Establishing new Technological Systems of Innovation:
The role of R&D intermediaries

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INTRODUCTION
R&D represent a major increasing activity

- In 2002, global R&D expenditures represented at least $us 813 billion (National Science Foundation, 2008) and in 2006 it reached a $us 1 trillion mark (Howells, 2008)

- Government’s share on R&D declined and industry’s share increased during the 1980s and 1990s period

- Industrial R&D is becoming global and performed collaboratively, requiring partners, resources and ideas outside the company (Chesbrough et al., 2006; Huston and Sakkab, 2006; Teece, 1986)
Prospective trends in R&D

- The supply and availability of R&D talent worldwide
  - Competence building and innovation (Lam and Lundvall, 2006)

- The changing nature of R&D itself (its spread and interwave with other activities)
  - New activities interlinked with R&D (Dodgson et al., 2005)

- The blurring between producers and consumers of R&D
  - Activities related to research and innovation are ‘co-produced’ and co-consumed’ (von Hippel, 2005)

- The new forms of R&D organizations
  - Industry-University collaborative knowledge networks, building strategic university partnerships, network model of R&D, hybrid organizations as overlapping knowledge networks (Lam, 2004)

- The emergence of new R&D actors
  - Hybrid R&D organizations represent a much wider and more varied type of R&D facility
    - Involve new combinations of Public-Private Partnerships
New forms of R&D org. & Actors

- New types intermediary organizations, *usually hybrid combinations of public-private partnerships*, enable other organizations *to accelerate* their innovation outputs as well as providing the necessary *technological and scientific instruments to develop and test emerging technologies* (Winch and Courtney, 2007)

- R&D intermediaries, however may not only be relevant in terms of improving connectedness, create new possibilities and dynamism within innovation system (Howells, 2006)
  - Early studies on innovation systems introduced the role of intermediaries as linking players within a formative technological system
  - *Transforming relations* among agents as well as connecting upstream and downstream activities (Stankiewicz, 1995)
Innovation Systems

• Research on innovation systems studies the relations of public and private organizations affecting the creation, diffusion and use of new technologies
  – At the continental, national, regional, sectoral and technological level (Freeman, 1987; Lundvall, 1992; Cooke et al., 2004; Malerba, 2004; Carlsson, 1995)

• Technological systems of innovation are defined as:
  – “a network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure or set of new infrastructures and involved in the generation, diffusion, and utilization of technology (Carlsson and Stankiewicz, 1991)”
High-Level Research Question

- This research aims to contribute to empirical investigations of Technological Systems of Innovation by studying the role of **R&D intermediaries** during the formation phase of technological systems of innovation.

*How does the establishment of regional R&D intermediaries facilitate the formation of new technological systems of innovation?*
LITERATURE REVIEW

Intermediary Organizations
Technological Systems
Recent definitions on intermediary organizations

• Def. Innovation intermediaries
  – “an organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties (Howells, 2006; Chesbrough, 2006)”

• Def. Innovation brokers
  – “an organization acting as a member of a network of actors in an industrial sector that is focused neither on the generation nor the implementation of innovations, but on enabling other organizations to innovate (Winch and Courtney, 2008)”

• Def. R&D intermediaries
  – a hybrid organization, focused on a specific sector, dedicated to accelerate the innovation outputs of different innovation agents as well as providing the necessary technological and scientific instruments to develop and test emerging technologies, during the formation and establishment of technological systems
Types and Levels of Intermediary Organizations

**Firm Level**
- Private Funding
  - Innovation intermediaries
- Private - Public Funding
  - Innovation brokers
- Public Funding
  - University research centers: Entrepreneurial Universities

**Technological System Level**
- Networked Incubators: IdeaLab
- R&D intermediaries
- Science parks, business incubators: Cambridge science park

**National or Continental Level**
- Large Independent technology and research organizations: The association of independent research and technology organizations (airto)
- Hybrid research organizations: Institute for one world health
- Public National or continental Institutions: European Institute of Innovation and Technology (EIT)
Functions of intermediary organizations

- **Knowledge processing, combination and recombination** Turpin et al. (1996); Wright et al. (2008); Shohert and Prevezer (1996); Hargadon and Sutton (1997); Hargadon (2002, 1998); Toutie and Shapira (2008)
- **Foresight and diagnosis** Van der Meulen and Rip (1998); Seaton and Cordey-Hayes (1993)
- **Scanning and information processing** Bessant and Rush (1995)
- **Commercialization: Exploiting the Outcomes** (Howells, 2006)
- **Intermediating science policy and public institutions** Hansen et al. (2000); Chesbrough (2006); Kodama (2008); Callon (1994)
- **Managing intellectual property (IP)** (Howells, 2006)
- **Testing and validation** (Dodgson et al. 2005, 2006)
- **Accreditation of standards** (Howells, 2006)
- **Evaluating the outcomes** Winch and Courtney (2007)
Intermediary Org. & Innovation Systems  

(Carlsson and Jacobsson, 1995)

• The role of intermediaries is to provide compensating mechanisms for weaknesses within different parts of technological systems

• Intermediaries act as:
  – bridging institutions to monitor the development of emerging technologies
  – establish a communication system in different technological systems
  – become centers of excellence for the integration of various technologies

• These results, however, are achieved only through governmental policy that aims to create a functioning technological systems
Functions perspective for studying systems of innovation

- This approach is suitable for describing as well as influencing the creation, diffusion and exploitation of technologies within systems

- The fundamental reasons are:
  - It allows researchers to conduct comparisons between innovation systems with different institutional set-ups
  - It enables a more systematic method of mapping the determinants of innovation cycles and feedback loops
  - It allows to deliver a clear set of policy targets as well as methods to meet this targets (Hekkert et al., 2007)
  - It allows to determine the boundaries of the system by analyzing what promotes or hinder the development of these functions
  - It describes the way through a specific set-up shapes the generation, diffusion and utilization of new technology (Jacobsson and Bergek, 2004)
  - It allows to explore all types of system elements, i.e. actors, networks and institutions
## Functions and indicators of Systems of Innovation

<table>
<thead>
<tr>
<th>Functions</th>
<th>Indicators</th>
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<tbody>
<tr>
<td>Knowledge Development and Diffusion</td>
<td>R&amp;D projects; patents; and investments in R&amp;D</td>
</tr>
<tr>
<td>Entrepreneurial Experimentation</td>
<td>No. of new entrants, no. of different types of applications, the breath of technologies used and the character of technologies employed</td>
</tr>
<tr>
<td>Influence on the direction of search</td>
<td>governmental policies that setting the targets to use a specific technology, beliefs of potential research coming from new articles and future development of technologies, articulation and perception coming from the demand side</td>
</tr>
<tr>
<td>Market formation</td>
<td>No. of new niche markets; no. of customer groups; no. of firms and R&amp;D centers collaborating with universities</td>
</tr>
<tr>
<td>Development of positive external economies</td>
<td>No. and type of organizations supporting the new TSI; political influence for developing the market; no. of complementary org.</td>
</tr>
<tr>
<td>Legitimation</td>
<td>Rise and Growth of interest groups and their lobby actions; visions and expectations; alignment with current legislation</td>
</tr>
<tr>
<td>Resource mobilization</td>
<td>Volume capital and VC, volume and quality of human resources, complementary assets</td>
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SPECIFIC RESEARCH QUESTIONS
Specific Research Question (1)

• This research aims to explain the process R&D intermediaries facilitate during the formation phase of TSI
  – The first specific research questions for this research is:

  **How do R&D intermediaries facilitate the creation of the system functions during the ‘nursing phase’ of technological systems of innovation?**

• This question is explored, studying how R&D intermediaries influence the components and the performance of a number of innovation functions, during the ‘nursing phase’, of a technological system of innovation
Specific Research Question (2)

• Different factors influence during the formation and development of TSI, these could be divided into:
  – Inducement mechanisms: i.e. public policy
  – Blocking mechanisms: i.e. high uncertainty or weak connectivity

• R&D intermediaries contribute to the formation of TSI and, may, influence the inducement and blocking mechanisms of TSI that influence different system functions.
  – The second specific research questions for this research is:

  How does the establishment of R&D intermediaries reduce the strength of blocking mechanisms and/or increase the strength of inducement mechanisms during the formative phase of a technological system of innovation
Traditional Model for studying Innovation Systems

Organizations

Institutions

Innovation Systems
Conceptual Model of Research

1. Study of the system Functions
2. Inducement and blocking mechanisms
RESEARCH DESIGN

Focus of study
The scheme of study
Data collection and analysis
Focus of Study

• Living Labs represent a form of R&D intermediation attempting to establish functional regions where a variety of stakeholders form a Public-Private-Partnership (PPP) of universities, firms, public agencies, institutes of technology and people for creating, prototyping, validating, and testing of new services, products and systems in real-life contexts (CoreLabs, 2008)

• Living Labs expect:
  – To contribute to innovation and development process of different organizations
  – To offer a context for accelerating the innovation process
  – To provide medium or long-term services in large and small scale necessary for the development of new technologies
Characteristics of Living Labs

• Facilitating collaboration for research among various agents
  – Living Labs act as catalyst of projects around their research lines to accelerate the innovation and development process of new technologies

• Connecting science and policy initiatives
  – Living Labs were either established as university initiatives or as public governmental initiatives to enhance the R&D in the local region, connecting basic “upstream” and downstream” activities to accelerate the development of new technologies in the region

• Providing Services for Stakeholders
  – Living Labs act as service providers, setting up and managing experimental platforms with large number of users who embrace a joint discovery process through the use of prototypes
The scheme of study

1. The selection of the technological systems
   - **Focus:** Knowledge field of selected Living Labs
   - **Depth:** Living Labs in specific ICT technologies
   - **Domain:** organizations, university research labs and entrepreneurs interacting with selected living labs

2. The components of study
   - **Organizations:** ‘snowball method’
   - **Networks:** expected to have small number of members but with a high level of interaction
   - **Institutions:** innovation policies affecting the TSI
## 3) Innovation system functions and indicators for Living Labs

<table>
<thead>
<tr>
<th>Functions of Technological systems of innovation</th>
<th>Indicators for innovation systems</th>
<th>Functions of Intermediary organizations</th>
<th>Characterizing Purposes of Living Labs</th>
<th>Indicators to observe in Living Labs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Development and Diffusion</td>
<td>R&amp;D projects, network size and intensity; size and orientation of R&amp;D projects; learning curves; development of a new technology</td>
<td>Knowledge processing, generation and combination</td>
<td>Conduct medium or long-term studies involving users</td>
<td>R&amp;D projects, network size and orientation of R&amp;D;</td>
</tr>
<tr>
<td>Entrepreneurial Experimentation</td>
<td>No. of new entrants and diversifying established firms; no. experiments; no. different types of applications; no. of diversifying activities of incumbents; breadth of technologies used</td>
<td>Testing and validation</td>
<td>1) Provide insight into the unexpected ICT uses and new service opportunities, 2) experience and experiment with ICT solutions in contexts familiar to users or in real-world contexts and 3) try out ICT solutions with large number of users</td>
<td>No. of new collaborators with living labs, no. of different applications; no. of experiments; no. of different type of applications</td>
</tr>
<tr>
<td>Influence on the direction of search</td>
<td>Targets set by governments; no. press articles; incentives from taxes; expression of interest of leading customers; regulatory pressure</td>
<td>1) Foresight and diagnosis; 2) Scanning and information processing</td>
<td>Investigate the context of use</td>
<td>Public targets on innovation; no. and type of incentives; no. of new end-users</td>
</tr>
<tr>
<td>Market formation</td>
<td>No. of niche markets; lead users; customer groups; actor strategies; market size; purchasing processes</td>
<td>Commercialization: Exploiting the Outcomes</td>
<td>Involve users as co-creators</td>
<td>no. of new niche markets; no. of customer groups; no. of firms and R&amp;D centers collaborating with universities no. and type of organizations supporting the new TSI; polical influence for developing the market; no. of complementary org.</td>
</tr>
<tr>
<td>Development of positive external economies</td>
<td>Specialized intermediaries, information flows, political power, pooled labour markets</td>
<td>Gatekeeping and brokering</td>
<td>Facilitating collaboration for research among various agents</td>
<td></td>
</tr>
<tr>
<td>Legitimation</td>
<td>Rise and Growth of interest groups and their lobby actions; visions and expectations; alignment with current legislation</td>
<td>1) Evaluation of outcomes; 2) Validation and regulation; 3) Accreditation and standards; 4) Intellectual Property: Protecting the results</td>
<td>1) Evaluate or validate new ICT solutions with users and 2) conduct technical testing in a (semi) realistic context of use</td>
<td>no. and type of companies supporting living labs; private and public expectations of new technologies; alignment with legislation</td>
</tr>
<tr>
<td>Resource mobilization</td>
<td>Volume capital and VC, volume and quality of human resources, complementary assets</td>
<td>Intermediaries between science policy and industry</td>
<td>Connecting science and policy initiatives</td>
<td>no. and amount of public funding; no. of researchers involved in new technologies; no. of firms trying to enter the formative TSI</td>
</tr>
</tbody>
</table>
4. Identifying the blocking and inducement mechanisms
   – We empirically study the strategies of Living Labs for reducing the strength of blocking mechanisms as well as for increasing the effect of influencing mechanisms
Methodology

- Two longitudinal comparative case studies
  - Opposite case studies
    - One a European Project which did not produce any type of successful technology (10 million) or an emerging technological system
      - Actors: INSEAD, UPC, University of Nottingham, BIBA, Danfoss, SAP, FIAT, EU (6th European Project)
      - Funding: 10 million Euros
    - Living Labs in Hasselt, Barcelona and Helsinki which developed new technologies and apparently developed new technological systems
      - i-city Hasselt
      - Funding: Private and public institutions 1-5 million Euros
      - Actors: Microsoft, Leuven and Hasselt University, IWT,
      - Technologies: eHealth, eGovernment, new media, services and mobile devices
Data collection and analysis

**Data collection**

- **Interviews**
  - This method will be used with managers of Living Labs, firms, research institutes and entrepreneurs using semi-structured interviews

- **Surveys**
  - Used for collecting confirmatory information from Living Labs

- **Observations**
  - We specially search for events and incident that facilitate or block the formation of new TSI

- **Archival data and presentations**

**Data analysis**

- **Grounded theory**
  - To capture the main patterns affecting the formation of TSI facilitated by the Living Labs

- **Visual mapping**
  - to understand different mechanisms through temporal flow charts and the relationships between different actors involved on different sectoral and TSI
PRELIMINARY RESULTS AND EXPECTED CONTRIBUTIONS
Preliminary results of 2007-2008 analysis

<table>
<thead>
<tr>
<th>Category</th>
<th>Results</th>
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<tbody>
<tr>
<td>Origin</td>
<td>University, governmental funding agency and few private initiatives</td>
</tr>
<tr>
<td>Sources</td>
<td>Public funding, offering contracted research and resources from competitive projects</td>
</tr>
<tr>
<td>Objective</td>
<td>Provide facilities for fostering collaborative innovation processes and connecting policy initiatives with public and private research</td>
</tr>
<tr>
<td>Sectors or Industries</td>
<td>IT industry, more specifically on the ICT sector, such as mobile and new media, eHealth and eGovernment</td>
</tr>
<tr>
<td>Stakeholders</td>
<td>National and regional authorities, large and small firms, research centers and a broad range of end-users during the creation and development of new technologies</td>
</tr>
<tr>
<td>Role and functions</td>
<td>Coordinators, administrative supporters or innovation brokers that offer different testing and experimentation platforms, linkages with other distant organizations as well as brokerage between science and policy</td>
</tr>
<tr>
<td>Metrics of performance</td>
<td>No. of spinoffs, no. of firms involved in projects, launched products to the market, academic outputs as well as the increase on the public awareness of Living Lab activities</td>
</tr>
</tbody>
</table>
Expected contributions

• The expected contributions of this research are:
  – The explanation of the process R&D intermediaries facilitate, during formative TSI in the ‘nursing phase’
  – The strategies R&D intermediaries use to increase the strength of inducement mechanisms and reduce the influence of blocking mechanisms in formative TSI
  – The dynamics/interaction of intermediaries between subsystems/regional systems and national/international systems
Framework for policy implications

Failure Case
- Entrepreneurial activities did not exist
- Openness to external agents was not present
- Involvement of R&D intermediaries was not existent
- Supplier and users did not interact on tech. development

Success case
- Entrepreneurial activity was present in collaboration with int. firms
- Continuous involvement and control from other stakeholders
- Technologies were locally demanded
- Tech. development was continuously development

Policy implications
- Intermediaries need to be involved in X and Y phases
- Intermediaries need to have an strong relation with firms and
Thank You

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Conceptual Model of Research

**Organizations:**
Universities, entrepreneurs and firms developing new competing technologies

**Institutions:**
Regional governments creating new institutions necessary for the development of new technologies

**R&D intermediary**
Facilitate the formation of system functions, necessary during the ‘nursing phase’ of formative TSI

**System functions for a new TSI**
- Knowledge Development and Diffusion
- Entrepreneurial experimentation
- Influence on the direction of search
- Market formation
- Development of positive external economies
- Legitimation
- Resource mobilization

**Blocking and inducement mechanisms:**
affecting the formation of system functions

**A dynamic TSI with developing system functions on the ‘nursing phase’**