DEPARTMENT OF ECONOMICS & MANAGEMENT

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- EX LABORE FRUCTUS -

Economics of Science

Economics of Innovation

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Science as a quasi public good

- Competitive markets provide poor incentives for the production of a public good.
- The non-excludable nature of public goods invites free-riders and consequently makes it difficult for providers to capture the economic returns. Thus, incentives for provision are not present.
- The non-rivalrous nature of public goods means that if and when public goods are produced, the market will fail to provide them efficiently where marginal cost equals marginal revenue since the marginal cost of an additional user is zero.
- Such observations regarding the provision of public goods, however, relate to incentives that are market based.
  - An important contribution of the sociologists of science and the economists who have extended their work is the demonstration that a non-market reward system has evolved in science that provides incentives for scientists to produce and share their knowledge, thus behaving in socially desirable ways.

Dasgupta & David, 1994 / Merton, 1973
[*cf.* Sauermann and Stephan, 2013]

- Focus on the nature of the individuals undertaking R&D projects and on the nature of the knowledge produced by these individuals
- Two types of individuals undertaking R&D are identified
  - Scientists
  - Technologists

Priority in scientific discovery

- Sort of intellectual property right
- The scientist aims at being the first in discovering new knowledge
  - Recognition in place since centuries
- This priority gives prestige and fame to the scientist

Form of recognition

- Eponymy: link the name of the scientist to the discovery
  - Copernicus
  - Pitagora
  - Higgs boson
- Awards
  - Nobel

Mechanisms to priority recognition

- Publication
  - Main mechanism to gain recognition in scientific community
- Publishing give visibility to the work of scientists
- The higher the quality of the article, theoretically, the higher the level of visibility and recognition of the academic scientist

Compensation in science

"Rosovsky (1990) recounts how, upon becoming dean of the Faculty of Arts and Sciences at Harvard, he asked one of Harvard's most eminent scientists the source of his scientific inspiration. The reply (which "came without the slightest hesitation") was "money and flattery." (p. 242) " (Stephan 2010, p. 223)

Compensation in science (2)

- Two forms of remuneration:
  - Fixed part
  - Part linked to scientific productivity (measured mostly in terms of publications)
    - Does this quite recent approach favour or hamper the output of scientific research? 20 years debate (see Dasgupta and David, 1994; Nelson and Rosenberg, 1994; David, 1997)
- Number of publications, quality of the outlet, number of citations/impact
  - Career progress
  - Research projects and funds
  - Conferences, consultancies, research contracts, andso on

Scientific research

“Research often provides answers to unposed questions. Consequently, the risk associated with such research can be lessened by shifting goals during the course of research. Nelson (1959) argues that this strategy is more appropriate for scientists working in a nonprofit-based environment than for scientists working in the profit sector because the former can more easily capture the rewards regardless of where the research leads. On the other hand, companies having a broad technological base can benefit from research that is not directed to a specific goal. At the time General Electric developed synthetic diamonds, for example, it was the most diversified company in the United States.” (Stephan 2010, p. 233)

Scientists

- Curiosity for science and the search for prestige and fame are the main means to professional growth (Dasgupta-David 1994); priority confers this prestige (Stephan, 1996):
  - Aim of the scientist who produce new knowlegde is the maximum diffusion of this knowledge, and the main mechanims is the publication
- Incentives and returns are mostly of a non-monetary form, directly. Monetary returns appear to mostly be indirect, although present (recall Rosovsky quote)

Technologists

- Industry R&D works differently
- Priority may be important, but what is central is the profit the new knowledge can render
- Technologists don't aim at diffusion, but at secret: the less the new knowledge get diffused the higher its advantage are appropriable by the inventor (company)
- Technologists are rewarder in relation to the profits the company gain from the new knowledge

Moreover

Arora and Gambardella, 1994:

- Academic knowledge tend to be more abstract and seek to derive comprehensive theory from specific phenomenon
- Industrial knowledge tend to be more specific and aim at creation prototypes without much consideration to scientific underlying principles
  - Produce specific applications of new knowledge

University vs Industry R&D

	Orizzonte temporale della ricerca svolta	Orientamento alla diffusione	Orientamento allo sfruttamento
Università	Principalmente di lungo termine	Alto	Basso
Imprese	Principalmente di breve termine	Basso	Alto

Fonte: Piccaluga (2001)

University vs Industry Institutional Logics differences

- Grounding on Institutional Logics theory (evolution of Neo-Institutionalism):
  - Nature of the work
  - Characteristics of the workplace
  - Characteristics of the workers
  - Disclosure of research results

- How would you characterise open source software?
  - Incentives
  - Returns
  - Characteristics of individuals participating in os

Real Effects of Academic Research

Adam Jaffe, 1989

Jaffe, 1989 - Introduction

- It is conventional wisdom that “Silicon Valley” near San Jose, California and Route 128 around Boston owe their status as centers of commercial innovation and entrepreneurship to their proximity to Stanford and MIT.
- Several other areas of the country, such as San Antonio/ Austin in Texas and Raleigh/Durham in North Carolina have tried explicitly to build new centers of high-technology industry around their universities.
- It is certainly plausible that the pool of talented graduates, the ideas generated by faculty, and the high quality libraries and other facilities of research universities facilitate the process of commercial innovation in their neighborhood, but there has been very little systematic empirical analysis of this phenomenon.

Jaffe, 1989 – Introduction (2)

- Knowledge is, after all, a public good.
  - There has been much recent interest in “spillovers” of research among firms.
- There is even more reason to believe that spillovers exist from universities to firms, since the former have less incentive to try to keep research secret.
- For none of these spillover phenomena are the “transport” mechanisms understood.
  - If the mechanism is primarily journal publications, then geographic location is probably unimportant in capturing the benefits of spillovers. If, however, the mechanism is informal conversations, then geographic proximity to the spillover source may be helpful or even necessary in capturing the spillover benefits.

Modeling spillovers from university research

- Knowledge production function *a la* Griliches:

$$\log(P_{ikt}) = \beta_{1k}\log(I_{ikt}) + \beta_{2k}\log(U_{ikt}) + \beta_{3k}[\log(U_{ikt})\log(C_{ikt})] + \epsilon_{ikt}$$

- where *i* indexes the unit of observation (states, in this case), *k* indexes technological areas, and *t* indexes time. *P* is corporate patents, a proxy for new economically useful knowledge; *I* is R&D performed by industry and *U* is university research. ϵ_{ikt} is a stochastic error whose properties will be discussed below. The variable *C* is a measure of the geographic coincidence of university and industrial research activity within the state. Allowing the potency of university spillovers to depend on *C* is intended to mitigate the arbitrariness of states as observation units.

Results and conclusions

- The analysis of state-level corporate patent activity provides some evidence of the importance of geographically mediated commercial spillovers from university research.
- The effect is statistically strongest in Drugs, slightly smaller and less significant in Chemicals, and smaller but quite significant in Electronics, etc.
- There is only weak evidence that spillovers are facilitated by geographic coincidence of universities and research labs within the state.
- It is interesting that the effect comes through more clearly within technical areas than it does in the total across areas. This suggests that the spillovers are limited to specific areas and not just the diffuse effect of a large research university.

Summing up

- Jaffe’s 1989 paper was the first seeking to explore this relationships
  - Many other works followed, mostly finding similar results
- The importance of geography and of spillovers probably not suited for state-level analyses
  - Recent works mostly seeking to analyse the relationship at smaller geographical level

- Example of further reading:
  - Aghion et al., 2009: The Causal Impact of Education on Economic Growth: Evidence from U.S.
  - Cowana, R., Zinovyeva, N., 2013. University effects on regional innovation [on Italy]
  - Toivanen, O., Vaananen, L., 2006. Education and invention [on Finnish inventors moving to US]

Further research topics

- Agglomeration economies and R&D
- Knowledge spillovers and its geographical dimensions
- Consequences of agglomeration economies and R&D spillovers on the economic system (municipality, region, country, etc)
- …