BURGUNDY SCHOOL OF BUSINESS

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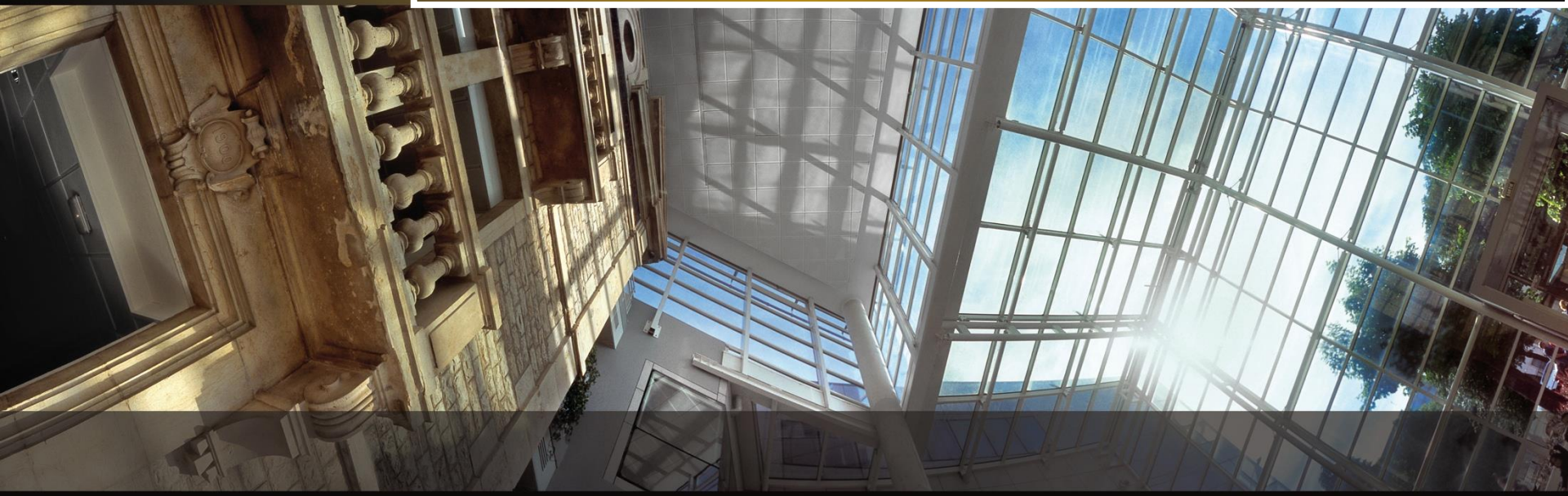
The Process of Innovation: Obstacles, Complementarities and Dynamics



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The Process of Innovation: Obstacles, Complementarities and Dynamics

1. The process of innovation

2. Innovation measures and CIS - Community Innovation Survey

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1. The process of innovation

Oslo Manual (2005) classifies four main forms of innovation:

- **Product**, **Process**, **Organizational** and **Marketing** innovations

Innovation is defined

as **major changes**

aimed at enhancing your **competitive position**,

your **performance**,

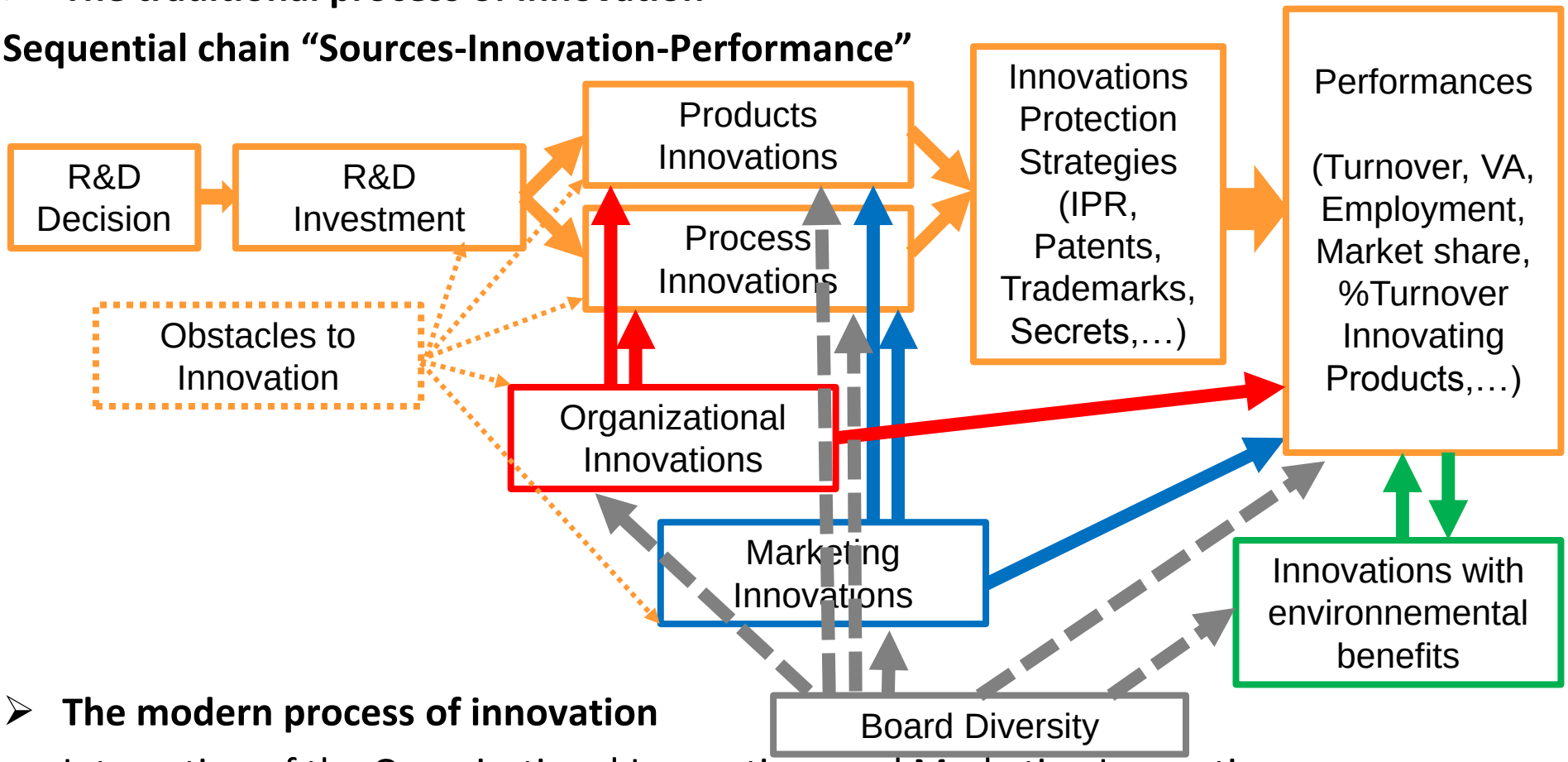
your **know-how**

or your **capabilities** for future enhancements

1. The process of innovation

- **The traditional process of innovation**

Sequential chain "Sources-Innovation-Performance"



- **The modern process of innovation**
  - Integration of the Organizational Innovations and Marketing Innovations
  - Implications for environment, CSR, and Sustainable Development
- **Board diversity and innovation**

1. The process of innovation

Oslo Manual (2005) classifies four main forms of innovation:

- **Product**, **Process**, **Organizational** and **Marketing** innovations

❑ **Product** and **Process innovations**
within the topic of **Technological Innovations**

- Demand pull
- and/or Technology push

The traditional process of innovation

Obstacles to Innovation

❑ **Organizational** and **Marketing innovations**
within the topic of **Management Innovations or Non-Technological Innovations**

- Understanding of organizational innovations
- Potential source of competitive advantage

The modern process of innovation

2. Innovation measures and CIS - Community Innovation Survey

French Community Innovation Survey (CIS) since 1990 (3 year period)

INSEE - National Statistical Office in France (20 000 firms - 8th wave in 2010-2012)

- **Innovation 1991 – Appendix of EAE "Firm Annual Survey" (1986-90)**
- **CIS1 (1990-92)**
- **CIS2 (1994-96)**
- **CIS3 (1998-00)**
- **CIS4 (2002-04)**
- **CIS5 (2004-06)** "***Overlapping data" with three years' CIS length Eurostat requirement***
- **CIS6 (2006-08)**
- **CIS7 (2008-10)**
- **CIS8 (2010-12)**
- **CIS9 (2012-14)** ***Available December 2016***
- ***CIS10 (2014-16) Survey validated during Summer 2016***

Insee
Mesurer pour comprendre

Enquête communautaire sur l'innovation 2012

SIREN : xxx xxx xxx

STATISTIQUE PUBLIQUE

Since 2005, I am Representative of the Scientific Community within Design Committee for the French Community Innovation Survey CIS, INSEE, Paris, France.

2. Innovation measures and CIS - Community Innovation Survey

Community Innovation Survey (CIS) since 1990 (3 year period)

INSEE - National Statistical Office in France (20 000 firms - 8th wave in 2010-2012)

- **General information (size, sales, sector…)**
- ***Product (good or service) innovations [2 types] (0,1)***
  - *New to the market*
  - *Only new to the firm*

"A **product innovation** is the market introduction of a **new** good or service or a **significantly** improved good or service with respect to its **capabilities**, such as **quality**, **user friendliness**, **software** or **subsystems**.

The innovation must be new to your enterprise, but it does not need to be new to your market.

It does not matter if the innovation was originally developed by your enterprise or by other enterprises."

2. Innovation measures and CIS - Community Innovation Survey

Community Innovation Survey (CIS) since 1990 (3 year period)

INSEE - National Statistical Office in France (20 000 firms - 8th wave in 2010-2012)

- **General information (size, sales, sector…)**

- ***Product (good or service) innovations [2 types] (0,1)***
  - *New to the market*
  - *Only new to the firm*

- ***Process innovations [3 types] (0,1)***
  - *New or significantly improved methods for the manufacture or production*
  - *New or significantly improved logistics systems or delivery or distribution*
  - *New or significantly improved supports activities for its processes*

- ***Innovation activity in progress or abandoned (0,1)***

⇒ If at least one YES among three: Firm is defined as technological innovative firms

⇒ If NO to these 3 questions go directly to questions on Org. and Mkg. Innovations

2. Innovation measures and CIS - Community Innovation Survey

Community Innovation Survey (CIS)

- **Innovation activities and expenditures**
- **Sources of information and co-operation for innovation**
- **Effects of innovations**
- **Objectives of innovations**

- **Obstacles to innovation: projects or activities of innovation**
  - ***Abandoned during conception / Abandoned at the beginning / Delayed projects***

  Only for firms with technological innovating activities (Product, Process or Project)
  - **CIS 2, 3, 4, 5 and 7 for all firms**
  - **CIS 9 only for non-innovating firms**
- **Obstacles to innovation for all firms** *(Financial, Knowledge, Market obstacles)*

- **Environmental benefits of innovation**
- **Strategies to reach objectives of the firm**
- **Protection methods for innovation**

2. Innovation measures and CIS - Community Innovation Survey

Community Innovation Survey (CIS)

- ***Organizational Innovations [4 types] (0,1)***

- *New business practices in the organization of the work or of the company procedures*

- *New knowledge management systems to improve the use or exchange of information, knowledge and ability, within the company, or so as to collect information outside of the Company*

- *New organization methods for the workplaces in the company, for the purpose of a better distribution of responsibilities and decision-making*

- *New management models for external relations with other companies or public institutions*

Community Innovation Survey (CIS)

- ***Marketing Innovations [4 types] (0,1)***

- *Design: If the firm introduces significant modifications in the design of the product or in the packaging of the goods or services*

- *Product promotion: If the firm introduces new techniques or channels for the promotion of the product*

- *Product positioning: If the firm introduces new methods for the positioning of the product in the market or sales channels*

- *Establishing prices: If the firm introduces new methods for establishing the prices of the goods or services*

3. Obstacles to innovation

Studies on obstacles to innovation using Community Innovation Survey (CIS):

- Mainly aimed at understanding their **impact on firm's attitude towards R&D activities and propensity/intensity of innovation**

(Arundel, 1997; Asso and Vito, 2010; Blanchard et al., 2012; Hyytinen and Toivanen, 2005; Mohnen and Röller, 2005; Mohnen et al., 2008; Savignac, 2008; Segarra-Blasco et al., 2007; Tiwari et al., 2008; Tourigny and Le, 2004; Mancusi and Vezzulli, 2010; Wziatek-Kubiak and Peczkowski, 2011)

- Minor attention has been paid to the **determinants of obstacles to innovation**

(Baldwin and Lin, 2002; D'Este et al., 2012; Galia and Legros, 2004; Hölzl and Janger, 2011; Iammarino et al., 2009; Mohnen and Rosa, 2000; Schneider and Veugelers, 2008; Tourigny and Le, 2004)

3. Obstacles to innovation

Obstacles to innovation:

- *Cost and Financial*
- *Knowledge*
- *Market*
- *Institutional*
- *Other reasons for not innovating*

(Oslo Manual, 2005)

Table 7.2. **Factors hampering innovation activities**

Relevant for:	Product innovations	Process innovations	Organisational innovations	Marketing innovations
Cost factors:				
Excessive perceived risks	•	•	•	•
Cost too high	•	•	•	•
Lack of funds within the enterprise	•	•	•	•
Lack of finance from sources outside the enterprise:				
Venture capital	•	•	•	•
Public sources of funding	•	•	•	•
Knowledge factors:				
Innovation potential (R&D, design, etc.) insufficient	•	•		•
Lack of qualified personnel:				
Within the enterprise	•	•		•
In the labour market	•	•		•
Lack of information on technology	•	•		
Lack of information on markets	•			•
Deficiencies in the availability of external services	•	•	•	•
Difficulty in finding co-operation partners for:				
Product or process development	•	•		
Marketing partnerships				•
Organisational rigidities within the enterprise:				
Attitude of personnel towards change	•	•	•	•
Attitude of managers towards change	•	•	•	•
Managerial structure of enterprise	•	•	•	•
Inability to devote staff to innovation activity due to production requirements	•	•		
Market factors:				
Uncertain demand for innovative goods or services	•			•
Potential market dominated by established enterprises	•			•
Institutional factors:				
Lack of infrastructure	•	•		•
Weakness of property rights	•			•
Legislation, regulations, standards, taxation	•	•		•
Other reasons for not innovating:				
No need to innovate due to earlier innovations	•	•	•	•
No need because of lack of demand for innovations	•			•

3.1. Obstacles to innovation – Study #1 (RP, France, 2004)

Community Innovation Survey (CIS)

Obstacles to innovation (1772 firms)

Obstacles		Description	Postponed projects (%)	Abandoned projects (%)
OBS1	ECO RISK	Excessive perceived economic risk	21.3	18.7
OBS2	COSTS	Innovation costs too high	19.9	14.7
OBS3	FINANCING	Lack of appropriate source of finance	13.8	5.8
OBS4	RIGID ORG	Resistance of change in the firm (rigid organization)	16.6	3.3
OBS5	SKILLED	Lack of skilled personnel	21.2	3.4
OBS6	INFO TECH	Lack of information on technologies	17.0	5.5
OBS7	INFO MARK	Lack of information on markets	16.2	4.4
OBS8	INSTITUT	Legislation, regulations, norms, standards	14.2	3.7
OBS9	CUSTOMER	Lack of customer responsiveness to new products and processes	18.8	9.2
		Met at least one obstacle	67.6 (1197)	39.3(696)

Source: SESSI (1997).

CIS2 -1994-96: main obstacles are, compared to **financial constraints**:

- **Lack of skilled personnel**
- **Resistance of change in the firm (rigid organization)**

Galia, F. and Legros, D. (2004). Complementarities between Obstacles to Innovation: Evidence from France. ***Research Policy***, Vol. 33, No. 8, pp. 1185-1199 [A+ Ranked Journal, CNRS List Ranked no. 1]..

3.1. Obstacles to innovation – Study #1 (RP, France, 2004)

Complementarities and innovation

Complementarities:

Intuitive ideas of **synergies**, **systems** effects and **mutual** reinforcement

i.e. "the whole is more than the sum of the parts"

Mathematical concept of lattices and qualitative variables (0,1)

Vienott (1989), Topkis (1998), Vives (1999), Amir (2004),
Milgrom and Roberts (1990, 1995), Athey and Stern (1998)

A practice is more likely to be adopted at a higher level
if other practices are adopted at high level, too

3.1. Obstacles to innovation – Study #1 (RP, France, 2004)

Empirical literature studying complementarities between various practices or strategies:

⇒ **Three types of approaches** - Athey and Stern (1998):

1 - Testing the positive correlation between various practices conditional on a certain number of common explanatory variables (**CORR**)

2 - Factor which has an effect on one variable will not be correlated with another variable unless the variables are complementary (**RED**)

3 - Modeling firm's objective function by a set of regressors, including the interactions effects or clusters between several practices or strategies (**PROD**)

+ 3 ext. - Theoretical concept of supermodularity within the mathematical concept of lattices (**SUPERMOD**)

3.1. Obstacles to innovation – Study #1 (RP, France, 2004)

- Multivariate probit model: 9 equations estimating the 9 obstacles to innovation

Table 4
Multivariate probit model of obstacles to innovation in postponed projects (1772 firms)

	ECO RISK	COSTS	FINANCING	RIGID ORG	SKILLED	INFO TECH	INFO MARK	INSTITUT	CUSTOMER
Intercept	−0.900***(0.146)	−0.821***(0.151)	−1.182***(0.163)	−1.380***(0.165)	−0.908***(0.151)	−1.264***(0.172)	−1.312***(0.162)	−1.289***(0.170)	−1.117***(0.157)
Nb empl. (log)	0.011(0.032)	−0.020(0.032)	0.022(0.036)	0.040(0.035)	−0.023(0.031)	−0.001(0.034)	0.015(0.034)	−0.019(0.034)	−0.003(0.033)
Med. low tech.	−0.184**(0.090)	0.038(0.095)	−0.019(0.106)	−0.070(0.099)	0.069(0.091)	0.019(0.101)	0.063(0.099)	0.182(0.116)	−0.032(0.094)
Med. high tech.	−0.098(0.100)	0.154(0.103)	0.162(0.111)	0.042(0.106)	0.039(0.101)	0.091(0.106)	0.228**(0.106)	0.475***(0.122)	0.065(0.101)
High tech.	−0.185(0.140)	0.041(0.142)	0.072(0.159)	−0.315**(0.157)	−0.243*(0.151)	−0.083(0.146)	−0.051(0.151)	0.587***(0.151)	−0.394***(0.154)
French group	−0.086(0.104)	−0.215**(0.105)	−0.337***(0.117)	−0.050(0.119)	−0.015(0.104)	0.029(0.115)	0.064(0.111)	−0.307**(0.120)	0.019(0.107)
Foreign group	−0.087(0.110)	−0.344***(0.107)	−0.438***(0.117)	0.107(0.117)	0.127(0.106)	−0.012(0.113)	−0.085(0.112)	−0.206*(0.116)	0.123(0.107)
Internal R&D	0.213**(0.097)	0.102(0.097)	0.169(0.113)	0.258**(0.112)	0.100(0.099)	0.135(0.105)	0.161(0.114)	0.271**(0.118)	0.124(0.105)
External R&D	−0.169**(0.084)	−0.058(0.086)	−0.134(0.093)	−0.038(0.090)	−0.020(0.083)	0.202**(0.085)	0.027(0.089)	0.080(0.095)	0.118(0.086)
Training	0.179**(0.077)	0.094(0.082)	0.110(0.092)	0.029(0.086)	0.205***(0.077)	0.028(0.083)	−0.032(0.084)	−0.067(0.091)	0.016(0.082)
Cooperation	0.084(0.079)	0.222***(0.083)	0.112(0.091)	0.038(0.084)	0.088(0.079)	0.189**(0.081)	0.074(0.086)	0.011(0.088)	0.161**(0.083)

- Estimate of the disturbance covariance matrix

Table 5
Estimate of the disturbance covariance matrix—obstacles to innovation in postponed projects (1772 firms)

	ECO RISK	COSTS	FINANCING	RIGID ORG	SKILLED	INFO TECH	INFO MARK	INSTITUT
ECO RISK	1							
COSTS	0.37(0.044)	1						
FINANCING	0.29(0.051)	**0.44** (0.045)	1					
RIGID ORG	0.10(0.052)	0.11 (0.053)	0.36 (0.052)	1				
SKILLED	0.12(0.049)	0.14 (0.049)	0.34 (0.050)	**0.46** (0.043)	1			
INFO TECH	−0.02$^{n.s.}$(0.053)	0.16 (0.052)	0.19 (0.056)	0.39 (0.047)	**0.49** (0.041)	1		
INFO MARK	0.17(0.051)	0.10 (0.052)	0.21 (0.056)	**0.41** (0.046)	0.33 (0.047)	**0.41** (0.047)	1	
INSTITUT	0.18(0.054)	0.19 (0.055)	0.25 (0.058)	**0.42** (0.050)	0.28 (0.052)	0.37 (0.052)	**0.50** (0.046)	1
CUSTOMER	0.23(0.048)	0.16 (0.051)	0.15 (0.054)	0.27 (0.049)	0.19 (0.048)	0.29 (0.048)	**0.49** (0.042)	0.38 (0.049)

Between parentheses are standard deviation. Correlation coefficients in bold indicate higher values of correlation. *Source*: SESSI (1997).

3.1. Obstacles to innovation – Study #1 (RP, France, 2004)

- Multivariate probit model: 9 equations estimating the 9 obstacles to innovation

Table 6
Multivariate probit model of obstacles to innovation in abandoned projects (1772 firms)

	ECO RISK	COSTS	FINANCING	RIGID ORG	SKILLED	INFO TECH	INFO MARK	INSTITUT	CUSTOMER
Intercept	−1.624***(0.160)	−1.357***(0.163)	−1.414***(0.210)	−1.967***(0.297)	−1.917***(0.246)	−1.855***(0.244)	−1.757***(0.271)	−1.660***(0.279)	−1.752***(0.185)
Nb empl. (log)	0.112***(0.032)	0.024(0.035)	−0.046(0.050)	0.015(0.068)	0.030(0.047)	0.023(0.050)	−0.006(0.062)	−0.055(0.063)	0.094***(0.039)
Med. low tech.	−0.187**(0.096)	−0.146(0.103)	−0.043(0.149)	−0.187(0.181)	−0.062(0.161)	−0.213(0.158)	−0.014(0.158)	0.078(0.205)	−0.006(0.120)
Med. high tech.	−0.079(0.105)	0.056(0.109)	−0.006(0.157)	0.013(0.187)	−0.195(0.198)	−0.158(0.172)	−0.071(0.171)	0.113(0.221)	−0.006(0.129)
High tech.	−0.104(0.137)	−0.077(0.149)	−0.037(0.222)	0.109(0.270)	−0.125(0.252)	−0.186(0.199)	−0.033(0.250)	0.533***(0.247)	−0.034(0.174)
French group	0.088(0.108)	−0.003(0.117)	0.079(0.156)	0.046(0.210)	0.049(0.184)	0.176(0.164)	0.074(0.208)	0.027(0.198)	−0.003(0.141)
Foreign group	−0.006(0.113)	−0.013(0.123)	−0.125(0.161)	0.073(0.228)	0.108(0.187)	0.040(0.181)	0.144(0.197)	−0.127(0.213)	−0.120(0.136)
Internal R&D	0.172(0.110)	0.266**(0.114)	0.027(0.146)	0.065(0.193)	−0.080(0.182)	0.114(0.167)	0.008(0.184)	−0.085(0.175)	−0.094(0.134)
External R&D	0.025(0.089)	0.026(0.088)	0.133(0.127)	0.027(0.166)	0.310**(0.148)	0.102(0.124)	−0.009(0.141)	−0.035(0.180)	−0.037(0.108)
Training	−0.082(0.083)	0.047(0.086)	−0.051(0.121)	−0.152(0.168)	−0.037(0.163)	−0.096(0.127)	−0.029(0.141)	0.023(0.140)	0.049(0.102)
Cooperation	0.132(0.085)	−0.024(0.086)	0.116(0.129)	0.078(0.169)	−0.170(0.154)	0.163(0.132)	0.063(0.173)	0.259***(0.153)	0.060(0.105)

- Estimate of the disturbance covariance matrix

Table 7
Estimate of the disturbance covariance matrix—obstacles to innovation in abandoned projects (1772 firms)

	ECO RISK	COSTS	FINANCING	RIGID ORG	SKILLED	INFO TECH	INFO MARK	INSTITUT
ECO RISK	1							
COSTS	**0.48** (0.044)	1						
FINANCING	0.34 (0.070)	**0.53** (0.062)	1					
RIGID ORG	0.28 (0.085)	0.25 (0.096)	**0.61** (0.081)	1				
SKILLED	0.15$^{n.s.}$ (0.095)	0.42 (0.081)	0.38 (0.094)	**0.49** (0.011)	1			
INFO TECH	0.16 (0.080)	0.29 (0.074)	0.32 (0.092)	0.40 (0.011)	**0.54** (0.085)	1		
INFO MARK	0.29 (0.076)	0.27 (0.084)	0.31 (0.011)	0.35 (0.013)	0.40 (0.099)	0.36 (0.011)	1	
INSTITUT	0.36 (0.076)	0.43 (0.078)	0.35 (0.011)	**0.49** (0.014)	0.38 (0.012)	0.45 (0.093)	0.40 (0.013)	1
CUSTOMER	0.38 (0.054)	0.33 (0.059)	0.25 (0.077)	0.28 (0.010)	0.23 (0.094)	0.20 (0.088)	0.35 (0.083)	**0.52** (0.077)

Between parentheses are standard deviation. Correlation coefficients in bold indicate higher values of correlation. *Source*: SESSI (1997).

3.1. Obstacles to innovation – Study #1 (RP, France, 2004)

F. Galia, D. Legros / Research Policy 33 (2004) 1185–1199

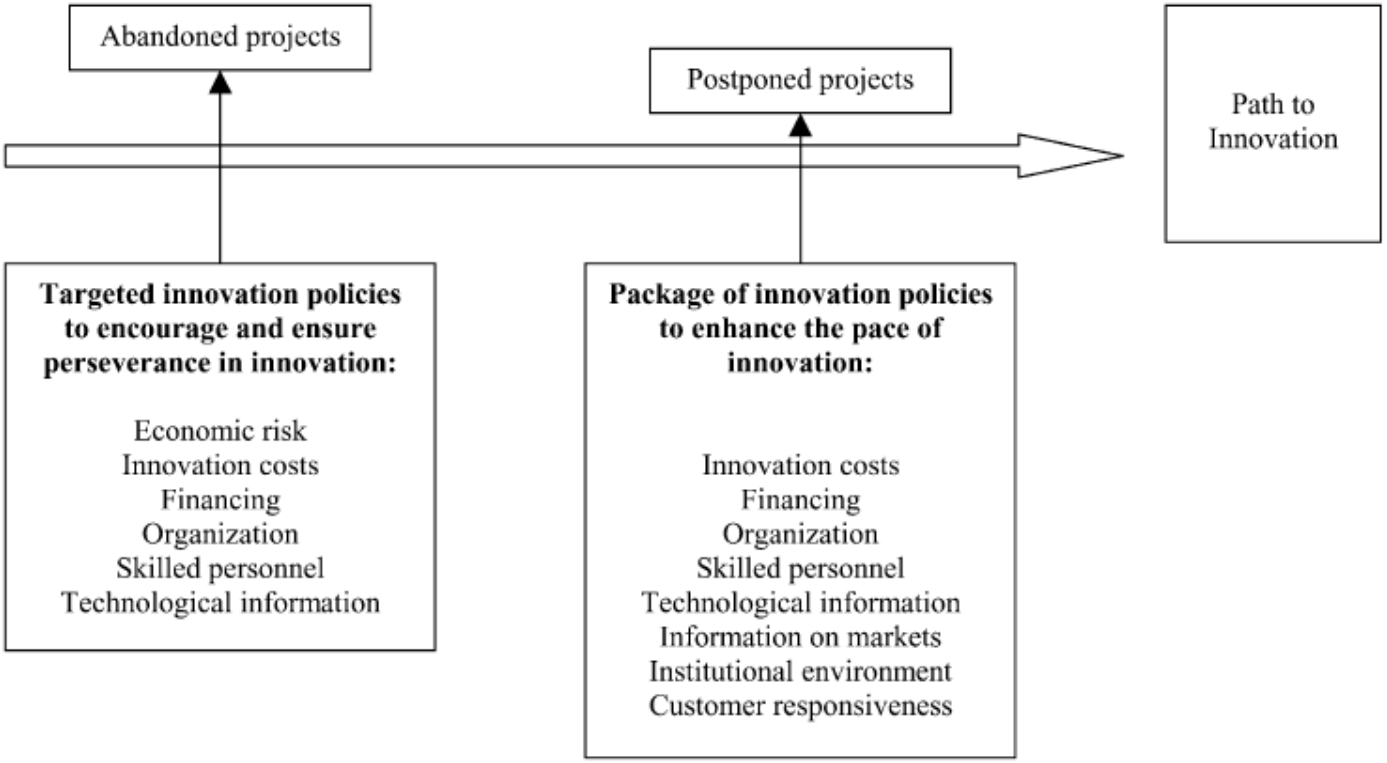


Fig. 1. Innovation policies on the path to innovation.

Economic and managerial implications of complementarities between obstacles

- **Futile to combat them individually and separatly**
- **Synergies in a coherent manner**

3.2. Obstacles to innovation – Study #2 (ICBM, France and Italy, 2015)

Different types of obstacles:

- **Revealed barriers** to innovation: reflects the degree of difficulty of the innovation process and the learning experience consequent on the firm engaging in innovation activity
- **Deterring barriers** to innovation: encompasses the obstacles that prevent firms from committing to innovation

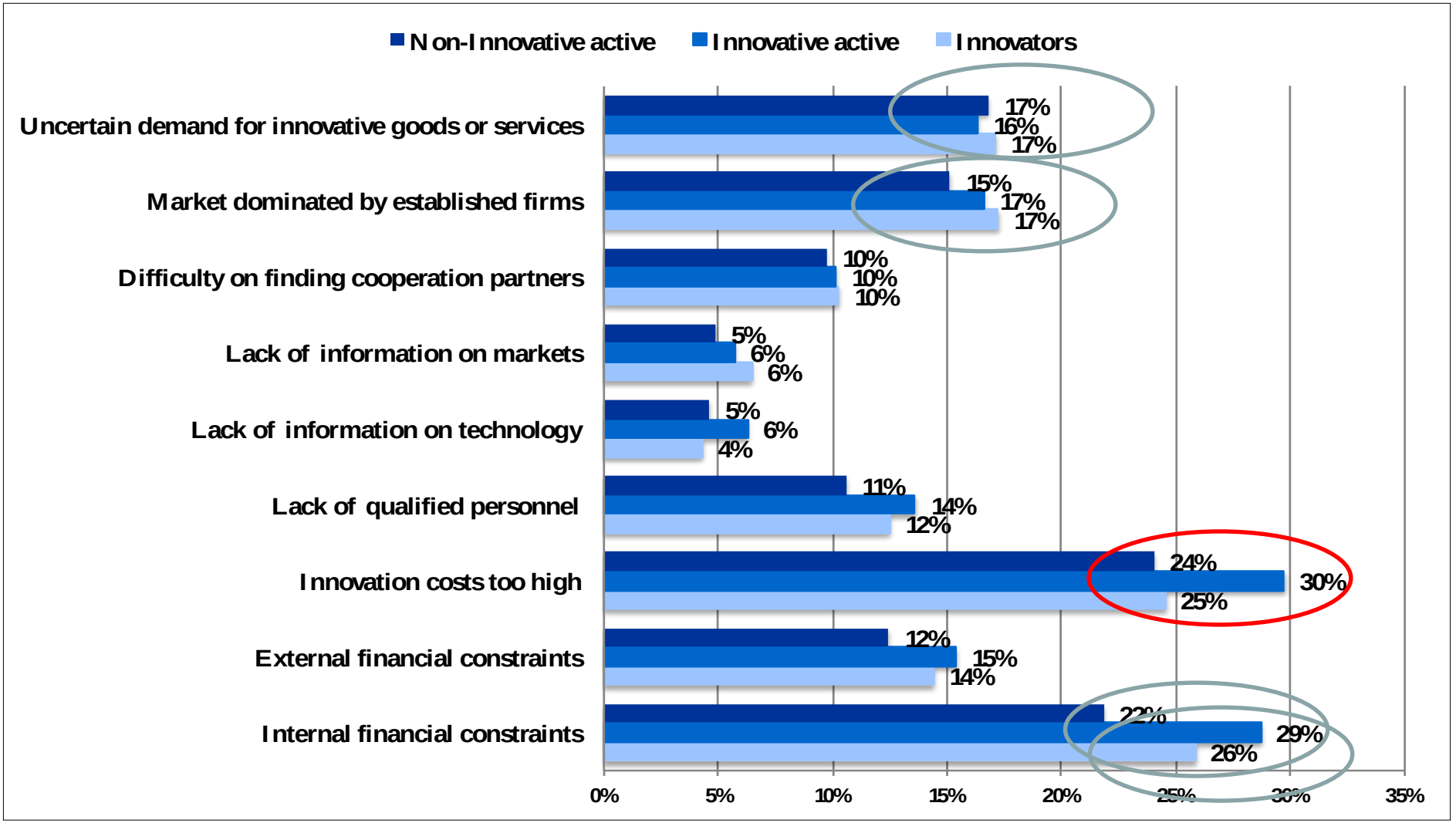
D'Este, P., Iammarino, S., Savona, M., and von Tunzelmann, N. (2012) What hampers innovation? Revealed barriers versus deterring barriers. *Research Policy* 41(2), 482–488.

Determinants of obstacles to innovation within innovation profiles:

- **Innovators**: firms that introduce product or process innovation *(6364 firms, 30.7%)*
- **Innovative active**: firms engaged into innovation activities but without reaching the expected output *(1063 firms, 5.1%)*
- **Non-innovative active**: firms not involved in innovation activities *(13320 firms, 64.2%)*

Galia, F., Mancini S. and Morandi, V. (2015), Obstacles to Innovation and Firms Innovation Profiles: Are Challenges Different for Policy Makers?, ***ICBM – 1st International Conference on Business Management***, 2-3 June 2015, Valencia, Spain.

3.2. Obstacles to innovation – Study #2 (ICBM, France and Italy, 2015)



3.2. Obstacles to innovation – Study #2 (ICBM, France and Italy, 2015)

CIS4 in France and Italy: "L'Innovation" - Community Innovation Survey (CIS)
2002-2004 - 20,747 manufacturing and services sectors firms

Predominant impediments for each innovative profile:

- **internal financial constraints**
- innovation **costs** too high
- **market dominated** by established firms
- **uncertain demand** for innovative goods or services

The only evident difference among innovation profiles:

- **economic barriers perceived by *Innovative-active* firms**
- suggests that the high costs involved in innovation projects and the lack of internal financial resources have an high probability to delay or giving up the innovation development

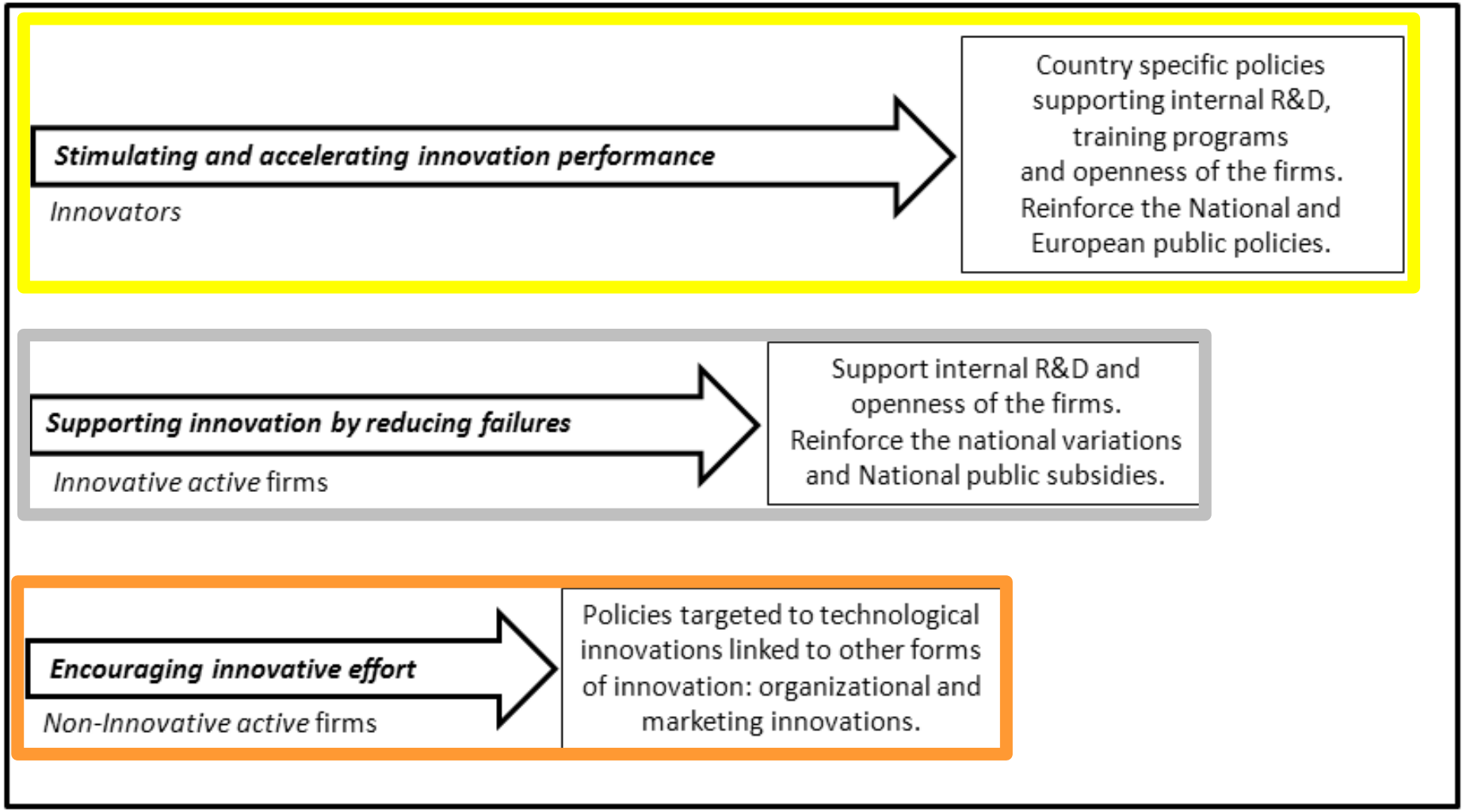
3.2. Obstacles to innovation – Study #2 (ICBM, France and Italy, 2015)

- **Multivariate probit models** explaining obstacles to innovation that allow taking into account the **possible interdependence** between the perception of different types of obstacles

Dependent variables:

- Types of innovation activities: Internal R&D, External R&D, Equipment, Knowledge, Training, Marketing, Cooperation
- Sources of information (9 types)
- Ability to appropriate the results of innovative activities
- Public financial support: National, EU
- Wider innovation: Organizational, Marketing
- Size
- High growth
- Group membership
- Industry dummies
- Competition
- International and/or national market
- Country specific effect (impact of national innovation system)

3.2. Obstacles to innovation – Study #2 (ICBM, France and Italy, 2015)



3.2. Obstacles to innovation – Study #2 (ICBM, France and Italy, 2015)

Pro-innovation public policies should take into account that the **causes** of the **perception of obstacles vary across innovation profiles**

Thus, both to stimulate the **involvement of *Non-innovative*** *active* firms in innovation activities, to **enhance innovative efforts** of the other firms and to **help firms in introducing innovation**, **pro-innovation policies should aim**:

- First: **reducing economic and financial obstacles**
- Secondly: **helping firms in facing market-related obstacles**

Nature of the most perceived obstacles is similar across the three innovation profiles (*Innovators*, *Innovative active* and *Non-innovative active):*

- internal financial constraints, innovation costs too high, market dominated by established firms and uncertain demand for innovative goods or services
- Hampering effect of **innovation costs** is more evident for ***Innovative active* firms**

3. Obstacles to innovation: Conclusion

- Better understanding of the factors hampering innovation and the determinants of these obstacles in order to suggest **how innovation could be stimulated or facilitated**
- **Nature of the most perceived obstacles seems to be similar across the firms' innovation profiles**: internal financial constraints, innovation costs too high, market dominated by established firms and uncertain demand for innovative goods or services
- Hampering effect of **innovation costs** is more evident for ***Innovative active* firms**
- However, the **drivers of the perception of obstacles vary** across different **types of obstacle** and, at the same time, vary across **innovation profiles**
- Thus, **public policies** aimed at **supporting innovation development** may **differ from** the ones targeted to **encourage innovation activities**

3. Obstacles to innovation: Conclusion

Next steps:

- panels of CIS data avoiding overlapping of data period
- international comparison including France and Italy
- disaggregated analysis of sectors (manufacturing / services)
- link information focused on obstacles to innovation and cooperation

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

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The fateful triangle: Complementarities in performance between product, process and organizational innovation in France and the UK☆

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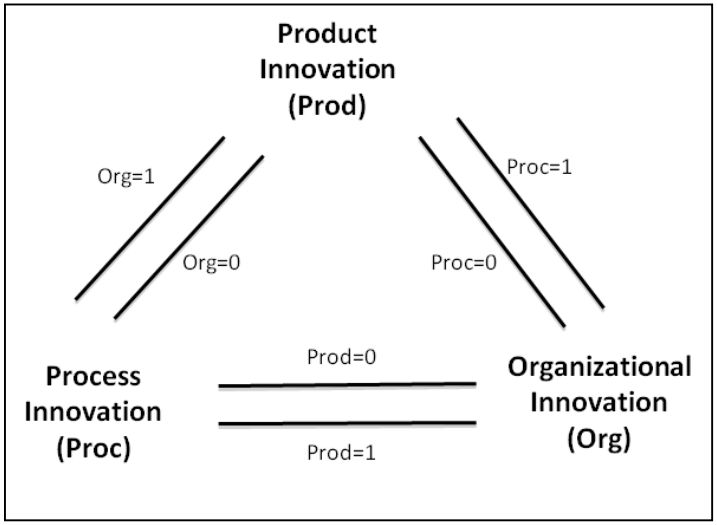
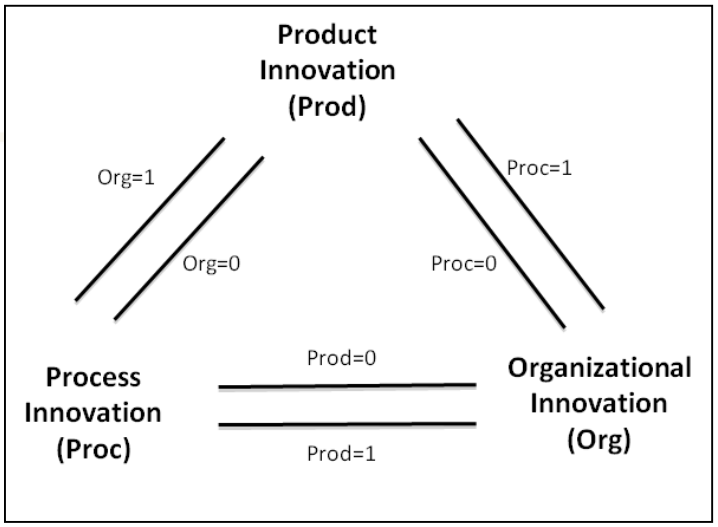
- Explore the **triangle** of relationships between:
- **Product innovation**
- **Process innovation**
- and **Organizational innovation**



Ballot, G., Fakhfakh, F., Galia, F. and Salter, A. (2016). "The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation in France and the UK", *Research Policy*, Vol. 44, No. 1, pp. 217-232 [A+ Ranked Journal, CNRS List Ranked no. 1].

4. The Fateful Triangle



- Explore the **triangle** of relationships between:
- **Product innovation**
- **Process innovation**
- and **Organizational innovation**

- Examine the ***complementarities-in-performance*:** the **effects of** complementarities and substitutions between these forms of innovation on the **performance** of the firms

- Implement a **new testing procedure** for complementarity: ***conditional* vs. *unconditional*** tests

- **Test if the triangle depends on:**
  - **National context**: France and the UK
  - **Size** of firms
  - **Capabilities** of firms (R&D)

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4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Motivation

- **Results should bring some light on:**

- **Theoretical issues**: the firm according to Milgrom & Roberts (1990) benefits from having certain complementary practices

- **Is this prediction supported by the data (*i.e.* all innovation forms complementary)?**

- **If not, are there partial complementarities?**

- **Foundations for the theory**: new products may require new processes and new methods of management, marketing… (Damanpour & Evan, 1984; Damanpour, 1991; Freeman & Soete, 1997; Birkinshaw, Hamel & Mol, 2008; Mol &Birkinshaw, 2009)…

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Empirical literature studying complementarities between various practices or strategies:

⇒ **Three types of approaches** - Athey and Stern (1998):

1 - Testing the positive correlation between various practices conditional on a certain number of common explanatory variables (**CORR**)

2 - Factor which has an effect on one variable will not be correlated with another variable unless the variables are complementary (**RED**)

3 - Modeling firm's objective function by a set of regressors, including the interactions effects or clusters between several practices or strategies (**PROD**)

+ 3 ext. - Theoretical concept of supermodularity within the mathematical concept of lattices (**SUPERMOD**)

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Innovation and complementarities literature

Two axes of economic/management literature on sources of innovation and the effects of innovation on firm performance

➢ First axis: Sequential chain "Sources-Innovation-Performance"

Long history of econometric studies on the effects of **R&D** on ***technological*** **innovation** and the two main forms: **product** and **process**

Mairesse & Mohnen (2005) for a survey, Crépon-Duguet-Mairesse (1998), Leiponen (2000)…

Recent extensions on organizational and marketing innovation: Mol & Birkinshaw (2009), Schmidt & Rammer (2007)

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Innovation and complementarities literature

Two axes of economic/management literature on sources of innovation and the effects of innovation on firm performance

➢ **Second axis: Complementarities and innovation**

Complementarities:

Intuitive ideas of **synergies**, **systems** effects and **mutual** reinforcement

i.e. "the whole is more than the sum of the parts"

Mathematical concept of lattices and qualitative variables (0,1)

Vienott (1989), Topkis (1998), Vives (1999), Amir (2004),
Milgrom and Roberts (1990, 1995), Athey and Stern (1998)

A practice is more likely to be adopted at a higher level
if other practices are adopted at high level, too

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Two axes of economic/management literature on sources of innovation and the effects of innovation on firm performance

➢ Second axis: Complementarities and innovation

a) "Traditional" methods - *Complementarities-in-use*: two sets of activities are linked, the use of one practice often requires the use of other practices

Schmidt & Rammer (2007), Roper, Du, Love (2008), Evangelista & Vezzani (2010), Ballot et al. (2011)

b) Supermodularity theory and tests - *Complementarities-in-performance*: performance effects of the use of different practices in combination with one another

i) **General theory**: Milgrom & Roberts (1990,1995)

ii) Complementarities between **sources** of innovation with appropriate econometric tests of **supermodularity** and **submodularity**: Cassiman & Veughelers (2006), Mohnen & Röller (2005), Belderbos, Carre, Lokshin (2006)

iii) Complementarities between **forms** of innovation: Corrazin & Percival (2006), Percival & Corrazin (2008)

c) Trying to study the innovation chain *and* the complementarities in innovation forms: Polder, Leuwen, Mohnen, Raymond (2010, being revised)

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

France and UK CIS4 - 2002-2004, Manufacturing firms

Total sample of firms for the Heckman test

- **UK: 3627 firms**
- **France: 5691 firms**
- *Pooled: 9318 firms*

Sample of firms which innovate or try to innovate used for the production functions of the innovation forms

- **UK: 2014 firms**
- **France: 3201 firms**
- *Pooled: 5215 firms*

Table 1: Definition of variables and descriptive statistics (firms with technological innovating activities – Product, Process or Project – and all firms[1])

Name of variables	*Description*	*Pooled* 5215 firms *(9318 firms)*	*UK* 2014 firms *(3627 firms)*	*France* *3201* firms *(5691 firms)*
Product innovation	If the firm introduces a product that is new-for-the-market (0,1)	50.74 % *(28.40 %)*	49.35% *(27.40 %)*	51.61% *(29.03 %)*
Process innovation	If the firm introduces a new process (0,1)	67.69 % *(37.88 %)*	55.16% *(30.63 %)*	75.57% *(42.50 %)*
Organizational innovation	If one of the following: new or significant improved organizational structure, system for managing knowledge, or marketing activities (0,1)	63.97 % *(46.39 %)*	60.43% *(43.64 %)*	66.20% *(48.15 %)*

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

- **Explore the forms of innovation and combinations** (eight exclusive combinations *(Wijk))*

Table 2: Descriptive statistics of forms of innovations and the eight exclusive associated combinations

	Pooled	*UK*	*France*
Product innovation	2646 (50.74%)	994 (49.35%)	1652 (51.61%)
Process innovation	3530 (67.69%)	1111 (55.16%)	2419 (75.57%)
Organizational innovation	3336 (63.97%)	1217 (60.43%)	2119 (66.20%)
Product innovation only (W100)	374 (7.17%)	192 (9.53%)	182 (5.69%)
Process innovation only (W010)	637 (12.21%)	229 (11.37%)	408 (12.75%)
Organizational innovation only (W001)	395 (7.57%)	229 (11.37%)	166 (5.19%)
Product and process innovation (W110)	423 (8.11%)	137 (6.80%)	286 (8.93%)
Product and organizational innovation (W101)	471 (9.03%)	243 (12.07%)	228 (7.12%)
Process and organizational innovation (W011)	1092 (20.94%)	323 (16.04%)	769 (24.02%)
All forms of innovations (W111)	1378 (26.42%)	422 (20.95%)	956 (29.87%)
None (W000)	445 (8.53%)	239 (11.86%)	206 (6.44%)
Nb of firms with technological innovating activities (Product, Process and/or Project)	5215	2014	3201

Sources: CIS 4 (UK and France)

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Two approaches for testing complementarities:

- **4.1 *Complementarities-in-use*:** two sets of activities are linked, the use of one practice often requires the use of other practices (CORR and RED)
  - Identify the relatedness in the use of different practices
  - Find evidence that some practices are usually combined with others
  - **Descriptive statistics, trivariate probit, multinomial logit**
- **4.2 *Complementarities-in-performance*:** performance effects of the use of different practices in combination with one another (PROD and SUPERMOD)
  - Direct test of the economic value and performance
  - Mutual product of the joint use of practices produce economic benefits that are greater than the individual parts
  - **Heckman OLS regression on labour productivity as a performance function with test of the endogeneity of Wijk for supermodularity tests**

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

- Qualitatives Variables: Mathematical concept of lattices

Vienott (1989), Topkis (1998), Vives (1999), Amir (2004), Milgrom and Roberts (1995), Athey and Stern (1998)

- The theory of supermodularity based on Topkis (1978) lattice theory allows for the discreteness of the factors/strategies, notably taking binary values (present (1), absent (0)).

- **Supermodularity**: performance function **f(x1,x2)**
- Case of two types of innovation: Product (x1) and Process (x2):

⇒ $\mathbf{f}(1,1) - \mathbf{f}(0,1) > \mathbf{f}(1,0) - \mathbf{f}(0,0)$

Introducing Product innovation (x1) is more efficient-productive when Process innovation (x2) is introduced simultaneouly

⇒ **f(x1,x2) is supermodular**

⇒ Two practices: only one inequality constraint

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

- Case of **three types of innovation**:

  Product (x1), Process (x2) and Organization (x3):

- Set of eight exclusive combinations ***W1i1j1k*** from W000 to W111 where 1_i=1 if the firm introduces a **product** innovation; zero otherwise,

  1_j=1 if the firm introduces a **process** innovation; zero otherwise,

  and 1_k=1 if the firm introduces an **organizational** innovation; zero otherwise

- **Supermodularity**: performance function **f(x1,x2,x3)**

- Testing complementarity between Product (x1) and Process (x2)

  NOT only one inequality constraint,

  ⇒ but **TWO inequality constraints**

f(1,1,0) - **f**(0,1,0) > **f**(1,0,0) - **f**(0,0,0) when ORG is absent

f(1,1,1) - **f**(0,1,1) > **f**(1,0,1) - **f**(0,0,1) when ORG is present

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

- Testing complementarity between Product (x1) and Process (x2)

NOT only one inequality constraint, but TWO inequality constraints

f(1,1,0) - **f**(0,1,0) > **f**(1,0,0) - **f**(0,0,0) when ORG is absent

f(1,1,1) - **f**(0,1,1) > **f**(1,0,1) - **f**(0,0,1) when ORG is present

- Testing substituability is replacing '>' by '<'

- Testing these two inequality constraints **together**:

  ***unconditional* complementarity** (Kodde & Palm, 1986),

  but can lead to inconclusive interpretations

- We then **introduced a more detailed approach** than the literrature:

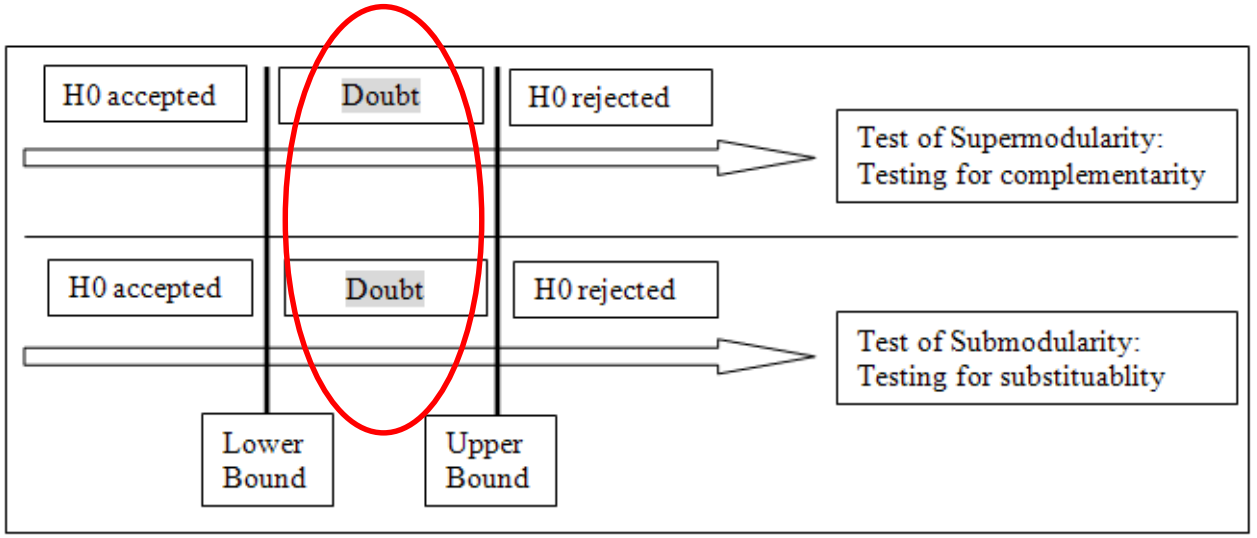
  Testing these two inequality constraints individually:

  ***conditional* complementarity**

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

- ***Unconditional* complementarity tests** (Kodde & Palm, 1986) can lead to inconclusive interpretations

Appendix 1: Testing complementarity and substituability of the 7 possible cases of interpretation (Kodde-Palm LR tests)



Critical values for two constraints:
at 5% level: lower bound (df=1) = 2.706 and upper bound (df=2) = 5.138
at 1% level: lower bound (df=1) = 5.412 and upper bound (df=2) = 8.273

We accept H0 if LR statistic is smaller than the lower bound. We reject H0 if this LR statistic is larger than the upper bound. If this statistic is between the bounds, the outcome is within the doubt region.

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

- ***Unconditional* complementarity tests** (Kodde & Palm, 1986) can lead to inconclusive interpretations

	Test of Supermodularity: Testing for complementarity	Test of Submodularity: Testing for substituablity	Interpretation
Case 1	H0 accepted	H0 rejected	Strict complementarity (Strict COMPL.)
Case 2	H0 rejected	H0 accepted	Strict substituability (Strict SUBST.)
Case 3	H0 accepted	Doubt	Weak complementarity (Weak COMPL.)
Case 4	Doubt	H0 accepted	Weak substituability (Weak SUBST.)
Case 5	H0 accepted	H0 accepted	Inconclusive
Case 6	H0 rejected	H0 rejected	Inconclusive
Case 7	Doubt	Doubt	Inconclusive

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

- Case of **three types of innovation**:

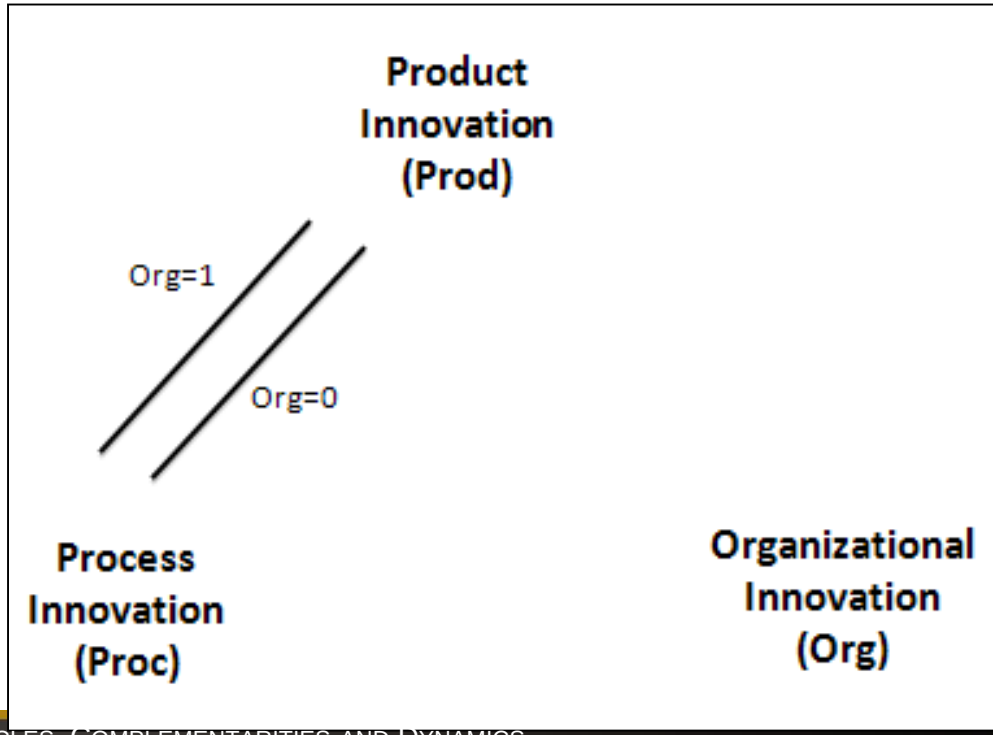
  Product (x1), Process (x2) and Organization (x3)

- Testing ***unconditional*** and ***conditional*** complementarity between Product (x1) and Process (x2):

TWO inequality constraints:

- when Organization (x3) is absent (Org=0)

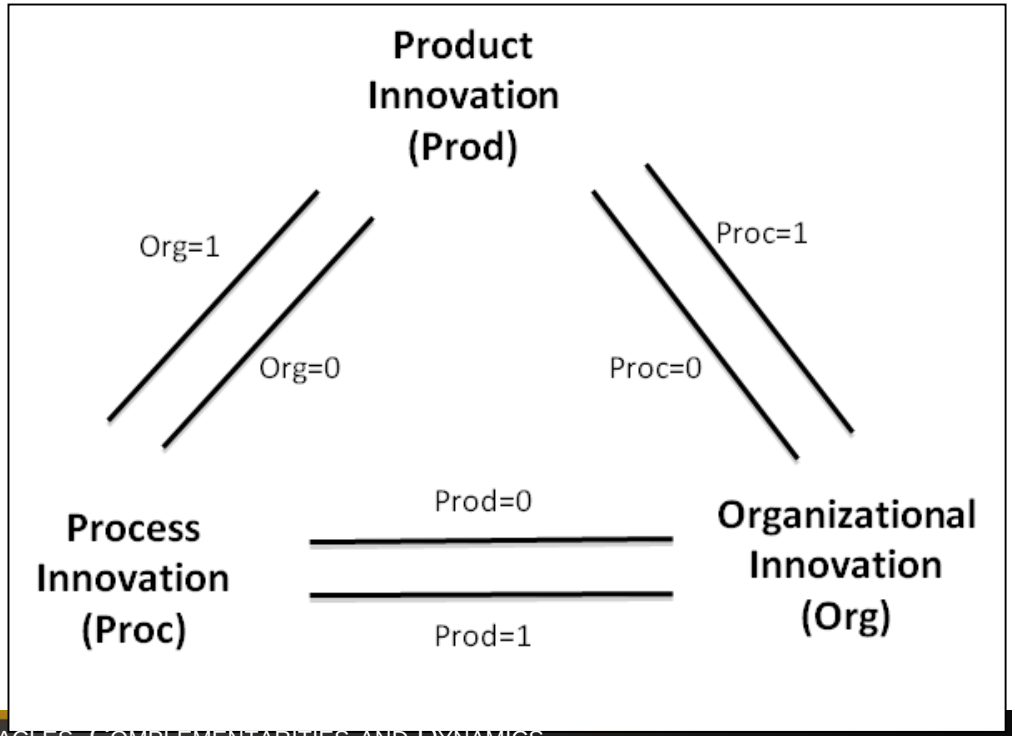
- when Organization (x3) is present (Org=1)



4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

- **Testing for the THREE couples** (pair-wise tests):
  - Product and Process
  - Product and Organization
  - Process and Organization

- Testing **SIX inequality constraints**



4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Results: *Complementarities-in-use*

Trivariate probit: main results

- **Size** has a positive effect on **process** and **organizational** innovations, no effect on product **(economies of scale)**
- **Internal R&D** has a positive effect on **product innovation**, negative on process for FR, and positive on organizational innovation in UK only
- **Training** has no effect on product, and a positive effect on process and organizational innovations.
- **Cooperation, openness** have always a **positive** effect
- **Informal appropriability** has always a **positive** effect, confirming many enquiries about its higher protection than formal protection.

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Trivariate probit: similarities and differences between Countries

- **UK:** complementaritiy between process and organizational innovation
  - and also between product and organizational innovation
  - no relation between product and process innovation

- **France:** complementarity between process and organizational innovation
  - no relation between product and organizational innovation
  - substitution between product innovation and process innovation

Correlations of residuals	UK		France	
Product / Process	0,019	0,54	-0,062**	-2,06
Product / Organization	0,079**	2,12	0,034	1,13
Process / Organization	0,185***	4,96	0,265***	8,18
Nb of observation	2014		3201	

Sources: CIS 4 (UK and France), Industry dummies are not reported.
Significance levels at *** 1%, ** 5% and * 10%.

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Multivariate probit: eight exclusive innovation combinations (Wijk)

- The number of significant factors increases in the number of different forms of innovation done simultaneously
- firms need a **more systematic use of the diverse possible strategies** when the aim is innovation in all forms
  - **Size** becomes a positive factor only when the firm innovates in the 3 forms
  - **R&D** is the most often positive & significant factor, except for process only
  - **Training** always increases innovation except when there is only product innovation, (or Prod combined with Org in UK)
  - **Cooperation** always enhances the probability of innovation mainly in UK, but less in France
  - **Sources (Openness)**: positive only when Org Innov
  - **Intellectual protection, formal or not**, increases the probability of innovating, although much less in UK
  - **Financial, knowledge and market obstacles to innovation** no influence, except financial in UK

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Results: *Complementarities-in-performance*

Performance is regressed on the eight combinations of innovations and control variables

Table 3: Exclusive innovation combinations and performance. Dependent variable: Log of sales per employee (2004 in Euro)

	UK		*France*	
	Coef.	z	Coef.	z
W000	0,843***	7.71	0,758***	5.35
W100	0,813***	7.45	0,723***	5.16
W010	0,876***	7.97	0,759***	5.23
W001	0,866***	7.80	0,734***	5.16
W110	0,903***	8.00	0,773***	5.33
W101	0,878***	8.00	0,789***	5.47
W011	0,880***	8.07	0,758***	5.31
W111	0,886***	7.93	0,775***	5.43

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Results: *Complementarities-in-performance*

- **Size** has no influence

- **R&D** has a positive effect on performance, which can be interpreted as an "absorptive capacity" effect (Cohen-Levinthal,1990) since innovations are controlled for

- **Financial** and **knowledge obstacles** have the right negative sign but are significant only for France, while the **market obstacles** are always significant (less rent from innovations)

- **Appropriability methods** have no effect on performance, but these have normally been captured in the innovation equations

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

***Unconditional* complementarity tests** (Kodde & Palm, 1986) lead **mostly to inconclusive interpretations**

- Only two cases of conclusive interpretations

	UK	*France*
Supermodularity Submodularity PROD / PROC	1.108*** (H0 accepted) 0.008***(H0 accepted) **Inconclusive**	0.977***(H0 accepted) 0.610*** (H0 accepted) **Inconclusive**
Supermodularity Submodularity PROD / ORG	0.622*** (H0 accepted) 0.145***(H0 accepted) **Inconclusive**	1.873***(H0 accepted) 0.000*** (H0 accepted) **Inconclusive**
Supermodularity Submodularity PROC / ORG	0.000*** (H0 accepted) 2.251***(H0 accepted) **Inconclusive**	0.222***(H0 accepted) 1.622*** (H0 accepted) **Inconclusive**
5%	Lower bound : 2.706	Upper bound : 5.138

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Unconditional complementarity tests **by sub-samples:**

- Lead **mostly to inconclusive interpretations**
- Only two cases /24 of conclusive interpretations

- SME: all tests are inconclusive

- Large firms: week substituability between PROC / ORG in UK

- Low R&D: all tests are inconclusive

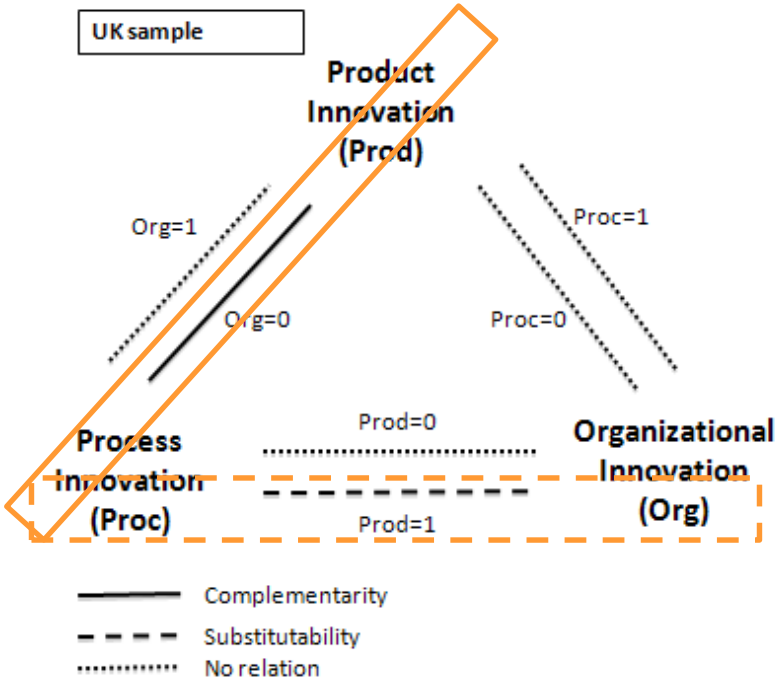
- High R&D: all tests are inconclusive

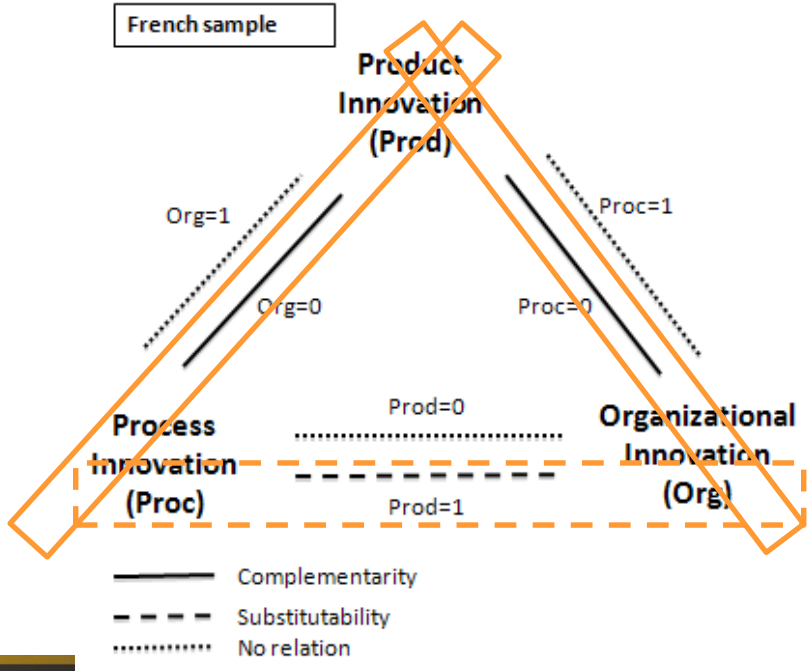
- We then implement a more detailed approach than the literrature: ***Conditional* complementarity**

4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Conditional complementarities comparing France and UK:

- Similar results on ***conditional*** **complementarities** between **product** and **process** when organizational innovation is absent
- Only for **French** firms, **product** and **organizational** innovations are ***conditional*** **complements** when firms do **not** introduce **process** innovation
- ***Conditional*** **substitution** effect in both countries between **process** and **organization** when product is introduced





4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

First lessons comparing France and UK:

1. **French firms** can only choose between **two strategies -**
   "technological strategy" (Product-Process)
   and "structure oriented strategy" (Product-Organization),
   but the estimated returns are likely to be higher for none of the two.
   UK firms must choose the **"technological" (Product-Process) strategy**.

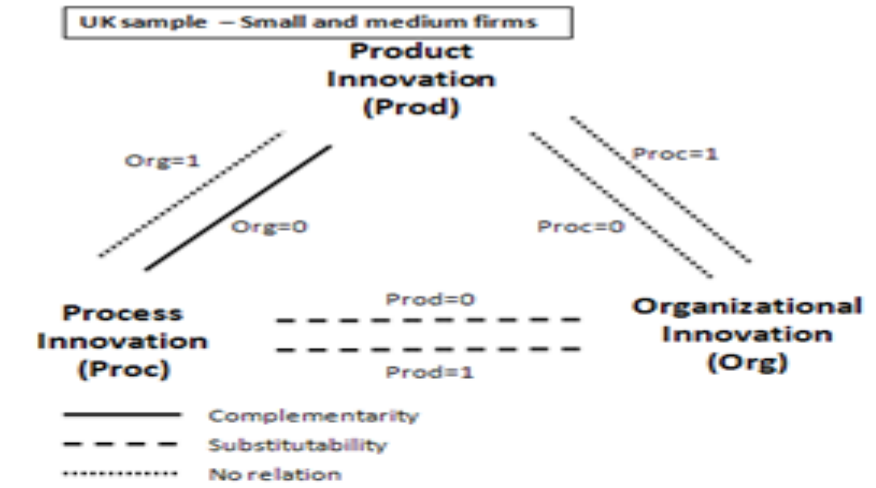
2. Strategies are then **Country dependent**. Contingency theory applies: there is **no unique best strategy**

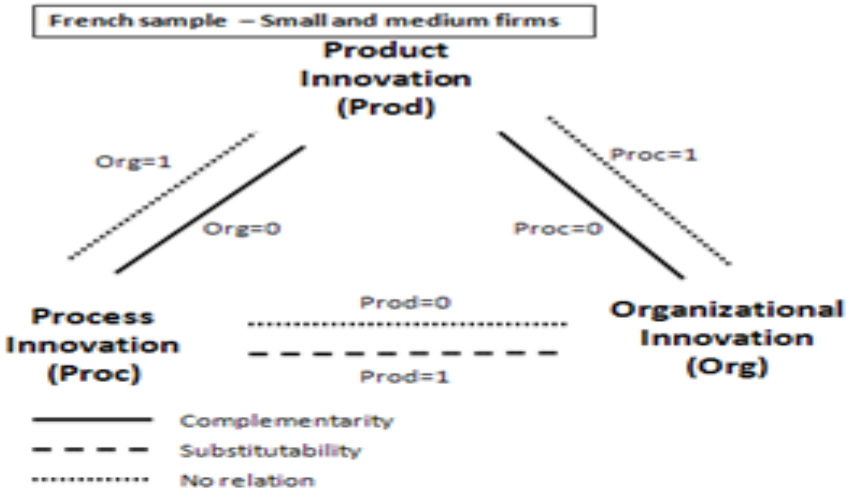
   ↳ **Strong strategic implications** for French and UK **managers**

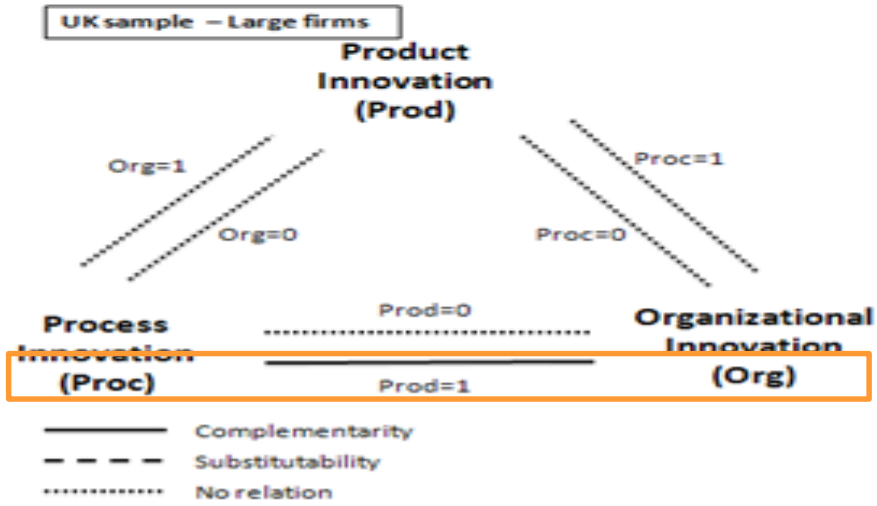
4. This suggests further **sample splits**

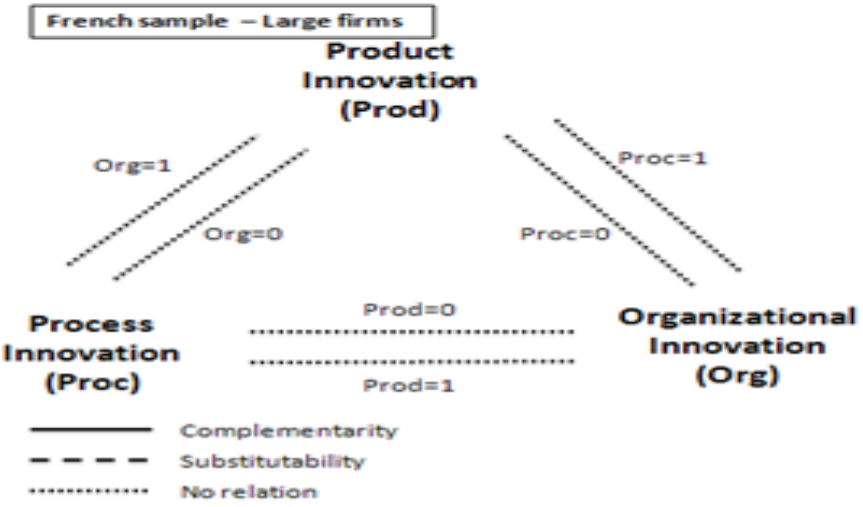
4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Sample split according to size: small-medium versus **large** firms



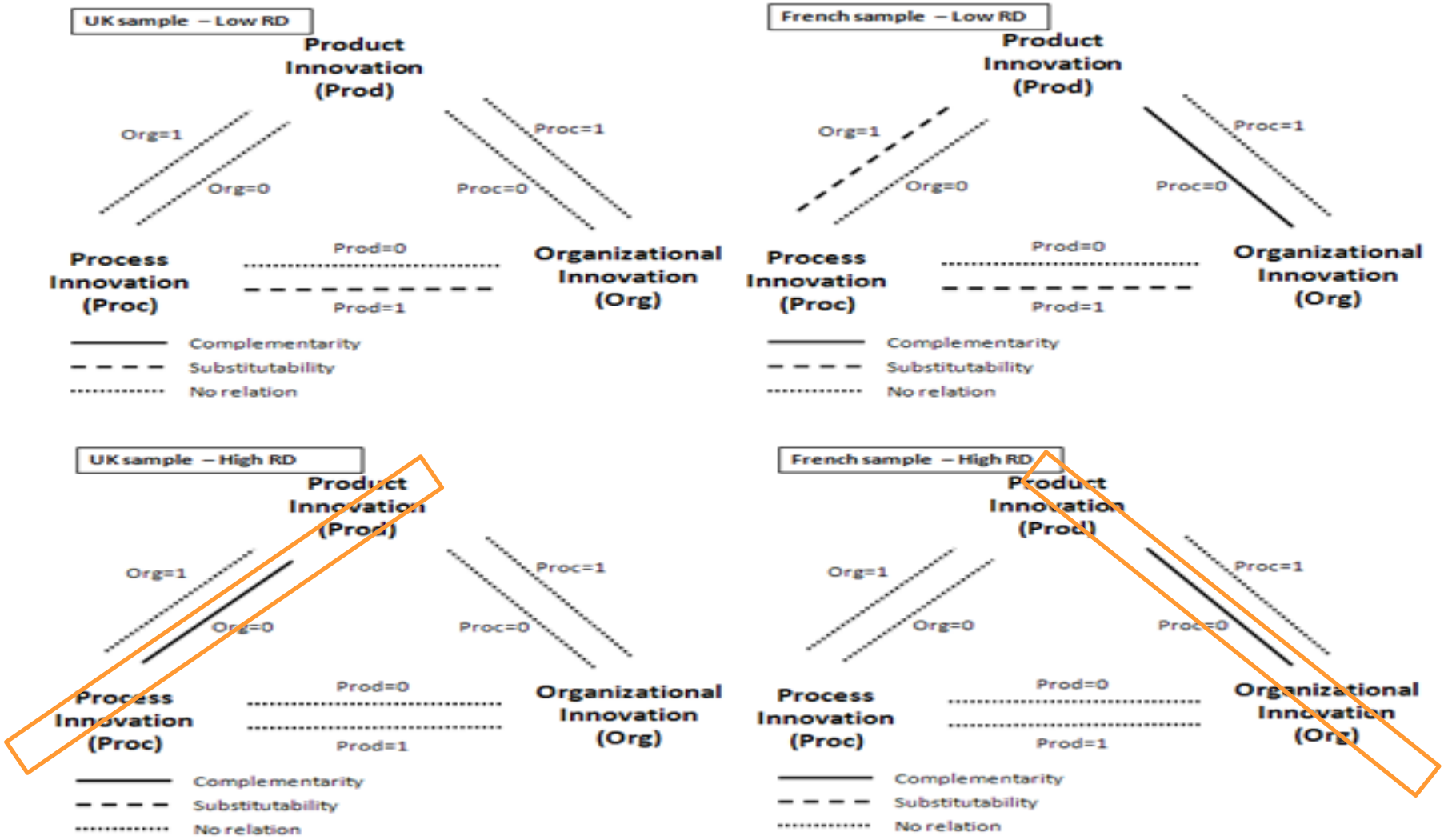






4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Sample split on "capabilities": high-tech / low-tech firms



4. The Fateful Triangle: Complementarities in Performance between Product, Process and Organizational Innovation

Lessons from the size slipt:

- **SMEs** have to **choose** clearly between the **"technological strategy"** and the **"structure-oriented strategy"**, for cost reason
- **Large UK** firms should choose an **product-process-organization strategy** benefiting from economies of scale

Lessons from the "capabilities" slipt:

1. **High Tech firms** benefit more from complementarities than Low Tech firms: logical in the context of the competition by innovation
2. French firms and UK firms should choose different strategies:
   - **"Structure oriented strategy" (Product-Organization) for French firms**
   - **"Technological strategy" (Product-Process) for UK firms**

5. Crossroads to Roma: Dynamics of Innovation Strategies

Exploring the Path of Product, Process, Organizational and Marketing Innovations

Ballot, G., Fakhfakh, F. and Galia, F. (2017)

"All roads lead to Roma" - "Tous les chemins mènent à Rome":

refer a bronze monument built 20 BC

called Milliarum Aureum (lat. "Golden Milestone")

Which road would you take?

"Where do you start,
when you want to know
every road to Rome?"

Gross B., Schmitt P. and Reimann R. (2015)
construct a map with all roads
converging to Roma:
486.713 starting points aligned in a
26.503.452 km² grid covering all of Europe
(Open Source Data from OpenStreet Map)

http://roadstorome.moovellab.com/countries
http://bigbrowser.blog.lemonde.fr/2015/12/10/toutes-les-routes-menent-a-toutes-les-romes/

5. Crossroads to Roma: Dynamics of Innovation Strategies

Which road of innovation would you take for performance?

Main objectives of this paper:

- Study the **dynamics of innovation strategies**
- Identify and characterize the **firms' path of innovation**
  with **four forms of innovation:**
  product, process, organization and marketing
- Explore the **determinants** of the different path of innovation
- Estimate the **impact of the paths of innovation on performance**

5. Crossroads to Roma: Dynamics of Innovation Strategies

Answering the following four questions contribute to the existing literature:

(i) What are the main firms' **dynamics of innovation strategies**?

(ii) Are we able to **identify and characterize different paths of innovation strategies**?

(iii) What are the **determinants of the paths of innovation strategies**?

(iv) Does the **different paths of innovation leads to different performance**?

5. Crossroads to Roma: Dynamics of Innovation Strategies

Literature review: theoretical background

- “Knowledge accumulation”
- “Success breeds Success”
- R&D Sunk Cost
- Appropriation Theory

- Dynamic capabilities
- Technological Dynamic Capabilities - R&D Capabilities
- Organizational Dynamic Capabilities
- Path dependence

5. Crossroads to Roma: Dynamics of Innovation Strategies

Literature review: theoretical background

- "Knowledge accumulation": experience in innovation is associated with dynamically increasing returns in the form of learning-by-doing and learning-to-learn effects: new ideas by recombining (re-arranging) old ones (Leonard-Barton, 1992; Foss, 1997; Geroski, Van Reenen, and Walters, 1997; Duguet and Monjon, 2004; Latham and Le Bas, 2006, Nelson and Winter, 1982; Teece, Pisano, and Schuen, 1997; Antonelli, Crespi, and Scellato, 2013)

- "Success breeds Success": innovation feeds performance and profitability, economic and commercial successes, higher permanent market power, reducing financial constraints, enhance technological opportunities which later funds innovation activities (Flaig and Stadler, 1994; Cefis, 2003; Latham and Le Bas, 2006; Cefis and Ciccarelli, 2005; Crespi, and Scellato, 2012)

- R&D Sunk Cost: engage in R&D activities with start-up - initial costs that are usually not recoverable, time choice implications between investing and not investing in R&D activities, barrier to both entry to and exit from R&D activity. Long-term commitment, strategy and innovation as a systematic component, routines firms' behavior (Latham and Le Bas, 2006; Antonelli, Crespi, and Scellato, 2012)

- Appropriation Theory: products innovation, compared to other forms of innovation, become persistence 'gold medal' when outcomes can be protected with strong intellectual property (Teece,1986)

5. Crossroads to Roma: Dynamics of Innovation Strategies

Literature review: theoretical background

- Dynamic capabilities: ability of the management for "appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competences toward changing environment" (Nelson and Winter, 1982; Teece and Pisano, 1994; Teece, Pisano, and Shuen, 1997; Helfat, 2000; Eisenhardt and Martin, 2000; Zollo and Winter, 2002; Teece, 2007)

- Technological Dynamic Capabilities - R&D Capabilities: R&D capabilities are important for firms to gain the 'sensing' capabilities for identifying the most important technological developments in the market and forecast the direction of change. Learning capabilities of the firm and absorptive capacity literature, 'local search' - 'exploitation' / 'exploration' (Cohen and Levinthal, 1989; Freeman and Soete, 1997; Zahra and George, 2002; Lewin et al., 2011; Lichtenhaler and Ernst, 2012)

- Organizational Dynamic Capabilities: strong managerial dynamic capabilities are important drivers of the firm's ability to introduce innovations (Damanpour, 2014; Damanpour, 2016; Freeman & Soete, 1997; Birkinshaw, Hamel & Mol, 2008; Mol &Birkinshaw, 2009; Battisti and Stoneman, 2010…)

- Path dependence: 'history matters': '. . . the characteristics of the processes that are analyzed and their results are fully determined and contained in their initial condition'. Opportunities and strategic alternatives for learning will be 'close in' to previous activities (Teece, 1988; Leonard-Barton, 1992; Teece and Pisano, 1994; Utterback, 1996)

Literature review: empirical evidence

- Empirical evidence mainly related

  to **persistence of innovation rather than dynamics**

(Cefis and Orsenigo, 2001; Roper and Hewitt-Dundas, 2008; Peters, 2009; Raymond, Mairesse, Mohnen and Palm, 2010; Clausen, Pohjola, Sapprasert and Verspagen, 2011; Antonelli, Crespi and Scellato, 2012; Ganter and Hecker, 2013; Love, Roper and Vahter, 2015; Trigero and Córcoles, 2013; Le Bas and Scellato, 2014; Haned, Mothe, and Nguyen, 2014; Hecker and Ganter, 2014; Lhuillery, 2014; Triguero, Córcoles, and Cuerva, 2014; Suarez, 2014; Tavassoli and Karlsson, 2015; Kesidou and Demirel, 2015)

- **Different measures of "innovation"**: Innovation counts, Innovation output, Innovation activities, R&D intensity, Cooperation, Patents, TFP growth

- **Data and methods:** Time series analysis, Panel, Dynamic panel data, Transition Probability matrixes, Probit model, Multinomial probit model, Survival model, Dynamic discrete choice panel data model

Literature review: empirical evidence

- **Main results of previous empirical evidence on persistence of innovation**:

  - Level of persistence differs according to the **typology of innovation**: product/process innovation, complex/simple innovators, low/high-tech sector. Higher persistence for R&D investments and for product innovation

  - **Organizational innovation** is a determinant factor for innovation persistence

  - Persistence characterized by a **strong threshold effect**: only great innovators have a stronger probability to keep innovating

  - Correlation between **innovation** and persistence of **profit** and **performance**

5. Crossroads to Roma: Dynamics of Innovation Strategies

Data: Three waves of French CIS over a ten-year period

between 2002-2012 (CIS 4, CIS 6 and CIS 8)

to **avoid overlapping effect** that exist in previous panel studies

- **with FARE database** over six-year period between 2008-2013 that provide all performance information

Figure 1: CIS periods and potential overlapping effects

CIS 4 (2002-2004)		*CIS 5 (2004-2006)*		CIS 6 (2006-2008)		*CIS 7 (2008-2010)*		CIS 8 (2010-2012)		===>	FARE 2013 Performances
2002	2004	*2004*	*2006*	2006	2008	*2008*	*2010*	2010	2012	===>	2013

CIS 4 (2002-2004)		X		CIS 6 (2006-2008)		X		CIS 8 (2010-2012)		===>	FARE 2013 Performances
2002	2004	X	X	2006	2008	X	X	2010	2012	===>	2013

5. Crossroads to Roma: Dynamics of Innovation Strategies

Data: Three waves of French CIS between 2002 and 2012

Community Innovation Survey (CIS): CIS4 (2002-04), CIS6 (2006-08) and CIS8 (2010-12)

5. Crossroads to Roma: Dynamics of Innovation Strategies

Community Innovation Survey (CIS): CIS4 (2002-04), CIS6 (2006-08) and CIS8 (2010-12)

- **General information (size, sales, sector…)**

- ***Product (good or service) innovations [2 types] (0,1)***
  - *New to the market*
  - *Only new to the firm*

- ***Process innovations [3 types] (0,1)***
  - *New or significantly improved methods for the manufacture or production*
  - *New or significantly improved logistics systems or delivery or distribution*
  - *New or significantly improved supports activities for its processes*

- ***Innovation activity in progress or abandoned (0,1)***

If at least one YES among three: Firm is defined as technological innovative firms

If NO to these 3 questions go directly to questions on Org. and Mkg. Innovations

5. Crossroads to Roma: Dynamics of Innovation Strategies

Community Innovation Survey (CIS): CIS4 (2002-04), CIS6 (2006-08) and CIS8 (2010-12)

- **Innovation activities and expenditures** *(sum R&D)*
- **Sources of information and co-operation for innovation** *(Cooperation, Breath, Depth, Make, Buy,…in the three waves, Market pull and Technology push only in CIS4)*
- **Effects of innovations** *(in CIS4)*
- **Objectives of innovations** *(in CIS6)*
- **Obstacles to innovation: projects or activities of innovation**
  - ***Abandoned during conception / Abandoned at the beginning / Delayed projects***

    Only for firms with technological innovating activities (Product, Process or Project) *(in CIS4)*
- **Obstacles to innovation for all firms** *(Financial, Knowledge, Market obstacles in CIS4)*
- **Environmental benefits of innovation** *(in CIS6)*
- **Strategies to reach objectives of the firm** *(in CIS8)*
- **Protection methods for innovation** *(Formal IPR in CIS4 and CIS8, Informal IPR in CIS4)*

5. Crossroads to Roma: Dynamics of Innovation Strategies

Community Innovation Survey (CIS): CIS4 (2002-04), CIS6 (2006-08) and CIS8 (2010-12)

- ***Organizational Innovations [3 types] (0,1)***

- *New business practices in the **organisation of the work** or of the **company procedures** (0,1)*

- *New organisation methods for the **workplaces in the company**, for the purpose of a better **distribution of responsibilities** and **decision-making** (0,1)*

- *New management models for **external relations** with other companies or public institutions (0,1)*

5. Crossroads to Roma: Dynamics of Innovation Strategies

Community Innovation Survey (CIS): CIS4 (2002-04), CIS6 (2006-08) and CIS8 (2010-12)

- ***Marketing Innovations [2 types] (0,1)***

- *Significant modifications in the **design** of the product or in the packaging of the goods or services (0,1)*

- *New methods for the **positioning** of the product in the market or sales channels (0,1)*

5. Crossroads to Roma: Dynamics of Innovation Strategies

Three waves of French CIS (2002-2012) and **FARE** (2008-2013):

- **1,817 firms**

CIS 4 (2002-2004)		X		CIS 6 (2006-2008)		X		CIS 8 (2010-2012)		===>	FARE 2013 Performances
2002	2004	X	X	2006	2008	X	X	2010	2012	===>	2013

- **Technologically active firms** during at least one period:

  Firms with technological innovating activities (Product, Process or Project)

  (1,604 firms, 88.28%)

- **Non-technologically active** firms during all the three periods:

  Firms without any technological innovating activities

  (213 firms, 11.72%)

5. Crossroads to Roma: Dynamics of Innovation Strategies

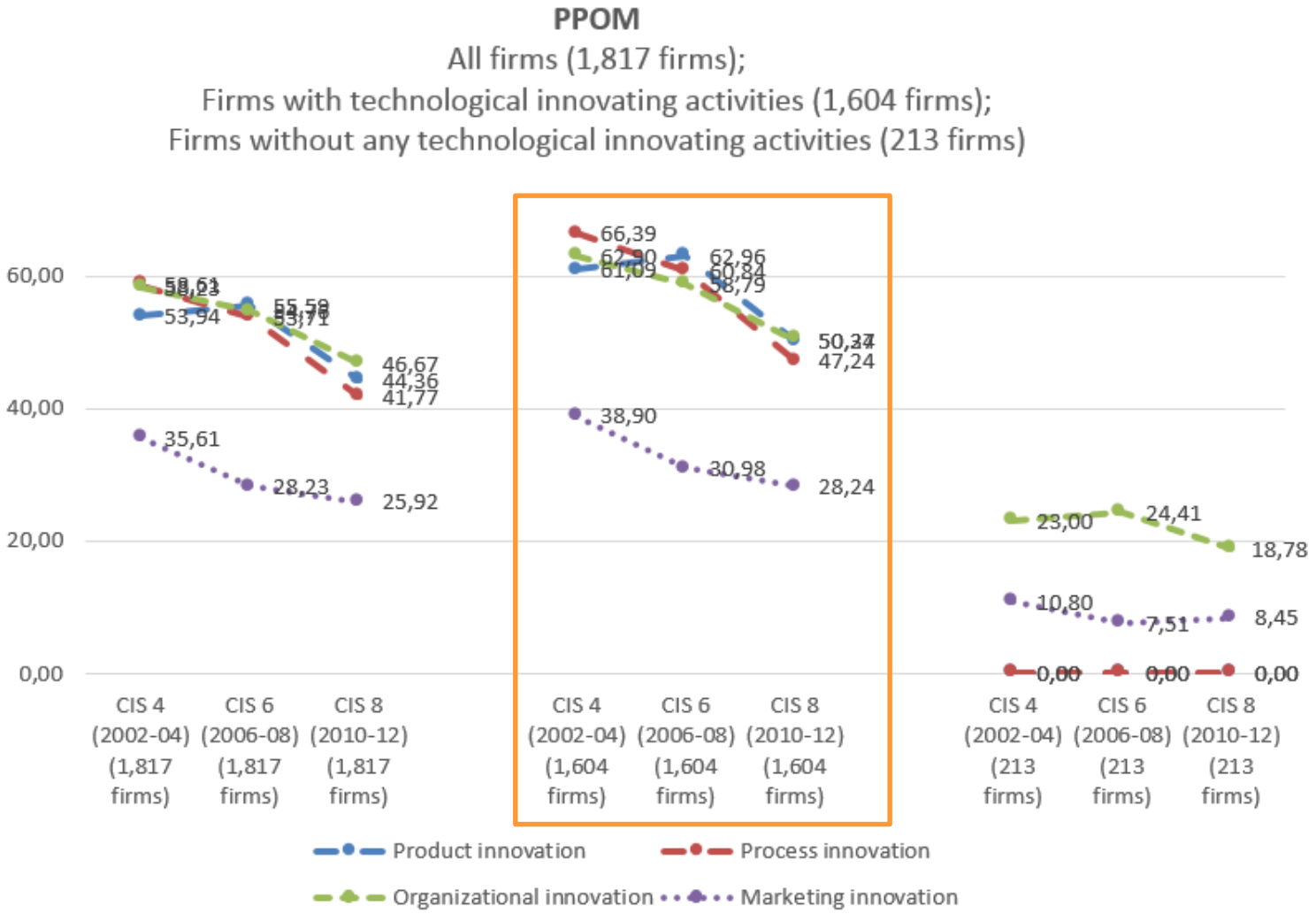
Table X1: Descriptive statistics of forms of innovations and the sixteen exclusive associated combinations (firms with technological innovating activities – Product, Process or Project – during at least one period and all firms[1])

	CIS 4 2004 (2002-2004) 1,604 firms *(1,817 firms)*	CIS 6 2008 (2006-2008) 1,604 firms *(1,817 firms)*	CIS 8 2012 (2010-2012) 1,604 firms *(1,817 firms)*
Technologically active firms during at least one period: Firms with technological innovating activities (Product, Process or Project)	100% *(88.28%)*	100% *(88.28%)*	100% *(88.28%)*
Product innovation	61.09% *(%)*	62.96% *(%)*	50.24% *(%)*
Process innovation	66.39% *(%)*	60.84% *(%)*	47.24% *(%)*
Organizational innovation	62.90% *(%)*	58.79% *(%)*	50.37% *(%)*
Marketing innovation	38.90% *(%)*	30.98% *(%)*	28.24% *(%)*
At least one form of innovation among four	88.15% *(%)*	84.41% *(%)*	72.38% *(%)*
Mean of innovation forms (0-4) (Sd. Dev.)	2.29 (1.28)	2.13 (1.33)	1.76 (1.41)
Min / Max	0 - 4	0 - 4	0 - 4
Product innovation index (0 -100) [2 types: NwM & NwF] (S.D.)	43.35 (40.40)	46.32 (40.68)	37.50 (42.10)
Process innovation index (0 -100) [3 types] (S.D.)	40.44 (36.73)	36.88 (36.77)	27.22 (34.20)
Organizational innovation index (0 -100) [3 types] (S.D.)	36.76 (34.56)	40.04 (39.19)	33.81 (38.59)
Marketing innovation index (0 -100) [2 types] (S.D.)	27.15 (37.29)	18.42 (29.58)	18.14 (31.31)

Sources: CIS 4 (2002-2004), CIS 6 (2006-2008) and CIS 8 (2010-2012) France

[1] Figures in brackets and italics concern all firms in the sample (1,817 firms). Other figures concern the sample of 1,604 firms with technological innovating activities (Product, Process or Project) during at least one period.

5. Crossroads to Roma: Dynamics of Innovation Strategies



Results: descriptive statistics of dynamics of innovation

- Exploring in more details the **dynamics of innovation**
  with the **Four forms of innovation**:
  Product, Process, Organization and Marketing (PPOM)

- Set of sixteen exclusive combinations ***W1i1j1k1l*** from W000 to W111 where

1_i=1 if the firm introduces a **Product** innovation; zero otherwise,
1_j=1 if the firm introduces a **Process** innovation; zero otherwise,
1_k=1 if the firm introduces an **Organizational** innovation; zero otherwise,
1_l=1 if the firm introduces a **Marketing** innovation; zero otherwise

5. Crossroads to Roma: Dynamics of Innovation Strategies

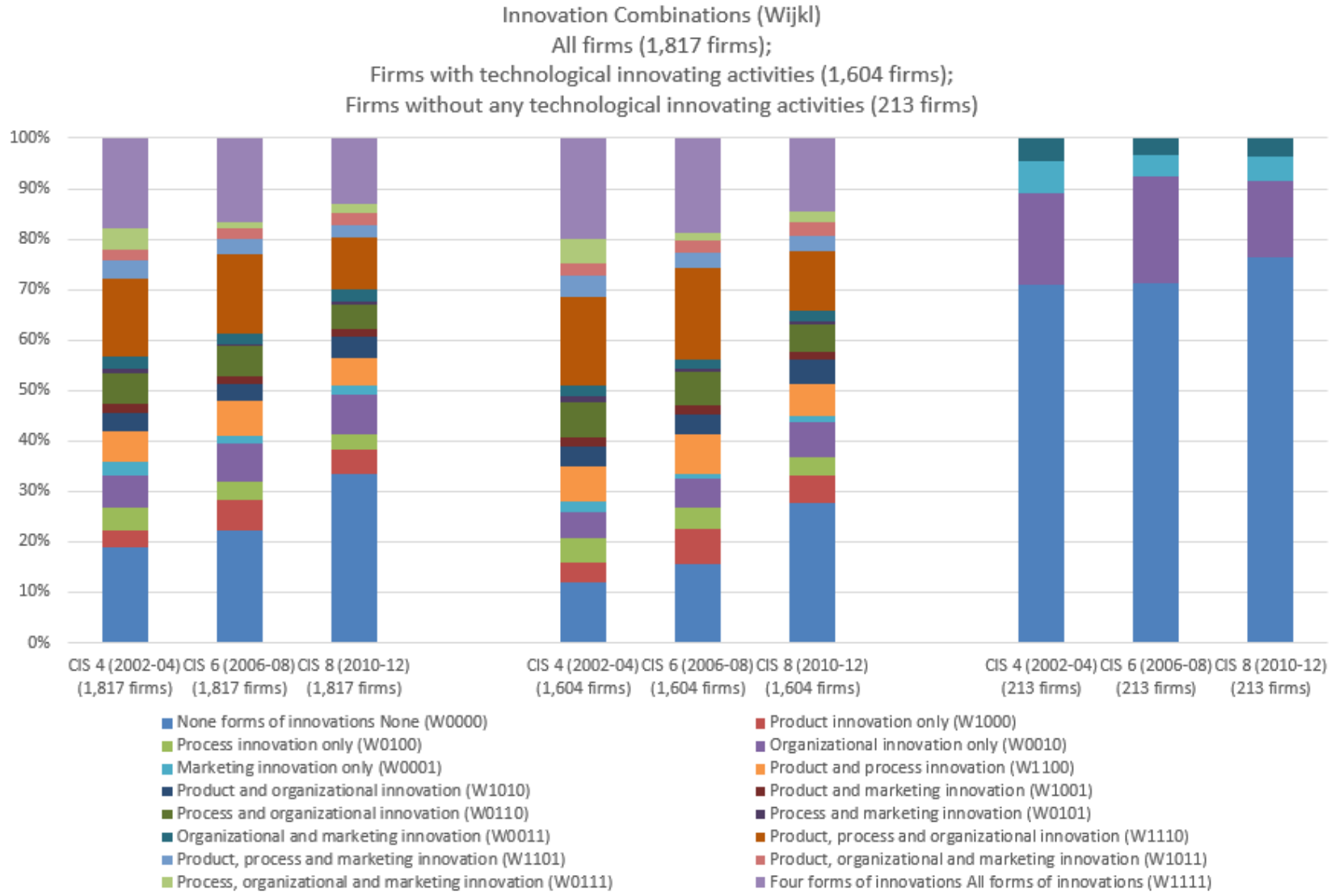
Table X1: Descriptive statistics of forms of innovations and the sixteen exclusive associated combinations (firms with technological innovating activities – Product, Process or Project – during at least one period and all firms[1])

	CIS 4 2004 (2002-2004) 1,604 firms *(1,817 firms)*	CIS 6 2008 (2006-2008) 1,604 firms *(1,817 firms)*	CIS 8 2012 (2010-2012) 1,604 firms *(1,817 firms)*
Technologically active firms during at least one period: Firms with technological innovating activities (Product, Process or Project)	100% *(88.28%)*	100% *(88.28%)*	100% *(88.28%)*
None forms of innovations None (W0000)	***11.85% (%)***	***15.59% (%)***	***27.62% (%)***
One form of innovation	***16.03% (%)***	***17.95% (%)***	***17.27% (%)***
Product innovation only (W1000)	3.99% *(%)*	6.98% *(%)*	5.55% *(%)*
Process innovation only (W0100)	1.93% *(%)*	1.24% *(%)*	3.49% *(%)*
Organizational innovation only (W0010)	5.05% *(%)*	5.67% *(%)*	6.92% *(%)*
Marketing innovation only (W0001)	2.06% *(%)*	1.06% *(%)*	1.31% *(%)*
Two forms of innovations	***23.18% (%)***	***22.52% (%)***	***21.01% (%)***
Product and process innovation (W1100)	6.98% *(%)*	7.86% *(%)*	6.30% *(%)*
Product and organizational innovation (W1010)	4.05% *(%)*	3.80% *(%)*	4.80% *(%)*
Product and marketing innovation (W1001)	1.93% *(%)*	1.81% *(%)*	1.68% *(%)*
Process and organizational innovation (W0110)	6.86% *(%)*	6.80% *(%)*	5.36% *(%)*
Process and marketing innovation (W0101)	1.18% *(%)*	0.50% *(%)*	0.69% *(%)*
Organizational and marketing innovation (W0011)	2.18% *(%)*	1.75% *(%)*	2.18% *(%)*
Three forms of innovations	***28.86% (%)***	***25.18% (%)***	***19.51% (%)***
Product, process and organizational innovation (W1110)	17.39% *(%)*	18.08% *(%)*	11.72% *(%)*
Product, process and marketing innovation (W1101)	4.18% *(%)*	3.18% *(%)*	2.99% *(%)*
Product, organizational and marketing innovation (W1011)	2.49% *(%)*	2.49% *(%)*	2.62% *(%)*
Process, organizational and marketing innovation (W0111)	4.80% *(%)*	1.43% *(%)*	2.18% *(%)*
Four forms of innovations All forms of innovations (W1111)	***20.07% (%)***	***18.77% (%)***	***14.59% (%)***

Sources: CIS 4 (2002-2004), CIS 6 (2006-2008) and CIS 8 (2010-2012) France

[1] Figures in brackets and italics concern all firms in the sample (1,817 firms). Other figures concern the sample of 1,604 firms with technological innovating activities (Product, Process or Project) during at least one period.

5. Crossroads to Roma: Dynamics of Innovation Strategies



5. Crossroads to Roma: Dynamics of Innovation Strategies

Econometric Methodology in four steps:

[Step 1]: Selection equation with Probit model

- Explaining dummy for firms with technological innovating activities – Product, Process or Project – during at least one period (0,1)

[Step 2]: Cluster analysis and transition probability matrix on the four forms of innovation: Product, Process, Organization and Marketing (PPOM)

- Identify characterize the firms path of innovation and the dynamics of innovation strategies

[Step 3]: Multivariate logit model explaining the different clusters

- Explore the determinants that leads firms to be part of the different path of innovation

[Step 4]: Linear regressions estimating the performance (level and variation of sales and employment)

- Estimate the impact of the paths of innovation on performance

5. Crossroads to Roma: Dynamics of Innovation Strategies

[Step 1]: Selection equation with Probit model

- Explaining dummy for firms with technological innovating activities

  – Product, Process or Project –

  during at least one period (0,1)

Positive and significant influence of:

- Group membership
- National market
- European market
- Informal IPR
- Financial obstacles

Table R.1: Results of the selection equation Dependent variable: dummy for firms with technological innovating activities – Product, Process or Project – during at least one period

	Coef.	Std. Dev.
Group	0.408***	0.106
Local market	-0.003	0.104
National market	0.534***	0.126
European market	0.471***	0.123
International market	-0.06	0.119
Informal appropriability	0.365***	0.060
Financial obstacles	0.256**	0.113
Knowledge obstacles	0.215	0.143
Market obstacles	0.100	0.114
Constant	3.865***	0.598
Pseudo-R squared	0.221	
N Obs	1,817	
N Censored	213	

Sources: CIS 4 (2002-2004), CIS 6 (2006-2008), CIS 8 (2010-2012) and FARE (2008-2013), France

Industry dummies are not reported.

Significance levels at *** 1%, ** 5% and * 10%.

5. Crossroads to Roma: Dynamics of Innovation Strategies

[Step 2]: Cluster analysis and transition probability matrix on the four forms of innovation: product, process, organization and marketing

- Identify characterize the firms path of innovation and the dynamics of innovation strategies

First step: cluster our firms through a hierarchical clustering method and identify the optimal number of clusters

Second step: starting from the centroids obtained in the hierarchical clustering, we use a nonhierarchical method to assign firms to clusters

Four clusters are identified:

Four path of innovation

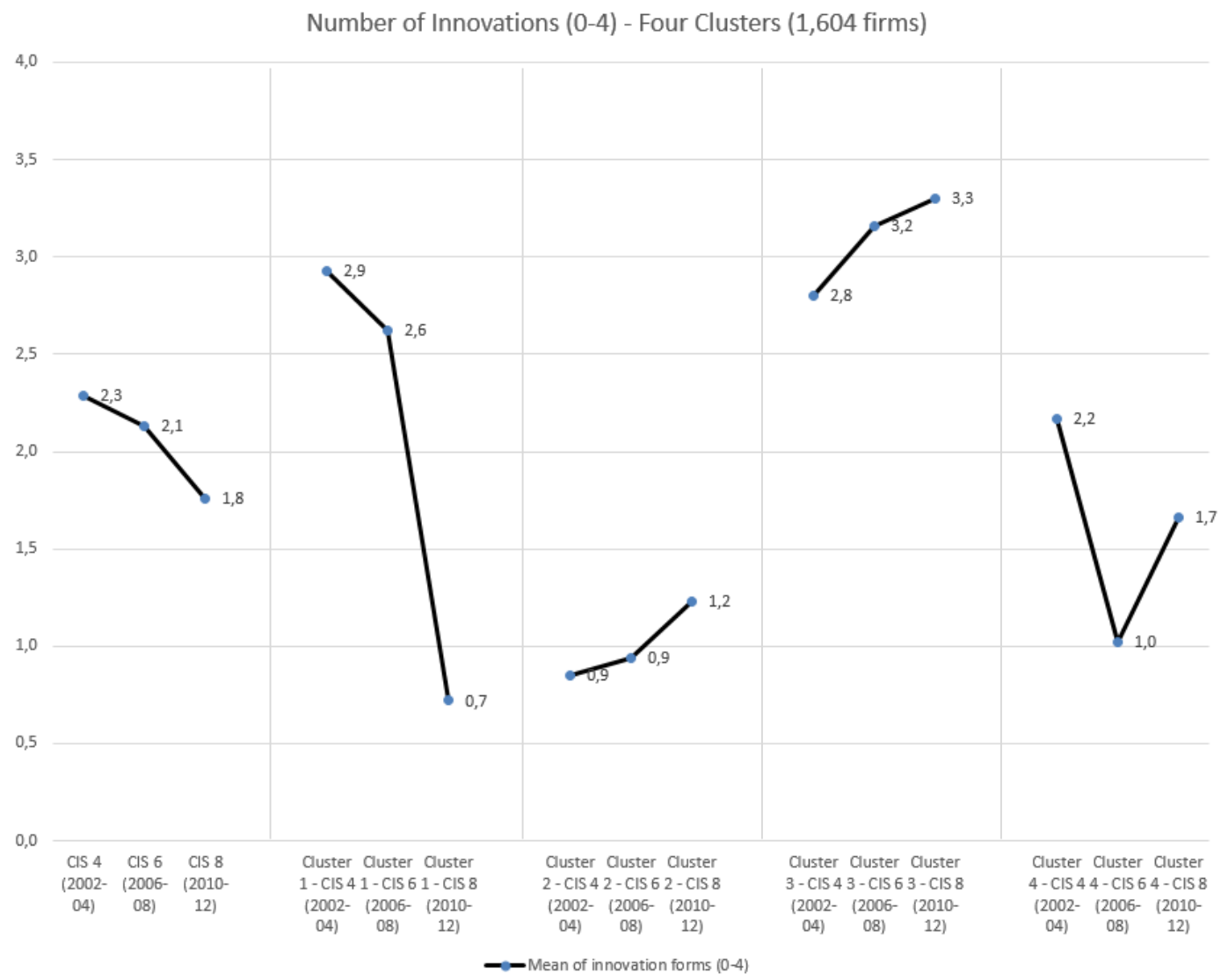
and associated dynamics of innovation strategies

5. Crossroads to Roma: Dynamics of Innovation Strategies

Table X3.1: Descriptive statistics of the four clusters of firms with technological innovating activities – Product, Process or Project – during at least one period (1,604 firms)

	All firms 1,604 firms			Cluster 1 496 firms (31.0%)			Cluster 2 370 firms (23.0%)			Cluster 3 475 firms (29.6%)			Cluster 4 263 firms (16.4%)		
	CIS 4 (2002-2004)	CIS 6 (2006-2008)	CIS 8 (2010-2012)	CIS 4 (2002-2004)	CIS 6 (2006-2008)	CIS 8 (2010-2012)	CIS 4 (2002-2004)	CIS 6 (2006-2008)	CIS 8 (2010-2012)	CIS 4 (2002-2004)	CIS 6 (2006-2008)	CIS 8 (2010-2012)	CIS 4 (2002-2004)	CIS 6 (2006-2008)	CIS 8 (2010-2012)
Product innovation	61.09	62.96	50.24	74.80	83.87	30.44	20.27	29.19	36.76	78.53	93.89	93.05	61.22	15.21	29.28
Process innovation	66.39	60.84	47.24	82.46	71.98	17.34	17.03	28.92	30.81	78.11	90.11	86.74	84.41	31.94	55.89
Organizational innovation	62.90	58.79	50.37	81.05	64.31	15.52	28.92	25.68	30.08	74.74	82.95	90.32	55.13	51.33	71.10
Marketing innovation	38.90	30.98	28.24	55.44	42.54	9.48	19.73	10.27	24.59	48.05	49.89	60.63	16.35	4.18	10.27
At least one form of innovation among four	88.15	84.41	72.38	98.99	96.98	49.40	57.77	59.46	59.46	96.21	100	100	96.20	67.68	84.03
Mean of innovation forms (0-4)	2.29	2.13	1.76	2.93	2.62	0.72	0.85	0.94	1.23	2.80	3.16	3.30	2.17	1.02	1.66
Sd. Dev	1.28	1.33	1.41	0.96	1.06	0.82	0.89	0.94	1.26	1.07	0.79	0.68	0.92	0.87	1.04
Min / Max	0 - 4	0 - 4	0 - 4	0 - 4	0- 4	0 - 3	0 - 3	0 - 4	0 - 4	0 - 4	1 - 4	2 - 4	0 - 4	0 - 3	0 – 4
Product innovation index (0 -100) [2 types: NwM & NwF]	43.35	46.32	37.50	54.73	60.58	20.16	13.37	19.05	24.86	60.31	72.42	75.26	39.54	10.64	19.77
Process innovation index (0 -100) [3 types]	40.44	36.88	27.22	50.80	42.94	7.59	7.65	14.32	15.49	51.29	58.87	55.50	47.40	17.49	29.65
Organizational innovation index (0 -100) [3 types]	36.76	40.04	33.81	48.79	44.89	9.13	15.31	14.50	20.27	45.47	60.07	65.40	29.51	30.67	42.33
Marketing innovation index (0 -100) [2 types]	27.15	18.42	18.14	39.11	25.80	5.94	13.24	5.44	13.91	34.42	29.68	40.73	10.02	2.28	6.27

5. Crossroads to Roma: Dynamics of Innovation Strategies



5. Crossroads to Roma: Dynamics of Innovation Strategies

Table X3.2: Descriptive statistics of the four clusters of firms with technological innovating activities – Product, Process or Project – during at least one period (1,604 firms)

•	All firms 1,604 firms			Cluster 1 496 firms (31.0%)			Cluster 2 370 firms (23.0%)			Cluster 3 475 firms (29.6%)			Cluster 4 263 firms (16.4%)		
	CIS 4 (2002-2004)	CIS 6 (2006-2008)	CIS 8 (2010-2012)	CIS 4 (2002-2004)	CIS 6 (2006-2008)	CIS 8 (2010-2012)	CIS 4 (2002-2004)	CIS 6 (2006-2008)	CIS 8 (2010-2012)	CIS 4 (2002-2004)	CIS 6 (2006-2008)	CIS 8 (2010-2012)	CIS 4 (2002-2004)	CIS 6 (2006-2008)	CIS 8 (2010-2012)
None forms of innovations None (W0000)	***11.85***	***15.59***	***27.62***	***1.01***	***3.02***	***50.60***	***42.43***	***40.54***	***40.54***	***3.79***	***0.00***	***0.00***	***3.80***	***32.32***	***15.97***
One form of innovation	***16.03***	***17.95***	***17.27***	***7.66***	***12.30***	***27.02***	***34.59***	***31.35***	***20.27***	***8.68***	***2.95***	***0.00***	***19.01***	***36.80***	***25.86***
Product innovation only (W1000)	3.99	6.98	5.55	1.41	6.85	11.29	10.08	13.78	7.57	1.68	1.89	0.00	3.04	6.84	1.90
Process innovation only (W0100)	4.93	4.24	3.49	2.22	3.23	4.64	6.22	8.38	5.14	2.95	0.21	0.00	11.79	7.60	5.32
Organizational innovation only (W0010)	5.05	5.67	6.92	2.42	1.21	8.37	12.43	7.03	5.95	2.74	0.63	0.00	3.80	21.29	18.63
Marketing innovation only (W0001)	2.06	1.06	1.31	1.61	1.01	3.02	4.86	2.16	1.62	1.26	0.21	0.00	0.38	1.14	0.00
Two forms of innovations	***23.18***	***22.52***	***21.01***	***21.17***	***27.22***	***21.32***	***17.57***	***21.89***	***20.00***	***21.05***	***15.79***	***12.63***	***38.78***	***26.62***	***36.88***
Product and process innovation (W1100)	6.98	7.86	6.30	6.05	11.69	11.09	0.54	5.68	6.49	6.95	9.47	1.89	17.87	0.76	4.94
Product and organizational innovation (W1010)	4.05	3.80	4.80	3.23	5.85	4.64	2.70	3.51	3.51	6.32	1.89	6.11	3.42	3.80	4.56
Product and marketing innovation (W1001)	1.93	1.81	1.68	1.41	3.63	2.42	3.24	1.62	3.24	1.89	1.05	0.63	1.14	0.00	0.00
Process and organizational innovation (W0110)	6.86	6.80	5.36	6.45	3.02	0.20	4.86	8.38	2.97	4.00	2.32	2.32	15.59	19.77	23.95
Process and marketing innovation (W0101)	1.18	0.50	0.69	1.01	0.81	0.81	2.43	1.08	1.03	0.63	0.00	0.42	0.76	0.00	0.38
Organizational and marketing innovation (W0011)	2.18	1.75	2.18	3.02	2.22	2.22	3.36	1.62	2.70	1.26	1.05	1.26	0.00	2.28	3.04
Three forms of innovations	***28.86***	***25.18***	***19.51***	***36.90***	***33.87***	***1.01***	***5.41***	***5.95***	***13.78***	***36.42***	***42.74***	***44.00***	***33.08***	***4.18***	***18.25***
Product, process and organizational innovation (W1110)	17.39	18.08	11.72	21.77	22.58	0.00	0.00	2.43	3.24	22.53	33.68	29.05	24.33	3.42	14.45
Product, process and marketing innovation (W1101)	4.18	3.18	2.99	4.23	5.44	0.59	0.27	1.08	3.24	6.11	4.21	6.74	6.08	0.00	0.38
Product, organizational and marketing innovation (W1011)	2.49	2.49	2.62	3.43	4.23	0.40	2.43	0.81	4.05	2.95	3.16	5.26	0.00	0.38	0.00
Process, organizational and marketing innovation (W0111)	4.80	1.43	2.18	7.46	1.61	0.00	2.70	1.62	3.24	4.84	1.68	2.95	2.66	0.38	3.42
Four forms of innovations All forms of innovations (W1111)	***20.07***	***18.77***	***14.59***	***33.27***	***23.59***	***0.00***	***0.00***	***0.27***	***5.41***	***30.11***	***38.53***	***43.37***	***5.32***	***0.00***	***3.04***

5. Crossroads to Roma: Dynamics of Innovation Strategies

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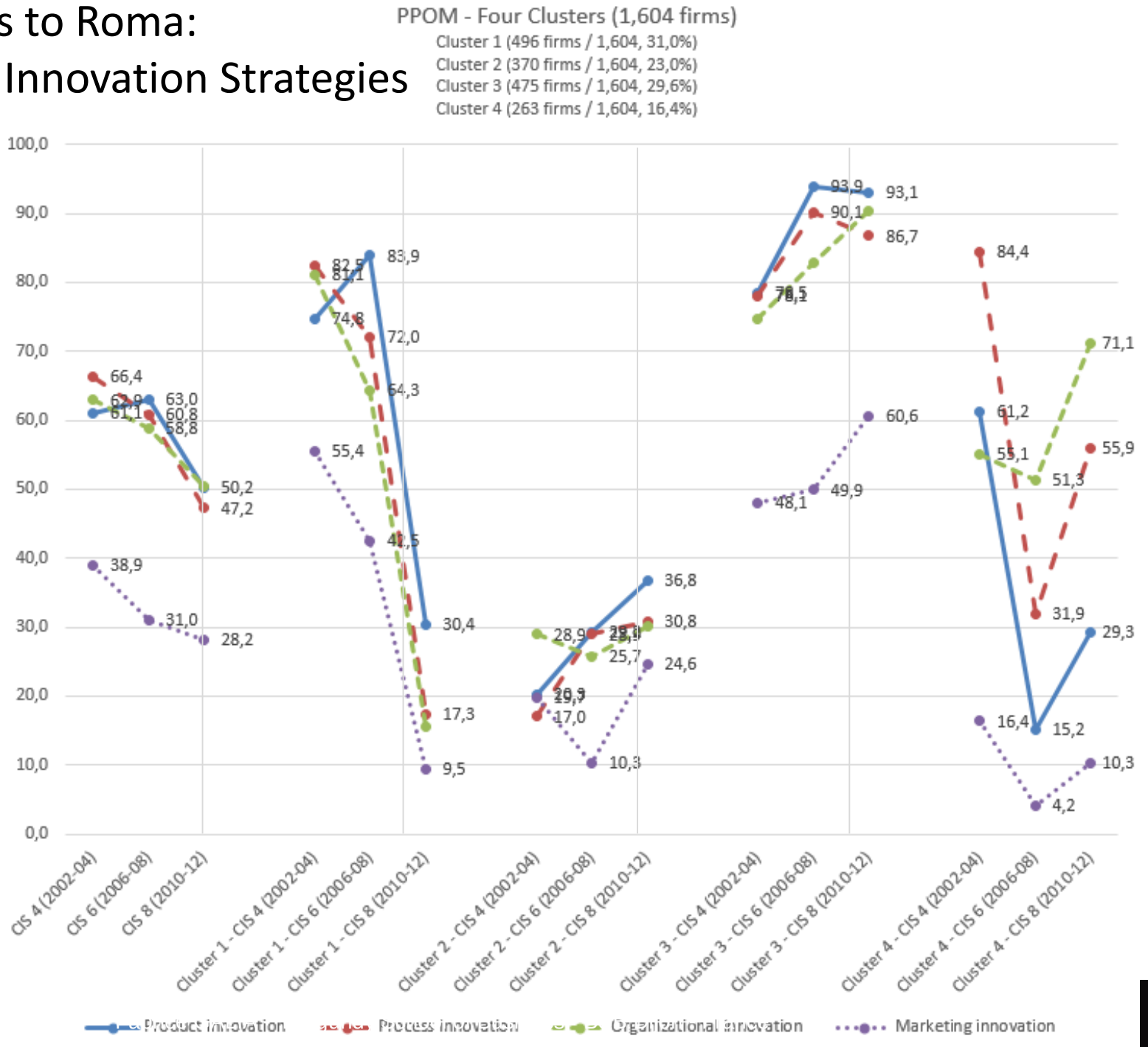
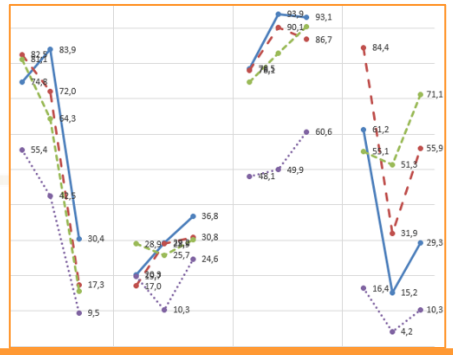
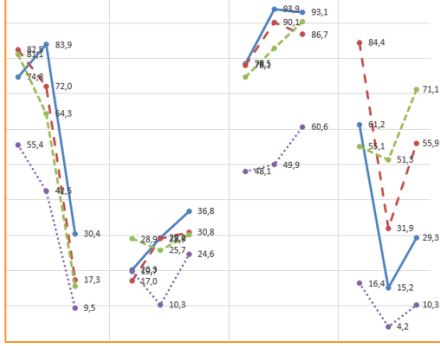
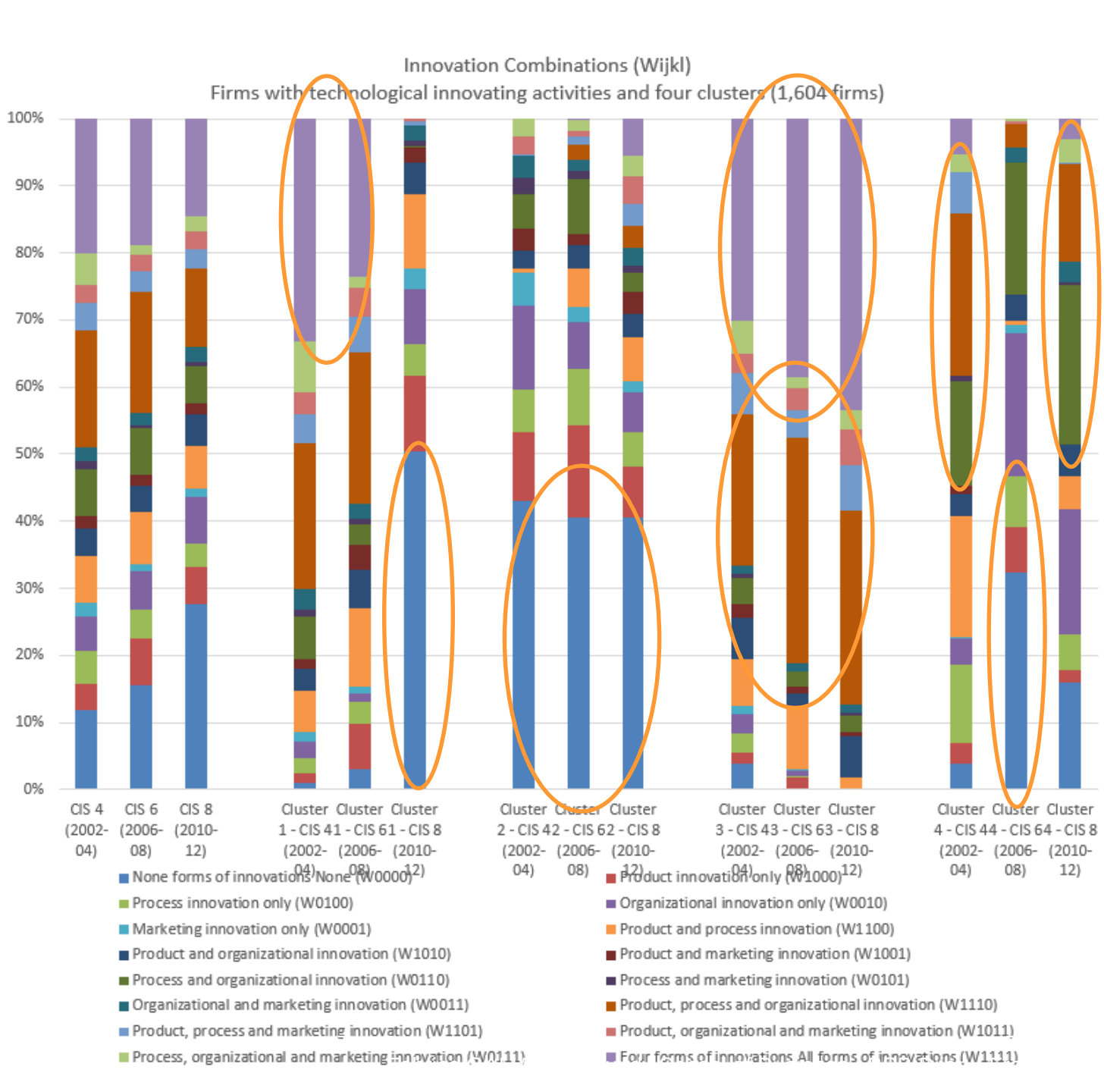


5. Crossroads to Roma: Dynamics of Innovation Strategies



Cluster 1 496 firms (31.0%)	Cluster 2 370 firms (23.0%)	Cluster 3 475 firms (29.6%)	Cluster 4 263 firms (16.4%)
From PPOM, Prod&Proc&Org, Proc&Org => To NONE, Prod only, Prod&Proc	From NONE, Prod only, Org only => To NONE, Prod only, Prod&Proc, 3 forms of innovation	From PPOM, Prod&Proc, Prod&Proc&Org, => To PPOM, Prod&Proc&Org, Prod&Proc&Mkg, 2, 3 or 4 forms of innovation	From Prod&Proc, Proc&Org, Prod&Proc&Org, => To NONE, Org only, Proc&Org, Prod&Proc&Mkg, = Diversity of innovation to Org. innovation
Decreasing dynamics of innovations	**Slightly, moderately increasing dynamics of innovation - Increasing complexity -**	**Intensifying dynamics of innovations - Constantly innovating -**	**Irregular, instable dynamics of innovations - Decelerating dynamics of innovation -**




Innovation Combinations (Wijkl)
Firms with technological innovating activities and four clusters (1,604 firms)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CIS 4 (2002-04)
CIS 6 (2006-08)
CIS 8 (2010-12)
Cluster 1 - CIS 4 (2002-04)
Cluster 1 - CIS 6 (2006-08)
Cluster 1 - CIS 8 (2010-12)
Cluster 2 - CIS 4 (2002-04)
Cluster 2 - CIS 6 (2006-08)
Cluster 2 - CIS 8 (2010-12)
Cluster 3 - CIS 4 (2002-04)
Cluster 3 - CIS 6 (2006-08)
Cluster 3 - CIS 8 (2010-12)
Cluster 4 - CIS 4 (2002-04)
Cluster 4 - CIS 6 (2006-08)
Cluster 4 - CIS 8 (2010-12)
None forms of innovations None (W0000)
Product innovation only (W1000)
Process innovation only (W0100)
Organizational innovation only (W0010)
Marketing innovation only (W0001)
Product and process innovation (W1100)
Product and organizational innovation (W1010)
Product and marketing innovation (W1001)
Process and organizational innovation (W0110)
Process and marketing innovation (W0101)
Organizational and marketing innovation (W0011)
Product, process and organizational innovation (W1110)
Product, process and marketing innovation (W1101)
Product, organizational and marketing innovation (W1011)
Process, organizational and marketing innovation (W0111)
Four forms of innovations All forms of innovations (W1111)

5. Crossroads to Roma: Dynamics of Innovation Strategies

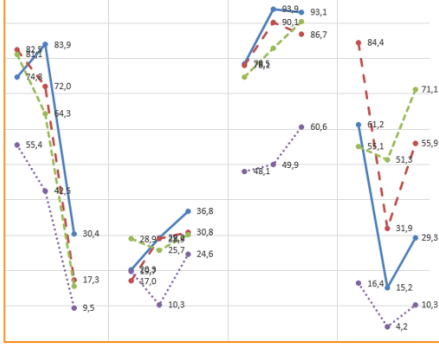


Table R.3: Results of the multivariate logit model explaining the four different clusters (Cluster 2 as reference: Slightly - moderately increasing dynamics of innovation)

	Cluster 1 Decreasing dynamics of innovations		Cluster 3 Intensifying dynamics of innovations - Constantly innovating -		Cluster 4 Irregular – Instable dynamics of innovations - Decelerating dynamics -	
	Coef.	Std. Dev.	Coef.	Std. Dev.	Coef.	Std. Dev.
Employment variation	4,726	5,775	5,588	5,655	3,898	6,430
Sales variation	-0,261	4,208	-2,993	4,115	-0,522	4,679
BREADTH 04	0,196	0,363	0,250	0,349	0,184	0,378
BREADTH 04 ^2	-0,023	0,028	-0,020	0,027	-0,021	0,030
BREADTH08	-0,163	0,364	-0,156	0,353	-0,290	0,381
BREADTH 08 ^2	0,019	0,029	0,022	0,028	0,018	0,031
DEPTH 04	0,831 **	0,330	0,683 **	0,311	0,513	0,375
DEPTH 04 ^2	-0,105 **	0,049	-0,098 **	0,046	-0,067	0,059
DEPTH 08	0,440	0,381	0,438	0,366	0,446	0,440
DEPTH 08 ^2	-0,038	0,073	-0,022	0,071	-0,031	0,084
Cooperation 04	0,537	0,444	0,392	0,424	0,174	0,487
Cooperation 08	-0,358	0,456	-0,332	0,441	-1,095 **	0,492
Cooperation 12	-0,303	0,423	0,546	0,410	-0,084	0,467
RD sum	0,000	0,000	0,000	0,000	0,000	0,000
Market pull	0,344	0,286	0,360	0,274	0,145	0,299
Technol. Push	0,487 **	0,238	0,319	0,228	0,409	0,257
Formal IPR 04	0,362 *	0,216	0,190	0,209	-0,291	0,242
Informal IPR 04	-0,454 **	0,191	-0,405 **	0,184	-0,428 **	0,212
Group	0,331	0,608	0,144	0,584	0,912	0,694
European market	2,044 **	0,878	1,607 *	0,838	1,596 *	0,904
International market	-0,846	0,762	-0,883	0,742	-1,510 *	0,799
Constant	13,403	5698,457	14,767	5698,457	17,005	5698,457

Sources: CIS 4 (2002-2004), CIS 6 (2006-2008), CIS 8 (2010-2012) and FARE (2008-2013), France
Industry dummies are not reported.
Significance levels at *** 1%, ** 5% and * 10%.

[Step 3]: Multivariate logit model explaining the different clusters

- Explore the determinants that leads firms to be part of the different path of innovation

Compared to Cluster 2:

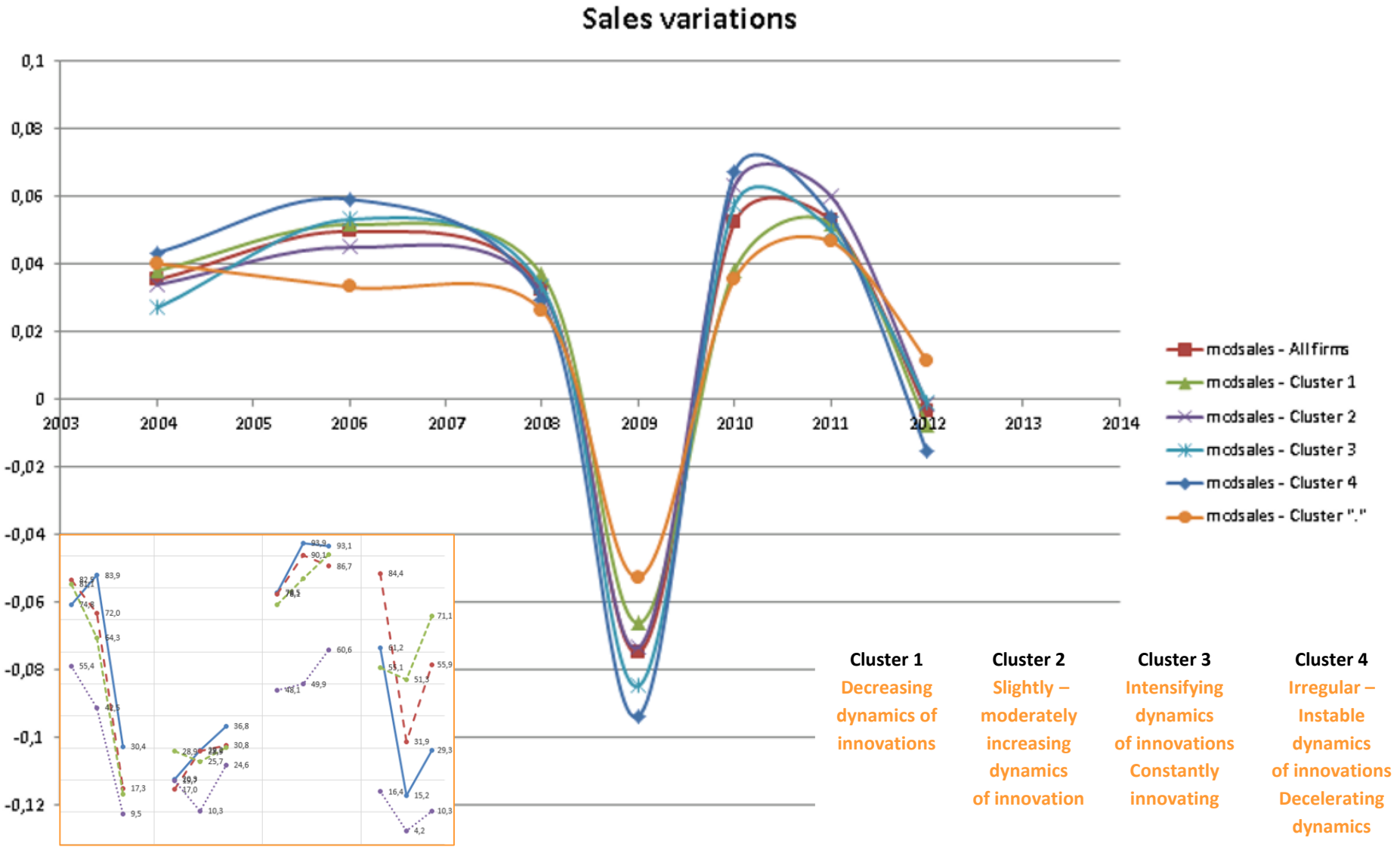
- Depth (+), Depth^2 (-), Informal IPR (-) for Cluster 1 and 2
- Tech. push (+), Formal IPR (+) only for Cluster 1
- Cooperation 08 (-) only for Cluster 4
- European market (+) for all Clusters

5. Crossroads to Roma: Dynamics of Innovation Strategies

Impact of the paths of innovation on diverse performance indicators (level and variation):

- Sales
- Employment
- Value added
- Capital

5. Crossroads to Roma: Dynamics of Innovation Strategies



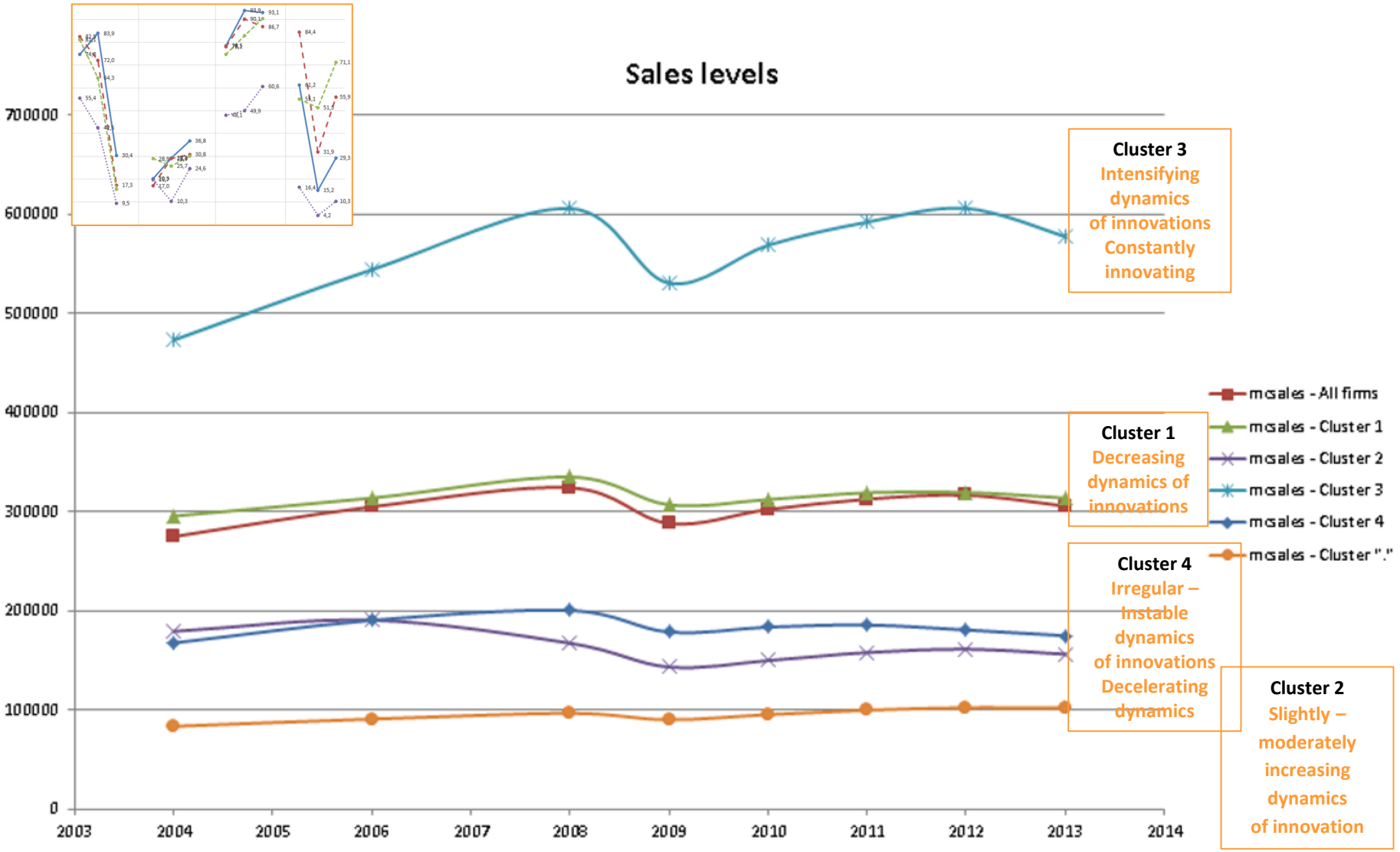
Cluster 1
Decreasing dynamics of innovations

Cluster 2
Slightly – moderately increasing dynamics of innovation

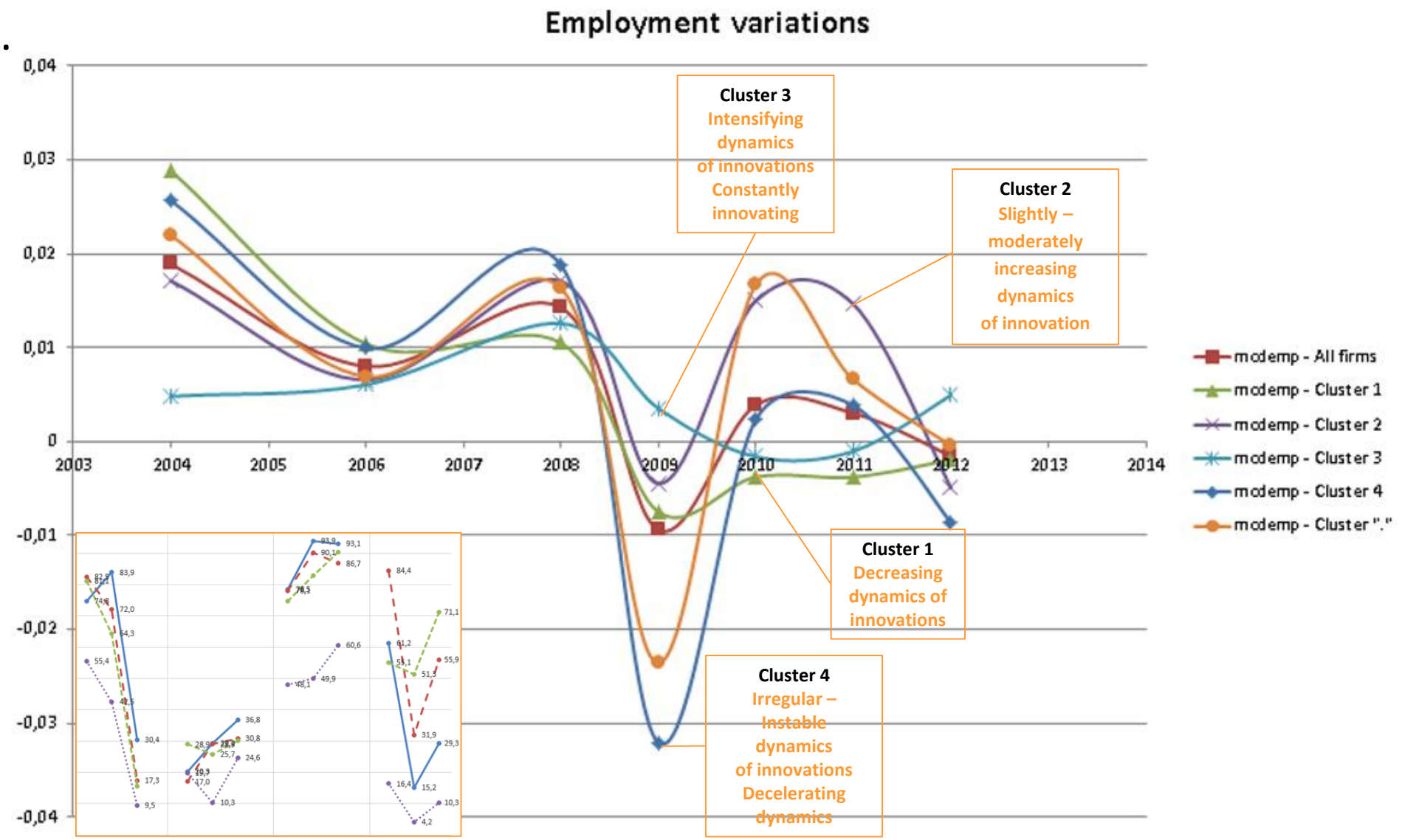
Cluster 3
Intensifying dynamics of innovations Constantly innovating

Cluster 4
Irregular – Instable dynamics of innovations Decelerating dynamics

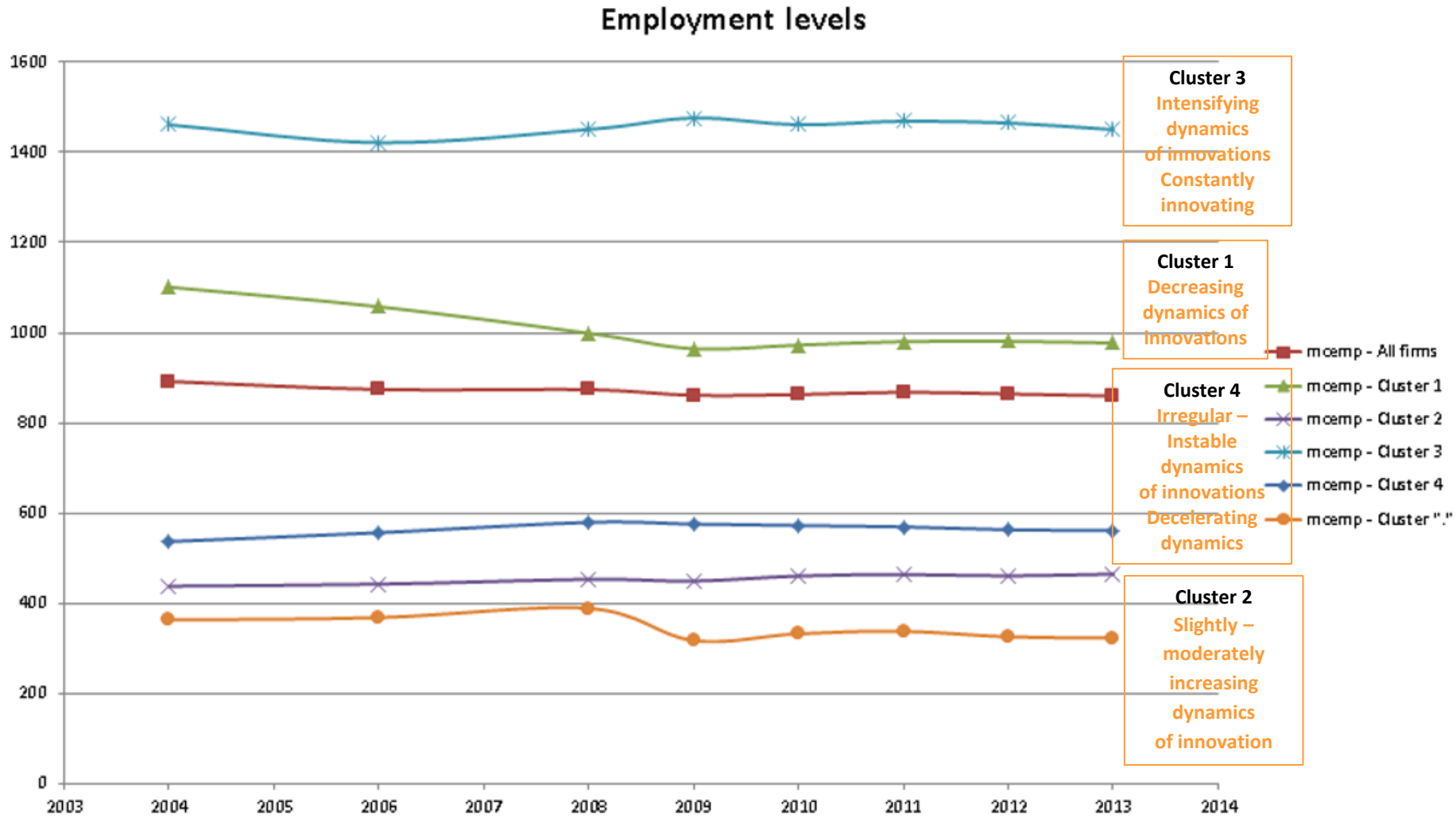
5. Crossroads to Roma: Dynamics of Innovation Strategies



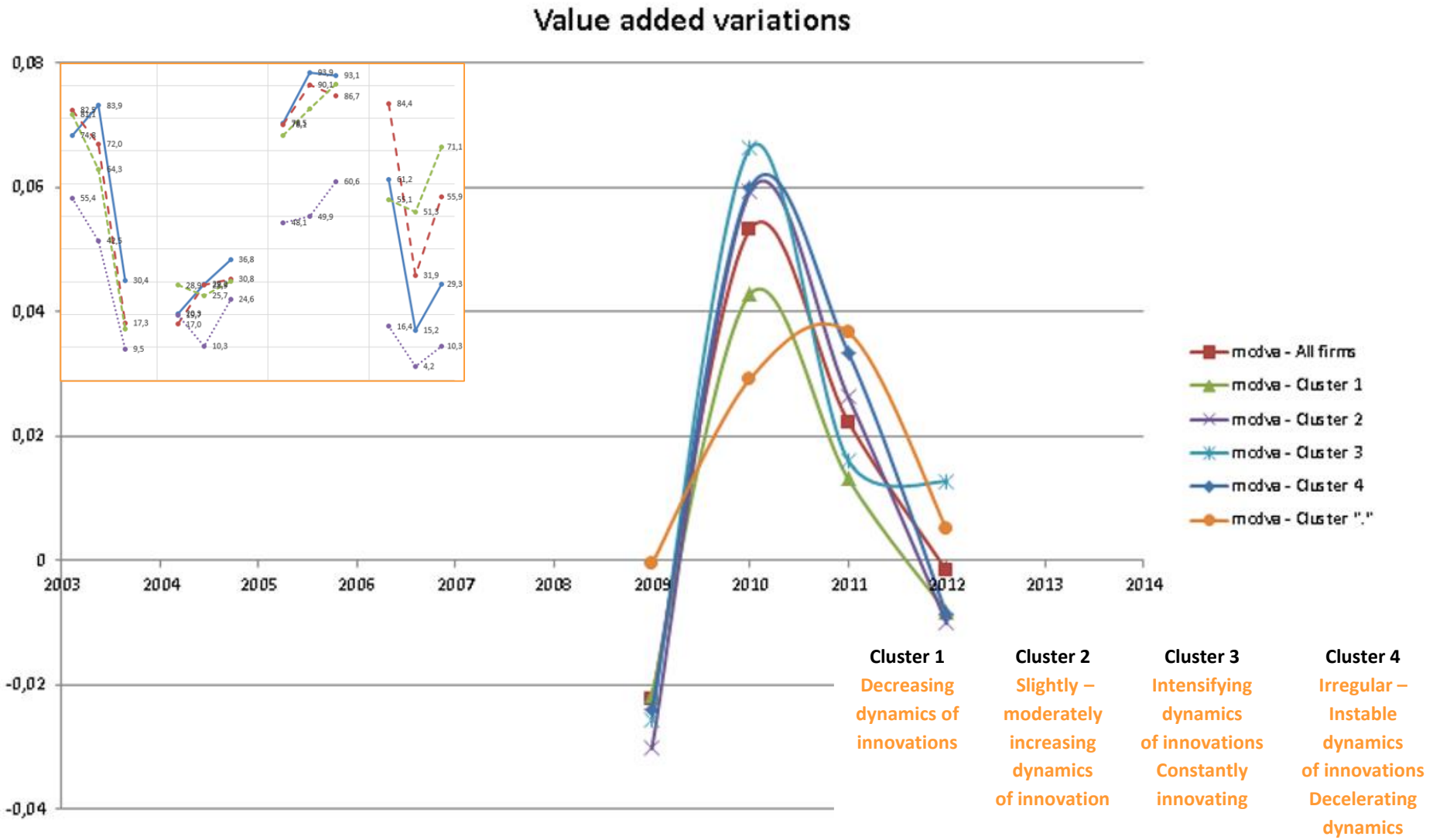
5. Crossroads to Roma: Dynamics of Innovation Strategies



5. Crossroads to Roma: Dynamics of Innovation Strategies



5. Crossroads to Roma: Dynamics of Innovation Strategies



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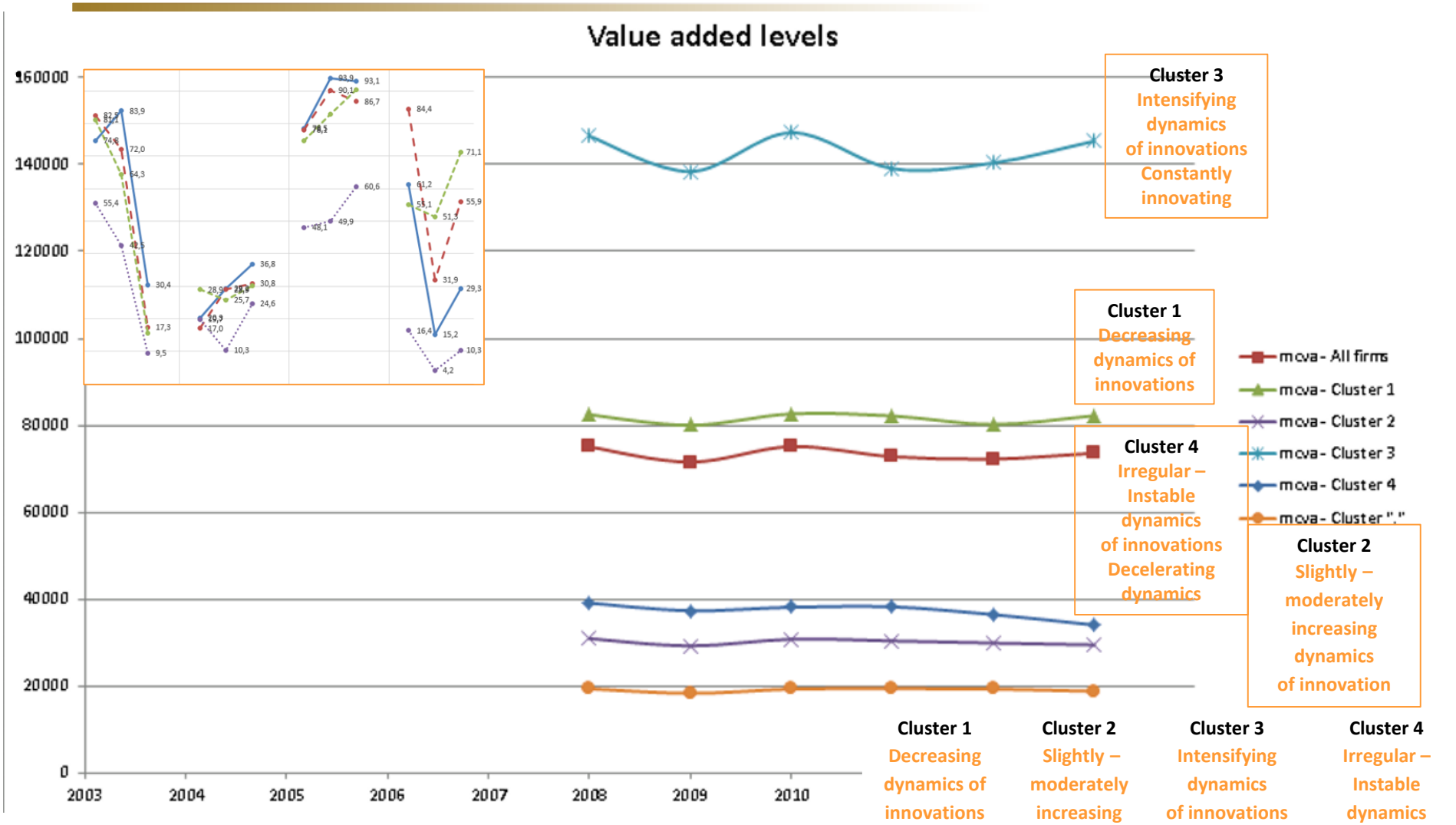
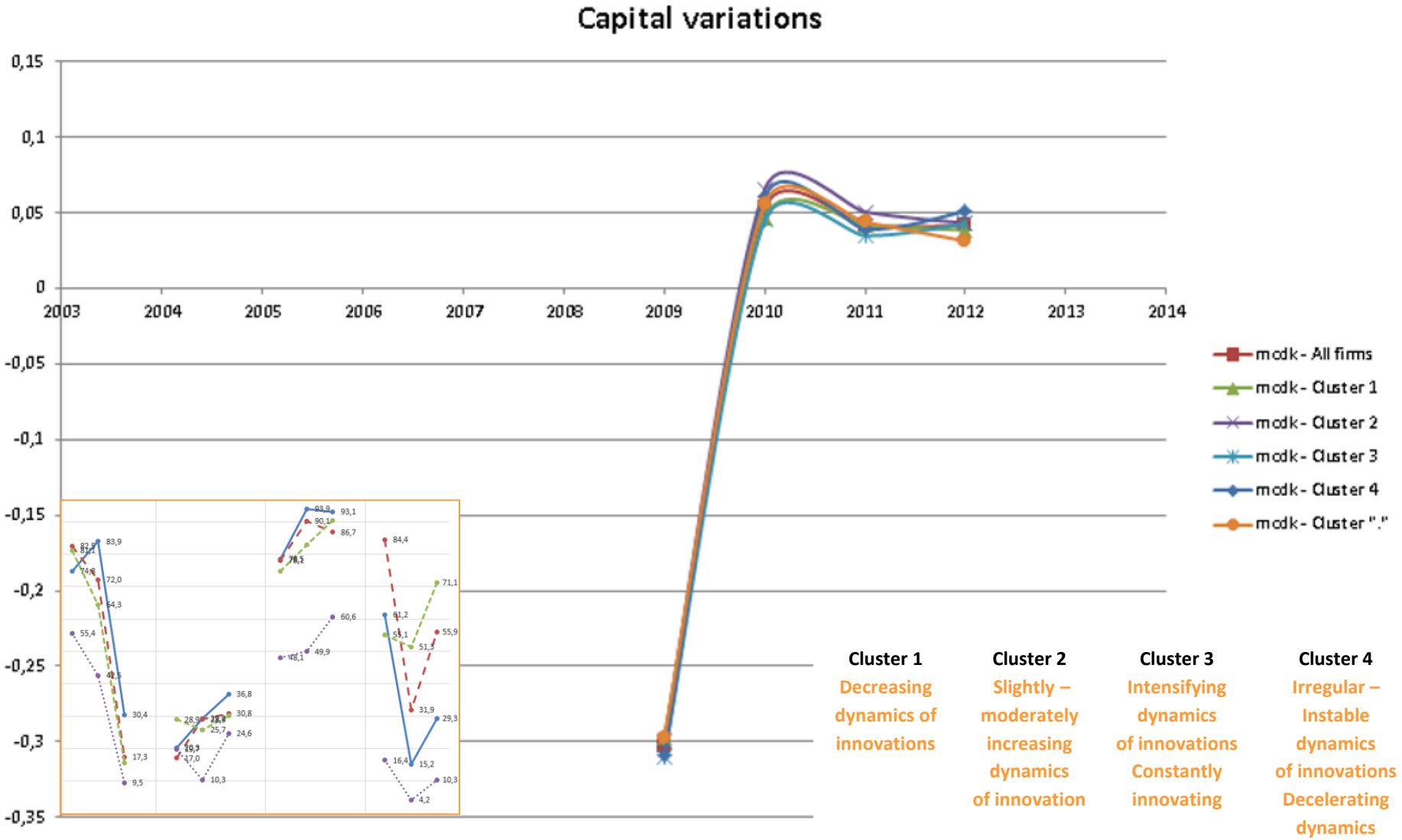
5. Crossroads to Roma: Dynamics of Innovation Strategies



5. Crossroads to Roma: Dynamics of Innovation Strategies



Cluster 1
Decreasing dynamics of innovations

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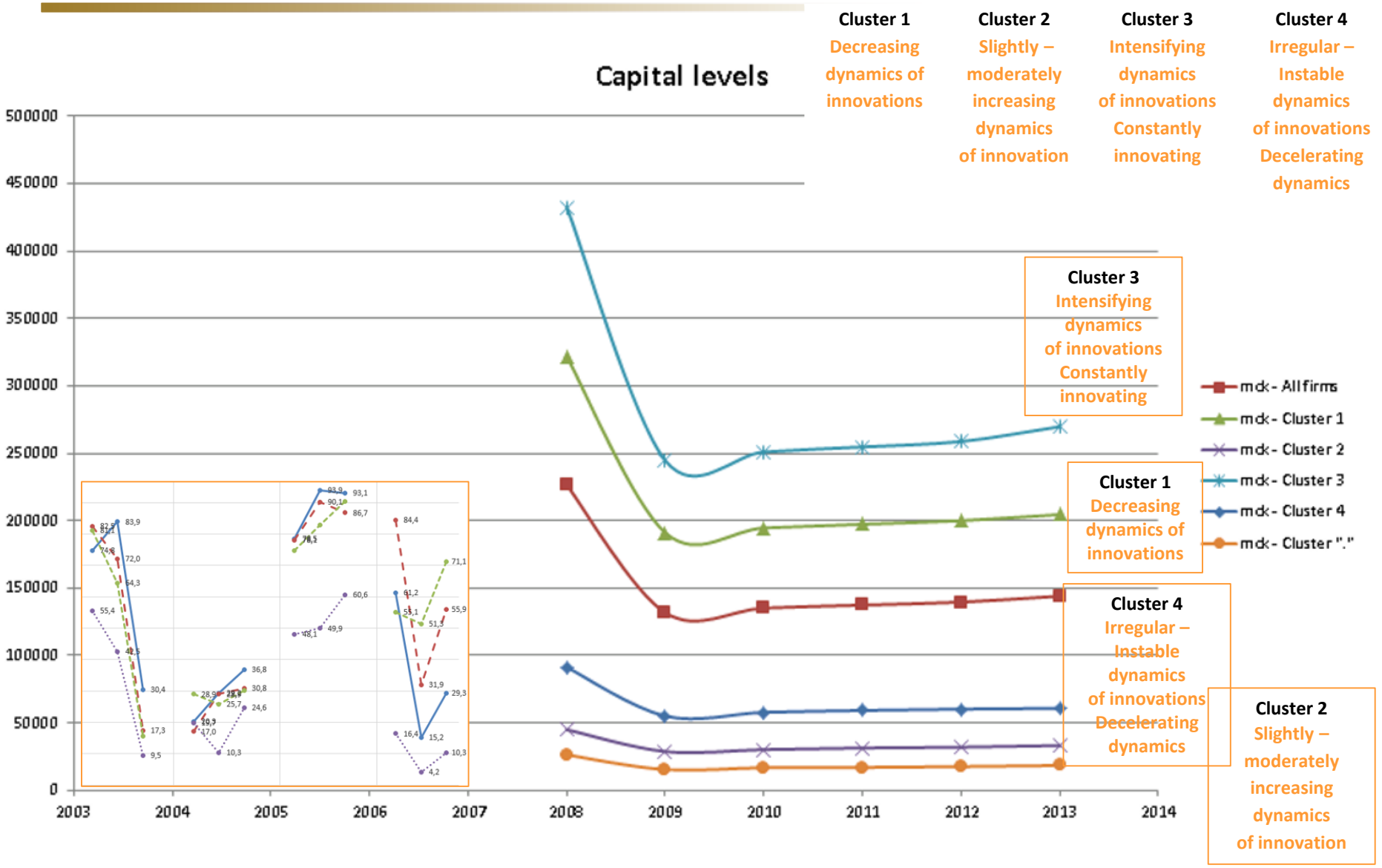
5. Crossroads to Roma: Dynamics of Innovation Strategies



5. Crossroads to Roma: Dynamics of Innovation Strategies

[Step 4]: Linear regressions estimating the performance (level and variation of sales and employment)

Estimate the impact of the paths of innovation on performance

- Initial conditions (2002)
- **Clusters 1, 3, 4 on Sales**
- **Cluster 3 on Employment**
- Depth 04 (-)
- Depth 04 ^2 (+) on Employment
- Buy 04 (-) on Employment
- Buy 12 (-)
- Cooperation 04 (+) on Sales
- Cooperation 12 (+)
- R&D (0!)
- Formal IPR (+)
- International market (+) on Sales

Table R.4: Results of linear regressions explaining the firms' performance (Log of sales and Log of employment)

	Sales		Employment	
	Coef.	Std. Dev.	Coef.	Std. Dev.
Employment initial level 02	-0,160 ***	0,055	0,571 ***	0,042
Sales initial level 02	0,940 ***	0,044	0,189 ***	0,033
Cluster 1	0,343 **	0,146	0,157	0,110
Cluster 2	Ref.	-	Ref.	-
Cluster 3	0,312 **	0,138	0,178 *	0,104
Cluster 4	0,346 **	0,167	0,106	0,126
BREADTH 04	-0,059	0,071	-0,036	0,054
BREADTH 04 ^2	0,004	0,005	0,003	0,004
BREADTH08	0,035	0,067	0,002	0,051
BREADTH 08 ^2	0,000	0,005	0,001	0,004
DEPTH 04	-0,107 *	0,055	-0,092 **	0,041
DEPTH 04 ^2	0,010	0,008	0,013 **	0,006
DEPTH 08	0,052	0,046	0,039	0,034
DEPTH 08 ^2	-0,006	0,006	-0,003	0,004
MAKE 04	-0,027	0,128	-0,019	0,096
MAKE 08	-0,186	0,116	-0,056	0,088
MAKE 12	-0,043	0,128	-0,043	0,096
BUY 04	0,063	0,069	0,136 ***	0,052
BUY 08	-0,012	0,078	-0,011	0,059
BUY 12	-0,144 **	0,065	-0,084 *	0,049
Cooperation 04	0,175 **	0,072	0,024	0,054
Cooperation 08	-0,003	0,075	0,007	0,056
Cooperation 12	0,169 **	0,070	0,088 *	0,053
RD sum	0,000 ***	0,000	0,000 ***	0,000
Formal IPR 04	0,077 **	0,034	0,091 ***	0,026
Informal IPR 04	0,025	0,028	-0,006	0,021
Group	-0,101	0,098	-0,060	0,074
European market	-0,154	0,121	-0,011	0,091
International market	0,284 ***	0,097	0,064	0,073
Constant	1,596 **	0,651	-0,046	0,490

Sources: CIS 4 (2002-2004), CIS 6 (2006-2008), CIS 8 (2010-2012) and FARE (2008-2013), France
Industry dummies are not reported.
Significance levels at *** 1%, ** 5% and * 10%.

5. Crossroads to Roma: Dynamics of Innovation Strategies

[Step 4]: Linear regressions estimating the performance (level and variation of sales and employment)

- ➢ Estimate the impact of the paths of innovation on performance

- ✓ Importance of initial conditions

Enhancing better performance:

- ➢ **Sales** with all path of innovation (Clusters 1, 3, 4)
  Cooperation 04, Cooperation 12, R&D, Formal IPR, International market,
  Negative influence of Depth 04 and Buy 12

- ➢ **Employment** with path of 'Gold Medal' innovative firms (Cluster 3)
  Buy 04, Cooperation 12, R&D, Formal IPR, International market,
  Negative influence of Depth 04 and Buy 12

Conclusion

Which road of innovation would you take for performance?

- Different roads, **dynamics of innovations** and **path of innovation**
- Influenced by depth of **information sources**, **Tech. push**, **Formal IPR** and **European market**

Differentiate the **impact of the paths of innovation on performance:**

- Importance of **initial conditions**
- **Increasing dynamics of innovation strategies**: 'Gold medal' firms stay the best performing firms
- Positive influence of Cooperation, Continuous R&D, Formal IPR, International market

5. Crossroads to Roma: Dynamics of Innovation Strategies

Contributions to the existing literature:

- Explore in **details** the **dynamics** of innovation strategies and associated firms' **path** of innovation with four forms of innovation: **product, process, organization and marketing**
- Explore the **determinants** of the different path of innovation
- Estimate the **impact** of the paths of innovation **on diverse performance indicators**
- An original dataset constituted by **three waves of French CIS** over a ten-year period between 2002 and 2012 (CIS 4, CIS 6 and CIS 8) to **avoid** overlapping effect and **FARE database** over six-year period between 2008-2013

Agenda:

- More fine grained simultaneous models to check stability and variables choices
- Estimate impact of path of innovation to all **measures of performance**

Gracias por su atención

Thanks for your attention

Muy bien venidos a Dijon!

Your are more than welcome to come to Dijon!

Preguntas? Comentarios?

Questions? Comments?

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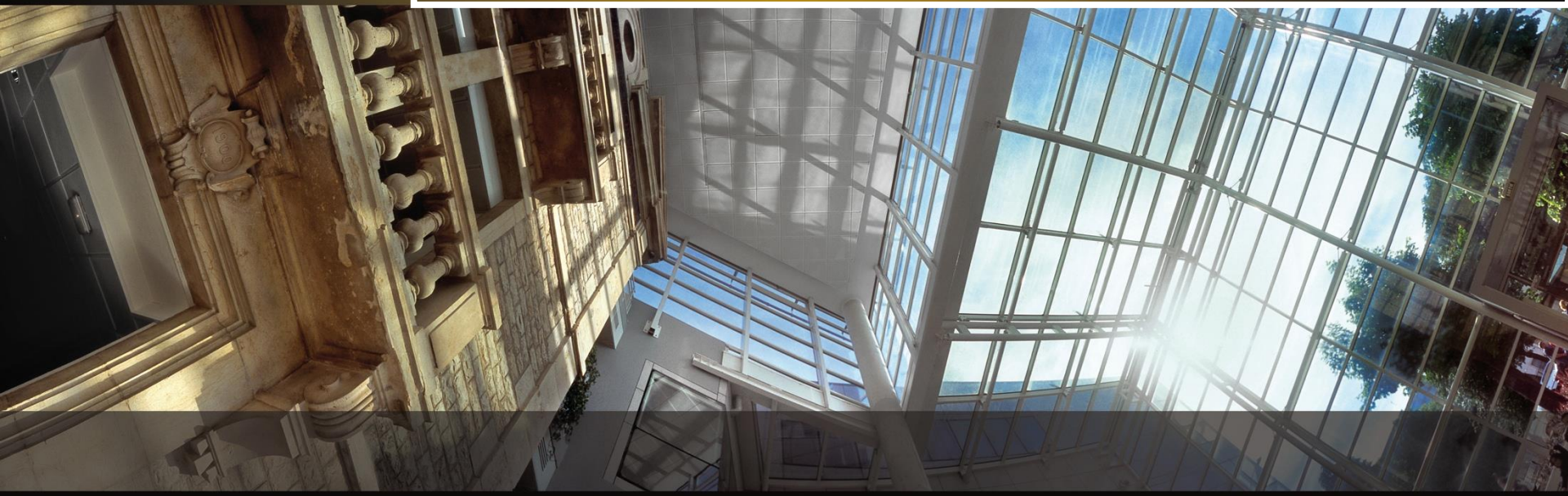
The Process of Innovation: Obstacles, Complementarities and Dynamics



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Chair Corporate Governance

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Universidad Diego Portales - Santiago - Chile - May 24th, 2017