

Economics of Innovation

Lecture 1 – Introduction

<http://www.economics-of-innovation.com>

Lecture 1

Course objectives

- To provide students with a comprehensive and advanced understanding of the origins, dynamics, and consequences of innovation from an economic perspective
 - Leaving the static perspective (mostly) behind
 - This is where economics gets really interesting and relevant (at least in my view)
 - For business students / applied people: Analytical tools and a "bird's eyes perspective" (let's make that an "eagle's eye"...))
- Tapping into different areas of economics
 - Macroeconomics
 - Industrial organization
 - Labor economics

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Pre-requirements

- Students are expected to have solid backgrounds in economics
 - Growth theory (Solow)
 - Microeconomics
 - Competitive markets
 - Monopoly
 - Oligopoly (Cournot)
 - Game theory (Nash equilibrium)
 - Welfare
 - Public goods
 - Externalities
- Contents build on BA course "Intro to ESOE"

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Recommended background reading - 1

- Hal Varian (2010): *Intermediate Microeconomics*, 8th ed
 - Ch 1: **The Market**
 - Ch 15: Market Demand
 - Ch 16: **Equilibrium**
 - Ch 18: Technology
 - Ch 22: Firm Supply
 - Ch 23: Industry Supply
 - Ch 24: **Monopoly**
 - Ch 27: Oligopoly
 - Ch 28: Game Theory
 - Ch 29: Game Applications
 - Ch 34: **Externalities**
 - Ch 35: **Information Technology**
 - Ch 36: **Public Goods**

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Recommended background reading - 2

- Sørensen & Whitta-Jacobsen (2005): *Introducing Advanced Macroeconomics*
 - Ch 1: Macroeconomics for the long run and the for the short run
 - Ch 2: **Some facts about prosperity and growth**
 - Ch 3: Capital accumulation and growth: The basic Solow model
 - Ch 5: **Technological progress and growth: The general Solow model**

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Contents

1. Introduction – terminology and measurement issues
2. Innovation and economic growth
3. Incentives to innovate and market failure
4. Market structure and innovation
 - Discussion of homework 1
5. Diffusion of innovation
6. Strategic management of innovations in network markets
7. Labor market effects of innovation
 - Discussion of homework 2

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Terminology: Innovation

- Used in various contexts with different meanings
 - Economics
 - Sociology (e.g. distribution of social power and change)
 - Law (e.g. patents)
 - Business (e.g. use of new ideas, perceptions of costumers)
 - Common language ("introduction of something new; new idea, method, or device," *Merriam-Webster Dictionary* 2003)
- No right or wrong definition, context determines if definition is appropriate
- In economics, *innovation* is closely related to *technology* and *knowledge*

Terminology: Technology 1

- Technology in an economic sense:
 - The goods and services produced and the means by which they are produced in a firm, an industry or economy (Stoneman 2002)
 - Technology in its purest form is knowledge – knowledge to pursue our goals and solve our problems (Simon 1973)
 - To *innovate* means to generate and to apply *new* knowledge / *new* technology that solves practical problems
 - No innovation without new knowledge, but not vice versa

Terminology: Technology 2

- Different ways to express technology in microeconomics:
 - Production function
 - Examples: Cobb-Douglas and Leontief
 - Production possibility set
 - Input requirement set
 - Isoquant
 - Cost function
 - Specific characteristics of technologies / production functions
 - Monotonicity and convexity
 - Returns to scale (decreasing, constant, increasing)

Terminology: Technological change & innovation

- Technological change
 - ...means change in the goods and services produced and the means by which they are produced (Stoneman 2002)
- Technological advances
 - ...are changes where the new is in some sense superior to the old
- Product innovation
 - ...are technological advances in the nature and types of products produced
 - For example, higher quality or creation of new supply function
- Process innovation
 - ...are technological advances in transforming inputs into outputs
 - For example, lower marginal costs

Process innovation

- General interpretation in microeconomics:
 - Lowering production costs for given level of output, or...
 - ...same production costs (or input requirements) lead to a higher level of output
- Many different sources possible, for example:
 - New machinery
 - Changes in layout of factory
 - New work flows or procedures
 - Better management methods (e.g. just-in-time production or employee motivation)
 - Better raw material or intermediate inputs employed (suppliers)
 - Better or faster access to crucial information
 - Less mistakes

Terminology: Innovation cont.

- The classic definition of innovation by *Schumpeter* (1934): "carrying out of new combinations"
- Five possible cases
 - Introduction of a new good
 - Introduction of a new method of production
 - Opening of a new market
 - Opening of a new source of supply
 - Carrying out of the new organization of an industry, like the creation or breach of a monopoly position
- This is largely compatible with the more precise, modern microeconomic definition of innovation
- Subjective dimension of innovation – new for whom?

Terminology: Innovation cont.

- Different degrees of innovativeness
 - Radical (major, basic...) vs.
 - Incremental (minor, improvement...)
 - Different degrees in between
- Schumpeter restricted his analysis to radical innovations
 - Discontinuous change
 - Destroys existing market equilibria
 - "Creative destruction"
 - But: Most innovations are not radical, nevertheless they have economic implications
- Invention vs. innovation: Innovation requires practical use of an invention (adoption and diffusion)

Innovation and microeconomics - 1

- The core of microeconomics is concerned with *static* efficiency
 - The pricing system
 - Allocation of resources and rents
- Innovation is inherently *dynamic*
 - It changes the status quo
 - It distorts static efficiency
- Does microeconomics have anything to say about innovation?
 - Consequences of innovation: Yes! (e.g. comparative statics)
 - Origins of innovation: Yes! (see next slide)

Innovation and microeconomics - 2

- How can microeconomics help us understand the origins of innovation?
 - In many markets, innovation (and the strive for at least temporary monopoly profits) is a major competitive weapon
 - Many firms cannot leave innovation to chance, a random occurrence is not satisfactory. Instead, attempts to innovate become *routinized* activities of firms (R&D, collaborations etc.)
 - Microeconomics helps us understand the incentives to innovate
 - Just like other investment activities, attempts to innovate are characterized by
 - investments now...
 - ...in expectation of (uncertain) returns in the future.
 - Hence, the standard micro-economic theory of investment can readily be applied

Measurement of innovation

- Measuring inputs and outputs of inventive activity is problematic
 - Identification
 - Valuation
- Innovations differ widely with respect to
 - Magnitude of problem overcome
 - Technical potential
 - Economic contribution
 - Economic costs
- Costs not necessarily related to economic contribution (e.g. Internet vs. super-sonic airplanes)

Measures for innovation input - 1

- R&D expenditures
 - Advantages
 - Available from official statistics with many details
 - Relatively good comparability across sectors, countries and time
 - Disadvantages
 - Imprecise and subject to measurement error
 - R&D expenditure is neither a necessary nor a sufficient condition for innovation
 - Exclude individual and independent inventors and inventions made by people in non-R&D jobs
 - Inventions are often made for non-pecuniary motives (joy)
 - Firm- and industry differences in technological opportunities and R&D efficiency usually unknown – make interpretation of innovation input data very hard

Measure of innovation input - 2

- Measures of knowledge stock (accumulated R&D capital)
 - Depreciation?
 - When does new knowledge lose its commercial value? Unknown...
 - Spillovers?
 - A firm might use knowledge generated elsewhere – this usually does not show up in R&D costs
 - Lags?
 - Spending on R&D generates new knowledge only with a significant time gap – how long before R&D spending should count as part of knowledge stock? Unknown...

Measures of innovative output - 1

- Patents
 - Advantages:
 - Availability
 - long time series (the patent system is old and records have been stored since the introduction of patent law)
 - much detail (applicant, type and nature of invention, relation to previous inventions)
 - publicly available (e.g. Internet and patent offices)
 - Represent a new and technically feasible device
 - Someone believes the economic value of the patent warrants the expense of application
 - Very strong empirical relationship between
 - R&D intensity and patents
 - MF productivity and patents

Measures of innovative output - 2

- Patents
 - Disadvantages:
 - Not all inventions are patented
 - Most patents never used – measure of invention, not innovation
 - Firms and inventors might patent strategically to prevent competitors from commercializing an idea
 - Value of patents vary significantly, highly skewed distribution – we cannot readily assume that all patents have the same economic value
 - Average value of patents is likely to vary across time and space
 - Different importance of patents across industries – makes comparisons difficult
 - Identification of innovator is not always straight forward (e.g. subsidiaries or spin-offs of large firms)

Measures of innovative output - 3

- Patent citations
 - Advantages
 - Number of citations is a proxy for the technological value of a patent
 - More informative about the economic value of a patent as well
 - Does have legal relevance
 - Citations are available (although difficult to analyze)
 - Disadvantages (again):
 - Not all inventions are patented
 - Difficult to compare across countries, sectors, time periods...
 - Older patents more likely to have citations, although they might not be more valuable than newer patents (weighting over time?)

Measures of innovative output - 4

- Questionnaires – the ‘subject’ approach
 - e.g. Community Innovation Survey
 - Advantages
 - Differentiates between different kinds of innovation
 - Simple questions
 - Disadvantages
 - Subjective measurement
 - Who was asked?
 - How did the respondents interpret the question?
 - What was the reference points of the respondents?
 - Economic value of innovations unknown
 - Very similar to patents in this respect

Measures of innovative output - 5

- Questionnaires – the ‘object’ approach
 - Focuses on the objective output of innovation, the technologies or products themselves
 - For example, the SPRU database of major technical innovations in British industry from 1945 – 1983 (N = 4,300, information provided by 400 technical experts from different backgrounds)
 - For example, US Small Business Administration database of innovation by SMEs in 1982
 - Advantages:
 - Validated judgments about what is a (relevant) innovation
 - Historical perspective and many details available
 - Disadvantages:
 - Subjective because of personal judgment
 - Biased because it does not include all (incremental) innovations

Summary

- Innovation can be clearly defined from an economic perspective
- Classic economic tools can be used to analyze the origins and consequences of innovation, although innovation is (until now) not the core topic of economics nor a stand-alone field within economics
- Yet, the importance of innovation is widely recognized
- Innovation is difficult to measure, but the attempt to do so is worthwhile and not hopeless...
