Perfectly Competitive Innovation
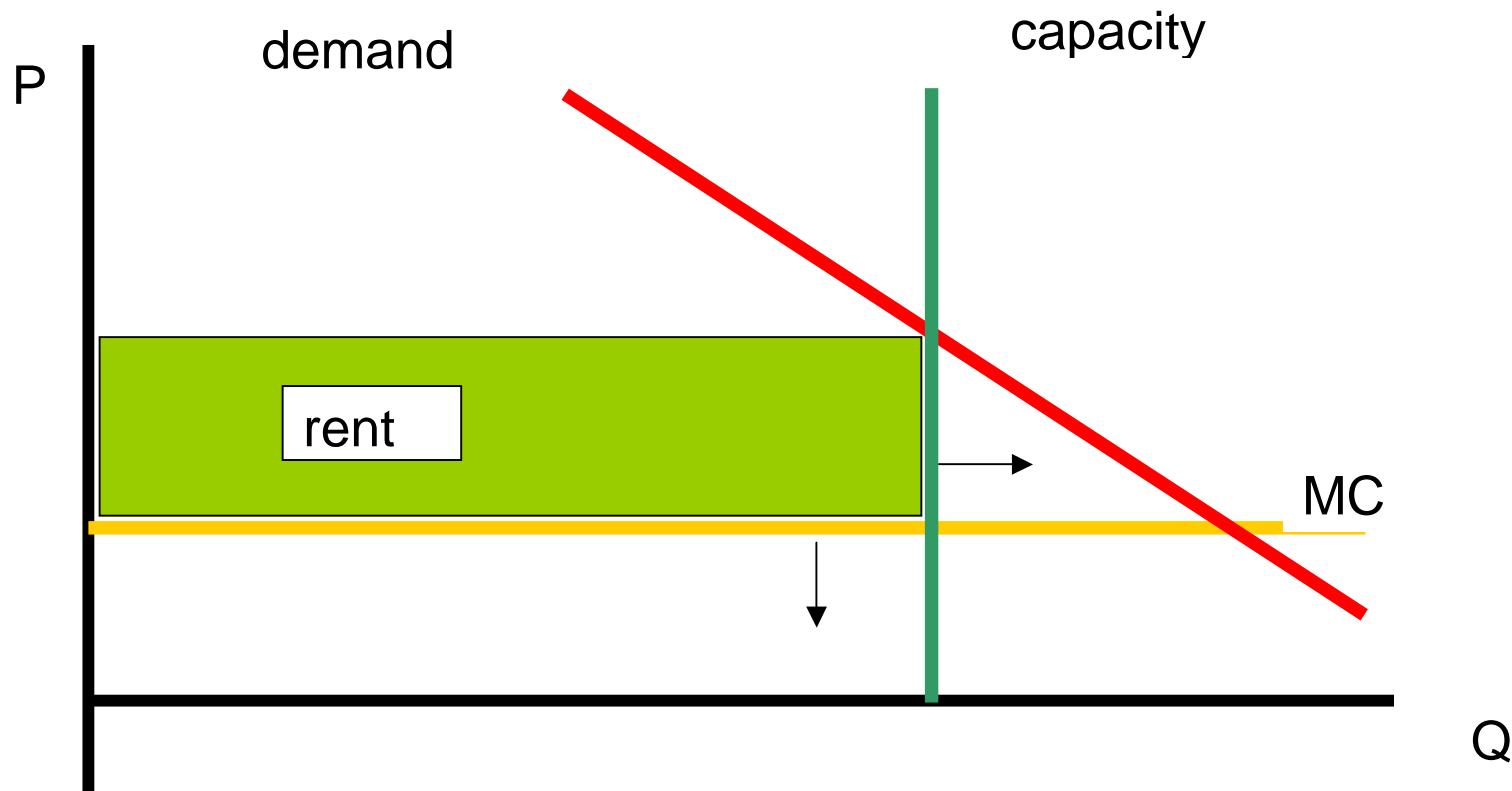
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September 15, 2005

Competition and Innovation

Firms must be able to sell their products at prices in excess of unit production costs if they are to recover their up-front outlays on research and development. In other words, some imperfect competition is necessary to support private investments in new technologies. Gene Grossman and Elhanan Helpman (1994)

➢ Widely believed

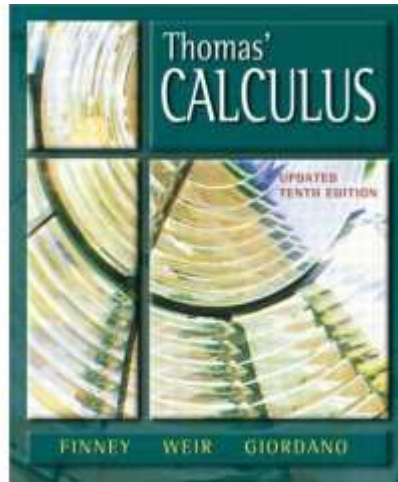➢ Wrong as a matter of theory

➢ Wrong as a matter of fact

Fixed Factors and Competitive Rents

In general equilibrium fixed factors get competitive rents

Innovation is about the creation of new fixed factors

Abstract Ideas and Copies of Ideas

➢ What is the commodity space?

➢ The Fundamental Theorem of Calculus

➢ What matters is my copy, your copy, the copy in a book

➢ Embodied copies of ideas are sold and new copies produced

➢ Abstract ideas have no economic meaning or value

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The 24/7 Model [Quah]

➢ an innovator or creator faces a fixed cost of C to produce a single initial copy of a new good

➢ assume that from the moment in which the innovator sells any fraction of this first copy, she is in immediate and perfect competition with the purchaser(s) of this idea

➢ every copy of the idea contains a template for the idea that is a perfect substitute for the original idea: any purchaser of the idea can make copies of the idea using exactly the same technology for producing copies that is available to the original innovator

➢ ideas are so freely reproducible that merely in the process of using ideas, more copies are created that may be freely sold

Notation and Assumptions

➢ initial cost C single initial copy in period $t = 0$

➢ periods t has k_t copies available

➢ consumed, yielding a utility of $u(k_t)$

    ❑ reproduce themselves and additional copies

    ❑ βk_t copies will be available at time $t + 1$ where $\beta > 1$

➢ each owner of a copy is endowed the following period with β copies

➢ common discount factor of $0 \leq \delta < 1$

➢ MP3 electronic files distributed on a peer-to-peer network

➢ The initial copy is used to "seed" the network

➢ Copies reproduced and downloaded at same time they are listened to

Analysis of the Model

➢ number of copies in circulation grows exponentially: $k_t = \beta^t$

➢ innovator's rents the discounted present value of the revenue stream from renting copies

$$q_0 = \sum_{t=0}^{\infty} (\beta\delta)^t u'(\beta^t).$$

➢ unless $u'(1) = 0$ this competitive rent is always positive

➢ innovator will be willing to innovate provided that $R = q_0/C \geq 1$.

Improved Reproduction Technology

➢ Increased β due to the "Internet"

➢ approaches the conventional case where prices fall quickly to zero, and competition is alleged to fail to produce innovations

➢ two failures in conventional wisdom

   ❑ ignores the initial period when only the initial copy is available

      ▪ $q_0 \geq u^{'}(1)$ regardless of β

      ▪ however, the same technological improvement that leads to increased β may also shorten period length so that $u^{'}(1)$ does effectively fall to zero

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Perils of Rounding off Small Numbers to Zero

➢ increasing β may increase competitive rents

$$\frac{dq_0}{d\beta} = (1/\beta)\sum_{t=0}^{\infty} t(\beta\delta)^t u'(\beta^t)\left[1 + \frac{\beta^t u''(\beta^t)}{u'(\beta^t)}\right].$$

➢ can be either positive or negative

➢ depends on whether demand elasticity $-u''(k)k/u'(k)$ is greater or smaller than one

➢ demand elastic competitive rents become infinite

➢ doesn't depend on period length

➢ demand is inelastic, prices may fall to zero sufficiently quickly that revenue falls to zero

➢ note the hidden assumption in the conventional story

➢ moral: if revenue is a small number times a large, don't round off the small number to zero

Robustness – General Production

utility $\sum_{t=0}^{\infty} \delta^t [u(c_t) - wL_t]$

c_t flow of consumption services from copies

L_t labor supplied at the constant wage w.

copies depreciate at a fixed rate ζk_t units available tomorrow, allow $\zeta > 1$ to include the 24/7 case.

k_t^c, ℓ_t^c inputs used to produce consumption

k_t^k, ℓ_t^k inputs used to produce copies

$c_t = F(k_t^c, \ell_t^c), \ x_t = G(k_t^k, \ell_t^k)$

$k_{t+1} = \zeta k_t + x_t, \ k_0 = 1$

Nothing changes

Are Spillover Externalities Important?

What on earth are they?

Travelpro – the modern wheeled roll-on suitcase with a retractable handle

Becker [1971]

Firms introducing innovations are alleged to be forced to share their knowledge with competitors through the bidding away of employees who are privy to their secrets. This may well be a common practice, but if employees benefit from access to salable information about secrets, they would be willing to work more cheaply than otherwise

Consequences of Spillover Externalities

Back to 24/7 model for simplicity

$$\beta = \beta_0 + \beta_S$$

β_0 copies that wind up in the hands of the original owner

β_S copies that wind up in the hands of fortunate passers-by

$$q_0 = \sum_{t=0}^{\infty} (\beta_0 \delta)^t u'(\beta^t).$$

price driven by total number of copies β^t

innovator collects rents only on copies β_0^t that have not escaped his control

Nothing Changes

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Complementary Sales

➢ perfect competition *post* innovation

➢ *ex ante* no innovator a price taker

➢ an innovation lowering the cost of making cars will have an impact on price of cars

➢ creation of a new idea or fixed factor will generally affect prices in other markets as well

➢ perfect competition assumes perfect divisibility

➢ two first halfs of a book a poor substitute for the whole

➢ perfect divisibility and perfect competition means we can ignore effect of production on the prices of substitutes and complements

➢ not so with indivisibility

➢ writing a novel will change the demand for the author's services on the lecture circuit, etc.

Innovation with Two Commodities

a quantity of single other commodity

utility of the representative consumer $u(c_t, a)$

analysis of the time path of c_t not affected by the presence of a

net change in the price of a due to innovation, assuming perfect competition post innovation

$$Q = \sum_{t=0}^{\infty} \delta^t \left[u_a(c_t, a) - u_a(0, a) \right] = \sum_{t=0}^{\infty} \delta^t \int_0^{c_t} u_{ac}(c, a)dc.$$

if a is a substitute for c_t (cross partial is negative) innovation causes the price of a to fall

if a is a complement of c_t, (cross partial is positive) innovation causes the price of a to rise.

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Consequences

➢ innovator does not own any a then Q does not matter

➢ innovator owns (some portion of) a then the incentive to innovate is decreased/increased as the complementary good is a substitute/complement

➢ owner of a car factory has reduced incentive to create new type of car, because this will lower the value of his existing cars

➢ writer of a song will increased incentive to create new song, because this will raise the value of his live performances

Complementary Sales

➢ case of complements particularly important

➢ in practice it provides a significant source of competitive rents

➢ in the case of complementary sales, raising the efficiency of reproduction (increasing β) always increases Q

➢ perfectly possible to have innovation under perfect competition even when the reproduced good is given away for free

➢ think radio and television

Endogenous Ownership

➢ Car factory owner sells factory before innovating

➢ Hirshleifer [1971] substantial first mover advantage from ability to trade in markets on the basis of inside information about innovation

➢ If short-sales are possible private value of innovation under perfect competition is generally much greater than the social value

➢ too much rather than too little innovation.

Open Source Software

voluntary renunciation of copyright and patent

buyers are entitled to make own copies, modified or not, and sell them

voluntary renunciation of trade-secrecy

original creator publishes the source code

conditions of the market are essentially those of perfect competition

➢ this market shouldn't exist by conventional story

➢ Lerner & Tirole and other economists who have studied the market find it puzzling – they never once examine competitive rents

➢ is the market itself significant – or does open source simply free-ride off the proprietary market making cheap imitations of software that never would have been produced in the first place absent monopoly power?

➢ what exactly are the competitive rents in this market?

Open Source Innovation

➢ Google, Linux and Apache

➢ Linux a knock-off of Unix, Openoffice Writer a knock-off of Microsoft Word

➢ almost all software, proprietary or not, an imitation of some other software

➢ Microsoft Windows a knock-off of Macintosh, which is a knock-off of Smalltalk

➢ Microsoft Word a knock-off of Wordperfect, which is a knock-off of Wordstar

➢ Microsoft Excel a knock-off of Lotus 1-2-3 which is a knock-off of Visicalc
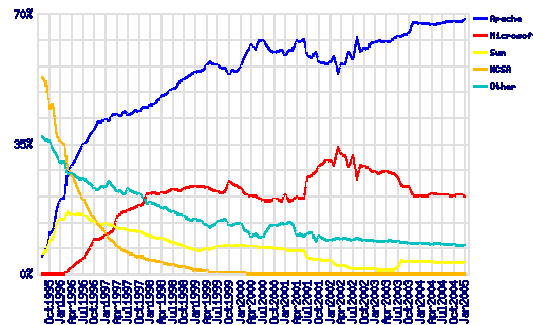
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The Internet

Internet is the greatest recent innovation in computer software.

Internet dominated by open source software

First webservers were open source

Open source Apache webserver has about 70% market share

Sendmail, bittorrent

Word Processing

Does invention of Microsoft Word make is easier or harder to write another word processor?

➢ Does not help problem of coding and debugging

➢ Forces expensive backwards file compatibility

➢ Reduces greatly size of market

Sources of Competitive Rents

➤ Not a charity

➤ Most significant source of competitive rents appears to be through complementary sale of expertise

July 10, 2002

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if you have a question would you prefer to call the person who wrote the software or the person who copied it?

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Books

19th Century U.S. book written in England not entitled to copyright in the U.S.

yet American publishers found it profitable to make arrangements with English authors. Evidence before the 1876-8 Commission shows that English authors sometimes received more from the sale of their books by American publishers, where they had no copyright, than from their royalties in [England] Arnold Plant [1934]

U.S. 1850 population 23.2 million, per capita GDP $1930 (1996 $)

U.K. 1851 population 27.5 million, per capital GDP $2838
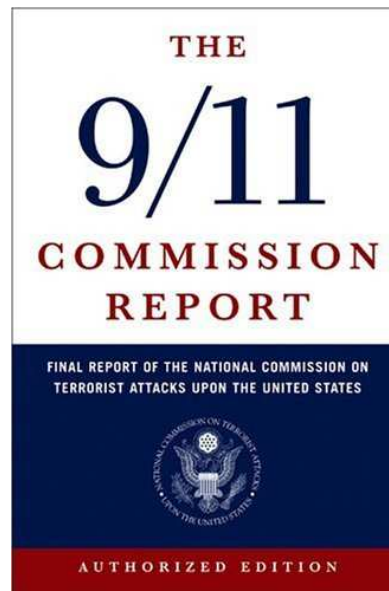
iteracy rates in both countries roughly 85%.

enormous price differential between sale price of books without copyright in the U.S. and with copyright in the U.K

Dickens' *A Christmas Carol* sold for six cents in US, for two dollars and fifty cents in England.

9/11 Commision Report

➢ government document, not covered by copyright

➢ released to the public at noon on Thursday July 22, 2004

➢ freely available for downloading from a government website

➢ printed version published by W.W. Norton simultaneously

The 81-year-old publisher struck an unusual publishing deal with the 9/11 commission back in May: Norton agreed to issue the paperback version of the report on the day of its public release. (An indexed hardcover edition will follow.) Norton did not pay for the publishing rights, but had to foot the bill for a rush printing and shipping job; the commission did not hand over the manuscript until the last possible moment, in order to prevent leaks. The company will not reveal how much this cost, or when precisely it obtained the report. But expedited printings always cost extra, making it that much more difficult for Norton to realize a profit. In addition, the commission and Norton agreed in May on the 568-page tome's rather low cover price of $10, making it that much harder for the publisher to recoup its costs. (Amazon.com is currently selling copies for $8 plus shipping, while visitors to the Government Printing Office bookstore in Washington, D.C. can purchase its version of the report for $8.50.) There is also competition from the commission's Web site, which is offering a downloadable copy of the report for free. And Norton also agreed to provide one free copy to the family of every 9/11 victim. Brendan Koerner [2004]

Norton's Royalty Free Windfall

➢ Norton got to publish first and to use the word "authorized" in the title

➢ St. Martin's Press in collaboration with the New York Times released own version about two weeks after Norton

➢ 6.9 million copies of the report were (legally) downloaded over the Internet.

➢ Norton sold about 1.1 million copies, charged between a dollar and a dollar fifty more than St. Martin's; other publishers also estimated Norton made on the order of a dollar of profit on each copy

➢ Norton's contract called upon them to donate their "profits" to charity

➢ Norton did "donate $600,000 to support the study of emergency preparedness and terrorism prevention."
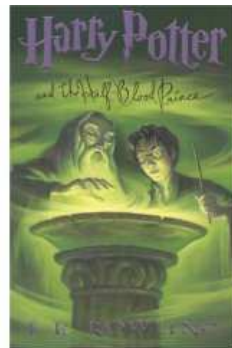
Implications for Literature

Including free downloads, about about 8 million copies of *9/11 Commision Report* in circulation

initial print run for *Harry Potter and the Half-Blood Prince* 10.8 million hardcover copies

if J. K. Rowling forced to publish her book without copyright we can expect her to earn well over a million

less than the billions she currently earns

but more than in her previous occupation as a French teacher

Ideas of Marginal Social Value

➢ Competition does not result in full appropriation of social surplus

➢ Intellectual property does not result in full appropriation of social surplus

➢ Intellectual property increases appropriation of social surplus, but also increases cost of innovation due to downstream effects

➢ Full appropriation of social surplus is irrelevant

➢ Condition for first best: marginal idea must have full appropriation

Scale of Market

Intellectual property introduces a trade-off between the number of marginal ideas produced and the usefulness of inframarginal ideas

Empirical examination of this tradeoff leaves little doubt that we have far too much IP and that it should be reduced as the size of market grows

Blockbuster Ideas

ideas of great social value will be produced under competition

➢ great blockbuster novels

➢ life-saving drugs

generate such great surplus relative to the cost of creation that relatively little of that surplus need be captured by the innovator to make it worth her while

great works of Shakespeare and Mozart were created under conditions of perfect competition.

Marginal Ideas

Marginal ideas face less competition

➢ *Harry Potter and the Half Blood Prince* scanned and illegally released onto the Internet within hours of appearing in print

➢ No trace of pirate versions of Sara Rath's opus *Star Lake Saloon and Housekeeping Cottages: A Novel* published six days earlier

Marginal ideas aren't going to get much protection from the law

Impact of the Internet: example of comic strips and t-shirts

Rosenberg raves that he has been able to make five times as much off his merchandising as off his subscriptions and that advertising doesn't come close to generating the revenue he gets off t-shirts, noting a profit margin of up to 50%, which would be as much as $9 per item in some cases. Stevens quotes $4-$5 as his margin. Rosenberg further claims to have tripled his 2003 income by switching to t-shirt sales in the last three months of 2003. Todd Allen [2005]

Pharmaceuticals

➢ cost of bringing a new drug to market large, roughly $200 million 1989 dollars

➢ companies required to disclose chemical formula for their products as part of the FDA approval process, and make available to other manufactors the results of their clinical trials

➢ without patents, industry would operate under "negative" patent in which the government forces disclosure as a condition of doing business

➢ widely perceived that with elimination of patents generics would enter the market at roughly the same time as the original and there would be no profit or rent with which to cover the high cost of creating new drugs

➢ not obvious

➢ Lanjouw [1999] examines Indian pharmaceutical industry

➢ Since 1972 product patents on pharmaceuticals not recognized in India

➢ takes about 5 years for a new drug to enter the Indian market as a generic following its introduction elsewhere

two reasons

Wait and See

generic manufacturers generally wait a year to see how the new drug does on the market before making the decision to enter

highlights problem with common view that imitators have an advantage because they only need to imitate successful products

true that few would spend a lot of money imitating a product that sold very little at a low price

by the time an imitator has learned that the original is selling a lot of units at a high price, the innovator has already pocketed quite a bit of money.

Generic Entry

process of imitation and clearing regulatory hurdles takes 3-4 years

Lanjouw conjectures time to imitate is short and primary delay is regulatory one

patent protection for a drug lasts only about 10 years

appears without patent that the innovator of a new product would enjoy a 5 year rather than 10 year monopoly

when generics enter price of the original does not change much, and the original retains about 50% market share

Revenue Gain from Patent

6% real interest rate, normalize the flow of revenues from monopoly to be 1

10 years protection present value is roughly $.6 \times 1 + .4 \times .5 = .85$

5 years protection $.3 \times 1 + .7 \times .5 = .65$

loss of present value would be only about 25%