The Value of Patents

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Literature review topics

- This lecture – economics of patents and patent value
- Next lecture - the role of patents in tech transfer and technological development

Economics of patents

- Theory and tradeoffs
- Do patents promote innovation?
- What do we mean by patent value?
- Some results for patent valuation

Simple economic view of patents

- Trade off limited-term right to exclude (monopoly) in return for incentive to innovate (and reveal the innovation)
  - Good for innovation
  - Bad for competition
- But……
  - Is this true in practice?

Patent system as viewed by a "two- handed" economist

Effects on	Positive	Negative
Innovation	creates an incentive for R&D and innovation investments	impedes the combination of new ideas & inventions; raises transaction costs; inhibits cumulative invention
Competition	facilitates entry of new or small firms with limited assets; enables vertical disintegration	creates short-term "monopolies", which may become long-term in network industries

Patents may inhibit innovation

- The patent thicket
  - problem of contracting when many inputs are essential - high transaction costs lead to breakdown
  - Large numbers of patents in a given area, impossibility of adequate search
  - Ex post holdup by patentholder after costs are sunk
  - Given litigation costs, even "invalid" patents can be enforced
  - Increases the risk of innovation
  - Discourages entry (increases sunk costs)

Patents may help competition

- Increases dynamic competition by facilitating entry
  - Useful for securing financing in knowledge-intensive industries (where there are few tangible assets)
- Can lead to competition-enhancing vertical disintegration by facilitating trade in technology (specialization; interface standardization)
  - Chemicals - Arora, Fosfuri, Gambardella
  - Semiconductor design firms – Hall & Ziedonis

When do patents encourage innovation? - theory

- When one product = one patent
  - May produce too much innovation, not too little (patent racing literature)
- When one product = many patents
  - Uncertain, but probably too little (Bessen-Maskin)
- When one invention builds on another
  - Uncertain due to difficulty of contracting between first and second inventor (Scotchmer)

When do patents encourage innovation? - empirics

- Methodology:
  - Compare innovative performance of economies with different patent systems
  - Compare the same economy before and after changes to the system
- Challenges:
  - Need an innovation measure other than domestic patents
  - Hysteresis – patent system affects industry structure and strategy, so changes may not produce immediate response
  - Simultaneity – patent systems tend to develop along with economies, as a result of demand from firms

Historical 19C evidence

- Variation across Europe and the US in patent law
  - Moser (2005) – strength and existence of patent system had little effect on overall innovation (world's fair exhibits), but change in focus
  - Lerner (2001) - increase in patenting by foreigners but no increase by firms within country or by firms in those countries in Britain (that is, no increase in innovation)

20th century cross country evidence

- Ginarte and Park (RP 1997); Park and Ginarte – 60 countries, 1960-90.
  - R&D intensity predicts strength of IPR in developed countries
  - strength of IPR (including coverage of pharmaceuticals) positive for R&D in developed countries
- Kanwar and Evenson (OEP 2003) – 32 countries, 1981-95.
  - similar results, also using G-P index
  - no controls for simultaneity
- *More in the next lecture*

Survey evidence

- Industrial R&D managers in the US
  - Yale survey (Levin, Klevorick, Nelson, and Winter 1983)
  - Carnegie-Mellon survey (Cohen, Nelson, and Walsh 1994)
- EU innovation surveys
  - 1993 CIS for Norway, Germany, Luxembourg, the Netherlands, Belgium, Denmark, and Ireland – 2,849 R&D-performing firms (reported in Arundel 2001)
- → patents not the most important means of securing returns to innovation
  - Only ~10% of respondents rate them first or second
  - Exceptions: pharmaceuticals, specialty chemicals, medical instruments, auto parts

A useful taxonomy

- "discrete" product industries
  - food, textiles, chemicals including oil and plastics, pharmaceuticals, metals, and metal products
  - patents used to exclude, and sometimes for licensing; also to prevent litigation
- "complex" product technologies
  - machinery, computers, software, electrical equipment, electronic components, instruments, and transportation equipment
  - patents used in negotiations (cross licensing and other), and to prevent litigation
- In general, patents more important for appropriability in discrete product industries
- Strategic uses (cross licensing, negotiations) greater in "complex" product industries

Summary

- The role of patents in encouraging innovation is ambiguous
  - Positive on balance in discrete product industries
  - Neutral or negative in complex product industries
  - BUT considerable heterogeneity within industry
- Patents may actually help competition if they facilitate entry or leapfrogging

What is the value of a patent?

- Private value
  - (1) Value of a patent right – incremental value of owning a patent on an innovation
    - Renewal value – alternative is competition
    - Asset value – alternative is monopoly
  - (2) Value of the underlying innovation (including the value of owning the patent)
- Social value
  - (3) Benefit to society of the innovation (including value captured by the innovator)
- Note: SV >?< PV

Some general issues

- The relationship between innovation and patenting is variable – depends on technology, time, and institutional setting
- The average value of a patent right is also variable
  - varies with the strength of patents and the legal environment
  - Is generated endogenously by the amount of patenting firms do in response
- Patent portfolios may have a higher value than the patents they contain

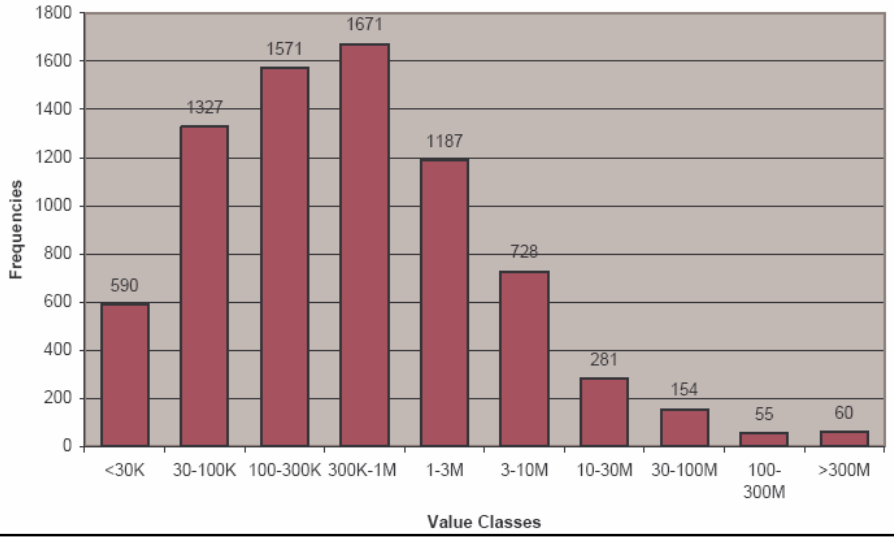
Measuring patent value

- Survey evidence on individual patents
  - Harhoff, Scherer, and Vopel (RP 2002) – German patentholders
  - EU Patval survey, now in US, Japan, and Korea
- Market value of the firms that hold patents – measures "portfolio" value

Patent value surveys – measure asset value

- "If in 1980 (issue date) you had known how its contribution to the future profitability of your enterprise would unfold, what is the minimum price for which you would have sold the patent, assuming that you had a good-faith offer to purchase?" (Harhoff, Scherer, Vopel, Research Policy 2002)
- "The inventors were asked to estimate the minimum price at which the owner of the patent, whether the firm, other organisations, or the inventor himself, would have sold the patent rights on the day on which the patent was granted. To improve the accuracy of this estimate we asked the inventor to assume that he had all the information available at the moment in which he responded to the questionnaire." (Giuri et al 2005, Patval Survey)

19. Patent value distribution for European firms (euros)



Patent value correlates (1)

- Useful survey summarizing patent value correlates: van Zeebroeck and van Pottelsberghe de la Potterie: Filing strategies and patent value, September 2007
  - References (citations) variables
  - Geographical scope of coverage
  - Length (renewals)
  - Legal disputes
  - Prosecution history
  - Ownership variables

Patent value correlates (2)

- Patent characteristics
  - Forward citations
  - Number of EPO X or Y citations
  - Number of backward patent citations
  - Number of backward non-patent citations (mixed)
  - Institutional origin of forward citations; share of self citations
  - Generality index (?)
  - Basicness/Originality index (?)
  - Number of claims
  - Number of IPC classes (mixed)

Patent value correlates (3)

- Geographical scope (families)
  - Triadic
  - Number of countries worldwide
  - Number of EPC validation states
- Length (renewals)
- Legal disputes
  - Litigation
  - Opposition and opposition outcomes
  - Multiple opponents

Patent value correlates (4)

- Prosecution history
  - Number of inventors listed (mixed)
  - Filing route - PCT vs. direct (mixed)
  - Accelerated search request at EPO (-)
  - Accelerated examination request at EPO
- Patent ownership characteristics
  - Ownership structure (co-applicants -)
  - Cross-border ownership
  - Applicant size (mixed)
  - Market size (mixed)
  - Academic inventor (-)
  - Independent inventor (-)

Market value approach

- Relate the financial market valuation of a firm to its assets:
  - Tangible – plant, equipment, inventories, etc.
  - Intangible – knowledge capital, patent stocks, reputation, etc.
- Coefficients in the regression are the shadow value of the various assets in the market
- NOT structural parameters – vary over time and space

Market value (Tobin's q) regression

$$V_{it}(A_{it}, K_{it}) = b_t [A_{it} + \gamma K_{it}]$$

Non linear: $\log V_{it} - \log A_{it} =$
$\log q_{it} = \log b_t + \log(1+\gamma_t K_{it}/A_{it})$

Linear: $\log q_{it} = \log b_t + \gamma_t K_{it}/A_{it}$

Interpretation:

$q_{it} = V_{it}/A_{it}$ is Tobin's q; A_{it} is measure of tangible assets
K_{it} = knowledge capital
b_t = overall market level (approximately one)
γ_t = relative shadow value of K assets

Knowledge capital

- Usually measured using a declining balance formula:

$$K_{t+1} = (1-\delta)K_t + R_t$$

where R stands for R&D investment or patents, or for patents weighted by citations

- Including both R&D and patents – gives marginal value of "patent right"
- Including patents only – gives the marginal value of the underlying innovations

What have we learned from this regression?

- Large amount of research using this equation, primarily US, UK, Europe, and Japan (survey on my website)
- With a few exceptions, patent stocks help to explain market value, with or without R&D in the equation
- Some estimates of patent value obtained, largely consistent with other approaches
- Caveat: simple counts are a very noisy indicator (=> downward bias to coefficient)
  - Using weights like forward citations helps

Some estimates of (worldwide) patent value for the US

Study	Data sample	Estimated patent value
Griliches (1981), with R&D	157 US public manufacturing firms, 1968-74	$200K
Cockburn and Griliches (1988), without R&D	722 US public manufacturing firms, 1980	$213K
Hall et al. (2005), with R&D	2261 US public manufacturing firms, 1985-95	$80K (med)
Hall et al. (2005), without R&D	2261 US public manufacturing firms, 1985-95	$348K (med)
Bessen (2007), without R&D	3451 US public manufacturing firms, 1979-97	$376K

Results using (forward) citation weights

- Cites per patent are more important than patent yield itself - increase of one cite per patent is associated with an increase of 3-4% in market value
- Highly nonlinear relationship
  - Only having cites per patent above the median matters
  - 50-75% boost to market value if citations per patent average above 20!
- Do citations received before value is measured matter more or less than those received after?
  - Less, although they are useful for forecasting.
  - Predictable and unpredictable citations receive approximately equal weight.
- Self cites worth about twice as much as ordinary cites (but depends on portfolio size)

Future work

- Market value and other patent characteristics
- Determinants of opposition/litigation (other than pure value measures)
  - Strategic interaction between firms