Determinants of innovative performance: insights from economics

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Innovative performance

- 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
- Performance:
  - of an economy, sector, or firm
  - growth, profitability, productivity

Limitations

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

Basic economics of innovation

- Starting point (Nelson and Arrow):

Innovation is the production of new information, which implies

  - Increasing returns within the firm ("natural monopoly")
  - Nonrival - more than one firm can use it at the same time
  - Nonexcludable – cannot prevent others from using it

- All this creates a number of problems for policy and business strategy, even though they do not hold in their extreme form

Overview

- Determinants of innovation
- Economic evidence
  - mostly using R&D and patents as proxies for innovative activity
- New findings from innovation surveys

Determinants

- Classifying the determinants of innovation
  - Supply
    - Cost
    - Market structure and appropriability
  - Demand
  - Environment – government and institutions
- *NB: All these factors imply a number of policy levers*

Supply of innovation

- Cost of capital (interest rates, tax subsidies, etc.)
  - Corporate governance
- Venture capital availability
  - Skilled investors
  - Exit possibilities (financial markets)
- Cost and availability of trained scientists and engineers
- “technological opportunity”; public research sector

Cost of capital for R&D investment

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

Venture capital

- Even in the US, supplies a small share of capital for investment, but that share is important
- "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
- However, across countries, VC availability explains very little once we control for income level

Public research sector

- In many instances, innovation relies on scientific knowledge
- Such knowledge has a “public good” nature and is 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

Market structure; appropriability

- Firm size
- Market share
- Competitive pressure (domestic or global)
- Position in value chain – commodity or differentiated product?
- Appropriability – ability to capture value via IPRs or other means

Market structure and innovation

- 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)

Appropriating returns to innovation

- Survey evidence in the US rates the following in importance for securing returns to innovation:
  - Lead time, first mover advantage
  - Secrecy
  - Complementary sales/service
  - Patents (more important in chemicals)
- Recently importance of patenting appears to have risen
  - Probably for defensive reasons

Demand for innovation

- Market size
- Consumer tastes
  - Willingness to adopt something new
- Needs of downstream firms
  - Demand for improved inputs

Environment

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

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

Cross country results

- 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

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?

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

What have we learned? (2)

- R&D-productivity revisited
  - CDM model of R&D $\Rightarrow$ innovation $\Rightarrow$ productivity
  - estimated for ~12 countries
  - confirmed rates of return to R&D found in earlier studies
  - innovation output statistics are much more variable ("noisier") than R&D, as was found for patents
    - need to be instrumented by R&D

What have we learned? (3)

- Crowding-out or additionality of government support for innovation

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

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
- Complementarity of innovation policies (Mohnen-Roeller) – results suggest that policy choice among financial/skill availability/regulatory) should be
  - Joint to encourage firm to begin innovation
  - Single to encourage increase in innovation intensity

Innovation systems

- More examples of interaction effects:
  - Effective VC requires thick financial market for exit
  - Good tertiary education does not produce much industrial innovation if the people trained are channeled into secure govt lab jobs
  - R&D tax credits may not be effective if firms do not feel competitive pressure to innovate
  - 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

Final remarks

- A welcome innovation - the new inventor survey approach
  - Related to the innovation surveys but focused on inventors rather than firms
  - Pioneered in Europe
  - Now in Japan and US
  - Look forward to an excellent conference and to learning about the first comparative results