SUNK COST AND FREE RIDING JUSTIFICATIONS
- A RISK ANALYSIS APPROACH

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ABSTRACT

This paper, through risk analysis methodology, addresses two popular arguments against extending the scope of exception to copyright in digital environment: the sunk cost argument and the free riding argument. It concludes that while both arguments are legitimate, they were built upon many doubtful assumptioscial vrants). Concerned issues are imperfect information and collective action. The purpose of the risk assessment method is to find a viable beliefs/expectations: the likelihood of failure (R&D sunk cost) or free riding. The beliefs/expectations will then be confirmed or rejected by data from statistics or experimental sources. From each possible belief, the paper proposes solution concepts that could bring Bayes-Nash equilibrium. The starting point of analysis will be the assessment of consumer demand in each market.

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INTRODUCTION

In 1944, Von Neumann and Morgenstern set a stepping stone formula for behavioural theories $U(p) = \sum_{x \in Supp(p)} p(x)u(x)$, in which U(p) is the expected utility of a set of choice, u(x) is the best payoff of the state x, measured by utility, and p(x) is the probability that u(x) is reached. The formula shows that probability is as just important as the payoffs. Sixty years latter, economists and laywers still pay more attention to payoffs than probabiliies. Academic papers have too many pros and cons arguments with what "may be" or "could be" happening, but not so many analyses on probability - how likely a hypothetical risk will happen. The neglect of probability partly explains why an academic mind is different from a practical mind.[1]

This article attempts to bring risk analysis and probability calculation to the discussion about the interface between copyright and competition. The case *IMS Health* could be used as an introduction to my paper:[2]

> IMS Health (the incumbent) is a pharmaceutical database company. It holds copyright in a specific data format that later become a standard in the industry. When it appeared that competitors of IMS were using this format, IMS sued for copyright infringement and won the case. The competitors complained to the European Commission, arguing that, in effect, the use of IMS's data format was essential for them to supply sales information to the consumers and IMS has abused its copyright in the data format. In July 2001, the Commission ordered IMS to grant a copyright licence of the format to its two competitors. The appeal is now pending before the EU's Court of First Instance.

Similar cases on abuse of standard control, as presented above, are numerous.[3] The incumbents usually used two arguments to justify their refusal to license. The first argument is that innovation in the digital environment requires large expenses in research and development (R&D). They are sunk costs, and exercising exclusive rights is the only way to recover these costs.[4] The second argument is that exception to copyright would encourage

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1 Sunstein (2002). Giddens (1999) also warned that society development (modernity) has not taken enough attention to risk calculation. For him tradition, risk and democracy are the core of his Third Way philosophy, which have been widely approved by social-democratic parties in the US, UK and Germany.

2 European Commission's Decision dated 3 July 2001 (COMP D3/38.044).

3 See *Sega Enterprises Ltd. v. Accolade, Inc.*, 977 F 2d 1510 (9th Cir. 1992), *Atari Games Corp. v. Nintendo of America Inc.* 975 F.2d 932 (Fed. Cir. 1992), *Sony Computer Entertainment, Inc. v. Connectix Corp.* 203 F.3d 596 (9th Cir. 2000). See also *Triad Systems Corp v. Southeastern Express Co.* 64 F.3d 1330 (9th Cir. 1995).

4 Stiglitz (2001).

competitors to free ride, i.e., taking advantages of the innovation efforts of the rightholder without paying back to the incumbent or without making his own innovation.[5] The question is whether and when these arguments are justified.

Sunk cost and free riding are old arguments, but they are essentially the two most important embedded arguments in a so-called "new" economy theory.[6] Current studies have usually taken for granted that R&D expenses are *prima facie* sunk costs, and granting exception to copyright will encourage free riding. This paper reconsiders these assumptions using game models and statistical surveys (see the appendices at the end of the paper) as the toolkit. My main argument is that sunk cost and free riding are risks. Risk prevention is a matter of risk assessment and probability calculation, which in turn relies on imperfect information. When the incumbent and the entrants enter games with imperfect information, we need beliefs (assumptions) in order to find concept solution - which is called as Bayes equilibrium.[7]

Between sunk cost and free riding concerns, the recovery of sunk cost should be prioritised. When sunk costs are fully recovered, the incumbent will be at equal levels with the entrants. The concern that the entrants free ride the incumbent's innovation efforts will be less than the situation when both concerns are dealt with at the same time.

1. TAXONOMY OF THE MARKETS FOR RISK ANALYSIS

1.1 INNOVATION AND NON-INNOVATION MARKETS

The starting point of any competition law discussion is to define relevant market, in which I propose to divide markets protected by intellectual properties according to consumer demand for innovation. Where most consumers have a constant demand for a

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5 McFadden (2001) and Adar and Huberman (2000). Stigler (1974) also defined a close concept, so-called "cheap riders", denoting people who only contribute minimally to the common group, in hoping to enjoy a large surplus.

6 "New economy" denotes the economy that is based on information and communication technology (ICT). It is said to be different from the old economy because of its "network externality:" the more consumers use a product, the more valuable it will be and hence attract more consumers. Hence instead of having "decreasing return" like the old economy, the new economy is characterised by "increasing return" and standardisation. The second characteristic of the new economy is the "high fixed cost and low marginal cost." That is, it is costly to innovate and market the first product, but it is cheaply to reproduce it. See Alborn, Evans and Padilla (2000). Brian Arthur (1996).

7 Baird, Gertner and Picker (1994): 79-119.

new and improved product, such a product market is called innovation market. The opposite is a non-innovation market. This taxonomy has been used in the US. Under the Department of Justice's Intellectual Property Guideline, innovation markets are referred to those "consist of the R&D directed to particular new or improved goods or processes and the close substitutes of that R&D."[8] Although this definition does not focus on consumer demand, it does rule out many markets involving intellectual properties as innovation markets. Using this definition, the markets for copier services (*Kodak v. Image Technical Service*) [9], data formats (*IMS Health*) or television listing (*Magill*) would not be considered innovation markets. There is no R&D capacity in the market of service, data collection and television listing. If we think all markets involving products protected by intellectual properties are innovation markets, then could we say that a product market is innovative just because its products are protected by trademarks?

Based on the innovation/non-innovation market taxonomy, we could now look at the relationship between the incumbent and the entrants. Three possibilities may emerge to this relationship: competing, non-competing and mixture. In the first type (competing), both sides are in the same market of substitutable products. For example, Netscape and Internet Explorer are substitutable web browsers (*US v. Microsoft*). [10] In the second type (non competing), both sides are in different market layers, such as the market for motherboard and the market for microprocessors (*Intel v. Intergraph*). [11] In the third type (mixture), one side (either the incumbent or the entrant) is active in many levels of production, whereas the other side is active only in one product market. An example could be seen in the complaint of Sun Microsystems against Microsoft before the European Commission.[12] Sun was active in server operating system market (Unix),[13] where as Microsoft was active in the operating

8 See OECD (2000): 9 (Intellectual Property Guideline, § 3.2.3).

9 504 US 451 (1992).

10 165 F.3d 952 (D.C. Cir. 1999), see 1.5.3(c)(ii).

11 195 F.3d. 1346 (1999), see 1.5.3(c)(iii).

12 31st Report on Competition Policy 2001 SEC (2002) 462 Final: 59.

13 We set aside Sun's desktop operating system Solaris, as its market share is very small compared to Microsoft's ones (at that time Windows 98). In the server operating system market however, the market share of Unix is comparable to that of Windows NT.

system market for both desktop (Windows 98) and server (Windows NT). The relationship between Windows 98 and Unix are neither competing nor non-competing. It is a mixture of both. Although Windows 98 did not directly compete with Unix, it indirectly competed with Unix by cross-subsidising Windows NT. Thanks to the monopoly profits from Windows 98 and other Microsoft software, Microsoft afforded to charge Windows NT at a lower price than other software vendors could.

	Innovation markets	Non-innovation markets (involving intellectual property)
Competing	US v. Microsoft (re Web browser)	IMS Health v. Commission Kodak v. Technical Image Services
Non-competing	Intel v. Intergraph	Magill
Mixture (cross-subsidisation)	Sun v. Microsoft (re Java) Microsoft (re Windows NT)	Not yet reported.

Figure 1: innovation markets vs. non-innovation markets

1.2 PESSIMISTIC, OPTIMISTIC AND REALISTIC BELIEFS

a. Pessimistic and Optimistic Beliefs

The taxonomy of markets into innovation and non-innovation is important for setting the beliefs (assumptions about sunk cost and free riding) that are necessary for our study of games with imperfect information between the incumbent and the entrant. Using dialectic methodology, the taxonomy of beliefs shall include thesis (pessimistic beliefs), antithesis (optimistic beliefs) and synthesis (realistic beliefs - what I will present in this paper).

The incumbent's pessimistic beliefs about users could be found in the ex ante/ex post argument of Korah,[14] or the creative destruction of Schumpeter (1941). As knowledge is a public good (i.e., non-rivalrous and non-excludable)[15], people may wait until some innovators make the creative product first and then learn the technology without paying. If the advantages of an innovator are not higher than that of free riders, and no one would like to play a dominated strategy, the innovators would lack incentive in the end. Consequently,

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14 Korah (1994): 189 - 190.

15 Stiglitz (2001).

people follow the crowd, i.e., free ride. Hence, the biggest risk of sunk cost is that public good would be under-produced, and the biggest risk of free riding is that it would solicit spillover effect and become a collective action. Korah (1990) argued that an exercise of intellectual property might look anti-competitive if perceive ex post, but actually it is the blood of the making public good if perceive *ex ante*.

Recent studies have taken network externality into account and see sunk cost and free riding differently - so-called the "new economy" theory. Start-up investments become more sunk than ever, because start-up firms - the entrants - must subsidise consumers to counter the incumbent's network externalities. Brian Arthur (1996), Ahlborn, Evans and Padilla (2001) argued that the only way to recover sunk cost is to penetrate quickly into the market, lock-in consumers and then charge monopoly price.

Contrary to this argument, many studies (so-called the incumbent's "optimistic" beliefs about competitors) argued that limited free riding might actually benefit the incumbent, as it extended the customer base to him.[16] However, they have not answered the question: how could we keep free riding to a "limited extent" as they suggested, before free riding could become a collective action and uncontrollable? Experiments showed that the free riding problem does not become less relevant in the context of network externality. Adar and Huberman (2001) conducted a survey on free-riding in a digital environment (Gnutella) and came up with a warning result:

> "70% of Gnutella users share no files, and nearly 50% of all responses are returned by the top 1% of sharing hosts. Furthermore, free riding is distributed evenly between domains, so that no one group contributes significantly more than others, and that peers that volunteer to share files are not necessarily those who have desirable ones."[17]

The pessimistic and optimistic beliefs on sunk cost and free riding meet at one point: firms need to gain market share in the first period, and profits in the second period. Sutton noted that a business process consists of two steps: incurring R&D investment (pre-standard) and recover of such investment (price/quality competition).[18]

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16 See e.g., Takeyama (2002), Scorba (2002), Bakos, Brynjoffson and Lichtman (1999): 117.

17 For those who dispute the problem of free-riding, please refer to the rise and fall of Napster.

18 Sutton, J. (1991): 29.

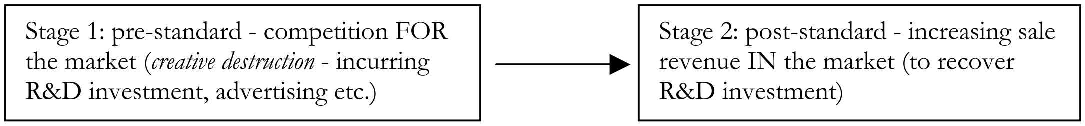

Figure 2: R&D investment and sunk cost recovery

In the first period, free riding should be encouraged (weaving the "net"). In the second period, it should be limited for the sunk cost in the first period to be recovered. The problem is that if free riding has become a collective action in the first period, how we could control it in the second period. Therefore, to prevent collective action is the main issue behind the free riding concern.

b. Realistic Beliefs

In game theory, a belief is found based on some assumptions on expectations or values. They are embedded in people's mind and guide people's behaviours. When the incumbent behaves in a certain way that is optimal given he beliefs, he has reached a Bayes equilibrium solution concept. However, when the beliefs do not correspond with the facts about the users, they would have to update their beliefs and find different dominant strategy.[19]

Observation from Appendix 9 about software (innovation markets) showed that in a period optimistic beliefs prevailed, in another period pessimistic beliefs prevailed. In the 1980s and the early 1990s it took relatively short time for a software product to take leadership and the creative destruction were full speed ahead (optimistic beliefs prevailed). In the late 1990s, established standards tended to become excessive inertia. Those who have already controlled standards took pessimistic beliefs about free riding. This trend showed that the larger the consumer base and the stronger the network externality, the more difficult for entrants to replace the incumbent's standards. On the contrary, the second column in Appendix 7 also showed that for less innovative markets entry is simpler (e.g., markets for IT services, as opposed to the market for software packages).

From the above observations, I propose the third belief, that the risk of sunk cost non-recovery is higher in innovation market than in non-innovation market. In the contrary, the

[19] Baird, Gertner and Picker (1994): Chapter 3.

risk of free riding (i.e., the entrants free ride the efforts of the incumbent) is higher in non-innovation markets than in innovation markets. From there, the design of legal measures to addressing sunk cost and free riding risks should be different depending on the degree of the risks and the capacity of the firms involved to counter the risks.[20] These beliefs are backed by the analysis below.

2 SUNK COST RECOVERY

2.1 SUNK COST, SWITCHING COSTS, OPPORTUNITY COST AND "PREMIUM"

The new economy theory suggests that absorbing economic rent from switching costs is the only way to recover high sunk costs that the incumbent has incurred in R&D investment. On the contrary, we are concerned that *after* a standard is established, the incumbent will abuse their power. Referring back to Sutton model in 1.2, we could have the model of sunk cost recovery following the "using a sprat to catch a macheral" principle, as presented in Figure 3. In the pre-standard period, the incumbent must incur their "sunk costs". These costs apply to the entrants as well if they want to enter the market. When the consumers want to change suppliers, they also face a type of sunk costs - "switching costs."[21] In the post-standard period, the incumbent starts recovering their "sunk costs", but at the same time, consumers become locked-in and switching costs increase.[22]

20 Over-simplistic perception would lead to extreme policy and unhealthy reaction from society. For example, Appendix 1 at the end of this paper showed that during three years since 1996, when the US Patent and Trademark Office (USPTO) issued Guideline for Software Patent, the number of business method patents have increased seven times, ten times more than the average increase of all patents in the same period. With that speed, the common (possible business methods) would dry out quickly.

21 An example of switching costs is software upgrade. The cost reserved for upgrade constitutes 51% of all software expenses, and at the same time the major source of software engineering failure (so-called wasteful upgrade). See Well and Broadbent (2001). The reason for wasteful upgrade is that consumer keep expending more on the old software because they have already incurred a large sunk cost on it. If they switch, they would have to pay a large switching costs. See Nilsen (1992), Chen and Hitt (2001).

22 This is one of the main hypothesis in my on-going PhD project: if appropriate measures are not taken, switching costs will increase day-by-day, in the same way as Shubik's dollar auction game does (see Poundstone (1992): 261.

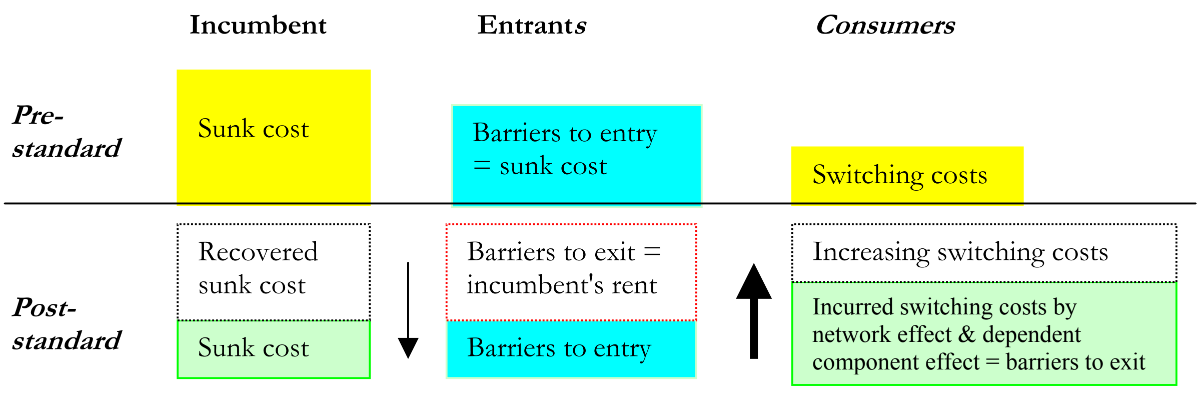

Figure 3: relationships between sunk costs-switching costs; and barriers to entry-exit.

If the entrants want to penetrate a market, they must (1) pass the barriers to entry that the incumbent has passed, and (2) subsidise the consumers to pass their barriers to exit.[23] The arrows in Figure 1 show the decrease and increase of costs, as well as the need to strike the balance. If the access to an essential interface and data format (the standard) were granted too early, sunk cost would not be recovered. On the other hand, as long as access was not granted, consumer's barriers to exit, network externalities and incumbent's rent from them increase day-by-day. Thus, the right of the standards owner to recover its sunk cost should not extent more than necessity.

There is an argument that the incumbent has legitimate interests in recovering not only sunk costs but also opportunity costs of "once-in-a-lifetime" occasional major success.[24] In addition, granting access to the standard does more than helping the entrants saving sunk cost. It actually gives the entrants the opportunity to gain access to the market(s) that they would not have otherwise. Therefore, the incumbent is entitled to charge the entrants not only the sunk cost in association with the standard, but also a premium in exchange for the entrant's trading right. Paying premium for commercial right is a common practice in many markets such as the taxicab (medallions), telephone (spectrum) and oil and gas markets.[25]

While it is legitimate to prevent free riders from grasping the fruit created by the incumbent, the State's obligation is not to give "once in a lifetime" opportunity for the

23 See Brian Arthur (1996) for consumer subsidisation and market penetration.

24 Sutton (1998): 227.

25 Viscusi, Vernon and Harrington (2001): 465-93, 520-25, 620-31.

incumbent but merely sufficient incentive for innovation. Moreover, these arguments forget the fact that network effects is a combination of many factors, not only the incumbent's innovation but also the consumer's participation. Therefore granting the incumbent a sole right to exploit "once in a lifetime" opportunity is inadequate.[26]

With respect to the "trading rights" argument, it is legitimate to include non-R&D expenses into the scope of recoverable sunk costs, such as the costs of advertisement and distribution. When these costs are already recovered, the incumbent is of no less disadvantageous than any entrants with respect to the market he established.

Having said that, the incumbent has no legal basis or any vested power to grant trading right (which is normally the power of the state).[27] Moreover, he earns advantages as first-movers, in addition to the network externality that he enjoys.[28] In this context, granting the incumbent the right to charge entrants "premium" for trading right in order to recover the sunk costs is an unsound argument. The "trading right" argument is only relevant for the purpose of free riding prevention, to be discussed in 4.1(c).

2.2 RECONSIDERING SUNK COST ASSUMPTIONS

There are four common assumptions about sunk costs that might create bias in favour of the incumbent. First, R&D costs are always sunk costs. Second, to give a fair judgment, the calculation of sunk cost must be exact. Third, only the incumbent's sunk costs are worth recovering, other firms' sunk costs should come second. Fourth, granting exclusive protection is the only way to recover sunk costs. These assumptions are considered below.

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26 Warren-Boulton and Baseman (1995).

27 In *Victoria Park Racing and Recreation Ground Company Ltd. v. Taylors and Others* [1937] 58 CLR 479, the defendant has built a high platform on his land that oversaw the plaintiff's spectacle, causing his loss of audience. The magistrate court stated that the defendant has "misappropriated … something that the plaintiff has created and alone is entitled to turn into value." Latter, the High Court of Australia rejected this decision, saying that there was no property right in the spectacle and therefore there was nothing to be protected.

28 For first-mover advantages, see Baird, Gertner and Picker (1994): 63, 159-86, Stiglitz (1997): 139-52.

a. Assumption 1: R&D costs are sunk costs

In principle, sunk costs are "costs that firms cannot recover should it exit the market,"[29] but we always assume that some costs are prima facie sunk, such as R&D investment.[30] This common assumption is doubtful. Firstly, all costs, sunk or otherwise, in the end should be met by (1) increasing quality, (2) reducing costs and (3) increasing sale revenues from consumers.[31] The incumbent incurs a cost in expectation that he could raise sale revenues in the future. The two-stage competition in 2.1 shows that sale revenues in stage 2 would define whether the costs incurred in stage 1 (*ex post* expenses) are sunk. With respect to *ex post* sunk costs, one can apply the historic cost accounting to calculate both the profits in the second stage and the costs in the first stage to compare and see if they have been already recovered. If the financial statement of a company shows profits, it means that the company has recovered all of its costs, sunk or otherwise. Sutton (1998) proposed a simple formula according to which *ex post* sunk cost is recovered when: $P (u_i \mid u_{-i}) - F (u_i) > 0$. $P (u_i \mid u_{-i})$ is the second-stage profit of that firm that offers the level of u_i. $F (u_i)$ is the "sunk" costs incurred (R&D, advertising,) for firm i in order to reach market competence u_i.

There is an argument that calculating ex post sunk costs are simple, but knowing whether such costs have been recovered may be complex, particularly when cross-subsidisation comes into play. Many firms make losses, but some of their products are profitable. Likewise, some firms are profitable not because of the R&D in a particular product, but because of luck, or of the investments made many years ago. That being the case, it is necessary to separate the cash flow of one product from another, so that Sutton's formula as described above could be applied.

The difficulties in the recovery assessment nevertheless do not change our conclusion about the wrong assumption that "R&D cost is a sunk cost." If one knows a cost is "sunk" (in the sense that it does not increase revenue) in advance, he would not incur it.[32]

29 Stiglitz J. (1997): 125.

30 *Id.*, see also argument of the defendant in *Consten and Grundig v. Commission*, Case 56/64.

31 McFadden and Peltzman (1987): 939.

32 Cornish (1999): 368-69 also noted that the risk coverage will depend on the likely return of investment. OECD (2002a) : 100 showed that during the 1990s private rather than public R&D increased, i.e., R&D does pay profits.

McFadden and Peltzman (1987) noted that R&D investment may become sunk, but it is actually a sunk cost only if it is not offset by resale and consumer sale revenues. The issue is not whether, but when R&D costs became "sunk."[33] It is also not true that an R&D investment cannot be recovered by any cash flow when firms exit the market: they could do so by way of technology transfer. All these arguments point to the fact that sunk costs are costs of failure. If all R&D costs are truly "sunk", why are private firms keener to target R&D than the government (see Appendix 2)? Why are profit rates of innovative companies higher than non-innovative companies?[34]

With appropriate accounting methods, recovery of *ex post* sunk cost (R&D actual investment and related promotion expenses) is no longer a question, only recovery of the *ex ante* sunk cost (future R&D investment that fails to be recovered) is. One might ask why should we treat the failure costs of R&D investment differently than other costs of failure. Risk management concept rather than law should deal with this matter. The answer is in the public policy to tolerate R&D failure. That being the case, one should be more specific about risk of failure rather than easily accept that all R&D investments are sunk. To make the matter worse, too lenient approach toward sunk cost recovery could also nurture bad management.[35]

b. Assumption 2: the Calculation of Sunk Cost Must be Exact

If the calculation of sunk cost must be exact, then we have to take into account the sunk cost not only of the incumbent, but also of the incumbent's competitors. Many firms rushed to develop standards and all of them have incurred large sunk costs.[36] It is a paradox that only the firm that has successfully set the standard would be able to recover these costs. Appendix 8 showed that the failure of firms to make profits did not necessarily attribute to

33 McFadden and Peltzman (1987): 940.

34 Ichibiah and Knepper (1991): 52.

35 If R&D costs were readily thought as sunk cost, then the costs coming out from bad decision making would not bear negative consequences. See Cadonia, Bushman and Dickhaut (1989).

36 OECD (2002b): 316 showed that in software industry, IBM, Sun and HP could be more innovative than Microsoft (if we calculate the number of software patents granted). In the market however, Microsoft had profit every year, whereas all other three had losses.

lack of R&D. What would happen to the sunk cost of unsuccessful firms? These firms may either continue competing with the incumbent in the mainstream market or exploring niches in the downstream markets. The first option is difficult in a market that requires compatibility between products. The second option is also infeasible with the incumbent's control of sub-markets by controlling interfaces and data formats.[37]

If we argue that society should tolerate failures in R&D investment, then the failed firms should have the right to recover part of their own R&D sunk cost. Otherwise, the risk of failure would harm the willingness to take risk in R&D. Kahneman, Knetsch and Thaler (1991) have noted the "reverse" sunk cost issue. That is, small firms might give up a failed or failing venture too easily if the prospective to recover R&D investment is slim.[38]

I do not conclude that the policy that allows *only* successful R&D to be rewarded discourages rather than encourages innovation. My conclusion is that there is no point to calculate an exact amount of sunk costs of the incumbent if we do not take into account the R&D sunk costs of other firms. The point of granting the incumbent the right to recover sunk cost is to give incentive for further innovation, not to calculate an exact amount. An inexact but transparent rule of R&D calculation should be accepted, as long as it gives enough incentive to the incumbent for further innovation.

c. Assumption 3: Entrants Faces Smaller Sunk Costs than the Incumbent

The assumption that only the incumbent faces high sunk costs forgets the fact that the incumbent's control of infrastructural interfaces and data formats. By so doing, he controls a barrier to exit of consumers in both upstream and downstream markets. As noted in Figure 3, the entrant must subsidise consumers to overcome this barrier; and cost could

37 Sutton (1998): 71 *et seq.*, quoting examples R&D competition between Kodak and Agfa, Kodak and Ilford, Unilever and P&G, McDonnell Douglas and Lockheed and conclude that the losers tend to either withdraw from the market or adopt the standard of the winners.

38 See also Devine and O'Clock, P. (1995).

become sunk if the entrant fails to recover.[39] Another conclusion from Figure 3 is that the entrant's price must win both the price competition with the incumbent and the switching costs of the consumers. As the profit margin of the entrant*s* is already low compared to that of the incumbent, they will be in a more disadvantageous position than the incumbent.[40] It is doubtful whether the incumbent, who already recovered *ex post* sunk costs needs more exclusive rights in order to compete with less advantageous entrants.[41]

d. Assumption 4: Exclusive Protection is the Only Method to Recover Sunk Costs

It was commonly believed that if a R&D project fails, its expense is wasted. That assumption is not true. R&D expenses are expenses to create knowledge and experience.[42] At the very least, the innovators could recover sunk cost in R&D failure indirectly through learning by doing or knowledge reuse. Hence, while deciding whether a compulsory licensing of a standard could make the incumbent R&D sunk cost irrecoverable, courts should take into account these two factors as a safety net for innovators.

With "learning by doing", the failure in the first step could become the success in the next step. In the 1980s Microsoft's VisiCalc failed to compete with Lotus 1-2-3, and Word Star failed to compete with Word Perfect.[43] Yet, thanks to experiences on VisiCalc, Microsoft decided to intensify R&D software that requires higher processor's capacity. In

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39 Shapiro and Varian (1999) noted that IBM have failed attract consumers to their operating system (OS/2), although it was sold five times lower than Windows and offer similar functions. In addition, Posner, R. (1998b: 56) noted that high sunk costs from R&D investment equally apply to both the incumbent and the entrant*s*, if one firm would like to outperform the other. For downstream firms, the incumbent also enjoys advantages as the first comer. Stiglitz, J. (1997: 125) also warned a risk that after the entrant*s* have incurred a large sunk cost; the incumbent reduces its prices to deter entry.

40 Viscusi, Vernon and Harrington (2001): 807-15.

41 See Sutton (1998): 65-80. Let u^ be the currently highest competence level in the rmarket (e.g., the competence of the incumbent), and u_{N+1} is the competence of the potential entrant. For the entrant to gain market share, he must be superior than the incumbent with respect to his competence level, so $u_{N+1} = k \cdot u\hat{}$ $(k \geq 1)$. Assuming that at the worst case scenario, the entrant captures a fraction of a(k) for the current sales revenue in the market. Current sales revenue is Y(u), so the entrant's profit under the worst case scenario is $a(k) \cdot Y(u) - (k \cdot u\hat{})^{\beta} \leq 0$ (β is the effectiveness of the entrant). We have $u\hat{}^{\beta} \geq (a(k)/ k^{\beta}) \cdot Y(u)$ (1). Similarly, in the best-case scenario we have $Y(u\hat{}|u) - u\hat{}^{\beta} \geq u\hat{}^{\beta}$. (2). Combining equations (1) and (2) we have $Y(u\hat{}|u)/(Y(u)) \geq a(k)/k^{\beta}$. That being said, if the market share of the incumbent, i.e., $Y(u\hat{}|u)/(Y(u))$ is larger than *max* $[a(k)/k^{\beta}]$, entry is difficult and therefore cannot be a collective action. Hence, it is not necessary to charge an access fee.

42 Cooter and Ulen (2000): 40.

43 See Ichibiah and Knepper (1991): 97-100 and Aglian and Howitt (1990).

the end, it had outperformed Lotus 1-2-3 by MS Excel, and outperformed Word Perfect by MS Word (see Appendix 9).

The second indirect method to recover sunk costs is to join force with other firms through knowledge reuse. This concept stems from the principle that to recover sunk costs in R&D, one should change R&D results from a legal asset to a business asset.[44] Appendix 6 showed that software is the sector that particularly attracts most strategic alliance to share or recover R&D expenditure. In addition, a specific form of joining R&D force is through transfer the R&D results or to be acquired by larger firms.[45]

e. Conclusions from Reconsidering the Sunk Cost Assumptions

Our analysis above shows that there are many possibilities to recover sunk cost and at the same time improve consumer welfare, without recourse to exclusive protection. Exclusive protection might not be the best way to recover sunk cost and make profits, let alone the only way. Reconsidering the assumptions on sunk costs is necessary to change the unconditional sympathy of the judge on the sunk cost justification. Consequently:

1) Only the costs of failure could be called sunk costs, and the law allows such costs to be recovered as a policy to encourage innovators taking risks in future R&D. As such, the law allows innovators to recover not only *ex post* R&D investment but also part of *ex ante* R&D corresponding to the risk of failures.

2) The calculation of sunk cost needs not be exact, but it must cover relevant *ex post* R&D and certain *ex ante* R&D to create sufficient incentive for innovation.

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44 Sutton (1991): 320 and Sutton (1998): 345 and 387, through the competition in computer industry on IBM 360 standard and its aftermath, observed that the best strategy to compete with a proprietary network is to join a open network. The purpose is to improve network effects until the open network could outperform the proprietary network. See also See Shapiro and Varian (1999): 256. Farrell and Klemperer (2001) also noted that when firms do not have installed base, the best way to gain leverage is to use network effects. However, when firms already have installed base, they might prefer incompatibility.

45 E.g., the acquisition of Microsoft on Connectix in 2002, whose main motivation is to acquire Connectix's technology in Virtual PC, a software that allowed Mac users to use Microsoft's software. See communication in www.connectix.com, last visited 28 Apr. 2003.

3) Exclusive protection of the incumbent's standard increases sunk costs for the entrants. Therefore, it should be granted as the last, rather than the first, resort. When control of a standard is at issue, the court should explore other possibilities to recover R&D investment before accepting the sunk cost justification.

4) There are always two natural mechanisms to recover R&D investment costs to backup any errors in calculation of sunk cost: learning by doing and knowledge reuse.

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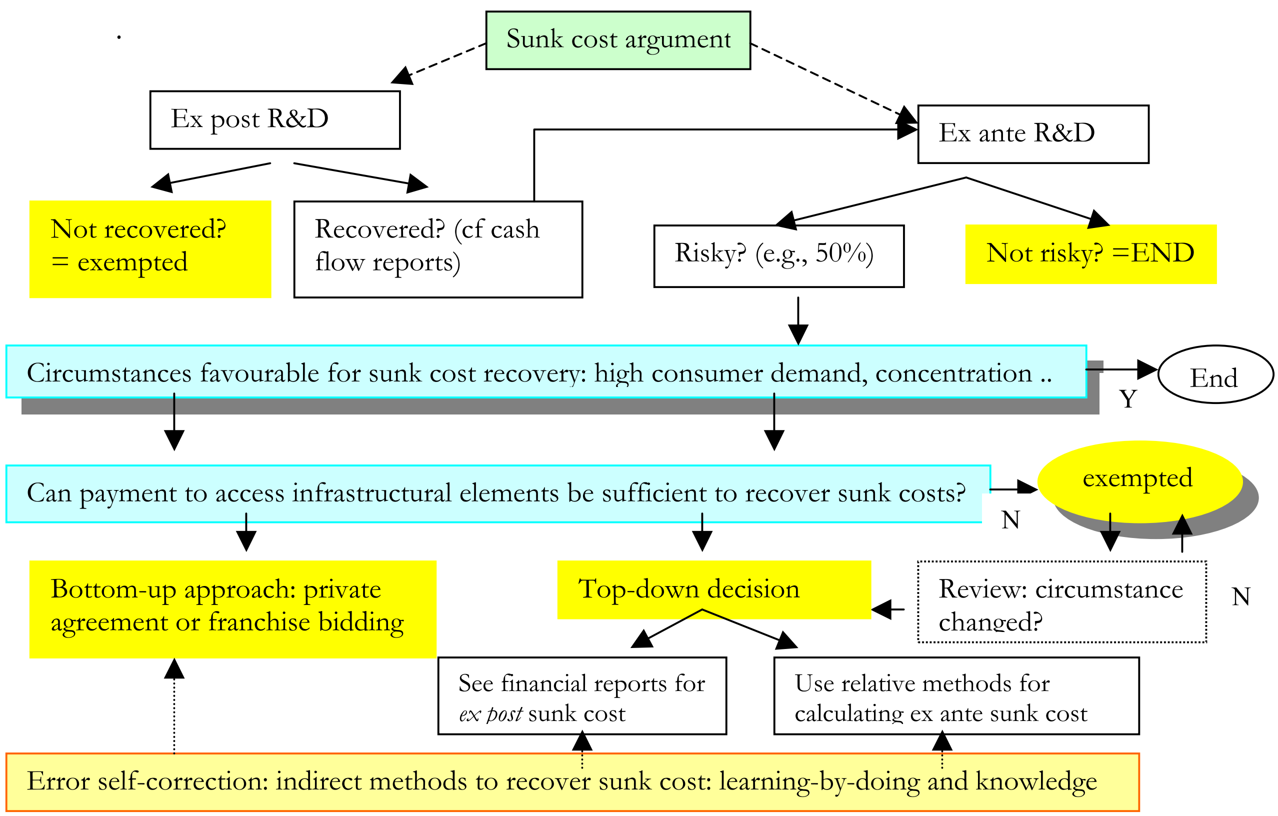

Figure 4: Sunk cost recovery procedure

Where the incumbent can prove that it has not recovered its ex post sunk cost, the court should allow it to refuse licensing the interfaces/data formats to the competitors. This condition should be subject to review, and the entrant could apply for access when the balance sheet shows that the incumbent has recovered its *ex post* sunk cost. To guarantee that a certain part of *ex ante* sunk cost shall be recovered and to prevent free riding, the access fees should be designed so that the negative consequence to the incumbent should be minimal. These issues will be discussed in Section 2 below.

2 CALCULATION OF ACCESS FEES

3.1 BOTTOM-UP VS. TOP-DOWN APPROACHES

When the circumstance justifies the grant of access to an interface or data format, the next question is how to decide the license fees payable to the incumbent and the term of payment. Here the court may apply either the bottom-up approach (let the parties decide) or the top-down approach (the court will decide). A logic conclusion from Coase Theorem is that priority should be given for the bottom-up approach.[46] A top-down decision, however 'fair' and 'exact,' still face a risk of arbitrariness and could make either the incumbent or the entrant dissatisfied, if not in the short-term then in the long-term. On the contrary, bottom-up approach lets private parties to be responsible for their own mistakes. Hence, top-down approach could be used only when the bottom-up approach is infeasible.

There is an argument that the bottom-up approach cannot be applied when transaction costs are high. That is when (1) one party has monopoly over the other (high bargaining costs), (2) the trust relationship between them is low (high search costs), or (3) the litigation costs to enforce the agreement would be too high (high enforcement costs).[47] These however do not preclude bottom-up approach. The law has many experience in lowering transaction costs, such as the adoption of the UK's Unfair Contract Terms Act 1977. The only problem is how to design the law to balance the parties' bargaining power.

3.2. BOTTOM-UP APPROACH BY PRIVATE AGREEMENT

At the first glance, private agreement between the incumbent and the entrant might seem infeasible because the bargaining powers are imbalanced.[48] In our context however, the

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46 See Coase (1960), reprinted in Coase (1997): 101 or Cooter and Ulen (2000): 87-91. The Coase theorem stated that other things equal and transaction costs are zero, property rights are not important, and the ones that value an asset the most will pay the most for the asset.

47 *Id.*: 88. Transactions costs are the costs that prevent people from making a fair and efficient private agreement. They include (1) search costs, (2) bargaining costs and (3) enforcement costs.

48 Ridyard, D. (1997).

court already decided that the incumbent must grant access of the standard to other firms. What the incumbent could decide is limited to (1) which firms would be eligible for the access and (2) on what terms, similar to a decision-making process under ultimatum game:[49]

> Two players decide to split $10 under the condition that unless they agree how to split each will get nothing. Delays matter because of inflation. In theory, player 1 should offer $1 or even one cent to player 2, and player 2 should accept (it is better than nothing). However, recent surveys and experiments showed that player 1 usually proposes to split $10 equally to make sure that player 2 will agree as soon as possible, although player 2 could be eager to accept low offers.[50]

The above scenario showed that high transaction costs does not preclude a fair deal from coming into being, as long as a conclusion of an agreement is the only option for the parties. By granting player 2 the right to preclude player 1's benefit (through rejecting the offer), the bargaining power of player 1 has been decreased, and he must refine their selfish strategy to opt for co-operation. Likewise, in our context player 1 (the incumbent) must reduce the access fees until it is feasible for the entrants to agree.

One may argue that the entrants could also play a "reverse" ultimatum game, i.e., they reject until player 1 offers $9.99. This scenario is not realistic; in the same way as the scenario that player 1 offers $0.01 is not realistic. Potential entrants must compete with each other to accept the offers as soon as possible, because delays matter (they may be excluded from the successful agreement). In fact, many deals between large firms and small firms have been concluded in fair term, even in favour of small firms.[51] Their strategies are consistent with Kant's categorical imperative: act in the way you wish others to act.[52] In addition, to maintain fairness between the parties during the course of negotiation, the court may play a role of a mediator and a watchdog of due process in negotiation.

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49 Rubinstein. (1982): 97-110; Kreps (1990): 119.

50 Rubinstein, A. (2003) *A Beautiful Mind - John Nash and Game Theory*, Speech at the London School of Economics (LSE) 3 Feb. 2003. Rubinstein conducted surveys through the Internet to students in Tel Aviv University, Tilburg University and LSE. As player 1, from 40 to 45% of the surveyed students replied that they would split the $10 bill equally. As player 2 however, from 60 to 70% replied that they would accept $1 if the player 1 so offered.

51 An example is an agreement in 1980 between Microsoft (then was a small entrant) and IBM (a large incumbent) on using IBM technical specifications to design the first disk operating system (DOS) for IBM computers. See Ichibiah and Knepper (1991).

52 McCarty, M. (2001): 348.

3.3. BOTTOM-UP APPROACH BY BIDDING

Instead of private agreement, the incumbent may also announce bidding to increase his access fee. In theory, bidding is the optimal method to find the users that value access the most.[53] Since only the most efficient bidders could pay high price for bidding, this process in theory may satisfy two purposes: reward the incumbent for its "once-in-a-lifetime" opportunity, and provide entrant*s* access to the micro-infrastructural factors.[54] To stimulate competition among standard users, the court could request the incumbent to allow more than one entrant to use the data format, so that the these markets become oligopolistic rather than monopolistic.

a. Preventing Herd Behaviour in Bidding Process

Given the advantages of bidding, it also entails risk of over-bidding. The bidding for the third generation (3G) telephony spectrum is an example, in which deficit from overbidding will likely be passed to consumers.[55] The 3G bidding price became too high because it was organised in multiple rounds, where bidders have to decide simultaneously without having information about the bidding price of other bidders. Banerjee (1992) observed that uninformed players in sequential decision making might elicit a momentum that runs off the equilibrium path (herd behaviour - in this case bidding upward). That was the reason why 3G spectrum bidding leads to overbidding. The bidders have to decide based on (1) their beliefs on the strategies of other bidders, (2) the inference from others' past actions, and (3) the fear of losing out of the market.[56]

The over-bidding scenario will not be repeated in the bid for standard access for two reasons. First, the entrants will have to compete with the incumbent in the same market. As the price of the product that uses the standard is known, the bidder would have better

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53 Coase, R. (1997): 92. See also Coase's analysis in *Sturges v. Bridgman* 1 Ch.D. 852 (1879).

54 According to Viscusi, Vernon and Harrington (2001): 451, it was generally perceived that bidding is more efficient than regulation, and regulation is more efficient than public enterprise.

55 That was the case in the recent bidding for third generation telecommunication spectrum bidding. For the structure of the spectrum bidding in various countries, see Klemperer, P. (2000 and 2002) and Coase, R. (1999).

56 People normally appreciated loss more than gain. See Kahneman and Tversky (1997).

information on how to offer the bid price. Second, the bid for standard access is not a bid for a future market where the demand side is unclear, but a bid for entering a current market (the incumbent's market) where the demand side could be assessed. In addition, to avoid herd behaviour, we may either (1) provide a more direct mechanism for aggregating private information, such as organising an open bid or (2) cut the sequence of inference, by organising a closed and one-off Dutch bidding.[57] In short, to avoid the mistake of over-bidding, bidders should have more information on other bidder's strategies and realistic estimation of the relevant markets.

b. Bidding and Dollar Auction Game

Another risk of bidding is that the incumbent set the starting bid too high to discourage other bidders. One of the methods to avoid this risk, the law should treat the incumbent *at par* as if it is a bidder, following the reversion of the dollar auction game: [58]

> Many bidders join a bid for a US$10 note. Whoever bids the highest receives the money, minus the bid. However, the second highest bidder would have to pay his bid price, but not receive any money. When, the bid reaches US$10, the bidders must decide whether to stop, or to bid higher than US$10 in order to avoid being the second highest bidders (and must pay the bid price). The threat of being second highest bidder would encourage them to push the bid higher.

Applying the game to our context, the incumbent will be considered as one of the bidders. When he offers a price for an access, he implies that he value the standard that high, and any firm paying such price for the access would be able to compete with him and make profits. If no other bidders pay for the bid price, the incumbent is deemed the bid winner. He will be responsible for repay the bid price to the State (akin to taxes) so that the latter can compensate consumers for being charged the economic rent that the incumbent is enjoying for controlling the standard.[59] His situation is similar to that of the second bidder in the dollar auction game.

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57 Baird, Gertner and Picker (1994): 213-216.

58 This game is found by Martin Shubik. See Poundstone, W. (1992): 261-62.

59 When the consumers are locked-in with a standard, their switching to other suppliers incur switching costs, which are a source of economic rent for the standard owner i.e., the incumbent. See Farrell and Klemperer (2001).

The incumbent then has a choice, either to reduce switching costs by allowing entrants access to the standard ⇒ reduce rent ⇒ do not have to repay the rent to the state, or keep switching costs ⇒ pay rent to the state. The fear of paying rent could make the incumbent offer a reasonable price and the entrants could win the bid.[60]

In practice, the above suggestion could not sustain, as the incumbent could pass over the price to the consumers. Even if the court prohibits the incumbent from increasing the product price, he could still able to do so by cross-subsidisation. In the end, the consumers would not enjoy any benefits. When consumers participate in the game between the incumbent and the entrants, our game model no longer stands. To make the game models applicable to the facts, it is necessary either to exclude the consumers from the game, or create the conditions that the consumers could participate in the game actively so that the Nash equilibrium could be reached.

The first option does not stand. The consumers could not be excluded from the game, as they are the ultimate payers of it. For the consumers to participate actively in the game (the second option), they must have a choice. Hence, the court should not accept compensation from the incumbent in lieu of the access. Rather, they should require stick to the ultimatum game: the incumbent must offer a price so that the entrants can agree. Following the ultimatum game, the court should impose a fine to the incumbent for delay making an agreement, so that he could be motivated to comply with the order.[61]

3.4 TOP-DOWN APPROACHES

a. General Approach and Burden of Proof

Private agreement or bidding may not be successful because neither the entrant nor the incumbent is willing to proceed. In this case, the court could apply top-down methods to

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60 The solution seems abstract, but it is successfully applied to internalise rent in air pollution (allocation of property over air to the state, and the polluter must pay for the rent it enjoys - i.e., the environment). See Pindyck and Rubinfeld (1999): 653-55. Firm emitting externality (pollution) must pay emission fees, which is proportionate to their emission level and the life of the factory. This rule is applied in Germany.

61 E.g., in *US v. Microsoft* 165 F.3d 952, the Columbia District Court has imposed a fine of one million dollars per day upon Microsoft until it complies with the court order.

calculate "sunk" cost amount that the incumbent may recover as the last resort. As discussed in 2.2, the top-down method consists of two parts: recovery of the *ex post* R&D expenses of creating the standard and a fraction of *ex ante* R&D expenses for improving products associated with the standard in the future. *Ex post* R&D expenses can be assessed from the incumbent's financial report. For assessing the *ex ante* sunk cost, the court may choose one of the two options: either to calculate average R&D risk on industry-by-industry basis, or to calculate average R&D risk on a case-by-case basis. As argued in 2.2(b) and summarised in 2.3, the point is not to calculate an exact *ex ante* sunk cost but to provide enough incentive for innovation. Hence, using what option to calculate *ex ante* sunk costs should be at the discretion of the court, albeit the choice is consistent and non-discriminatory.

b. Recovery of ex ante *Sunk Cost on Industry-by-Industry Basis*

Since the allowance to collect *ex ante* sunk costs is a policy matter of providing incentive and not an exact science, the court should be flexible in allowing *ex ante* sunk cost recovery. As noted in 2.2(a), *ex ante* sunk cost recovery should be linked with the average risk of failure on an industry-by-industry basis.[62] Sutton (1998) suggested a chart that considers the demand for R&D investment and the risk of R&D failure, as Figure 5 below. Under this figure, if R&D in a market will not pull further consumer demand will not save cost, there is *no ex ante* R&D costs to begin with. The taxonomy of markets into innovation and non-innovation ones concludes that it is unreasonable to reserve an ex ante R&D cost in markets where the demand for innovation is low.

62 The experiment studies of Sutton, J. (1998) showed that each industry is characterised by different degree of risk and risk-aversion requirement from the firms in that market.

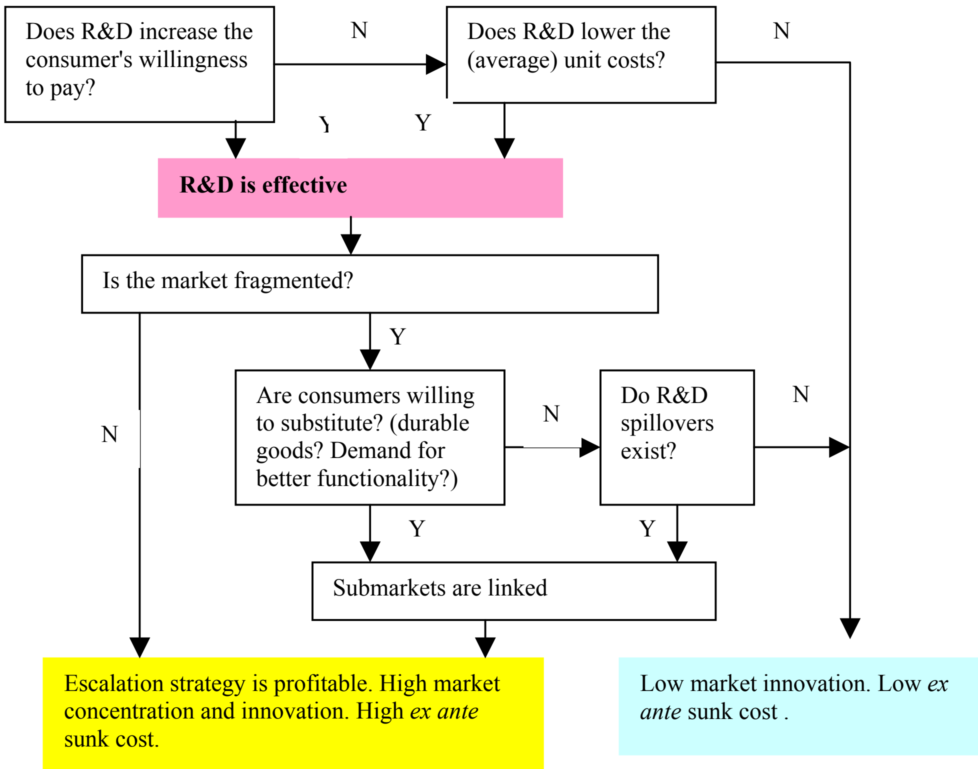

Figure 5: Profitability on R&D and ex ante sunk cost estimation

In contrast, if an analysis shows that we are dealing with an innovation market, it is necessary to reserve funds to cover *ex ante* R&D failure. Here the court could seek expert opinion on the average risk of an industry from market research consultants.[63] For example, if the expert opines that approximately 50 percent of R&D investments lead to unsuccessful outcomes in an industry, the incumbent should be protected to cover 50 percent of all R&D investments in the next year. If for any unexpected reason that it incurs more losses from R&D investments in the subsequent years, the incumbent may adjust the license fee to the infrastructural elements to offset such loss accordingly. On the other hand, if the profits from successful R&D increase, high enough to cover the risks, the rate of recovery

[63] E.g., IDC, Gartner Dataquest, Nielsen Netratings or McKinsey & Co.

allowance should be reduced.[64] An example of this scenario is the packaged software industry in North America (see Appendix 3 at the end of this paper).

Apart from the R&D risk per industry, the size of the companies also determines whether such firm is already self-motivated to innovate without further exclusive rights guarantee. For the same risk, small companies are more vulnerable to failure than large companies, and therefore would deserve higher rate of coverage from *ex ante* sunk costs.[65] As big companies are more eager to spend R&D investment than smaller ones, the former has capacity to cover risks better,[66] and their recovery allowance rate should be lower than the latter (see Appendix 5 for the profit prospectus of top software vendors).

c. Calculation of ex post *and* ex ante *Sunk Costs*

If the court prefers to allow the incumbent to recover the exact sunk cost rather than an estimated amount as specified in subsection (b), they may require the incumbent to calculate the sunk cost and recognise it as a limit of its right to refuse licensing. Contrary to the arguments that sunk costs cannot be calculated,[67] there are many methods to calculate both *ex post* sunk costs and *ex ante* sunk costs. When sunk costs are *ex ante*, we could apply one or more of the following techniques for calculation of software engineering costs: algorithmic costs modelling, expert judgment, analogical estimation, and Parkinson's Law.[68]

> Alternatively, they could follow some of the more general approaches in calculation, as the ones proposed by Sutton (1998). Moving from Sutton formula in 2.2(a) on *ex post* sunk cost,

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64 Viscusi, Vernon and Harrington (2001): 492 also noted that if the market is highly competitive and firms are predominantly risk-preferred (as in ICT markets), it is important to keep that momentum not being distorted by too high protection of incumbent's sunk cost. In this case, protection would lead to high consumer's barriers to exit and harm the competitiveness of the market.

65 Dasgupta, and Stiglitz, J. (1980). Kaplan, Luski and Wettstein (2002).

66 *Id.*: 25-26, quoting experimental studies from Vossen (1999) and Cohen and Klepper (1996).

67 Korah, V. (1990): 99.

68 Sommerville, I. (1995): 599 - 601 for calculation of person-months with respect to future R&D. Algorithmic costs model uses historical cost information that relates some software metric to the project cost (looking at the past). Expert judgment and analogical estimation look at the present to compare a programme cost with a similar programme. Parkinson's Law determines the costs by available resources and time taken to fulfil the task. One of the methods that bases on Parkinson's Law is COCOMO (combined costing model), which based on three types of formulas for simple, moderate and embedded project complexity. The costs differ dependent on product attributes, computer attributes and personnel attributes. See Boehm, B. (1981): 596.

firm inflicts a failure at level N in the future when $P(u_{N+1} \mid u) - F(u_{N+1}) < 0$ (stability condition). In which $F(u_i) = u_i^{\beta}$; u_i denotes competence for product i through R&D, advertising, …; β measures the "effectiveness" of these R&D and/or advertising. The higher β, the less effective is R&D and advertising. Determination of β requires backward induction, experimental studies, probability calculation and mark-to-market accounting techniques. While calculating β, the following factors should be taken into account:[69]

- Product innovation: does R&D solicit the buyers' willingness to pay?
- Process innovation: does R&D lower the cost of production?
- Market and sub-markets fragmentation: the degree of substitution between the products, the possibility of reuse or spillover application of the R&D?

As noted in 2.2(b), it is unnecessary to design an exact method of sunk cost calculation. A court can estimate the demand for future innovation as proposed in Figure 2. If such a demand exists, it can set a conventional method, then it requires the incumbent to prove ex ante sunk cost before requesting the entrants to share such costs with the incumbent. If no entrant is able to compensate the incumbent, such amount could be used to calculate for how long the incumbent could hold its absolute exclusive rights on the standard (so as to recover sunk cost and opportunity cost) before it could be licensed for capable entrants.

d. Burden of Proof

For the top-down approach to be applied fully, we must assume that government has all the information and never makes a mistake in allocating resources. These objectives could be unattainable if there is information that the government does not know, such as the risk of R&D failure in the future. The incumbent should know the most about the risk in its business, not the court nor other companies. According to the rule of unravelling result and moral hazard, he should bear the burden of proof.[70] Moreover, when the burden of proof is on the incumbent, it would accept the loss for its own miscalculation. Therefore, it is better to let the incumbent prove the risk rather than second-guessing that the risk is high and the incumbent should be protected.

When the burden of proof is on the incumbent, courts would have difficulties in verifying these evidences. Ex ante sunk cost is normally private and non-verifiable

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69 Sutton (1998): 65-70. Apart of β, Sutton also proposed to calculate another parameter, $\alpha = \max[a(k)/k^{\beta}]$, in which a(k) denotes a fraction of the current sales revenue that the firm captures in the worst case scenario with future R&D.

70 Arrow, K. (1978), and Baird, Gertner and Picker (1994): 89-95, 309, 317

information.[71] To verify it, one needs to turn it into verifiable information.[72] As noted, in industry risk calculation (subsection b), the percentage of failure in each industry could be verifiable information through expert opinions. However, with respect to case-by-case risk calculation (subsection c), information such as the incumbent's business plan and market trend is harder to verify, as it may include business secrets. Therefore, the industry-by-industry approach should be preferred to the case-by-case approach, unless the incumbent could prove that his information is verifiable and is willing to reveal his business secrets.

The final point to remark is that there is no hard and fast rule as to whether the rightholder should be able to recover a percentage of their *ex ante* sunk cost. Rather, the approach should be trial and error. An arbitrary ruling on ex ante sunk cost, based on the risk indication of the industry and the size of the companies should be acceptable. As arbitrary rulings are based on beliefs and expectations, the latter's role is very important and should be verified. Experiments and statistics should be constantly conducted from time to time as to whether the access of interfaces or data formats encourage or discourage innovation.[73]

4. FREE RIDING PREVENTION

4.1 FREE RIDING RISKS

Free riding is usually is problem of public good.[74] As a public good is non-excludable and non-rivalrous, its creator would not feel any physical constraints when someone else uses it without paying him. For the same reason, free riding of intellectual property is difficult to detect and punish, hence it could opt to become a collective action.[75] That was what Hardin (1968) called "the tragedy of the commons." The basis of this trap is capped in

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[71] Baird, Gertner and Picker (1994): 178-186.

[72] *Id.*: 152-157.

[73] In practice, the European Commission and the Court of Justice have used a quasi-marginal approach to apply the essential facilities doctrine. It started from liberal approach in granting access in *Telemarketing* or *Commercial Solvents* [1985] ECR 3261, to a narrower view in *Volvo*, latter extended the scope of the doctrine in *Magill* (C-241-242/91), and then narrowed it in *Bronner* [1998] ECR I-7791.

[74] Baird, Gertner and Picker (note 35): 308.

[75] *Id.*: 189.

a game of non co-operative bargaining called *hunt stag*.[76] The point of the game is that when players do not trust each other and are selfish, they could free ride each other's trust by defecting, although if they co-operate the payoffs would be improved for all.[77]

a. Free Riding Risks in Innovation Markets

In practice, whether the entrant will free ride the efforts of the incumbent will depend on many conditions, not just the mutual trust between the parties. In an innovation market, mere access to a standard does not guarantee the entrant success. The consumers are not interested in the standard as such, but in the end-product. If market entry requires a substantial value-added innovation from the entrant, the entrant could not merely free-ride the efforts of the incumbent. He must exert innovative efforts ("sunk" costs, as explained in previous sections). An example is software developers commercialising products under GNU Public License (GPL).[78] The open standard concept under GPL or copyleft requires that the source code of any software protected under GPL should be accessible to the public. As such, firms may co-operate for innovation and spread the risk of failure. Linux kernels are examples of GPL-standards. The software created by Linux kernels is still protected by copyright.[79] Software developers collect fees through services and provisions in integrated packages, follow the principle: "*free of use, not free of charge*."[80]

On the face of it, it seems that GPL or Free Software would create a floodgate for free riding. In reality, many companies and governments have voluntarily submitted their

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76 *Id.*: 33. Two hunters co-operate to hunt a stag (a deer), with the expectation that each would receive three utilities (long term gain). When a hare happens to pass within reach of one of them, he would forfeit hunting stag for chasing the hare, his friend would get nothing. Knowing that one hunter has defected, the other hunter also defects and chases the hare. If the hare were caught, they would have one utility only (short term gain).

77 The main risk of "free riding" need not only come from non-innovative firms but also innovative entrants, who may "pollute" the current standard of the incumbent by creating incompatibility. See *Sun v. Microsoft* 49 USPQ2d 1245 N.D. Cal 1998 (Microsoft's pollution of Java virtual modules (JVMs)).

78 Stephens, R. (2000), Lambert, P. (2001), Stallman, R. (2000).

79 Unisys Management Consulting (2001): 40 noted that in reality, GPL has not abolished copyright. It is a specific way to exercise copyright by narrowing the scope of right in respect of the kernels that has become common standards.

80 Stallman, R. *Id.* "Use" means "study" and "copy verbatim", not installation and interaction for commercial purpose. Linus Thornvald, founder of several Linux kernels legitimately holds copyright of many Linux kernels.

software under the GPL scheme, and Linux standards come out as a big rival to proprietary standards:[81]

	COPYRIGHT ENFORCEMENT	
	Open Source	*Proprietary*
Operating system	Linux	Windows, Solaris, AIX
Graphical user interface	Gnome	Windows, Macintosh
Desktop application	Open Office	MS Office
Database	MySQL, Postgres	SQL Server, Oracle, DB2
Browser	Mozilla	Netscape, Internet Exporer
Group e-mail	Ximian Evolution	MS Outlook, Lotus Notes
E-mail server	Bynari	MS Exchange, Lotus Domino
Instant messaging	Jabber	AOL, MSN, Yahoo

> We could see how GPL software earns money through the example of MySQL. This database open-source product gives its users two options. Those who acquire it free must agree to document and share any improvement they made. If a user does not want to share its improvements, MySQL will sell them the same software for US$395 for a single copy (far less than the price charged by Oracle or Microsoft). By March 2003, about 4,000 companies have paid MySQL a fee, compared with four million users of the free version, which in turn enhance MySQL network externality.[82]

One could say that "free riding" is a by-product of positive network externality, but in fact, it is not easy to "free ride" GPL products. For those who do not know how to innovate, accessing MySQL does not give them any more advantage (MySQL standards are free and open for all). To enter information solution markets, they have to share their improvement with MySQL -- they are no longer free riders. Even where they use the free version of MySQL, it only gives them a toolkit, which they cannot sell to anyone. The users must apply MySQL tools to design information solutions. Technically speaking, they free ride MySQL technology, but in fact, it is a *quid pro quo* action.[83] So far, no statistical evidence has been shown that free riding in MySQL or other Linux-software has become a collective action. The availability of many open source or free software in the market also has not significantly boosted the number of software followers or free riders or their investment.

81 Bulkeley, W. (2003). GPL software written for Linux operating systems have won supports from many governments such as China and Germany, as well as multinational enterprises such as Oracle, Sun Microsystems and IBM.

82 *Id.*

83 MySQL needs more people using their standards so that its database could become a *de facto* software infrastructure. Moreover, the free users do not compete with MySQL, as MySQL is not present in the information solution market.

OECD (2002b) noted that the share of software in business sector in the US has increased only from 6.8 percent in 1990 to 12.4 percent in 1999 (in terms of nominal gross fixed capital formation). Appendices 3 and 4 also showed that if the downstream markets (application software) are larger enough, firms in upstream markets (system infrastructure software) would innovate regardless of the risk of free riding.

Statistically, the rapid growth in private R&D throughout all the sectors in the last years showed that if free riding were an easy way to make money firms had not voluntarily invested in R&D "sunk" costs that much. OECD data (2002a) in Appendix 2 showed that total R&D investment grew by 53 percent between 1999 and 2000 in real term, whereas public R&D investment grew only 8.3 percent. Many countries such as Scandinavian countries and the US allocated up to 16 percent of their R&D in information and communication technology (ICT) despite the threats from piracy.[84] Surprisingly, small firms who have small customer base and are more vulnerable to free riding threats appeared to be more aggressive in R&D than large firms.[85]

b. Free Riding Risks in Non-Innovation Markets

When the market is non-innovative, the risk of free riding is higher, if the entrant does not have to take much effort from accessing the standard to market entry. In *British Horseracing v. William Hill*,[86] the English court held that using a copyrighted database without authorisation is free riding, even if the copyright owner does not exploit his product commercially, because the defendant did not put any value-added to the plaintiff's database that he used. This case also showed that not only damages or competition, but also any *effect* of free riding that makes the cost/benefit calculation disfavouring the innovators would affect the innovation motivation.

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84 OECD (2002a): 108.

85 *Id*: 104-105.

86 [2001] ECLR 257. See Philips and Firth (2001): 362. The plaintiff collected horseracing data and distributed it freely on its website. The defendant offered online betting service and tap-in the plaintiff's website without its consent.

IMS Health v. Commission, as noted in the Introduction is another case involving competing firms in a non-innovation market, but here the chance of free riding is low. If IMS was to grant access to its competitors, the latter still have to collect data in order to market their products, which is a much harder work than just design a data format. In this case, free riding was not easy.

Even when free riding is easy, many other factors can affect whether a user chooses to free ride or to co-operate. For example, both students and working people equally like music and are equally capable to download music through Napster. However, Liebowitz (2002) showed that the risk of free riding (piracy) is significantly higher among students than among other communities. Likewise, citizens in Germany and Singapore have similar incomes (GDP per capita), but data from the Business Software Alliance (BSA - 2001) showed that the rate of software piracy in Singapore is much higher (51 percent) than in Germany (29 percent). Many factors have contributed to the risks. In case of Napster, working people have less time for downloading and more money to spend on music than students do. In case of software piracy, Rodriguez Andres (2002) explains that law enforcement and income level are determinant factors, but the comparison between Germany and Singapore shows that they are not. Statistical data showed that for free riding to become a collective action, not only opportunity to free ride, but many other factors come into cost-benefit calculation of users (to free ride or not to free ride). Hence our assumption that the risk of free riding is high in non-innovation markets is already more pessimistic than reality. Courts should not over-traumatise over this perception.

To sum up, to assess the free riding risk one needs to compare the cost of creating a standard with the cost of adding value to it to bring the end product to the consumers. If the cost of adding value is small compared to the cost of creating a standard, the risk of free riding is high. Hence, in most innovation markets, the risk of free riding by mere access to the standard is low if we assume that the cost of innovation is high. In non-innovation markets, the risk of free riding will depend on the size of efforts needed to enter the market after the access.

c. Free Riding, Trading Right and Collective Action

In 2.1, it is argued that the incumbent should not be entitled to charge the entrant for a trading right (in association with the access to the standard) as long as his sunk cost is or will certainly be recovered. Having said that, there is a case for charging trading right in order to prevent free riding from becoming a collective action, when "innovation" is only a weakly dominant strategy as opposed to "free riding".

Prevention of collective action only answers one part of the free riding concern: whether free riding behaviour can be excluded in respect of the use of the current standard (short-term objective). The second part of the concern is whether firms that share the same standard in innovation markets would be motivated to innovate and improve such a standard (long-term objective). Figure 6 below explains the logic of free riding consideration:

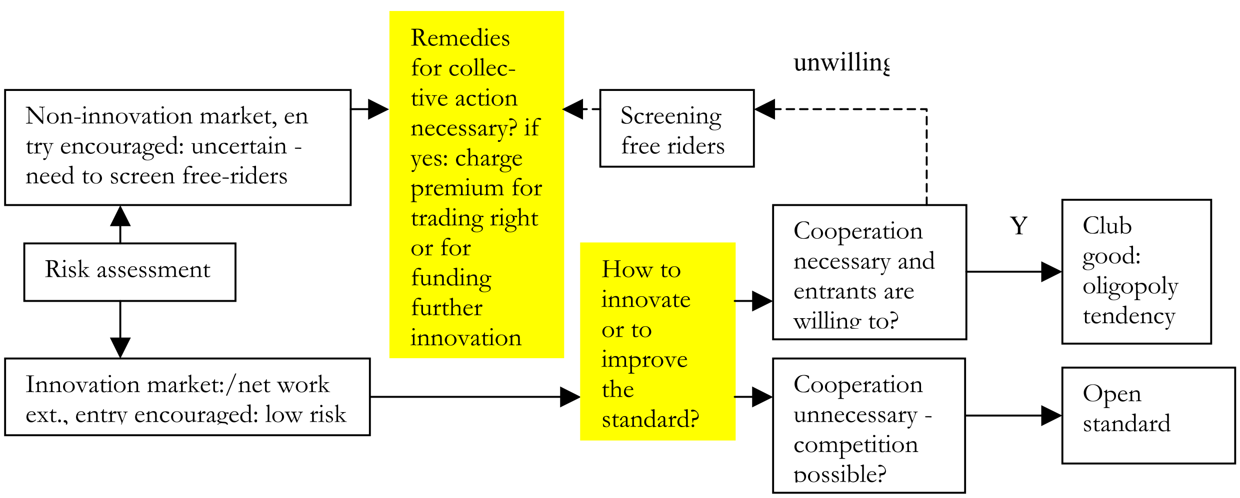

Figure 6: Free riding assessment and remedies:

4.2 SHORT-TERM OBJECTIVE: PREVENTING COLLECTIVE ACTION

We can start analysing by calling the remedies for collective action problem as the "carrot" and the "stick." In the stick approach, a leader, who has the largest stake on the development of a public good and the risk that free riding could become a collective action, dominates all players in the game. The "leader" will punish any players who free ride his contribution to the public good, even if by punishing he suffers short-term losses. In the second approach ("carrot"), the law will design a mechanism of contribution to a public good, so that those who value it the most will reveal their true types and contribute voluntary. The force behind the "carrot" approach is that unless the high-valuing players contribute, the public good will be exhausted or will not be created.

a. The "Stick" Approach

A general approach to prevent collective action is to turn a non co-operative game with sub-Pareto optimal equilibrium to a co-operative game with Pareto optimal equilibrium, through the players' common interests and their common ideas of efficiency.[87] This could be done by designing the *embedded games* to which the users of a public good play.[88]

> Assuming that an incumbent controls an essential standard, he has to decide whether he could exploit it on his own (moves left) or share it with other users i.e., entrants (moves right).[89] When the incumbent chooses the latter option, all users will enjoy benefit from the network externality among consumers that use the same standard. Depending on whether the incumbent moves left or moves right, the entrants will decide whether it should compete or co-operate with the incumbent. For simplifying purpose, we assume there is only one entrant. If the incumbent moves left (no share), the entrant will play a non co-operative game (e.g., prisoner's dilemma) and both will reach Nash equilibrium with payoff (2, 2). If the incumbent moves right (share), the entrant will decide whether it should free ride the incumbent good will, or co-operate with the incumbent in various forms (pay for the use of the standard, share other innovative results with the incumbent etc.). Therefore, the entrant enters a non co-operative bargaining game with the incumbent (e.g., hunt stag).

This subgame has two pure Nash equilibria. The first equilibrium is that both the incumbent and the entrant contribute to the public good. That being the case, the incumbent receives the payoff of 6, and the entrant receives the payoff of 2 (he gains 4 from using the standard but loses 2 due to the cost of his contribution to the product). The second equilibrium is that the entrant defects and therefore the incumbent punish him by withdrawing the license that allowed him to use the standard. The incumbent receives 0 but the entrant receives 3, being the profit incurred during the time he was able to use the standard. The purpose of regulation is to design a mechanism so that the first equilibrium (both co-operate) is the only equilibrium of the game. The payoffs between users are explained in Figure 7 below.

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87 Baird, Gertner and Picker (1994): 42 and 189-191.

88 This game is taken from *id.*: 192 with payoff modification to be suitable with market with network externalities.

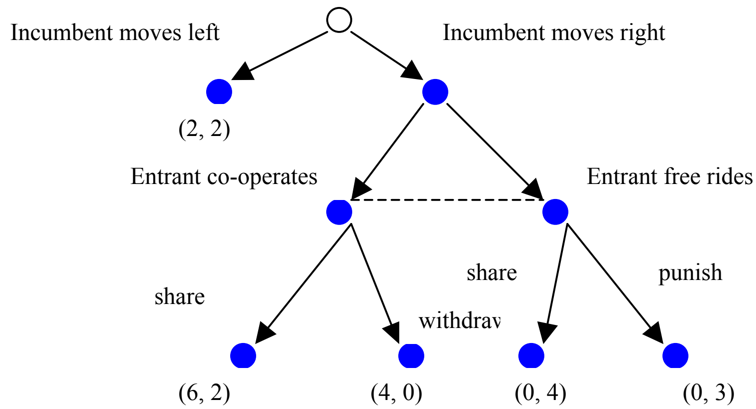

Figure 7: Embedded co-ordination game. Payoffs: incumbent, entrant

Here the dominant strategy for the incumbent would be to share the standard with the entrant and the entrant co-operates. However, the incumbent could only do so if the entrant commits himself not to free ride the incumbent's effort. Otherwise the risk of being free ridden would make the incumbent hesitate to share and consequently both parties would enter a non co-operative game with Nash equilibrium (2, 2).

Given that the best payoff from winning the co-operative game (6) is three times higher than the payoff in the Nash equilibrium under the non co-operative game (2), it pays for the incumbent to keep punishing the free rider and receive the payoff 0 (folk theorem). When the punishment is carried out, a rational entrant will infer that the incumbent's threat to punish upon discovery of free riding is a credible threat, and that the incumbent would never play dominated strategy. Even if the incumbent suffered losses twice to prove that his threat is credible, his victory in the third time would offset them. By so doing, the incumbent enjoys a payoff of 6 instead of 2 that he would receive from non co-operation initially.

The above mechanism suffers from one problem: the punishment might be ineffective toward the entrant. The entrant's payoff in case of punishment is 3, higher than his payoff when the incumbent moves left (2). Therefore, his dominant strategy would be to free ride regardless of the incumbent's strategy. In order to make "share-contribute" the unique equilibrium, it is necessary to reduce the payoff of the entrant when he free rides. The incumbent may require the entrant to pay the incumbent damages equivalent to his profits during the free riding period so that his payoff will be 0, lower than the payoff in the Nash equilibrium under the non-cooperative game. For this scenario to be realistic, the incumbent

[89] *Id.*: 193.

must receive information on the types of the entrant (whether he is a free rider or a contributor) and the amount of the entrant's profits. This information is difficult to obtain, as it is observable but non-verifiable.[90]

In addition, many entrants free ride not because they are free riders by type, but because they have the opportunity to free ride and free riding brings more profits than contributing. That being the case, it is not necessary to identify the type of the entrant, but to design a game that only contributors could survive. In theory, either reducing the payoff of free riding or increasing the payoff of contributing could achieve this objective. The first approach could hardly be feasible for two reasons. First, the entrant would not voluntarily reveal their free riding intention voluntarily to the incumbent, as this information does not serve his benefit.[91] Second, free riders could save expenses on contribution, therefore their product could be priced lower than that of the contributors and gain more consumers. Consumers are indifferent whether they buy products from a free rider or a contributor as long as the price is low, hence they could end up rewarding the wrong side of the game. These difficulties point us to the second approach (the "carrot" approach): finding an incentive mechanism in which contributors would receive more benefits than free riders in the end.[92]

b. The "Carrot" Approach

The key point in the "carrot" approach is that users value a public good differently. Although many users share a public good (e.g., using the same interface or data format), some users value the good higher than other does. The high valuers should be more willing to contribute to the improvement of the public good. User's valuation of a public good is private and non-verifiable information.[93] If the users reveal their true value, they would have to contribute more than others do, whereas if they do not reveal a true value, they would

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90 *Id.*: 109. Information is observable but not verifiable when the incumbent can identify the entrant's type through his intuition or experience in course of dealing, but a third party, such as a court, cannot.

91 See the beer-quiche game in Cho and Kreps (1987).

92 In his Nobel lecture, Stiglitz (2001) also noted that "carrot" (incentive) in the long run is a more effective measure than stick, because productivity is dependent on reward, not threats.

93 Baird, Gertner and Picker (1994): 206-07.

have to contribute less. Since the information is non-verifiable, under-valuation will not be punished, and therefore this free riding behaviour could become a collective action.

> To avoid this scenario, Baird, Gertner and Picker have proposed a game that elicits players to reveal their true preference as follows.[94] Assuming there are two players bargaining over contribution to a public good that costs $2.7 to create. The players could value the public good at $0, $1 and $2 (the probability of each valuation is 1/3). If both players value the good at $2, each would contribute $1.35 to the cost of making the public good. If one player values the good at $1 and the other values the good at $2, the low valuer will pay $1.25 and the high valuer will pay $1.45 to the making of the public good. If one player values the good at $1 and the other values the good at $0, or both values the good at either $1 or $0, the public good will not be created. If one player values the good at $2 and the other values the good at $0, then the public good will not be created, the low valuer will have to pay the high valuer $0.3. Using the Bayes' rule to calculate payoff's probabilities, the result will be as follows.[95]

		True values		
		$0	$1	$2
Declared values	$0	-$0.10	-$0.10	-$0.10
	$1	-$0.42	-$0.08	-$0.25
	$2	-$0.83	-$0.17	$0.50

According to this table, the players reach their Bayes-Nash equilibrium and best payoffs when they declare their true value. The success of the model is that each player's valuation of the public good is independent of every other's.

There are several factors that have contributed to this success. The first factor was that the low valuer was required to pay $0.3 to the high valuer otherwise the public good would not be created. It shows that a low valuer could end up bearing losses. This is particularly true when a player has its true value at $1 or $2 but declares only $0 or $1. These people could be free riders or cheap riders, who pretend valuing low in order to contribute less to the making of the public good. The second factor that contributed to the model's success was that those who valued the public good at $0 and $1 would suffer expected loss from playing the game. Even when a player has the true value of the public good at $1, he must contribute at least $1.25 in order for the public good to be made. In the end, only players

94 This game is based on Vickrey-Clark-Groves mechanism. See Clarke (1971), Groves (1973), and Vickrey (1961).

95 See *id.*: 207-208 for details on the payoff calculation.

that value the public good more than their contribution toward making the good would have the incentive to contribute.[96]

When we apply the model of Baird, Gertner and Picker to our context, it would imply that the incumbent should charge the entrants for access to that standard proportionally to the latter's valuation of the standard. For example, the access fee consists of a flat fee and a top-up fee, calculated by the percentage of the sale proceeds from the products that use the standard.[97] Only the entrants that value the standard more have the incentive to pay for the access fees, and by so doing, they are no longer free riders. When the incumbent expects to upgrade his product after three years, he could design the access term consistent with the upgrade term. Consequently, after three years, only entrants that co-operate with the incumbent to upgrade their products would have the revenue to pay the renewal fees to use the standard. Here the rationality of "access fee" proves the legitimacy of charging the premium for a trading right, as discussed in 4.1(c) above.

The state's next concern is that the incumbent shall not overcharge the access fees to the entrants (otherwise consumers would be likewise overcharged). For that purpose, it should require that the flat minimum fees as noted in the paragraph above should be calculated *pro rata* with the *ex post* sunk cost to make or improve the standard. For example, if the cost to make/improve the standard is $1 million and there are two users, the minimum flat fees for the entrant could be $0.5 million. This amount could be adjusted if it is unreasonable given the product price that the incumbent is charging the consumers and his current market share.[98] If the incumbent allows another entrant to have access, the flat fee should be reduced to $0.33 million. The earlier entrant should automatically enjoy the reduction through a "most-favoured user" clause.

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96 McFadden (2001). Unless high valuers contribute, they could not enjoy benefits deriving from the public good.

97 Stigliz (1974), Allonso and Watt (2002) also noted that fixed percentage royalty is efficient to the parties when one of them is risk adverse. In our case, the entrant should be risk adverse, since they have no verifiable information on their future profits and no confirmation as to whether or not their beliefs on the value of the standard is true or not.

98 In order to prevent the incumbent from putting too high a minimum access fee, the state could apply the pricing method according to the dollar-auction game, as noted in 2.3 above.

There is a risk that the entrants do not have enough information to decide whether they could pay for the price the incumbent asks. As noted in 2.2(b and c), the entrants bear several disadvantages as latecomers. They are also constrained by the "reverse" sunk cost concern. When the entrants make a decision to pay for the access fees, they set the value of the standards based on their beliefs. Such beliefs are dependent on various factors: the consumer demand in the market (present and future), technology trends that affect consumer demand, the incumbent's innovation and marketing strategies, the number of future entrants etc. These factors are uncertain, and sometime the entrant's miscalculation is not the only result that leads to his failure. Therefore, the entrants must put probabilities on them. Later entrants may update the beliefs using Bayes Rule when other players (consumers, competitors or the incumbent) take actions and confirm/reject these beliefs. As the entrant's strategy and expected payoff are consistent with his beliefs, these factors will change when the beliefs are updated. As such, the court may require the incumbent to allow the entrants renegotiate the term of access when unexpected events occur that alter the entrants' reasonable belief.[99]

A drawback of both the "stick" and the "carrot" approach is that they do not facilitate voluntary co-operation between the incumbent and the entrants. These approaches could work when one firm is an innovation leader, which also undertakes all innovative efforts. Other firms will "pay as you go." It ignores the fact that one firm could be innovative in one period, but another firm could be more innovative in another period, which was the essence of Schumpeterian creative destruction.[100] If the entrant wants to improve the standard but the incumbent, as the copyright owner, disfavours it, innovation could be retarded. Hence, the stick and carrot approach is only appropriate where the market(s) concerned are non-innovation market(s), or when the markets concerned are innovation markets but the entrants are unwilling to co-operate with the incumbent to improve the standard (see Figure 6 in 4.1(c)).

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99 See Baird, Gertner and Picker (1994): 85-87, 112-17; and Article 6.2.2 of the UNIDROIT Principles of International Commercial Contracts, which allow the parties to renegotiate where "*the occurrence of events fundamentally alters the equilibrium of the contract either because the cost of a party's performance has increased or because the value of the performance a party receives has diminished.*"

100 Schumpeter (1941).

When the market is a non-innovation one, prevention of a collective action would suffice to prevent free riding in both the short term and the long term, because the concern on standard innovation does not exist. When the market concerned requires constant innovation, the risk of collective action from the entrants is low.[101] However, regulators should focus on the long-term objective of free riding prevention: how to maintain a favourable environment for innovating the standard. The answer will depend on how the incumbent would prefer his product to be improved: with co-operation from the entrants (co-operation) or without (competition). Each option will be discussed below.

4.3 LONG-TERM OBJECTIVE: INNOVATION AND PROMOTION OF THE STANDARDS

a. Innovation through Co-operation

i. Conditions for Co-operation

In theory, co-operation should be an optimal form to create a public good such as the standard or other copyrightable works. Since a public good is non-rivalrous and non-excludable, it is better if all the users of such good share the cost of its formation and the benefits from it.[102] For co-operation to take place, rational choice theory requires two conditions (1) that a co-operative surplus exists (i.e., gaining common interests or avoiding common threats), and (2) there is no serious impediment to exchange (i.e., low transaction costs).[103] Albanese and Van Fleet (1985: 245) showed the relationship between a member of a co-operative group (either the incumbent or the entrants) and the group in the following chart in Figure 8. Given the clear rule of sanction and reward in the co-operation scheme, the chart shows that there is a relationship between discovering the free riders/contributors and individual performance:

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101 See 3.1(a).

102 Ulen, T. (1999): 801-02.

103 *Id.*: 803-06. Baird, Gertner and Picker (1994): 42. Transaction costs include search costs, negotiation costs and enforcement costs, see Coase (1960): 114. Search costs are the cost of finding the individuals that are capable of contributing to the commons and could reveal their nature. Negotiation costs are the cost of agreeing as to the contribution to the common and distribution of the profits. Enforcement costs are the cost of finding the free riders/excessive contributors, then carrying out sanctions or rewards according to the agreed co-operation scheme.

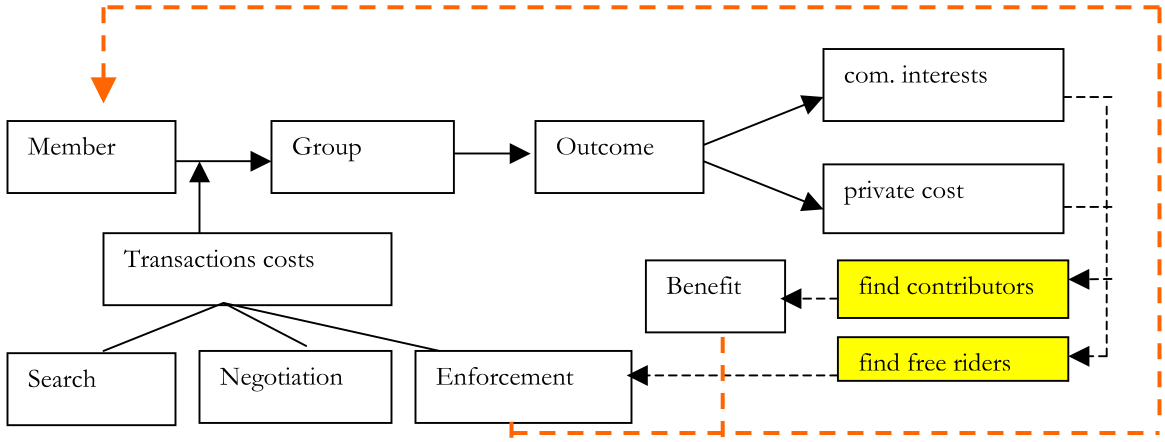

Figure 8: co-operation and the free riding problem

In this chart, the group member will contribute its innovative efforts to improve the standard and receive an outcome: common interests and private cost/payoff.[104] If outcomes from different entrants are visible, the incumbent could draw from the outcomes among the entrants who are the free riders and who are not. As a matter of efficiency for co-operation and fairness, the free riders will be excluded from the benefit of co-operation. Those who contribute more to the standard will receive more benefit.[105] The mechanism of co-operation must provide the payoffs so that the cost of free riding is more than its benefit, or the benefit of co-operation is larger than the benefit of free riding.[106] For that purpose, the incumbent must be able to identify the contributors and the free riders. Finding contributors is not difficult, as they already have the incentive to signal their performance to the incumbent. Finding free riders is more problematic, as it was not favourable information that the free riders want to reveal.[107] Hence the two key issues of co-operation should be how to find free riders and how to sanction/reward individual performance.

104 Hardin, G. (1968): 1244 noted that private payoffs could play a more important role than common interests. He noted that the key question is not whether my efforts are good for the common, "what is the utility *to me* of adding more *my* (efforts)?"

105 On the ground of philosophy, Habermas (1996): 166 also noted that the conditions for successful co-operation is to exclude free riders from the co-operative benefits and reward outstanding contributors.

106 See McCarty (2001): 23-27 (on Gary Becker's cost-benefit analysis of human behaviours). Experimental studies showed that people are more eager to co-operate than rational choice theory expects. They could co-operate even knowing that some (but not most) others free ride their efforts. See Ulen, T. (1999): 804-06.

107 Baird, Gertner and Picker (1994): 89-95 (unravelling result), 125-42 (non-verifiable information) and 207 (signal).

ii. Finding free riders

Adar and Huberman (2001: 9), in the experiment on free riding of Gnutella, observed that co-operation would not take place if the group members were too numerous. The studies from Albanese and van Fleet (1985) in another context (working hours) also verified this judgment. To solve this issue, they suggested that a large group must be subdivided into subgroups so that each member of a subgroup can monitor the conduct of other members. Moreover, in a subgroup each member has an interest in finding the free riders because free riding behaviour is more likely to harm the common interests in a subgroup than in a large group.[108] Applying this suggestion to our context, the incumbent might enhance co-operation by granting access to standard only selectively to certain entrants that are capable of innovating and having their behaviour controlled. Hence, instead of an open access to a standard, the court may allow for selective access, and the downstream market will be oligopolistic rather than perfect competitive.[109] From the consumer's viewpoint, the issue is not how many entrants will be granted access to the standard, but whether consumer welfare before and after granting access to the standard are different. Tolerating oligopolistic market but prohibiting monopoly could be a solution to prevent free riding.[110]

iii. Sanction/reward mechanism

There are many ways that standard users could construct sanction/reward mechanism through co-operation, which could be classified in two approaches: "opportunity"-focused approaches and "threat"-focused approaches. The first approach says that firms co-operate when they need to explore a profit maximising opportunity. The second approach says that

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108 Albanese and Van Fleet (1985): 246. Another related method of finding free riders is to hold collective responsibility. That is, the incumbent grants public good to a group of entrants, in which they will be jointly liable if any of them free rides the public good. This method is recommended in Stiglitz and Arnott (1990) for credit institutions.

109 See also McFadden (2002): 7-8. In practice, IBM and Dow Chemical are also selective when licensing their technology to other firms, so as to avoid free riders and guarantee stable stream of license fees. See Davis and Harrison (2001).

110 Hayek (1986): 104-111 noted that one should worry about whether competition exists at all, and whether consumers have a freedom of choice rather than whether oligopoly exists. However, a problem of oligopoly is that it could lead to entry deterrence, which in turn may lead to too little niche opportunity exploration. See Gilbert and Vives (1986).

firms co-operate when they need to counter a common threat.[111] They are considered below.

(1) Opportunity-focused approach

In the opportunity-focused approach, the co-operative group may require each member to contribute to the commons and take benefit from it (common pool).[112] The common pool could be effective when there is mutual trust between the members of the group, or when the number of the group member is limited and the interest of the incumbent is secured.[113] In our context, the mutual trust between the incumbent and the entrants may be low (otherwise they would have co-operated voluntarily without recourse to the EFD or fair use). Suppose an incumbent allows entrants to access a standard, under the condition that the entrants must share with the incumbent any relevant innovation they have made. This condition does not guarantee that (a) each entrant will contribute any new knowledge and (b) the knowledge he contributed is the best knowledge he knows. Consequently, every member would prefer to step back and wait for others to contribute first. Waldman (1987) noted that this situation might arise where efforts are costly and uncertain but free riding is easy.[114] It is also called "cheap riders", which Stigler (1974) defined as those who pretended to contribute their efforts to a common good, but they only contributed low quality results, keeping high quality results for themselves.[115]

Although cheap rider may become a collective action, Stigler did not conclude that it would destroy co-operation by the end of the day. Many labour experiments studies also confirmed that free-riding *may* destroy co-operation when it becomes a collective action, but

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111 To be fair, each approach has its own opportunities and threats. The term used here explains the main reason why firms co-operate.

112 Baird, Gertner and Picker (1994): 195. Common pool is applied in joint research agreement, cross-licensing or pool-licensing. Examples of this scheme is the joint research among European mobile telephones to build GSM standard for the second generation of mobile phones, or the joint venture from European aircraft companies in producing passenger aircraft (Airbus).

113 *Id*: 196-97 (solution for common pool between creditors) and Granstrand (1998). See also the findings of Harsanyi on the roles of cheap talk and persuasion to follow common interests, quoted by McCarty (2001): 343.

114 Although the studies were on the context of entry deterrence, it could apply to the context of innovation markets, where R&D expenses are high and uncertain, and copying is easy.

115 For experimental results on cheap rider in Gnutella, see Adar and Huberman (2000).

it *will* actually destroy co-operation when collective action reaches the *critical mass*, i.e., when the number and volume of free riders exceed the number and volume of co-operators.[116] Because we limited our context to innovation markets, where it is not easy for free riding to become a collective action, our assumption is that it takes time before free riding reaches a critical mass. The question is not whether the time lag would be enough to give advantages for the co-operators, but whether the ones who co-operate always find that co-operation is the only way (or the best way) to reach optimal payoffs. The issue then returns to the balance of payoffs between big firms and small firms as discussed in 4.2, which emphasises the importance of the market leader. Many economists also conclude that the survival of co-operation is decided not by the free riders, but by the market leaders: whether they see profit potential out of co-operation or not.[117]

Alternatively, the members of the group may decide not to specify a level of contribution, but make clear that the amount of reward will be proportional to the degree of contribution.[118] In theory, this approach seems more feasible than the previous approaches as it is based on verifiable information (proportionality). Its enforcement requires only transparency - clear information as to who is contributing how much. In practice however, it is not easy to estimate one's contribution compared to others, especially when their efforts are overlapped or when the information about how useful the contribution was is non-verifiable.[119] To that end, making the size of the group smaller as suggested not only helps to identify free riders, but also reduces transactions costs overall. The smaller the group, the larger the share of an individual, the bigger the stake of each individual in the common.[120]

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116 See the studies of Guth, Schmittberger and Schwartze (1982), Thaler (1992), Ulen (1994), Andreoni (1988), quoted by Ulen (1999).

117 The studies from Stigler (1974), Gilbert and Vives (1986), Kaplan et al. (2002) showed that big firms normally see higher profit potential in innovation, and hence eager to co-operate with other firms in innovation efforts notwithstanding the risk of free riding. Historical data collected from 1887 to 1986 from Agarwan and Gort (2001) also showed that big firms are also more eager to transfer their technology to small firms, which in turn will lower the latter set up cost.

118 This is called "incomplete contract" in game theory. See Baird, Gertner and Picker (1994): 112-16.

119 *Id*: 109.

120 *Id.* In *The Nature of the Firm*, Coase (1937): 394-95 also noted that firm exists because individuals want to reduce transactions costs in co-operation. However, when the size of the firm gets larger, transactions costs might increase, and hence there might be a tendency either to outsource or to spin-off.

(2) Threat-focused approach

In the opportunity-focused approach, the standard users gain benefit directly from co-operative efforts, so are the entrants, although the distribution of benefits between them might not be equal.[121] In the threat-focused approach, firms support one common standard against the threat from rival standards, and at the same time compete with each other in downstream markets and gain benefits (indirectly) from there. The support of Linux standards from many companies as noted in 4.1(a) is an example of the threat-focused approach. Here firms are willing to invest in developing the standard because the *threat* of abandoning the standard is high. In the case of Linux these threats are:

- The threat from rival standards - Microsoft Windows.[122] It is clear to IBM or Sun that unless they co-operate to support a common standard, they may not compete with Microsoft. This scenario is similar to the *battle of the sexes* game, in which players find a better payoff by co-operation than non co-operation.[123]

- The threat from the rivals' end products, which are superior than Linux-based products because of a better platform e.g., Windows XP;

- The potential loss of sunk cost and switching costs if Linux-based operating systems were defeated and firms have to adopt other standards;[124] and

- The "durable good" threat. Unlike physical machines, software products are not amortised by usage. Therefore, consumers will not replace old software products unless the new ones are much improved. For so doing, the underlying platform (i.e., the common operation system) should also be improved.

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121 Stigler (1974).

122 Because of the popularity in Windows (95 percent of desktop market and 40 percent of server markets), the only way that IBM or Sun Microsystems could compete with Microsoft is to join force. Linux could be an ideal meeting point. The standard is opened, based on Unix technology, closed to Sun's Solaris and IBM's OS/2. Without the threat from Microsoft, Sun would support Solaris and IBM would support OS/2. See Lohr, S.: "Sun, Again, Bets against the Odds" *NY Times* 23 Feb. 03.

123 Baird, Gertner and Picker (1994): 42.

124 See McFadden and Peltzman (1987). It is similar to the sunk cost fallacy of the runner-up bidder in the dollar auction game at 2.3(c) above.

These threats could be applied *mutatis muntandis* in our hypothesis (access to standard). Moreover, the incumbent still holds copyright of the standard and may refuse licensing where the entrants are appeared to be mere free riders. This could be another credible threat for the entrants.

Appendix 6 showed that the trend toward R&D co-operation is clear in the 1990s. The assumption that a single innovator will earn all profits is no longer true for many reasons. They include: (1) high mobility of labour markets, (2) difficulties of attracting R&D loan or R&D venture capital, (3) complexity of innovation, (4) spin-off.[125] Even large companies such as Intel and IBM are now outsourcing or entering co-operation with outsiders in many of its projects.[126] OECD (2002: 106) observed that R&D co-operation nowadays is more likely than it was before 1990. Appendix 6 also showed that the co-operation trend is increasing, especially for pooling data (information retrieval). The assumption that co-operation is hard to achieve because people tend to free ride each other need to be revised.

(3) Tendency toward oligopolistic markets

All stakeholders - the incumbent and the entrants can react on threats or on opportunities by forming co-operation. However, they do not react to the same extent. Appendices 7 and 8 showed that larger stakeholders (e.g., firms that have large market share) would keenly target the threat/opportunity more than smaller stakeholders do. Hence, they could be willing to improve the common more than others could.[127] However, they are subject to the constraints that if they improve the platform and share the improvement with others, other members may benefit more than they do. To avoid that risk, larger stakeholders may call other stakeholders to join in a common effort to innovate the platform. Those who do not join might be excluded from the benefits of innovation.[128] In the end, an open standard (public good) could end up as semi-open standard (club good - to

125 OECD(2002a): 106-08.

126 *Id.*: 109 and 111.

127 Stigler (1974), Lenway and Rehbein (1991), Mueller and Geithman (1991).

128 Heide, Dutta and Bergen (1998).

be opened for the member of a certain group).[129] Cornes and Sandler (1996: 545-47) observed that a club could be effective if the members are homogenous, and the stability of the club depends on whether a core (common threat or common interests) exists. When club members co-operate with each other, there might be a risk of collusion.[130] Therefore, the antitrust authority should not stop monitoring the conduct between the incumbent and the entrants even when they have agreed on the access term.

b. Innovation by Competition

The threat-focused co-operation model is very close to the strategy of innovation through competition. It means firms will compete in downstream markets but at the same time share the same platform. The mixture of co-operation and competition is also called *co-opetition*.[131] This approach is practical when full co-operation is not necessary or could not be achieved, because the common interest is weak, or because the common threat could be dealt with without co-operation, and/or because transaction costs are too high.[132]

The GNU Public License (GPL) and Linux standards, again, could be used as an example of co-opetition. Small firms, who have a limited consumer base, may hope to use GPL to expand their network externality. Their strategy is to improve the standard and diffuse it to other users. Large firms also have interests in developing the standards, but they may prefer to keep their development closed.[133] Many firms adopt a hybrid approach – i.e., they provide basic technology free of charge. Upgrade and services will be chargeable unless the users agree to cross-license.[134]

Just a few years ago many people were still sceptical about the capacity of GPL to spur competition. However, when some firms have chosen the strategy to compete, innovate and

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129 Cornes and Sandler (1996): 353-57.

130 Gilbert and Vives (1986).

131 Shapiro and Varian (1999): 228.

132 See the conditions of successful co-operation in 3.3(a)(i).

133 Aigrain, P. (2002).

134 See the example of MySQL in 3.1(a) above.

have succeeded, other firms have quickly followed. This fact showed that not only free riding could become (negative) collective action, but competition and innovation could also become (positive) collective action. Simon (1955) noted that people are bounded rational and eager to follow trend, hence stimulating innovation through competition is even easier than through co-operation. An example is the R&D competition race to gain monopoly in the downstream market. Appendix 1 showed that the number of software patent (indicating R&D concentration) increased by nearly six times during the 1990s, and business method patents have increased seven times. Hence, we need to stimulate R&D is some successful "show cases" and a competition-friendly environment. That is: low barriers to entry, low barriers to exit and adequate intellectual property protection in downstream markets.[135]

The GPL was so far successful in lowering the barriers to entry and to exit through an open standard. However, the open standard approach does not totally exclude free riders. This solution concept is built under a belief that free riders will always stay behind innovators, and the market is large enough so that all firms can find their niches. As consumers' utilities for one type of product or service are not homogenous, free riders may only dominate the market of low valuers, but innovators will dominate the market of high valuers.[136] If the number of high valuers is large enough, firms will innovate notwithstanding the fact that free riding still exists and may become a collective action.

The above argument is not complete. According to Ulen (1999: 810-11), labour experiment studies showed that people have a stronger sense of fairness than rational choice theory predicts. It is doubtful whether the open standard approach is enough to stimulate innovation through competition in the end. For the time being, firms see adopting the Linux standard as the only strategy to prevent Microsoft's penetration. When they all focus on one "big" problem, free riding is considered "small" problem, especially when this "small" problem could be offset by positive network externality. Having said that, it does not mean that a small problem will never become a big one. Therefore we always have to come back to the first question: assessing the risk of free-riding (see 4.1) to check if competition in an open standard market is sustainable.

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135 For statistic data on the development of Linux, see OECD (2002b): 227-32.

136 Takeyama (1997 and 2002) and Scorba (2002).

SUMMARY AND RECOMMENDATIONS

The key issue in sunk cost and free riding concern is risk assessment. Since information about risk is uncertain, we need to approach it through probability (Bayes Rule). However, Bayes Rule must go hand in hand with statistics, otherwise the result is unconvincing. Apart from game models, this paper has been benefited from recent statistics regarding R&D investment, the trend of co-operation and the risk of free riding from OECD, BSA or private survey in the Napster litigation. It is hoped that future economic studies on copyright should make the best use of statistic data to prove pre-existed theories. For both sunk costs and free riding concerns, game theory and experimental studies are useful tools to predict whether (a) the concerns are justifiable, and (b) court intervention is necessary or effective.

So far, game models and data shows that the reality of R&D is now changed from what we assumed about them in the past. R&D is retarded rather by the lack of consumer demand than by the risk of free riding or the size of "sunk" costs. The differentiation of expectation judgement among users with respect to innovation have created the difference between innovation and non-innovation markets . This taxonomy follows the mainstream of taxonomies in previous studies, such as "high-quality users/low-quality users" by Takeyama (2002), "quality differentiation" by Scorba (2002), or "high-valuing users/low-valuing users" by Bakos, Brynjoffson and Lichtman (1999). It is time now considering changing basic assumptions about sunk costs and free riding that they are the main risks for all markets that involve intellectual property rights. In particular:

(1) To recover sunk costs: it is necessary to redefine what are sunk costs, reconsider assumptions about sunk costs, differentiate *ex post* and *ex ante* sunk costs (because the legitimacy to recover sunk costs in each case is different), identify the circumstances in which sunk costs could be recovered without exclusive rights. Thereafter, we may consider *ex lege* sunk cost recovery methods, either bottom-up or top-down – not for the sake of exactness but of transparency.

(2) To prevent free riding: it is necessary to assess the risk that free riding could become a collective action, through comparing the cost/benefit of innovation versus the cost/benefit of free riding and classify the product market

accordingly. If the risk of collective action is real, the incumbent may limit the number of entrants and impose access fees. When there is a demand for continuous innovation or improvement for the standard, it is necessary to assess whether that objective could be achieved by competition or co-operation. If the latter is required, the incumbent should be allowed to limit the number of entrants so that he could monitor their free riding/co-operation conducts. In any event, the solution to the free riding problem could only come after the incumbent's sunk cost has been recovered and will surely be recovered.

The checklist questionnaire that a court should ask in order to verify to incumbent's justifications could be as follows:

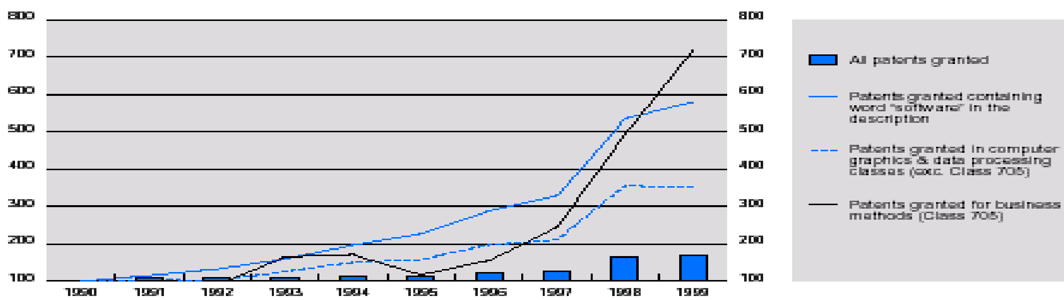
- Has the incumbent recovered its *ex post*/*ex ante* sunk costs? Is it necessary to recover *ex ante* sunk cost? How much is the demand for future R&D with respect to the standard, and how much risky is R&D activity in the market?

- Is the market concerned a non-innovation market or an innovation one? How high is the risk that free riding may become a collective action? Is there a demand for continuous innovation with respect to the standard? If so, is it necessary to ensure co-operation between the entrants and the incumbent or innovation could sustain by itself by competition?

APPENDICES

Appendix 1:

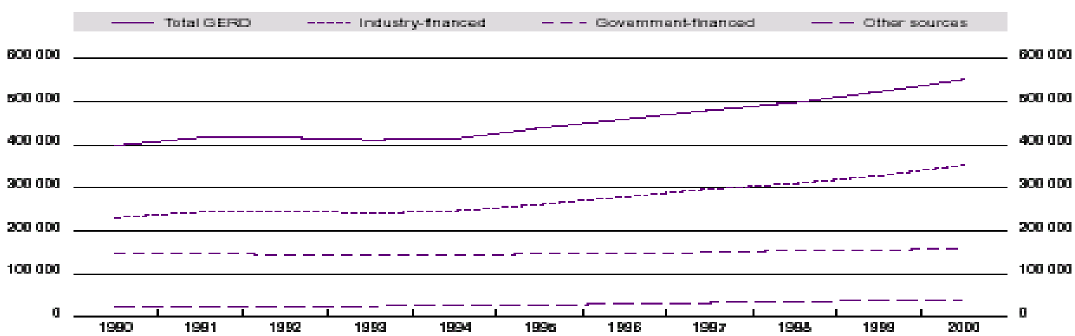
Figure 3. Patents granted in the United States, 1990-99
Index 1990 = 100



Note: US Patent Class 705 is also known as "business methods". USPTO patent counts by class only take into account the original classification of each patent in order to avoid double counting. These patent counts cover all patent documents, including utility, design, plant and reissue patents, as well as statutory invention registrations and defensive publications.
Source: US Patent and Trademark Office (USPTO), "Patent Counts by Class by Year: January 1977-December 1999" (April 2000); and USPTO Full Text Database for number of patents with the word "software" in the description.

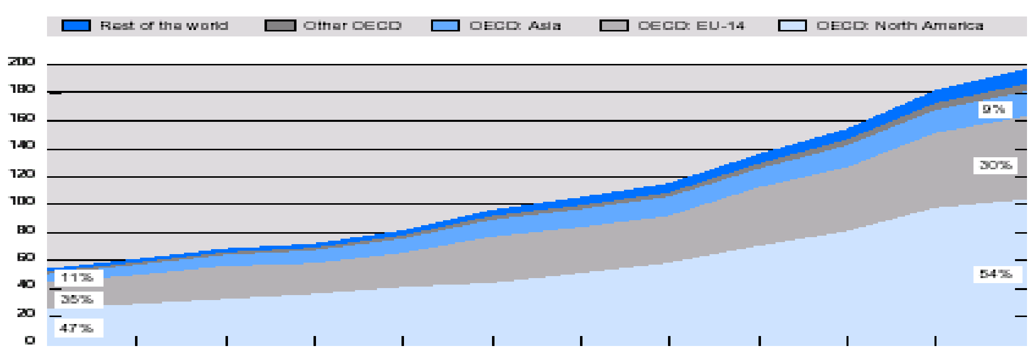
Appendix 2:

Figure 3.1. Gross expenditures on R&D in the OECD region, 1990-2000
Millions of constant 1995 PPP dollars



Appendix 3:

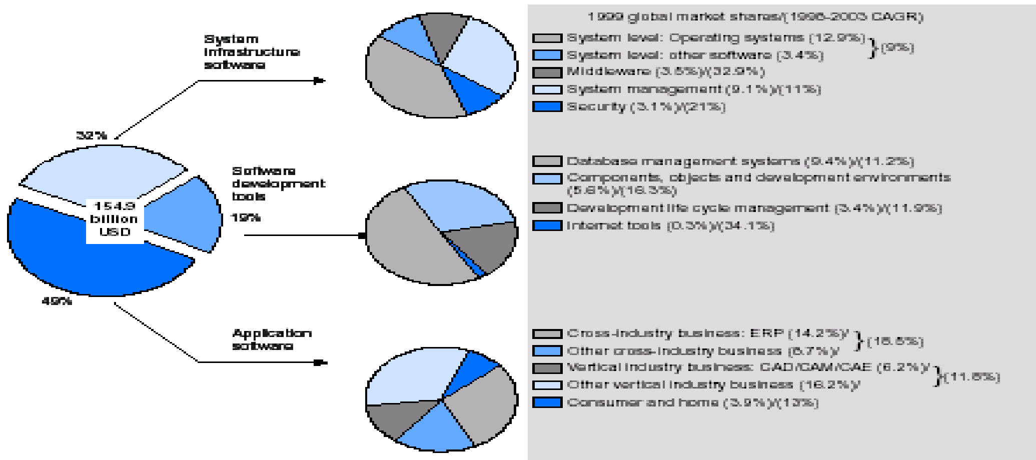
Figure 5. Geographical breakdown of packaged software markets, 1990-2001
Billion current USD



Note: OECD North America includes Canada, Mexico and United States. OECD Asia includes Australia, Japan, Korea and New Zealand. Other OECD include the Czech Republic, Hungary, Norway, Poland, the Slovak Republic, Switzerland and Turkey.
Source: OECD, based on data from WITSA/IDC.

Appendix 4:

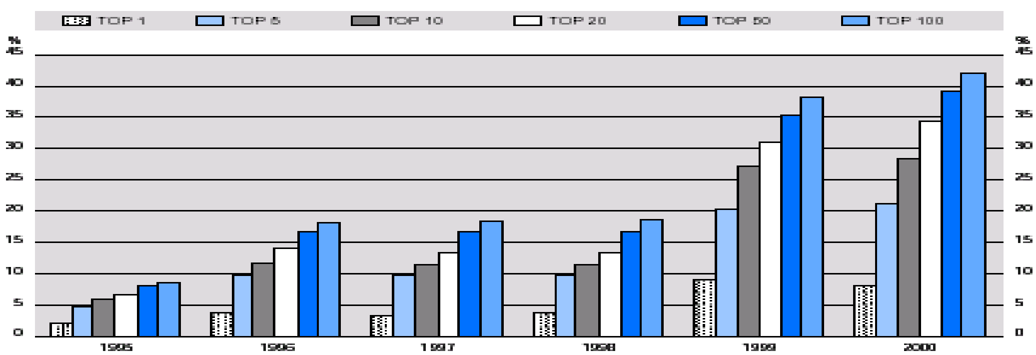
Figure 7. World packaged software market by segments, 1999



Note: Estimated market shares based on data from IDC.
Source: OECD, based on IDC and US Department of Commerce, 2000*b*.

Appendix 5:

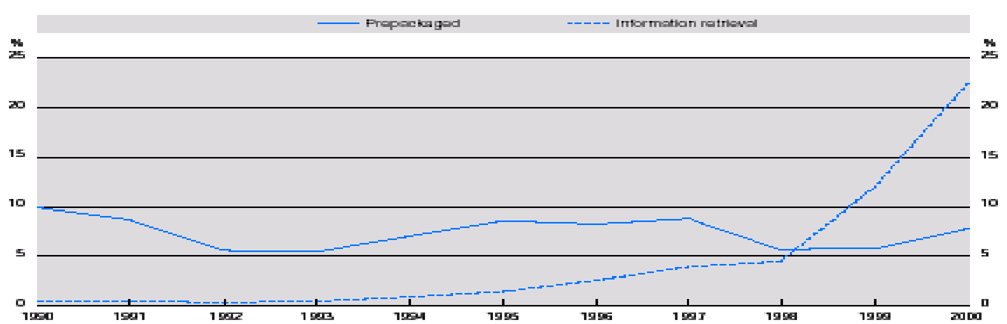
Figure 11. Share of top software and services vendors on world markets, 1995-2000



Note: Break in series in 1999. Software and services revenues until 1998 only include license fees and revenues from product maintenance and support. Revenue from professional services/consulting, custom programming, training and hardware sales was excluded. In 1999, revenue from training and software-related services was added.
Source: OECD, based on data from *Software Magazine* and WITSA/IDC.

Appendix 6:

Figure 9. Share of selected software-related strategic alliances in all announced alliances, 1990-2000



Note: The selected software-related strategic alliances comprise those mainly concerned with packaged software (US SIC 7372) or information retrieval services (US SIC 7375).
Source: OECD, based on Thomson Financial.

Appendix 7:

Table 2. Leading vendors worldwide by license and service revenues, 1999

Top ten by software license			Top ten by service revenue		
1999 overall ranking	Company	License revenue (USD millions)	1999 overall ranking	Company	Service revenue (USD millions)
2	Microsoft Corp.	21 591	1	IBM Corp.	32 200
1	IBM Corp.	12 700	3	PricewaterhouseCoopers	17 300
8	Computer Associates International Inc.	4 962	5	Andersen Consulting LLP	8 941
4	Oracle Corp.	3 873	7	Compaq Computer Corp.	6 623
6	Hewlett-Packard Company	2 542	6	Hewlett-Packard Company	6 192
10	SAP AG	1 946	4	Oracle Corp.	5 455
11	Sun Microsystems Inc.	1 302	10	SAP AG	3 125
20	Unisys Corp.	1 207	12	Bull Worldwide Information Systems	2 790
7	Compaq Computer Corp.	1 156	14	Ernst and Young LLP	2 000
19	Novell Inc.	1 092	11	Sun Microsystems Inc.	1 935
	Top ten total	52 371		Top ten total	86 562

Note: Software license revenue estimates provided by IDC for Hewlett-Packard Company, Unisys Corp. and Compaq Computer Corp.
Source: *Software Magazine*, 2000.

Appendix 8:

Annex Table 3.9. Number of patents granted to major software vendors in the United States which include the word "software" in the description, 1999

	IBM	Hitachi	HP	Sun	Microsoft	Compaq	Unisys	Oracle	EMC	Novell
"Software" in the description	1 036	210	284	339	227	166	46	76	29	46
All US patents granted to firm	2 756	1 008	850	560	352	251	91	85	68	54
Patents including "software" in the description as a percentage of all US patents granted to firm	38%	21%	33%	61%	64%	66%	51%	89%	43%	85%

Source: USPTO Full Text Database for number of patents with the word "software" in the description. Total number of patents granted to each company in 1999 has been taken from US PTO "Patenting by Organizations 1999" (April 2000). These databases include information on all patent documents including utility, design, plant and reissue patents, as well as statutory invention registrations and defensive publications.

Appendix 9:

Annex Table 3.15. Changes in product leadership in PC software, 1974-97

		Introduction date	Leadership start date[1]	Years to leadership	Years spent as leader
Word processors (1979-97)					
MicroPro	WordStar (8-bit)	1979	1980	1	7
WordPerfect Corp.	WordPerfect (16-bit)[2]	1980	1987	7	6
Microsoft	MS Word (32-bit)	1983	1993	10	5+
Spreadsheets (1979-97)					
Personal Software[3]	VisiCalc	1979	1979	0	5
Lotus Corp[4]	Lotus 1-2-3	1983	1984	1	9
Microsoft	MS Excel	1985	1993	8	5+
Database (1981-97)					
Ashton-Tate[5]	DBASE	1981	1981	0	12
Borland[6]	Paradox	1985	1993	8	1
Microsoft	MS Access	1992	1994	2	4+
Personal finance (1985, 1989-97)					
MECA Software[7]	Managing Your Money	1984	n.a.	n.a.	n.a.
Monogram	Dollars and Sense	1983	n.a.	n.a.	n.a.
Intuit[8]	Quicken	1984	±1987	3+	11+
Operating systems (1977-97)					
Digital Research	CP/M (8-bit)[9]	1974	1977	n.a.	7
Microsoft	MS-DOS/PC-DOS (16-bit)	1981	1984	3	9
Microsoft	Windows (16-bit)	1985	1993	8	3
Microsoft	Windows 95 (32-bit)	1995	1996	1	2+

1. A category leader is defined as the product with the highest share of shipments and at least 25% market share (see source).
2. WordPerfect was released for Data General minicomputers in 1980 and for Windows in 1987.
3. VisiCorp (former Personal Software, publishers of VisiCalc) sued Software Arts (writers of the programme) in 1983, and a settlement was later reached. Software Arts was sold to Lotus Development Corp in 1985, which decided not to continue publishing VisiCalc. (www.bricklin.com/history).
4. Lotus was acquired by IBM in 1995 (www.lotus.com and www.ibm.com).
5. Excel was released for Macintosh in 1985 and for Windows in 1987.
6. Dbase is currently published by dBase.Inc (See www.borland.com and www.dbase.com).
7. www.borland.com.
8. US competition authorities blocked the merger between Intuit and Microsoft in 1995.
9. CP/M was developed around 1974, but its first major OEM (original equipment manufacturing) deals were in 1977.

Source: D. S. Evans, A. L. Nichols and B. J. Reddy (1999), "The Rise And Fall Of Leaders In Personal Computer Software", mimeo, National Economic Research Associates Inc., January (based on data from International Data Corporation and press releases), plus information from several company Web sites.

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