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The impact of R&D on productivity at firms' level analysis:

The case of internet-based content and application providers (ICAPs) company

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Problem : The Europe-US Gap (past)

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Period/countries	Growth in		
	GDP	GDP per capita	GDP per hour work
1950-1973			
EU-15	5.5	4.7	5.3
US	3.9	2.4	2.5
1973-1995			
EU-15	2	1.7	2.4
US	2.8	1.8	1.2
1995-2006			
EU-15	2.3	2.1	1.5
US	3.2	2.2	1.3

Source: van Ark, O' Mahony and Timmer (2008)

No	Variables	European Union	
		1980-1995	1995-2004
1	Market economy output (2)+(3)	1.8	2.2
2	Hours worked	-0.6	0.7
3	Labour productivity	2.4	1.5
	Composition		
4	Labour composition	0.3	0.2
5	Capital services per hour	1.2	1
6	ICT capital per hour	0.4	0.5
7	Non-ICT capital per hour	0.8	0.5
8	Multi-factor productivity	0.9	0.3
	Contribution of the knowledge economy to labour productivity	1.6	1.1

Source: van Ark, O'Mahony and Timmer (2008)

Problem : The Europe-US Gap (present)

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Macro level analysis

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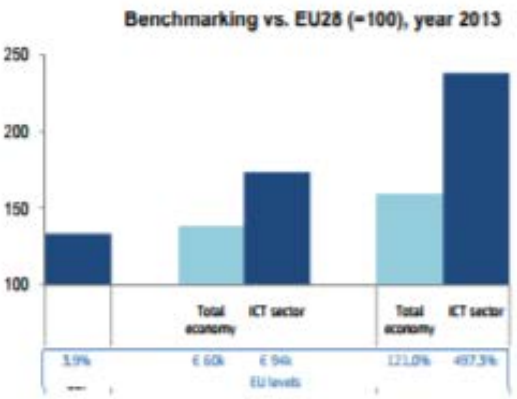

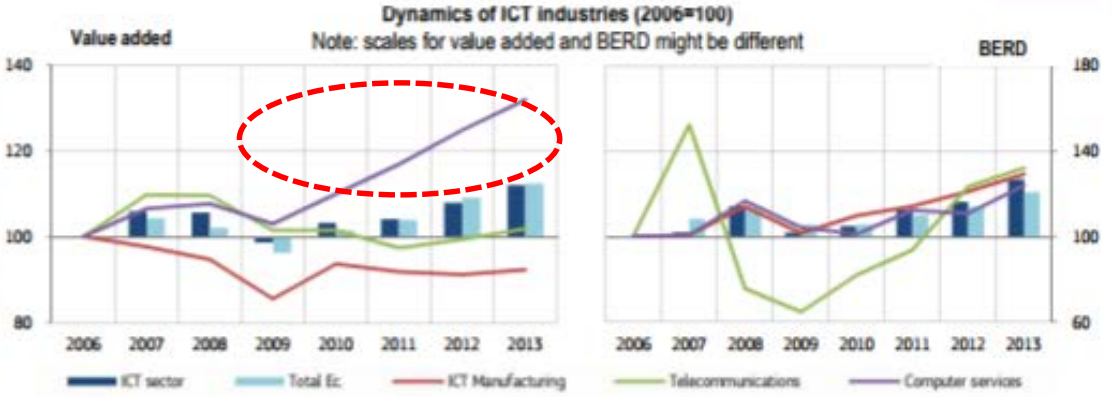

R&D performance

Business expenditure in R&D (BERD - € mln)

Total economy	**201,462**	**218,474**	**227,082**	**212,408**	**212,939**	**221,906**	**229,797**	**243,541**	**148.6%**	**121**	**126**
ICT sector	61,514	62,800	70,301	62,606	64,519	69,344	71,536	77,976	296.5%	127	111
Manufacturing	*30,791*	*30,950*	*35,141*	*31,255*	*33,796*	*35,156*	*37,299*	*39,811*	*388.9%*	*129*	*80*
Telecommunications	*1,738*	*2,648*	*1,316*	*1,125*	*1,426*	*1,628*	*2,147*	*2,296*	*72.7%*	*132*	*82*
Computer services	*28,985*	*29,202*	*33,844*	*30,226*	*29,297*	*32,560*	*32,089*	*35,869*	*278.1%*	*124*	*183*
ICT sector as a % of Total	**30.5%**	**28.7%**	**31.0%**	**29.5%**	**30.3%**	**31.2%**	**31.1%**	**32.0%**			

Source : de Panizza & Rohman (JRC, European Commission, 2016)

Problem : The Europe-US Gap

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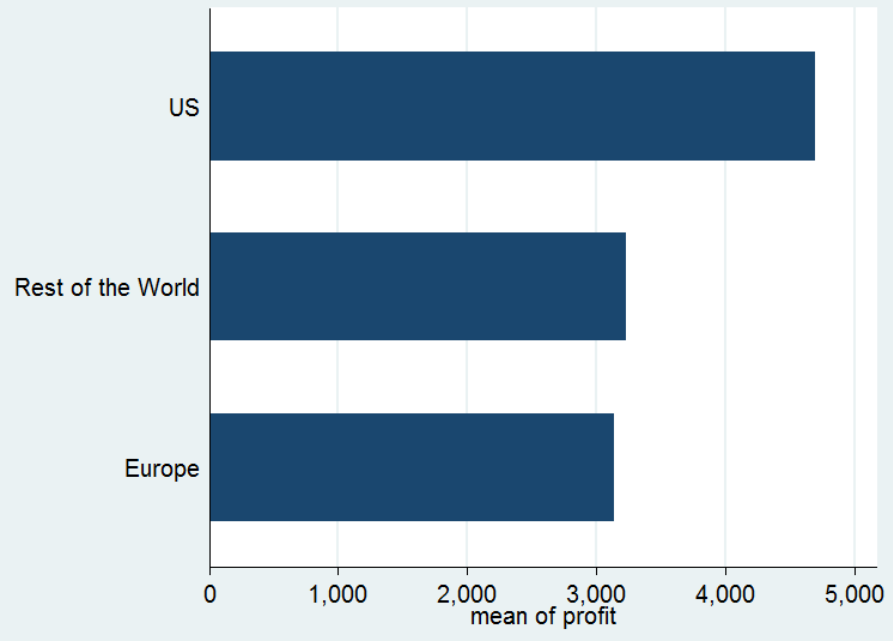
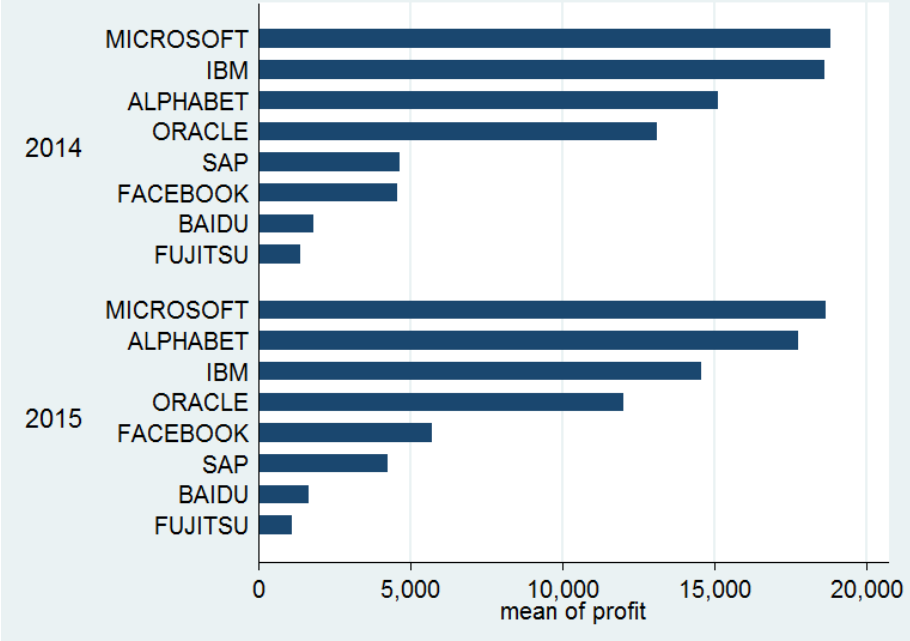
Industry level analysis

Profit made by the top 500 R&D performing companies (2014-2015)



Profit made by the computer services industry (2014-2015)



Source : R&D Industrial Scoreboard (European Commission, 2016)

Research background

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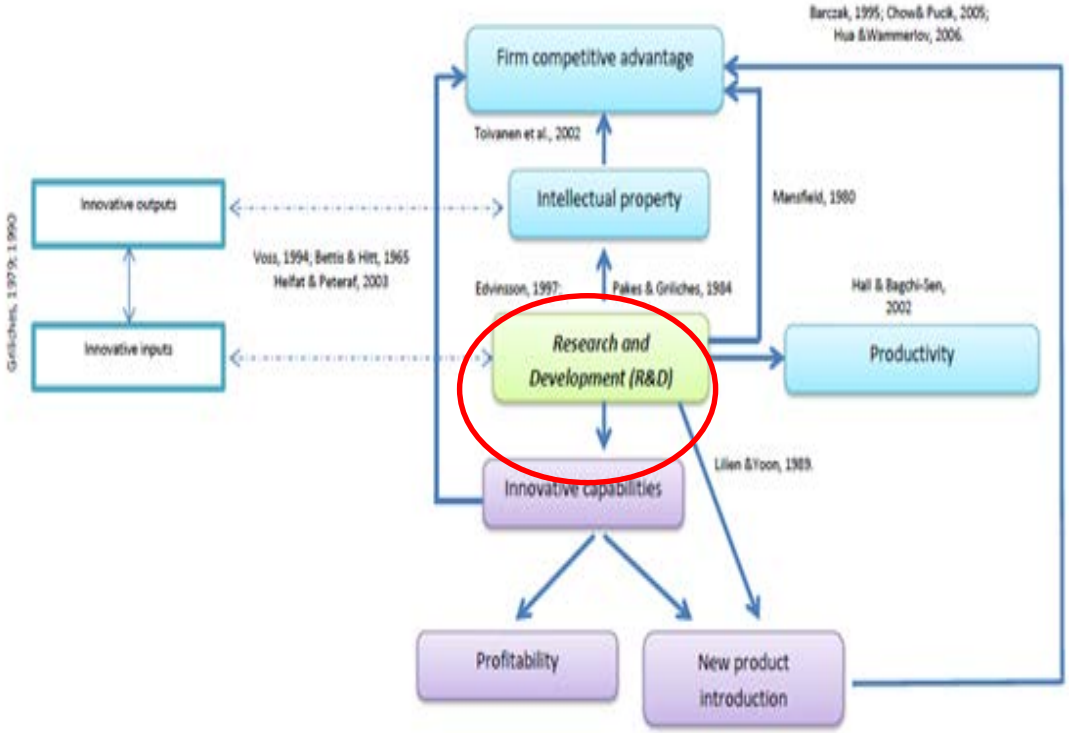
- Since the seminal work by Crépon, Duguet and Mairesse (1998), many studies analysed the relationships between R&D, innovation and productivity with a similar analytical framework, using what after their initials is now referred as the "CDM" model approach.

- The relationship that goes from R&D to innovation is quite straightforward (considering that the aim of R&D performance *is* to achieve some innovations, mostly of a technical nature). Other common determinants of innovative activity include :

- ***the existence of cooperation, export orientation and foreign ownership*** (Crespi & Zuniga, 2012; Gazaniol, 2012; Resende, et al., 2014)
- ***R&D collaboration***, Lee, et al., 2016; Maietta, 2015)
- ***The industry life cycle*** (Tavassoli, 2015)
- ***Market structure and degree of competition*** (Blazsek & Escribano, 2016)
- ***The role of tacit knowledge*** (Romero, 2014)
- ***Structure of labour markets*** (Wachsen & Blind, 2016).

Research background



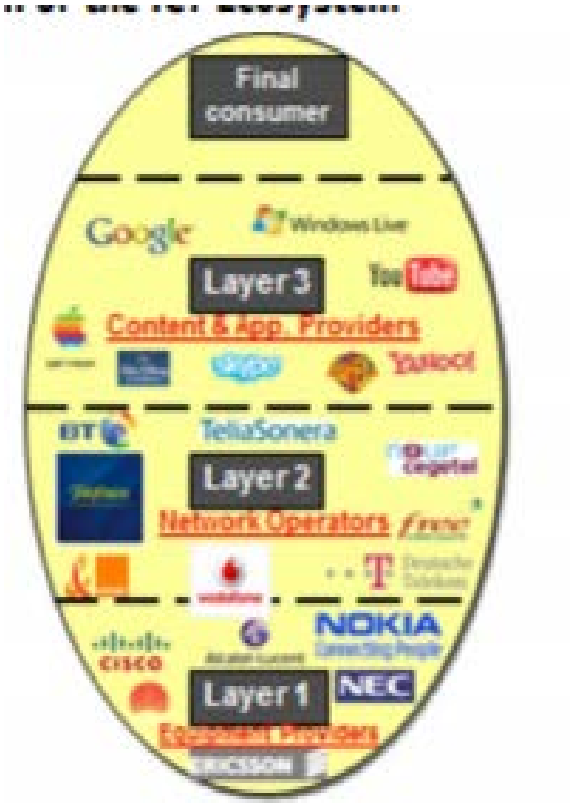
Complementarities between different types of innovation

- Jha and Bose (2015) : process innovation positively impacts product innovation but not vice versa; Hervas-Oliver et al. (2015): process innovations strengthen the impact of organizational innovation. Ballot et al. (2015): conditional complementarities between product and process innovations between organizational and product innovations, but no complementarities between all three forms of innovation.

Covariates

- Sun and Du (2010): the transfer of foreign technologies and foreign investment did not have any significant impact on product innovation in China high-tech manufacturing industries. Chudnovsky et al. (2006) came to similar conclusions for the case of Argentina.

ICT ecosystem



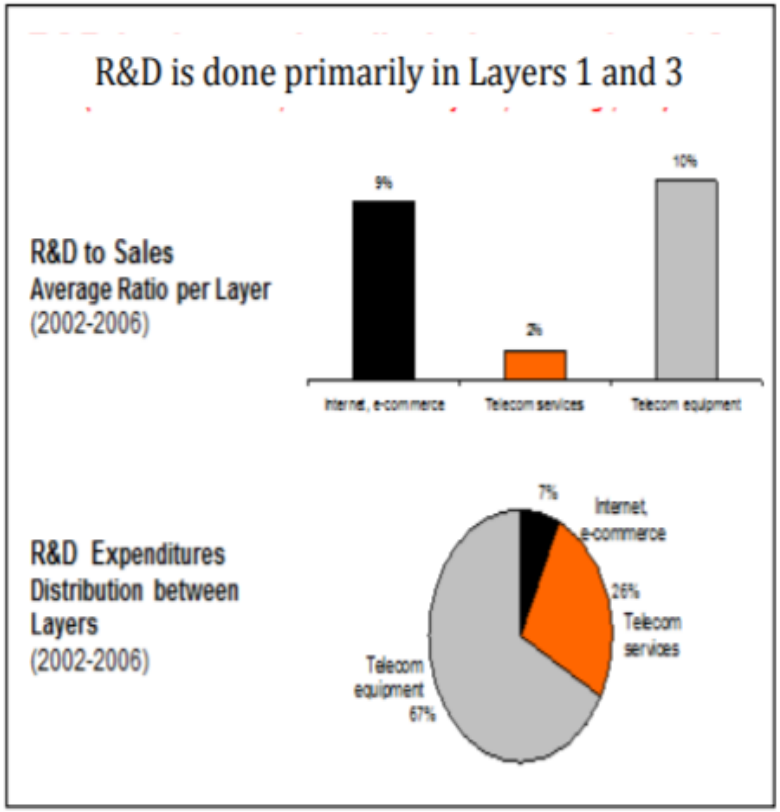
Interaction between layers

Layer 3 – the platform, content and applications layer – characterized by high intensity of entrepreneurship and innovation .

Six key characteristi
open low-cost acces
marginal costs; high

Layer 2 (the networ
economic forces wh
coupled with low ma
and substantial entr
by a small number c

Layer 1 players (the
may be divided into
establish significant
have not. This has b
different company G
further force for cha
innovative competitc
as Huawei and ZTE



Source: Fransman. The New ICT Ecosystem. Cambridge, 2011

R&D between layer

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Layer	Company Name	Overall Rank	R&D Expend. (2011, Euro mill.)	R&D Intensity (Rank)	Profitability (Rank)
I	Microsoft	2	7,583	13.3 (4)	29.9 (3)
I	Samsung	5	6,858	6.2 (8)	9.4 (7)
I	Nokia	15	4,910	12.7 (5)	-2.8 (14)
I	Sony	18	4,311	6.7 (7)	-1.0 (13)
I	Ericsson	29	3,657	14.4 (2)	7.8 (9)
I	Huawei	41	2,907	18.6 (1)	-
I	Fujitsu	49	2,370	5.3 (9)	2.3 (10)
I	Apple	59	1,877	2.2 (12)	31.2 (2)
I	NEC	70	1,611	5.3 (9)	2.2 (11)
I	**AVERAGE LAYER I**		**4,009**	**9.41**	
II	NTT	47	2,664	2.5 (11)	11.7 (6)
II	Telefonica	103	1,089	1.7 (13)	17.4 (5)
II	AT&T	115	925	1.0 (14)	8.0 (8)
	AVERAGE LAYER II		**1,559**	**1.7**	**12.4**
III	Google	26	3,990	13.6 (3)	32.0 (1)
III	Amazon	67	1,637	4.4 (10)	1.8 (12)
III	eBay	100	1,118	12.4 (6)	20.4 (4)
	AVERAGE LAYER III		**2,248**	**10.1**	**18.1**

Source : Fransman's report for JRC European Commission

Company Characteristics	Company Names
High R&D-Intensity – High Profitability	Microsoft, Samsung, Ericsson, Huawei ?, Google, eBay
High R&D-Intensity – Low Profitability	Nokia, Sony, Fujitsu, NEC, Amazon
Low R&D-Intensity – High Profitability	Apple, NTT, Telefonica, AT&T

Where is R&D?

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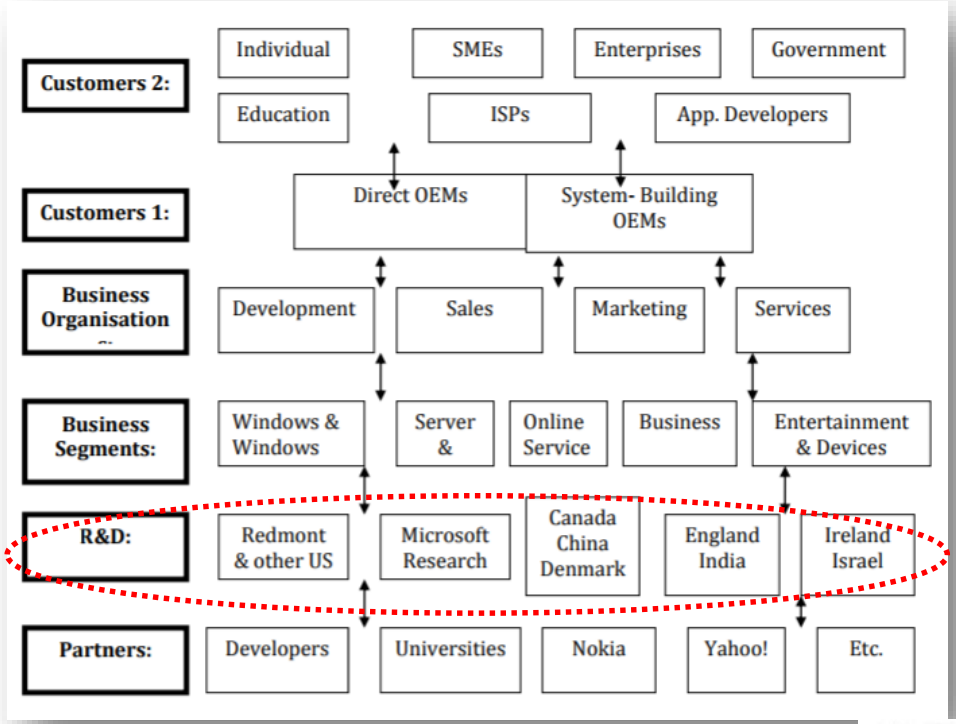
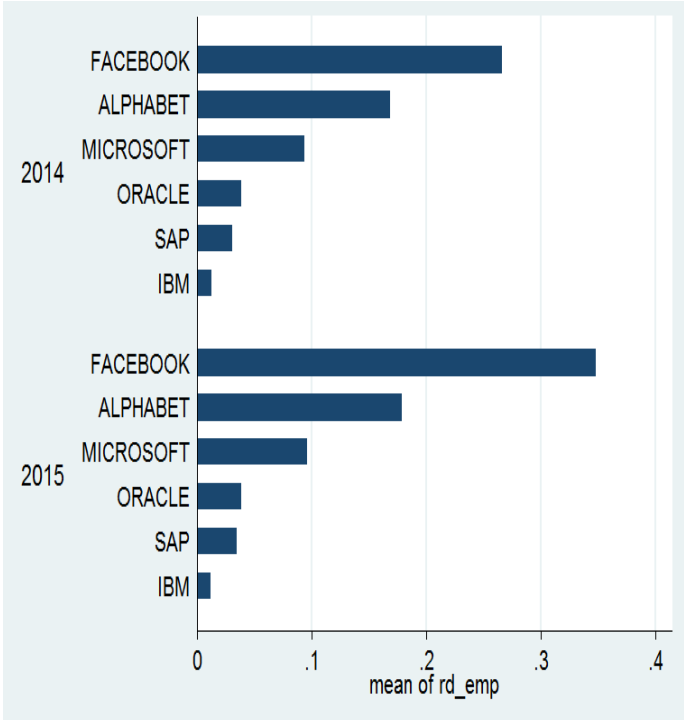
Case of Microsoft





Source : Fransman's report for JRC European Commission

Research questions

- What is the role of R&D in building the dominant position of a company relative to the competitors?
- Is R&D expenditure responsible for higher productivity level?

- The focus of this study is internet-based company which has shown the domination of the US firms at the third layer of Fransman's ICT ecosystem model.
- Google, Yahoo, Amazon and YouTube demonstrate the superiority of the US ICAPs compared with their counterparts in other countries and continents.

Model building

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[1] $$D_{it} = \begin{cases} 1 & \text{if} \quad \delta Z_{it} + \varphi_i + \varepsilon_{1it} > 0 \\ 0 & \text{if} \quad \delta Z_{it} + \varphi_i + \varepsilon_{1it} < 0 \end{cases}$$

[2] $$R\&D_{it} = \begin{cases} \beta X_{it} + \alpha_i + \varepsilon_{2it} & \text{if } D_{it} = 1 \\ 0 & \text{if } D_{it} = 0 \end{cases}$$

[3] $$INN_{it} = \gamma \widehat{R\&D}_{it} + \omega W_{it} + \theta_i + \mu_{it}$$

$$P_{it} = \vartheta \widehat{INN}_{it} + \rho Y_{it} + \sigma_i + \tau_{it}$$

- Identifying determinants of R&D
- Identifying determinants of innovation using (1) as a predictor.
- Identifying the link between innovation and productivity using (2) as predictors

Data : R&D Scoreboard

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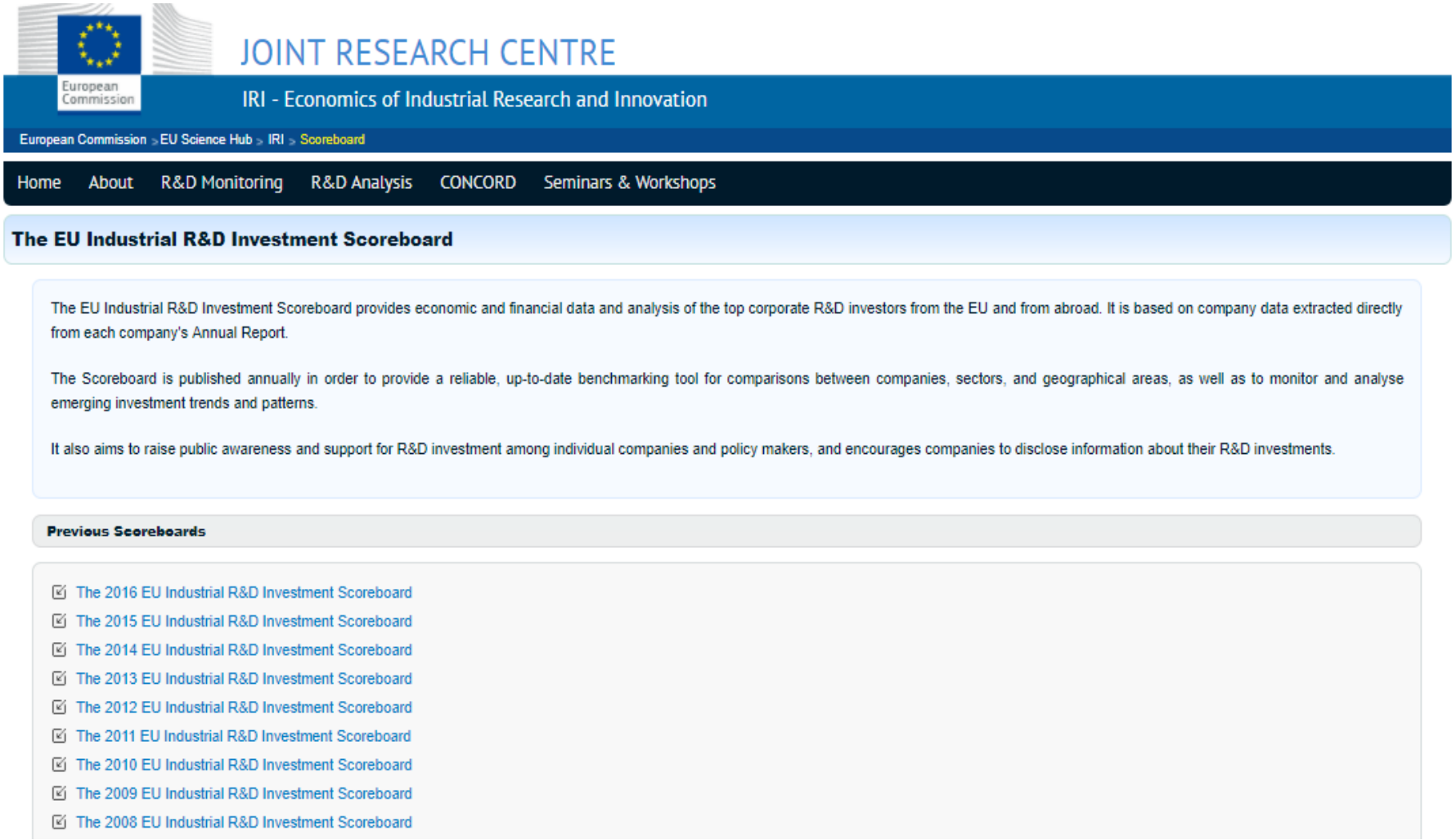

Descriptive statistics

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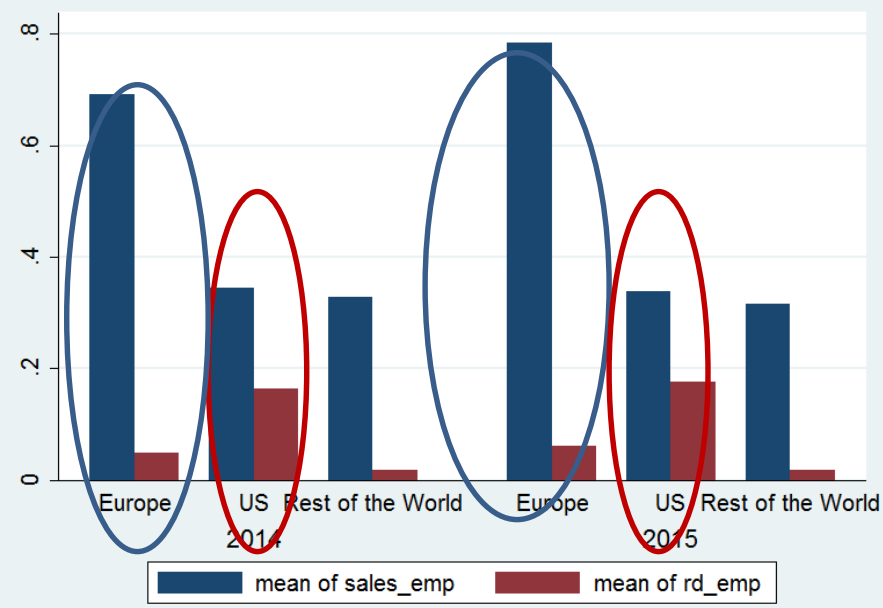
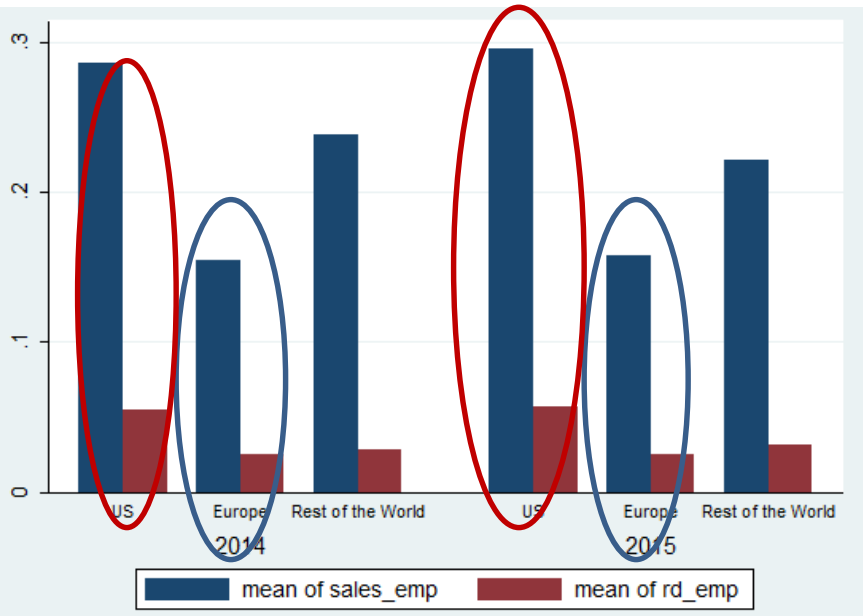
Between regions : all firms



Between regions : Software and computer services



R&D and productivity

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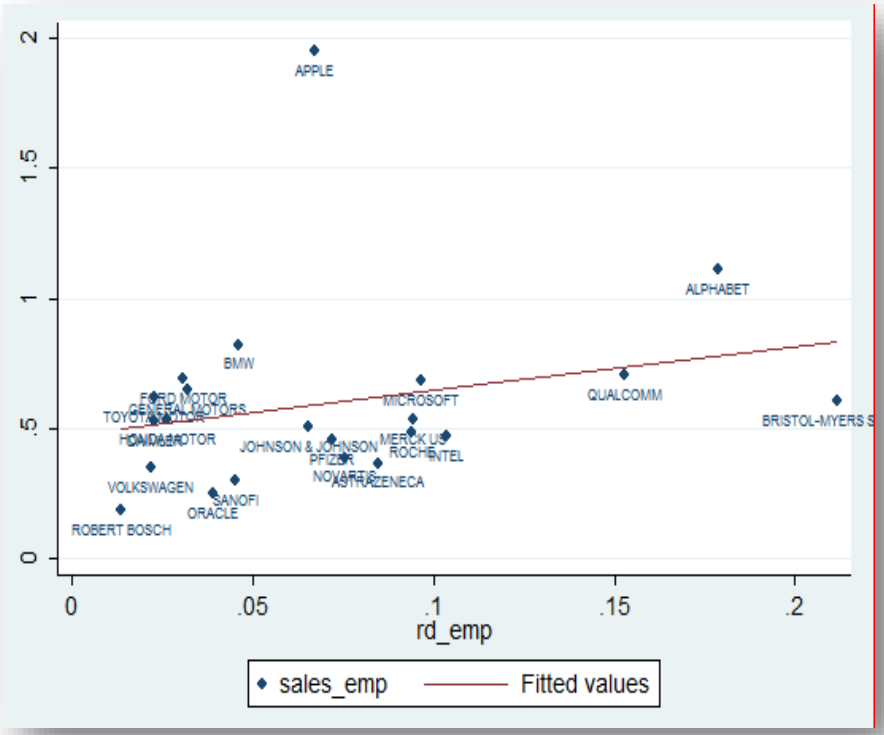
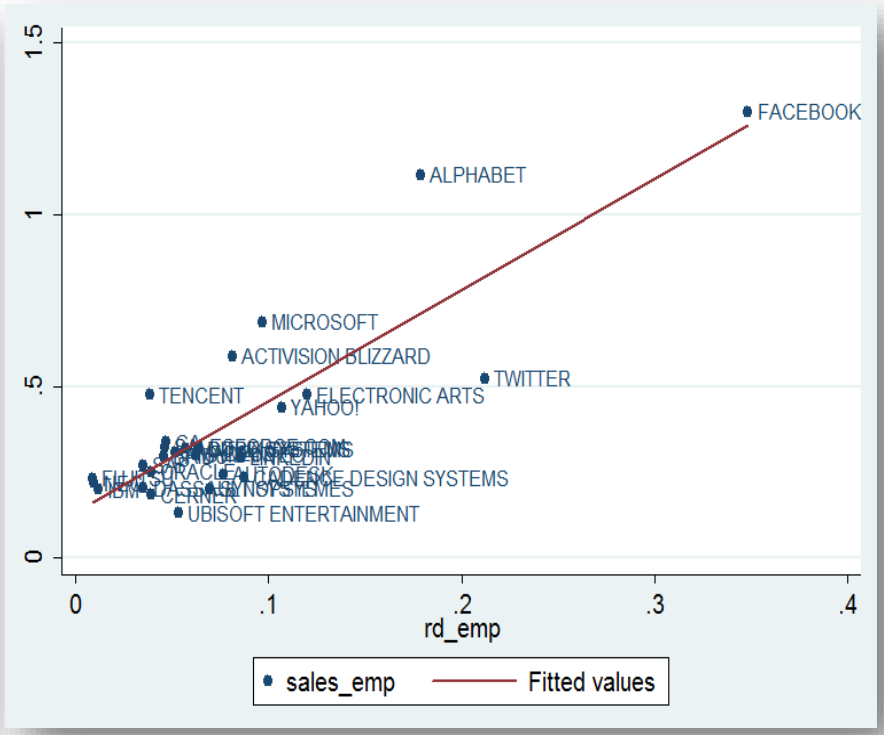
All firms



Software and computer services



R&D and productivity : dynamic

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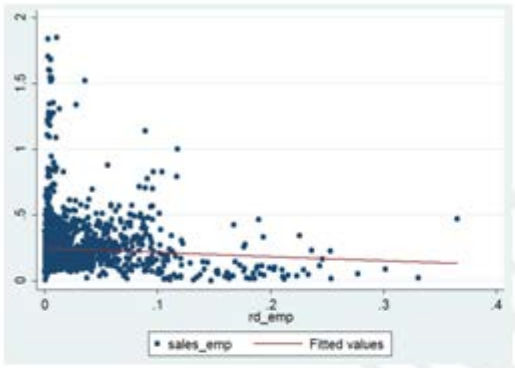
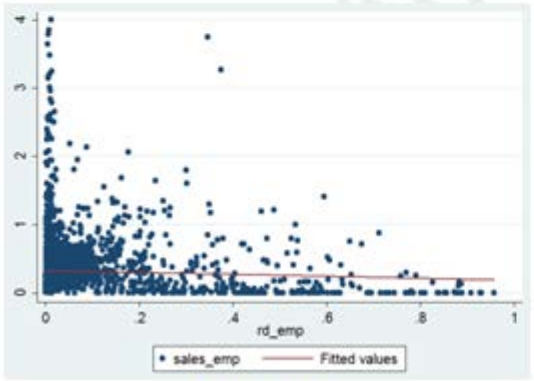
All firms

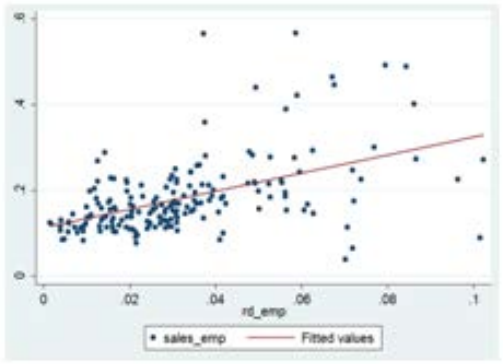


2000-2004

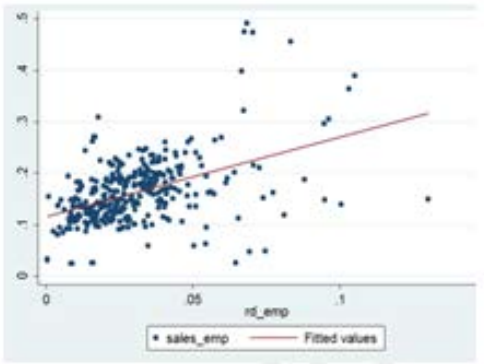


2014-2015

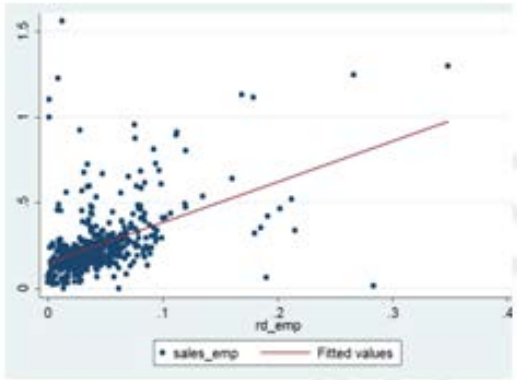
Software and computer services



2000-2004



2003-2006



Econometric results

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All samples and internet companies

Variables	2000-2003 all	2000-2003 internet companies	2003 all	2003 c
Research and development	0.0930***	0.315***	0.141***	
	6.223	-8.512	-13.79	
Dummy country	Yes	Yes	Yes	
Dummy sector	Yes	No	Yes	
Number of observation	1,913	154	3,635	
R-squared	0.32	0.496	0.365	

Dummy region

Variables	All companies	Internet base
R&D	0.0216**	0.254***
	-2.148	-9.266
Europe	0.0232	-0.243***
	-0.597	(-2.830)
Rest of the world	-0.0996***	-0.244***
	(-2.895)	(-3.713)
Control		
Capex		
Constant	-1.344***	-0.630***
	(-33.11)	(-6.868)
Observations	3,962	446
R-squared	0.058	0.338

Cross

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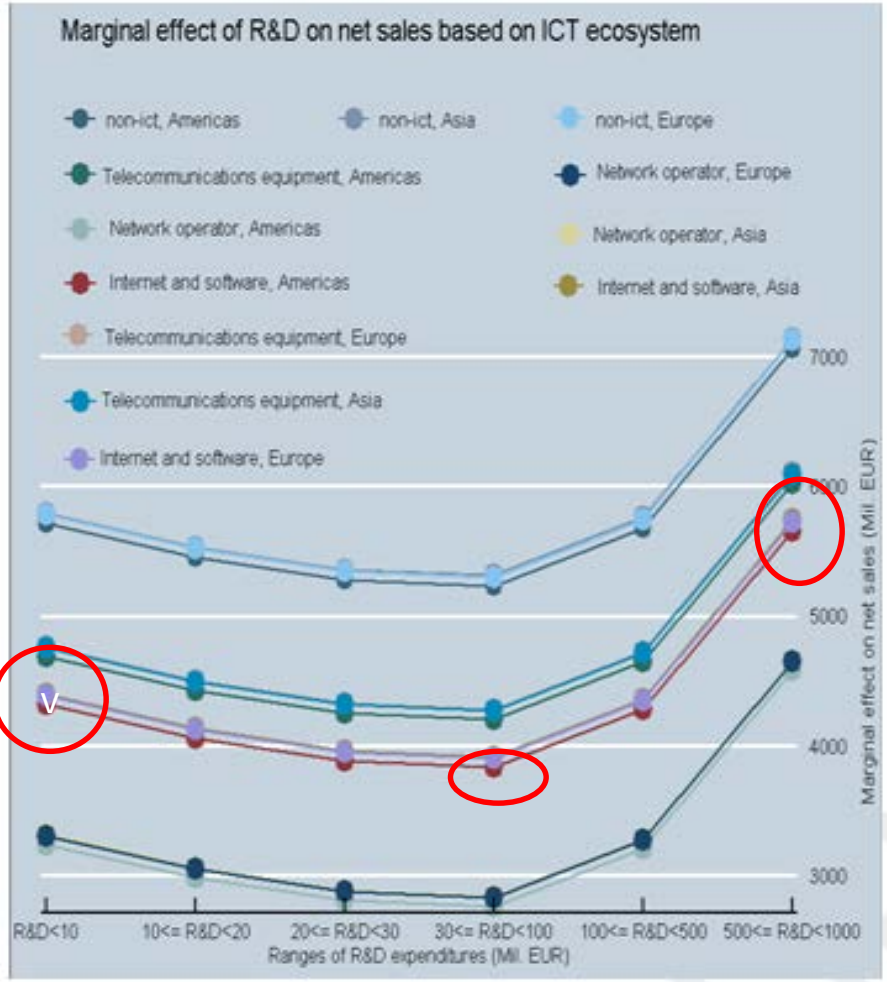

Conclusion

❑As productivity gap is generally regarded as the problem making the EU ICT sector lagging behind (compared to the US, for instance), the strategy to foster innovation and thus productivity should be correctly implemented.

❑Firms' level analysis : most data about innovation are collected at firm-level. This is the case, for example, for data relating to R&D expenditure, patents, and science and technology related employment. Thus single firm is assumed to be the appropriate unit of analysis when it comes to relevant data regarding innovation (Fransman, 2014).

❑The innovation behavior of groups of companies is greatly influenced by their symbiotic relationships with other groups. To exemplify, telecoms operators in Layer 2 are able to enjoy relatively low levels of R&D intensity because they are able to rely on the R&D performed by their ICT equipment providers from Layer 1 or simply outsourced their R&D activities.

❑We found that:

- Over the years the role of R&D on (presumably innovation) and productivity increases.
- The role of R&D is more visible in software and internet services (3rd layer of ICT ecosystem) than for all firms.
- The parameters are bigger among the US firms, BUT:
- Controlling the covariates the marginal impact of investment is greater among the EU firms.

Future direction

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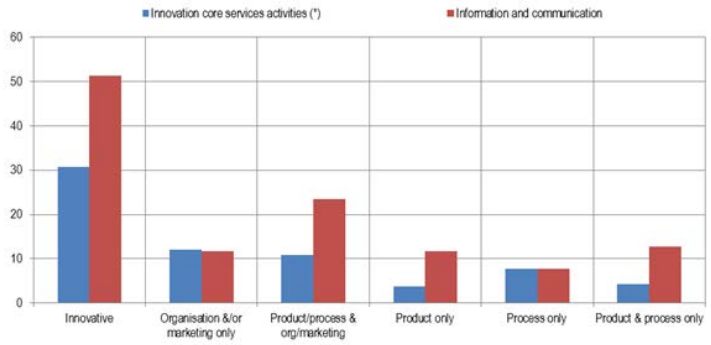
❑To understand the second block of the CDM model on how R&D affects innovation capabilities? Are all type of innovation going hand-in-hand? Do the types of innovation differ by layer?



❑Are there any different patterns of innovation between innovation families (technical vs. non technical?)
❑The investigation will also be carried out to see the different of funding schemes. An important aspect is to see the impact of structural fund and to compare the performance of the ICT and non-ICT firms as the recipients of such funding schemes.
❑The conventional view is that a reduction in taxes (e.g. through R&D tax allowances) and/or the granting of subsidies may be used as effective policy tools increasing the incentive to innovate. We will test whether the fiscal measures, can be used to supplement the other incentives to innovate.

THANK YOU.
ANY QUESTIONS?