Part VII. R&D and intellectual property

Chapter 19. Intellectual property

Slides
Industrial Organization: Markets and Strategies
Paul Belleflamme and Martin Peitz, 2d Edition

Chapter 19. Learning objectives

- Understand the appropriability problem of innovation, and the rationale behind public and private solutions to this problem.
- Analyze how intellectual property (IP) protection should optimally be organized.
  - What length and breadth should patents have?
  - How do the market for licenses and the possibility of pooling patents affect the optimal design of the IP system?
- Be able to apply the general analyses to the specificities of the digital economy.

Information and appropriability

- Activities generating information suffer from the 3 generic sources of market failure.
  - Indivisibilities
    - R&D programmes involve high fixed set up costs, display economies of scale (from extensive division of highly specialized labour)
    - Knowledge is inherently discrete.
  - Uncertainty: 2 sources of uncertainty for R&D
    - Technological uncertainty → how to make a new product and how to make it work?
    - Market uncertainty → how to sell the new product and make it a commercial success?
    - + moral hazard problems (why does the product fail? inherent scientific difficulty or lack of effort?)

Information and appropriability (cont'd)

- 3 generic sources of market failure (cont'd)
  - Public good nature
    - Information is nonrival
      - Its consumption by one person doesn't prevent (rival) its consumption by another person.
      - At any level of production of information, the marginal cost of delivering it to an extra consumer is zero.
    - Information is nonexcludable
      - One person cannot exclude another person from consuming information.
      - Excludability depends on the available technology for exclusion and on the institutional (legal) framework.
  - 3 market failures $\Rightarrow$ problem of appropriability
    - General presumption: markets provide too little incentive to introduce new innovations.

Intellectual property protection

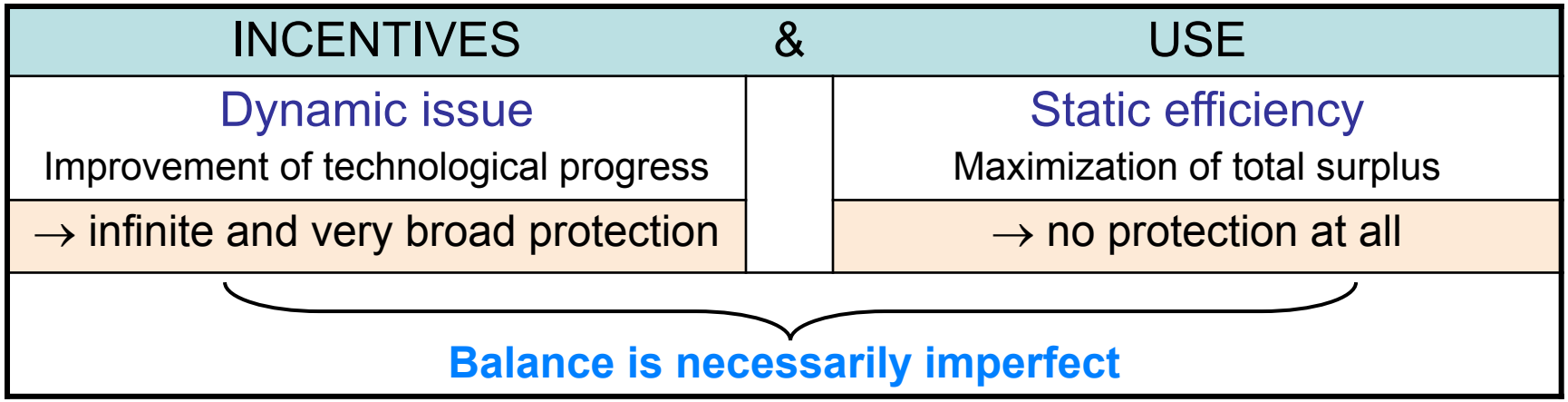
- Intellectual property (IP)
  - Legal rights resulting from intellectual activity in the industrial, scientific, literary and artistic fields.
    - Industrial property branch → inventions, business methods, industrial processes, chemical formulae, unique names
    - Copyright branch → all information products that derive their intrinsic value from creative expression, literary creation, ideas, or presentations
- Main objective of IP law
  - To promote innovation and aesthetic creativity.
  - How? By granting exclusive use of the protected knowledge or creative work to the creator.

Intellectual property protection (cont'd)

- Incentives versus use
  - Nonexcludability → hard to appropriate the returns from intellectual activities → underproduction problem
  - But exclusivity allows creators to set prices above (zero) marginal costs → underutilization problem
- IP law solves the 2 problems sequentially
  - Legal protection makes the good excludable
    - ⇒ Creators have incentives to produce new information.
  - Once protection is over, the good falls in public domain.
    - All users may access the good for free (i.e., at marginal cost).
- IP law strikes a balance between
  - Incentives to create and innovate
  - Use of the results of creation and innovation

Intellectual property protection (cont'd)

- **Lesson**: IP law attempts to find the best possible compromise between investment considerations (how to provide the right incentives to create and innovate), and static efficiency considerations (how to promote the diffusion and use of the results of creation and innovation).



Intellectual property protection (cont'd)

- Main IP regimes

	Patent	Copyright
Requirements for protection	Novelty, inventive step, practical use	Originality, authorship, form of expression
Ownership	First to file First to invent	Author/creator
Rights	*Bundle of rights extending to the idea*: exclusive rights against all commercial uses (make, use, sell the innovation)	*Economic and moral rights on the form of expression*: exclusive rights against copying (rights of performance, display, reproduction, derivative works)
Scope of protection	Wide	Narrow
Duration	20 years from filing	Life of author + 70 years
Costs of protection	Filing, issue, and maintenance fees; litigation costs	No filing necessary; suit requires registration; litigation costs

Intellectual property protection (cont'd)

- Gradual reinforcement of IP protection
  - Strengthening
    - US, early 1980s: legal and procedural reforms provided stronger protection to holders of existing patents.
    - EU: move towards a European patent
  - Broadening
    - New categories of inventions have been protected, either through an extension of patent protection (software, business methods, genetic inventions) or through the creation of 'sui generis' rights (semiconductors, databases).
  - International harmonization
    - TRIPS Agreement, 1994: includes a general definition of patents, which adopts US criteria and, thereby, broadens the scope of patentable inventions internationally.

Alternative incentive mechanisms

- Reward systems
  - Government finances technical and artistic creation.
  - Static efficiency: free access → no deadweight loss, but taxation → distortions (for patents, product users pay)
  - Dynamic efficiency: uncertainty about costs/benefits of research → subsidy might give too little (too much) incentive (no need for such information to implement patents)
- Trade secrets
  - No need for public intervention
  - Information is still non-rival but the absence of diffusion creates a cost for society.
  - Offers no protection against independent innovations

Protection of IP in practice

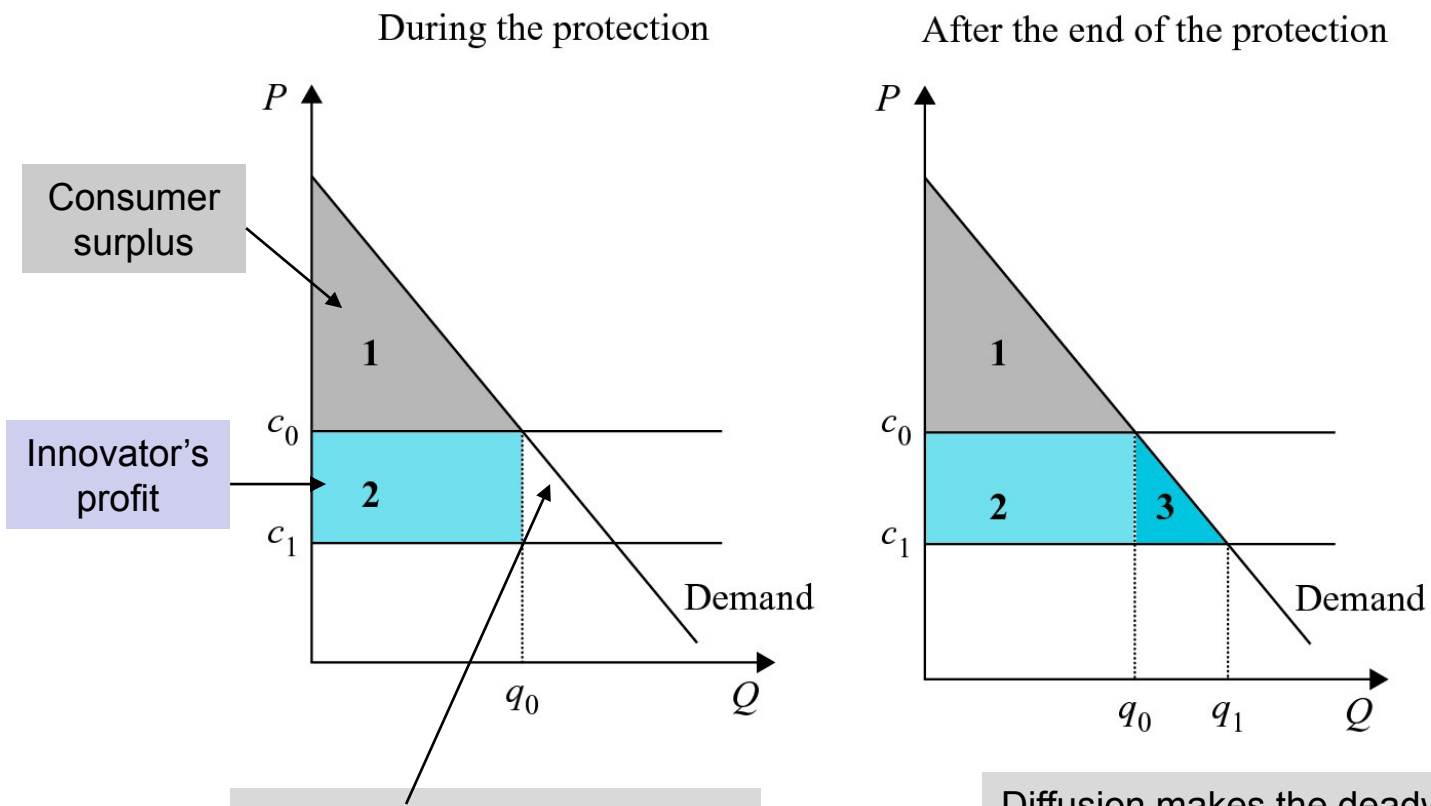
- Survey of innovators
  - Managers claim that "lead time, learning curves, and sales or service efforts are substantially more effective in protecting IP than patents are". (Anand and Galetovic, 2004)
  - Patents are seen as a secondary or complementary instrument for protecting IP.
  - Why? Firms often consider that a patent …
    - can easily be 'invented around' by imitators,
    - is costly to obtain and to enforce,
    - is detrimental because of the disclosure requirement.
  - Exceptions: chemical and pharmaceutical sectors
    - R&D processes are long, very costly and highly uncertain.
    - Knowledge is more codified → lower imitation costs

Protection of IP in practice (cont'd)

- Patent explosion
  - US, 1980-2001: # of patent grants more than tripled
  - Europe: comparable trend
  - Private value of these patents? (Scotchmer, 2004)
    - The values of patent rights are very dispersed.
    - The distribution of values is very skewed, with most of the value provided by a few high-earning patents.
    - The average value of patent rights is much lower than the average R&D cost of innovation.
- Patent paradox?
  - Huge ↑ in patents >< patents seen as weak protection
  - Potential explanation: patents = 'trading device'
    → Patent portfolio theory: patents are more valuable when aggregated than when taken individually.

Optimal design of IP rights

- Static versus dynamic efficiency
  - Graphical analysis



A temporary reduction in static efficiency enhances investment incentives

Optimal patent length

- Objective
  - Determine the right balance between
    - incentives (= private return on R&D investments accruing to the innovator during the duration of the patent)
    - and use (= social benefits accruing to consumers and other firms once the patent expires and competition emerges).
- Model
  - Innovator with strictly convex cost function

$$C(x) = \frac{1}{2}\phi x^2$$

ϕ : exogenous efficiency of innovation technology

- Assume ϕ large enough $\rightarrow x$ always < 1 $\rightarrow x$ can be seen as success probability of innovation.

Optimal patent length (cont'd)

- Innovator's problem
  - With prob. x, innovation successful → innovator obtains
    - During patent life (patent length = T): monopoly profit π^m
    - After patent expiration: competitive profit $\bar{\pi}$, with $0 \leq \bar{\pi} < \pi^m$
  - PDV of innovator's return in case of success

$$P(T) = \int_0^T e^{-rt}\pi^m dt + \int_T^\infty e^{-rt}\bar{\pi} dt$$

  - Innovator choose x to maximize $xP - (1/2)\phi\ x^2$

$$x^*(T) = P(T)/\phi$$

    - $P(T)$ ↑ with T → $x^*(T)$ ↑ with T → **the longer the patent protection, the higher the innovator's return and, hence, his incentive to invest in R&D.**

Optimal patent length (cont'd)

- Policymaker's problem
  - Social return on innovative effort

$$S(T) = \int_0^T e^{-rt} W^m dt + \int_T^\infty e^{-rt} \bar{W} dt, \text{ with } \bar{W} > W^m$$

  - Task: choose T to maximize $S(T)$ given $x^*(T)$

$$\max_T x^*(T) S(T) - \tfrac{1}{2}\phi\left(x^*(T)\right)^2$$

  - F.O.C.

$$\frac{\partial x^*(T)}{\partial T} S(T) = x^*(T)\left(\phi \frac{\partial x^*(T)}{\partial T} - \frac{\partial S(T)}{\partial T}\right)$$

Marginal dynamic gain — Marginal static loss

Trade-off between static efficiency and investment incentives

Optimal patent length (cont'd)

- Conclusion
  - Optimal length balances 2 effects of longer patent
    - Marginal dynamic gain: innovation ↑
    - Marginal static loss: R&D cost ↑ and consumer surplus ↓
  - Optimal patent duration is **finite**. Why?
    - Diminishing returns to R&D: it will take progressively greater increases in T to achieve a given probability of success
    - Discounting: consumer benefits from innovation won't be realized until after the patent expires → the larger T, the smaller the present value of those benefits.

- **Lesson**: A patent that is unlimited in duration cannot be welfare maximizing.

Case. **Extension of the copyright term in the US**

- 1998: Copyright Term Extension Act (CTEA)
  - extends duration of existing US copyrights by 20 years.
- 1999: constitutionality of CTEA is challenged
  - By a group of commercial and non-commercial interests relying on the public domain for their work.
- 2002: 17 economists support the petitioners
  - "*It is highly unlikely that the economic benefits from copyright extension under the CTEA outweigh the costs.*"
  - Arguments drawn from previous framework:
    - The revenues earned during the additional 20 years of protection are so heavily discounted that they lose almost all value, while the extended protection of existing works generates immediate deadweight losses (which are even larger when taking the increased cost of creating new derivative work into account).

A logo representing opposition to the CTEA, using a reference to its "Mickey Mouse Protection Act" pejorative denomination (Source: Wikipedia)

Optimal patent breadth

- Extent of monopoly power can also be curbed by limiting patent breadth.
- Breadth? Measures degree of patent protection
  - Not directly defined in IP law; matter of interpretation
    - Patent office: is innovation novel, inventive (non-obvious)? How legitimate are the claims put forward by the applicant?
    - Courts: is there infringement?
- Economists study breadth in 2 ways
  - Innovation is threatened by horizontal competition
    - Product space: broader patents excludes more substitutes
    - Technology space: cost of inventing around the patent?
  - Innovation might be supplanted by improved innovation
    - See cumulative innovations below

Optimal patent breadth (cont'd)

- Horizontal competition
  - Extension of previous model
  - $b \in [0,1]$ measures breadth

$$\begin{cases} \pi(b) \text{ with } \pi(1) = \pi^m \text{ and } \pi(0) = \overline{\pi} \\ W(b) \text{ with } W(1) = W^m \text{ and } W(0) = \overline{W} \end{cases}$$

$\pi'(b) > 0$ and $W'(b) < 0 \rightarrow$ breadth exerts, like length, opposite effects on innovator's profit and social welfare

  - Private and social returns on innovation

$$P(T,b) = \int_0^T e^{-rt}\pi(b)dt + \int_T^\infty e^{-rt}\overline{\pi}dt$$

$$S(T,b) = \int_0^T e^{-rt}W(b)dt + \int_T^\infty e^{-rt}\overline{W}dt$$

Optimal patent breadth (cont'd)

- Horizontal competition (cont'd)
  - Innovator's solution $x^*(T,b) = P(T,b)/\phi$
  - Totally differentiating

$$\frac{dT}{db} = -\frac{\partial P/\partial b}{\partial P/\partial T} < 0$$

    - Length and breadth are substitutable policy tools.
  - Policymaker's task: find optimal patent breadth–length mix, anticipating innovator's optimal conduct.
    - Max S w.r.t. T and b, fixing innovation activity x at some required level
    - Define $T(b)$ by solving above equation
    - Express $S(T(b),b)$

Optimal patent breadth (cont'd)

- Horizontal competition (cont'd)
  - Differentiate $S(T(b),b)$

$$\frac{dS}{db} = \frac{\partial S}{\partial T}\frac{dT}{db} + \frac{\partial S}{\partial b} = -\frac{\partial S}{\partial T}\frac{\partial P/\partial b}{\partial P/\partial T} + \frac{\partial S}{\partial b}$$

$$\text{So, } \frac{dS}{db} > 0 \Leftrightarrow \frac{\partial P/\partial b}{\partial P/\partial T} > \frac{\partial S/\partial b}{\partial S/\partial T}$$

    - An increase in patent breadth stimulates investment in innovation relatively more than patent length while reducing the post-innovation welfare relatively less.
    - → Increasing breadth is welfare-enhancing
      → Optimal patent is broad and short.
  - Otherwise, if $dS/db < 0$
    - → Increasing breadth is welfare-detrimental
      → Optimal patent is narrow and long.

Optimal patent breadth (cont'd)

- **Lesson**: If the marginal rate of substitution of patent length for breadth is larger on the incentive to innovate than on social welfare, the optimal patent is broad and short; otherwise, it is narrow and long.

Rewards vs. patents

- Same model as before
  - PDV of profits and social welfare for a given patent length T

$$P(T) = \int_0^T e^{-rt}\pi^m dt + \int_T^\infty e^{-rt}\bar{\pi}dt = \frac{1}{r}\bar{\pi} - \tau(\bar{\pi} - \pi^m),$$
$$S(T) = \int_0^T e^{-rt}W^m dt + \int_T^\infty e^{-rt}\bar{W}dt = \frac{1}{r}\bar{W} - \tau(\bar{W} - W^m),$$

    - where $\tau = (1\text{-}e^{-rT})/r$ is the discounting-adjusted length of the patent
- First best
  - Government chooses R&D effort and puts innovation immediately in the public domain.
  - Maximization program $\max_x x\left[\int_0^\infty \overline{W}e^{-rt}dt\right] - \frac{1}{2}\phi x^2 = x(\overline{W}/r) - \frac{1}{2}\phi x^2$
  - Optimal R&D effort and expected social welfare

$$x_{FB} = \overline{W}/(\phi r)$$
$$W_{FB} = \overline{W}^2/(2\phi r^2)$$

Rewards vs. patents (cont'd)

- Second best
  - Innovator chooses R&D effort based on private value of innovation
  - Patents
    - Private value of innovation = monopoly profits (and corresponding deadweight loss) for T periods
  - Rewards
    - Private value of innovation = some reward R
    - Innovation becomes public immediately $\rightarrow$ no deadweight loss
  - Trade secrets
    - Private value of innovation = monopoly profits (and corresponding deadweight loss) for as long as the secret does not leak

Rewards vs. patents (cont'd)

- Patents
  - Innovator's optimal R&D effort: $x_P = P(T)/\phi$
  - Expected social welfare: $W_P = x_P S(T) - \frac{1}{2}\phi x_P^2$
  - $W_P < W_{FB}$: **The patent system fails to achieve the first best outcome**.
  - 2 sources of welfare loss relative to the first-best
    - Deadweight loss because of monopoly pricing
    - Investment in R&D is insufficient because the innovator can only appropriate the private (and not the social) value of the innovation

Rewards vs. patents (cont'd)

- Rewards
  - Innovator's problem: $\max_x xR - \frac{1}{2}\phi x^2 \rightarrow \quad x_R = R/\phi$
  - Social welfare: $SW_R = x_R\left[\int_0^\infty \overline{W}e^{-rt}dt\right] - \frac{1}{2}\phi x_R^2$
  - Recall first-best analysis

$$SW_{FB} = x_{FB}\left[\int_0^\infty \overline{W}e^{-rt}dt\right] - \frac{1}{2}\phi x_{FB}^2$$

  - $\rightarrow$ **It is possible to achieve the first-best outcome under the reward regime by rewarding the innovator with the social value of the innovation:**

$$x_R = x_{FB} \text{ and } SW_R = SW_{FB} \Leftrightarrow R = \overline{W}/r$$

  - BUT, this requires perfect information...

Rewards vs. patents (cont'd)

- Rewards
  - Suppose **imperfect information**
  - → Reward based on some estimation of the social value of the innovation: $R = (1 - s)\, S(0)$, with $-1 < s < 1$
  - Innovator's optimal effort: $x_R = R/\phi = (1-s)S(0)/\phi$
  - Expected social welfare:

$$W_R = \tfrac{1}{2\phi}(1-s^2)S(0)^2 = (1-s^2)W_{FB} < W_{FB}$$

  - **The reward regime under imperfect information fails to achieve the first-best.**
    - Only distortion comes from an inadequate investment in R&D: too low (high) if social value is under- (over-) estimated
    - No deadweight loss

Rewards vs. patents (cont'd)

- Rewards vs. patents

$$W_P > W_R \Leftrightarrow W_P > (1 - s^2)W_{FB} \Leftrightarrow |s| > \sqrt{1 - (W_P / W_{FB})}$$

- **Lesson**: Both the patent and the reward systems fail to achieve the first-best outcome. In the reward system, the investment in R&D is inadequate because the public authority cannot perfectly evaluate the social value of the innovation and fails thus to grant a reward that would achieve the first-best outcome. In the patent system, there is a deadweight loss due to monopoly pricing on top of an insufficient investment in R&D. Either system may be superior to the other; the patent system outperforms the reward system whenever the public authority fails to evaluate the social value of the innovation with enough accuracy.

Trade secrets vs. patents (cont'd)

- Trade secrets
  - The innovator may try to capture the private value of the innovation by keeping the innovation secret.
  - Risk: secret leaks out → innovation in public domain
  - **Model**
    - A competitor may discover the innovation according to a Poisson process with exogenous parameter $\lambda > 0$.

      λ : ease with which the competitor can discover or circumvent the innovation covered by trade secret

      $e^{-\lambda t}$: probability that innovation remains secret at any date t
    - Private and social values of the innovation:

$$P(\lambda) = \int_0^{\infty} \left(e^{-\lambda t}\pi^m + \left(1 - e^{-\lambda t}\right)\bar{\pi}\right) e^{-rt} dt = \frac{1}{r}\bar{\pi} - \frac{1}{r+\lambda}\left(\bar{\pi} - \pi^m\right),$$
$$S(\lambda) = \int_0^{\infty} \left(e^{-\lambda t} W^m + \left(1 - e^{-\lambda t}\right)\bar{W}\right) e^{-rt} dt = \frac{1}{r}\bar{W} - \frac{1}{r+\lambda}\left(\bar{W} - W^m\right)$$

Trade secrets vs. patents (cont'd)

- Trade secrets vs. patents
  - Comparison

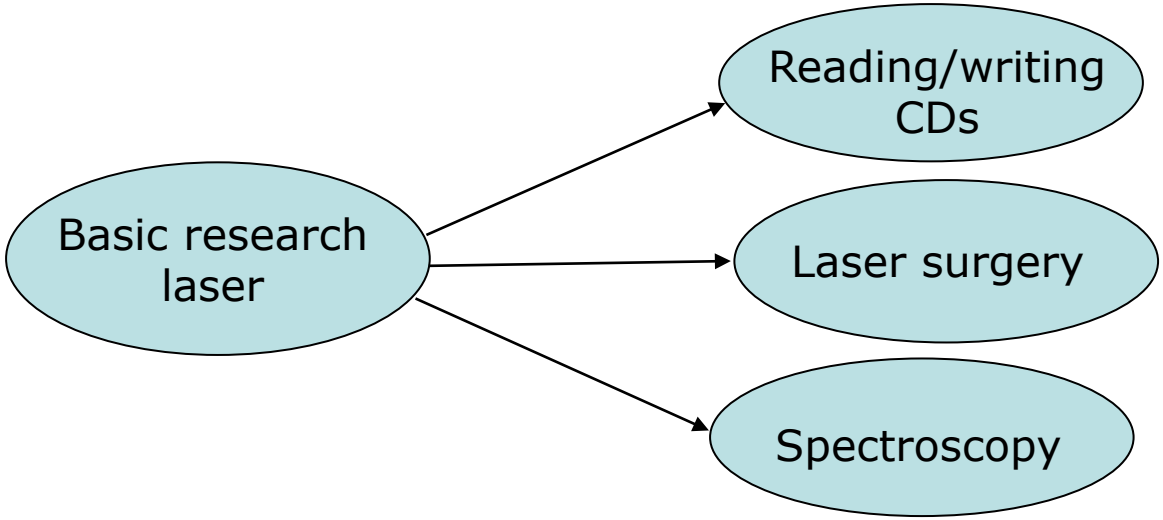
$$P(T) > P(\lambda) \Leftrightarrow \tau > \frac{1}{r+\lambda} \text{ and } S(T) > S(\lambda) \Leftrightarrow \tau < \frac{1}{r+\lambda},$$

    - where $1/(r+\lambda)$ is the discounting-adjusted duration of the secret.

- **Lesson**: Ignoring dynamic efficiency considerations, the interests of the innovator and of society are completely at odds when it comes to choosing between patents and trade secrets: the innovator prefers patents over secrets when patents have a longer duration (adjusted for discounting) than secrets, whereas the exact opposite prevails for society.

Cumulative innovations

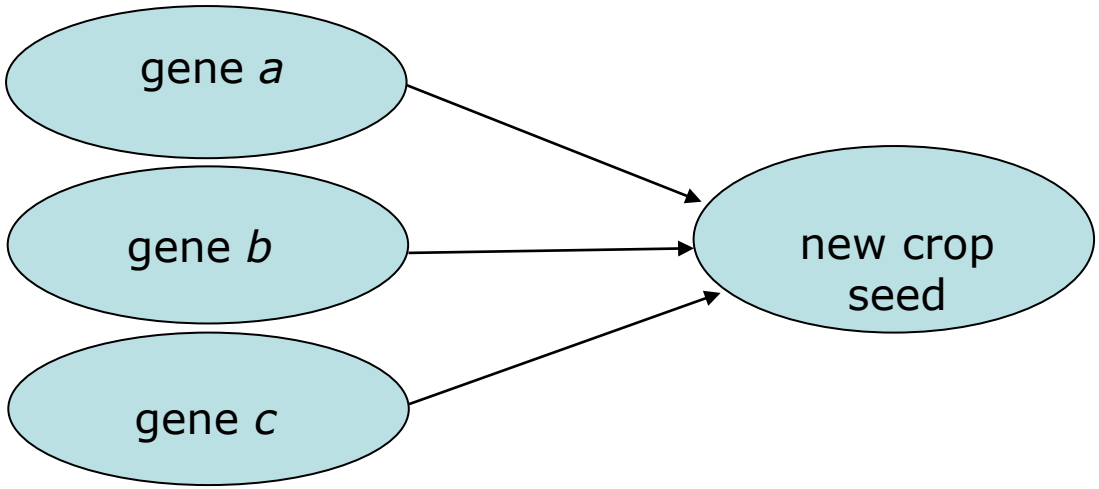
- 2 types of cumulativeness
  - Sequential innovations → a particular innovation leads to many second-generation innovations



- Hold-up problem → a patent on the first-generation innovation confers the patentee a hold-up right over subsequent innovations. Ex ante licensing may alleviate the problem.

Cumulative innovations (cont'd)

- 2 types of cumulativeness (cont'd)
  - Complementary innovations → a second-generation product requires the input of a number of different first-generation innovations



  - 'Tragedy of the Anticommons' → prices are higher if they are set by independent patentees rather than jointly
    Cross licensing and patent pools may alleviate the problem.

Sequential innovations

- Sharing of incentives and hold-up
  - Cumulative innovations → different innovators
    - Patent for each innovator?
    - Patent for initial innovator on all posterior innovations?
  - Hold-up problem
    - Innovator may be reluctant to invest in R&D if exploitation of results depends on a 3rd party owning an anterior patent.
    - Primary component of patent litigation and patent licensing.
    - Rise of Patent Assertion Entities (PAEs) or "Patent Trolls"
      - Patent holders who license or bring suit using their patent without any intention to practice those particular patents.
      - Common in component-driven industries (e.g., IT)
      - More acute in the US where patent infringements can be punished through a permanent injunction.
        → RIM accepted to pay $612.5 million out-of-court settlement to NTP in 2006 to avoid the risk of its popular BlackBerry service being shut down.

Sequential innovations (cont'd)

- Simple model
  - 2 cumulative innovations
  - 1st innovation
    - In isolation, has value v_1.
    - Can only be realised by firm A at R&D cost c_1.
  - 2nd innovation
    - Can only be realised by firm B, if 1st innovation exists.
    - Its value is v_2 and the R&D cost is c_2.
  - $v_1 + v_2 - c_1 - c_2 > 0 \rightarrow$ innovations are socially desirable.
- Optimal patent?
  - Patent on each innovation?
    - Works only if $v_1 - c_1 > 0$. Otherwise, 1st innovator doesn't invest and no innovation takes place.

Sequential innovations (cont'd)

- Optimal patent? (cont'd)
  - Patent granted to firm A for both innovation?
    - Firm B has no guarantee to recoup its investment.
    - B can exploit its innovation only with A's agreement → Once R&D costs are sunk, B is exposed to A's opportunistic behaviour: A's best interest is to appropriate the value of the 2nd innovation, i.e., v_2.
    - Anticipating this, B has no incentive to innovate.
    - If $v_1 < c_1$, knowing that B won't invest, A has no incentive to invest either.

- **Lesson**: Because of the hold-up problem, a broad patent covering later developments of an innovation is not more efficient than a sequence of narrow patents.

Sequential innovations (cont'd)

- Optimal patent? (cont'd)
  - More general setting: need for longer patents
  - Can be mimicked through ex-ante licensing
    - Licensing before the 2nd innovator sinks funds into R&D (so, no room for opportunistic behaviour by 1st innovator).
  - Alternative view: not to apply IP for cumulative innovations
    - Competition between innovators → less incentives to invest
    - BUT, they can draw freely on all existing innovations
    - Application: open-source software (see below)

Complementary innovations

- Patent system creates a 'patent thicket'
  - Overlapping set of patent rights requiring that those seeking to commercialize new technology obtain licenses from multiple patentees.
- Danger: 'royalty stacking'
  - Multiple marginalization
  - Cournot's work on the pricing of complements (1838)
    - A single monopolist of several complements sets a lower price than separate monopolists, each controlling one of the goods.
  - Tragedy of the anticommons
    - If several individuals own rights of exclusion and exercise those rights, they restrict access and therefore use of common resources.

Complementary innovations (cont'd)

- Remedies?
  - Coordination of right holders' decisions
    - Patent pools → an entire group of patents is licensed in a package, either by one of the patent holders or by a new entity established for this purpose, usually to anyone willing to pay the associated royalties.
      - MPEG-2 video compression technology (9 companies)
    - Cross-licensing → agreement between 2 companies that grants each the right to practise the other's patents.
      - Common for microprocessors
  - Downside
    - Transaction costs
    - May be seen with suspicion by antitrust authorities
      - Pool should only contain complementary patents.

Intellectual property in the digital economy

- So far, we focused mainly on patents.
- Here, we look at works protected by copyright.
  - Literary, musical, choreographic, dramatic & artistic
- Same economic rationale but different balance
  - Protection offered by copyright is longer but narrower than the protection offered by a patent.
- Effects of digital technology and the Internet
  - Modification of the interaction between copyright holders, technology companies and consumers.
  - New issues
    - Music industry → end-user copying
    - Software industry → development of open source software

Digital music and end-user piracy

- Internet piracy
  - Record companies claim they suffer big revenue losses
  - What strategies could they use to counter this?
  - To which extent are the social interests aligned with the interests of copyright owners?
- Digital products
  - Digital copies → technical quality similar to the original
  - But
    - Original gives some additional value compared to copy
      - Printed booklet for music, printed manual for software
    - There exist complementary products (e.g., concerts)
      - Access to these products can be controlled.
      - May allow firms to indirectly appropriate some of the rents generated through end-user copying.

Digital music and end-user piracy (cont'd)

- Basic economic analysis: digital piracy **decreases** profits
  - Model
    - Monopoly producer of a digital product.
    - Faces the competition exerted by the availability of (illegal) digital copies.
    - Copies = imperfect substitutes for the original digital product
  - Main results
    - Because consumers with a low cost of copying or with a low willingness to pay for quality prefer copies to original products, the copyright owner is forced to charge a lower price (than in a world where digital piracy would not exist).
    - $\rightarrow$ Lower profits but larger welfare (from a static point of view)
    - Welfare may decrease from a dynamic perspective
      - Lower profits $\rightarrow$ fewer digital products created (or lower quality)

Digital music and end-user piracy (cont'd)

- Further developments: digital piracy may **increase** profits
  - Sampling role
    - Digital products = complex experience goods.
    - If an illegal copy can be accessed free of charge, consumers may learn their valuation of the product and if the latter is large, they may want to purchase the legitimate product.
  - Network effects
    - As it is the cumulated number of consumed copies that matter and not whether these copies are legitimate or not, digital piracy contributes to increase the willingness to pay for legitimate copies.
  - Indirect appropriation
    - Piracy can increase the demand for goods that are complementary to the pirated content; the producer is then able to capture indirectly the value that consumers attach to the pirated good.

Software protection

- Copyright or patents?
  - 2 types of protection required
    - Against consumers' copying → copyright
    - Against competitors' imitation → patent?
  - Is patent protection too strong for software?
    - Yes, given low costs of software innovation.
    - No, given that software innovation is cumulative.
      - See above
    - Yes, given that software generate network effects.
      - See Chapter 20
    - No, given that software are durable products.
      - See Chapter 10
    - Net effect???

Software protection (cont'd)

- No protection: open source software (OSS)
  - 2 ways to transmit software
    - In source code (can be interpreted and modified by programmers)
    - In object code (communicates with the hardware)
  - Which code is provided?
    - Most commercial software → only object code
    - Open source software → source code is available
  - Coexistence of both types of software
    - MS Windows vs. Linux / Apple Safari vs. Firefox
  - Open source licenses
    - Allow authors to fine tune access to sources by defining users' rights on usage, modification and redistribution

Software protection (cont'd)

- OSS: Motivations of contributors
  - Is programmers' behaviour consistent with the self-interested-economic-agent paradigm?
  - Need a cost/benefit analysis
  - Costs
    - Opportunity cost of time (what they could earn if working instead for a commercial software vendor)
  - Benefits
    - Contributing to an OSS may improve their performance in paid work
    - Benefit from efforts of others
    - Intrinsic pleasure and fun
    - Delayed benefits: peer recognition → ego gratification and prospect of future monetary compensation

Software protection (cont'd)

- OSS: Attitude of commercial firms
  - Much less intriguing for economists than the 'volunteer' participation of programmers
  - Motivations
    - Profit from complementary expertise or support.
    - Allocate some of firm's talented staff to OS programs (so as to keep abreast of OS developments and develop an absorptive capacity)
    - Compete directly with OSS providers in same market
    - Participate to an OSS project for strategic reasons
      - Preempt the development of a standard around a technology owned by a powerful rival.
      - Might be profitable to release some existing proprietary code and then rely on the OS community for further development

Software protection (cont'd)

- Open source vs. traditional IP incentives
  - Static efficiency → + because no deadweight loss
  - Dynamic efficiency → ?
    - + : quicker discovery of subsequent innovations
    - – : lower incentives ?
  - Distinct welfare implications
    - Own use incentives
      - May lead to under-provision of code (as benefits conferred on 3rd parties can't be appropriated).
    - Signalling incentives
      - May lead programmers to invest more in projects in which they can showcase their competence.
    - Social psychological incentives
      - Extrinsic (reputation, ego boost) and intrinsic (accomplishment, pleasure) motivations may lead developers to internalize social benefits.

Review questions

- Explain how IP law strikes a balance between dynamic and static efficiency considerations or, in other words, between incentives and use.
- What is behind the so-called ‘patent paradox’? How can it be explained?
- Why isn’t it optimal in terms of public policy to have patents that last forever? Discuss.
- Does a firm have incentives to license its innovation to rival firms? Discuss.

Review questions (cont'd)

- What is the meaning of the 'tragedy of the anticommons'? How does this problem apply to innovations and how can it be mitigated?
- What are the effects of end-user piracy of digital products on the producers' choices and on social welfare? Discuss.