Does government funding increase patenting in the nanotechnology field? A comparison of Quebec and the rest of Canada

Leila Tahmooresnejad – Polytechnique Montréal

Catherine Beaudry – Polytechnique Montréal

International Conference of Patent statistics for Decision Makers, 12-13 November, Rio de Janeiro-Brazil

Outline

- Introduction
- Theoretical Framework
- Data and Methodology
- Regression results
- Conclusion

Motivation

- Nanotechnology has experienced rapid growth over the last two decades.
- There is no doubt that this emerging technology plays an important role in future economic development
- Nanotechnology has become an essential priority
- Government organizations have increased their investment in nanotechnology research in the past two decades

- Public funding for research facilitates the production of knowledge and is a key element for innovation in high technologies

- Universities and their affiliated centers play a vital role in national innovation systems

Objectives

- Measure the impact of grants on the innovation outputs of academic researchers
  - Patents
    - quantity
    - quality
- Measure the impact of technological networks (co-invention networks)
- Compare the impact in Quebec and the rest of Canada

Government Funding

- US National Nanotechnology Initiative (NNI) program in 2000
- Accordingly, Canada has initiated a variety of programs to benefit from nanotechnology development through the National Institute for Nanotechnology (NINT)
- Nanotechnology in
  - Alberta (NanoAlberta)
  - British Columbia (British Columbia Nanotechnology Alliances),
  - Ontario (Nanotechnology Network of Ontario)
  - Quebec (NanoQuebec)

Quebec

- Quebec government-funded research is at the forefront of the nanotechnology revolution in Canada
- NanoQuebec has conducted several university-enterprise projects to facilitate the collaboration between universities and industry
- NanoQuebec has financed different innovative projects over the past decade

Theoretical Framework (I/II)

- The literature generally finds that there is positive correlation between federal research funding and scientific outputs
- More government research funding results more papers and more patents with a lower rate
- It is of great importance for policy makers to measure the efficiency and productivity of research financing in nanotechnology

Theoretical Framework (II/II)

- Citations and Claims are ‘proxy’
- High quality research obtains more citations
- Papers and Patents of researchers, who received funding, receive more citations
  - e.g. Patents of researchers, who received NSF funding, received more citations compared with those of other researchers in Nanoscale Science and Engineering

Data and Methodology

Data

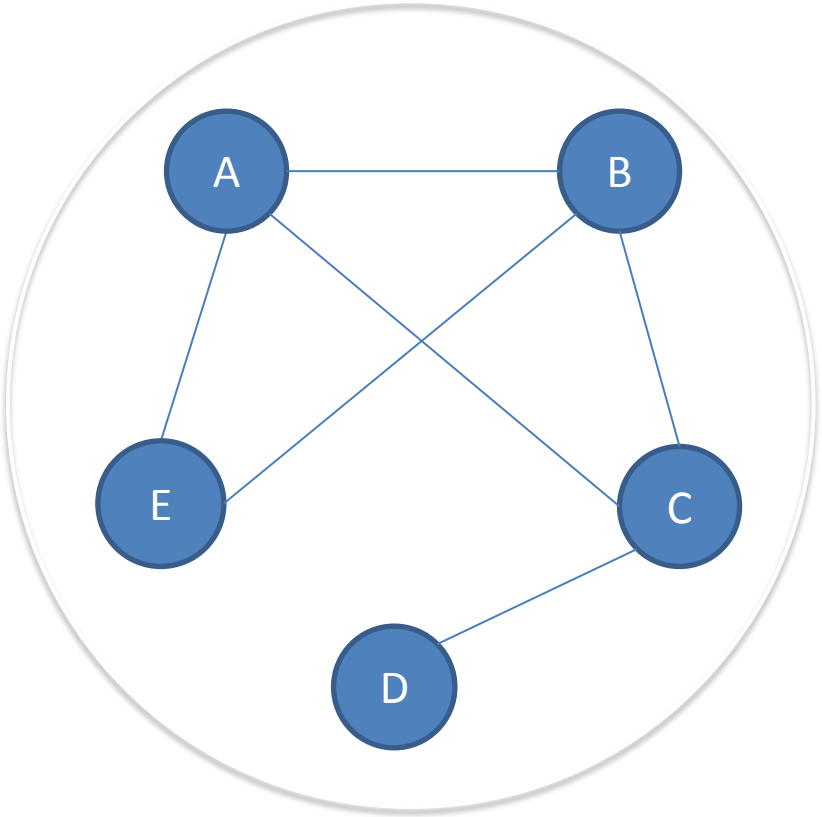
- United States Patent and Trademark Office (USPTO)
  - Extraction of nanotechnology scientific patents by using specific keywords in the title, abstract and keywords
  - Selection the patents where there is at least one Canadian inventor
  - Selection the patents where there is at least one inventor from Quebec
- Database of granting councils

Methodology

- Matching databases
- Creating a unique identifier for each individual researcher
- Data cleaning
- Creating co-invention networks
- Calculating network characteristics and the position of researchers

Network (I/III)

- A, B and C are the inventors of a patent
- A, B and E are the inventors of a patent
- C and D are the inventors of a patent
- Degree of a node
  - Number of links that are directly connected
  - A, B and C have 3 connections
  - E has 2 connections
  - D has 1 connection

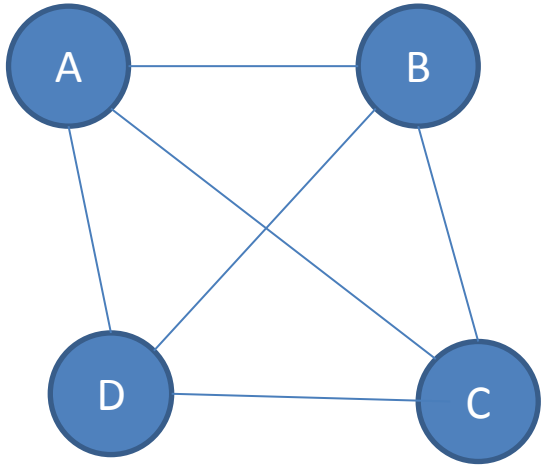


Network (II/III)

- Betweenness centrality of a node
  - is defined as the proportion of all geodesic distances between two nodes that includes this node.
  - It makes the node more powerful since it can control the knowledge flow between the other pair of actors
- Geodesic distance
  - Distance (shortest path) between two nodes

Network (III/III)

- Clustering coefficient
  - If two nodes are connected to the specific third node, they may also be connected to each other.
  - It is computed as the fraction of pairs of neighbors of a researcher that are directly connected each other.



Hypotheses

- ***Hypothesis 1***: *Public funding has a beneficial impact on the number of nanotechnology-related patents attributed to academic-inventors.*

- ***Hypothesis 2***: *Public funding has a beneficial impact on the quality of nanotechnology-related patents attributed to academic-inventors.*

Econometric Models

$$\begin{bmatrix} NumPat_{it} \\ NumCitation_{it} \\ NumClaim_{it} \end{bmatrix} = a + b_{S1} GrantAmount_{it-l} + b_{S2} \left[GrantAmount_{it-l} \right]^2$$

$$+ b_{P1} NumPatent3_{it-1} + b_{P2} NumPatent3_{it-1}^2$$

$$+ g_b NetworkM1_{it-2} + g_{c1} NetworkM2_{it-2} + g_{c2} \left[NetworkM2_{it-2} \right]^2$$

$$+ g_{bp} [NetworkM1_{it-2} \times NumPatent3_{it-1}] + g_{bc} [NetworkM1_{it-2} \times NetworkM2_{it-2}]$$

$$+ d_t \sum_t d_t + n_i + e_{it}$$

$GrantAmount3_{it-l}$

- The amount of average grants that are received in 3 years preceding the patent application with one year lag

$NetworkM1_{it-2}$

- The intermediary position of academic –inventors in the co –invention network over 3 years preceding the patent application with 2 years lag

$NetworkM2_{it-2}$

- The cliquishness centrality of academic –inventors in the co –invention network over 3 years preceding the patent application with 2 years lag

Results and Comparison

- Quebec
- Rest of Canada

The Impact of Public Funding on Patents

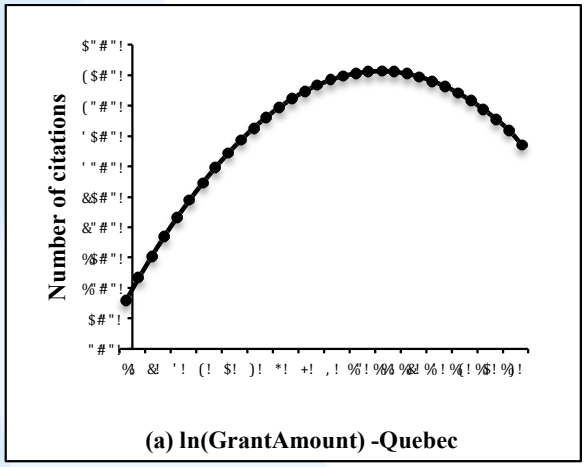
The number of patents

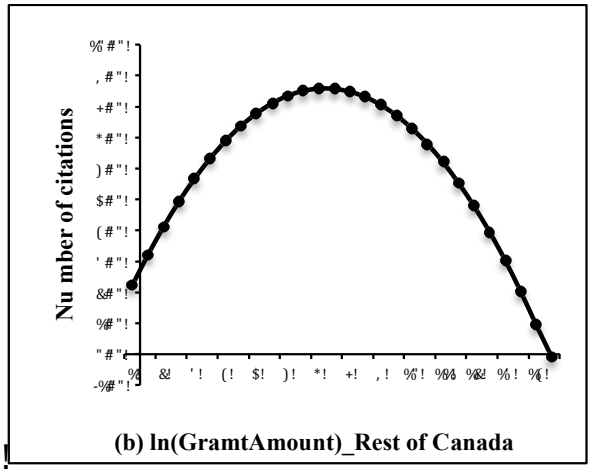
- We could not find a major effect of public funding on the number of patents
  - Quebec
  - Rest of Canada

- Explanation
  - Nanotechnology is an emerging field
  - We focused on academic inventors
  - Technological innovations require more industry involvement

Patent Quality

- **The number of citation**
  - Positive impact in Quebec (left graph)
  - Positive impact in the rest of Canada (right graph)

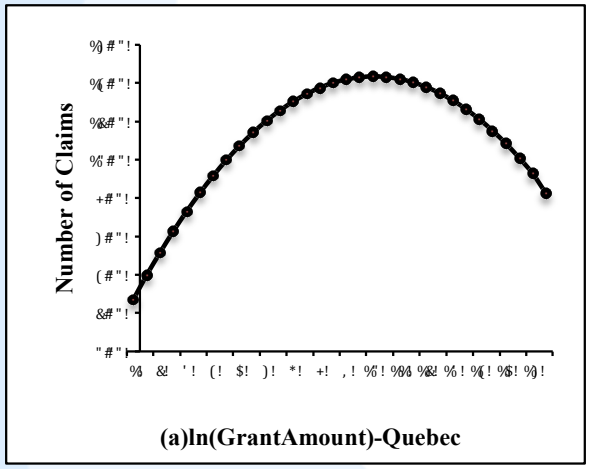


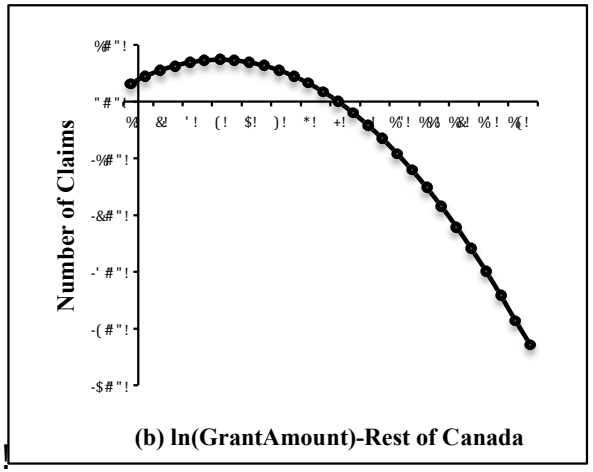


Patent Quality

The number of claims

- Positive impact in Quebec (left graph)
- Positive impact in the rest of Canada (right graph)





The Impact of Network measures on Patents

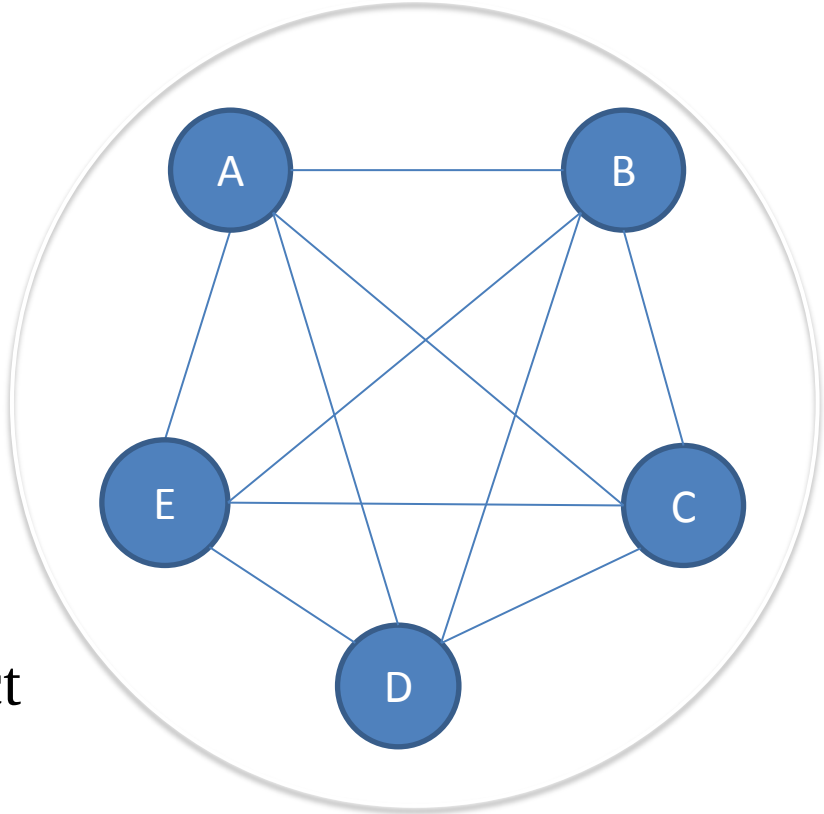
Network Measures

- **Network Measure1 (Betweenness centrality)**
  - **We could not find a positive impact**
    - **Quebec**
    - **Rest of Canada**
- **Network Measure2 (clustering coefficient)**
  - Significantly Positive impact
    - Quebec
    - Rest of Canada

Network Measure2

- Higher clustered groups
  result diminishing returns

- Some degree of integration
  can yield better results,
  but more integrated groups
  tend to have a negative impact



Conclusion

Conclusion

- More grants do not increase academic patents in the field of nanotechnology
- More grants are correlated with patent quality considering a threshold
- Collaboration of researchers has positive impact on both quantity and quality of patents

Thank you