Regional innovation systems in biotechnology

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The presentation

- Concepts used to describe regional innovation
- Complex systems and their dynamics
- Biotechnology
- Biotechnology regional innovation systems
- Systems dynamics
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1. Concepts used to describe regional innovation

- Industrial districts (Marshall)
- Dynamic industries and firms (Perroux)
- Clusters (Porter)
- Regional innovation systems (Cooke)
- Anchor tenants (Feldman)

Industrial districts

- These are agglomerations of small and medium sized firms in one particular industrial sector
- The first to note their existence was Alfred Marshall, (1842-1924), a British economist studying English industrial cities
- Today this idea is used in Italy where you find these small cities, specialised in such industries as textiles, garment, shoes, glasses, electric lamps, etc.
- It describes a traditional regional organisation of industry, today in total disappearance

Dynamic industries and firms

- This is a much more modern approach.
- Perroux (1903-87) observed in France that many agglomerations were built around either large assemblers (i.e. Automobile companies) or industrial materials providers (i.e. steel or petrochemicals)
- His approach was used in many countries from France and Italy to Brazil to build large car, aircraft, petrochemical or steel products poles
- In this approach, like in Marshall, universities and government laboratories do not play any role

Clusters

- This approach comes from Michael Porter, a professor and consultant at Harvard.
- He calls clusters sets of interrelated firms and other institutions linked by commonalities and complementary characteristics
- Porter was criticised for not being too specific about what were these commonalities and complementarities, and for not defining what the geographical or industrial boundaries where.

Regional innovation systems

- In the analysis of regional biotechnology agglomerations, this is one of my preferred concepts. A definition is as follows
- "Regions which possess the full panoply of innovation organisations set in an institutional milieu /…/ where systemic linkage and interactive communication among the innovation actors is normal, approach the designation of regional innovation systems. The organisations can be expected to consist of universities, basic research laboratories, applied research laboratories, technology transfer agencies, regional public and private /…/ governance organisations, vocational training organisations, banks, venture capitalists, and interacting large and small firms. Moreover they should demonstrate systemic linkages through concertation programmes, research partnerships, value added information flows, and policy action lines from the governance organisations. These are systems that combine learning with upstream and downstream innovation capability and thus warrant the designation *regional innovation system*" (Cooke and Morgan, 1998: 71)

Anchor tenants

- These are large firms, large universities or public laboratories that produce huge amount of knowledge and attract or spin-off other firms, and create labour pools
- Examples: Philips Semiconductors and AMD in Dresden (Germany)
- IBM Software Lab in Toronto (3,500 R&D employees)
- In biotechnology these are such universities as UCLA, UCSF, or Stanford in the US; U of T or UBC in Canada (see their web sites), and NIH labs in Maryland and Washington DC.

2. Complex adaptive systems and dynamics

- Regional systems are complex systems characterized by
- Dispersed interaction among heterogeneous agents
- No global controller that can exploit all opportunities
- Cross-cutting hierarchical organisations with many tangled interactions
- Continual adaptation by learning and evolving agents
- Perpetual novelty as new markets, technologies, behaviours and institutions create new niches in the ecology of the system
- Out-of-equilibrium dynamics with either zero or many equilibria existing and the system unlikely to be near optimum

3. Biotechnology

- A large and rapidly growing set of technologies used in many industries, not an industry in itself
- Main users are in human health (therapeutics, medical devises such as diagnostics and other), animal health, ag-biotechnology, environmental remediation, food industry (functional food), mining, industrial chemicals, etc.
- Two main types of companies are involved:

  - dedicated biotechnology firms (DBFs) conducting R&D in one or several applications, and

  - industrial users such as large pharmaceutical firms, agricultural farms, grain traders, consulting engineers, mining companies and the like.

Biotechnology (cont.)

- In the early years of biotechnology (i.e. 1980s) many observers believed that DBFs would grow into large firms and eventually dislodge incumbent corporations in such industries as pharmaceuticals or chemicals. This did not happen; large established corporations finally learned biotechnology, are buying DBFs or establishing their own R&D labs in biotechnology. Few DBFs became large independent biotechnology firms (i.e. Amgen).
- Also, biotechnology products are more difficult to produce and commercialise than previously expected
- Still, thousands of DBFs exist in OECD countries including some 600 in Canada, with different degrees of success.

4. Biotechnology regional innovation systems

- Its main components (agents) are:

- Research universities (public or private)
- Government laboratories (federal or provincial)
- Venture capital corporations
- Angels
- Public funding agencies either federal (NIH, SBIR in the United States) or state-controlled ones (TEDCO in Maryland, Ben Franklin Technology Partnerships in Pennsylvania, California Institute for Regenerative Medicine in San Francisco)
- Pharmaceutical corporations are not usually based in the same regions as biotechnology firms

Research universities (public or private)

- They provide key components in the system such as
- Star scientists (defined as professors with patents and a large number of publications)
- Laboratory workers
- Labs (space), expensive equipment: autoclaves, DNA sequencing technology, microplate readers, freezers…
- New ideas: research results that can be used both in scientific publication and in commercial technology applications

Government laboratories

- They provide scientists and equipment, as well as ideas
- At least in the US and Canada, government labs are less dynamic components of regional systems because their hiring and retention system not often allow researchers to leave the laboratories to launch a DBF or work for a company and come back if they wish so. Universities are much more flexible than public labs in their contracts with professors.
- Also, universities train people in the latest advances in such a dynamic science; government labs usually do not train students

Venture capital and angels

- Venture capital firms (VC) provide funds, management advice, prestige, and networking to DBFs. Because they only support a percentage of less than 50% of DBFs, those supported have passed a major filter. They invest in exchange of shares (equity). They exit their investments through different mechanisms such as IPOs, M&A and other.
- VC investment is made is several rounds of increasing amounts as R&D moves forward and risk declines
- Angels are wealthy individuals that also invest in new DBFs, usually in the first stages, with similar criteria as VC

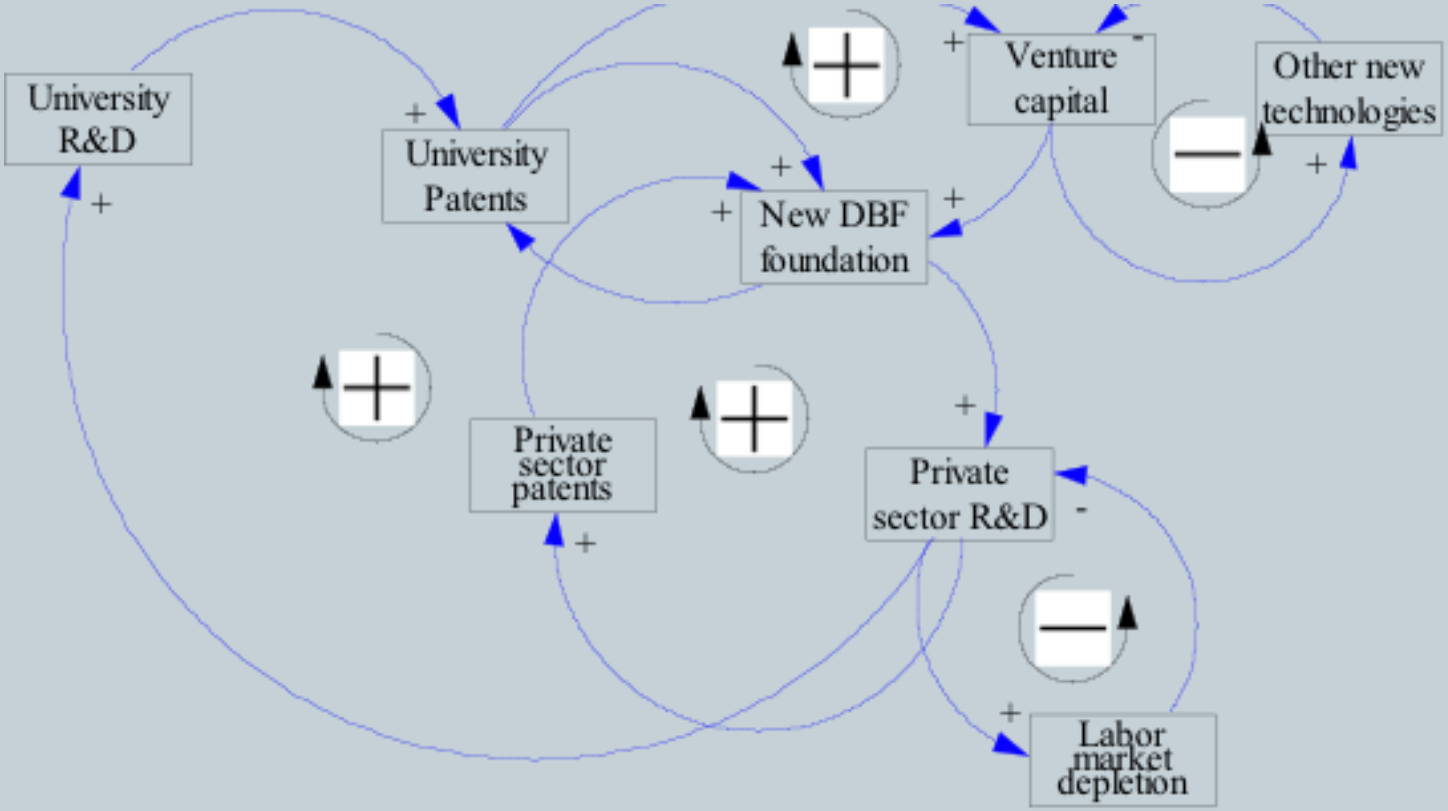
Public funds

- They are either federal (reimbursable tax credits for R&D, direct subsidies such as SBIR, STTR and NIH) and state programs (California Institute for Regenerative Medicine – stem cell research), TEDCO, Ben Franklin Technology Partnerships and many others
- Together they provide every year many billions of non reimbursable research dollars to academic and DBF research
- US global leadership in biotechnology is due to such large support (30-40 billion dollars a year)
- Canadian governments invest 1 billion dollars a year in biotechnology R&D (in public and private organisations)

5. System dynamics

- As I proposed before, regional innovation systems are made of these heterogeneous agents (academic, public labs, VC, angels, public funding agencies) in continuous interaction and learning.
- A influence diagram model can help to illustrate what goes on in the region

A system dynamics model: positive and negative feedbacks



6. Policy implications

- In order to create biotechnology regional innovation systems, governments must first evaluate the regional strengths (academic, public labs, VC, angels, other), find out what elements (agents, activities) are needed to complete the system, support these elements or nurture their creation, and have an idea of the funds and strategies needed to build or complete the RSI
- An example of the regional Argentinean strengths in biotechnology comes from publication

Argentina: biotechnology publication and patents (1996-2008)

Organisation	Articles (and US Patents)
CONICET	948 (1)
Universidad de Buenos Aires	606 (0)
Universidad de La Plata	322 (0)
INTA	180 (0)
Universidad Nacional de Córdoba	141 (0)
Universidad Nacional de Tucumán	123 (0)
Universidad Nacional de Rosario	86 (0)
PROIMI	81 (0)
Universidad Nacional del Sur	66 (0)

INTA: Instituto Nacional de Tecnología Agrícola
PROIMI: Planta piloto de procesos industriales microbiológicos

Venture capital is lacking

- The few existing figures in VC and angels in Argentina tend to show that there is little capital available for biotechnology firms in this country
- One (best) way to go would be to try to attract VC firms and personnel from North America and Western Europe, not an easy task these days.
- As Josh Lerner has shown, public VC experiences have most often been disastrous in both advanced and emerging countries

Patents are lacking

- Another way of attracting VC is getting patents, particularly US or EU patents, the most valuable in VC eyes, because more difficult to be granted.
- Patenting is costly and complex for academic institutions, and public labs
- Governments should create specific funds to support and give incentives to academics to patent
- These funds should be allocated by public agencies different from universities and government laboratories, starting with a small pilot program, evaluation, and fund renewal or program redesign, in a sort of iterative process

How many regional systems in a country

- The US has at most ten RSI in biotechnology around San Francisco, Los Angeles, San Diego, Boston, Washington DC and a few other agglomerations (the largest in the country)
- Canada has three: Montreal, Toronto and Vancouver, the largest metropolitan areas
- France has clearly two: Lyon and Paris (the two largest cities)
- Argentina may start with one (Buenos Aires), followed eventually by Córdoba, or Rosario

Conclusion

- Regional Innovation systems in biotechnology are complex evolving systems with at most half a dozen types of agents, of which research universities are the anchor tenant
- Where all elements are not present, public policy should try to attract them (i. e. foreign VC or angels) through the appropriate routines in universities and public labs (hiring internationally on meritocratic bases, patenting in countries with VC and angels).
- Public support should be abundant, patient and smart, and like in the case of Israel, or Singapore, not relying exclusively on local human capital