises with the highest innovation expenditure in total innovation expenditure of the sector

Source: Eurostat

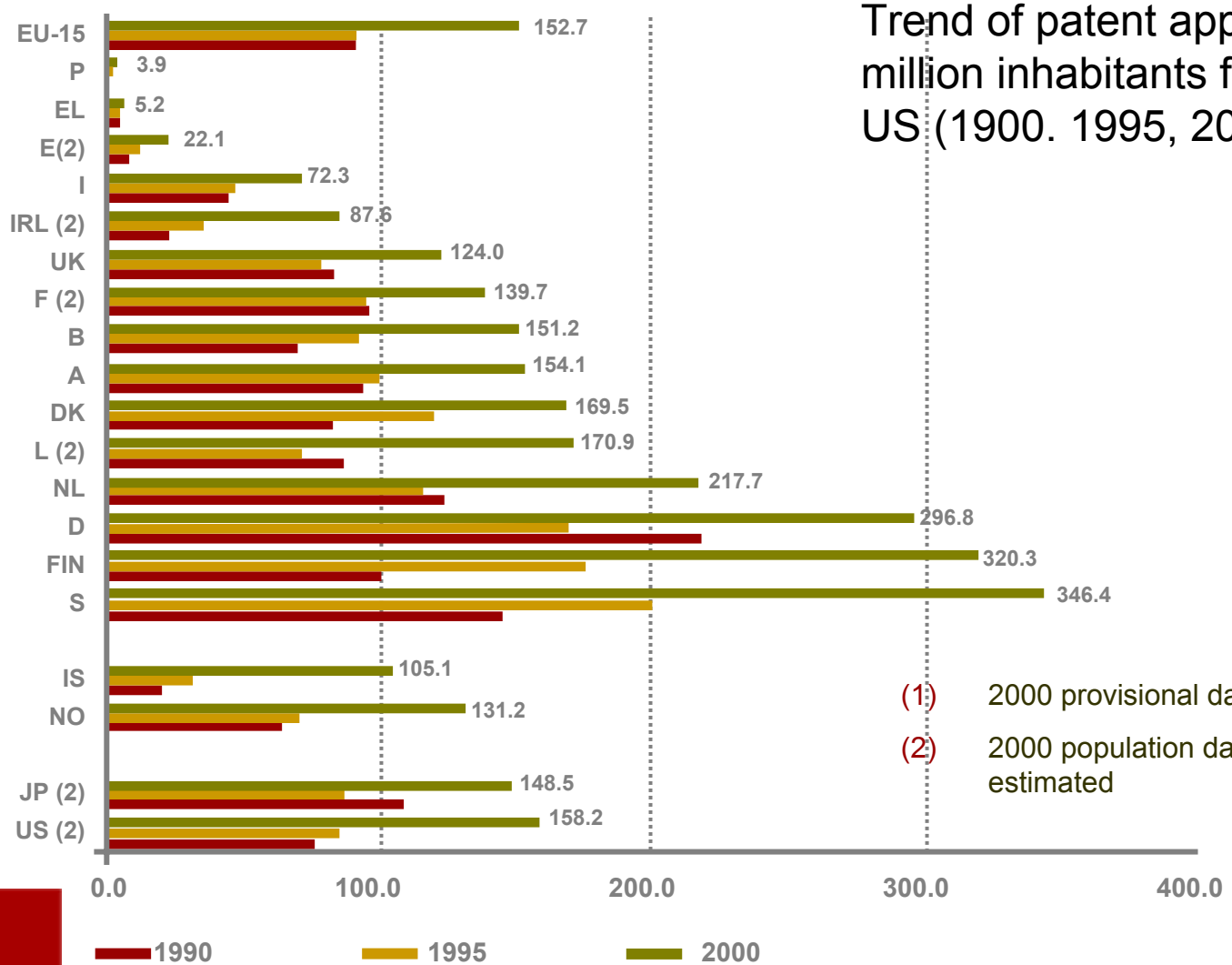
…and variation in firm size…

Innovation expenditure as a share of total turnover, 1996



…at the same time output varies by country…

Trend of patent applications to the EPO per million inhabitants from EEA, Japan and the US (1900. 1995, 2000) (1)



(1) 2000 provisional data

(2) 2000 population data for E, F, IRL and L have been estimated

Source: Eurostat, datra: EPO

…by industry…

Concentration of new and improved products	Concentration of new and improved products within sector[1]	Share of new or improved products in total turnover		
		All product innovators	Largest 1% of product innovators	Smallest 99% of product innovators
Total Manufacturing	55	32	55	21
Food, beverages & tobacco	34	17	41	13
Textile & leather	25	18	88	15
Wood, pulp & printing	33	15	42	11
Coke & chemicals	44	27	47	20
Rubber & other non-metallic	41	27	56	20
Basic & fabricated metals	41	16	20	14
Machinery & equipment	39	37	44	33
Electrical & optical equipment	67	52	72	33
Transport equipment	72	54	65	37
NEC & recycling	22	29	55	25

[1] Share of the group of 1% of enterprises with the highest turnover of new and significantly improved products in total turnover of new and significantly improved products of the sector

Source: Eurostat

…and by country and industry…

Relative distribution of total number of enterprises, manufacturing sector (%), 1996

	EU	B	D	DK	E	F	I	IRL	L	NL	A	P	FIN	S	UK	EEA	NOR
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Low-tech	42	48	33	39	51	43	44	44	31	40	52	68	41	36	38	43	51
Medium-tech	30	31	34	28	30	32	30	24	43	32	28	19	24	30	29	30	29
High-tech	27	22	32	33	19	26	26	32	26	28	20	13	35	34	32	27	20

Number of innovators (%), 1996

Total	51	34	69	71	29	43	48	73	42	62	67	26	36	54	59	51	48
Low-tech	43	28	64	66	20	36	41	65	26	55	66	21	29	44	52	43	43
Medium-tech	49	36	62	59	28	37	49	73	46	57	61	28	35	47	54	49	45
High-tech	68	47	80	85	53	62	59	86	53	79	81	49	46	71	71	68	66

Number of novel innovators (%), 1996

Total	21	14	24	27	11	20	26	27	21	28	24	7	18	25	19	21	14
Low-tech	14	10	16	26	6	12	19	21	15	20	19	4	12	13	12	14	10
Medium-tech	19	15	19	27	9	18	26	24	15	24	24	10	15	27	16	19	12
High-tech	34	22	36	30	25	33	40	36	36	44	36	15	25	34	29	34	27

Turnover due to new or improved products as a share of total turnover (%), 1996

Total	33	14	45	21	27	21	27	32	:	25	31	14	25	31	23	32	20
Low-tech	17	11	25	10	14	10	18	13	:	19	24	7	10	16	17	17	11
Medium-tech	23	10	24	22	25	17	31	30	:	20	29	4	17	19	20	23	21
High-tech	45	18	57	38	39	29	33	51	:	35	42	34	47	39	29	45	33

Table 8: Turnover due to novel products as a share of total turnover (%), 1996

Total	6	3	4	5	9	8	13	8	:	7	6	7	7	7	7	4	6
Low-tech	4	2	4	3	4	3	8	3	:	4	6	1	2	2	4	2	4
Medium-tech	6	2	3	5	10	9	11	16	:	11	4	1	5	3	6	5	6
High-tech	8	3	4	9	14	11	20	10	:	8	7	22	16	10	9	7	8

Table 9: Total innovation expenditure as a share of total turnover (%), 1996

Total	3.7	2.1	4.1	4.8	1.8	3.9	2.6	3.3	:	3.8	3.5	1.7	4.3	7.0	3.2	3.7	2.7
Low-tech	1.8	1.2	1.9	2.3	1.1	1.0	1.7	1.4	:	1.6	1.9	1.8	4.0	2.8	2.6	1.8	1.7
Medium-tech	2.2	2.5	2.3	5.9	1.4	1.8	2.2	3.5	:	1.8	3.2	1.0	1.1	2.3	2.3	2.2	1.8
High-tech	5.3	2.7	5.3	8.5	2.9	6.8	3.8	5.1	:	7.9	5.5	2.2	6.9	9.8	3.9	5.3	5.3

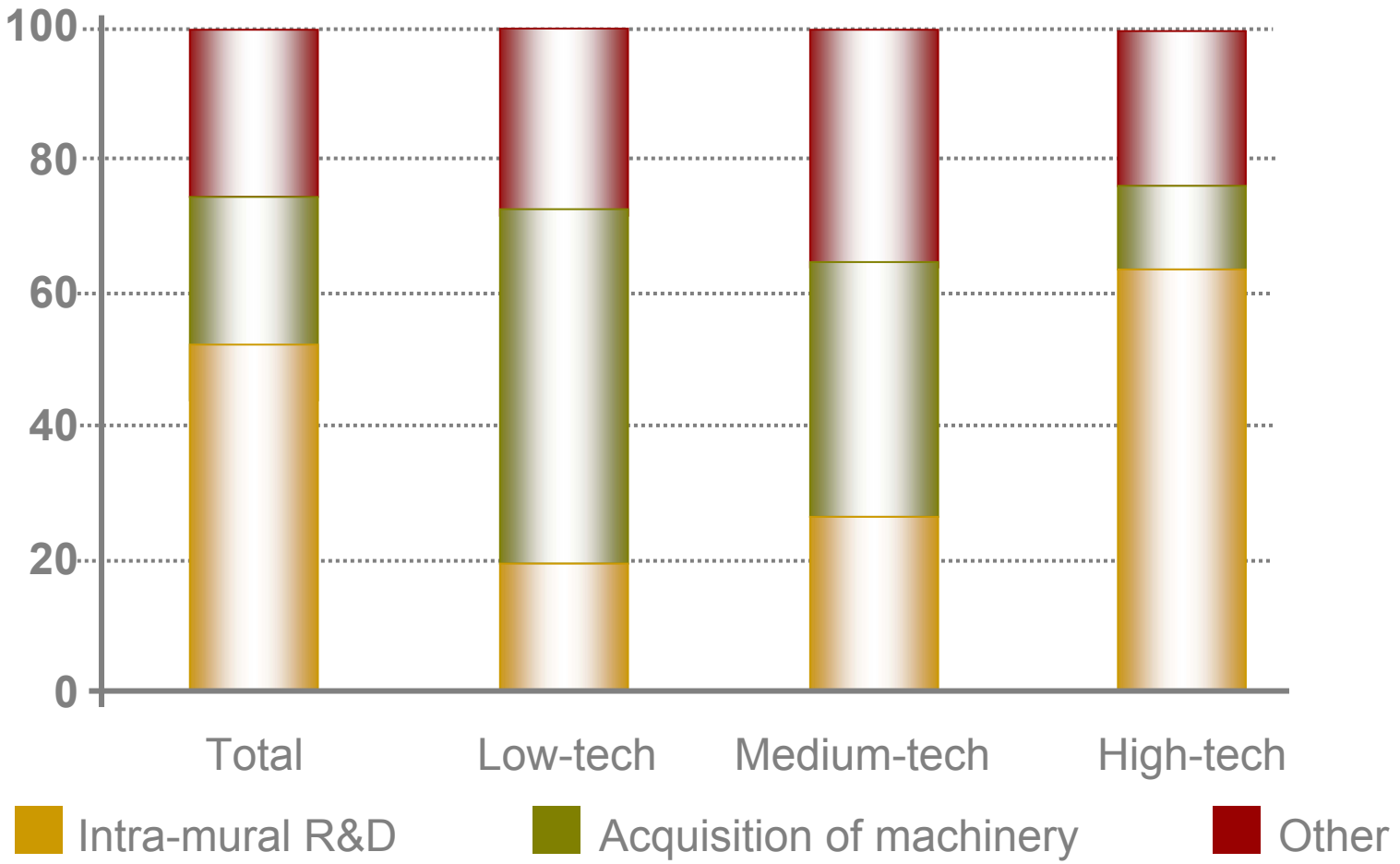
Source: Eurostat

…but what happens in the process of converting inputs into outputs?

- Variation cannot be explained by country, industry, and size only
- There remains important variation in innovation performance between organizations taking into account these different dimensions
- Management needs to focus on the organization of the innovation process where...

…content of innovation expenditures varies…

Structure of innovation expenditure, 1996



Source: Eurostat

…as does importance of information sources

Information Sources for Innovation Process

% firms that find source important or crucial for innovation process	
• Internal Information Sources	91%
• External Information Sources	
* Vertical (suppliers, customers)	81%
* Horizontal (competitors)	69%
* Research institutes	24%
– Universities	
– Public research institutes	
– Technical centers	
* Freely available information (spillovers)	53%
– Patent information	
– Conferences, publications	
– Trade fairs, expositions	

Source: Cassiman and Veugelers (1999)

Different innovation activities matter…

Definition of Innovation Activities (0/1)		
	Description Variable	Number of Firms (percentage of innovating firms)
MAKE	Innovative firms that have own R&D activities and have a positive R&D budget.	**360 (81%)**
BUY	Innovative firms a cquiring technology through at least one of the following external technology acquisition modes: licensing and/or R&D Contracting/R&D advice and/or Take-over and/or Hire-away.	**307 (69%)**
Buy License	Innovative firms acquiring technology through licensing.	132 (30%)
R&D Contracting	Innovative firms acquiring technology through R&D Contracting.	187 (42%)
Take-over	Innovative firms acquiring technology through Take - over.	74 (17%)
Hire-away	Innovative firms acquiring technology through hiring away personnel.	184 (42%)
R&D Cooperation	Innovative firms that cooperate in R&D. Cooperative partners can be either research institutes, and/or vertical partners such as suppliers or customers and/or competitors.	**133 (30%)**
Research Institutes Cooperation	Innovative f irms that cooperate in R&D with research institutes and universities.	132 (29%)
Vertical R&D Cooperation	Innovative firms that cooperate in R&D with suppliers and/or customers.	133 (30%)
Competitor Cooperation	Innovative firms that cooperate in R&D with competitors.	29 (7%)
A total of 714 firms responded, 445 firms innovated.		

Source Cassiman and Veugelers (2002)

… are strongly related,…

Unconditional Correlations between Innovation Activities										
	1	2	2.1	2.2	2.3	2.4	3	3.1	3.2	3.3
1. MAKE	1.00									
2. BUY	***0.14***	1.00								
2.1 *LICENSING*	0.07		1.00							
2.2 *R&D CONTRACTING*	0.24		0.28	1.00						
2.3 *TAKE OVER*	0.03		0.19	0.13	1.00					
2.4 *ATTRACTING PERSONNEL*	0.07		0.11	0.16	0.27	1.00				
3. COOPERATION	***0.38***	***0.28***	0.14	0.36	0.05	0.13	1.00			
3.1 *VERTICAL*	0.29	0.21	0.19	0.23	0.05	0.12		1.00		
3.2 *RESEARCH*	0.30	0.26	0.11	0.37	0.09	0.11		0.45	1.00	
3.3 *COMPETITORS*	0.11		0.13	0.22	0.00	0.04		0.33	0.30	1.00

Source Cassiman and Veugelers (2002)

…performed by the same firms…

	MAKE/BUY/ COOP	***MAKE/BUY***
NoMake&Buy&Coop	21 (6%)	21 (6%)
MakeOnly	70 (19%)	85 (23%)
BuyOnly	32 (9%)	33 (9%)
Make&Buy	128 (35%)	227 (62%)
Make&Coop	15 (4%)	
Buy&Coop	1 (0%)	
Make&Buy&Coop	99 (27%)	
TOTAL	366 (100%)	

Source Cassiman and Veugelers (2002)

…while improving innovation performance!

	%SalesNewP	%SalesNewP
NoMake&Buy&Coop	14.2%	14.2%
MakeOnly	14.8%	14.8%
BuyOnly	15.3%	14.9%
Make&Buy	**23.3%**	**21.8%**
Make&Coop	15.2%	
Buy&Coop	0%	
Make&Buy&Coop	**19.8%**	
TOTAL	**19.1% (316)**	

Source Cassiman and Veugelers (2002)

Why would this complementarity exist? (I)

- Technological Orientation of the Firm
  - Internal R&D allows the firm to scan the environment and screen the different technological options
  - External technology is easier integrated into the innovation process given the absorptive capacity internal R&D activities provide (research tourism)
  - Many technology transactions are based on the exchange of technology as in cross-licensing and R&D cooperation
  - External technology in turn increases the efficiency of the internal R&D activities

Depends on the nature of information sources

Innovation Strategy and Information Sources

% firms that consider information source important or crucial

	Internal	Vertical	Competitors	Universities	Spillovers
Make	91%	76%	66%	23%	42%
Buy	78%	87%	77%	16%	42%
Make & Buy	96%	82%	69%	28%	61%

Source: Cassiman and Veugelers (1999)

Why would this complementarity exist? (II)

- Appropriating and protection intellectual property
  - Internal R&D activities provide better protection through secrecy
  - Combining internal and external technologies increases the complexity of the innovation allowing for better protection
  - Acquiring external technology allows firms to gain lead time

Strategic protection is key...

Protection of Innovation

% firms that consider protection mechanism very effective or crucial

	Legal Protection	Strategic Protection
Chemical	36%	87%
IT	18%	82%
MecEng	28%	82%
Food	26%	66%
Textile	8%	75%
Wood	19%	65%
Other	25%	75%
Total	**24%**	**75%**

Source: Cassiman and Veugelers (1999)

...In particular for firms combining internal and external technology acquisition

Innovation Strategy and Appropriation

% firms that consider protection mechanism very effective or crucial

	Legal Protection	Strategic Protection
Make	21%	64%
Buy	14%	53%
Make & Buy	28%	85%

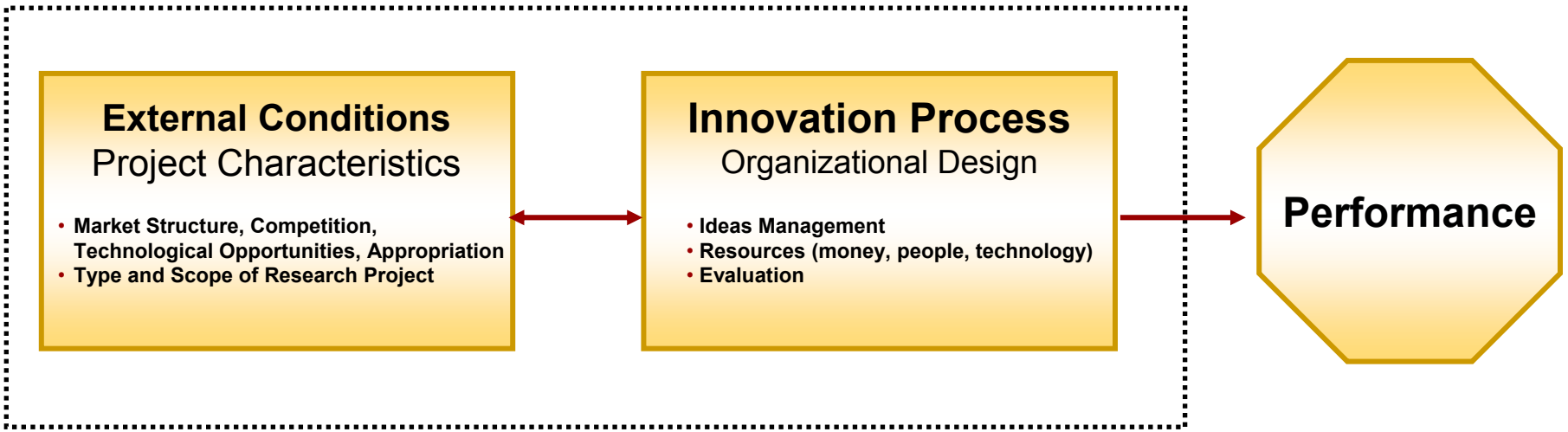
Source: Cassiman and Veugelers (1999)

Questions to Ask

- What are the important information sources for our innovation process?
  - Internal or External?
  - External: Applied or Basic? Spillovers?
- How do we best appropriate the returns to our innovations?
  - Legal or Strategic means?
  - Strategic: secrecy, complexity or lead time?
- Improve the performance of your innovation process by optimizing the combination of technology **make and buy** activities

Current project: the organization of innovation

- What is the proper organization of the innovation process? How do External Conditions and Project Characteristics interact with the organization of the project (of the process)?
  - Relevant information and resources to make good decisions
  - Incentives to use information and resources productively



- Survey with Project Managers at the same research site

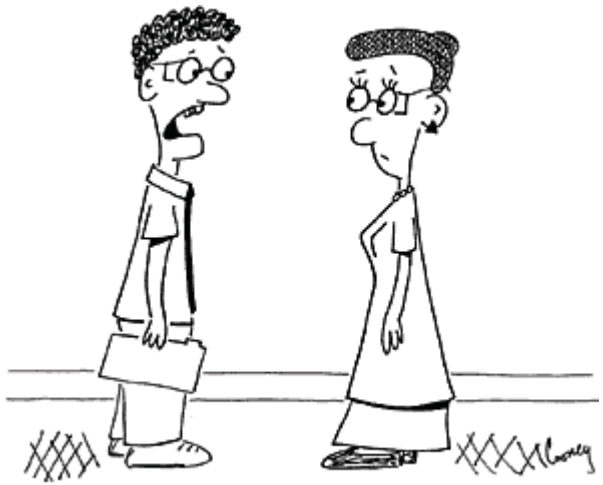
Key Interest: Complementarity between internal and external technology and knowledge sources at different levels.

Conclusions (I)

- Innovation Strategy matters. The combination of different innovation activities such as internal R&D, technology acquisition and R&D cooperation improve the performance of the innovation process
- The R&D orientation of the firm and the type of projects performed are an important determinant for the existence of these complementarities between internal and external technology acquisition
- Effective strategic protection is related to the combination of internal and external technology

Conclusions (II)

- Given these complementarities it is hard to experiment with one innovation activity
- Complementarity between innovation activities leads to a more complex and harder to copy innovation process and might be the source of a (more) Sustainable Competitive Advantage through innovation



"Since we moved away from serendipity-led R&D nobody yells 'Eureka!' anymore."

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