Policy for innovation: insights from economic research

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Definition of innovation

- the first attempt to put a new product or process into practice (Fagerberg, Mowery, and Nelson, Oxford Handbook of Innovation, Chapter 1)
- the introduction of a new product or process to the market
- commercialization of an invention

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Some preliminary considerations

- Is invention an economic phenomenon?
  - In many cases, no
  - especially radical inventions
- However, making invention into successful innovation requires
  - Money
  - A market with willing buyers
- => subject to economic analysis

Some preliminary considerations

- Innovation & R&D are not the same thing
  - However, link is largely stochastic
  - Often focus on R&D because
    - We can measure it
    - It is directly responsive to policy
- E.g., Lisbon agenda
  - Achieving a 3% target for R&D/GDP
  - Shortfall largely in the business share of R&D (not in Sweden!)
    - One reason for this may be that the government share can be controlled directly by policy makers

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Overview

- Determinants of innovation – policy levers
- Economic evidence
  - mostly using R&D and patents as proxies for innovative activity
- Some new findings from innovation surveys
- Systems view

Determinants

- Classifying the determinants of innovation
  1. Supply
     a. Cost (of capital, inputs, science base)
     b. Market structure and appropriability
  2. Demand
  3. Environment – government and institutions
- *NB: All these factors imply a number of policy levers*

1a. Cost of capital

- R&D tax credits
  - Shown to be effective at increasing R&D in many countries (usually one for one)
  - Less evidence on their effects on innovative output
    - preliminary results for US suggest increased patenting
- In some countries (notably the UK but also LAC):
  - required rate of return to R&D can be quite high
- Market value of R&D assets in the US implies
  - private depreciation rates of around 15-35% (relatively high)
- We know less about other types of innovation investment
  - now being collected by survey, but reporting limited

1a. Venture capital

- A "contracting structure developed to manage the extreme uncertainty, information asymmetry, and agency costs that inevitably bedevil early-stage, high-technology financing" (Gilson, Stanford Law Review, 2003)
- Three pillars (all essential):
  - Source of capital
  - Specialized financial intermediaries
  - Entrepreneurs
- Even in the US, VC supplies a small share of capital for investment, but that share is important
- However, across countries, VC availability explains very little once we control for income level

1a. People

- Education system
  - Availability of highly trained scientists and engineers in the relevant discipline
  - Flexibility in training – the ability to retrain in a different (possibly related) field
- Immigration policies
  - Help to solve supply bottlenecks in S&E
  - Can be a source of entrepreneurs

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1a. Public research sector

- Much innovation relies on scientific knowledge
- This knowledge often the output of publicly funded research (either in public or private institutions)
- Developing effective links between such organizations and inventors/innovators seems to be a difficulty identified by many government policy makers, including those in the US.

Are all countries “below average” in performance?

Or is commercialization simply a very difficult process?

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1a. Industry-university links

- Faculty role very important in US
  - Obtaining invention disclosure a function of share retained by researcher
  - Participation in startup helps to predict its success
  - More successful researchers start firms
  - Entrepreneurial researchers also publish more, even after startup

1b. Market structure

- Large economic literature, theoretical and empirical, concludes that there is an inverted u-shaped relationship
  - Perfect competition leaves no profits for investing in innovation
  - Monopoly that is not threatened by entry has no incentive to innovate
  - Between the two, innovation first increases (due to increasing market share) and then decreases (due to lack of competitive threat)

1b. Appropriating returns

- Survey evidence in the US rates the following in importance for securing returns to innovation:
  1. Lead time, first mover advantage
  2. Secrecy
  3. Complementary sales/service
  4. Patents (more important in chemicals)
- Recently importance of patenting appears to have risen.
  - Probably for defensive reasons
  - Also because of the “knowledge economy” and increased importance of intangibles

2. Demand for innovation

- Market size
  - For small economies, thinking outside the country very important
- Consumer tastes
  - Needs
  - Willingness to try something new
- Needs of downstream firms
  - Demand for improved inputs

3. Environment

- Macro economy (stability; exchange rates)
- Regulatory environment
- Educational system
- Public-private research interaction
- Standard setting process
- => “national innovation system”

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What do we know?

- Considerable information on individual factors
  - Earlier work based on R&D/patent data
  - Newer work using innovation survey data
- Less on how they work together (mostly qualitative or very aggregate evidence)
  - Cross country studies
  - Some work on policy complementarity

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Innovation surveys

- Pioneered in US by Nelson, Cohen, Levin, Winter, et al. (Yale, CMU surveys)
- Now widespread:
  - EU countries (CIS surveys)
  - Canada, Australia, New Zealand
  - Norway, Switzerland, Russia, Turkey
  - Argentina, Brazil, Chile, Colombia, Mexico, Peru, Uruguay, Venezuela
  - South Korea, Taiwan, Singapore, Malaysia, Thailand, Japan, China
  - South Africa

Next few slides from Mairesse-Mohnen survey (in progress 2007)

Survey measures

- Innovation:
  - Product or process new to market (yes/no)
  - Share of sales from new products
- Demand pull/technology push:
  - Weak,moderate,strong effect on innovation activities (according to firm)
- Productivity – sales per worker, or TFP

Next four slides summarize some findings from the surveys

What have we learned? (1)

- R&D-productivity revisited
  - CDM model of R&D ⇒ innovation ⇒ productivity
  - estimated for ~12 countries
  - confirmed rates of return to R&D found in earlier studies
  - Like patents, innovation output statistics are much more variable ("noisier") than R&D

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What have we learned? (2)

- On determinants of innovation
  - probability of innovating increases with firm size
  - intensity of innovation is constant or decreasing with firm size
  - demand pull often significant and positive
  - technology push positive, less often significant
    - (controlling for industry)
  - incumbents tend to innovate more and innovation is persistent within firms
  - R&D, especially continuous R&D, matters for innovation

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What have we learned? (3)

- Crowding-out or additionality of government support for innovation
  (e.g., Czarnitski, Duguet, Arvanitis, Hall and Maffioli, etc., Klette et al. survey)
  - Matching estimators or simultaneous modeling of government support and firm performance
  - Most studies find additionality
  - Mixed evidence on performance (positive for Europe, less so for Latin America)

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What have we learned? (4)

- Complementarities (supermodularity: the whole is more than the sum of its parts) between
  - different types of innovation, e.g. product and process innovation (Miravete and Pernías 2006)
  - internal and external technology sourcing (Cassiman and Veugelers 2002)
  - different types of cooperation strategies (Lokshin, Belderbos, Carree 2005)
  - internal skills and cooperation (Leiponen 2003)
  - However, results are mixed and heavily dependent on the appropriate correction for unobserved heterogeneity

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Looking across countries

- Furman, Porter, Stern (RP 2002):
  - Measured innovation by patents
  - Varies one-for-one with population, FTE S&Es, R&D, GDP, or lagged patents across countries, high explanatory power
  - Best model includes GDP per capita, stock of patents, R&D spending or personnel, educ share of GDP, IP strength, private R&D share, univ R&D share, and degree of specialization of economy, explains 98% of variance across countries
  - Not a causal test, however

Innovation systems (1)

- Policies interact in a number of ways – more often complementary than substitutes
  - Mohnen-Roeller suggest policy choice among financial/ skill availability/ regulatory) should be
    - Joint to encourage firm to begin innovation
    - But needs to be only single to encourage increase in innovation intensity

Innovation systems (2)

- Effective VC requires thick financial market for exit (some notable failures).
- Good tertiary education does not produce much industrial innovation if the people trained are mainly channeled into secure govt lab jobs (LAC).
- R&D tax credits may not be effective if firms do not feel competitive pressure to innovate (Canadian case).
- Rapid increases in research funding tend to raise salaries of S&Es (whose supply is inelastic in the short run), somewhat reducing their real effectiveness (evidence for US, OECD).

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Thank you for listening

I look forward to learning about the situation in Sweden

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