
Patents: Who uses them, for what and what are they worth?

Ashish Arora
Heinz School
Carnegie Mellon University

Major theme: conflicting evidence

Value of patents

- Received wisdom in economics and management – patents are not very valuable.
 - Changing slowly
 - Growing interest in patents and patenting
- More recent studies show much higher values
 - Renewal studies
 - Survey based studies

How value is extracted:

- Users & uses of patents
 - Incentives for R&D investments or “*harvesting*”?
 - Basis for market for technology
 - Bargaining chips?
 - Fences
-

Value of patents? Many more questions than answers

Evidence from 1950s-1970s

- Survey (Levin et al., Brookings) that there are many effective ways (other than patents) for protecting innovation.
- Steady decline in patent/R&D
- Patent renewal studies show highly skewed distributions
 - Typical (median and modal) patent values are small
- Licensing not very profitable (e.g., Caves et al. 1983)

More recent evidence

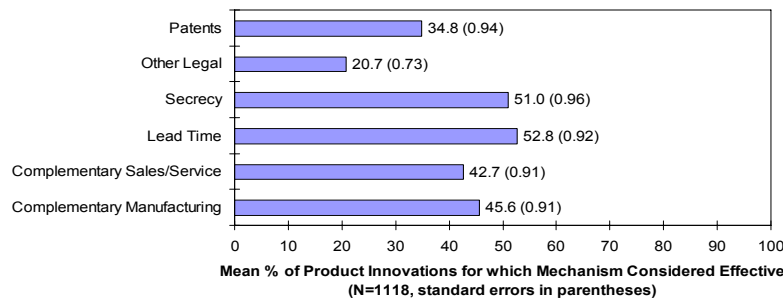
- Survey (Cohen, Nelson and Walsh, 2000) shows patents are still deemed less effective than alternatives
 - In most industries, the majority of inventions are not patented
- However, econometric analysis from same data shows patent protection is valuable and stimulates R&D
- Direct survey based measures of value
 - Patents are valuable (ten times as valuable !)
- Strong growth in licensing and market for technology

Has the world changed so much?

Survey based evidence suggests that there are many effective ways (other than patents) for protecting innovation.

Often, incorrectly interpreted to mean patent protection is not valuable

Effectiveness of Appropriability Mechanisms for Product Innovations



Source: Cohen, Nelson and Walsh, "Protecting their intellectual assets", 2000 NBER

Relationship between patents and other mechanisms?

Published patent renewal studies showed highly skewed distributions with small average values of patents ~\$15K

TABLE 5 Distribution of the Value of Patent Rights, by Technology Field: 1970 Cohort

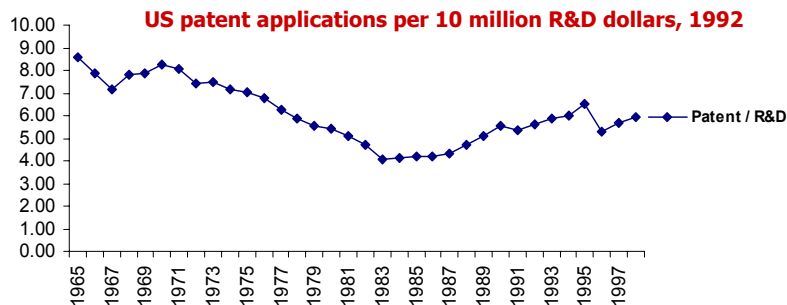
Quantile	Pharmaceuticals	Chemicals	Mechanical	Electronics	Electronics (excluding Japan)
.25	515 (128)	447 (103)	638 (312)	1,450 (1,256)	627 (279)
.50	1,631 (539)	1,594 (591)	2,930 (1,666)	7,933 (9,228)	3,159 (1,708)
.75	5,427 (2,437)	5,807 (2,859)	13,769 (9,935)	46,964 (53,265)	16,322 (11,055)
.90	11,787 (6,061)	13,735 (7,039)	40,840 (35,547)	170,958 (315,079)	53,122 (58,822)
.95	19,920 (11,211)	24,363 (13,814)	83,857 (81,228)	402,292 (826,778)	113,403 (105,162)
.99	52,139 (34,565)	69,906 (46,983)	321,966 (375,386)	2,016,797 (4,984,719)	481,429 (538,827)
Mean	4,313 (1,995)	4,969 (2,591)	15,120 (13,692)	68,502 (134,208)	19,837 (18,020)

Notes: Figures refer to the private value of patent rights (in 1980 U.S. dollars), measured from date of patent application. They are simulated using parameter estimates for the log-normal patent-renewal model with fixed cohort effects in μ and year effects in δ , columns (3) in Table 4. The discount rate is set at .10. Estimated standard errors in parentheses are computed by the delta model.

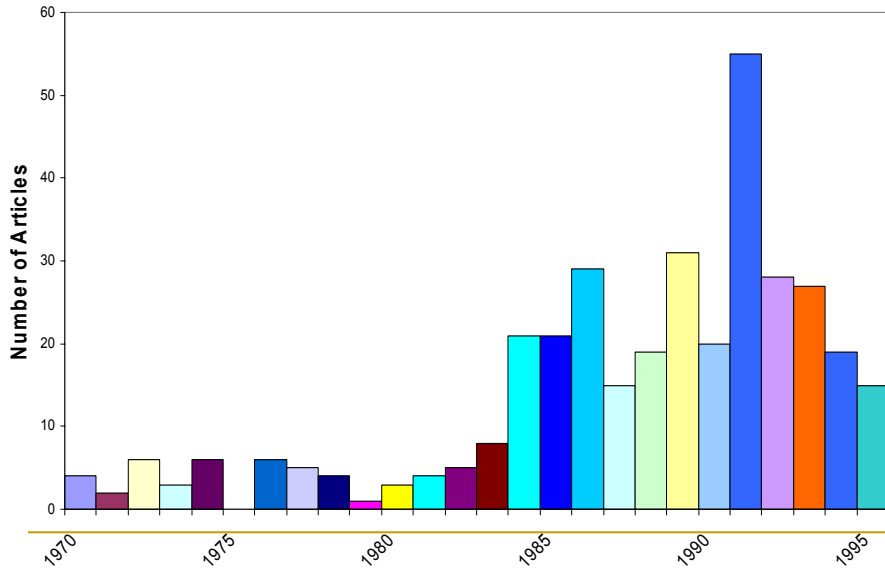
Source: Schankerman, 1998, RJE

Rapidly growing interest in patents since 1980s

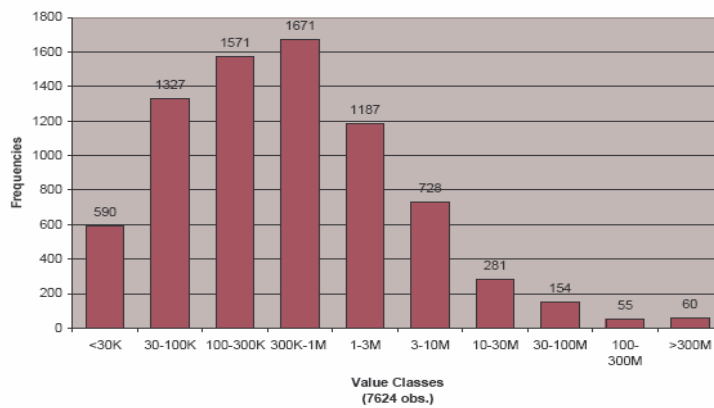
1. Since 1984, annual patent applications (and grants) in U.S. have grown rapidly. (Hall, 2003)
 - 30% of increase due to increase in patent per R&D dollar (Kim and Marschke, 2003).
 - Increase would have been even greater but for the increase in R&D share of pharmaceuticals (which has low patent per R&D dollar)



Number of "Patent" Articles in Economics Publications, 1969-95, Source: F.M. Scherer, 2003



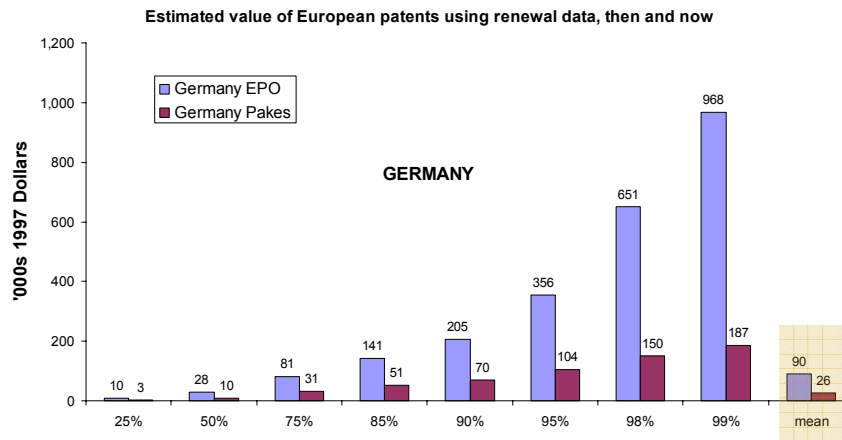
Distribution of Patent Values (Gambardella, Harhoff and Verspagen, "Value of patents", 2005)



Patent value distribution is skewed but high average value between 300K and 1 million Euro.
1993-97 data

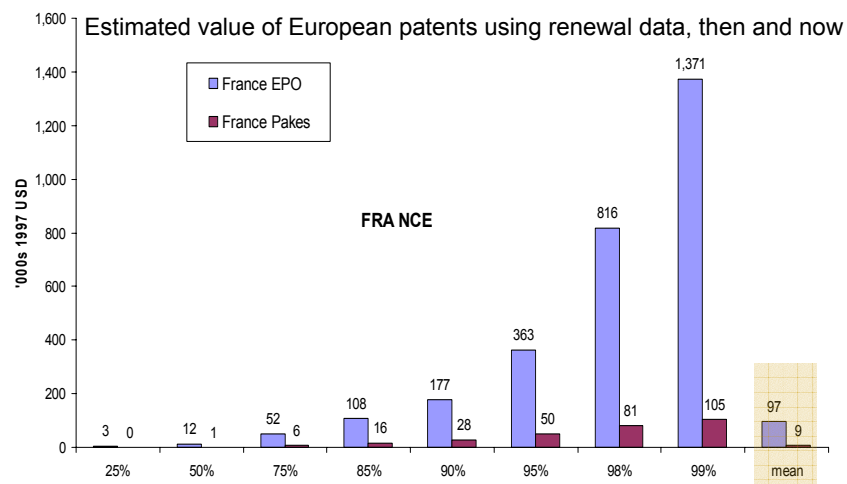
Even renewal studies indicate 7x to 10x higher values of patents than earlier studies (source: Yi Deng, 2003, mimeo)

But still much smaller than direct estimates from PatVal

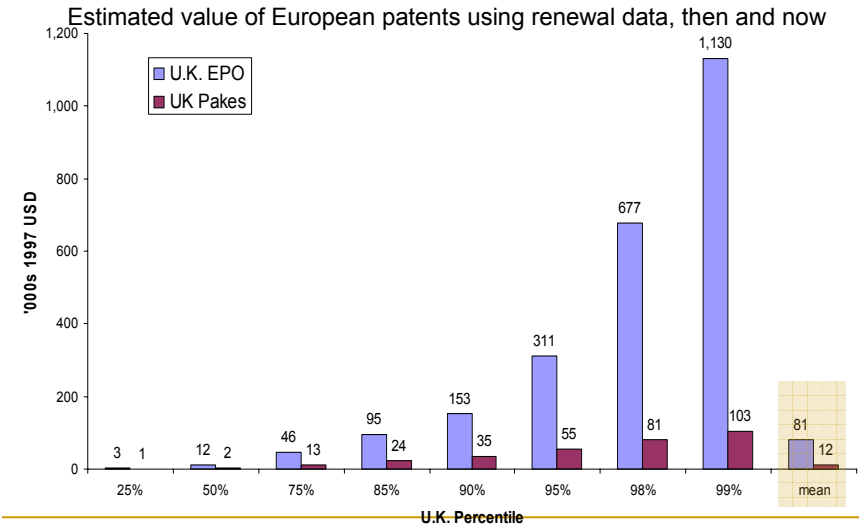


Mean value is important, not median

Even renewal studies indicate 7x to 10x higher values of patents than earlier studies (source: Yi Deng, 2003, mimeo)



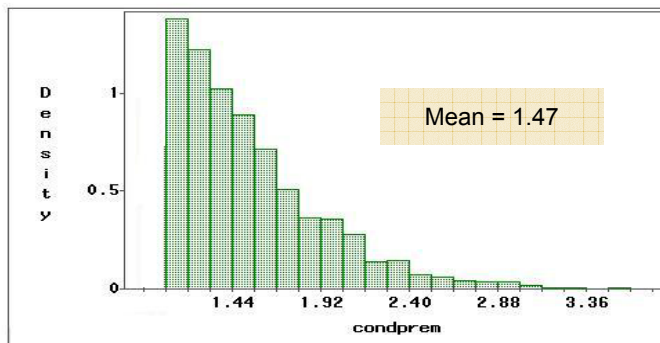
Even renewal studies indicate 7x to 10x higher values of patents than earlier studies (source: Yi Deng, 2003, mimeo)



Econometric analysis of CMU Survey data: Patent protection adds 47% to value of innovation for patented innovations.

Estimated value of Patent premium for patented innovations

(source: Arora, Ceccagnoli and Cohen, 2003, NBER)



"Patent Premium" = % addition in value of innovation captured by innovator relative to not patent

Estimated using R&D response to patenting behavior

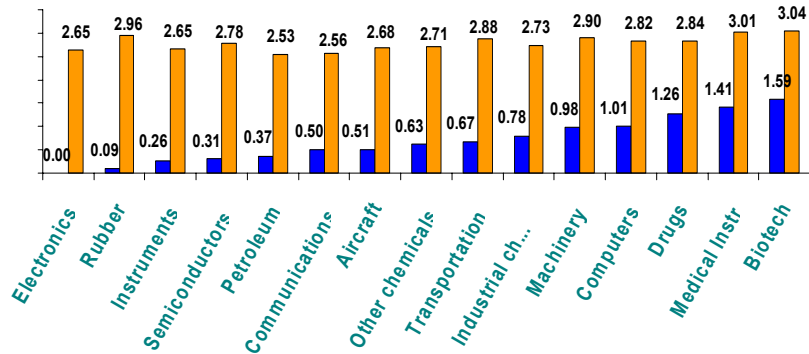
Measures value of patent protection, not value of a patent

Estimated value of patent protection: Econometric estimates from surveys.

"Patent Premium" = % addition in value of innovation captured by innovator relative to no patent.

Estimated using R&D response to patenting behavior. Measures value of patent protection, not value of a patent

■ Average Patent Premium, All Innov. ■ Average Patent Premium, Patented innov.



(source: Arora, Ceccagnoli and Cohen, 2003, NBER)

Major theme: conflicting evidence

Value of patents

- Received wisdom in economics and management – patents are not very valuable.
 - Changing slowly
 - Growing interest in patents and patenting
- More recent studies show much higher values
 - Renewal studies
 - Survey based studies

How value is extracted:

- Users & uses of patents
 - Incentives for R&D investments or "harvesting"?
- Basis for market for technology
 - Bargaining chips?
 - Fences
 - Thickets and anticommons?

Product patent uses across industry types

(Cohen, Nelson and Walsh, 2000, NBER)

<u>Intended Use</u>	<u>Industry Type</u>	
	<u>Discrete</u>	<u>Complex</u>
	(patent applic. wtd.)	
□ Negotiations	33%	81%
□ "Cross-licensing"	10	55
□ Player: Block <i>and</i> negots.	29	61
□ Fences: Block <i>but not</i> negs./lics.	45	11

"discrete" = food, textiles, chemicals, oil and plastics, pharmaceuticals, metals, and metal products
"complex" = machinery, computers, electrical equipment, electronic components, instruments, and transportation equipment

1. What drives these differences?

- Strength of patent?
- Market Structure?
- Nature of technology
- Firm size and strategy?

2. Relationship to value of patent?

Is the increase in private value also imply increase in social value (or is this pure rent capture)?

- Patents used to exclude, as bargaining chips This is privately valuable. But might this reduce social value?

"... several of the manufacturers in our sample were clearly "ramping up" their patent portfolios and "harvesting" their "latent inventions" to add to their stock of issued patents. ... The increased volume of patent filings appeared to reflect a "deeper reach" into an existing pool of inventions rather than a shift in R&D activities per se.

Hall and Ziedonis, 2001, "The Patent Paradox Revisited: An Empirical Study of Patenting in the US Semiconductor Industry, 1979-95,"

- Patents become privately more valuable. Their social value increases if, for instance, they stimulate R&D or promote entry of technology specialists.

Evidence from CMU survey (1991-93): Patent protection stimulates R&D even in semiconductors. It also stimulates a “deeper reach” into existing innovations.

% increase in R&D and patenting with doubling of patent premium

	R&D	Patents/ R&D
All	33%	59%
Semiconductor	28%	72%
Biotech	48%	28%

source: Arora, Ceccagnoli and Cohen, 2003, NBER

Fragmentation of patent rights and the spectre of the “anti-commons”

The Spectre

- Too many patents pertaining to a commercializable innovation creates a “patent thicket”.
- Negotiating the patent thicket may be difficult & expensive and may cause delays or even block research and commercialization.
- Universities and small firms may be particularly culpable.
- Many suggest that this is happening in bio-med sector – gene patents, proteomics. (Heller and Eisenberg, Shapiro)
 - Concern over “reach through” patent claims
 - Concern over “reach through” licensing provisions

The Evidence (for bio-med)

- No significant evidence of delays or blocking of scientific research (Walsh, Cho & Cohen, 2005)
 - Mostly because academic scientists do not bother to read patents
- Other evidence: (Walsh, Cohen & Arora, 2003)
 - There are more patents that need to be reckoned with (but not nearly as many as feared)
 - There are newer types of patent holders
 - No significant delays in or blocking of commercialization.
 - “Reach through” licensing provisions not a serious problem.

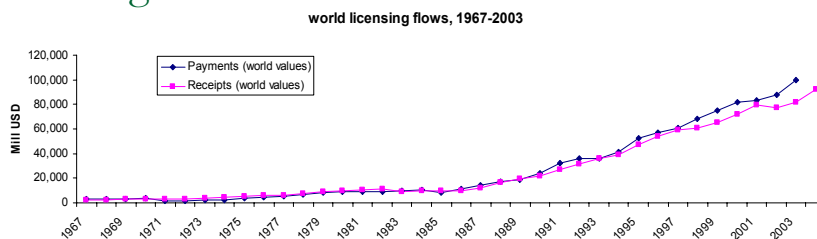
Need to learn a lot more about how patents are used and how this affects social and private value

Reasons to patent, CMU survey (1991-93) (Cohen, Nelson and Walsh, 2000)

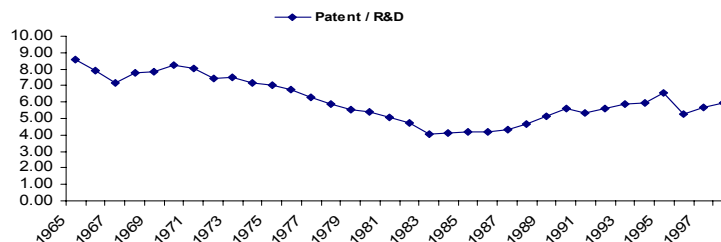
	<u>Products</u>	<u>Processes</u>
□ Prevent copying	96%	78%
□ Patent blocking	82	64
□ Prevent suits	59	47
□ Use in negotiations	48	37
□ Enhance reputation	48	34
□ Licensing revenue	28	23
□ Measure performance	6	5

Licensing motive is smaller than reputation!
Perhaps because respondents are all manufacturing firms in US

Worldwide, licensing has grown rapidly in last two decades, coinciding with growth in patenting.



Source: Athreye and Cantwell (2005)



Patents and Market for Technology:
Increases in patent protection will result in differences in how patents are used.

- Based on CMU Survey data, 1991-93 (cf. Cohen et al. 2000)
- Patents are used for licensing by smaller firms lacking complementary assets, and for commercialization by larger firms.

10% Change in Patent Effectiveness Leads to:

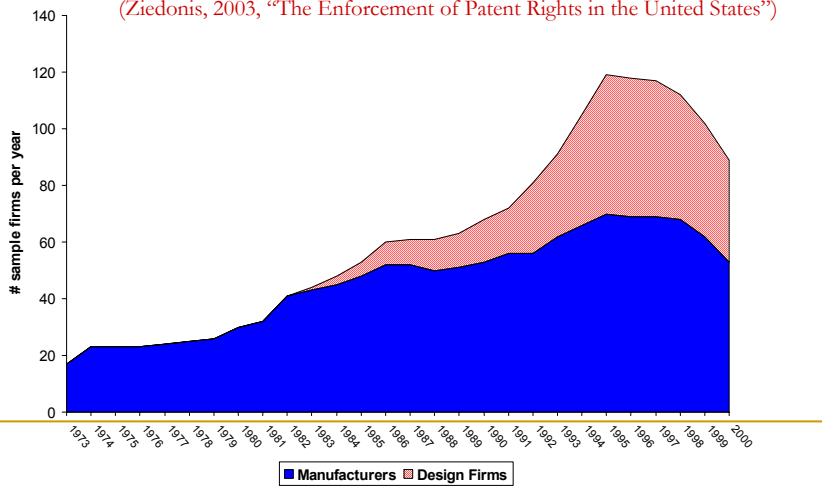
	Small Firm	Large Firm
% change in licensing propensity	6%	2%
% change in the propensity to license patented innovations	1%	-3%

Source: Arora and Ceccagnoli, "Patenting and licensing", 2005

Patents and Market For Technology

Patents promote entry of specialized design firms in semiconductors BUT- Patents used for horizontal competition and VC; not for "vertical" licensing

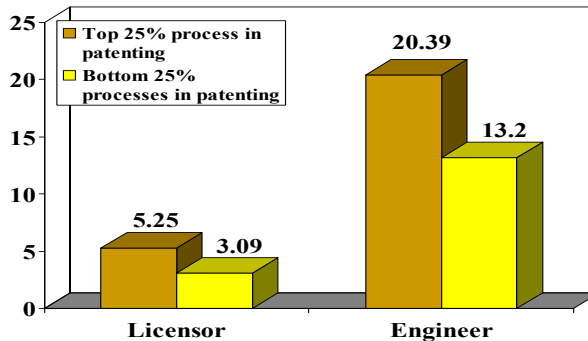
U.S. semiconductor mfg. and design firms, by year
 (Ziedonis, 2003, "The Enforcement of Patent Rights in the United States")



**Patents and market for technology:
Patents enable entry of specialized tech suppliers
in chemicals:**

**Processes with higher rates of patenting have more
specialized suppliers.**

**Average # of Specialized Engineering Firms by process category,
for a sample of 139 process technologies (1980-90)**



Source: Arora, Fosfuri & Gambardella, "The division of inventive labor", 2003

Many questions, much speculation and conflicting results: Need better data –need well done surveys and careful econometric analysis e.g., CMU Survey, PatVal Survey

- Poor understanding of how patents are used under what circumstances and by whom
 - When license
 - When block or negotiate
 - How this affects perceived value of patent
- How value of patent is related to other patents ("fence" – renewal studies cannot capture)
- Patents and market for technology
 - What role do patents play
 - What are other barriers to market for technology