Management of Innovation: Lessons for Policy

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Introduction

Field of ‘innovation studies’ now ~50 years old

What have we learnt about the nature of the innovation process?

What have been the key developments in our understanding?

How do these help us with managing the innovation process more effectively?

What are the wider policy implications?

From individual entrepreneur to corporate innovator

Schumpeter – one of few economists in early/mid 20th C to consider importance of innovation

'Schumpeter Mark I' – stressed central role of individual entrepreneur

'Schumpeter Mark II' – gave increasing importance to collective innovative activities of large firms and in-house R&D

- reflected changes in US industry in mid-20th C

But still some examples of Schumpeter Mark I, e.g.

- Jeff Bezos @ Amazon
- Larry Page & Sergey Brin @ Google
- Mark Zuckerberg @ FaceBook

From *laissez faire* to government programmes

Pre-WWII – limited involvement of government in R&D & innovation, except in agriculture & medicine

WWII – Manhattan project, radar, cryptography, etc.

Post-WWII – major R&D programmes in defence, nuclear energy, space etc.

Based on belief in 'linear model' of innovation

Basic res → Applied res → Tech devlpt → Innovation

1950-60s – Gov't emphasis on supply-side policies

- Public investment in research and development
- Training of QSEs

From single division to multi-divisional efforts

Burns & Stalker (1961), *The Management of Innovation*

- Technological innovation influenced by different forms of organization (e.g. mechanistic VS organic) with their associated communication patterns
- Successful innovation requires integration of R&D with knowledge of market etc.
  - often hindered by internal divisions in the firm

From science push to demand pull

Science-push model – V Bush (1945)

- Provided rationale for government funding
- Favoured by scientists

Demand-pull model – changed market demand 'calls forth' innovation

Mkt demand ➔ App res ➔ Tech devlpt ➔ Innovation

- Often attributed to Schmookler (1966)
- Model picked up by e.g. Myers and Marquis (1969)
  - Study of >550 innovations in five industries
  - "Recognition of demand is a more frequent factor in innovation than recognition of technical potential"

2 models have very different policy implications, so various empirical studies to investigate

Science push VS demand pull

- Project Hindsight (1969) – DoD funded
  - Study of 20 military innovations
  - Critical research events primarily ‘technology’ rather than ‘science'
  - 95% of critical research events directed towards a DoD need
  - ➔ demand pull more important
  - BUT arbitrary cut-off point of 20 years
- TRACES (1968) – NSF funded
  - Study of 5 civilian innovations
  - Longer time-period
  - 70% of critical research events ‘nonmission-oriented’
  - ➔ science push more important
- Battelle (1973) – NSF funded
  - Study of ~10 civilian innovations
  - Distinguished ‘decisive’ from ‘significant’ research events
  - ‘Recognition of technical opportunity’ important in 89% of decisive events, cf. 69% for ‘recognition of need’

Science push VS demand pull

- Comroe & Dripps (1976) – NIH funded
  - Move from anecdotes to “objective, scientific techniques”
  - Key research underpinning advances in cardiovascular medicine
  - 62% of the research ‘basic’ – pays off “twice as handsomely”
- *Wealth from Knowledge* (1972*)*
  - Study of 84 innovations
  - Innovation “must involve synthesis of some kind of need with some kind of technical possibility”
  - Rejected simple linear models – “the sources of innovation are multiple”
- Gibbons & Johnston (1974)
  - Study of information inputs to 30 innovations
  - Interactions between basic and applied research are complex
- Mowery & Rosenberg review (1979)
  - Innovation an “iterative process, in which *both* demand and supply forces are responded to”
  - i.e. both demand and supply side influences crucial to understanding innovation process

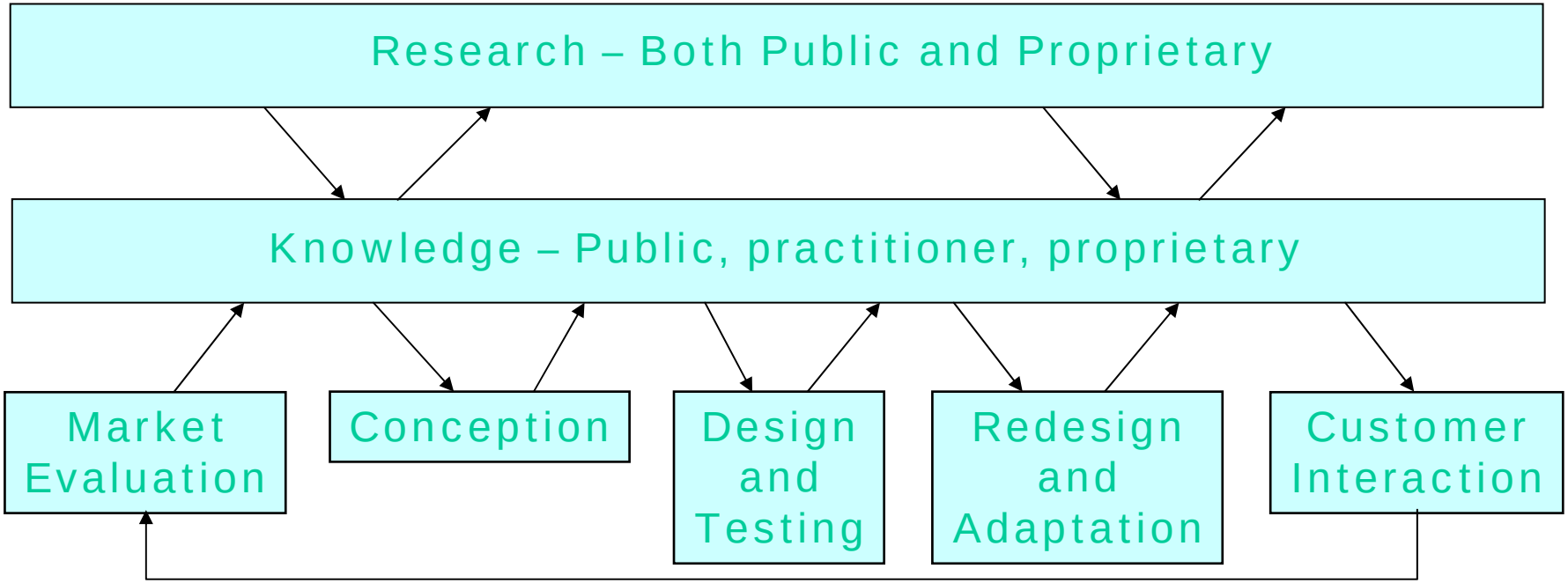
From single factor to multi-factor explanations of innovation

Early studies – focus on ***successful*** innovations

Project SAPPHO (Rothwell et al., 1974)

- 43 matched pairs of successful & unsuccessful innovations
- Most important factor = ‘user needs understood’
- Other significant factors include
  - attention to marketing
  - size of project team
  - good communication with external scientific community
  - support of senior ‘product champion’
  - coordination of R&D, production & marketing
- Success not greatly affected by
  - R&D organisation, incentives, academic qualifications of staff, size of firm, no. of QSEs, project planning, growth rate of firm

From linear model to interactive 'chain-link' model



Adapted from Kline & Rosenberg (1986)

A better representation of (complex) reality

- But harder to use for policy/management purposes

STI researchers keep 'slaying' ***the*** linear model

- But what happened to the other linear model?

From static to dynamic model of innovation

Abernathy & Utterback (1975 & 1978) – dynamic model of product & process innovation in specific industrial sector

- Initial period dominated by radical product innovation
- Attracts new entrants ➔ several competing designs
- Process innovations then become more important
- Emergence of a dominant design (e.g. Model T Ford, Boeing 747, IBM PC)

Barras (1986 & 1990) – innovation in services follows ‘reverse product cycle’?

- Cycle starts with process improvements to increase efficiency of delivery of existing services – larger firms likely to dominate
- Moves on to process innovations which improve service quality
- Leads to product innovations through generation of new types of services – scope for small entrepreneurial firms to generate radical innovations

From one innovation process to several sectoral-specific types

From earlier empirical studies, clear that sources & nature of innovation process vary with sector

Pavitt (1984) – analysed sectoral patterns

- Database of ~2000 innovations
- Taxonomy of different types of sectors
  - supplier dominated
  - scale intensive
  - specialised equipment suppliers
  - science based
- Taxonomy clarifies some of earlier differences in empirical findings re
  - S&T push VS demand pull
  - product VS process innovation
  - relationship between firm size and innovation

From neo-classical to evolutionary economics

Nelson & Winter (1982)

- Technological change and innovation central – generate ‘variation’ in form of new products, services etc.
- Firms compete with these products/services – market provides ‘selection’ mechanism
- Products/services strongly influenced by ‘routines’ within firms (standardized patterns of action) – provide ‘self-replication’ mechanism

i.e. analogy with biological evolution and‘survival of the fittest’

From the optimising firm to resource-based view of the firm

Neo-classical economists – view firms as optimising organisations – perfect information & rationality

Resource-based view of firm (Wernerfelt, 1984) – firms a collection of human & physical resources

- e.g. brand names, tech knowledge, equipment, skilled personnel, trade contacts, efficient procedures, capital

Subsequent work on e.g.

- knowledge & competence as strategic assets (Winter, 1987)
- absorptive capacity (Cohen & Levinthal, 1990 – see below)
- core competences (Prahalad & Hamel, 1990)
- core capabilities & rigidities (Leonard-Barton, 1992)
- dynamic capabilities (Teece et al., 1997)
- social & intellectual capital (Nahapiet & Ghoshal, 1998)

From individual actors to systems of innovation

Freeman (1987) – success of Japan heavily dependent on wider national system of innovation (NSI)

Lundvall (1988, 1992), Nelson (1993) – extended to other countries

Definition

> "that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies." (Metcalfe, 1995)

How effectively a NSI operates depends not just on the strength of the individual actors (companies, gov't labs, universities etc.) but more particularly on ***the strength of the links*** between them

From market failure to system failure

Nelson (1959) & Winter (1962)

- Scientific knowledge a ‘public good’ – i.e.
  - ‘non-rival’ – others can use the knowledge without detracting from the knowledge of the producers
  - ‘non-excludable’ – others cannot be stopped from using the knowledge
- Because they cannot appropriate all the benefits from their investment, private firms will tend to under-invest in R&D
- To achieve the socially optimal level of investment in S&T, government therefore needs to fund R&D

New rationale for public intervention = to overcome system failures & develop/strengthen links in NSI

- e.g. via networks, collaboration, Technology Foresight
- From ‘picking winners’ to building links

From one to ‘two faces’ of R&D

Cohen & Levinthal (1989 & 1990) – two roles of in-house company R&D

- to develop new knowledge internally
- to identify potentially useful external knowledge and quickly exploit it

Concept of ‘absorptive capacity’ – crucial for

- combining technologies (see below)
- successful open innovation (see below)

Jaffe and others – R&D generates ‘spillovers’

- firms need to be in position to exploit effectively spillovers generated by others

From single-technology to multi-technology firms

Many major innovations involve bringing together previously separate streams of technology

- ‘confluence’ (Martin & Irvine) or ‘technology fusion’ (Kodama)

Granstrand, Patel & Pavitt (1997)

- Technological diversity of growing importance to innovation
- In some sectors, firms need to combine several technologies
- ➔ Need for strategic alliances, links with universities etc.

From national to multi-level systems of innovation

NSI concept extended to other dimensions

- Regional system of innovation – e.g. Saxenian, Cooke
- Sectoral system of innovation – e.g. Malerba

Regional system of innovation also influenced by e.g. cultural factors

- R Florida – cities/regions with more cultural diversity & 'bohemian' lifestyles more creative/innovative?

Firms need to have effective links with all these different levels of systems if to benefit fully

From closed to open innovation

Knowledge required for innovating becoming more organisationally dispersed.

Locus of innovation shifting from within the firm to networks, alliances, collaborations etc. – i.e. innovation increasingly co-produced with partners (suppliers, users, universities etc.)

Variously characterised (e.g. by Powell et al., Chesborough, von Hippel etc.) as

- open innovation
- networked innovation
- distributed innovation
- interactive innovation
- democratic innovation

Firms need good links with external knowledge sources + ability to exploit these promptly & effectively

From R&D management to innovation leadership

R&D management – developed range of semi-formal tools for project planning

- e.g. portfolio analysis, project milestones etc.

Innovation leadership (e.g. Isaksen & Tidd, 2006) – 'upper echelon theory' (Hambrick & Mason, 1984)

- Decisions & choices by top management influence performance in 3 main ways:
  - *Cognition* - assessment of env't, overcoming limited cognition
    - "I think there is a world market for about five computers" (T.Watson, CEO IBM, 1948)
  - *Style & process*
    - given uncertainty, explore implication of a *range* of possible futures
    - encourage use of multiple sources of information, debate & scepticism
    - ensure broad participation & informal channels of communication
    - change strategy in the light of new & unexpected evidence
  - *Climate*
    - support, encouragement & resources for creativity & innovation

Conclusions

Over last 50 years, significant developments in our understanding of the innovation process

Original simple model ('science-push') gradually refined and made more complex

Embedded in framework of evolutionary economics and 'systems of innovation'

- "the Yale-Stanford-Sussex synthesis" (Dosi)

Important lessons for

- how best to manage innovation process within the firm
- for policy-makers

BUT complex models of innovation process more difficult to explain ➔ *Are they still as useful?*

Main developments in our understanding of innovation

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From *laissez faire* to government programmes

From single division to multi-divisional efforts

From science push to demand pull?

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From static to dynamic model of innovation

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From one innovation process to several sectoral-specific types

From neo-classical to evolutionary economics

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