Intellectual Property and the Scale of the Market

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Introduction – What is IP?

- Intellectual property: patents and/or copyrights
- economically relevant good: copies of ideas
- not the same as real property – the ip holder has the right to control other people's copies of his idea
- provides a time-limited monopoly
- economic rationale for ip: first copy subject to indivisibility or "fixed cost," followed by distribution at zero marginal cost
- good with fixed cost, constant marginal cost will not be produced under competition, so rationale for government intervention
- in this case government provision of private monopolies

Problems with IP

- not necessary for production of ideas; competitive rents due to short-run capacity constraints, first-mover advantages
- may reduce rather than increase innovation when innovations build on existing innovations (downstream innovation problem)
- impact on secrecy and other private rent-seeking ambiguous
- problems of rent-seeking when government gives away monopolies
- probems of transaction costs involved in controlling copies of ideas

Suppose IP is necessary – how much

- Gilbert & Shapiro, Gallini – length versus breadth in a one-good world
- can “breadth” be legislated easily?
- same term limit for many different kinds of ideas

U.S. law

- 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

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?
- G7 nations about 2/3rds of world GDP; so WTO can potentially expand market size by 50%
- world real GDP has risen about two orders of magnitude (100 times) during the 20th century
- we argue that IP length should decrease with the size of market, as a rule of thumb roughly in inverse proportion (double market, halve length of protection)
- potential solution of IP dilemma's above?

The Model

characteristics of ideas $\omega \in \Omega$, topological space

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

implicit in this formulation: individual ideas are small relative to size of economy

Manhatten Project during 1942-1945 $7 billion per year in 1996 $; GDP in 1944-1945 about $1700 billion per year in 1996 $

Manhatten Project cost approximately 0.4% of GDP

NASA expenditures in 1964-68 in current dollars about $5 billion per year; GDP in 1966 in current dollars about $790 billion

moon landings cost approximately 0.6% of GDP

privately financed ideas:

the movie “The Titanic” cost $200 million in 1997

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

high end privately financed ideas on the order of 1/10,000 of US GDP

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; $g(1) = 1$

Production

amount of labor input $y(\omega)$ must overcome the indivisibility $h(\omega)$

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

$y(\omega) < h(\omega)$ then $x(\omega) = 0$

$y(\omega) \geq h(\omega)$ then $x(\omega) \geq 0$

per capital consumption denoted $z(\omega) = x(\omega)/\lambda$.

Consumption

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

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

$v(z,\omega) \geq 0$ 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 $z \to \infty$

(it is this that is traditionally assumed: 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

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

Labor Demand

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

Patent Equilibrium

Hart (1979), Makowski (1980), Acemoglu and Zilibotti (1996) – basically a monopolistically competitive equilibrium

fixed common length of patent protection for all ideas

average present value of the flow of consumption, a fraction ϕ occurs under monopoly, and a fraction $(1-\phi)$ occurs under competition

potentially many individuals who can produce or make use of any particular idea

do not explicitly model the “patent race” by which patent is awarded, and simply assume that through some procedure, a particular individual is awarded a “patent” for a particular idea

provides a complete monopoly over that particular good while the patent is in effect

after expiration, anyone who wishes to do so may make copies of the ideas that had been previously introduced under the patent regime so output and consumption jump to infinity and price, and we have assumed revenue, falls to zero

a type of good is produced if, given the patent length ϕ, the prospective monopolist finds it profitable to overcome the indivisibility; in this case $h(\omega)$ units of labor are used

market for innovation equilibrated through the wage rate of labor w.

higher is w fewer ideas produced, less demand for labor

amount of labor used in the production of ideas is strictly less than the total endowment 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

monopolist for good with characteristics ω

sells z units of output to each of λ consumers

receives price $v_z(z,\omega)$, revenue per unit of time $\lambda z(\omega) v_z(z(\omega),\omega)$, assumed to have a unique maximum at $z^M(\omega)$

cost faced by the monopolist is $wh(\omega)$

$\rho(\omega) = z^M(\omega) v_z(z^M(\omega),\omega)/h(\omega)$ *private value* per unit of indivisibility of a good with characteristics ω evaluated at the revenue-maximizing point $z^M(\omega)$

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

note that $\underline{\rho}$ strictly decreasing in $\phi\lambda$, as term length or scale of market increases, "lower quality" ideas introduced

Social Welfare

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

reformulation in terms of ρ

the measure $h(\omega)\eta(\omega)$ quantity of ideas in terms of the amount of labor needed to produce them

restrict $h(\omega)\eta(\omega)$ to the σ-subalgebra of the Borel sets of Ω on which $\rho(\omega)$ is constant; make the regularity assumption that this measure is represented by a continuous density function $\mu(\rho)$

for any measurable function $f(\omega)$ define "conditional value" $\overline{f}(\rho)$ in much the same way as a conditional expectation is defined

$\overline{f}(\rho)$ is defined μ almost everywhere by the condition that

$$\int_B \overline{f}(\rho)\mu(d\rho) = \int_B f(\omega)\eta(d\omega)$$

for every B in σ-subalgebra of Borel sets of Ω on which $\rho(\omega)$ is constant

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

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

rewrite per capita social welfare

$$g(\lambda)\int_{\underline{\rho}}^{\infty}[\phi\overline{\nu}^M(\rho) + (1-\phi)\overline{\nu}^C(\rho) - 1/\lambda]\mu(\rho)d\rho + L$$

$\sigma(\rho) \equiv \overline{\nu}^M(\rho)/\rho$ to be the ratio of social surplus to private revenue

$d(\rho) \equiv (\overline{\nu}^C(\rho) - \overline{\nu}^M(\rho))/\overline{\nu}^M(\rho)$ distortion introduced by monopoly

rewrite per capital social welfare as

$$g(\lambda)\int_{\underline{\rho}}^{\infty}[\phi\rho\sigma(\rho) + (1-\phi)\rho\sigma(\rho)(1+d(\rho)) - 1/\lambda]\mu(\rho)d\rho + L$$

Assumptions & Definitions

for any $\underline{\rho} > 0$

$$\int_{\underline{\rho}}^{\infty} \mu(\rho) d\rho < \infty,$$

i.e. amount of labor required to produce all ideas exceeding a particular quality is finite

quadratic utility and linear demand

$v(\omega, z) = b(\omega)\left(Z(\omega)^2 - [z - Z(\omega)]^2 \right)$ for $z \leq Z(\omega)$

$v(\omega, z) = b(\omega)Z(\omega)^2$ for $z > Z(\omega)$

then

$\sigma(\rho) = 1.5,\ d(\rho) = 0.5$

quality neutrality

three different measures of quality

private value ρ, public value of monopoly output $\overline{\nu}^M(\rho)$, public value of competitive output $\overline{\nu}^C(\rho)$

quality neutrality all three measures agree

$\sigma(\rho) = \sigma$, $d(\rho) = d$

so $\overline{\nu}^M(\rho) = \sigma\rho$, $\overline{\nu}^C(\rho) = (1+d)\sigma\rho$

variation in mass of ideas with quality

mass of ideas does not decline rapidly with quality

$\rho^2\mu(\rho)$ is non-decreasing

mass of ideas declines rapidly with quality

$\rho^2\mu(\rho)$ is non-increasing

global conditions, we can also define the mass to decline rapidly or not at a particular value of ρ

Protection and the Scale of The Market Under Quality Neutrality

Case 1: quality is neutral and the mass of ideas does not decline rapidly with quality

- there is a unique protection length $\phi(\lambda)$ that maximizes social welfare
- $\phi(\lambda)$ is non-increasing
- for λ sufficiently large $\phi(\lambda)$ is strictly decreasing

Case 2: quality is neutral and the mass of ideas declines rapidly with quality

- for λ sufficiently large $\phi(\lambda)$ is unique and strictly decreasing

Intuition:

if the mass of ideas declines rapidly with quality, then as the scale of the economy grows, the demand for labor grows even more rapidly

in case 1: reduce protection on the “small” margin to get reduced monopoly in the interior

in case 2: once the labor constraint binds, can lower wages and reduce protection for pareto improvement

Digression on the MPAA

super-optimal protection can drive up the wage rate for the relevant supply of labor when the labor constraint is binding

lobbyist groups point to the high cost of producing movies as reason for strong copyright protection

much of high cost due to paying a few stars large salaries; opportunity costs for these stars small: Harrison Ford worked as a carpenter and Lars Ulrich as a service station attendant

reducing copyright protection lowers rents earned by these stars, reduces costs of producing movies of a given quality

MPAA sponsors ads featuring marginal workers concerned about losing jobs due to piracy saying the big stars will not be hurt

the opposite is true; no good public policy argument for promulgating socially costly monopolies in order to further enrich already rich stars

An Example

$\mu(\rho) = \rho^{-\alpha}$ for $\rho \leq \overline{\rho}$

$\mu(\rho) = 0$ for larger ρ

$\alpha < 2$ ideas do not decrease rapidly with quality

$\alpha > 2$ ideas do decrease rapidly with quality

optimal protection is non-increasing for all α

Other Comparative Static Results

- Increasing marginal cost of labor equivalent to decreasing λ, so generally increases optimal protection
- Reducing indivisibility h is equivalent to increasing λ so generally decreases optimal lprotection.
- Copyright: modern computer technology enormously reduced indivisibility – equivalent of multimillion dollar recording studio of 15 years ago today for 10's of thousands of dollars

Competitive Rents

simple case: first mover and/or competitive rents proportional to private revenue ρ

ϕ fraction of monopoly revenue earned by monopolist

θ extent of protection

ϑ fraction of monopoly revenue earned by the first mover

then $\phi = \theta + \vartheta$, analysis in terms of ϕ unchanged

optimal $\theta = \phi - \vartheta$

for $\phi \geq \vartheta$ nothing changes, except protection is lower

once $\phi < \vartheta$ eliminate protection entirely

reinforced when take account of direct and rent-seeking costs of public provision of monopoly

Positive Marginal Cost of Distributing Ideas

- same labor used to produce ideas is used to distribute them and produce goods using them – complex because introduces a third margin
- additional factor of production - unskilled labor in plentiful supply

replace $v(z,\omega)$, with $v(z,\omega) - mc(\omega)z$

Quality Nonneutrality

- goods with lower private quality have even lower social value$\sigma'(\rho) > 0$ and/or $d'(\rho) > 0$ even greater decline with scale of market
- $\sigma'(\rho), d'(\rho) < 0$ system of awarding private monopolies loses much – private gain poorly correlated with public benefit; might be better to have the government pick winners

Alternatives To Government Grants of Monopoly

- government award prizes for innovation
- 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
- prize money is simply paid back to same innovator - mandatory licensing
- mandatory 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

- 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

- 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
- current X-prize unleashed innovation in aerospace technology: first privately funded supersonic flight just took place