Intellectual Property and the Scale of the Market

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What IP and Why?

- Intellectual property: patents and/or copyrights, but not trademark
- Economic rationale for IP: first copy subject to indivisibility or “fixed cost,” followed by distribution at zero marginal cost
- Goods with fixed cost + constant marginal cost will not be produced under competition. Hence government “should” create time-limited monopoly

How Much IP?

- What is the optimal level of protection?
- What is the tradeoff between increasing the monopoly distortion for inframarginal ideas versus increasing the number of marginal ideas that are produced?
  - Copyright is life of author plus 70 years for individual works, 95 years for works for hire
  - Design patents are 20 years, ornamentation patents are 14 years
  - ***Do these terms make sense?***

Scale of Market

- How does the scale of the market figure into the computation of optimal protection?
  - G7 nations about 2/3rds of world GDP; so WTO can potentially expand market size by 50%, even without growth
  - World population has risen by a factor of about 4 and real GDP has risen by a factor of about 20 during the 20th century
  - We argue that IP length should decrease with the size of markets.
  - Rule of thumb: roughly in half inverse proportion (quadruple the market, halve the protection)
- Is relevant measure of scale population or GDP?

Literature

- Gilbert & Shapiro, Gallini – length versus breadth in a one-good world
- Can “breadth” be legislated easily?
- Grossman and Lai – optimal size of protection independent of market size

Optimal IP Length

- Trade off between monopoly distortion on inframarginal ideas versus discouragement/encouragement of marginal ideas
- How does this depend on the scale of the market?

The Model

characteristics of ideas $\omega \in \Omega$ a compact subset of $\Re^n$

minimum labor $h(\omega) \geq 0$ to produce, create or invent idea with characteristics ω; $h(\omega)$ a continuous function

measure $\eta(\omega)$ the "number" of ideas with characteristics ω in an economy of unit size

$x(\omega)$ consumption of a "representative" idea with characteristics ω

if labor input less than $h(\omega)$ then $x(\omega) = 0$, otherwise any level $x(\omega)$ attainable

positive marginal cost of output examined in the paper

per capita consumption is $z(\omega) = x(\omega)/\lambda$

Continuum of Ideas Model: individual ideas are small relative to size of economy

Consider the size of some big ideas:

Manhattan Project (1942-1945): $7 billion per year in 1996 $;

GDP in 1944-1945 about $1700 billion per year in 1996 $

Manhattan Project cost approximately 0.4% of GDP

NASA (1962-73) about $15 billion per year in 1994 $; Apollo project about 1/3 of it

1968 GDP, in 2000 $, about $3,700 billion

Moon landings cost approximately 0.15% of GDP

Privately financed ideas

"The Titanic" cost $200 million in 1997

DiMasi et al [1991] estimate average cost of bringing a new drug to market at $231 million 1987 $

Privately financed ideas at most 1/10,000 of US GDP

- Note that all these "big" ideas are in fact composed of many small ideas

The Model (continued)

Continuum population of agents of size λ (the scale of the economy)

Total number of ideas with characteristics ω available in an economy of size λ is $\eta(\omega)g(\lambda)$

$g(\lambda)$ is assumed non-decreasing in λ; $g(1) = 1$

if $g(\lambda) = \lambda$ an economy that is twice as big has twice as many ideas

Consumption

Representative individual has Dixit-Stiglitz utility over goods with different characteristics

Consuming z units of a good with characteristics ω gives utility $v(z,\omega)$

$v(z,\omega) \geq 0$ continuous in ω, non-decreasing, and at least up to a limit z^*, smooth and strictly increasing

$\lim_{z\to\infty} v(z,\omega) = v^C(\omega) < \infty$, $v(0,\omega) = 0$

$zv_z(z,\omega) \to 0$ as $z \to \infty$

(this just means: competitive rents are zero)

$zv_z(z,\omega)$ has a unique maximum at $z^M(\omega)$

Utility ℓ from leisure $0 \leq \ell \leq L$, where L is the individual endowment of time; leisure = all activities that take place outside of the idea sector

Individual Utility

$$\int v(z(\omega),\omega)g(\lambda)\eta(d\omega) + \ell$$

Labor Demand=Labor Supply

$$\lambda(L-\ell) = \int y(\omega)g(\lambda)\eta(d\omega).$$

Where:

either $y(\omega) = h(\omega)$ when the good is produced,

or $y(\omega) = 0$ otherwise.

Patent Equilibrium

Hart (1979), Makowski (1980), Acemoglu and Zilibotti (1996)

Fixed length ϕ of patent protection for all ideas.

- a fraction ϕ of total time occurs under monopoly,
- a fraction $(1-\phi)$ of total time occurs under competition

Potentially many individuals can produce or make use of any particular idea.

A particular individual is awarded a “patent” for a particular idea.

When patent expires, output and consumption jump to infinity, price and revenues to zero

- A type of good is produced if, given the patent length ϕ, the prospective monopolist finds it profitable to overcome the indivisibility
- Market for innovation equilibrated through the wage rate w.
- Higher w means fewer ideas produced
- When labor demand is strictly less than λL, then wages $w = 1$
- Otherwise w chosen to reduce demand for labor to the point where the amount of leisure is 0

Problem of the Monopolist

sells z units to each of λ consumers at price $v_z(z, \omega)$

revenue $\lambda z(\omega) v_z(z(\omega), \omega)$ has a unique maximum at $z^M(\omega)$

cost is $wh(\omega)$

Private Return per unit of indivisibility of a good with characteristics ω

$$\rho(\omega) = z^M(\omega) v_z(z^M(\omega), \omega)/h(\omega)$$

introduces good if

$$\phi\lambda\rho(\omega)h(\omega) \geq wh(\omega) \text{ or } \rho(\omega) \geq w\,/\,\phi\lambda \equiv \underline{\rho}$$

Note: $\underline{\rho}$ strictly decreasing in $\phi\lambda$; "lower quality" ideas introduced

Per-Capita Social Welfare

$$\int_{\rho(\omega)\geq\underline{\rho}} [\phi v(z^M(\omega),\omega) + (1-\phi)v^C(\omega) - h(\omega)/\lambda]g(\lambda)\eta(d\omega) + L$$

Return Neutrality

$$\nu^M(\omega) \equiv v(z^M(\omega), \omega)/h(\omega)$$

$$\nu^C(\omega) \equiv v^C(\omega)/h(\omega)$$

quadratic utility/linear demand $\nu^M = 3/2, \nu^C = 2$

strong return neutrality $\nu^M(\omega), \nu^C(\omega)$ constant

we assume “weak” return neutrality meaning conditional on ρ.

Aggregate Monopoly Revenue

$$M(\rho) = \int_{\rho}^{\infty} \rho(\omega) h(\omega) \eta(\omega) d\omega$$

$$\Upsilon(\rho) = -\rho M'(\rho) / M(\rho)$$

Assume $\Upsilon(\rho)$ is differentiable

Proposition

Suppose return neutrality. If, for some $\tilde{\rho}$***,*** $\Upsilon'(\rho) \neq 0$ ***for*** $0 \leq \rho \leq \tilde{\rho}$***, then there exists*** $\tilde{\lambda}$ ***such that*** $\hat{\phi}(\lambda)$ ***is unique and strictly decreasing for*** $\lambda > \tilde{\lambda}$***. If*** $\Upsilon'(1/\lambda\hat{\phi}(\lambda)) > 0$ ***then*** $\hat{\phi}(\lambda)$ ***is unique and non-increasgin and conversely.***

When the elasticity of total monopoly revenue is increasing with ρ, loss of marginal ideas from decreasing protection more than compensated by inframarginal gains of reduced monopoly distortions

When the elasticity of total monopoly revenue is declining with ρ, demand for labor grows more rapidly than the population

Relation with Production Function Approach

(Grossman and Lai)

Q is quantity of ideas (they are assumed to be all of the same quality)

$Q = f(\ell)$ for production function of ideas

$\ell = f^{-1}(Q)$; corresponding marginal cost $1/f'(\ell)$

so

$$M(\rho) = f\left[[f']^{-1}(\rho)\right]$$

Υ the elasticity of M same as elasticity of research output w.r.t. labor

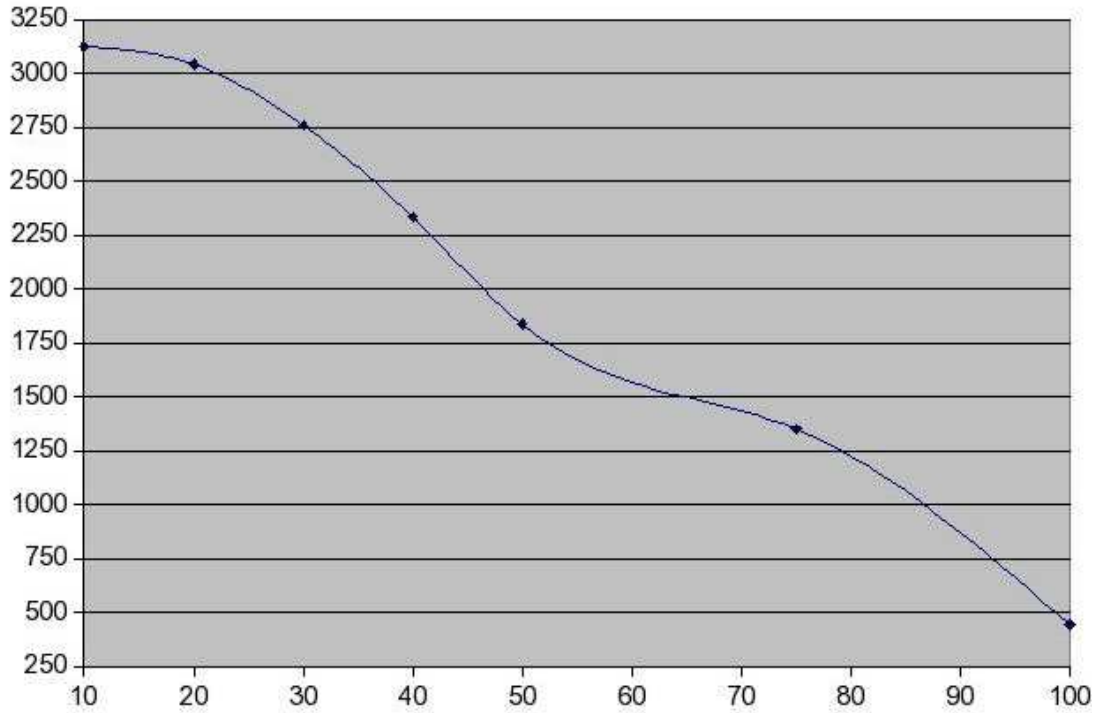
Cobb-Douglas implies constant elasticity or Pareto tail

if $g(\lambda) = \lambda$ implies per capita labor goes up linearly with the scale of the economy

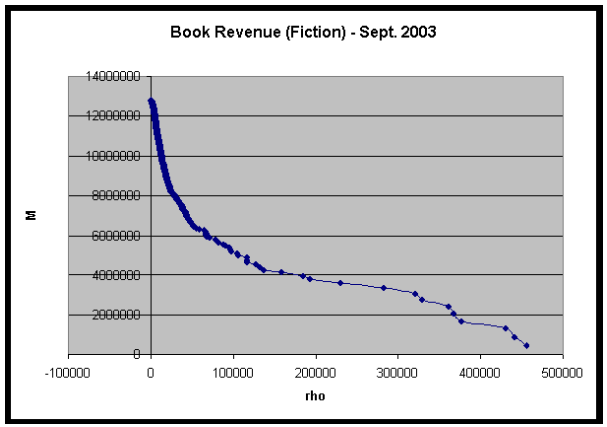
Measuring Aggregate Revenue

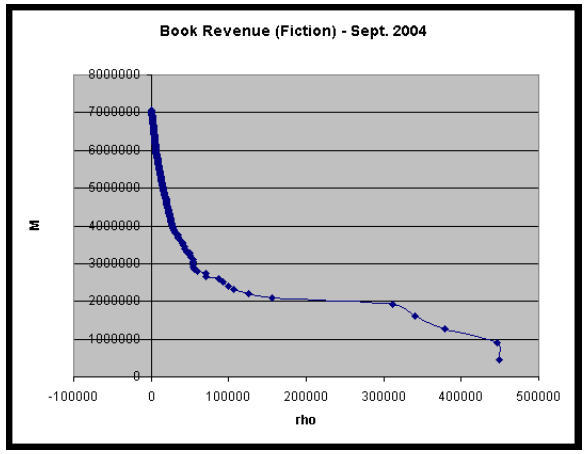
- all authors take the same amount of time to produce a novel and have the same opportunity cost so $h(\omega)$ is constant
- authors earn all their income from the sale of their novels
- profits from the sale of a book can be perfectly anticipated in advance.

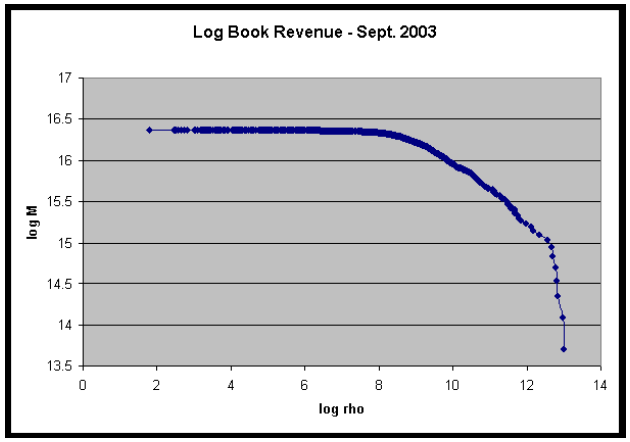
Author's Income Distribution Proportional to U.S. Income Distribution

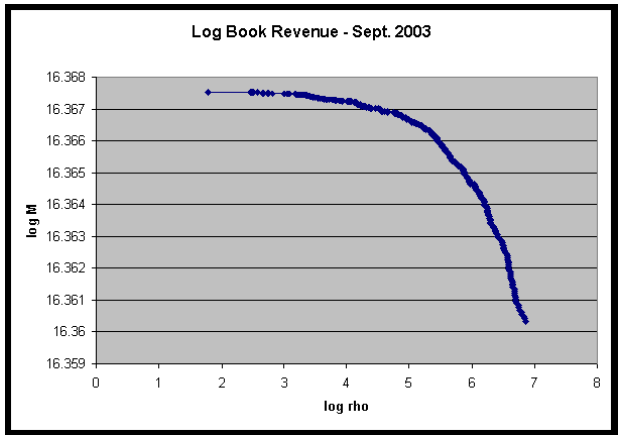


Hardback Novels

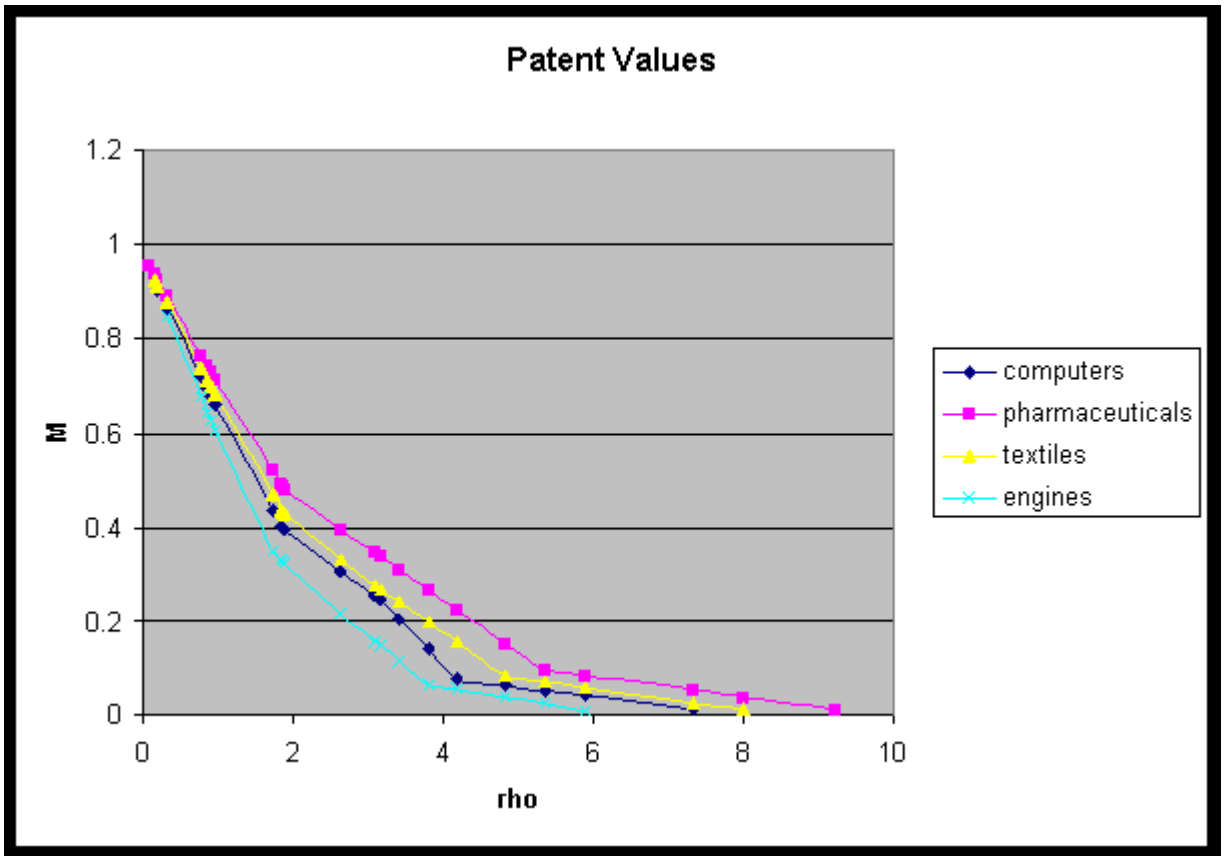








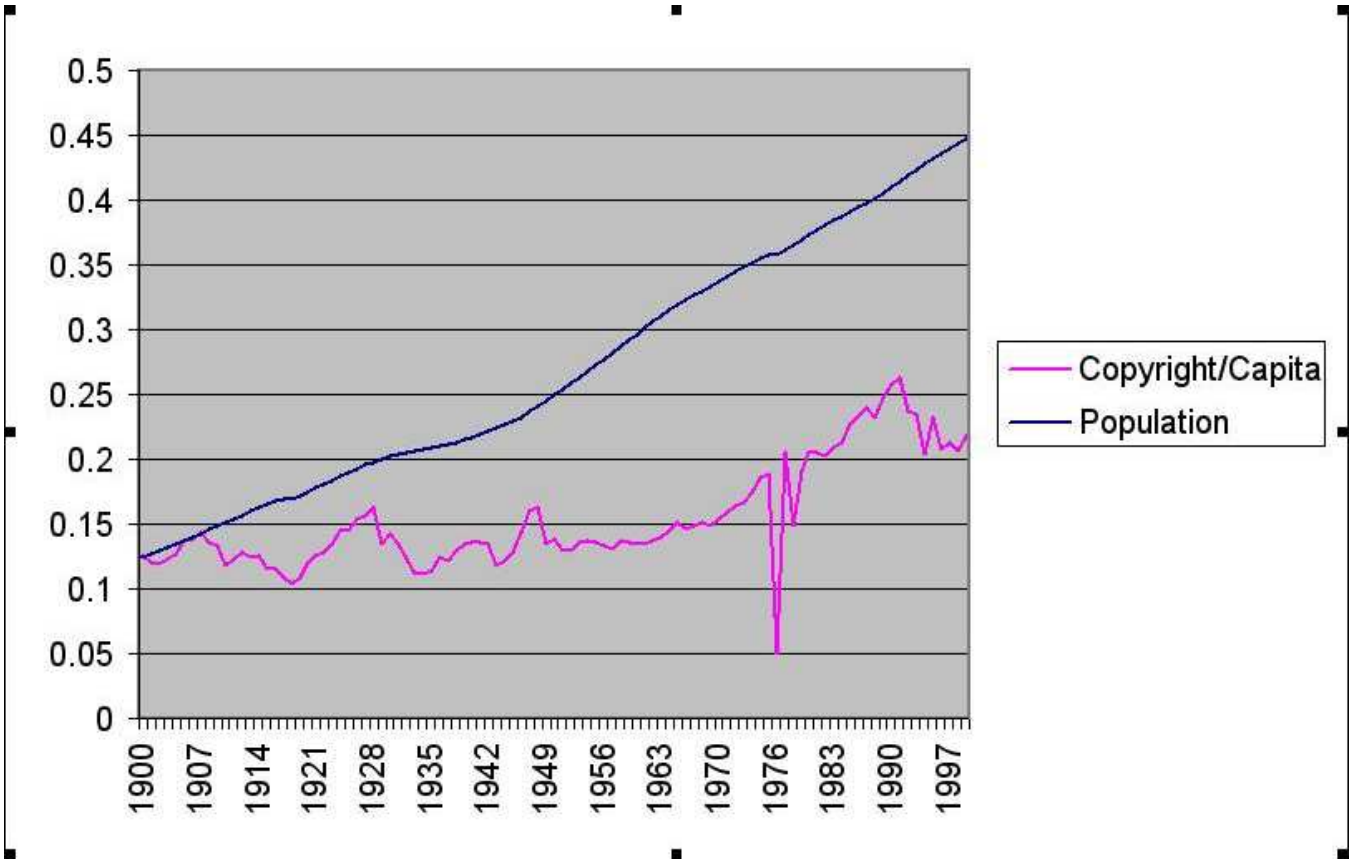
For Patents from Lanjouw

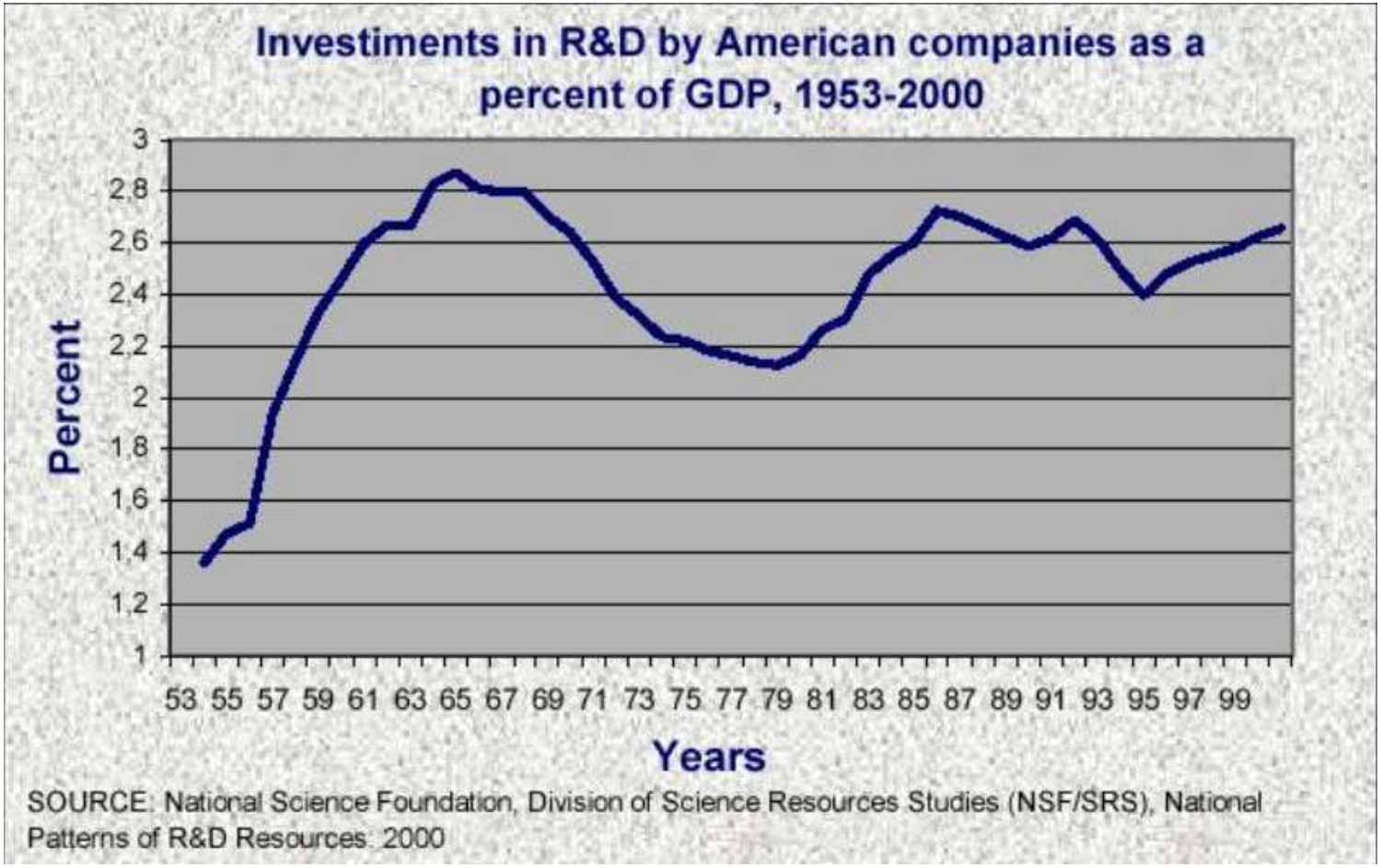


Elasticities and $-\rho M'(\rho)$

Computers	Pharmaceuticals	Textiles	Engines
.22 [.17]	.14 [.12]	.19 [.15]	.32 [.23]
.74 [.40]	.53 [.33]	.66 [.38]	.95 [.45]
.93 [.30]	.75 [.30]	.88 [.31]	1.12 [.32]
3.76 [.60]	2.35 [.48]	2.42 [.44]	3.04 [.42]
2.73 [.12]	2.81 [.16]	3.02 [.14]	3.37 [.12]

Labor Demand and Scale of Market




Investiments in R&D by American companies as a percent of GDP, 1953-2000
Percent
3
2,8
2,6
2,4
2,2
2
1,8
1,6
1,4
1,2
1
53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91 93 95 97 99
Years
SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), National Patterns of R&D Resources. 2000

data for 1980-90 from Kanwar and Evenson plus CIA 1990 World Factbook

FIGURE 4.12. Cross Sectional Data

IPRs Strength	Size Elasticity [Population]	N	Average GDP USD billions	Exports
1	0.21 [0.21]	7	108	14
2	0.38 [0.22]	7	94	33
3	0.38 [-0.04]	12	394	85
4	0.13 [0.14]	4	1586	178

Digression on labor constraint binding

- Super-optimal protection drives up the wage rate
- Lobbyists point to the high cost of producing new goods (movie, music, drugs) as reason for strong copyright protection
- Much of high cost is due to a few “stars” large salaries
- Opportunity costs for these stars is often small
- Reducing protection lowers rents earned by these stars so reduces costs of producing ideas of a given quality

Quality Nonneutrality

- Goods with lower private quality have even lower social value: obviously optimal protection should show even greater decline with scale of market
- Private and social values go the opposite direction
  - optimal protection may increase with scale of the market
  - so what's socially valuable is not privately valuable
  - exactly the wrong ideas get produced
  - might be better to have the government pick winners

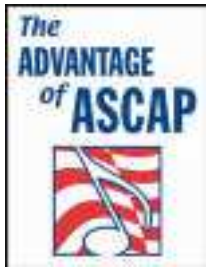
Other Remarks

- competitive rents will be optimal without any protection at all when the economy is large enough
- rent-seeking means that inframarginal ideas get the most protection – aggravates the monopoly distortion without increasing the marginal ideas produced
- harmonization means small low protection countries raise their protection and large high protection countries lower their protection – not everyone raises protection

Government Grants of Monopolies or Government Prizes?

- financed by imposing a sales tax on sales of newly invented goods
- similar to Gilbert and Shapiro [1990] “breadth” measure, and therefore less distortionary than temporary monopolies
- public and private prizes have been widely used historically and are of demonstrated practicality
- historians of aviation argue that prizes played important role aviation innovation

Mandatory Licensing



- prize money is simply paid back to same innovator
- mandatory (statutory, compulsory) licensing widely used - in copyright radio play of music and xeroxing of copyrighted materials; in patent, mandatory licensing widely used in Taiwan until forced to reform their patent system by the United States
- efficiency improvement from replacing unregulated monopoly with regulated monopoly

Cost Based Prizes

- no reason to pay proceeds of taxes on new goods to original innovator
- better that proceeds be used to defray the costs of producing innovations of high social value
- best to pay h the indivisibility rather than the social value because raising revenue is distortionary
- intellectual property system makes little use of social knowledge of h (exception of "non-obviousness" requirement of patents now largely defunct); rewards scaled to value not cost
- if social value poorly correlated with private value rewards based on other information about social value/cost likely to lead to better mix of innovations being produced

Conclusion

Competition = Good

Monopoly = Bad