Evaluation of the Economic Impacts of Collaborative R&D

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Structure of Presentation

1. *Introduction*: Networks and why do they matter
2. *Part I*: Innovation Impacts of Publicly Funded Collaborative R&D
3. *Part II*: (a) Networked Research: European Policy Intervention in ICTs; (b) Network Structure and Robustness
4. *Part III*: Research Partners
Why Networks Matter

A key question in economics, business strategy, and policy research is why firms differ in terms of conduct and performance (profitability).

In answering this question, economists have typically viewed firms as stand-alone entities, striving for the best solutions (profit maximization) by reacting to external stimuli (opportunities) and/or by making effective use of their internal resources and capabilities.

However, the image of atomistic agents competing for profits against each other in an impersonal marketplace is increasingly inadequate in a world in which firms are embedded in networks of social, professional, and exchange relationships with other economic agents.
Why Networks Matter

The conduct and performance of firms can be more fully understood by examining the network of relationships in which they are embedded.

Strategic networks potentially:
- provide firms with (a) access to information, resources, markets, and technologies, and (b) advantages from learning, scale, and scope economies; and
- allow firms to achieve strategic objectives such as sharing risks and outsourcing value-chain stages and organizational functions.

Networks, however, may also lock firms into unproductive relationships or preclude partnering with other viable organizations.
What Can Networks Tell Us: STI Indicators

STI indicators can be grouped into four sets:

- Input indicators
- Output indicators
- Innovation indicators
- Process indicators
What Can Networks Tell Us: STI Process Indicators

Economists would argue that the first three kinds of indicators could fit well to the classic mold of a production function, \( Y = f(X) \), where \( X \) is a set of S&T input indicators and the \( Y \) stands for the S&T output indicators and innovation indicators.

We are only now starting to unravel the middle, the “black box”, the transformation of one into the other (function \( f \)).

Some of the information collected through the innovation surveys is heading towards the process/transformation by trying to pull in qualitative information on agent behavior. Still, nobody can claim we are there yet.
Knowledge Production Function

\[ Z \xrightarrow{k} X \xrightarrow{v_1} v \xrightarrow{K} u \xrightarrow{R} P \]
What Can Networks Tell Us: Innovation Network Indicators

This is exactly where innovation network indicators fit in.

Innovation network indicators account for the complex formal and informal relationships among economic agents involved in innovation, including companies, universities, and government agencies.

SciSIP to funds to build very extensive longitudinal data that allows to investigate innovation networks. This data could (and should) be complemented with other publicly available time-series information on the performance of individual organizations. Data collection issues.
Data Handling (NCRA-RJV)

- Database of all RJVs registered with the US Department of Justice under:
  - the National Cooperative Research Act (NCRA, 1984)
  - the National Cooperative Research Act (NCRPA, 1993)

- Based on the announcements in the Federal Register.

Data Handling (Patents)

- **Patents**
  - Includes 2,923,922 patents in the USPTO’s database granted from 1963 to 1999.
  - Lists patent number, grant year, application year, assignee, original classification

- **Citations**
  - Includes all U.S patent citations for patents granted from 1975 to 1999
  - Contains 16,522,438 observations about “citing” and “cited” patent numbers

- **Assignees**
  - Lists 175,115 company and assignee names and associated assignee number
Data Handling (Merged)

- N-Entities are entities identified in both the NCRA-RJV DB and the Patent DB.
- Merged database mirrors the characteristics of the two parental databases.

[Diagram showing the overlap of NCRA-RJV DB and Patent DB with counts of 2,435 N-entities, 6,517 Entities, 175,115 Assignees]
Data Handling (Automotive SIC 371)

- N371-Entities are selected on the basis of the following criteria:
  - N-entities.
  - Primary sector is SIC 371 (Motor vehicles and motor vehicle equipment).
Data Handling (Automotive 371)

- N371-RJVs are defined as those having at least one N371-entity member.
- 1,635 entities have memberships in N371-RJVs.
E.g. Entity 1’s patent cite Entity 3’s patent.
Patent Network

Inter-organizational relation via patent citation.
Data Handling: Alliance Network

N-RJVs: R1, R2, R3, R4

N-entities: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

E.g. Entity 1 has 1 membership in RJV R1.
Entity 3 has 2 memberships in RJV R1.

5 years span
N-RJVs:

N-entities:

RJV network
EXAMPLE:
ALLIANCE NETWORKS
IN COMMUNICATIONS SERVICES
Data Overview

- Data drawn from the INNET database focusing on alliances among communications firms (participant SIC: 48 & 7375)
- Number of alliances
  - 1,965 (International), 631 (U.S.)
- Number of entities
  - 2,039 (International), 690 (U.S.)
- Covered period: 1985-2002
Network Visualization

Visualization of 86-90 (International) Inter-firm Network

(Different color represents different component; size of circle represents the kind of k-core it belongs to)

(K-core: a subgraph in which each node is adjacent to at least a minimum number, k, of the other nodes in the subgraph. There are 4 levels of k-cores in this network)
Network Visualization

Visualization of 91-95 (International) Inter-firm Network
(There are 5 levels of k-cores in this network)
Network Visualization

Visualization of 96-00 (International) Inter-firm Network

(There are 6 levels of k-cores in this network)
Network Visualization

Visualization of 86-90 (U.S.) Inter-firm Network
Network Visualization

Visualization of 91-95 (U.S.) Inter-firm Network

(There are 4 levels of k-cores in this network)
Network Visualization

Visualization of 96-00 (U.S.) Inter-firm Network
(There are 4 levels of k-cores in this network)
PART II
Innovation Impact of Publicly Funded Collaborative R&D
Objective

- This paper investigates empirically the direct impacts on product and process innovation to partners in collaborative R&D projects partially supported by public funds.

- The examined partnerships are drawn from the population of FP5 and FP6 projects (1998-2006). FP projects have traditionally focused on more explorative, pre-competitive research.

- Advantages include large, representative sample; rich information on partner, project, organizational, and market characteristics; focus on direct innovation gains in terms of new/improved products and processes
Background

Even though several studies have explored the performance implications of collaborative R&D, because of controversies regarding the definition and measurement of performance in research consortia, the available empirical evidence is rather fragmented and, to some extent, equivocal.

- One reason has been the lack of common, appropriate data
- Another reason is the lack of consensus concerning the definition and measurement of performance in collaborative research.
- A third reason is disagreements on the level of analysis: focus on the partnership or on the individual partner.
Outputs

Factors related to project, organisation and market conditions

Knowledge outputs

Commercialisable outputs

New products

New processes

Nature of research: Uniqueness, imitatibility etc

Nature of commercialisation process
Hypotheses

1a: Partners with a strong innovation history, as reflected in R&D related activities, past innovation performance, and repeated participation in such projects, will be more likely to gain in terms of innovation from their participation in cooperative R&D projects.

1b: Partners with strong integrative capabilities will be more likely to gain in terms of innovation from their participation in cooperative R&D projects.

2: Partners with strong appropriation capabilities will be more likely to derive innovation impacts from their participation in cooperative R&D projects.
Hypotheses

3: Project uncertainty will be positively related to innovation impacts, but the relationship will be non-linear (inverse U-shaped). As uncertainty becomes excessively high, the returns to the partner will begin to diminish.

4: When a given project builds on related past R&D activities, partners will be more likely to obtain innovation impacts from their participation in that project.

5: Partners participating in projects initiated when the relevant market is at early stages of its development will be more likely to obtain innovation impacts.
Sample

Total population 121,600 organizations
Randomly selected a representative sample of 54,492 (70.4% from FP5, 29.6% from FP6)
7,098 (3,379 enterprises, 3,719 research organizations) completed questionnaire
Overall response rate 13.03%
Distribution of completed questionnaires identical to original sample: 70.2% for FP5 and 29.8% for FP6 projects
Set of responses balanced in terms of instruments and countries
Setup

Measurement items developed and tested by previous studies were used as much as possible, such as those for innovation history and performance, and appropriation capabilities (Community Innovation Surveys (CIS)).

The constructs of interest to the study were tapped using both multiple questionnaire items (one-to-five Likert scales) and categorical (dummy-coded) variables. Following confirmatory factor analyses, we constructed composite measures of these constructs by averaging the respective individual items.

- Two dependent variables: product innovation, process innovation
Setup

**Independent variables**

**Firm effects:** past intramural R&D, past extramural R&D, past new to market product innovation, past new to firm product innovation, past process innovation, integrative capabilities, formal appropriation capabilities, informal appropriation capabilities.

**Project effects:** project novelty, project novelty squared, project complexity, project complexity squared, project builds on past R&D.

**Market effects:** emerging market, early stage of market development, fast growth.

**Controls**

**Firm controls:** firm size, firm age, first time participation, familiarity with partners, EU-15, EU-27, role in the project, manufacturing

**Project controls:** project size, project size squared, project duration, %partners from industry, leader from industry, idea from industry, FP6, Growth, IST, Quality of Life, EESD, constant.
Main Results

- A partner’s absorptive capacity, reflected in prior R&D experience and in the partner’s integrative capabilities, is an important determinant of innovation gains.

  Absorptive capacity also seems to mediate the effects of appropriation capabilities (a firm’s ability to “protect” is innovation position from rivals) on innovation impacts.

- Project uncertainty, as manifested in project novelty and complexity, has a curvilinear relationship to innovation: at moderate levels of uncertainty the effects are positive, but begin to diminish as uncertainty becomes excessive.

  Novelty affects product innovation. Complexity affects process innovation.
Project Novelty

Effect of Project Novelty on Product Innovation

$P(\text{Product Innovation})$ vs. Project Novelty
Effect of Project Complexity on Process Innovation

Project Complexity

Pr(Process innovation)

Project Complexity

1 2 3 4 5
Main Results

• Building on **past R&D activities** makes it more likely that the project will result in important gains in terms of innovation.

• Other factors that also positively influence the likelihood of innovation success include:
  - The partner plays a leading role in the project;
  - Partner size (smaller firms tend to innovate more);
  - The partner has previous collaborative relations with one or more of the other organizations in the project;
  - The project idea was initiated by an industrial partner.
PART II

Networked Research: European Policy Intervention in ICTs
Towards an ERA for IST:
Overall Objectives

Develop and apply a quantitative analytical framework for the assessment of the characteristics and performance of networks supported by IST RTD in FP5 and FP6.

Analyze knowledge and partnership networks in selected IST RTD domains, concentrating on network nature, topology, time evolution and effectiveness.

Supplement quantitative information with some qualitative information, and inter-organizational networks with inter-personal networks.
Towards an ERA for IST: Evaluation Questions

- How do the characteristics of the IST-RTD partnership and knowledge networks compare with the characteristics of the global partnership and knowledge networks of IST-RTD companies and with the characteristics of the related global networks?

- How well are the companies participating in IST RTD programs positioned in the global partnership and knowledge networks?
Towards an ERA for IST:
Evaluation Questions

- How effective are IST-RTD networks as mechanisms for transmitting knowledge?

- Are the Integrated Projects (IPs) and the Networks of Excellence (NoEs) creating leading “knowledge hubs”?

- What makes these “knowledge hubs” effective?
Towards an ERA for IST:
Evaluation Questions

- To what extent does the prominent network status of certain IST RTD companies of clusters match the EU technological leadership in certain areas?

- Are the global networks of selected “hub” companies with extensive ICT supply chains represented in the FP6 IST RTD?

- Are the perceived national IST “knowledge hubs” well integrated into the FP6 network?
Selection of IST technology domains

IST-RTD Framework Programme 6

Patent examiners

Matching of IPC codes with technological domains

Field experts

Matching of SIC codes with technological domains

PARTNERSHIP NETWORK 1a

EP-CESPRI

patents/citations

INNET

alliances

KNOWLEDGE NETWORKS

(Ilb, IIb, IIIb)

PARTNERSHIP NETWORKS

(Ila, IIIa)
Towards an ERA for IST: Network Types

- IST-RTD partnership network
- IST-RTD knowledge network
- Global partnership network of IST-RTD project participants
- Global knowledge network of IST-RTD project participants
- Global partnership network akin to the E technology units
- Global knowledge network akin to the E technology units
Towards an ERA for IST: Examined Programs

<table>
<thead>
<tr>
<th>Thematic Areas</th>
<th>FP6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Applied IST research addressing major societal and economic challenges</strong></td>
<td>Strategic objectives</td>
</tr>
<tr>
<td>- eSafety of road and air transports</td>
<td>- Broadband for all</td>
</tr>
<tr>
<td>- eHealth</td>
<td>- Mobile and wireless systems beyond 3G</td>
</tr>
<tr>
<td>- Technology-enhanced learning and access to cultural heritage</td>
<td>- Networked audiovisual systems and home platforms</td>
</tr>
<tr>
<td>- Towards a global dependability and security framework</td>
<td>- Open development platforms for software and services</td>
</tr>
<tr>
<td>- Networked business and governments</td>
<td>- Embedded systems</td>
</tr>
<tr>
<td>- eInclusion</td>
<td><strong>2. Communication, computing and software technologies</strong></td>
</tr>
<tr>
<td>- Applications and Services for the Mobile User and worker</td>
<td>- Pushing the limits of CMOS and preparing for post-CMOS</td>
</tr>
<tr>
<td>- Cross-media content for leisure and entertainment</td>
<td>- Micro and nano-systems</td>
</tr>
<tr>
<td>- GRID-based Systems and solving complex problems</td>
<td>- Advanced displays</td>
</tr>
<tr>
<td>- Improving Risk management</td>
<td>- Optical, opto-electronic, photonic functional components</td>
</tr>
<tr>
<td><strong>3. Components and micro-systems</strong></td>
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</tr>
<tr>
<td>- Embedded systems</td>
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Towards an ERA for IST: Examined Programs

<table>
<thead>
<tr>
<th>FP 5</th>
<th>FP6</th>
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</thead>
<tbody>
<tr>
<td><strong>Key Actions</strong></td>
<td><strong>Thematic Areas</strong></td>
</tr>
<tr>
<td>1. System and services for the citizen</td>
<td>1. Applied IST research addressing major societal and economic challenges</td>
</tr>
<tr>
<td>2. New method of work and electronic commerce</td>
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<tr>
<td></td>
<td>2. Communication, computing and software technologies</td>
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<td></td>
<td>3. Components and micro-systems</td>
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<tr>
<td>4. Essential technologies and infrastructures</td>
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Projects

Not Selected: 115 (27.3%)
Selected: 307 (72.7%)
Participants

- Not selected: 1340 (21.8%)
- Selected: 4814 (78.2%)

**Participants**: counted once for every project they have participated in
CA: Coordination Action
IP: Integrated Project
NoE: Network of Excellence
SSA: Specific Support Project
STREP: Specific Targeted Research Project
Organization Type

- **HE**: Higher Education
- **IND**: Industry
- **REC**: Research
- **OTH**: Other

![Bar graph showing selected and not selected statuses for different organization types](image-url)
### SMEs and Large Enterprises

<table>
<thead>
<tr>
<th></th>
<th>Large Company</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Not Selected</strong></td>
<td>1032</td>
<td>21.15</td>
<td></td>
</tr>
<tr>
<td><strong>SME</strong></td>
<td>260</td>
<td>21.17</td>
<td></td>
</tr>
<tr>
<td><strong>Selected</strong></td>
<td>3846</td>
<td>78.85</td>
<td></td>
</tr>
<tr>
<td><strong>SME</strong></td>
<td>968</td>
<td>78.83</td>
<td></td>
</tr>
</tbody>
</table>

![Bar chart showing comparison between SME and Large Company]
Indicative Analysis: 3 subjects
Subject 1: Identifying HUBs and their relative roles
Hub definition

• An organization is a hub in a specific network if it has many links and/or if it connects the otherwise unconnected parts of the network.

This translates into high degree centrality and/or high betweenness centrality.
STYLIZED 3A PARTNERSHIP NETWORK

Stylized model of Network 3a (Alliances)

Intuition behind the concept of a Partnership Hub

A Hub is defined as a node exhibiting high value of betweenness and degree

The node labelled “HUB 3a” is the designated Hub for this network.
Yellow nodes indicate organizations participating in Framework Programme.
STYLIZED 1A PARTNERSHIP NETWORK

This is a stylized model of Network 1a (FP Participants)

The blue node is the 3a network relevant Hub

The yellow node represents the relevant Hub in the stylized 1a partnership network
Links Between 1a Hubs and 3a Hubs

Blue nodes are the 3a network Hubs

Yellow nodes represent the 1a network Hubs

1a Hubs are strongly interconnected and they are also connected with 3a Hubs

3a Hubs are NOT hubs in network 1a, BUT are gateways that connect FP organizations to the global network.
Blue nodes are the 3a network Hubs

Red nodes are other 3a network participants within distance 1 from 3a Hubs

Yellow nodes represent 1a network Hubs
This is the TA1 Network without the links related to IP.

The network is substantially different, with many isolated nodes and diminished complexity.
Subject 2: Effectiveness of KNOWLEDGE HUBs
Effectiveness of Knowledge Hubs

Hubs as *knowledge depositories*

- Number of Patents
- Number of Citations Received
- Number of Highly Cited Patents

Hubs at the *cross-road of information and ideas*

- Degree Centrality
- Betweeness Centrality
Effectiveness of Knowledge Hubs: Hypothetical Example
Effectiveness of Knowledge Hubs: Hypothetical Example

- closely matches that of global KHS in terms of three variables (number of patents, network centralities);

- lags seriously behind in terms of the remaining two variables that approximate the quality and the importance of their patent portfolios;

the FP KHS seem to perform better in diffusing knowledge through their centrality roles in the networks than in creating powerful and influential portfolios of new ideas.
Subject 3: Leadership
Leadership

Two different definitions of Leadership:

• **Technology Leadership:** the role played by each organisation in the innovative process

• **Market leadership:** the share of revenues in ICT among EU25
Technology Leadership

Technology leadership is defined in terms of two concepts:

• *Niche overlap* concerns the crowdedness of the technological area explored by organisations. Its measure is based on similarity of technological antecedents (i.e. co-citation).

• *Prestige* deriving from the direct technological ties between actors (i.e. direct patent citations).
Technology Leadership

Four different kinds of actors:

• **Technology Leaders:** a key source of knowledge spillovers for many other organizations in the industry. Their research activity is focused on the exploitation of opportunities in relatively mature and therefore highly crowded fields

• **Technology Brokers:** sources of knowledge in relatively new and unexplored fields
• **Technology Followers:** they do not contribute significant spillovers to other organizations and engage into relatively mature and crowded technological subfields.

• **Isolate Organisations:** they do not receive direct citations from many other organizations and are exploring relatively untapped technological subfields.
This analysis might suggest:

- The number of identified leaders and brokers that participate in the Framework Programme

- The number (and identity) of those who not only participate but they can also be characterized as Partnership HUBs in the Framework Programme.
Objectives

- The paper empirically investigates the factors playing an important role in determining the specific pairs of industrial partners in such partnerships.
- It reports the results of an extensive empirical examination of the factors that weigh in the selection of partners.
- Empirical investigation based on a large panel data set of cooperative R&D agreements registered with the US Department of Justice (DoJ) during the period 1985-1999 under the auspices of the National Cooperative Research Act of 1984 and its extension, the National Cooperative Production and Research Act of 1993.
Study Contributions

- Adds to empirical evidence on a core topic while explicitly taking into consideration modern concepts of network embeddedness;

- Covers a wide spectrum of industries including both manufacturing sectors and service sectors;

- Firm-level analysis using a large, unique dataset that extends for a decade and a half.
Hypotheses

**H1.** Firms are more likely to collaborate in R&D:
- the closer their technological profiles;
- the closer their industry specialization profiles;
- the higher the prospective R&D spillovers they can benefit from.

**H2.** Firms are more likely to collaborate in R&D:
- the more familiar they are with each other thru prior agreements;
- the more central positions they occupy in the knowledge network;
- the more central positions they occupy in the partnership network.

**H3.** Firms are more likely to collaborate in R&D:
- the higher their prior ind. experience with research partnering
- the more complex their main technological fields;
- the stronger the intellectual property protection in their business.
Data

Fifteen years of data of registered RJVs (1985-1999). New RJV registrations during this time period total of 796 in areas such as telecommunications, transportation equipment, advanced materials, energy and environment, software, electronic equipment, chemicals, manufacturing equipment, etc. Names of company participants cross-checked with commercial databases.

This data merged with NBER patent database which allocates US patents during 1963-1999 to individuals and organizations. This merging identified 2,435 entities that have participated in at least one RJV and have obtained at least one patent during this time period. We chose firms declaring one or more SIC codes and had longitudinal business performance indicators available from CompuStat. The process left us with 359 firms for the period 1989-1999. They cover a mixture of manufacturing and service sectors.
Method

We use a random effects probit model to estimate the likelihood that firm $i$ will partner with firm $j$ in year $t$. Let:

$$P_{ijt} = F [Z_t(i,j), N_t(i,j), Y_t(i), Y_t(j), L_t(I), L_t(J)]$$

$P_{ij} =$ probability that firms $i$ and $j$ will meet in a research partnership in year $t$.

$F =$ cumulative probability function.

$Z_t(i,j) =$ vector of variables describing resource/market interdependence between firms $i$ and $j$ in year $t$.

$N_t(i,j) =$ vector of network relationships between firms $i$ and $j$ in year $t$.

$Y_t(i) =$ vector of characteristics of firm $i$ in year $t$.

$Y_t(j) =$ vector of characteristics of firm $j$ in year $t$.

$L_t(I) =$ vector of market and technological characteristics of the primary industry $I$ of firm $i$ in year $t$.

$L_t(J) =$ vector of market and technological characteristics of the primary industry $J$ of firm $j$ in year $t$. 
Method

Dependent Variable

\[ \text{COLLABORATE}_{ijt} = 1 \text{ if firms } i \text{ and } j \text{ meet in a partnership in year } t; \]
\[ = 0 \text{ otherwise.} \]

Independent Variables

- **Resource/market interdependence** \( Z_t(i,j) \).

\[ \text{TECHPROXIMITY}_{ijt} = \text{degree of similarity in the technological profile of firms } i \text{ and } j \text{ in year } t. \]

\[ \text{R&DSPILLOVER}_{ijt} = \text{TECHPROXIMITY}_{ijt} \times R&D_{jt} \]

\[ \text{MARKETPROXIMITY}_{ij} = \text{degree of similarity in the market profile of firms } i \text{ and } j. \]
Method

• Network relationship, \( N_t(i,j) \).

\[
FAMILIARITY_{ijt} = \begin{cases} 
1 & \text{if firm } i \text{ and firm } j \text{ have collaborated before year } t, \\
0 & \text{otherwise.}
\end{cases}
\]

\[
ALLCENTRALITY_{ijt} = \text{joint centrality of firms } i \text{ and } j \text{ in the partnership network in year } t
\]

\[
PATENTCENTRALITY_{ijt} = \text{joint centrality of firms } i \text{ and } j \text{ in the knowledge network in year } t.
\]

• Controls

\[
SALES_{it} = \text{sales of firm } i \text{ in year } t.
\]

\[
ALLEXPERIENCE_{it} = \text{cumulative number of past partnerships entered by firm } i \text{ over the five years prior to year } t.
\]

\[
= 0 \text{ otherwise.}
\]
Method

$SALES_{jt} = \text{sales of firm } j \text{ in year } t.$

$ALLEXPRIENCE_{jt} = \text{cumulative number of past partnerships entered by firm } j \text{ over the five years prior to year } t.$

$= 0 \text{ otherwise.}$

$GROWTH_{It} = \text{growth rate of primary industry } I \text{ of firm } i \text{ in year } t.$

$INDUSTRY \text{ PATENT}_{It} = \text{Patent / R&D expenditures of primary industry } I \text{ (of firm } i) \text{ in year } t.$

$COMPLEXITY_{I} = 1 \text{ if industry } I \text{ (firm } i) \text{ is a complex product industry; }$

$= 0 \text{ otherwise.}$

$GPT_{I} = 1 \text{ if industry } I \text{ (of firm } i) \text{ is described as ICT, biotech or advanced materials; }$

$= 0 \text{ otherwise.}$
Method

\( GROWTH_{jt} \) = growth rate of primary industry \( J \) of firm \( j \) at \( t \).
\( INDUSTRY\, PATENT_{jt} \) = Patent/R&D expenditures of primary industry \( J \) (of firm \( j \)) at \( t \).
\( COMPLEXITY_{j} \) = 1 if industry \( J \) (of firm \( j \)) is a complex product industry;
\( = 0 \) otherwise.
\( GPT_{j} \) = 1 if industry \( J \) (of firm \( j \)) is described as ICT, biotech or advanced materials;
\( = 0 \) otherwise.

To control for unobserved temporal factors we use ten dummy variables, TEMP1-TEMP10, one less than the number of years in the panel.
Main Results

The likelihood of two firms collaborating in R&D strongly depends on three sets of factors:

- The resource and market interdependencies between the firms;
- Prior network interaction between them and their network positioning;
- The characteristics of each.

Firms are more likely to collaborate:

(i) the closer they are in terms of technological and market profiles,
(ii) the higher the expected knowledge spillovers among them,
(iii) the more familiar they are with each other through past interaction,
(iv) the more centrally located they are in knowledge networks.

Prior networking experience, product complexity, and involvement in general purpose technologies further raise R&D partner attraction.
Main Results

- The attraction of ‘localized’ R&D cooperation comes out clearly: similarities in both technological capabilities and market specialization and possibilities for higher knowledge spillovers positively affect the likelihood that two firms collaborate in R&D.

The closer two firms are, the lesser the transaction costs of collaborating and the higher the ability to learn from the partner.
Main Results

- The importance of value creation as a factor weighing in one’s decision for choosing a partner also comes out clearly: repeated R&D collaboration between the partners and mutual central positions in the partnership network build trust and social control mechanisms that decrease the transaction costs associated with any particular deal.

Combined to expectations for increased learning due to the partner’s central position in the knowledge network, these factors further enhance the incentives to work with the specific organization.
Main Results

- Finally, firms tend to collaborate the more experienced they are in networking, the more complex their products are, and the more they deal with general purpose technologies.

These results seem to confirm the ‘homophily’ finding in interpersonal networks (similar people tend to interact with each other). The idea of homophily has also been extended to interorganizational networks which, it has been argued, are more likely among partners of similar status and power.