

# Markets for technology in bio-pharmaceuticals: A view from the ivory tower

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# Outline

- Division of Innovative Labor and the markets for technology
- Markets for technology in biopharmaceuticals
- Problems in the markets for technology
  - “Science as a business”
  - Foundational patents
  - Patent thickets and anticommons

# Outline

- **Division of Innovative Labor and the markets for technology**
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  - “Science as a business”
  - Foundational patents
  - Patent thickets and anticommons

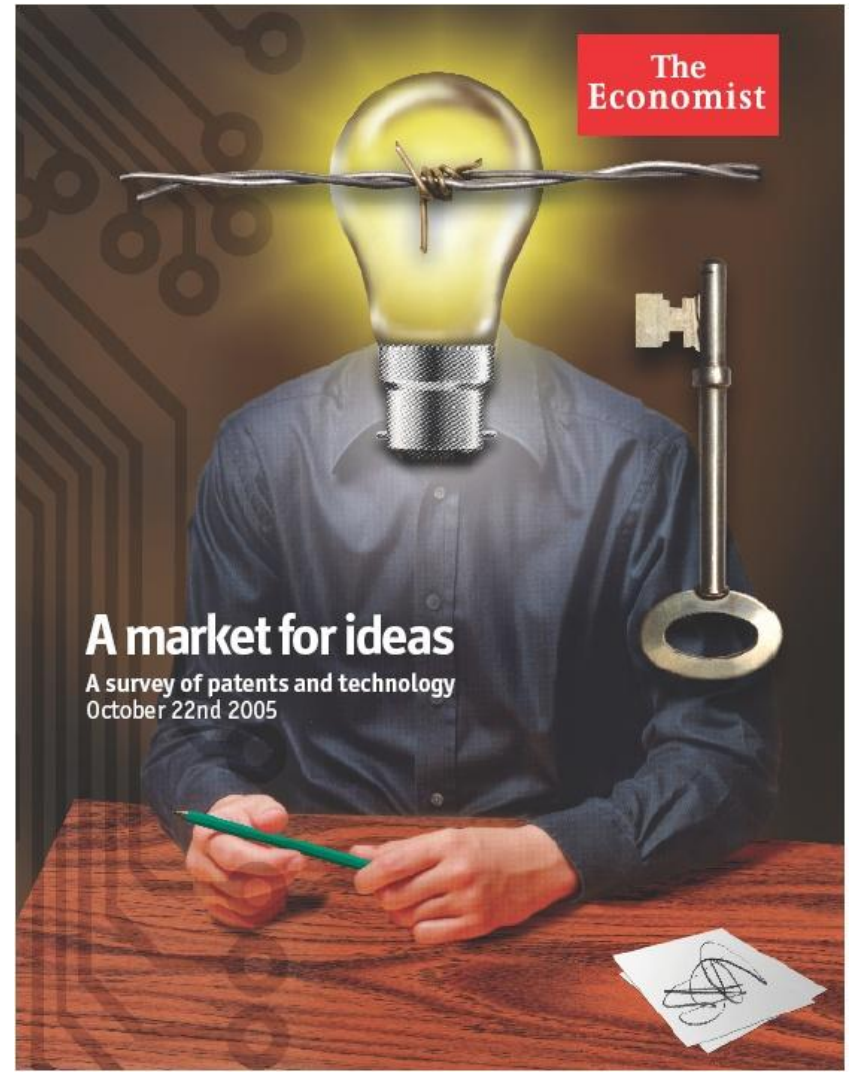
# Division of Labor v Division of Innovative labor

- A producer does not carry out all the steps inside the firm
    - buys inputs from others and sells outputs to other producers
  - Transactions facilitated by contracts and by property rights
    - But also commercial relationships, reputation
    - but also business models where inputs are given away free
  - This is normal
- Innovator does not carry out all the steps
    - Buys (or obtains) inputs from others
    - Sells (or provides) output to other producers
  - Transactions facilitated by contracts and property rights
    - But also commercial relationships, reputation
    - 'but also business models where inputs are given away free
  - Why isn't this normal?



Division of labor is limited  
by the extent of the  
market

- *Division of innovative labor is limited by the extent of the market for technology*
  - Market for technology – licensing, R&D contracts, ...



## Estimates of technology licensing in the US, 2002 (IRS + BEA data)

### Distribution of IRS Receipts for Types of IP-Licensing Service Commodities across Industry Sectors, 2002, Billions of Dollars

Sector	Licensing of Rights to Use IP Protected as Industrial Property	Licensing of Rights to Use IP Protected by Trademarks	Licensing of Rights to Use IP Protected by Copyright	Licensing of Rights to Use a business format under a franchise	Payments for rights to use <b>Natural Resources</b> and Other intangibles	Total
Manufacturing	59.5	9.4	1.0	2.9	-	72.8
Distributive Services	1.0	6.9	0.1	5.1	-	13.1
Information	1.9	4.9	6.6	0.0	0.1	13.5
Finance and Insurance	0.2	0.7	0.0	1.4	0.0	2.4
Professional and Business Services	3.0	0.2	1.6	1.5	0.4	6.7
Other Industries	1.0	0.7	0.1	4.8	0.8	7.5
Total	66.6	22.8	9.4	15.7	1.3	115.9

**\$30-40Bn for mid 1990s**  
Arora, Fosfuri, Gambardella, 2001

Carol Robbins, Dept. of Commerce, 2006, tab 7

# Growth of patents and MFT coincide after 1980s

*S. Athreye, J. Cantwell / Research Policy 36 (2007) 209–226*

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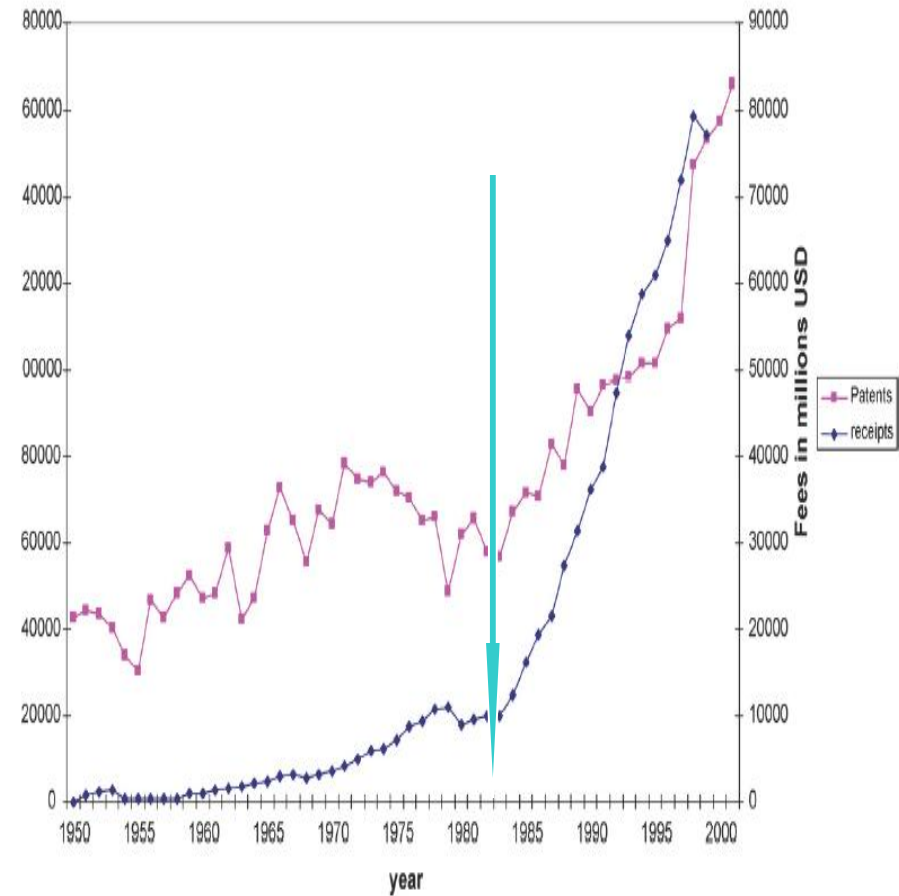
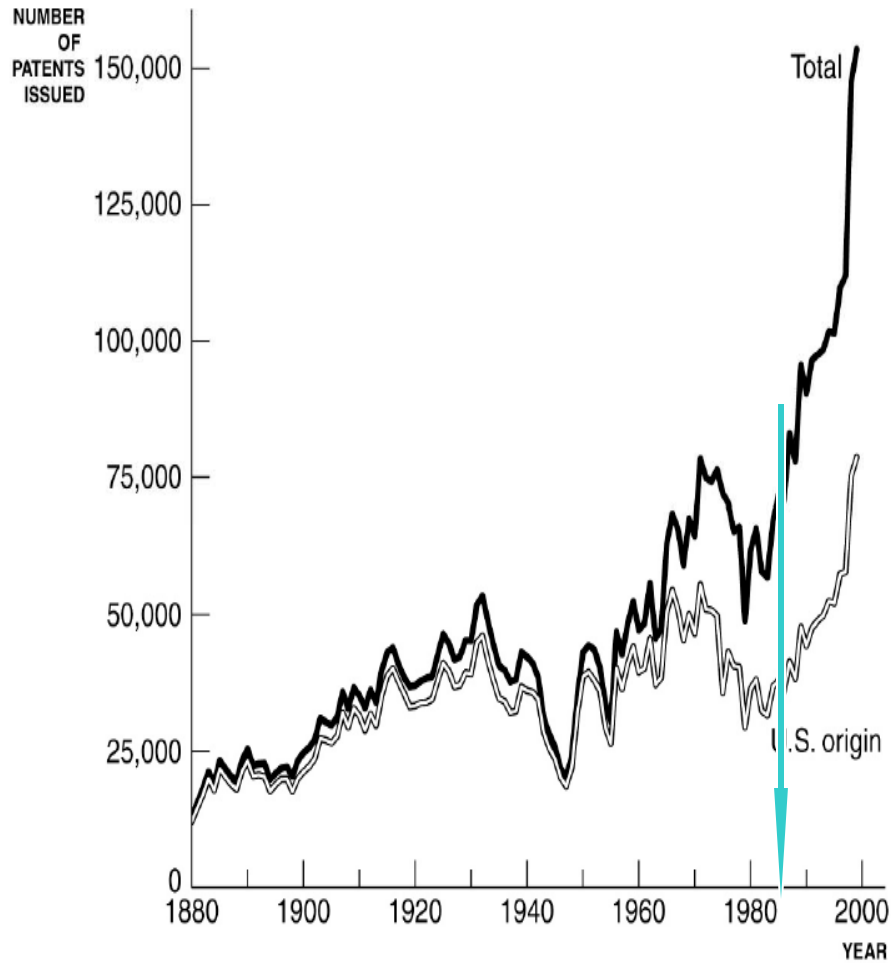
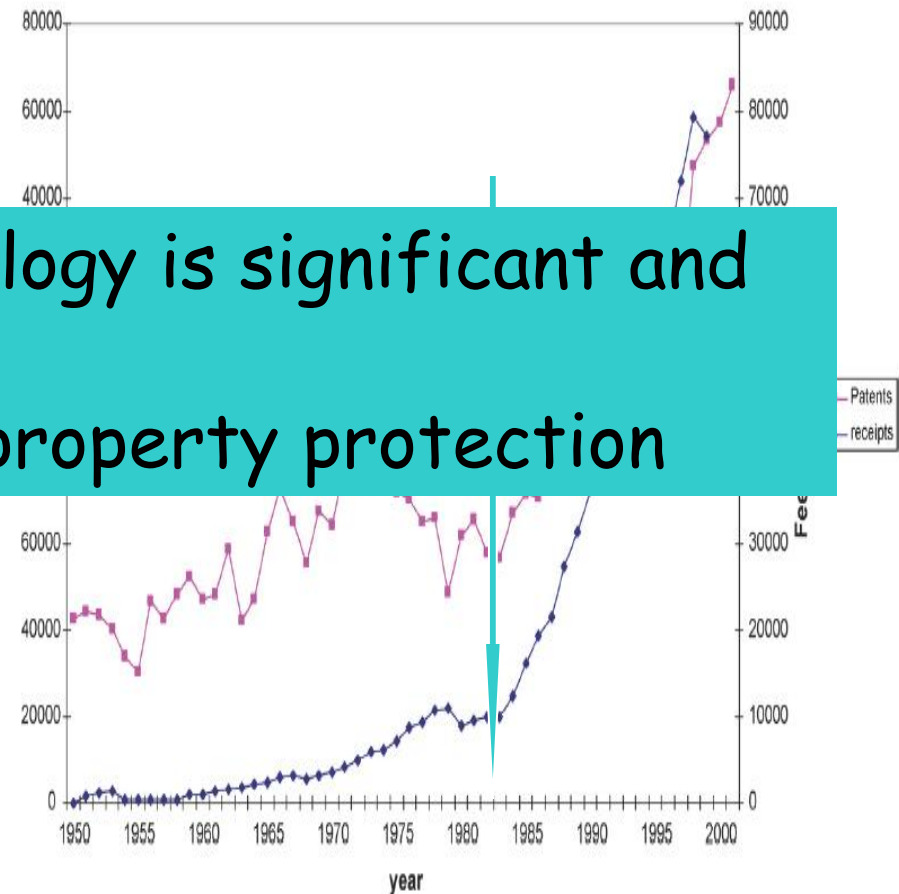


Fig. 2. Growth in non-US held patents and worldwide royalty and license revenues.

# Growth of patents and MFT coincide after 1980s

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The Market for Technology is significant and growing over time.  
Related to intellectual property protection

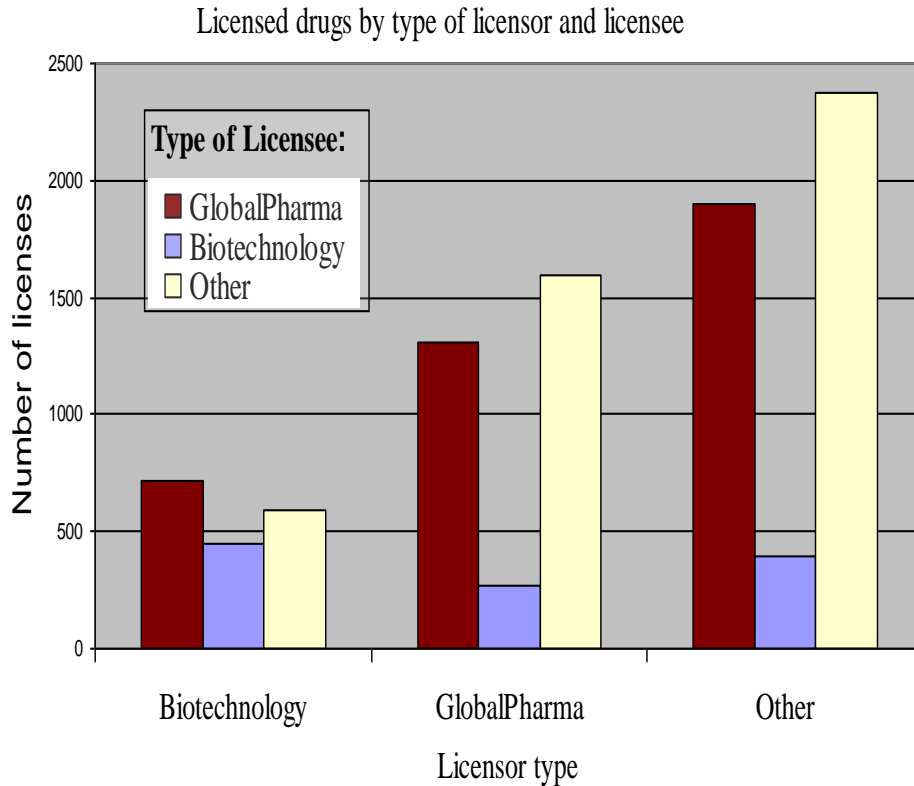
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# The market for technology in bio-pharma is significant

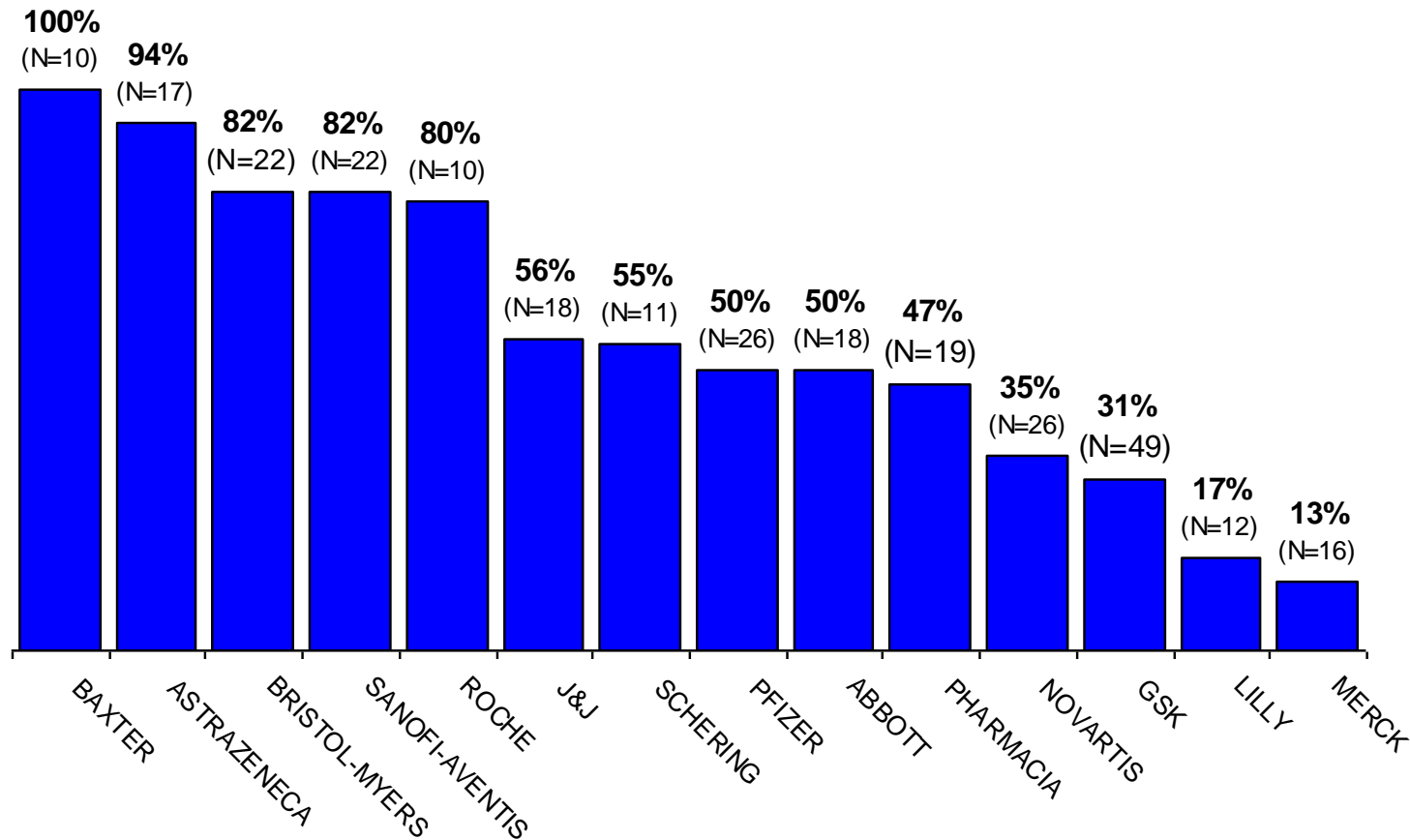


- Market for technology is not confined to biotechs licensing to pharma
- Significant licensing amongst pharma firms as well.

Source: Alcacer and Gittelman, 2008

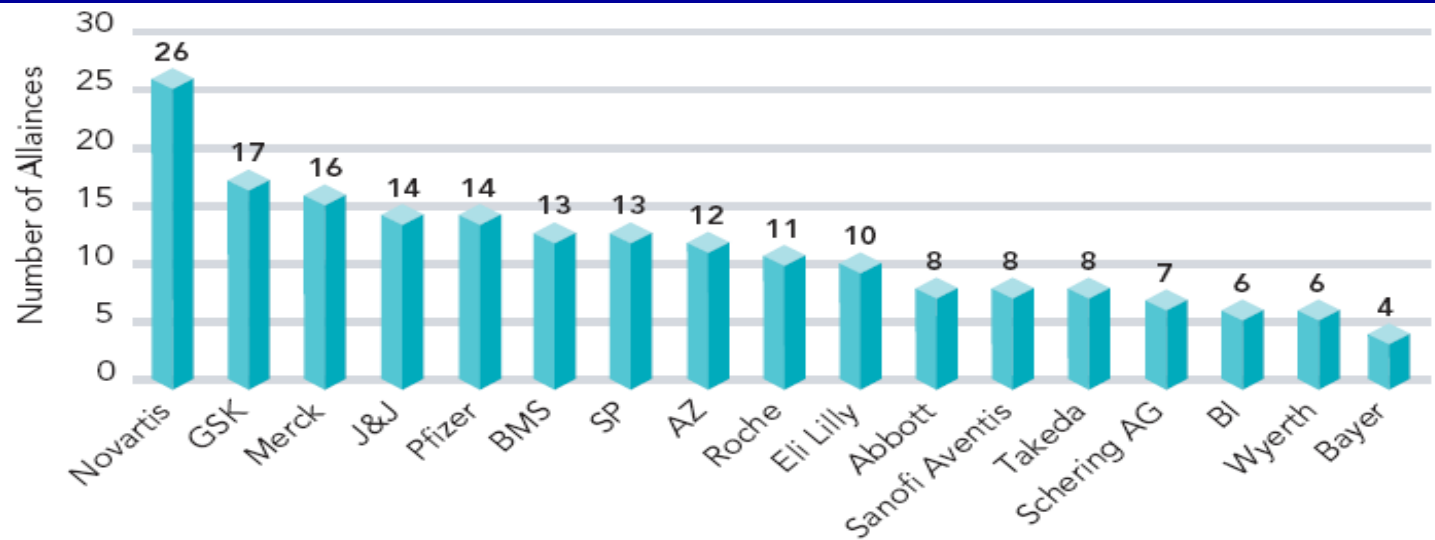
# Pharma firms rely extensively on outside knowledge for their products.

Percent of new drugs with more than 50% of patent attached to the drug being not held by the commercializing firm, for companies with >10 NDAs --> 1989-2004



Source: Ceccagnoli, Graham, Higgins, Lee; 2008

# Big Pharma Alliances in 2006

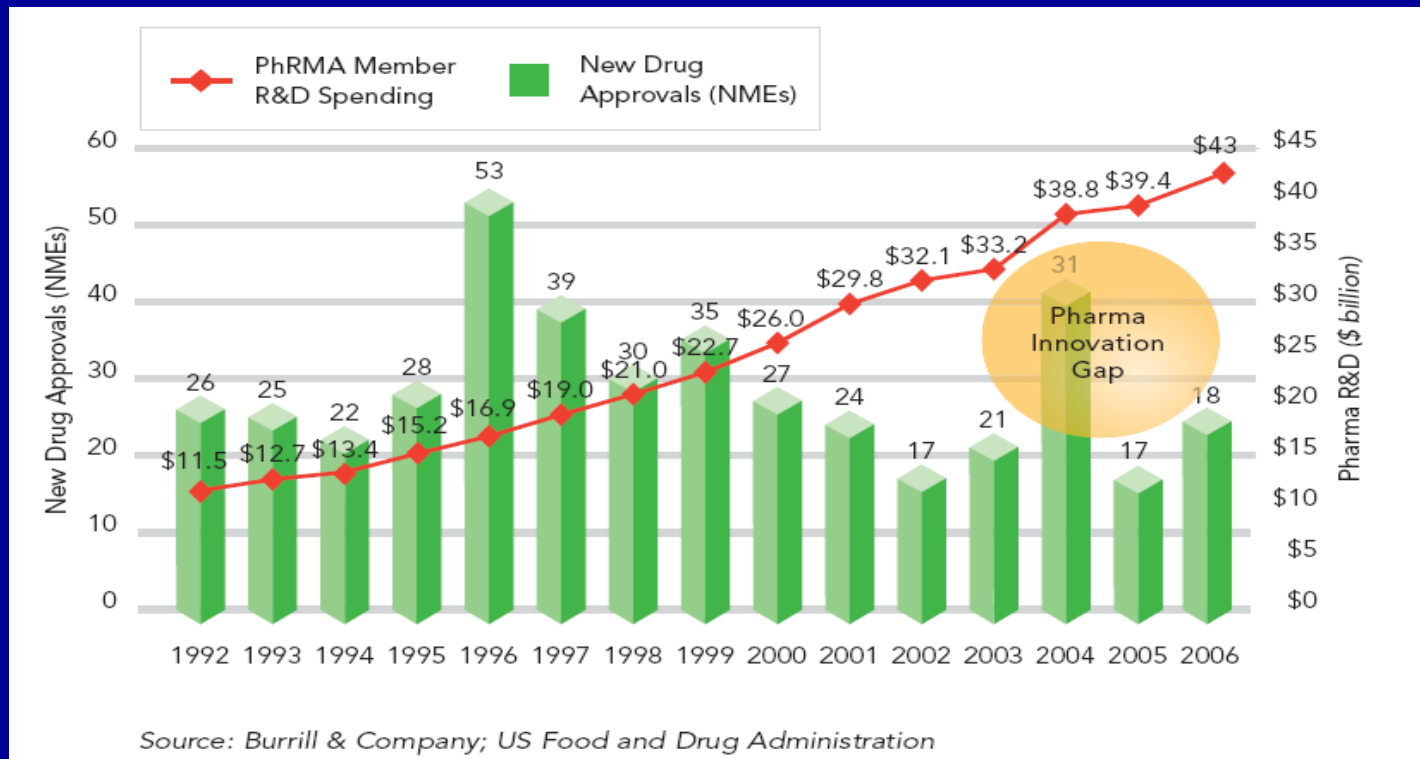


Source: Data from Windhover's Strategic Intelligence Systems Database; analysis by Burrill & Company

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# Innovation Gap Getting Wider

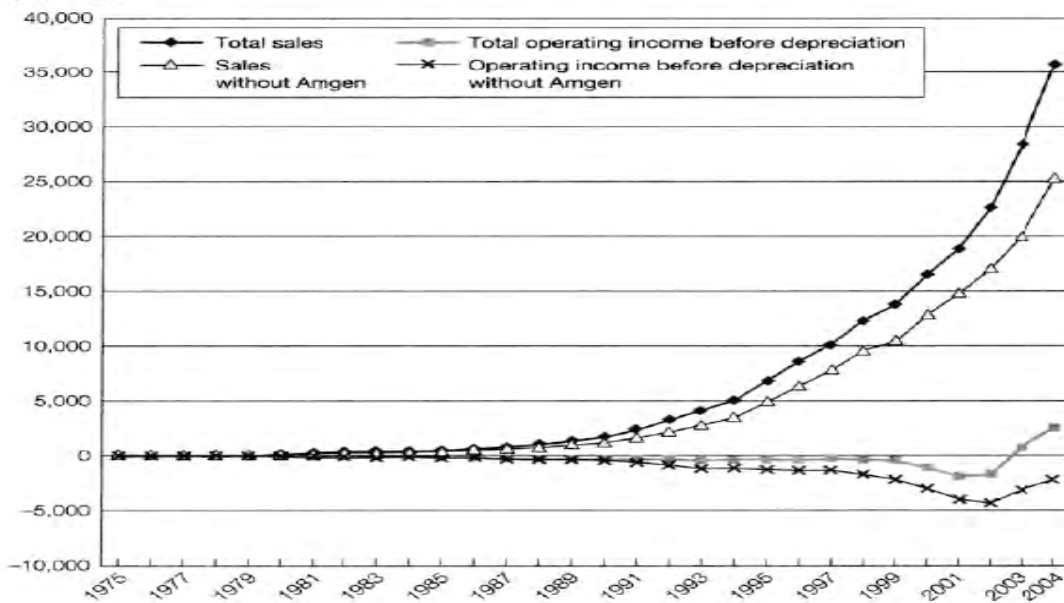


# Science as a business: The biotech sector has not made money

FIGURE 6-2

**Biotech revenues and profitability with and without Amgen, 1975–2004\***

\$ millions

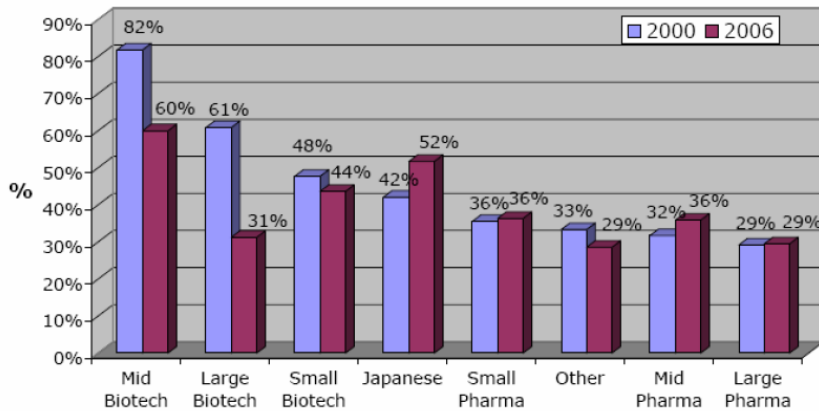


\*Values are inflation-adjusted.

Source: Gary Pisano, *The Business of Science*, 2006)

# Science as a business: Problem may be insufficient technology trade

**Percentage of Originated Compounds with a Licensing Agreement in place**



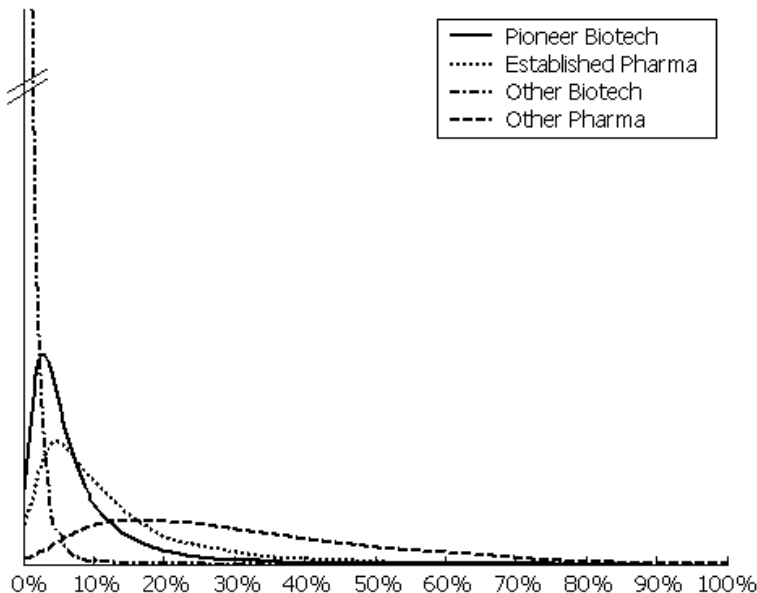
- Biotechs, esp mid sized, more likely to seek to develop drugs in-house instead of relying on deals.
- Most likely reflects the working of the capital markets that finance these firms, and problems in corporate governance.

- Could reflect failure of division of innovative labor
  - Biotech firms are trying to develop drugs themselves – trying to become fully integrated pharma companies
  - Emulate Amgen, Genentech...
- Problem may be the imperfections in the market for technology
- Other evidence suggests problem lies in the capital market – investors versus managers of biotech firms
  - Guedj and Scharfstein – biotech developed drugs fail more frequently in clinical III.
  - Arora et al. – Biotech initiated projects that are licensed before clinical tests fare better than those kept in-house by biotech
- Perhaps scientific challenges are harder?



# Biotechs are less successful drug developers

Distribution of success probabilities,  
by firm type, all pharma indications,  
1988-2002



- Pharmaceutical firms have higher success rates
- Biotechs may be swinging too hard for the fences:
- Pharma can make money off “singles” but biotechs must hit home-runs?
- Perhaps scientific challenges are harder?

Source: Arora, Gambarella, Magazzini,  
Pammoli, 2008

# Problems in the market for technology: patents and their discontents

- Foundational patents
  - Interfere with cumulative innovation
    - Research tools
  - Preventing use of knowledge
    - By firms
    - By academics
- Thickets and anti-commons
  - preventing use of knowledge?
    - By firms
    - By academics
  - Preventing flow of knowledge?

## Foundational Patents and follow on research

- Problems when patents poorly handled by universities.
  - Diagnostics
  - Clinical research – mixes research with practice and \$ flows.
- Bayh-Dole and unintended consequences
  - BRCA – Univ of Utah
  - Canavan – Miami Children's Hospital
  - Cox-2 – Univ of Rochester
  - Stem cells – University of Wisconsin
  - Oncomouse - Harvard

# Foundational patents: university patents may be as guilty as others in blocking research

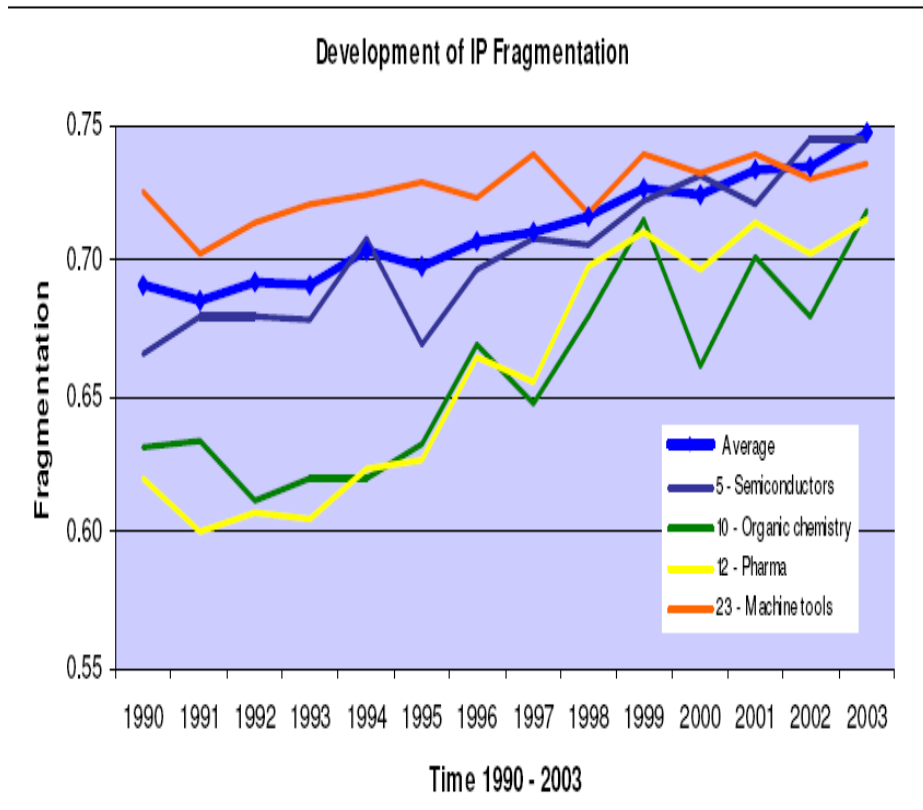
Table 4-2 Principal Assignees of Patents by Category

	Total Patents	Top Assignees
<b>Genes and Gene Regulatory Sequences</b>	6,145	<i>U. California</i> (153) Pioneer Inc. (150)
		Ludwig Inst. (72) Monsanto (72) Chiron Corp. (71) <i>General Hosp.</i> (71)
<b>SNPs and Haplotypes</b>	1,482	Pioneer (183) Dekalb Genetics (107) Stine Seed Farm (48) <i>U. California</i> (39) <i>John Hopkins</i> (25)
<b>Gene Expression Profiling</b>	7,428	<i>U. California</i> (215) Incyte (170) Affymetrix (117) Gen-Probe (100) <b>DHHS</b> (96)
<b>Protein Structure</b>	39	Abbott Labs (3) Connaught Labs (3) <i>U. California</i> (3) <i>U. Alberta</i> (3)
<b>Protein-protein interactions</b>	6,964	Genentech (181) <i>U. California</i> (178) <b>DHHS</b> (84) Chiron (82) Immunex (78)
<b>Modified Animals</b>	652	<i>U. California</i> (26) <i>General Hosp.</i> (11) Pharming BV (10)

<b>Software</b>	60	Abgenix Inc. (9) Millennium (8) Rosetta (4)
		Pioneer Hi-Bred (3)
<b>Algorithms</b>	91	Cytokinetics (42) All others (2 or 1)
<b>Databases</b>	1,466	Affymetrix (108) <i>U. California</i> (45) Agilent Tech. (34) Nanogen (22) Sequenom (18)
<b>EGF</b>	765	Sugen (23) Genentech (16) <i>U. California</i> (12) <b>DHHS</b> (12) <i>Yale</i> (11)
<b>CTLA4</b>	63	Bristol-Myers Squibb (20) <i>Dana Farber</i> (6) Repligen (4) Genetics Inst. Inc. (3) Pfizer (3)
<b>NF-kB</b>	94	<i>U. California</i> (7) Bristol-Myers Squibb (6) Tularik (5) Ariad (3) <i>Dalhousie Univ.</i> (3)

Note: The assignee is the company or organization assigned ownership on the original patent. Through consolidations, mergers and acquisitions, and other transactions, ownership may change. Private organizations, foundations, and hospitals are distinguished from commercial entities by *italics*. Government entities are indicated by **bold** typeface.

# Thickets and patent fragmentation

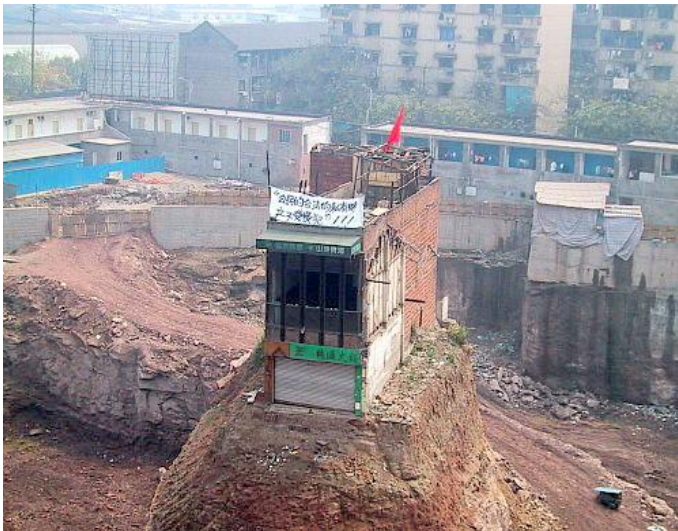


Source: Cockburn, MacGarvie and Mueller, 2008

- Patent landscape becoming more complex
- Substantial litigation costs (and perhaps rising) (e.g., Lanjouw and Schankerman, 2003)
- Potential for harm exists – limited evidence as yet.

# Anti-commons: An uncommon tragedy?

- Heller and Eisenberg, Murray and Stern, v. Walsh and Co.
- If scientists are dissuaded from research because they will not be able to patent the findings, this is not evidence of anti-commons; this is evidence that the profit oriented research is shaped by profit opportunities.
- Clinical research in America, which is inextricably mixed up with “for-fee” clinical practice.
- Here anti-commons may be a problem since diagnostic tests more efficiently done as a battery



The owners of this Chongqing "nail house" refused to leave it, thwarting plans for a shopping mall.

[en.wikipedia.org/wiki/Tragedy\\_of\\_the\\_anticommons](http://en.wikipedia.org/wiki/Tragedy_of_the_anticommons)

Only 32 out of 381 respondents (8%) ... conducted research in the prior two years using ... knowledge covered by someone else's patent. ... No one reported abandoning a line of research. *Thus, of 381 academic scientists, even including the 10% who claimed to be doing drug development or related downstream work, none were stopped by the existence of third party patents.* (Walsh, Cho and Cohen, 2005)

- Only those scientists intending to patent were affected by existence of patents
- Problems in sharing may lie elsewhere, in materials transfer
  - exacerbated by legal concerns

# Anti-commons: An uncommon tragedy?

Table 4-3: Reasons for Not Pursuing Projects, by Research Goal and Pathway

	Random Sample	Research Goal			Pathways		
		DrugDisc	BasicRsrch	Other	CTLA4	EGF	NF-kB
No Funding	62	86	60	58	63	54	82
Too Busy	60	55	60	59	53	58	48
Not Feasible	46	41	46	47	33	55	53
Not Scientifically Important	40	24	41	45	40	36	50
Not Interesting	35	24	36	33	20	30	29
Too Much Competition	29	21	32	21	27	29	29
Little Social Benefit	15	21	14	15	13	5	22
Unreasonable Terms	10	21	9	6	7	9	19
Not Help w/ Promotion/Job	10	21	7	15	0	13	5
Too Many Patents	3	3	2	3	0	4	0
New Firm Unlikely	3	3	2	3	0	4	0
Little Commercial Potential	2	3	2	3	0	4	0
Little Income Potential	1	3	1	3	0	4	0
Not Patentable	1	3	1	3	0	4	0
Respondents	274	28	213	33	16	24	22

Source: Walsh et al., 2005.

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- Problems in sharing may lie elsewhere, in materials transfer
  - exacerbated by legal concerns
- Mainly scientific rivalry and resource costs!

Table 4-4 Sharing of Research Materials, by Consumer Sector and Supplier Sector

Sectors		Average Percent non-compliance	
Consumer	Supplier	Consumer Estimate (%)	Supplier Estimate (%)
University	University	18	7
University	Industry	32	27
Industry	University	25	38
Industry	Industry	22	26

Source: Walsh et al., 2005.