Review of Economic Research on Copyright Issues, 2004, vol. 1(2), pp. 29-53

SUNK COSTS, FREE-RIDING JUSTIFICATIONS, AND COMPULSORY LICENSING OF INTERFACES

NET LE

Abstract. This paper addresses two popular arguments against a compulsory license of software interface, using risk analysis methodology. These concerns are the non-recovery of sunk costs and the threats posed by free riders. My argument is that while both concerns are legitimate, they are remediable. The purpose of the law is not to allow the incumbent to recover its "sunk costs", but to give sufficient incentives for it to innovate. These two incentives are the monetary incentives (finding fair access fees and stimulating cooperation with the entrants after the license) and the time incentive (finding a period during which refusal to license is acceptable). With respect to the fair amount of access fees, it is better to provide a mechanism so that the licensor and the licensee can negotiate the fees themselves, rather than to impose a strict method of fee calculation. If the monetary incentives alone are sufficient to generate motivation for innovation, the time incentive should not be used.

"[There is] no benefit (yet potentially substantial costs) in perpetuating protection beyond [what is] necessary to recoup the fixed costs of creating the work. After that, it is fine to dump the copyrighted work into the public domain."
Landes and Posner (1989: p. 362).

1. Introduction

This article analyses two concerns that oppose compulsory licensing of a software interface, namely the non-recovery of sunk costs and free riding.

To illustrate, one could take the antitrust case against Microsoft before the European Commission. Two conflicting arguments are presented by the Commission Decision (the "Decision")[1] and Microsoft's defence in the press release dated 21 April 2004 (the "Release").[2] One of the two issues of the Decision is that Microsoft has abused a dominant position by creating interoperability between its product (the Windows desktop operating system) and rival products (server operating systems, such as Novell's Netware and the Linux Server). The core to the problem is that Microsoft has refused to give the rivals full access to the Windows application program interfaces (APIs). To create a workable competitive environment in the market for server operating systems, the Commission ordered Microsoft to license these APIs to competitors.

[1] Commission Decision of 24 March 2004 relating to a proceeding under Article 82 of the EC Treaty (Case COMP/C-3/37.792 Microsoft), C(2004)900 final (21 April 2004).

[2] http://download.microsoft.com/download/5/2/7/52794f65-8784-43cf-8651-c7d9e7d34f90/Comment% 20on%20EC%20%20Microsoft%20Decision.pdf.

Against the Commission's Decision, Microsoft argued that the APIs have crystallised its heavy investment in research and development (R&D), to be protected not only by copyright but also by many associated patents (Release, pp. 2-3). Had the APIs been free for the taking, Microsoft would not be able to recover the sunk costs it incurred while developing these APIs. Moreover, a compulsory licensing regime will encourage free riders, who do not innovate, but rather wait for other firms to innovate first, and then petition for a compulsory license.

The two concerns – the non-recovery of sunk costs and free riding will now be analysed via four questions:

1. Are there other justifications for refusal to license the APIs, apart from sunk costs and free riding (section 1)?
2. For how long should the incumbent be allowed to refuse to license the APIs (section 2)?
3. If the risks of sunk costs and free riding can be recovered by monetary payment, how high would the API access fee be (section 3)?
4. Can we provide sufficient incentives in the aftermath of compulsory licensing, so that the incumbent and the entrant can continue innovating (section 4)?

The analysis of the API license is about the aftermath: what the entrant will do after obtaining the license, and what the incumbent will do in response to the entrant's strategy. To understand these effects, we must have some means of predicting behaviour using game theory. Game theory posits that, regardless of how people go about making decisions, the actions they take are consistent with a few basic principles. According to the principle of strictly dominant strategies, a player will choose an action if that action leaves him better off than any other action would, regardless of what other players do (see e.g., Baird et al., 1994, p. 271). Our task is to design the law so that when the incumbent and the entrant play their dominant strategies and reach the Nash equilibrium, the outcome will be that the players will innovate and the consumers will benefit.

The impact of free riding on the incumbent's business is not the same at all times. It is better to deal with such a complex issue step-by-step: firstly the recovery of sunk costs, and later the prevention of free riding. Westkamp (2001) demonstrates that when sunk costs are recovered, the incumbent is not in a less advantaged position than the entrants. As he could compete with the entrants on a level playing field, the free riding risks would concern him less than if he needed to deal with both risks at the same time. What is more, usually the issue of free riding arises when the free riders take advantage of the incumbent's sunk costs (see e.g., Whish, 2001, p. 544). When the entrants share the R&D costs with the incumbent, they are no longer free riders. Landes and Posner (1989, p. 346) also note that "accidental/necessary copy does not involve free riding."

2. Preliminary Issues of Sunk Costs and Free Riding

Before analysing the risks of sunk costs and free riding, one could ask:

1. are they the only justifications possible for refusal to license an API?
2. when do they become relevant?

With respect to the first question, section 2.1 below argues that sunk costs and free riding are not only the common justifications, but also the only ones that could possibly be accepted for raising switching costs. Other arguments lack either a legal or an economic basis to become a serious challenge to API compulsory licensing. The second question is discussed in section 2.2.

2.1. **Justifications for refusal to license an API.** The first justification for refusal to license is that lock-in, bundling and refusal to license will enhance efficiency. The price of products sold in bundles could be lower than if sold as individual products. There is also a potential of combining complementary R&D assets, in such a way as to make successful innovation more likely, to bring it about sooner, or to reduce R&D costs.[3] However, even if this argument is true, using it to justify the refusal to license is irrelevant. The law does not prohibit the incumbent from exploiting market integration, including bundling, as long as the consumer has freedom of choice (*Microsoft Europe*, Decision dated 21 March 2004, Article 4).

The second justification for refusal to license is that the incumbent should recover not only the sunk costs but also the opportunity costs of a 'once-in-a-lifetime' success. Sutton (1998, p. 227) criticises that a grant of API access would give the entrants an opportunity to gain access to market(s) that they otherwise would not have.[4] In this vein, the incumbent should be entitled to charge the entrants a premium in exchange for the trading right. This argument also lacks a supportive legal basis. The incumbent has no vested power to grant a trading right, which is the power of the state;[5] and the State's obligation is not to give a 'once in a lifetime' opportunity to the incumbent, but to provide a sufficient innovation incentive.[6]

Invoking a 'once-in-a-lifetime' success is similar to alleging that "we used to have monopoly power, and it is unfair that after licensing the entrant we need to compete with rival products." To this argument, AG Tizzano notes in the *IMS* opinion that even if a product competes with another that is protected by intellectual property, the court would still support it, as far as it responds to a specific demand that the incumbent did not satisfy (paragraph 62).

The third justification is that the detriment to consumers caused by a refusal to license an API will be offset by the benefit the incumbent will provide for consumers. After bundling Internet Explorer with Windows, Microsoft has raised both costs and benefits to consumers. However, the 'offset' argument by itself does not show that the consumers should necessarily suffer the detriment. This argument must be combined with a proof that the risks of sunk costs are so high that the incumbent needs monopoly profits to recover them.

Jorde and Teece (1992, p. 47) offered a fourth justification, that the high price under monopoly is an incentive to spur innovation in a contestable market. However, if that were the case, innovative and low-priced office package software from

---

[3] Evans, Nichols and Schmalensee (2001, p. 120)

[4] Paying a premium for a commercial right is a common practice in the markets for taxicab (medallions), telephone (spectrum) or oil and gas; see Viscusi et al. (2001, pp. 465-93, 520-25, 620-31).

[5] In *Victoria Park Racing v Taylors* [1937] 58 CLR 479, the defendant had 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." Later, the High Court of Australia rejected this decision, saying that there was no property right in the viewing of a spectacle.

[6] I am indebted to Professor Dany Quah for this suggestion. Moreover, the incumbent's success is a combination of many factors, not only the incumbent's innovation but also the consumer's participation. Therefore granting the incumbent a exclusive right to exploit a "once in a lifetime" opportunity on the sole grounds that "it was theirs" is inadequate. See Warren-Boulton and Baseman (1995).

IBM or Sun would have taken over Microsoft's Windows platform on desktop PCs. This argument has not taken into account the costs incurred by consumers in relation with the incumbent's products, such as the files stored in a particular format or a software program that only runs on a particular operating system. These are switching costs, to be 'sunk' when the consumer switches from the incumbent's product to the entrant's product (see Klemperer, 1987). The problem of switching costs explains why the idea of contestable markets does not reflect competition on the digital environment. On the other hand, granting access to APIs would allow consumers to reuse the capital they have invested in the incumbent's product. For example, the user of a networked PC who bought a Windows desktop OS would not have to abandon this OS in order to enjoy all the benefit provided by a Linux server OS.

2.2. **Market taxonomy and the incumbent's risks.** Given that sunk costs and free riding could be risks that justify a refusal to license, the next question is when they become relevant arguments. To answer this question we need to assess the risks in a specific market.[7] If the risks of sunk costs and free riding in a market are small, copyright protection should not be used as a shield against competition law. In a non-innovative market, the demand for innovation is low by definition, and so are the R&D costs and the risk of sunk costs from R&D. In innovative markets, the demand for innovation is high, and so are the risks of R&D sunk costs.

With respect to the risk of free riding, it will depend on the motivation for innovation. The relevant question is: how probable is it that the incumbent will be less innovative because of the entrant's free riding? If innovation is purely profit-driven, then the impact of free riding on innovation will depend on whether the incumbent competed with the entrant. In *Magill* (1995, ECR I-743), the incumbent is active in the upstream market (broadcasting services) and the entrant is active in the downstream market (television program guide).[8] Even if the entrant could 'free ride' on the incumbent's effort, this behaviour does not affect the incentives to innovate. As the incumbent must produce television programs in any event as a by-product, the impact of free riding may be low. In *IMS* (COMP D3/ 38.044: 120 and 128) however, the incumbent and the entrant are competing in the same market, and therefore the impact of free riding is higher than in *Magill*.[9] Thus, the taxonomy between competition and non-competition relationships could be helpful in assessing the risks of free riding.

When markets are so subdivided, case studies involving refusal to license in Europe and the US can be allocated as shown in Figure 1 below. If the incumbent is competing with the entrant in an innovative market, the risks of sunk costs and

[7]Risk is a priority in the author's view. Cornish (1996, p. 320) says: "the very purpose of copyright protection is to allow recoupment for the initiative of creating the work and the investment risked in producing and marketing it."

[8]Three broadcasters (RTE, ITV and BBC) held copyright in their television listings. They used this right to refuse to license Magill (a publisher) to produce combined listings in one television guide.

[9]IMS Health (the incumbent) is a pharmaceutical database company. It holds copyright in a specific data format that later became 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. The case was ultimately solved under the judgement dated 29 April of the European Court of Justice, but the result was not conclusive.

free riding will be high. The API's control is the motivation of innovation, which otherwise can be endangered by free riders. If the incumbent does not compete with the entrant, free riding should be less worrying. Similarly, the impact of free riding and sunk costs on the incumbent's incentives to innovate could be lower if the market involved is non-innovative. One could therefore identify the incumbents who have a legitimate concern about the risks of sunk costs and free riding from those who only make a 'me too' argument. To focus, we will only analyse the markets where the risks of sunk costs and free riding are high: the incumbent competes with the entrant in the innovative markets. If the risks of sunk costs and free riding can be minimised in these circumstances, they can also be minimised in easier circumstances. This taxonomy is subject to an exception. If free riding directly affects the incumbent's motivation to innovate, then the risk of negative impact from free riding is high regardless of whether the incumbent competes with the entrant or not. A good example of this situation is *British Horseracing v William Hill* (2001, ECLR 257).[10]

		Risks of sunk costs	
		Innovative markets	Non-innovative markets
Risks of free riding	Competing	*US v Microsoft* (re Web browser) *Sun v Microsoft* (re Java) *Microsoft Europe*	*IMS Health v Commission* *Kodak v Technical Image Services* *Commercial Solvents*
	Non-competing	*Intel v Intergraph*	*Magill*

Figure 1. Market structure and the dual risks

After narrowing the scope of analysis to relevant situations, the next issue is to identify a measure that commensurates the risks. A refusal to license would be an extreme solution if the entrants are ready to pay the incumbent for the latter's R&D investment. Hence, the question of innovation is not only whether the incumbent should have the right to refuse to license (a time incentive), but also the price charged to the entrant for the API license (monetary incentives). If the R&D costs can be compensated by money, arguing about the right to refuse licensing is an over-reaction.

2.3. **The monetary incentives.** Regarding the monetary incentives, a reasonable access price could be set through negotiation. However, if the incumbent is a monopolist, how can such a negotiation result in a fair price? Here I present two possible methods for tackling the monopoly problem: either to recognise this market failure as a fact and call on the government to set the price (top-down approach,

[10]See Phillips and Firth (2001, p. 362). William Hill (WH) accessed a database developed by the British Horseracing Board (BHB) as part of its betting business, and was sued for infringement of database rights. WH alleged, among other things, that it had not 'free ridden' BHB's effort, as access to the database is freely available on the Internet. Judge Laddie rejected this argument, holding that the information extracted by WH was the most valuable part of BHB's database. The case refers to the ECJ for interpretation of the Database Directive 96/9/EC. Setting aside the technical parts, there is a policy behind the judgement, which is to provide an incentive to invest in the database; and the words 'incentives' bear a broader meaning than just profits.

so-called Pigouvian taxation), or to reduce the monopoly power of the incumbent by negotiation (bottom-up approach). At this stage, the preliminary questions are:

1. which approach will take priority, top-down or bottom-up?
2. who are the players and what is the nature of the API pricing game?

Concerning the first question, a top-down decision, however 'fair' and 'exact,' would face a risk of arbitrariness. Consequently, either the incumbent or the entrant will be dissatisfied. Phillips and Firth (2001, p. 28) emphasize: "if [a fair royalty] cannot be easily found, then the expense of referral of the matter to an arbitral body, and the resulting uncertainty, may detract from the advantages of the compulsory license system." At the international level, it is also unclear who is competent to measure a 'fair remuneration'. Alternatively, a bottom-up approach is based on voluntary actions, and therefore is more sustainable. Coase (1960, p. 14) also argued that the bottom-up approach is more efficient than the top-down one: "the problem in dealing with actions which have harmful effects is not simply one of restraining those responsible for them. What has to be decided is whether the gain from preventing the harm is greater than the loss which would be sufferred elsewhere as a result of the stoppingthe action." Our proposal for the monetary incentive is therefore limited to the bottom-up approach only.[11]

Concerning the second question, there are three players in the game of bargaining for a standard access price: the incumbent, the entrant and the consumer. As the incumbent wants the highest access price possible and the entrant wants the lowest access price possible, the latter may not want to reveal to the incumbent how much he values API access (see e.g., Baird et al., 1994, p. 122). If the incumbent charges a high API license fee to the entrant, the latter will likely pass the burden on the consumers, who will ultimately suffer detriment. Our objective is to protect the consumer by turning a non-cooperative game into a cooperative one, so that the parties will end up with a fair deal.

2.4. **The time incentive.** Consideration of the time incentive would be appropriate when the monetary incentives cannot prevent the risks of sunk costs and free riding, to the extent that they may affect the incumbent's incentives to innovate. However, this time incentive should not be excessively long. It should end when the incumbent's sale revenue has offset the R&D costs.[12] Timing is important to protect the consumers from suffering high switching costs (see section 1.1 above). On the one hand, if access to a standard were granted too early, the sunk cost would not be recovered. On the other hand, a consumer's switching costs can increase if API access is not granted. Therefore, the issue is not whether the incumbent

[11]To avoid repetition without contribution, top-down calculation of access fee will not be analysed in this thesis. Regarding the pricing methods in the field of communication technology, see the 15 pricing factors set forth in *Georgia Pacific Corp. v US Plywood Corp.* (1970) 318 F. Supp. 1116-20, including previous royalty rates by the rightholder, previous royalty rates by licensee/infringer, profitability of the product, availability of other, substitute technology, industry custom and average rates. See also Black (2002, p. 113) for the FCC's 1983 Access Charge Rules in US law, Anderman (1998, p. 219) for the OFTEL Regulation of Conditional Access for Digital Television Services in UK law, and Larouche (2000, p. 235-237) for EC law.

[12]In *Aer Lingus/British Midland Airways OJ* [1992] L96/34, the Commission only required Aer Lingus to interline with BMI for two years, which was sufficient to facilitate BMI to recover its initial investment, increase its quality to compete with Aer Lingus, in a market where switching costs are low (consumers do not incur many indirect costs while switching from one airline to another). However, the method to prove the two year period remains controversial. See also Anderman (1998, p. 201).

should have the right to refuse to license because the sunk costs are too high, but when or if these costs are recovered.

3. Implementation of The Time Incentive

3.1. **Rethinking the common assumptions of sunk costs.** As noted above, the question is how long can the incumbent refuse to license an API? The answer depends on the necessity of the incentive. Before discussing the issue of when the time incentive is necessary to recover the R&D sunk costs, three common assumptions about sunk costs that might exaggerate the risks should be highlighted. These assumptions are:

1. the exclusive right to refuse to license is the only method to recover sunk costs,
2. R&D costs are always sunk costs, and
3. it is impossible to calculate sunk costs.

3.1.1. *Assumption 1: refusal to license is the only method to recover sunk costs.* The first assumption is based on the hypothesis that if a R&D project fails, all R&D expenditure will be wasted, similar to an unsuccessful investment in tangible assets. This assessment is not correct. Cooter and Ulen (1997, p. 40) note that R&D expenditure on knowledge and experience is not completely wasted. At the very least, the innovators could recover the sunk costs in R&D failure indirectly through learning by doing, where the failure in the first project is the origin of the success in the next project.[13] The second indirect method to recover sunk cost is knowledge reuse.[14] In addition, a specific way to join R&D forces is by transferring the R&D results or being acquired by larger companies.[15] Learning by doing and knowledge reuse are the safety net for the incumbent to recover the sunk costs. They can partly remedy the risks that the time incentive might have been finished 'too early'.

3.1.2. *Assumption 2: R&D costs are always sunk costs.* Many economists, such as Stiglitz (1997, p. 125), Sutton (1998), Pindyck and Rubinfeld (2001, p. 208) assume that all R&D costs are prima facie sunk costs. This assumption can be oversimplistic. If someone knows a cost is 'sunk' in advance, why would he incur it? In the previous sub-paragraph, we have listed two instances where R&D expenditure is recovered, and they are not the only ones. According to Pindyck and Rubinfeld (2001, p. 204), sunk costs are the costs that a firm cannot recover should it exit the market, not the R&D costs as such. Even saying that sunk costs are the costs of exit is not entirely correct. In general, all costs, sunk or otherwise, in the end should

[13]See Ichbiah and Knepper (1991, pp. 97-100) on the failure of Microsoft in the VisiCalc project.

[14]See the 1995 Antitrust Guidelines for the Licensing of Intellectual Property, issued by the US Department of Justice and the Federal Trade Commission ("IP Guidelines"), sec. 3.2.2. Sutton (1991, p. 320) and Sutton (1998, p. 345 and p. 387), through the competition in the computer industry on the IBM 360 standard and its aftermath, observe that the best strategy to compete with a proprietary network is to join a open network. The purpose is to improve the network until the open network could outperform the proprietary network. OECD data (2002a) indicated that software is the particular sector that attracts most strategic alliance to share or recover R&D expenditure.

[15]E.g., the acquisition by Microsoft of Connectix in 2002, the main motivation for which was to acquire Connectix's technology in Virtual PC, a program that allowed Mac users to use Microsoft's software, see: http://www.connectix.com, last accessed 28 April, 2003.

be met by quality improvement, cost reduction or an increase in sales revenue. The incumbent incurs a cost in the expectation that he can raise sales revenue in the future. According to McFadden and Peltzman (1987, p. 940), R&D investments may become sunk, but they only actually become sunk costs if these investments do not improve the incumbent's returns. Whether the costs are sunk or not will depend on the result of marketing, not the nature of the costs. Sunk costs are the costs of failure upon exiting a market.

One may ask: why should R&D failures be different from other failures such as mismanagement? The answer is in the policy to promote R&D. The law should tolerate R&D failure because of the value of R&D to society, not on its success, but on getting more knowledge (see e.g., Quah, 2002). One could learn from a failure as much as from a success. However, it is incorrect to say that all R&D costs are sunk costs, and that the risks of sunk costs in all R&D projects are high. One should be more specific about the risk of failure rather than easily accept that all R&D investments are sunk costs. Too lenient a treatment of sunk costs could nurture a bad management attitude (moral hazard, see Stiglitz and Driffill, 2001, p. 109).

3.1.3. *Assumption 3: it is impossible to calculate sunk costs.* Assumption 3 is the most difficult to rebut, although it has not been extensively discussed. It is almost impossible to calculate the relevant sunk costs that have created an API, due to three reasons. Firstly, R&D costs are ongoing expenditure. Once a cost calculation is finished, it is already incorrect because new costs have been incurred. Secondly, R&D expenditure is used in many applications (see e.g., Granstrand, 1999, p. 145). Our rebuttal of assumption 1 shows that learning by doing, and knowledge reuse are two relevant factors in the recovery of sunk costs. For the same reason, an API can be a result of 'knowledge reuse', such as the scroll bar on the screen of Windows which is a result of innovative effort of Microsoft Office (Gates, 2000). It is impossible to calculate how many ideas have been used in order to create a product, and how many products have been created from an innovative idea. Similarly, before coming to an inventive idea, the incumbent might have spent time and money for many experiments in vain. These costs of failure should be recovered (see assumption 2), but how could we be sure that these costs are devoted exclusively to the API innovation, and not to another project? Thirdly, it is impossible to show how R&D expenditure has been spent. For example, we know that Microsoft's annual budget for R&D in 2001 was $5 billion. Although we do not know how this budget is allocated, these investments would not have been possible if Microsoft had not had gained monopoly profits in Windows and their application programs. If the court narrows the scope of the recovery of sunk costs only to the extent necessary to create the API, then the incumbent would lack funds to pursue revolutionary inventions.

The first challenge (sunk costs are ongoing expenditure) can be answered by the taxonomy of sunk costs (Pindyck and Rubinfeld, 2001, p. 205). The first type of sunk costs are ex ante sunk costs, expenditure that has been incurred in the past (until the date the dispute arises). The second type of sunk costs are ex post (or prospective) sunk costs – future expenditure that would not be recoverable once incurred. At the time API access is pending, the incumbent has only spent ex ante R&D expenditure. Ex post R&D expenditure and its 'sinking' scenario are still speculative. Ex ante sunk costs are recoverable when the incumbent's financial report shows that he makes profits, or when the entrants are ready to share these costs. With respect to ex post sunk costs, which can incur at any time in the future, the incumbent can recover them by 'monetary incentives' or through learning by doing and knowledge reuse. If the incumbent believes that a cost cannot be recovered, he should not incur it in the first place. As argued in section 2.4, exclusive rights to APIs should be the last incentive. Moving from the above, only when the incumbent has not recovered its ex ante expenditure in developing the API, and no entrants can share these costs in an API-related market, should the court then consider the time incentive. Thus, the court can set a cut-off date, similar to the cut-off date of a tax year, to separate between the ex ante sunk costs and the ex post sunk costs.

The second challenge (one R&D expenditure can be implied in many applications, and an invention is a result of many failures) is correct. However, it applies not only to the incumbent but also to the entrants (see Stigler, 1968, p. 67). As noted in sub-section 3.1.2 above, the main idea of allowing innovators to recover the sunk costs is to promote R&D by tolerating R&D failure.[16] If the law supports projects that involve taking on risks in R&D by allowing the costs of failure to be recovered, then not only should it support the successful projects but it should also give the failed ones a chance to compete in the next round. Otherwise, how could the failed firms innovate if by losing the innovation in the first round, they have lost the necessary consumer base for the second round's competition? Many firms invest in R&D to develop standards, but R&D recovery is not always awarded to those who had invested the most.[17] As Jorde and Teece (1992) argue, when the market is contestable, the firm that loses in the first round of competition is in a serious disadvantage compared to the incumbent, because it has lost the necessary consumer base that could support it in the second round of competition.[18] The policy that allows only successful R&D investments to be fully recovered might discourage rather than encourage innovation (Quah, 2002). In the same line, I have raised the problem of the lack of support for failed projects. However, my argument is not that the state must subsidise the failed projects, but rather that an inexact but transparent method of calculating R&D expenditure should be acceptable, as long as it gives a sufficient incentive to innovate, not only for the incumbent, but also for his competitors.

The third challenge (monopoly profits are necessary to fund future R&D), assuming this is true, is also applicable to both the incumbent and the entrants. There is no guarantee that the incumbent will use the R&D expenditure in mega-projects more efficiently than the other firms.[19] Antitrust law has been in force

[16] For a similar discussion in the context of patent, see Phillips and Firth (2001, p. 28, sec. 3.9). In addition, Stiglitz and Driffill (2001, p. 25) also warn that if society provides greater incentives than necessary, total output is likely to be higher but there will also probably be greater inequality (incentive-equality trade-off).

[17] OECD (2002b, p. 316) shows that in the 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 is clearly more profitable than the other three companies.

[18] For similar discussion in the context of patent, see Phillips and Firth (2001, p. 28, sec. 3.9).

[19] Following the theory of transaction costs and the nature of the firm of Coase (1937, 1960), when the size of a firm surpasses a certain level, new ideas and extraordinary inventions are less likely to be accepted in the large firm than they are in the small firm, due to bureaucracy and the switching costs inside the firm, between different divisions. For example, Robert Glaser, the chief-executive of RealNetworks used to be a chief software engineer of Microsoft (see Lohr, 2004). If he had enjoyed the multi-billion dollar R&D budget in Microsoft, he would have contributed his innovation to Microsoft rather than starting up a new firm.

for more than a hundred years, but we have not experienced situations in which more competition results in less innovation. If the incumbent needs R&D funds for mega-projects in the future, it can join forces with the entrants, or eventually request support from the state (Towse, 2001, and Quah, 2002). As noted in section 2.4, the time incentive entails both costs and benefits to the consumers; its use should be proved by necessity rather than hypothetical allegation.

3.2. **Rationalising the time incentive.**

3.2.1. *The time incentive applies only when ex ante sunk costs are not yet recovered.* The above analysis shows that there are many possibilities to recover sunk costs without recourse to the time incentive. Our arguments are:

1. A time incentive could increase switching costs for the consumers and result in market inefficiency. Therefore, this incentive is appropriate when no other measures exist that may provide a more appropriate remedy for the risk of sunk costs and free riding, in terms of social costs and benefits.
2. Not all R&D investments are sunk costs, only the costs of R&D failure upon exiting a market are. The time incentive is only one among many means to recover the sunk costs, such as learning by doing and knowledge reuse.
3. The calculation of sunk costs need not be exact, but it must provide the incumbent with a chance to recover ex ante R&D expenditure, which is directly related to the API, to provide a sufficient incentive for innovation.

3.2.2. *Calculation of ex ante sunk costs.* Ex ante sunk costs can be difficult to calculate because an API, being an interface of a data format, is related to many product markets. The cost of making an interface can be low, whereas the costs of promotion for an interface to become an API could be significantly higher. These costs should be included in the scope of the ex ante sunk costs. Calculating all relevant 'ex ante' sunk costs in association with the development of a standard would be difficult if the range of the API-related products is continuously expanding. It is therefore necessary to reduce the scope of the ex ante sunk costs to the relevant market that the entrants seek to enter. Although this is an economic rather than a legal issue, I would like to put across some ideas and address two questions:

1. how can we calculate the ex ante sunk costs?
2. which part of the ex ante sunk costs should be covered by the entrant before he can seek access?

The answer to the first question (ex ante sunk costs) can be found by analogy from the competition rules on predatory pricing. According to Areeda and Turner (1975), production costs, which include ex ante sunk costs, should be either short-run marginal cost (SRMC) or average variable cost (AVC), and pricing below these levels is unlawful.[20] If a competition authority knows how to apply the AVC method to determine whether the incumbent has used predatory prices, they can apply the same method to estimate the ex ante R&D costs invested to build the product. However, Whish (2001, p. 651) criticises the AVC and SRMC methods, as they do not take into account the economics of scale and of scope present in the

[20] AVC is calculated by dividing its variable costs by its actual output; see Areeda and Turner (1975). Whish (2001, p. 647) criticises Areeda and Turner's method for difficulty in assessing evidence in order to calculate the AVC. This method of calculation has been used in *AKZO v Commission* [1991] ECR I-3359.

software sector. This critic requires an alternative method to calculate the relevant costs involved in network development, entitled the long-run incremental cost (LRIC, see Whish, 2001, p. 652). This method takes the total long-run capital and operating costs of supplying a specified additional unit of output ("the increment") into account. It also implies separate accounting for the product whose market the entrant seeks entry.[21]

In reality, the calculation of ex ante R&D costs can be complicated, but it is not as difficult as it appears to be in theory. Since ex ante sunk costs are the costs that have been incurred, they are supposed to be recorded in the firm's book of accounts. Ex ante network promotional costs should be shown up by the historic cost accounting method.[22] The incumbent could take the profits in the second stage and deduct the costs in the first stage to see whether any costs, including R&D expenditure, have been recovered.[23] In addition, since tax law allows losses, including the loss from unfruitful R&D, to be deductible and carried forward, the fact that a firm is profitable in a financial year shows that its ex ante R&D costs, sunk or otherwise, have already been recovered.

Viscusi et al. (2001, p. 830) and Boos (2003, p. 198) go even further by pointing to the fact that in reality, economic profit can be achievable at an earlier stage than accounting profit, making ex ante sunk cost recovery more feasible. This is because accountants spend R&D rather than capitalize and depreciate it as they do to other fixed capital investments. This does not reflect reality. As argued in 3.1.1, knowledge from R&D is reusable and can last for many years. It is an investment rather than an expense. We can explain this observation as follows:

$$\begin{aligned} \text{Accounting profit } \Pi_A &= R - VC - r\&d - d_k K \\ \text{Economic profit } \Pi_E &= R - VC - d_{rd} r\&d - d_k K \end{aligned}$$

where R is revenue, VC is variable costs, $r\&d$ is current expenditures on R&D, d_k and d_{rd} are the depreciation rates of K and R&D capital ($d_{rd} < 1$). K is the fixed cost (plant and equipment) of investment. Since $d_{rd} < 1$, we have $\Pi_A < \Pi_E$. Therefore, if the accounting profit of the incumbent covers his ex ante R&D expenditure, then clearly the economic profits covers this expenditure as well.

To facilitate the calculation, separate accounting should be maintained for activities related to interconnection through the API and for other activities (see the preceding paragraph). In the near future, thanks to the development of identification technologies, such as IPv6 (Internet Protocol version 6), the API owner can

[21] The principle of separate accounting is emphasised in *Deutsche Post (id) and the Interconnection Directive* (Council Directive 97/33/EC, OJ [1997] L 199/32), Art. 9(2). In *Deutsche Post*, the dominant firm was required to set up a separate legal entity for the product in which the cost will be calculated. Each year, Deutsche Post must submit to the Commission a financial statement of this entity's loss and profits and itemised statement of transfer prices of all goods and services procured by the entity. See also OFT (1998) Guidelines to Competition Act 1998: the Application in the Telecomunication Sector.

[22] This method records costs according to the 'first-in, first-out' principle, without taking into account the future value of an asset ('mark-to-market'). Hence, if an expenditure was spent on R&D, it will be recorded as cost and deductible against revenues for tax purposes (Boos, 2003, p. 76). When the sales revenue is higher than the total relevant costs, the firm make profits, and the costs (including the R&D cost) have been recovered.

[23] Normally economic costs are different from accounting costs in that the former include opportunity costs and the latter do not. However, when a cost is sunk, its opportunity cost is zero (he will lose it anyway), therefore economic cost equal accounting cost in sunk cost calculation (Pindyck and Rubinfeld, 2001, p. 205).

have an identification number ('internet protocol', or 'IP') attached to any product that has been embedded with the API. He will have more information on how large his API network currently is, and what it has cost him to expand the API network from the beginning up to this stage.[24]

The answer to the second question (which part of the ex ante sunk costs should be recovered) aims at two objectives. Firstly, it determines the amount of the ex ante sunk costs, which must be recovered by the sales revenue from a product market. Secondly, if the entrant wishes to enter a product market without waiting for the full recovery of the ex ante sunk costs, then the answer to the second question will determine the access price that he has to pay the incumbent. My argument is that such a price (Π) will be equal to:

$$\Pi = abC \tag{1}$$

where a is the participation of the relevant product market in the total turnover of the incumbent's network; b is the expected market share of revenues that the incumbent would lose after the entry; and C is the total ex ante sunk costs for promoting the whole network, as estimated in the preceding paragraphs.

The rationale for (1) is that if the entrant enters a market, in which an incumbent is operating, he should bear the costs proportionally to the ex ante sunk costs of promoting the API network, to which his product will be attached.

Suppose that:

1. $a = 0.1$, i.e., the niche market that the entrant seeks to enter represents 10 percent of the total revenue of the incumbent in the whole network;
2. $b = 0.2$, i.e., the expected market share that the incumbent may lose to the entrant is 20 percent.

By (1), the access price that the entrant should pay is $0.1 \times 0.2 = 0.02$ or 2 percent of the ex ante network promotional costs. If the entrant joins a market in which the incumbent is not active, or the incumbent withdraws from the market after the API license, then the market share he will lose to the entrant would be 100 percent ($b = 1$), and in this case the entrant would have to pay 10 percent of the ex ante sunk costs of promoting the network.

If the API-related product is freely downloaded, then $a = 0$, and the entrant would not have to pay the incumbent for the access.

If the entrant seeks to enter many markets at the same time, the costs he shares will be proportional to the ex ante sunk costs of promoting all of these relevant markets by the incumbent. If the market the entrant seeks to enter constitutes the entire network of the incumbent (see *IMS*), then $a = 1$ (i.e. 100%) and (1) becomes

$$\Pi = bC \tag{2}$$

The calculation of entrant's share in the ex ante sunk costs in (1) is influenced by the efficient component pricing method (ECP) of Baumol and Sidak (1994).[25]

[24]For more information on IPv6, see www.ipv6forum.com. IPv6 is the next generation of IPv4, the system of Internet Protocol that is currently in place. IP is an identification protocol that helps devices or digital media communicate with each other on the Internet. The problem of IPv4 is that their number is limited, so that it is impossible to mark IP on each device. This problem can be solved with IPv6, which, theoretically, can manage 10^{38} hosts, sufficient to provide IP to each piece of software or media content. As long as IP is attached to a product, such a product is traceable anytime it is active and the PC is linked with the Internet.

[25]The ECP is subject to many assumptions: the monopoly's price for the complementary service has been based on a marginal-cost pricing rule; the monopolist's and rival producer's

This method requires that the access fee paid by the entrant to the incumbent (Π_2) be equal to the incumbent's opportunity costs of providing access, including any forgone monopoly profits. Assuming that there is only one market ($a = 1$), we have:[26]

$$\Pi_2 = bS_mQ$$

where S_mQ is the total monopoly profits, which is the monopoly surplus (S_m is monopoly price minus the average cost of a unit), multiplied by the total quantity of the products sold in a homogeneous market (Q); and b is the loss of monopoly profits, in terms of market share loss.

The ECP method has been applied in *Clear Communications v Telecom Corporation of New Zealand* [1995; 1 NZLR 385] (see e.g., Anderman, 1998, p. 217). Anderman (1998, p. 216, 226), Kahn and Taylor (1994), Economides and White (1995), and Noam (2001, p. 86) criticise this method as unrealistic. Since the entrant must compete with the incumbent, he cannot earn as much as the initial monopoly profits of the incumbent, and he cannot pay the incumbent an access fee equal to the latter's opportunity costs. In addition, since the incumbent does not need to pay the API access fee, he is able to price his final product lower than the entrant. The entrant cannot compensate the incumbent for monopoly profits except by overcharging consumers. If that were the case, the anti-abuse measure would lose any significance.[27]

In our proposal, S_mQ in the ECP formula has been replaced by C in (2). The ex ante sunk costs constitute the real loss, which must be compensated, as opposed to the hypothetical loss in the ECP formula. By doing so, the outcome will be both plausible and equitable. This method is plausible because competition authorities have more experience in calculating market shares than losses of monopoly revenue. This method is equitable because the compensation will be equal to the market share multiplied by the ex ante sunk costs (unchanged even after the license), and not by the monopoly revenue before the license.

With respect to (1), the burden of proving the market share that the entrant intends to capture (b) is on the entrant. The burden of proving the percentage of revenues from the relevant product market out of the total turnover of the incumbent's API-related network (a) and the ex ante sunk costs (C) is on the incumbent, as he is the only one who possesses information on these matters. If C is too difficult to estimate, the court can provide a grace period in which the incumbent does

---

components are perfect substitutes; the production technology of the component exhibits constant returns to scale; the rival producer has no market power; and the monopolist's marginal cost of production of the component can be accurately observed. For the critique of ECP, see Economides and White (1995); Anderman (1998, p. 216); and Ridyard (1996, pp. 450-51).

[26]This equation is formulated from the definition of ECP. In a Cournot duopoly market, the ECP formula can be explained by a different method, unrelated to market share loss, see Economides and White (1995).

[27]Justice Gault in *Clear Communications* raised this concern; see Anderman (1998, p. 218). Although the Privy Council later rejected this concern, it did so because of a statutory right for a telecommunication company to obtain monopoly profits. The Court did not considered whether telephone tariffs have been reduced because of the ruling, and whether consumers have benefited from the ruling. Note that in *Brooke Group Ltd. v Brown & Williamson Tobacco* (1993) 509 US 209, the US Supreme Court also held that the test used in pricing should be the 'equally efficient competitor' test, not the 'equally monopolist' (or ECP) test, see Werden (2004, p. 2-6).

not have to prove the recovery of ex ante sunk costs, as a hard and fast rule.[28] If, after the grace period, the incumbent fails to show convincing evidence within a reasonable deadline fixed by the court, the latter will assume that the incumbent has recovered his ex ante sunk costs. The time incentive will lapse and the only available option for him to recover sunk costs would be through monetary incentives.

4. A Monetary Incentive in the Rubinstein Bargaining Model

As was concluded in section 2.3, we have narrowed the scope of analysis of monetary incentives to the bottom-up method – the definition of a fair access fee via negotiation between the incumbent and the entrant. The key question now is how to persuade the parties to agree upon a fair access price when they have private information, conflicting interests and unequal bargaining powers. As Viscusi et al. (2001, p. 181) remark, access fees should not be so high as to deter entry. Here game theory can offer assistance, in particular the Rubinstein Bargaining model (Rubinstein, 1982).

To be sure, a game itself cannot estimate a 'fair' price. What is 'fair' is an outcome of either a costs calculation or a subjective assumption. A game is a set of formal tools used to study the strategies of the players, who have beliefs on their own initial payoffs (see Baird et al., 1994, p. 308). We have to assume that each party has its own 'subjective fair value' of the API access, but does not want to reveal his information.[29] Our purpose is a fair bargain, in which the incumbent will not overprice its API access or the entrant will not under-price the API license. In this game, we will also assume that the incumbent has recovered his ex ante sunk costs related to the API. Otherwise, refer to Section 3.2.2 for the method of calculating these costs. The payment made by the entrant to the incumbent will be reserved to cover the ex post sunk costs, so that the incumbent will have a sufficient incentive to innovate.

4.1. **Balancing risks – the core of the Rubinstein bargaining model.** The starting point of Rubinstein bargaining is the Ultimatum Game. This is a one-off game, in which two players decide how to split N dollars. The first player has the right to offer the second player x dollars, and the second player can either refuse or accept. Unless the second player accepts, in which case the payoffs are $(x, N - x)$, both parties will obtain nothing (0, 0) and the game ends. Rubinstein (1982) modified this game by allowing the players to renegotiate in an indefinite number of negotiation rounds until a deal is struck. However, there is an important condition: delay matters. That is, the value of N is reduced at a discount rate of δ after each round of negotiation (e.g., because of inflation). According to game theory analysis, a strictly rational second player would accept the split offered by the first player under the Ultimatum Game, because it is better than receiving nothing when negotiation fails (see e.g., Kreps, 1990, p. 119). Under Rubinstein

[28] As an example, IP Guidelines: 3.2.2 noted that a normal time to recover ex ante sunk costs and win consumer acceptance is two years from commercial introduction. For similar position, see the opinion of Mischo AG in *Renault* [1988] ECR 6039, para. 17 and 63, quoted by Anderman (1998, p. 216).

[29] I am indebted to Professor Michele Piccione from the LSE Economics Department for this suggestion.

bargaining (1982, pp. 97-110) however, the parties are likely to split the stake equally.[30]

During September and October 2003, I conducted two experimental studies of Rubinstein Bargaining in Vietnam and United Kingdom.[31] The questions posed were:

1. if you were the offeror in any round of negotiation, how much would you offer in the split (x)?, and
2. if you were the offeree in any round of negotiation, how much would you accept in the split?

The results from the experiments show that the majority of respondents decide rather early to split the stake equally, no matter whether the negotiation is one-off or if it will last indefinitely.[32]

The experiments show the importance of the balance of risks in negotiation. Both players want to make a deal rather than break it. If the players do not intend to conclude a transaction, they may not even enter into negotiation in the first place.[33] An unreasonable offer may solicit anger from the counter-party to no avail. Such a hostile move is not worth the transaction costs involved. If an offer were unreasonable and rejected, the offeror would risk receiving an equally bad or worse counter-offer, which he must reject. Time is wasted and the stake gets smaller. Using backward induction, we can see that a rational player should place a fair price from the beginning to save time and costs. That is, he must place an attractive offer, so that the probability for it to be accepted is larger than the probability of rejection.

In particular, when the first player offers the second player 10 percent and retains 90 percent of the stake, the chance that the second player does not want to play

[30]Rubinstein's theoretical model does not, in general, predict equal shares, but his exprimental research does. Rubinstein has even suggested that the ulitimatum game can end up with equal shares (see, for example, http://arielrubinstein.tau.ac.il/papers/Response.pdf)

[31]The experimental study in Ho Chi Minh City was done with 205 law and economics students (86 males and 119 females). The amount at stake ranged from a real VND10,000 (equivalent to US$1) to a fictitious VND10 million (equivalent to US$1000). The experimental study at the London School of Economics (LSE) was with 57 law students (22 males and 35 females). The amount at stake was £100.

[32]With reference to the first question, the result shows that the first players usually show generosity to a low stake but rationality to a higher stake, where the offer amount ranges from 40 percent of the stake (18 percent of the Vietnamese students) to 50 percent (44 percent of the Vietnamese students and 82 percent of the LSE students). The first players very rarely offer a low stake, like 10 percent, to the second players. With respect to the second question, 29 percent of the Vietnamese students replied that they would be happy being offered 30-40 percent of the stake; 39 percent of them replied that they required between 41-50 percent of the stake. Nearly 62 percent of the LSE students replied that they required at least 50 percent of the stake, and 15 percent said they required at least 60 percent.

[33]The experiments reported in Rubinstein (2003) conclude that both players want to reach an agreement rather than have no agreement at all. He conducted several surveys through the Internet with the students in Tel Aviv University, Tilburg University and LSE. Between 40 and 45 percent of the respondents said that they would split the stake (the $10 bill) equally as the offeror. On the other hand, between 60 and 70 percent of the students replied that they would accept 10 percent of the stake as the offeree. In Le (2003), the approval rate for a 1/9 split is only about 22 percent (in the experiment with Vietnamese students). For further discussion on balance of risks, see Benkler (2002, section C.1). Please note that the risk of being rejected by customers is also the reason why monopoly firms tend to charge durable goods at competitive price (see Coase, 1972).

a dominated strategy will be larger than when both parties receive 50 percent of the stake. If the first player thinks in terms of risk balancing, he does not want to be in a passive position by offering an amount that is likely to be rejected. As this argument goes, the first player should split the stake equally, especially when it is unclear whether the offeree is risk-loving or risk-averse. One may argue that the entrant can also play a grim strategy, i.e., he will reject any offer until he receives 99 percent of the stake. This scenario is not realistic. If the entrant delays, other entrants will appear and accept a reasonable offer. In short, not only the first player but also the second player should analyse the risk of failure.

To set a formula for the Rubinstein bargaining process, let us suppose that the value of the stake is N, and the discount factor (from delay) is δ. The first player offers x, leaving him $N-x$. Since he must wait an additional period before repeating the offer, a counter-offer from the second player is more attractive if it gives the first player more than $(N-x)\delta$. In order to do so, the first player must offer at least $\frac{x}{\delta}$ initially to the second player, in which case he receives $N-\frac{x}{\delta}$ (see Baird et al., 1994, p. 222). When the first and the second offers of the first player are equal, we get:

$$N-\frac{x}{\delta}=(N-x)\delta \quad \text{or} \quad \frac{x}{N}=\frac{\delta}{1+\delta}$$

A more complicated version of the Rubinstein bargaining model posits different disccount rates for the parties (δ_1 and δ_2, respectively). The key point in the Rubinstein bargaining model is that although the offeror enjoys an initial advantage, once the offer is on the table, the advantage goes to the offeree. The latter can use delays as an advantage (so-called "exit option", see Baird et al., 1994, p. 221). In addition, the rules of the game grant the second player the right to preclude the first player's benefit by rejecting the offer. Hence, the risks facing both parties are equal. A fair deal can be struck not only by minimising the risk of failure in negotiation, but also by creating risks, so that the bargaining powers of both players are balanced.

4.2. **A modified Rubinstein model, and the incumbent-entrant price negotiation game.** The Rubinstein model is now applied to two players: an incumbent and an entrant, bargaining over the API access price. To mimic the rule "delay matters", the court can order that for each period of delay in reaching an agreement on a fair price, the incumbent will have to pay the court a fine, so that he has an incentive to accept a fair offer. A good example of this type of strategy was in *US v Microsoft* [1998] 165 F.3d 952, where the Columbia District Court imposed a fine of one million dollars per day on Microsoft until it complied with the court order. Similarly, under Article 15 and 16 Regulation 17/62, OJ [1962] L 204/62 (as updated), the European Commission can fine an abusive dominant firm up to EUR 1 million or 10 percent of its turnover in all products, worldwide, in the preceding year. These sanctions are sufficiently severe to create an effect equivalent to Rubinstein's "delay matters" rule. Although the penalty is imposed on the incumbent only, for an entrant delay also matters (at the discount rate of δ_2) because he may lose a business opportunity. If he hesitates, other entrants can approach the incumbent earlier with a better offer.

Suppose that the incumbent makes an initial offer of £1 million for the API access fee, and the entrant makes an initial counter-offer of £0.1 million. They then bargain over how to split the difference of £0.9 million (N). The split ($\frac{x}{N}$)

will follow the Rubinstein model as in section 4.1 above. Below we will show that as long as the negotiation structure mimics the Rubinstein bargaining model, the parties will make reasonable offers voluntarily.

1. If the entrant were keen to receive the API license quickly ($1 - \delta_2$ is quite large), he would have to make a better counter-offer in the next round.
2. On the incumbent's side, we assume a discount rate of $\delta_1 = 0.9$ for the stake. That is, if the first round of negotiation fails, the surplus at stake will be reduced to $N\delta_1 = \pounds 810,000$.
3. This loss in the stake will urge the incumbent to make an offer that is acceptable to the entrant with the lowest δ_2.
4. To speed up the negotiation, the court may rule that the incumbent should pay a penalty of $(1 - \delta_1)N$, or in this case $\pounds 900,000 - \pounds 810,000 = \pounds 90,000$. This (absolute) penalty is applied in each period for which no license takes place, so that after nine rounds without having an offer accepted he would have lost any surplus he could possible obtain from negotiation.

The higher the penalty, the quicker the parties will arrive at an access price that benefits both parties. Our goal is not to find an 'optimal' penalty to impose on the incumbent, but to find a mechanism that can encourage the parties to end up with a fair access price, according to the information they have. If the incumbent wants to avoid the penalty, he may grant API access without charge, after recovering the ex ante sunk costs (this is an assumption in section 3.1 above). This would not put the incumbent in a disadvantaged position compared with the entrant, because he can compete with the entrant on a level playing field. In reality, a free API license is not rare. Upon request by the Federal Circuit, Microsoft has licensed rivals some of its Windows interfaces free of charge.[34]

As noted, in order to balance the risk of the incumbent (of being charged a penalty) with the risk facing the entrant, we have associated a discount rate of δ_2 with the entrant. To accelerate the negotiation process, we can make delay matter more, by exposing potential entrants to a further risk. Organising an auction among them can create such a risk (see Viscusi et al., 2001, p. 451). However, the bidders may be biased, or they may disregard the risk if they deduce a different result from past actions. To de-bias the bidders, it is necessary to either limit the chance for deduction, or minimise the role of deduction from the past actions through transparency enhancement.[35] Baird et al. (1994, pp. 213-216) have proposed either a closed and one-off Dutch auction or an open bid auction, so that one could make a decision after knowing what other bidders have decided. If one of the

[34]See Lohr (2003). As Microsoft has been steadily profitable since the mid 1980s (Ichbiah and Knepper, 1991, Appendix 1), we can assume that it has recovered all ex ante sunk costs necessary in promoting Windows and related products.

[35]See Le (2003). A game was set for 203 students, divided into three groups, as follows: you are in a hurry to get to school. There is a short cut road, but one part of this is a one-way street in the wrong direction. The probability of being caught by the police is 40 percent. The question for the first group was: 'will you take the short cut?' The question for the second group was: 'if you see many people successfully taking the short cut without being caught (positive deduction), would you take it also?' The question for the third group was: 'if you see some people were caught by the police (negative deduction), would you still take the short cut?' The result was that with negative induction, the percentage of people that would break the law was 20 percent. In the neutral group, such a percentage was 32 percent, and in the group inferred by positive induction, it was 44 percent.

bidders stops bidding, the others could infer this as a negative signal. Based on both positive and negative information, the bidders can make a rational offer.

5. The Aftermath of an API Compulsory License

5.1. **Collective action as the key issue.** I have argued so far that as long as the incumbent can recover his ex ante R&D sunk costs, he would have an incentive to innovate. The entrant should pay the incumbent a fair price for API access, to be reached by negotiation, following the Rubinstein model. The next question is: what will happen to the incumbent after recovering his ex ante sunk costs and receiving a 'fair' royalty? If the incumbent or the entrant had known beforehand that their API would be subject to compulsory license, when they have successfully delt with the issue of recovering sunk costs, would they be willing to incur the ex post sunk costs to improve the API? There are two possible answers to this question:

1. the incumbent and the entrant will invest, because in networked economy, the first mover is likely to gain the largest market share (optimistic beliefs), or
2. they will not invest, hoping that another firm will invest first and then they will bring a lawsuit to demand compulsory access (pessimistic beliefs).

For both viewpoints, collective action is the major risk in the aftermath of API licensing. From a pessimistic viewpoint, Korah (1994, pp. 189 - 190), Ahlborn et al. (2001), and Evans, Nichols and Schmalensee (2001) are concerned that free riding could give rise to a spillover effect or collective action, if people do not trust in the good faith of each other. From the 'optimistic' camp, Takeyama (1997), and Bakos et al. (1999, p. 117) argue that limited free riding might actually benefit the incumbent, as it extends the customer base. However, these arguments do not address the concern as to how the competition authority can keep free riding to a 'limited extent', before it becomes a collective action?

5.2. **Prevention of collective action using the stick and carrot.** According to Baird et al. (1994, pp. 189-191), in order to prevent a collective action one needs to turn a non-cooperative game into a cooperative game. The aim of a cooperative game is that each player pursues his best strategy by contributing to a common good, either paying for API access or sharing knowledge with the incumbent. Ellickson (1991, p. 124) proposes two methods that may ensure cooperation amongst self-interested players: the 'stick' (punishment for non-cooperative behaviour) and the 'carrot' (reward for cooperative behaviour). The first approach is taken after the free riding act has actually occurred. The second approach is a pre-emptive action to prevent potential free riding.

The core of the stick approach is to identify a leader, who has an incentive to punish free riders. The leader could be the one who has the largest stake when collective action occurs. Suppose that the leader is the incumbent. When the entrant free rides, the incumbent must take action. He may withdraw the license to the API or impose damages to the entrant (tit-for-tat). Baird et al. (1994, pp. 192-93) noted that a tit-for-tat strategy could generate a credible threat to the potential free riders and prevent collective actions. Through several experimental studies, Axelrod (1990) also argues that tit-for-tat is the most effective method to urge parties with conflicting interests to co-operate with each other.

The above conclusions are more hypothetical than real, because the temporal effect of free riding can be severe. Free riders can price their products lower than the incumbent. The consumers are indifferent whether they buy a product from a free rider or a contributor, as long as the price is low. They may reward the wrong side of the game. In addition, if the incumbent 'punishes' the free riders by price competition to drive them out, he will face difficulty in increasing the price afterwards.

With the 'carrot' approach, the incumbent will only grant access to suitable entrants, who put the highest value on the API. High-value entrants understand that if they do not contribute, the incumbent will lack funds to maintain or develop the API-related network and the API-related products risk becoming obsolete. Therefore, high-value entrants will be willing to pay more for API access than low-value ones. The problem with this approach is that the entrants' valuations of the API are private and non-verifiable. Therefore, they have an incentive to inform the incumbent of a low value of the API, in order that they contribute less than what they should. If under-valuation goes unpunished, free riding may become a collective action.

To address this issue, Baird et al. (1994, pp.206-7) propose a game in which all players must decide how much they will contribute in order to produce a public good, provided that the low-value players will have to pay a penalty when they indicate their valuation of the public goods (in this case the API) to be below a certain threshold. Under this structure, the players reach a Bayes-Nash equilibrium (the 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. However, only the players that have valued the public good at a value that exceeds their contribution would have access. When we apply this model to the API license, it would imply that the incumbent should be allowed to charge the entrants for the ex ante promotional cost (Π), following the calculation in section 2.2, as a method to screen free riders (see also Baird et al., 1994, pp. 85-87, 112-17).

A drawback of both the stick and the carrot approaches is that they do not facilitate joint innovative effort of the incumbent and the entrants. These approaches could work when one firm is the leader, which also undertakes all innovative effort. Other undertakings will 'pay as you go'. When the API or the API-related products require constant innovation, regulators should focus on the long-term objective of free riding prevention. That is, how to maintain a favourable environment for innovation incentives. Below we will analyse the favourable and unfavourable conditions after the API license that may support or against innovation.

5.3. **The incentives for API innovation.**

5.3.1. *The favourable conditions for innovation after the API license.* After API compulsory licensing, consumer demand for the incumbent's product may decrease, as the network supports both the entrant and the incumbent. At the same time, the entrant's threats will increase. Since the incumbent can no longer lever market power through a refusal to license, he must gain the customers' positive feedback on merits, i.e., by innovation, not by rent seeking. This task seems to be difficult, but the development of the Linux platform and the General Public License (GPL) shows that it is possible.[36] The key for competition feasibility is in the heterogeneity

[36]See Lambert (2001) and Benkler (2002). A good example is MySQL database toolkit. The source code of MySQL (protected under GPL) is accessible to the public. Software developers collect fees through services in integrated packages. Those who acquire its product free must agree to document and share any improvement they made. Otherwise, MySQL will sell them the same program for US$395. Bulkeley (2003) noted that about 4,000 companies have paid MySQL a fee,

of consumer demand – in other words, market opportunities. Oliver and Marwell (1988), and Hirshleifer (1988) argue that firms will be motivated to innovate as long as there are sufficient profit opportunities resulting from innovation. As long as the incumbent and the entrant can compete on a level playing field, who gains monopoly power by superior products or business acumen is no longer a competition law concern (US v Grinnell [1966] 384 US 563: 570).

In addition, the 'durable good' threat is another driving force to innovate, which applies to both systems – Windows and Linux. As the Coase Conjecture (Coase, 1972) demonstrates, in a market of durable goods, consumers will not replace old goods easily, and the producer cannot charge a price that is higher than the market price unless it can reduce the durability of the good. One way of reducing the durability of a good is to innovate (e.g., upgrade) and make the old good obsolete. That is why statistics from OECD (2002a, pp. 106-108, 119-111) shows that visionary companies have always seen the limit of the old system and prepared for the next wave of innovation. Sunk cost recovery will be therefore possible. In addition, an innovation market is not a place for free riders. Entry requires large start-up costs; hence, firms must compete on merits. As the risks of sunk costs and free riding can be less, a policy that supports compatibility among products can feasibly be implemented.

The above assessments assume that the incumbent has sufficient R&D capacity to carry out innovation, and the R&D capacity of the entrants does not threaten the existence of the incumbent's business. What would happen if these assumptions no longer hold true?

5.3.2. *The first unfavourable condition: insufficient R&D capacity.* When the incumbent has an insufficient R&D capacity to carry out continuous innovation in the market, Ulen (1999, pp. 801-02) suggests that the entrant and the incumbent should cooperate. Public goods, including APIs, are non-rivalrous and non-excludable. Therefore, cooperation is the optimal approach because all the users of such a good share the costs of making it.

However, in order for cooperation to be feasible, transaction costs (i.e., search costs, negotiation costs and enforcement costs) must be low.[37] Albanese and Van Fleet (1985, p. 245) describe the relationship between transaction costs and co-operation as follows. A group member will contribute innovative effort to improve the API and will generate two outcomes: common interests and private benefits.[38] By observing the outcomes, the incumbent can differentiate between free riders and contributors.[39] Those who contribute more to the API will receive a greater benefit. Finding contributors is not difficult, as they will signal themselves by their performance results. Finding free riders is more problematic, as they are likely to

---

compared with four million users of the free version, which in turn enhances MySQL network externalities.

[37]Ulen (1999, pp. 803-06), Baird et al. (1994, p. 42) and OECD (2001, p. 246) note that with low transaction costs a policy toward interoperability will encourage collaboration in R&D.

[38]Hardin (1968, p. 1244) demonstrates that private payoffs could play a more important role than common interests. He noted that the key question is not whether my effort is good for the common, but "what is the utility to me of adding more of my (effort)?" See also McCarty (2001, pp. 23-27).

[39]Habermas (1996, p. 166) also demonstrates that the conditions for successful co-operation are to exclude free riders from the co-operative benefits and reward outstanding contributors. For that purpose, the incumbent must be able to identify the contributors and the free riders.

hide their intention. If the entrants want to free ride, they may wait for the incumbent to contribute first.[40] When free riding becomes collective action, i.e., when the number and the sale volume of free riders exceed those of the co-operators, it will destroy cooperation.[41] To remedy this problem, many authors suggest that the number of the licensees should be reduced in order to identify and punish the free riders.[42] As the number of licensees is small, an act of free riding will harm the interests of each licensee in a small group more than if it were a member of a large group. Therefore, each licensee would have an incentive to identify the free riders.[43]

Cooperation between the incumbent and the entrant to develop the API after compulsory licensing is possible not only in theory but also in practice. The empirical study of Axelrod et al. (see Axelrod, 1997, p. 96) shows that rivals, such as AT&T and Sun Microsystems, have joined forces in supporting UNIX and now Linux as standards for operating systems. They stipulate that the firm's incentive to cooperate will outweigh the disincentive when there are either common interests or common threats (id: 105). Regarding common interests, the incumbent would be keen to collaborate with the entrant in order to reduce R&D costs.[44] Regarding common threats, a good example can be seen in the innovation effort supporting Linux platform of IBM and Sun. As Microsoft's market power is overwhelming, they understand that unless they co-operate to support Linux, they are not able to compete on merits.

5.3.3. *Second unfavourable condition: threats from a strong entrant.* If the incumbent's R&D capacity is weaker than the entrant's capacity, it may lose in the innovation race in the future. The entrants may be keen to research and develop the APIs, but equally they may take the largest shares in the R&D success, and eventually drive out the incumbent from the market, as it was in the case of *Sun v Microsoft* ([1998] 21 F. Supp.2d 1109). Sun is the copyright owner of Java virtual modules (JVMs), the applets that allow different software programs to interact with each other. It has licensed JVMs to Microsoft. Unknown to Sun, Microsoft modified 40 Java interfaces and deleted two important standards in a JVM, making Sun Java's products less compatible with Microsoft Java's programs. Consequently, the users who bought Microsoft's products could interact better with Windows than those

[40]Stigler (1974) called them "cheap riders", i.e., those who pretended to contribute, but they only contributed low quality results, keeping high quality results for themselves.

[41]Ulen (1999, pp. 804-06).

[42]See Farrell (1987, p. 34), Axelrod (1997, p. 111), Adar and Huberman (2000, p. 9), Cornes and Sandler (1996), and Albanese and van Fleet (1985, p. 246). Thus, API access should be granted only to a small group of entrants that are capable of innovation. In practice, IBM and Dow Chemical are also selective when licensing their technology to other firms, to avoid free riders and guarantee a stable stream of license fees. See Davis and Harrison (2001).

[43]Albanese and Van Fleet (1985, p. 246). Axelrod (1997, p. 116) also notes that if firms having close interests can group together so that their size is equivalent to the incumbent, the latter will more likely to ally with them to develop a common standard.

[44]See OECD (2001, pp. 176-179) on the case of MPEG2, when nine firms had formed a joint entity to convey a package license to their patents in digital moving picture technologies. Other examples of innovation cooperation between rivals nowadays are between Microsoft and RealNetwork to develop some aspects of media player standards, see WSJ Europe December 7, 2003.

who bought Sun's products.[45] This perspective can make the incumbent hesitant to cooperate. OECD (1999, p. 158) concludes that a legitimate business reason to refuse to license would include, apart from sunk costs and free riding, protection of the incumbent's reputation and existence. Viscusi et al. (2001, p. 711) also note that the best strategy to take when the future outcome entails too much uncertainty is the 'no regrets' option. Under this option, the incumbent should have the right to refuse to license, but he should bear the burden of proof.

6. Conclusion

The main question addressed in this paper is whether further innovation on an API is possible after it has been licensed. If innovation is impossible because of the high risk of sunk costs and free riding, then the compulsory license should not be granted. Two approaches that can remedy these risks are the monetary incentives (finding a fair access price and stimulating cooperation with the entrants) and the time incentive (finding a period during which refusal to license is acceptable). A fair access price is not just a result of analysing a game between the incumbent and the entrant, it is a combination between a hard and fast calculation of ex ante sunk costs and a game of price negotiation between the incumbent and the entrant, following the Rubinstein Bargaining model. Under this approach, my argument is that monetary incentives could be as good, or better, to support innovation than time incentives. In particular:

1. The law should allow the incumbent to set a minimum threshold for the access fee (so called Π – the proportion of the ex ante sunk costs of the API promotion to be multiplied by the market share that the entrant intends to capture).
2. When the incumbent has received or recovered a minimum amount (Π), he and the entrant can negotiate for a fee for the API license, following the Rubinstein bargaining model. To prevent the entrant from under-pricing the API, the incumbent should have the right to organise bidding for API access.
3. To prevent the risk of collective action in free riding, the court should allow the incumbent to cooperate with the entrant in R&D and to limit the number of entrants, which are capable of using the API to the benefit of consumers.
4. If the API access could endanger the incumbent's existence, the API license should not be granted.

Nevertheless, monetary incentives are better served for the purpose of sunk cost recovery than for the purpose of free riding prevention. For the later, monetary incentives can play some roles, but more work along these lines is needed.

References

Adar, E. and B. Huberman (2000), "Free Riding in Gnutella", *First Monday,* **5**.

Albanese, R. and D. van Fleet (1985), "Rational Behaviour in Groups: the Tendency of Free Riding", *The Academy of Management Review,* **10**; 244-55.

Ahlborn, C., S. Evans and A. Padilla (2001), "Competition in the New Economy – Is EU Competition Law Up to the Challenge?", 22 *European Competition Law Rreview,* **22**; 5-9.

[45] *Finding of Facts:* 74. The Court noted that Microsoft took steps "to maximise the difficulty with which applications written in Java could be ported from Windows to other platforms, and vice versa."

Anderman, S. (1998), *EC Competition Law and Intellectual Property Rights: The Regulation of Innovation*, Oxford, Oxford University Press.

Areeda, P. and D. Turner (1975), "Predatory Pricing and Related Practices under Section 2 of the Sherman Act: A Comment", *Harvard Law Review*, **88**; 697-733.

Axelrod, R. (1990), *The Evolution of Cooperation*, London, Penguin Books.

Axelrod, R. (1997), *The Complexity of Cooperation, Agent-based Models of Competition and Collaboration*, Princeton, Princeton University Press.

Bakos, Y., E. Brynjoffson and D. Lichtman (1999), "Shared Information Goods", *Journal of Law and Economics*, **42**; 117-156.

Baird, D., R. Gertner and R. Picker (1994), *Game Theory and the Law*, Cambridge MA, Harvard University Press.

Baumol, W. and G. Sidak (1994), "The Pricing of Input Sold to Competitors", *Yale Journal of Regulation*, **11**; 171-202.

Benkler, Y. (2002), "Coase's Penguin, or Linux and the Nature of the Firm", *Yale Law Journal*, **112**.

Black, S. (2002), *Telecommunication Law in the Internet Age*, New York, Morgan Kaufman Publishers.

Boos, M. (2003), *International Transfer Pricing – The Valuation of Intangible Assets*, Boston, Kluwer Law International.

Bulkeley, W. (2003), "Free Software Out of the Shadows", *Wall Street Journal Europe*, 4 April 2003: R3.

Coase, R. (1937), "The Nature of the Firm", *Economica*, **16**; 386-405.

Coase, R. (1960), "The Problem of Social Costs", *Journal of Law and Economics,* **3**; 1-44.

Coase, R. (1972), "Monopoly and Durability", *Journal of Law and Economics,* **15**; 143-49.

Cooter, R. and T. Ulen (1997), *Law and Economics*, 2nd Ed., New York, Addison Wesley Longman.

Cornes, R. and T. Sandler (1996), *The Theory of Externalities, Public Goods and Club Goods*, Cambridge MA, Cambridge University Press.

Cornish, W. (1996), *Intellectual Property – Patents, Copyrights, Trademarks and Allied Rights*, 3rd Edition, London, Sweet & Maxwell.

Davis, J. and S. Harrison (2001), *Edison in the Boardroom – How Leading Companies Realize Value From Their Intellectual Assets*, Hoboken NJ, John Wiley and Sons, Inc..

Economides, N. and L. White (1995), "Access and Interconnection Pricing: How Efficient is the Efficient Component Pricing Rule?", *Antitrust Bulletin*, **XL**; 557-97.

Ellikson, R. (1991), *Order Without Law – How Neighbors Settle Disputes*, Cambridge MA, Harvard University Press.

Evans, D., A. Nichols and R. Schmalensee (2001), "An Analysis of the Government's Economic Case in US v Microsoft", *Antitrust Bulletin*, **46**, No. 2.

Farrell, J. (1987), "Cheap Talk, Coordination and Entry", *RAND Journal of Economics*, **18**; 34-39.

Gates, W. (2000), "The Case for Microsoft: Why Windows and Microsoft Office Should Stay Under One Roof", *Time*, 7 May.

Granstrand, O. (1999), *The Economics and Management of Intellectual Property – Towards Intellectual Capitalism*, Cheltenham UK and Northampton MA, Edward Elgar Publishers.

Habermas, J. (1996), *Between Facts and Norms: Contributions to a Discourse Theory of Law and Democracy*, Translated by W. Rehg, Cambridge MA, MIT Press.

Hardin, G. (1968), "The Tragedy of the Commons", *Science*, **162**; 1243-48.

Hirshleifer, D. (1988), "Residule Risk, Trading Costs, and Commodity Futures Risk Premia", *Review of Financial Studies*, **1**; 173-93.

Ichbiah, D. and S. Knepper (1991), *The Making of Microsoft – How Bill Gates and His Team Created the World's Most Successful Software Company*, Rocklin, Prima Publishing.

Jorde, T. and D. Teece (1992), *Antitrust, Innovation and Competitiveness*, Oxford, Oxford University Press.

Kahn, A. and W. Taylor (1994), "The Pricing of Inputs Sold to Competitors: A Comment", *Yale J on Regulation*, **11**; 255-40.

Klemperer, P. (1987), "The Competitiveness of Markets with Switching Costs", *RAND Journal of Economics*, **18**; 138-50.

Korah, V. (1994), *EC Competition Law and Practice*, 2nd Edition, Oxford, Hart Publishing.

Kreps, D. (1990), *Game Theory and Economic Modelling*, Oxford, Clarendon Press.

Lambert, P. (2001), "Copyright, Copyleft and the Software Intellectual Property Right: Is Contract Still King?", *European Intellectual Property Review*, **23**; 165-9.

Landes, W. and R. Posner (1989), "An Economic Analysis of Copyright Law", *Journal of Legal Studies*, **18**; 325-66.

Larouche, P. (2000), *Competition Law and Regulation in European Telecommunications*, Oxford, Hart Publishing.

Le, N. (2003), "Sunk Cost and Free Riding Justification – A Risk Analysis Approach", paper presented at the 2nd Annual Conference of the Society for Economic Research of Copyright Issues, Northampton, MA (available at www.serci.org).

Lohr, S. (2003), "Microsoft eases licencing on its technology", *New York Times*, 4th December, 2003.

Lohr, S. (2004), "Musical Chairs With the Big Boys", *New York Times*, 21 March 2004.

McCarty, M. (2001), *The Nobel Laureates – How the World's Greatest Economic Minds Shaped Modern Thought*, Cambridge MA, MIT Press.

McFadden, D. and S. Peltzman (1987), "Technological Change, Sunk Cost and Competition – Comment and Discussion", *Brookings Papers of Economic Activities*, **3**; 883-947.

Noam, E. (2001), *Interconnecting the Network of Networks*, Cambridge MA, MIT Press.

OECD (1999), "The Essential Facilities Doctrine", Doc. OECD/GD(96)113, *OECD Journal of Competition Law Policy*, **4**; 133-68.

OECD (2001), "Competition Policy and Intellectual Property Rights", *OECD Journal of Competition Law Policy*, **2**; 180-202.

OECD (2002a), "Information Technology Outlook – ICT and the Information Economy 2002 – The Software Sector", *OECD Social Issues/Migration/Health*, **07/2002**; 320-414.

OECD (2002b), "Science, Technology and Industry Outlook – 2002 Public and Private Financing of Business R&D", *OECD Science & Information Technology*, **17**;118-54.

Oliver, P. and G. Marwell (1988), "The Paradox of Group Size and Collective Action – A Theory of Critical Mass (II)", *American Sociological Review*, **53**; 1-8.

Phillips, J. and A. Firth (2001), *Introduction to Intellectual Property Law*, 4th Edition, London, Butterworths.

Pindyck, R. and D. Rubinfield (2001), *Microeconomics*, 5th Edition, Berkeley, Prentice Hall.

Quah, D. (2002), "Matching Demand and Supply in a Weightless Economy: Market-driven Creativity With and Without IPRs", working paper (available at http://econ.lse.ac.uk/staff/dquah, last visited 26 November 2002).

Ridyard, D. (1996), "Essential Facilities and the Obligation to Supply Competitors under UK and EC Competition Law", *European Competition Law Review*, **8**; 438-52.

Rubinstein, A. (1982), "Perfect Equilibrium in a Bargaining Model", *Econometrica*, **50**; 79-109.

Rubinstein, A. (2003), "A Beautiful Mind – John Nash and Game Theory", Speech at the London School of Economics, 3rd February, 2003 (available at http://gametheory.tau.ac.il/lse/).

Stigler, G. (1968), *The Organization of Industry*, Oxford, Basil Blackwell.

Stigler, G. (1974), "Free Riders and Collective Actions", *Bell Journal of Economics and Management Science*, **5**; 359-65.

Stiglitz, J. (1997), *Wither Socialism?*, Cambridge, MA, MIT Press.

Stiglitz, J. and J. Driffill (2001), *Economics*, Norton Publishing Co.

Sutton, J. (1991), *Sunk Costs and Market Structure: Price Competition, Advertising, and the Evolution of Competition*, Cambridge MA, MIT Press.

Sutton, J. (1998), *Technology and Market Structure – Theory and History*, Cambridge, MA, MIT Press.

Takeyama, L. (1997), "The Inter-temporal Consequences of Unauthorized Reproduction of Intellectual Property", *Journal of Law and Economics*, **70**; 511-22.

Towse, R. (2001), *Creativity, Incentive and Reward: An Economic Analysis of Copyright and Culture in the Information Age*, Cheltenham and Northampton, MA, Edward Elgar.

Ulen, T. (1999), "Rational Choice Theory in Law and Economics", in Bouckaert and de Geest (eds.), *Encyclopedia of Law and Economics*, Cheltenham UK and Northampton MA, Edward Elgar Publishers; Section 0710.

Viscusi, W.K., J. Vernon and J. Harrington (2001), *Economics of Regulation and Antitrust*, 3rd Edition, Cambridge MA, MIT Press.

Warren-Boulton, F. and K. Baseman (1995), "Economics of Intellectual Property Protection for Software: The Proper Role of Copyright", *Standard View*, **3**; 68-72.

Werden, G. (2004), "Exclusionary Pricing Tactics: United States Antitrust Law", speech at the 4th Annual Conference on International and Comparative Competition Law on "The Trans-Atlantic Antitrust Dialogue", British Institute of International and Comparative Law, 10 May 2004.

Westkamp, G. (2001), "Balancing Database Sui Generis Right Protection with EU Monopoly Control Under Article 82(1) EC", *European Competition Law Review*, **21**; 13-24.

Whish, R. (2001), *Competition Law*, 4th edition, London, Butterworths.

Net Le, PhD (London School of Economics), Lecturer, Ho Chi Minh City Law College, Vietnam. e-mail: netle2000@yahoo.com. The author would like to thank Professors Tim Murphy, Alison Firth, Steve Anderman, Mr Andrew Murray, Ms Heather Harrison-Dinniss and Justina Fischer for their comments. The views expressed and any mistakes are the responsibility of the author.