Grantbacks, Territorial Restraints and the Type of Follow-On Innovation: The "But for..." Defence[1]

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Abstract

We analyse the effect of grantback clauses in licensing contracts. While competition authorities fear that grantback clauses might decrease the licensee's *ex post* incentives to innovate, a standard defence is that grantback clauses are required for the patent-owner to agree to license its technology in the first place. We examine the validity of this "but for" defence and the equilibrium effect of grantback clauses on the innovation incentives of the licensee for both non-severable and severable innovations. Under the 2004 EU *Technology Transfer Guidelines*, and the guidelines for some other jurisdictions, grantback clauses that apply to "non-severable" (read "infringing") innovations are considered to be less controversial than clauses that apply to "severable" innovations.. We show, to the contrary, that grantback clauses do not increase the patent-holder's incentives to license when non-severable innovations are at stake but they do when severable innovations are concerned – suggesting that the "but for" defence might be valid for severable innovations but not for non-severable ones. Moreover we show that, for severable innovations, grantback clauses can increase the range of parameters for which follow-on innovation by the licensee occurs.

Key words: licensing ; innovation; grantback
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1. Introduction

Patent-holders are not always best placed to exploit their own technology in the market. In particular, while the patent-holder might be quite competitive at home, it might not have the necessary local expertise to perform well in other geographic markets. Alternatively, using the existing production facilities of a local firm might be more efficient that serving a market through exports or investing in new local facilities.

When local expertise matters much or barriers to trade are significant, it is common for patent-holders to license their technology to a local firm and earn revenues from royalty payments[5]. While figures for the monetary significance of this activity are difficult to pin down, Zuniga and Guellec (2009) find that, in a recent survey of the European Union (EU) and Japan conducted in the second half of 2007, 20% of firms in Europe and 27% in Japan grant licenses to non-affiliated entities. The Organisation for Economic Cooperation and Development (OECD, 2015b and 2015c) finds that international trade in knowledge assets in the most recent figures of 2013 for 32 OECD countries were on average between 2% and 3% of GDP or a total of $364707.7M for receipts and payments[6].

Such licensing is generally seen as welfare increasing because it ensures that local production is done efficiently and also ensures that the technology diffuses to several markets as well as to several firms. Indeed, such efficiencies are the basis of the argument in the 2014 EU Technology Transfer Guidelines for the pro-competitive potential of licensing agreements[7]. This positive view can also be found in the US Antitrust Guidelines for the Licensing of Intellectual Property and in the preamble to the

[5] There is a large literature on entry mode choice in international trade, which covers many issues not addressed in this paper but does provide considerable evidence and theory to support this statement. A recent paper by Markusen and Xie (2014) and the special issue that it is a part of summarises many of the main features of this literature.

[6] This figure measures "cross-border, disembodied trade in technology….Licensing to reproduce/distribute computer software and audio-visual products are excluded." A full list of what is and is not included is in OECD (2015b) and OECD (2015c).

[7] See EC 2014, paragraph 17, "License agreements may also have substantial pro-competitive potential…Such integration…may lead to a cost/output configuration that would not otherwise be possible…Licensing may also serve the pro-competitive purpose of removing obstacles to the development and exploitation of the licensee's own technology…"

Japanese Guidelines for the Use of Intellectual Property under the Antimonopoly Act[8].

On the other hand, all of these authorities recognise that licensing contracts can be quite complex and that restrictions contained in them can diminish their social value. One such clause concerns how improvements to the licensed technology are treated and in particular whether improvements made by licensees must be "granted back" to the licensor. For grantbacks, the concern is, in the words of the proposed US Guidelines, that they "may reduce a licensee's incentives to engage in resarch and development and thereby limit rivalry." (FTC, 2016)[9]

Legal advice on the potential importance of including grantbacks in a licensing contract seems unambiguous as is the argument for why such clauses are necessary. In the words of one of many websites giving such legal advice, "a properly drafted grantback license can encourage the licensing of technology by removing the fear that the licensor could find itself competing with a licensee who has developed an improvement to its technology."[10] At the same time, the same legal advice states that, "an improperly drafted grantback clause risks being viewed as an anticompetitive provision that inhibits innovation."

Given this type of advice, one would expect that grantbacks would not be uncommon even if they carry some risk of being viewed as anti-competitive. Cockburn (2007) finds that 43% of licensing contracts contain such clauses. Moreira et al. (2012) find, furthermore, that grantbacks tend to be

[8] The EU TFEU states that "licensing as such is pro-competitive as it leads to dissemination of technology and promotes innovation by the licensor and licensee(s). In addition, even license agreements that do restrict competition may often give rise to pro-competitive efficiencies." (EC 2014). The Japanese Guidelines for the Use of Intellectual Property under the Antimonopoly Act similarly state (in translation) in the preamble that "technology transactions assist in promoting competition by enabling increased efficiency in the use of technology…" see Japan Fair Trade Commission (2007). The proposed update of the US Antitrust Guidelines states that, "Licensing…can lead to more efficient exploitation of intellectual property, benefiting consumers through the reduction of costs and the introduction of new products." (FTC, 2016)

[9] See also EU Technology Transfer Guidelines at paragraph 132, EU (2014); Japan Federal Trade Commission (2007) at 4.4.viii(c) and 4.4.ix(b) and Ning, Gong and Li (2016), "The negative effects of grant-backs on innovation and competition are therefore the focus of China's legislation".

[10] See McGurk (2013). This wording is echoed in the proposed new US guidelines, "A non-exclusive grantback …may be necessary to ensure that the licensor is not prevented from effectively competing because it is denied access to improvements developed with the aid of its own technology." See FTC (2016).

more commonly-used in licensing contracts between firms that are in the same product market and are familiar with the relevant technologies.

The exact legal guidelines for grantbacks have, in fact, changed over time. Despite a general unease about the provisions as potentially reducing innovation incentives[11], the Transwrap case[12] established that grantbacks were not *per se* illegal. In subsequent cases, it was similarly judged that grantbacks were not necessarily inconsistent with competition policies unless they were part of a more general pattern of anticompetitive behaviours. Under the 2004 EU *Technology Transfer* Guidelines, a somewhat different approach emerged. The seriousness of anticompetitive and, in particular, innovation concerns depended on the nature of the licensee's innovation. Grantbacks involving *severable* innovation – innovations that can be used without infringing upon the licensed technology – were viewed as more harmful than those that apply to *non*-severable innovations, especially when the grantbacks are exclusive.[13] This approach also can be seen in the Japanese Guidelines, where grantbacks of improved technology created by a licensee that cannot be used without the licensed technology (ie, non-severable innovation) would generally not be seen as impeding fair competition[14]. The revised 2014 EU Technology Transfer Guidelines drop this distinction, however.

A decidedly more negative view can be found in the 2008 Anti-monopoly Law of the People's Republic of China, which argues that grantbacks are likely "[to be] injurious to proper functioning of normal competition" despite the procometitive effects of "reducing licensing risks for licensors and…facilitating innovation". (Ning, Gong, and Li, 2016). Indeed the National Development and Reform Commission in China in a recent decision, rejected Qualcomm's royalty free grantback as restraining innovation and restricting competition in wireless communication technologies as a violation of the Anti-monopoly Law 17(1)[15]. Qualcomm was fined 6.088 RMB in this decision, and was required to remove the royalty free grantback.

Our paper takes these observations as a starting point. We design a model that allows us to focus on the main argument presented in these documents in defence of grantbacks, what we call the "but for…" defence that, but for the existence of the grantback the licensor of a basic technology would have no incentive to license in the first place for fear that the licensee would use access to the basic technology to improve it to the point of threatening the competitive position of the basic technology owner. In order to focus on this "but for…" argument, we postulate that the basic technology is "facilitating" in

[11] As stated in the proposed revision of the US guidelines, "Grantbacks may adversely affect competition, however, if they substantially reduce the licensee's incentives to engage in research and development and thereby limit rivalry." (FTC, 2016). Other jurisdictions' guidelines express the same fear.

[12] Stokes & Smith vs. Transparent-Wrap Mach. Corp. 156 F.2d. 198 (2d Cir. 1946), rev'd 329 US 637 (1947).

[13] In contrast to *severable* innovation, *non-severable* innovation is defined such that it cannot be exploited by a licensee without a licensor's permission.

[14] See Japan Fair Trade Commission (2007) point 4.4.viii(c) and 4.4.ix(b) note 21.

[15] See Section 2 NDRC Decsion of Administrative Penalty 2015, no. 1, as cited in Ning, Gong and Li (2016).

the sense that obtaining a license to use it is what allows the licensee the ability to improve the basic technology significantly. Without such use, the licensee would not be able to generate such improvements. We also postulate that the licensor and licensee potentially operate in local markets that are separated by a transportation cost, and also that the licensor and licensee are both well acquainted with the types of technology in the industry to the point that no asymmetric information on the quality of the licensed technology is present. Finally, we postulate that grantbacks can be accompanied by other legal covenants in the license, such as territorial restraints. These assumptions are all made to ensure that our model captures the typical case that appears to be the basis for current grantback guidelines.

In this framework, we analyse the procompetitive benefits of grantbacks with a focus on the question of whether the type of technology – severable or non-severable – has a bearing on the benefits of grantbacks and whether the "but for…" argument in favour of the use of grantbacks holds. We find that, when follow-on innovation infringes the initial technology, the parties always agree to license the basic technology. This is true both with and without grantbacks, so that the "but for…" justification for the use of grantbacks does not hold. However, as feared by antitrust authorities, grantback clauses inefficiently reduce incentives to undertake follow-on innovation. Still, because both parties actually benefit from the follow-on innovation, the parties themselves would not choose to include a grantback clause in their licensing agreement.

When we consider severable innovation, there is a real risk that the basic technology might not be licensed at all. This is because the follow-on innovation does not infringe the basic technology and therefore frees the innovator from any obligation under the initial licensing arrangement. If the follow-on innovation is large enough compared to the barriers to trade between the two markets, the follow-on innovator could compete quite effectively in the home market of the initial licensor. This threat means that, while the follow-on innovation will be licensed back to the owner of the basic technology, the royalty charged can be so high that basic innovation patent holder is better off not licensing – and hence enabling follow-on innovation – in the first place. There is, therefore, a potential case for a "but for…" defence. Indeed, we find that a grantback clause both increases the range of parameters for which the basic technology is licensed and lead to a better alignment of private and social incentives for follow-on innovation.

The policy implications are several-fold. First, as we said earlier, the 2004 EU technology licensing guidelines as well as the Japanese guidelines made a distinction between grantbacks for severable and non-severable innovation, but allowed easier defence of grantbacks in the non-severable case. Our

analysis suggests that this is the wrong way around: grantbacks are more defensible and improve innovation incentives more for severable innovations[16]. Second, the revised EU guidelines as well as the US Guidelines simply drop the distinction between severable and non-severable innovation. Our findings imply that this is not quite right either: our modelling suggests that these two cases do, indeed, provide differing incentives to use grantbacks and differing innovation and welfare effects. Third, in a setting such as ours, where there are insufficient innovation incentives generally, we find that grantbacks may or may not improve innovation incentives, depending on the type of follow-on innovation. This means that the fears about grantbacks' negative effects on innovation may or may not be well placed, again depending on the nature of the follow on with grantbacks generally improving matters for severable innovation.

Despite the importance of grantbacks empirically and the continuing shifting of their legal treatment, the economic literature on grantbacks is sparse. Van Dijk (200) argues that the use of grantbacks can be socially desirable precisely because they are likely to slow down the rate of innovation where there are socially excessive incentives to innovate. We take a different approach: we take for granted that we should consider an environment where innovation is socially insufficient since it is the overwhelming presumption of the guidelines on technology transfer. Within a model specifically designed to be consistent with insufficient innovation incentives we then examine whether innovation incentives rise or fall with grantbacks and when. In that sense, our work is complementary to Van Dijk's.

Our work is also complementary to that of Choi (2002), who proposes a model where a licensor faces the risk of obsolescence ("boomerang effect") from a licensee where the basic technology is "facilitating" in our sense. However, his model assumes that follow-on innovation is "severable", while in line with previous policy, comparing severable and non-severable innovation is a focus of our analysis. He also assumes that both parties can pursue the follow-on innovation and that licensing contracts are flexible enough that bargaining is always efficient. He also does not assume, as we do, that the licensee has a unique ability to improve on the technology. There is therefore no incentive to use a grantback clause under complete information. In order to explain the observation that grantbacks occur frequently, Choi suggests that under asymmetric information the license must be designed so as to incentivise the licensor to transfer a technology that has the potential to facilitate improvements rather than a lower quality technology that does not. A grantback can provide these

[16] We have introduced this point as part of a report contributed to the consultation process on the change in the guidelines. See Régibeau and Rockett (2011).

incentives more easily since it already incorporates insurance against obsolescence.

Our work does not rely on asymmetric information by design: we wish to explain grantbacks in the context we observe of similar firms that are familiar enough with the market and technology that asymmetric information effects are likely to be small. While Choi's work would apply more readily to situations such as licensing between, say, a developed and a developing country or a firm with high technological ability and a relative newcomer to a field, ours would apply more readily to licensing among equals. As the evidence suggests that licensees in developed economies are rather knowledgeable about the technologies involved, one might think that our framework applies better to licensing agreements between firms from advanced economies while Choi's mechanism might give us better insights into technology licensing in a "North-South" framework.

Our contribution compared to these papers, then, is to evaluate grantbacks in a setting that moves closer to some of the circumstances where we observe them and in a model designed to allow us to study the main argument for why firms might use them, without negating the contributions that already point out their advantages. We pull together these complementary lessons in the policy section at the end of the paper.

Our emphasis on evaluating grantbacks under severability and non-severability evokes Green and Scotchmer's (1995) work on a model of sequential innovation with varying standards of infringement applied to the improvement. These authors examine a case where patenting of the basic technology is enough to enable innovation by another firm. This means that the basic technology owner has less leverage than in our model in the initial licensing negotiations. Indeed, as an aside, the prominence of the "but for…" argument for grantbacks suggests that patent documents are not fully enabling but instead that licensing may be a prerequisite to facilitating improvements.

In their framework, Green and Schotchmer argue strongly in favor of *ex ante* licensing agreements (i.e. agreements reached before the follower invests in the second innovation), as these ensure that innovators invest in the improvement only if it increases their joint profit. If only *ex post* licensing is allowed, the second innovator cannot bargain over the sunk cost of the improvement – which can result in inefficiently low investment in improvements. They then consider how different infringement regimes affect the division of profit between the parties. This is similar to our comparison between severable and non-severable innovations; however, while they consider the infringement regime as a policy tool, we take each regime as given and ask whether the antitrust treatment of grantbacks should differ according to the type of follow-on innovation involved. Our analysis further

differs from Scotchmer and Green in that territorial exclusivity clauses provide a measure of protection to the initial innovator, which is not available in their model. As mentioned above, the first innovation is only facilitating if it is licensed in our model.

Finally, one of our main drivers is that the licensee can escape royalty payments for the basic technology by innovating in the case of severable innovation. This means that the licensor has an incentive to lower the initial license in order to tempt the licensee not to innovate: as the incentive to escape the license fee for the basic technology falls, the incentive to innovate in a way that would potentially make the basic technology owner's technology obsolete falls as well. This is a benefit for the licensor and affects the basic technology license terms, as well as the attractiveness of a grantback to address the same threat. The more favourable basic technology license terms are, then, a form of market sharing to deter market entry, which was analysed by Gallini (1984). Her paper, however, pointed out the incentive to share a market in order to reduce duplicative research expenditure. We have no such duplicative expenditure in our model since the licensee is uniquely endowed with the ability to improve on the basic technology.

The rest of this paper is organized as follows. Section 2 outlines the model structure in the multistage game. Section 3 examines the case of non-severable innovation while section 4 considers severable innovation. Section 5 extends the model to the case of two heterogeneous licensees and discussion policy. Section 6 concludes.

2 Model structure

A licensor (firm *L*) has patents covering a basic technology (*BT*). As shown in Figure 1, there are two markets: the patent-holder's home market and a "foreign" market. In each market the demand for the product that can be manufactured thanks to the technology is perfectly inelastic : all consumers have a reservation price equal to 1 and there is a mass 1 of consumers, as shown in the two panels of figure 1.[17] The patent-holder can serve the home market at no cost. By contrast, serving the foreign market involves a per unit cost requal to $c > 0$. We will refer to this cost as the level of "trade barriers". This covers both actual trade barriers such as transportation costs or tariffs and any other advantage that might accrue to a local firm that serves a different customer base. This structure allows us to incorporate (varying) efficiency gains from licensing to another firm and (varying) access concerns,

[17] We have also solved the model for asymmetric market size with a mass of consumers *m* in the licensee's market. This does not affect the nature of the results.

both of which are standard motivations to license.[18]

It follows immediately that if firm *L* were to commercialise its technology without relying on a licensee it would earn total profits equal to $Max\ [2-c,1]$. Alternatively, the patent-holder could serve the home market alone but could license another foreign firm – called firm *A* – to serve the foreign market. If each firm enjoys exclusive use of the technology in its respective market, then they obtain joint surplus equal to 2. Licensing, therefore, leads to an increase in joint surplus equal to the efficiency gain $Min[c,1]$.

We assume that the firms bargain over a per unit royalty (ie, a payment conditioned upon the use of the technology) to charge for the license[19]. While it is possible that multiple licensees are available so that the licensor can work from a very strong bargaining position, we assume the Nash Bargaining Solution is the more typical case, following our reading of the WIPO (2015) guidelines for "typical" licensing agreements. This document makes it clear that bargaining often does not afford such leverage to the licensor. Choi (2002) argues that a single licensee can be taken empirically as a "typical" case. As a result, we focus on the Nash Bargaining solution with equal bargaining power assumed. Under this assumption, and for the case of licensing the basic technology, it is straightforward to check that if the licensor and licensee bargain over a per unit royalty r, the solution of the corresponding Nash Bargaining solution splits this increase in surplus evenly between the two parties, i.e. $r = Min[c/2, 1/2]$.

We now investigate the properties of the optimal licensing contract when territorial restraints and further innovation by the licensee are considered. We will assume, as above, that the licensing contract specifies that the licensor is the only firm authorised to sell an infringing product in its home-market while the licensee is given exclusivity in its own market. This assumption is motivated both by actual practice and the current state of the law. Bleeke and Rahl (1979), for example, observe that the vast

[18] This allows us to vary market interaction between the assumption of Choi (2002), where markets are completely separate for the basic technology (but completely integrated under improvement), and Van Dijk (2000), where the firms compete for the same market at all points. Choi (2002), footnote 13, provides empirical motivation for the assumption of a single licensee in the market.

[19] Choi (2002) assumes a take-it-or-leave-it offer, whereas Van Dijk (2000) assumes a Nash Bargaining solution. The structure of their licensing payments differs from ours, with Choi assuming a flexible contract and Van Dijk assuming an upfront fixed fee. We assume a royalty that is conditional upon use, following upon the observation in Choi (footnote 8) that there is an 'apparent ubiquity of royalties as a mode of payment'.

majority of firms include some form of territorial restrictions in licensing contracts.[20] From a legal perspective, territorial restrictions in licensing contracts are usually allowed in the US and Europe, with the practice varying in other countries.[21] By incorporating both the varying transportation cost and the territorial restraint clause in the licensing contract, we put some structure on the separate of markets (or integration of markets) that is assumed in earlier work on grantbacks. The precise nature of the market separation matters to how the grantback works, as we will see below.

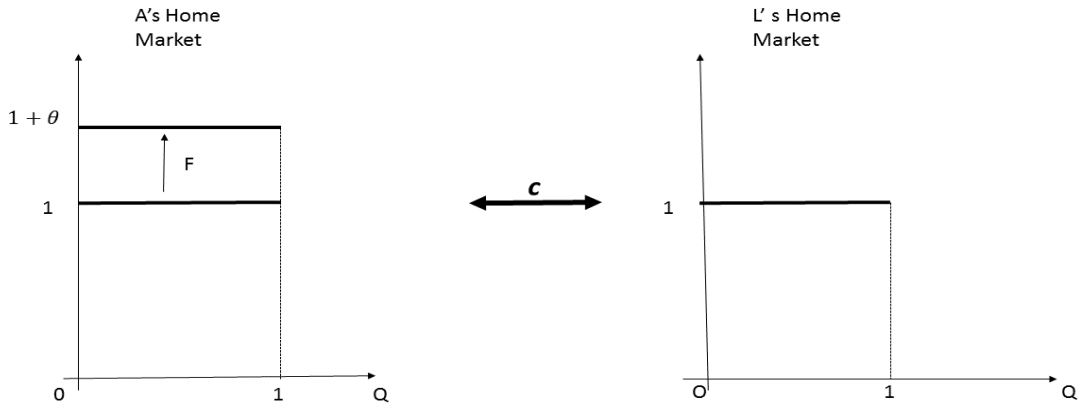

Figure 1: Demand, Innovation and Trade Barriers

Because grantback clauses are perhaps most often justified as a way of protecting the licensor from the harmful consequences of follow-on innovation by the licensee, we ignore further research efforts by the patent-holder, *L*, and focus our attention on the innovation activities of the licensee, *A*. We also assume that the very fact that firm *A* receives a licence for the basic technology, and therefore practices this technology, increases the probability that firm *A* might come up with *improvements* to this technology. In this sense, the basic technology is facilitating in our framework: the patent disclosure is not fully enabling but instead the technology must be practiced by the licensee in order for improvements to be forthcoming. We push this to the extreme by assuming that firm A cannot innovate in the absence of a license. On the other hand, once firm A has become a licensee of the basic

[20] Bleeke and Rahl (1979) draw a conclusion that "The response to this question strongly indicates that most corporations are not willing to compensate for the absence of restrictive [territorial] provisions by charging a higher royalty rate." We can understand that, where patents are present, territorial restrictions could be sought as a prerequisite to licensing contracts.

[21] See the summary of Delrahim (2004) who describes the positions of the US and EU. For other jurisdictions, see http://www.wipo.int/patent-law/en/developments/competition.html.

technology we assume that it can innovate immediately at a fixed cost *F*. Such an investment succeeds with certainty and increases the consumer' willingness to pay from 1 to $1+\theta$. The certainty of innovation and its immediacy are designed to allow us to focus on the "but for " defence of grantback clauses by underlining the potential damage that the licensor might suffer from the licensee's innovation whilst at the same time simplifying the model to focus on the argument of interest.

The licensee's innovation can be of two types. If the improved technology can be implemented without infringing the initial *BT* patent, then the innovation will be referred to as "severable". If, on the other hand, the improvement can only be used in conjunction with the *BT* and hence requires a license for the *BT* before it can be implemented, then we will say that the innovation is "non-severable". This is the terminology used by antitrust authorities in the EU but, as was mentioned in the introduction, the concepts underlying this are also present elsewhere, specifically in Japan. When an innovation is severable, firm *A* can sell the product of quality $1+\theta$, without relying on *BT* transferred from firm the licensor. This also means that *A no longer owes any royalty payment to the owner of the BT patents*. At the same time, this reduction in payments does not in any way void the licensing contract, even if the licensee no longer uses the *BT*. Specifically, if the licensor still relies on the *BT*, it is still contractually obliged not to sell in the licensee's territory. By contrast, when the innovation is non-severable, the improved technology (*IT*) cannot be applied without infringing upon *BT*[22]. Hence, the licensing contract is still fully effective, firm *A* is still prevented from selling in the licensor's territory, it still owes a royalty payment to the licensor, and all territorial restraints still bind. This is consistent with what is allowable under current treatment of licenses, as we have said.

This contract structure is important, as it will determine the effects at work in the severable innovation case. More precisely, notice that the licensee can escape royalty payments by innovating and so not using the *BT*. In the case of non-severable innovation, there is no such incentive to innovate: royalties are still due because the use of the improvement requires the assent of the *BT* owner.

For most of our analysis, we will focus on the case where $c<1$, so that "barriers to trade"are not prohibitive even in the absence of follow-on innovation. At times, however, we will also investigate the situation where the follow-on innovation makes it possible to overcome what were initially prohibitive barriers, i.e. $1\le c\le 1+\theta$.[23]

[22] This might be because the improvement itself infringes the patent for the *BT* or because, the improvement can only be *used* together with the *BT*.

[23] This is similar but not identical to the case studied in Choi (2002), where the markets initially are separate

The licensing game is structured as follows. In Stage 1, the licensor decides whether or not to enter into negotiations with firm A about licensing the patented technology. In stage 2, the two parties negotiate the terms of the licensing contract, i.e. the usage-based royalty r_1 that firm *A* commits to pay to the licensor for as long as it uses the basic technology. They also negotiate the possible inclusion of a grantback clause. A grantback clause specifies that the improved technology developed by the licensee must be made available to the licensor without compensation. More precisely, under our assumptions about territorial restrictions, the licensee is still free to use the improvement in its own market but the licensor is also free to use the improvement in its own home market. Critically, we assume that the grantback clause does not specify any payment from the licensor in exchange for the improved technology. While this assumption allows us to concentrate on royalty free grantbacks, which are the more controversial type of clause[24], what matters is that the parties cannot agree *ex ante* any payment that is *conditional* on the development of the follow-on innovation, its value, and its effective transfer. This reflects the fact that the parties would find it difficult to specify a payment that would depend on the yet unknown – and hard to verify – "quality" of the licensee's future improvement.[25]

Once the licensing agreement is reached, then, in stage 3, firm *A* innovates if it it is profitable to do so. Innovation involves a fixed cost *F* and creates an additional value of θ for consumers. We assume that whether or not this innovation would be severable is already known to all in stages 1 and 2. In other words we are either in a "severable innovation" case or in a "non-severable innovation case". In the Discussion section, we explain that relaxing this assumption would not affect the nature of our results. If the initial contract included a grantback clause, then the licensor also has access to the improved technology. Otherwise, the licensee negotiates with the licensor the access terms firm *L* could obtain for this improved technology. The outcome of this negotiation is a second royalty r_2 paid

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but fully integrated under improvement, as the transportation cost still applies to any cross-market movements in our model.

[24] Indeed, the Chinese law in this area identifies "requiring a licensee to gratuitously provide the licensor with the improved technology…" as automatically void. See Ning, Gong and Li (2016).

[25] The difficulty of *ex ante* licensing has been widely recognised, including Green and Scotchmer's (1995) comments that setting *ex ante* royalties in the way they assume possible would normally raise anti-trust fears. Making a similar point about the difficulty of setting royalties European Competition Law Annual (2005) comments that "… [parties] currently avoid any discussion of actual royalty rates [in *ex ante* negation], due in part of the fear of antitrust liability…"

by the initial licensor to firm *A*. Finally, in stage 4, both firms set prices and profits are realised.

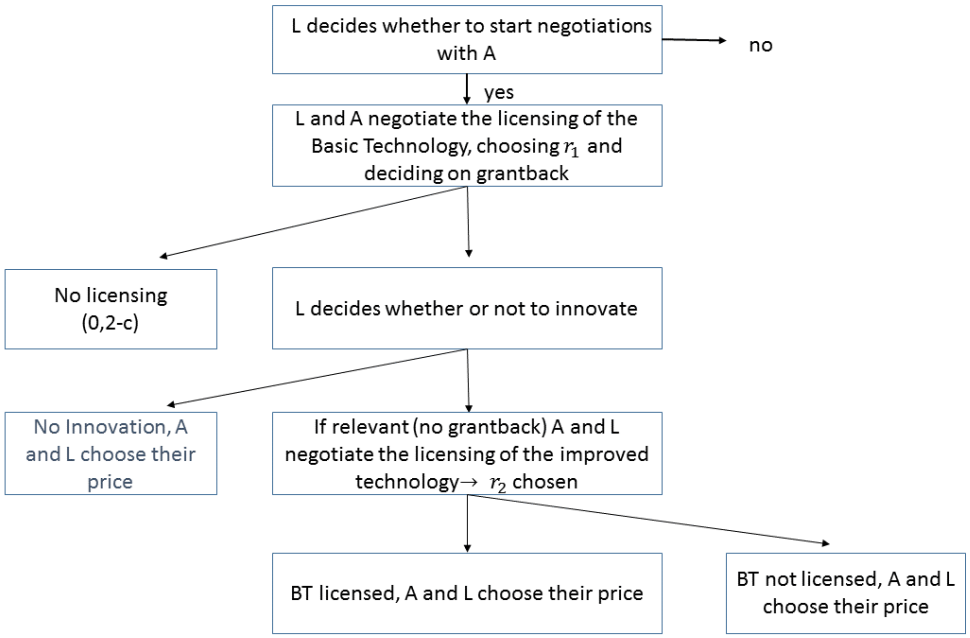


Figure 2 Timing of the game

3 Non-severable innovation

3.1 No grantback clause

We first consider the case where the parties agree to a licensing contract without grantback. If firm *A* gets a license and innovates, then it would license the resulting improvement back to the initial licensor for a royalty r_2, which is determined by the following Nash Bargaining Solution :

$$\max_{r_2}[(1+\theta+r_1-r_2)-(1+r_1)][(1+\theta-r_1+r_2)-(1+\theta-r_1)] \quad (1)$$

$$\leftrightarrow \max_{r_2}(\theta-r_2)r_2$$

The first term is the difference between the pay-off of firm *L* when it pays for access to the follow-on innovation and when it does not. Notice that, because a non-severable innovation always infringes *BT* (or requires the joint use of *BT*) the royalty, r_1, must still be paid by firm *A* to firm *L* in the event of

follow on innovation. The second term is the difference between firm *A*'s pay-off with and without licensing of the improved technology and boils down to the royalty paid by *L* to access the improved technology. The solution to the bargaining problem is:

$$r_2^{NN} = \frac{\theta}{2} \tag{2}$$

where we designate the case of no grantback and non-severable innovation by "*NN*". Not surprisingly, the two firms split the additional surplus created by the licensing agreement equally. Overall then, the additional profits that firm *A* gets if it innovates comes from two sources. Firstly, firm *A* can charge a price equal to $1+\theta$ instead of 1 in its home market. Secondly, *A* gets the royalty payment from *L*.

Firm *A* will therefore decide to invest in innovation as long as:

$$F \leq \frac{3\theta}{2} \tag{3}$$

Since the innovation is socially beneficial as long as $F \leq 2\theta$, incentives to innovate are socially insufficient. This is simply the result of the parties' inability to sign a contract conditional on the realisation of the innnovation before firm *A* must invest.

Assuming that the condition for innovation is satisfied, we move back to Stage 1, where the royalty, r_1, that *A* pays to get access to the basic technology is the solution to the following problem:

$$\max_{r_1}[(1+\theta+r_1-r_2^{NN}))-\pi_L^R][(1+\theta-r_1+r_2^{NN}-\mathrm{F})-\pi_A^R] \tag{4}$$

where $\pi_L^R = 2-c$ and $\pi_A^R = 0$ represent the profits of firms *L* and *A* when no agreement is reached so that *L* serves both markets (recalling that *c≤1*). Solving this bargaining problem, we get

$$r_1^{NN} = 1+\frac{\theta}{2}-\frac{c+F}{2} \tag{5}$$

Hence, firm *L* earns a net royalty equal to $r_1^{NN}-r_2^{NN} = 1-\frac{c+F}{2}$. The equilibrium profits are $\pi_L^{NN} = 2+\theta-\frac{c+F}{2} > \pi_L^R = 2-c$ and $\pi_A^{NN} = \theta+\frac{c-F}{2} > 0$ so that, when the cost of innovation is low enough that the licensee would engage in further innovation, firm *L* is better off if it decides to license its technology to firm *A*.

The intuition is again simple. Since the benefits from the anticipated innovation by the licensee form part of the expected joint surplus, the licensor's own pay-offs increase with the prospect and size of this innovation. In our setting, the initial negotiation anticipates the outcome of the second negotiation so that the future payment from the licensor to the licensee is incorporated into the initial royalty. Notice that such a solution is only possible because the licensee's follow-on innovation is non-severable so that the royalty agreed upon in stage 2 remains due once the follow-on innovation has occurred.

If the licensee does not find it profitable to innovate *ex post* (i.e. if $F \geq {}^{3\theta}/_{2}$), then, the stage 2 royalty and the profits of the two parties are obtained by taking $\theta = F = 0$ in the formula above. In this case, we can see that the *BT* is still licensed in order to get around the trade barriers between the two markets but innovation does not occur even though it would be efficient for $F \leq 2\theta$.

Overall, then, the fact that the initial licensing agreement would facilitate follow-on innovation by the licensee does not eliminate the incentive to license the basic technology in the first place. The "but for" defence does not hold: : we observe that the licensor would license even without a grantback clause because the licensor retains control over the entire stream of innovation for non-severable innovation. Hence, a grantback is not necessary to induce this licensing. Non-severability allows the initial licensor to agree a contract that will generate surplus despite innovation even where a grantback is not present: once improvement is available the initial innovator's agreement is required to allow the improvement to be commercialised. This allows a favourable royalty to be negotiated despite the lack of prior agreement through a grantback.

3.2. Grantback clause

The licensing agreement considered now includes a grantback clause. This means that firm *A* can no longer demand a royalty in return for *IT* in Stage 3, so that it will only invest in the follow-up innovation if the return in its home market exceeds the investment cost, i.e. if $F \leq \theta$. Since this range is smaller than in the absence of grantback, we conclude that a grantback clause does reduce incentives for follow-on innovation, as feared by Competition Authorities.

Assuming that firm *A* would innovate, the bargaining problem is stage 2 is:

$$\max_{r_1}[(1+\theta+r_1)-(2-c)](1+\theta-r_1-\mathrm{F}) \tag{6}$$

So that

$$r_1^{NG} = 1 - \frac{(c+F)}{2} \tag{7}$$

where the superscript "*NG*" represents the case of a non-sevearable innovation with a grantback. This royalty is equivalent to the *net* royalty earned by firm *L* without grantbacks. This of course means that the profits of firms *L* and *A* are exactly the same as for a license without a grantback clause. If $F > \theta$, there is no follow-on innovation and the pay-offs are abtained by setting $\theta = F = 0$.

The relevant pay-offs are summarised in Table 1.

Innovation Cost	**No GB**	**GB**	**Effect of GB**	**But-For Defence**
$\boldsymbol{F > 3\theta/2}$	Licensing, no innovation	Licensing, no innovation	None	No
$\boldsymbol{\theta < F \leq 3\theta/2}$	Licensing and Innovation	Licensing, no innovation	Discourages Innovation	No
$\boldsymbol{F < \theta}$	Licensing and innovation	Licensing and Innovation	None	No

Table 1: Innovations and Profits with Non-Severable Innovation

These results should not be surprising. Because the follow-on innovation is non-severable, the licensee can only exploit it in its own territory, whether or not there is a grantback clause. The only difference is that, absent the grantback clause, the licensee can extract its own royalty payment from firm *L* so that it can use the follow-on innovation in its own territory. This increases the licensee's incentives to innovate, although socially they remain insufficient. However, since this royalty payment is fully anticipated by both parties, it is counted as part of the licensee's share of the total surplus in stage 2 negotiations. This means that, overall, the sharing of rents is not affected. This argument establishes the following proposition:

Proposition 1: *With a non-severable innovation, the basic technology is always licensed, whether or not the licensing agreement includes a grantback clause. Therefore, the "but for" defence does not hold.*

Incentives for follow-on innovation are weaker with a grantback clause so that there is socially an underincentive to invent with grantbacks.

3.3. Would the Parties Choose to Include a Grantback Clause?

We now ask whether the parties would actually *choose* to include a grantback clause in their contract. After all, the fact that the "but for" defence is not valid and that a grantback clause can adversely affect incentives to innovate is only a strike against allowing grantback clauses if the parties would otherwise decide to make use of such clauses.

Since the clause only affects pay-offs for intermediate values of *F*, this is the only case worth considering. Over this range we can see from the preceding argument that both the licensor and the licensee are better off without a grantback clause precisely because it leads to efficient follow-on innovation and the benefits of this innovation can be shared through the initial licensing royalty. This argument establishes the following proposition:

Proposition 2: *If the follow-on innovation is non-severable and the inclusion of a grantback clause is determined as part of the negotiation process, then the parties agree not to have a grantback clause.*

4 Severable innovation

In the case of severable innovation, and in the absence of a grantback clause, firm *L* cannot extract any royalty payment from firm *A* in return for transferring *BT* in Stage 1 if follow-on innovation actually occurs in stage 3. This is because of our stark assumption that follow-on innovation occurs immediately, making *BT* obsolete. Furthermore, the royalty payments are linked to the actual use of the innovation[26]. Although firm *A* learns from licensing the *BT* , firm *A* does not actually employ it in production where *IT* is available.[27] We first consider the situation in the absence of grantback.

4.1. No Grantback Clause

[26] As discussed earlier on, these assumptions were chosen to bring the "but for" argument in favour of grantback clauses in the sharpest possible relief. Assuming that innovation only occurs after a period of actual use of the basic technology or that part of the royalty payment is independent of the actual use of that technology would not modify our qualitative results.

.

Assume that the licensee innovates but that the new technology is not licensed back to firm *L*. Firm *A* can charge a price equal to $1+\theta$ in its home market since firm *L* is still constrained by the territorial restraints in the first agreement.

Whether *A* or *L* serves the home market of firm *L* depends on the size of the follow-on innovation. If $\theta > c$, then the innovation advantage of firm *A* is larger than trade barriers so that firm *A* prevails and charges a price equal to $\theta - c$. If $\theta \leq c$, then firm *L* serves the market at a price equal to $c - \theta \geq 0$ [28].

By contrast, licensing the follow-on innovation back to *L* with a contract that includes territorial limits allows both firms to charge $1+\theta$ in their home market, with *L* transferring a royalty r_2 to firm *A*. For a large enough innovation ($\theta > c$), the royalty rate paid by *L* is determined by:

$$Max_{r_2}[1+\theta+r_2-(1+\theta+\theta-c)][1+\theta-r_2] \tag{8}$$

So that

$$r^{SN} = \theta + \frac{1-c}{2} \tag{9}$$

Where "*SN*" represents the case of a severable innovation and no grantback. It is readily shown that we obtain the same royalty and the same pay-offs if $\theta < c$[29]. This leaves the firms with the following profits:

$$\pi_A^{SN} = 2\theta + \frac{3}{2} - \frac{c}{2} > 1 + 2\theta - c \tag{10}$$

---

[28] Firm *A* operates under territorial restraints if it wishes to use *BT*, so the only way to enter firm *L*'s market is to use *IT*. If the price of *IT* equals *c*, then firm *A* just breaks even selling *IT* in firm *L*'s home market. With this "minimum" price, consumers earn $1+\theta-c$ from *IT* and 1 net of the price of *BT* if they purchase from firm *L*. This results in the price $c-\theta$ for *BT*.

[29] $Max_{r_2}[1+\theta+r_2-(1+\theta)-(\theta-c)][1+\theta-r_2]$, so that $r_2 = \theta + \frac{1-c}{2}$

$$\pi_L^{SN} = \frac{1+c}{2} > 0 \quad (11)$$

Since the licensing profits are higher than those obtained when the new technology is not licensed, we conclude that the follow-on innovation is made available to both firms.

Follow-on innovation arises if it is profitable for firm *A*, i.e if

$$1 - r_1 \leq 2\theta + \frac{3}{2} - \frac{c}{2} - F \leftrightarrow \frac{1}{2} + 2\theta - \frac{c}{2} + r_1 \geq F \quad (12)$$

Importantly, notice that, since innovation means that firm *A* does not need to pay any royalty to the owner of the basic technology, firm *L*, firm *A* sees these royalty "savings" as an additional benefit of innovating. Hence, there is a threshold value of r_1 above which follow-on innovation occurs as a means to "escape" these onerous royalty payments.

We can now move back to the second stage of the game where, having agreed to negotiate a licensing agreement, the owner of *BT* and the potential licensee agree on a royalty rate r_1. Without licensing, the *BT*-owner gets *2-c*. Under our assumption that $c < 1$, this profit is higher than firm *L*'s profits if firm *A* innovates. Hence firm *L* would always prefer to retain control of *BT* to the alternative of reaching an agreement with a royalty high enough to trigger follow-on innovation. We can therefore describe the negotiation as the choice of a royalty payment that is low enough to avoid triggering follow-on innovation, i.e:

$$Max_{r_1}[1 - r_1][1 + r_1 - (2 - c)] \; st \; r_1 \leq F + \frac{c-1}{2} - 2\theta \; \equiv \; r_1^{lim} \quad (13)$$

The interior solution of this maximisation problem is:

$$r_1^* = 1 - \frac{c}{2} \quad (14)$$

If there is no interior solution, the royalty rate is defined by the constraint, which we will label r_1^{lim} when licensing occurs.

We illustrate the maximisation problem in figure 3. The negatively sloped line is equation (13), drawn

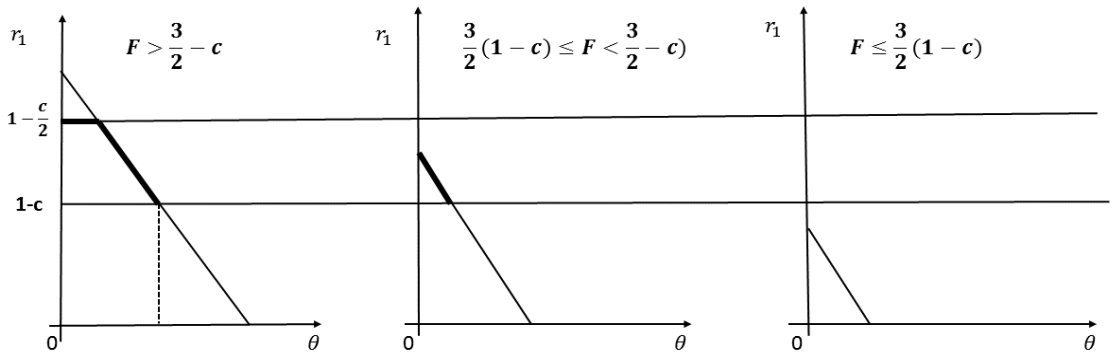
in (θ, r_1) space[30]. It is the constraint on the *BT* royalty such that firm *A* will not innovate. Where the optimal royalty, r_1^*, falls below this constraint, it is the equilibrium choice. Accordingly, we draw three panels in figure 13, according to where the intercept of the constraint falls compared to the top horizontal line, representing the optimal royalty, r_1^*, and the bottom horizontal line, representing the minimum royalty for which firm *L* would prefer to license BT instead of not licensing[31].

Where the value of θ is such that r_1^* violates the negatively sloped constraint, the equilibrium choice or royalty equals the constrained choice. This is illustrated as the heavy line in figure 13. The heavy line does not continue below the lower horizontal line because below this line, no licensing will occur in equilibrium.

As shown in Figure 3, there are three cases to consider, depending on the "efficiency" of follow-on innovation. If *IT* is inefficient ($F \geq \frac{3}{2} - c$, as in panel *a*), then the intercept of the constraint exceeds r_1^* and we find values of θ such that firm *A* does not innovate even if the initial agreement includes the optimal royalty rate r_1^*. The basic technology is therefore licensed at the rate calculated without considering the possibility of follow-on innovation. By contrast, if follow-on innovation is very efficient, as in panel *c*, then the intercept of the constraint falls within the range for which no licensing is the optimal choice for firm *L*: any royalty rate that is high enough to make the licensor prefer licensing to not licensing violates the constraint in equation (13). Accordingly, the owner of the basic technology prefers not to license at all. Finally, for intermediate levels of innnovation efficiency such as in panel *b*, the royalty rate r_1^* would trigger innovation but there still exists a rate that avoids innovation and is sufficient to make firm *L* decide to license, at a royalty defined by the constraint.

[30] The constraint can be re-written as $r_1 = F - \frac{1-c}{2} - 2\theta$. The intercept, then, is at $r_1 = F - \frac{1-c}{2}$. For any value of r_1 greater than this, our discussion of equation (13) explains that firm A would innovate, illustrated as the shaded area to the north-east of the constraint in the figure. Details appear in Appendix 1.

[31] This is the horizontal line such that $1 + r_1 \geq 2 - c$, or where the income from licensing the basic technology with no further innovation exceeds that of not licensing at all.



(a) (b) (c)

Figure 3: Royalty Setting under No Grantback

Accordingly, the basic technology is licensed under the conditions stated in the following lemma that determine the range of θ for which licensing will occur, the royalty rate at which licensing occurs, and the range of cost of innovation for which each solution applies[32]:

Lemma 1: For severable innovation, the basic technology is licensed under the following conditions and with the following royalty rates:

$$If\ F > \frac{3}{2} - c\ then\ r_1 = r_1^*\ for\ \theta \leq \frac{F}{2} + \frac{c}{2} - \frac{3}{4}.$$

$$r_1 = r_1^{Lim}\ if\ \frac{F}{2} + \frac{c}{2} - \frac{3}{4} < \theta \leq \frac{F}{2} + \frac{3}{4}(c-1)$$

$$If\ \frac{3}{2}(1-c) < F \leq \frac{3}{2} - c\ then\ r_1 = r_1^{lim}\ for\ \theta \leq \frac{F}{2} + \frac{3}{4}(c-1).$$

[32] See appendix 2 for derivations.

The parameter ranges for which the basic technology is licensed are shown in figure 4. This translates the ranges of the three panels of figure 3 into (F, θ) space. The range of *F* for which panel *a* was relevant is above the upper diagonal line, the middle range of panel *b* occurs between the diagonal lines, and the range below the lower diagonal line is equivalent to panel *c*.

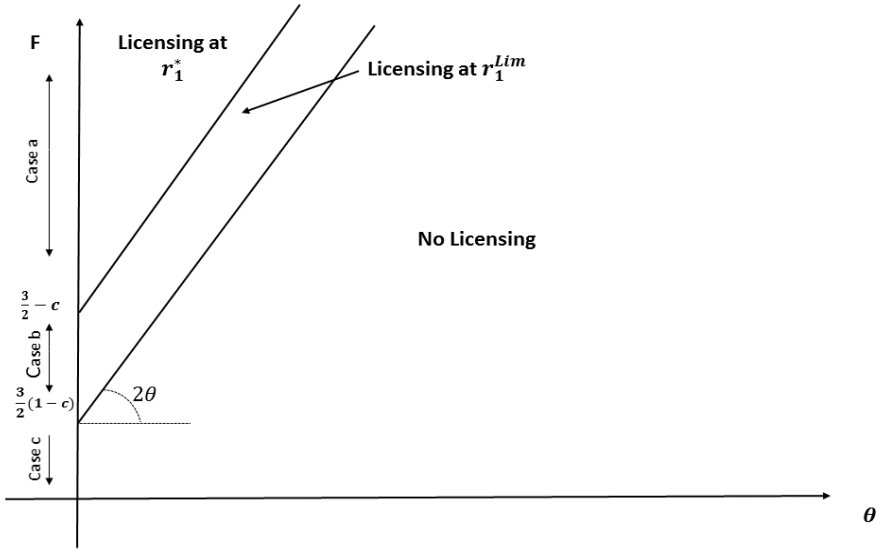


Figure 4: Licensing Conditions under No Grantback

Summarising, firm *L* only licenses *BT* if follow-on innovation will not take place and if the royalty it can charge makes it better off with licensing than without. This occurs if the follow-on innovation is sufficiently inefficient, where efficiency refers to the ratio of the cost, *F*, to the benefit, θ. If follow-on innovation is very inefficient then the possibility of follow-on innovation does not constrain the behaviour of the firms: *BT* is licensed at the rate that splits the bargaining surplus equally taking the lack of follow-on innovation as given.

For more efficient innovation, however, the licensor has to settle for a lower royalty in order to avoid triggering *ex post* innovation in order to "escape" the royalty payment.

Lemma 2: *With severable innovation and no grantback, the basic technology is only licensed if the follow-on innovation is sufficiently inefficient. The licensee of the basic technology never chooses to innovate.*

In all cases, the licensee never chooses to innovate. This is either because it is not possible (when *BT*

is not licensed) or it is not desirable (because the royalty rate on *BT* is chosen to be low enough that the innovation does not pay).

This latter case recalls the intuition for Gallini (1984), whereby a licensor allows access to his technology in order to discourage a potential entrant from researching a potentially leapfrogging technology. In her paper, both firms are full participants in the innovation market already and the question is whether the *BT* contract can be on sufficiently favourable terms to deter the licensee from incurring the expense of another technology "draw". Such deterrence can be socially desirable because it reduces duplicative R&D expenses, i.e. because the entrant's incentives to innovate might be socally excessive. In our model private incentives to innovate are too low. As a result, the potential benefits from such "innovation deterrence" comes from a different effect: setting royalty rates low enough to discourage follow-on innovation can make the licensing of the basic technology possible in the first place.

4.2 Grantback Clause

As in the previous section, because the follow-on innovation is severable, *L* cannot legally keep collecting royalties on a *BT* technology that is no longer used by the licensee[33].

We also need to make some assumptions about territorial restrictions, as they help to define the way in which markets are separated. Clearly, the territorial restrictions included in the initial licensing contract apply to all products that rely on the basic technology. There is also no reason why the parties could not agree that the grantback itself is subject to territorial restrictions. In particular, the parties could agree that the grantback to the initial licensor prevents both firms from exploiting the new technology in each other's home market. For now, we will assume that the grantback agreement does indeed include such restraints. If there is follow-on innovation, then both firm have access to the new technology under a grantback.

One might think that, since any agreed upon royalty would not be collected anyway when innovation occurs, the only relevant decision for the licensor is whether or not to offer a license to firm *A*. This would not be correct because the initial royalty influences the innovation decision of firm *A*. Since

[33] Remember in this respect that we look at variable royalties, not fixed royalty payments so the legal issue would be whether payment is extracted for a technology which is not used, not whether a given payment can be spread over a period that exceeds the period of actual use.

firm A no longer has to pay any royalty to the licensor then it will innovate if the pay-off after innovation, which involves "escaping" the initial royalty, as well as any price increase due to the superiority of the follow on technology, is higher than the payoff from not innovating whilst settling for a price that reflects the value of the basic technology, and continuing to pay the royalty to firm *L.*

Accordingly, firm *A* compares setting a price equal to $1+\theta$ in his home market (which is protected by the territorial restraints) to the pay-off from setting a price equal to 1 and paying a royalty to the owner of the basic technology, i.e. $1+\theta-F \geq 1-r_1 \leftrightarrow F \leq \theta + r_1$. We can see from this that a higher royalty makes *A* more eager to innovate since innovation means not having to make the royalty payment.

The owner of *BT* has three options then: not to license, which yields profits of $2-c$, license with a royalty low enough to make further innovation by the licensee unprofitable whilst leaving the licensor with profits equal to $1+r_1$, and license with a royalty which is high enough for innovation to occur. In this latter case, the *BT* owner obtains rights to exploit the new technology in its home market, protected by territorial restraints, yielding a profit of $1+\theta$. Figure 5 represents the *BT* owner's preferences over these three outcomes, where the diagonal line represents the equation $1+r_1 = 1+\theta \leftrightarrow r_1 = \theta$.

Importantly, the figure only shows firm *L*'s preferences without distinguishing between regions where firm *A* would actually innovate and regions where it would not.

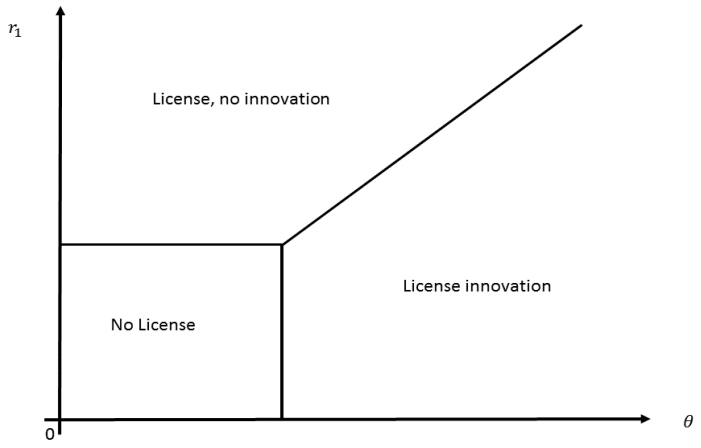


Figure 5: *BT* Owner Preferred Outcomes under Grantback

The shape of the three areas in figure 5 is easily understood. With innovation, firm *L*'s only reward from licensing its technology is the additional value θ created by exploiting the better technology in its home market: it receives no fee for *BT* since it is now obsolete and pays nothing for the improved version. Without innovation, licensing the initial technology yields a royalty payment of r_1. Hence, firm *L* prefers to license without triggering innovation if and only if r_1 is bigger thanθ. Without licensing, the licensor's profits do not depend either on the size of the follow-on innovation or on the level of the royalty agreed as part of the licensing of *BT,* so that we must merely compare the no licensing profit of $2 - c$ to either the licensing profit with innovation $(1 + \theta)$ or without innovation $(1 + r_1)$. This determines the vertical and horizontal lines, both of which have intercepts of 1-c. Licensing with or without innovation is then preferred to no licensing if the royalty received or the value of the follow-on innovation exceeds the surplus that the licensor could get on its own from the second market (1-c), i.e. if barriers to trade are sufficiently high.

We now proceed in three steps. We begin by introducing firm *A*'s decision to invest in follow-on innovation and establish firm *L*'s preferred outcome given the anticipated innovation behaviour of firm *A*. We then determine the outcome of the initial bargaining game for the *BT* license, taking the grantback clause as given. Finally we ask whether, as part of the initial bargaining, parties would agree to include a grantback commitment.

The Preferences of the licensee

Firm *A* innovates if:

$$1 + \theta - F \geq 1 - r_1 \leftrightarrow r_1 \geq F - \theta \qquad (15)$$

so that the "improvement" line reflecting the licensee's indifference between innovating or not has an intercept equal to *F* and a slope of -1 in the space of (F, r_1). We must now consider three cases, depending on where this line is located. We begin with parameter ranges where innovation costs are low, i.e. $F < 1 - c$. This case is shown in figure 6.a.

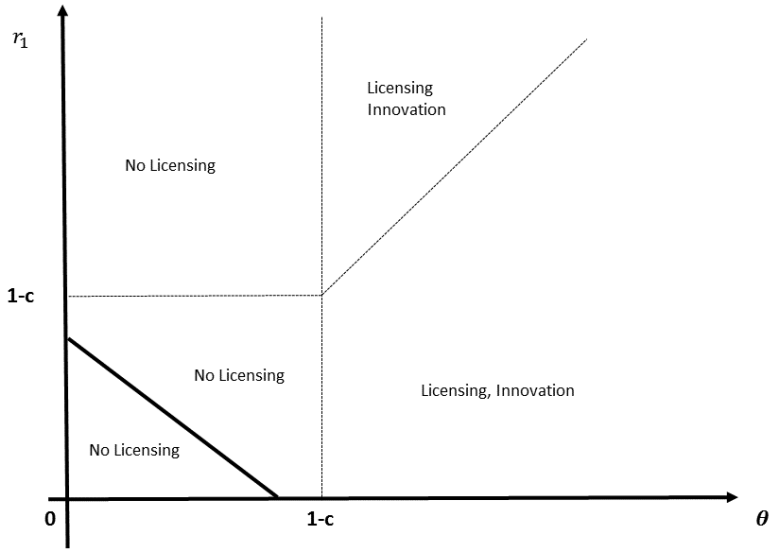


Figure 6.a. Firm *L*'s Preferred Feasible Outcomes, Low Innovation Cost, Grantback

Figure 6.a. illustrates the negatively sloped line that determines whether firm *A* innovates (above the line) or does not (below the line). Superimposing the regions of figure 5 we see that the two "licensing regions" from figure 5 fully lie above the "improvement line", so that where licensing occurs, it always leads to innovation. The only relevant choice for firm *L*, then, is between licensing with innovation (and no royalty income) above the negatively sloped line and no licensing. Firm *L* must, therefore, compare the payoff to licensing of $1+\theta$ to not licensing and getting a payoff of *2*-c. Licensing is preferred as long as the innovation is significant enough ($\theta \geq 1-c$). Otherwise, no licensing occurs.

We next consider the situation in figure 6.b., where $1-c < F \leq 2(1-c)$ so that the intercept of the negatively sloped "improvement line" is above the horizontal line $r_1 = 1-c$ but where the "improvement line" does still fall below the intersection of the lines $r_1 = 1-c$ and $r_1 = \theta$. There are two differences with respect to the previous case. Firstly there is now a range of parameters for which the patent-holder prefers licensing without innovation. This is shaded in the figure and repesents the area where firm *A* would prefer not to innovate, so that the choice for firm *L* is between licensing (earning $1+r_1$) and not licensing (earning 2-*c*). For the shaded region, the royalty is high enough that licensing is preferred. Secondly, the range for which licensing with innovation is preferred to no licensing shrinks by the area of the triangle of base $(1-c, F)$. In this area, the follow-on innovation is not valuable enough to warrant the investment by firm *A* at the agreed royalty rate.

At the same time, the royalty on *BT* is too small to make licensing without innovation worthwhile for firm *L*.

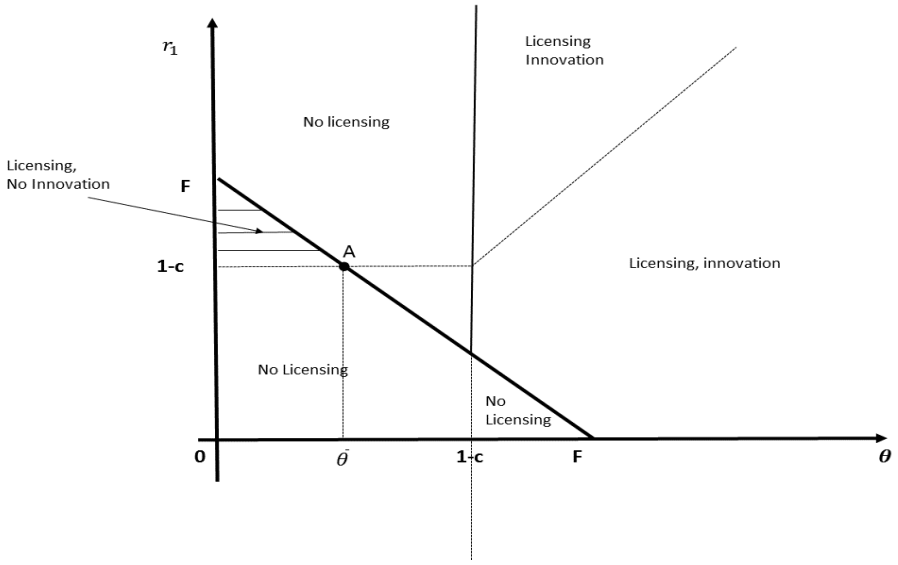


Figure 6.b. Firm *L*'s Preferred Feasible Outcomes, Moderate Efficiency, Grantback

Finally, if the cost of innovation is high enough, $F > 2(1-c)$, so that the innovation line lies above the point (1-*c*, 1-*c*), the pattern remains rather similar: the range where licensing that does not trigger innovation is preferred expands, while the range where licensing with innovation is preferred keeps shrinking. This is shown in figure 6.c[34].

[34] Details for figures 6.b. and 6.c are available in appendix 2.

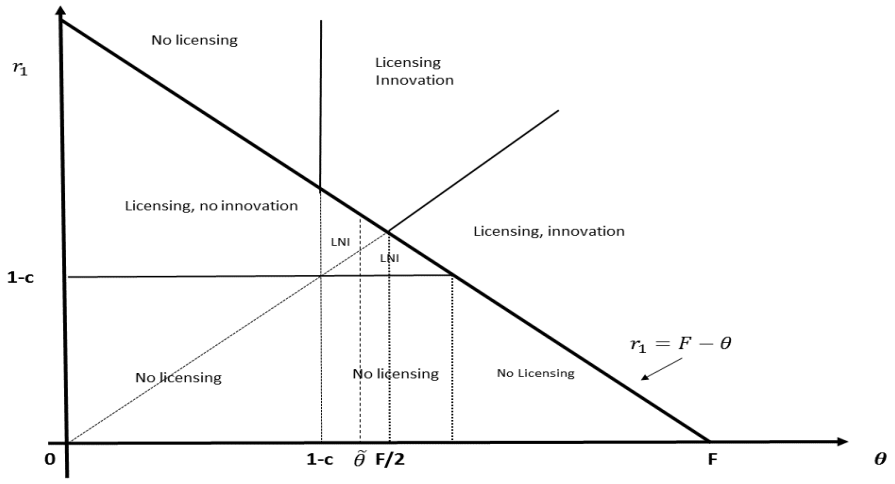


Figure 6.c. Firm *L*'s Preferred Feasible Outcomes, Inefficient Innovation, Grantback

Bargaining over the Licensing of the Basic Technology

Assuming that firm *L* chooses to license its basic technology, we must now determine the outcome of the stage 2 negotiations about the royalty associated with the use of the basic technology. Remember that this royalty will only be paid if firm *A* fails to innovate since it attaches to *BT* only. The improved technology receives no royalty under the grantback scheme and also renders *BT* obsolete so that it will be no longer in usre.

Consider first the situation represented in Figure 6.a. As follow-on innovation is very efficient, it occurs whenever firm *L* would prefer to license its technology. The equilibrium of the whole game is then straightforward: if $\theta \leq 1 - c$, then the basic technology is not licensed. Otherwise, it is licensed at a non-negative royalty rate. The size of the royaty rate is irrelevant to our further discussion as it will not be paid when improvement occurs and follow-on innovation will occur in equilibrium for any non-negative royalty.

We now turn to the situation depicted in Figure 6.b. For low values of θ, the only possible outcomes are no licensing or licensing at a rate small enough not to trigger innovation. Over the range where licensing is an option, both parties are better off with licensing than without it. The *BT* is therefore licenced for a royalty rate that lies between the horizontal line at *1-c* and the downward sloping

"improvement" line dividing the regions without follow-on innovation from those with follow-on innovation. While computing the royalty rate at which licensing occurs is of no particular interest for the purpose of determining the resulting licensing and innovation pattern, this rate will be needed once we discuss the parties' incentives to include a grantback clause in the initial licensing contract. We therefore establish the following lemma based on a restatement of figure 6.b.:

Lemma 3: Suppose that the innovation is severable and there is a grantback clause. Over the range $\theta \epsilon [0,\ F-1+c\ ]$, licensing without innovation occurs at the following royalty rates:

$$If\ F > 1-\frac{c}{2}\ and\ \theta \leq F+\frac{c}{2}-1\ then\ r_1 = r_1^* = 1-\frac{c}{2}$$

$$If\ F > 1-\frac{c}{2} and\ F+\frac{c}{2}-1 < \theta \leq F+c-1\ then\ r_1 = r_1^{max} \equiv F-\theta$$

$$If\ 1-c < F \leq 1-\frac{c}{2}\ and\ \theta \leq F+c-1, then\ r_1 = r_1^{max} \equiv F-\theta$$

The statement follows directly from the figure. If the optimal royalty, r_1^*, falls below the intercept (*F*) of the diagonal "improvement" line and at the same time the associated size of the improvement (θ) is such that firm *A* would not want to innovate, then the optimal royalty is charged, and *BT* is licensed but no innovation follows. This "threshold" size of improvement is indicated by $\bar{\theta}$ in figure 6.b. If it is the case that the royalty falls below the intercept, *F*, but at values of the improvement such that follow on innovation would normally occur, $\theta \geq \bar{\theta}$, the royalty for *BT* must be capped at $F-\theta$ for follow on innovation not to occur under *BT* licensing. If the royalty exceeds this, firm *A* has a large enough incentive to innovate in order to escape the royalty that innovation will surely follow *BT* licensing. Finally, if the optimal royalty is above the intercept, *F*, but the size of the improvement is small enough that a capped royalty would induce firm *A* not to innovate, then the royalty is similarly capped at $F-\theta$ and *BT* licensing occurs.

For values of θ above $\bar{\theta}$, but still to the left of *1-c*, the basic technology does not get licensed. As soon as $\theta \geq 1-c$, the two options are no licensing and licensing at a royalty which is high enough to trigger follow-on innovation. Both parties are better off with licensing so licensing occurs at a rate which is sufficiently high to lie above the "improvement" line. Since this royalty is never paid in our stylised framework, its precise amount is of no relevance to our further discussion.

If follow-on innovation is very inefficient ($F > 2(1-c)$), we find ourselves in the type of situation described in figure 6.c. Just to the right of $\theta = 1-c$, there is now a range $\theta \epsilon\ ]1-c, F/2[$, where

three outcomes are feasible depending on the size of r_1: no licensing, licensing at a rate that does not trigger follow-on innovation and licensing at a rate that is high enough to trigger follow-on innovation. Because we are to the right of $\theta = 1 - c$, firm *L* prefers licensing with innovation to no licensing. As the potential licensee also prefers licensing, the *BT* is licensed over this range at some royalty rate, r_1.

Now, consider a value of θ in this range, such as $\tilde{\theta}$. As long as the royalty is such that $r_1 < \theta$, firm *L* prefers licensing with innovation to licensing without innovation since it earns $1 + \theta$ with the grantback and $1 + r_1$ without follow on innovation. Over this range, however, the licensee innovates in order to avoid paying the royalty for the *BT* so that licensing followed by innovation is infeasible. If the royalty were set high enough to trigger innovation, in fact, the royalty would have to be such that $r_1 > \theta$, where firm *L* would prefer no improvement to follow-on innovation. Both parties, therefore, agree on a level of royalty which does not trigger innovation, i.e. a royalty in the interval $[\theta, F - \theta]$. For even larger values of θ, both parties agree to license at a royalty which is large enough to trigger innovation since royalties can be found on or above the "improvement line" and also below the line $r_1 = \theta$, where firm *L* also prefers licensing with innovation.

We can now summarise the analysis above in a single graph that gives us the equilibrium outcome as a function of F, θ and *c*.

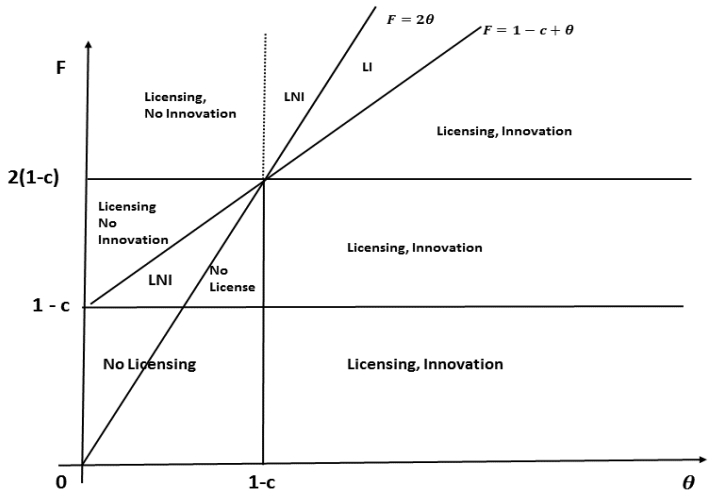


Figure 7: Equilibrium Outcome with Severable Innovation and Grantback

We will limit ourselves to two observations at this stage. Firstly, even with the grantback clause, the basic technology is not always licensed. The reason for this inefficiency is that, although the patent-holder would be happy to license if it could get a sufficient royalty and there was no innovation making the *BT* obsolete, these two conditions cannot be met simultaneously: any royalty which would make the patent holder happy to license would also trigger *ex post* innovation and make his technology obsolete. Secondly, conditional on licensing occuring, incentives for follow-on innovations are optimal since innovation occurs everywhere below $F = 2\theta$ line. This optimality results from the *ex ante* nature of the grantback: the fixed cost of innovation is not yet sunk at the time the grantback is negotiated, so that the parties can agree on a way to split the surplus that does not suffer from the hold up properties of an *ex post* license. In this sense, the grantback does not hamper innovation incentives.

In sum, the argument in the text establishes the following proposition:

Proposition 2*: With severable innovation and a grantback regime where innovation allows the licensee to escape royalty payments, the owner of the basic technology offers a license only if the expected size of the innovation is sufficient, or the cost of innovation is large enough. Licensing leads to innovation only if the size/cost ratio of the innovation is sufficiently large. Conditional on the parties reaching a licensing agreement, the licensee's incentives to innovate are socially optimal. Otherwise, innovation incentives are socially sub-optimal.*

In Defence of the "But For…" Defence

We can now compare the outcomes with and without grantback by combining the regions from figure 7 and figure 4 in a single graph. The dotted diagonal lines are those of figure 4 and represent the regions for which licensing (but no further innovation) occurs when no grantback is included in the contract. The solid lines represent the regions for the licensing configurations under grantbacks and the text in the figure represents the licensing outcomes for those regions.

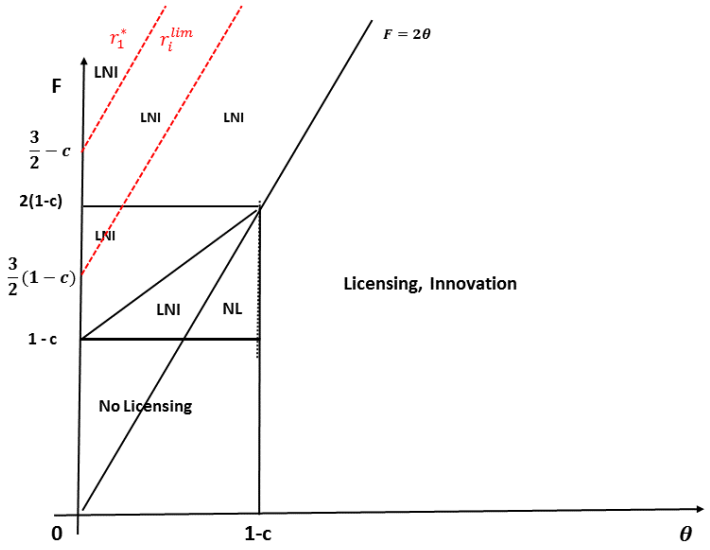


Figure 8: Comparing Outcomes with and without Grantback Clause[35]

Without grantback *BT* licensing only occurs above the lower of the two dotted lines and never results in follow-on improvements, whereas *BT* licensing occurs for all except the "no licensing" region in the lower left hand corner when grantbacks are present. Hence, a grantback clause not only promotes licensing, but also promotes licensing that gives rise to efficient follow-on innovation.

The intuition behind figure 8 is as follows. With severable innovation, the firm *L* knows that it will not be able to secure any royalty payment for its own basic technology if the licensee innovates. On top of this, in the absence of grantback, the licensor knows that it will have to pay a significant royalty to the licensee in order to avoid being made completely obsolete by the follow-on innovation. This proposition is unattractive enough that the owner of the basic technology only licenses if innovation is sufficiently inefficient that it is possible for the licensor to find a royalty that both provides significant revenue and also is low enough that it does not trigger follow-on innovation. Otherwise, it simply declines to license at all: it replaces itself by licensing and if this replacement effect is large enough then it will decline to license. With grantback, the licensor is assured to be able to use the follow on technology in the home market for free. This has two effects compared to the case without grantback. Firstly, because innovating does not allow the licensee, firm *A*, to obtain revenues from the *BT* owner,

[35] The graph is drawn with the intercept of the dotted line below 2(1-c). It can also lie above.

the licensee's incentives to innovate are reduced. The *BT* licensor, firm *L*, is therefore able to have a higher royalty included in the initial contract without triggering follow-on innovation. This improves the *BT* owner's incentives to license in the first place. Secondly, even if licensing leads to follow on innovation, the *BT* owner can now exploit this innovation in its own market for free. If the size of this innovation is sufficiently large, this is attractive.

This intuition is compatible with the "but for…" defence. Without a grantback in place, the *BT* owner is reluctant to license because of the threat of obsolescence or, if the firm wishes to avoid obsolescence, a steep royalty payment to the licensee for the improvement. With the grantback as a guarantee not to be caught in such an undesirable bargaining position, the *BT* owner is much more willing to license, even though this is may occur at a depressed royalty rate to reduce the temptation for follow-on innovation. Indeed, the cases where the *BT* owner deters innovation via "market sharing" are in fact the cases where it is socially efficient to do so, since the two firms are able to bargain *ex ante* on the agreement.

Proposition 3.: *With a severable innovation, a grantback clause increases the range of parameters for which licensing and innovation occur, with an intuition that provides strong support for a "but for" defence.*

4.3 Would the Parties Choose to Include a Grantback Clause?

Finally, we need to determine whether the parties would actually choose to include a grantback clause in the initial licensing agreement if such clauses were deemed to be lawful. Over the parameter range for which licensing occurs with grantback but not without it (below the lower of the two dotted lines in figure 8), both parties are better off with a grantback clause: the licensee because it makes positive profits rather than being "frozen out" of the basic technology, and the licensor because it is able to tap into the licensee's innovation or to share the market so as to reduce transportation costs, both at a profit.

The argument for the grantback is less clear over the range for which licensing occurs both with without grantback, or the upper portion of figure 8. Here, licensing leads to no follow-on innovation regardless of the grantback clause. In both cases, the reason is the same: the licensor "shares the market" in order to avoid being made obsolete. On the other hand, the licensor's alternatives are not the same with and without a grantback, and this can affect the level of royalty at which it "shares" the market.

Investigating this region more precisely consider figure 9, which shows the upper part of figure 8.[36] We have added the line of equation $F = \theta + 1 - \frac{c}{2}$, which divides the area where licensing with grantback occurs at the "interior" optimal royalty r_1^* (above) from the area where the contract involves a constrained royalty.

We must then distinguish three different areas. If innovation is very inefficient, above the top dotted line, then licensing occurs at the optimal royaty rate, r_1^*, both with and without grantback, making the parties indifferent about the clause. For somewhat more efficient innovation, above the new line we have added and the upper of the dotted lines, licensing still occurs at r_1^* if there is a grantback but the royalty must be set lower than that in order to avoid triggering innovation is there is no grantback. This is not surprising: the licensor's position is worse when no grantback is present so the royalty "cap" is lower. Over this range, the owner of the basic technology would support having a grantback clause, while the licensee would resist it[37].

Finally, there is a range below the new line we added and the bottom diagonal line on the graph, where the royalty is limited by the need to prevent innovation irrespective of whether or not the deal includes a grantback clause. However the "limit" royalties involved do depend on the presence of grantback. With grantback, we have $r_1^{max} = F - \theta$, while without grantback we have :

$$r_1^{lim} = F - \frac{1-c}{2} - 2\theta$$

The royalty is clearly larger with the grantback so that, once again, the *BT* owner favours the grantback while the licensee opposes it.

[36] Some other rankings of the vertical intercepts of the upward sloping lines are possible but these permutations would not affect our qualitative conclusions.

[37] We do not pursue this case further: the bargaining concerns the royalty rate, the grantback, and the basic technology, all of them decided simultaneously. While it would be possible to describe a particular outcome of this negotiation by putting more structure on the process, our basic argument can be established without this so we do not develop this case further.

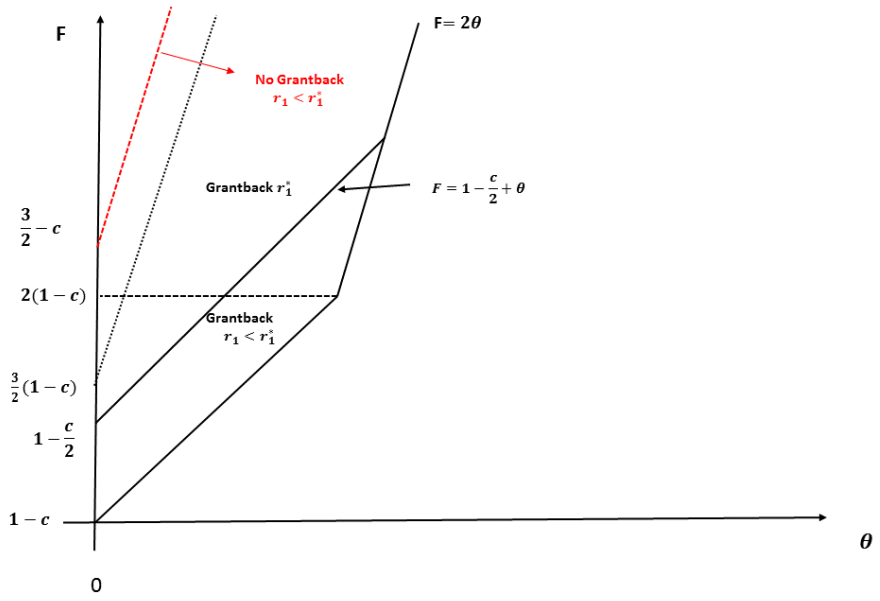


Figure 9: Upper Portion of Figure 8 with Royalty Limits Added

This discussion establishes the following proposition.

Proposition 5: *If the follow-on innovation is severable, the parties would agree to include a grantback clause as long as follow-on innovation is sufficiently efficient. This grantback clause improves social efficiency since it allows for licensing and innovation for parameter ranges where licensing would otherwise not occur but where it is socially desirable. In such cases, the "but for" defence applies with full force. For very inefficient follow-on innovation, both parties are indifferent with respect to the grantback clause. For an intermediate range of follow-on efficiency, the initial patent owner favours including a grantback while the licensee opposes it.*

5. Discussion and Extensions

Our results were obtained in a model with specific assumptions; however many can be dropped or modified without affecting the nature of our results. For example, the same type of results would obtain if we assumed that follow-on innovation was uncertain or occurred with a time lag. Introducing such features would only add one more parameter to an analysis that is already sufficiently complex.

More substantively, in the analysis so far we have assumed that trade barriers between markets are moderate in the sense that they are not high enough to fully isolate the markets, even in the absence of follow-on innovation ($c < 1$). If this assumption is relaxed. It should be clear that the analysis of non-severable innovation remains the same, for two reasons. Firstly, the fact that the licensee cannot use the follow-on innovation without continuing to rely on the basic technology ensures that "inter-market" competition is not an issue regardless of trade barriers. Secondly, increasing trade barriers make licensing more attractive to the *BT* owner since it decreases firm *L*'s own ability to serve customers outside of its home market. Since licensing in the non-severable case always occurred even for smaller trade barriers, it will still occur when these trade barriers become more substantial.

We can therefore concentrate on severable innovations. The most immediate effect of high barriers to trade is that they eliminate the regions in graphs 5 and 6 where θ and *F* are both smaller than $1 - c$, predictably shrinking the region where the *BT*-owner chooses not to license his technology: in order to extend the reach of its technology, firm *L* must now license since it cannot enter abroad on its own. Furthermore, in the absence of grant-back the region where the *BT* holder would wish to license such that it does not trigger follow-on innovation shrinks: for large enough transport costs, it may be that triggering follow-on innovation and then negotiating a license to be the local supplier of the superior technology dominates since the competitive threat is lower. This licensing generally occurs at a higher royalty rate, since there is less reason to cap the royalty to incentivise the licensee not to innovate. Grantbacks become relatively less desirable since the royalty is limited over a smaller range, making the argument for grantbacks less compelling in this case: the "but for" argument has at its basis the threat of entry in the *BT* owner's market by the licensee, so that when this threat is reduced the argument for grantbacks also becomes weaker.

Another feature of our analysis is that we assumed that all parties knew *ex ante* whether the follow-on innovation would be severable or not. We took this approach to emphasise the differences between the two types of innovation and evaluate the different legal treatment that they received under the 2004 *Technology Transfer* Guidelines. Still, in practice, any given licensing agreement implies the possibility that follow-on innovation might be of either type.

Moreover, it is entirely possible that the type of follow-on innovation would itself depend on the licensee's R&D efforts. If the licensee can modify its own R&D to select whether it produces a severable or a non-severable innovation after receiving the license and setting the licensing terms, then it would always choose a severable innovation – at the same innovation cost, *F*. Knowing this, the *BT* holder would need to anticipate the likelihood of severable innovation and plan on it in its own licensing

negotiations. If the cost of producing a severable innovation is larger than that of producing a non-severable innovation then the choice is less obvious. While we have assumed that there is no asymmetric information on the type of innovation choices available to the licensee, a situation where the licensee could choose either a severable innovation to escape an unattractive license or a non-severable innovation and retain the licensing agreement would call for a licensing contract with the royalty further constrained to incentivise the licensee to select the type of innovation favoured by the licensor.

On the policy side, allowing for the severability of the follow-on innovation to be endogenously determined means that the "vertical scope" of patent protection becomes relevant: the greater this scope, the more difficult it is to obtain a non-infringing follow-on innovation. In Green and Scotchmer (1995), it is optimal to ensure that the second innovation always infringes the first one. Essentially, this clearly assigns the property rights to the first innovator so that the ensuing bargaining process can deal efficiently with the externality between the two parties; however, we have also seen that, conditional upon licensing, follow on innovation occurs more efficiently in the case of severable innovation. So there cannot be any presumption that "maximum" vertical patent scope would actually be the optimal policy.

5.1 Policy

The governance of grantbacks under the various technology transfer guidelines that operate in different jurisdictions has several components. One concerns the overall effect of grantbacks on research incentives, where grantbacks have been seen as a risk to innovation incentives. A second concern is that, even if one accepts that not all grantbacks are bad, the grantback contract may have features that may make it generally socially undesirable. These features include whether the clause is exclusive, whether it includes remuneration for the follow on innovator and whether the technology to which it applies is severable or non-severable.

The academic work related to grantbacks has occurred in a variety of different models that address different aspects of this governance structure. As a result, they generally are complementary but can be gathered together to begin to shape a picture of an overall view on grantbacks. Van Dijk (2000) evaluates the argument for whether grantbacks reduce innovation incentives. He shows that grantbacks may indeed reduce innovation incentives, but observes that this is not necessarily bad for social welfare in a context where firms have similar research capabilities so that they "race" for research outcomes. Choi (2002) evaluates the argument for whether grantbacks promote innovation

or not, observing that under asymmetric information about the quality of licensed technology, grantbacks can be designed so as to facilitate high quality technology transfer, and hence innovation. This questions whether the grantbacks do, in fact, reduce innovation incentives at all in a context of firms with differing levels of familiarity with the technological field. Both papers comment on the need to evaluate the effect of grantbacks under differing abilities of patents to "block" further improvements. We focus on this by evaluating the role of grantbacks for severable and non-severable technologies.

The 2004 EU Technology Transfer Guidelines made this distinction and allowed a more lenient approach to grantbacks for non-severable innovation. Our modelling suggests the contrary: that differing treatment of the two types of technologies is, in fact, warranted but that severable innovation should receive more lenient treatment. Indeed, the most recent revision of the EU Technology Transfer Guidelines makes a step in this direction by dropping the distinction between the treatment of severable and non-severable innovation but does not go further, as our analysis suggests, to retaining the distinction but reversing the application of leniency.

Other jurisdictions do not tend to have this distinction, including the US's new draft Guidelines, although the treatment of grantbacks under a rule of reason would normally allow for such arguments to be made: as Choi (2002) points out the application of the Guidelines allows for an initial determination of whether a particular grantback reduces significantly licensees' incentive to improve and then considers offsetting procompetitive effects if the answer is affirmative. This second step allows for a "but for" defence, however we have additionally shown that in the case of severable innovation grantbacks may not, in fact, reduce even licensee incentives to innovate compared to the equilibrium behaviour when no grantbacks are used. Some jurisdictions, such as earlier EU versions of the technology transfer guidelines and the Japanese Guidelines, make the distinction but favour non-severable innovation. Our model suggests a way in which different types of technology could be treated, with severable, rather than non-severable, innovation being favoured.

Finally, we stop short of making recommendations about patent policy: our analysis takes the existence of severable and non-severable innovations as given and analyses grantback policy in this context rather than analysing patent policy. Indeed, while elements of our model follow Green and Scotchmer's (1995) analysis of patent policy for sequential innovation, we do not support large patent scope as strongly as that paper: even in the full information case, our model suggests reasons for limited patent scope to be socially optimal since severability can, in fact, increase innovation in equilibrium by licensees.

6. Conclusion

We have considered a model of grantbacks with some distinctive features compared to other models that have preceded it. We have modelled explicitly how the markets of the licensor and licensee are separated, both by contractual features and by transportation cost, illustrating how each plays a role in the final licensing payoffs and agreeements. We have focussed on the differing ways grantbacks can be used for technologies that are severable or non-severable, rather than focus on the case of severability. Indeed, our point is to comment on the legal treatment of these two types of innovation. We have modelled grantbacks in a setting where innovation incentives are generally insufficient with no "racing" component, in an effort to mimic the general feeling of technology transfer guidelines worldwide that innovation incentives fall short and need to be increased. Finally, we have modelled a basic technology that facilitates follow-on innovation rather than follow-on innovation that is enabled by the patent disclosure, as we find in the trade literature about grantbacks.

These choices have been made to try to mimic the environment in which grantbacks seem to be observed. They also make our model distinct from others in both its formulation and its results, which are complementary to other papers that have been written in this area.

We find that grantbacks can be socially desirable institutions in some settings. First, we find that they are more socially desirable in the case of severable innovation, as the "but for" defence has full force for this type of technology. Second, we find that we would generally expect to observe grantbacks in precisely this sort of situation: they are not the equilibrium behaviour for non-severable innovations, in our framework since they do indeed reduce innovation incentives for the licensee and since the licensor can benefit from those innovations the pair of firms agree to not have grantbacks precisely in the non-severable case. Third, we find that the licensor has an incentive to reduce royalty payments for its basic technology in order to "share" the market with the licensee as a means to extract more from the market than it could obtain if it allowed obsolescence. This strategic use of the initial license can have implications for whether improvements occur and for the social optimality of licensing. Indeed, it is precisely this strategic use of licensing to reduce follow-on innovation incentives that gives grantbacks their benefit in some cases: grantbacks reduce the threat from obsolescence and so reduce the need for strategic behaviour to control it.

Our setting allows us to examine how intellectual property rights and competition policy interact, but we do not extend our analysis to look at the optimal intellectual property regime in the sense of

allowing the government to choose the type of follow on technology available to the firms. Instead, we take the existence of severable and non-severable innovations as given. Despite this, the setting can be used to infer that our argument for broad patent scope would not be as strong as it has been in some other papers with sequential innovation due to our assumptions about the context of licensing and the type of licensing and grantback contracts available. We focus on the case of free grantbacks, since they are the subject of particular approbation, and examine a case where the "but for" defence is particularly salient. The pair of these assumptions, while they put institutional context on the analysis, also modify the bargaining positions and options of the parties.

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Appendix 1: Initial royalty with severable innovation and no grantback

There is follow-on innovation if

$$F \leq \frac{1-c}{2} + 2\theta + r_1$$

Assuming that there is no innovation, the bargaining between the parties is represented as

$$Max_{r_1}[1-r_1][1+r_1-(2-c)]$$

So that

$$r_1^* = 1 - \frac{c}{2}$$

The vertical intercept of the innovation constraint in figure 3 is

$$r_1^{INT} = F - \frac{1-c}{2}$$

Which is larger than r_1^* if $F > \frac{3}{2} - c$. So, if that condition is satisfied, there is a range of values of θ for which r_1^* is the agreed upon royalty. This range is from 0 to the value of θ for which the innovation constraint just binds at $r_1 = r_1^*$, i.e. up to

$$\theta = \frac{F}{2} + \frac{c}{2} - \frac{3}{4}$$

For larger values of θ, the equilibrium royalty is the highest royalty that does not trigger innovation, as long as this royalty leaves the licensor at least as well off a without licensing, i.e.

$$r_1 = F - \frac{1-c}{2} - 2\theta$$

as long as $1 + r_1 \geq 2 - c$, i.e. as long as

$$\theta \leq \frac{F}{2} + \frac{3}{4}(c - 1).$$

If $F \leq \frac{3}{2} - c$, then there is still a range where licensing occurs but at a royalty below r_1^* as long as the vertical intercept of the innovation constraint is higher than the minimum royalty that the licensor needs to make licensing worthwhile, i.e.

$$r_1^{INT} = F - \frac{1 - c}{2} > 1 - c \leftrightarrow \frac{3}{2}(1 - c)$$

Appendix 2: Initial royalty with severable innovation and grantback

We focus on the areas in figures 6.b. and 6.c. where there is licensing without innovation. The reasoning is the same as in appendix 1. The only difference is that the innovation constraint is now given by

$$F \leq \theta + r_1$$

So that $r_1^{INT} = F$. Hence if $F \geq r_1^*$, there is a range of values of θ for which r_1^* is the agreed upon royalty. This range is from 0 to the value of θ for which the innovation constraint just binds at $r_1 = r_1^*$, i.e. up to

$$\theta = F + \frac{c}{2} - 1.$$

For larger values of θ, the equilibrium royalty is the highest royalty that does not trigger innovation, as long as this royalty leaves the licensor at least as well off a without licensing, i.e.

$$r_1 = F - \theta$$

as long as $1 + r_1 \geq 2 - c$, i.e. as long as

$$\theta \leq F + c - 1.$$

If $F \leq r_1^*$, then there is still a range where licensing occurs but at a royalty below r_1^* as long as the vertical intercept of the innovation constraint is higher than the minimum royalty that the licensor needs to make licensing worthwhile, i.e.

$$F > 1 - c$$

Over this range we have:

$$r_1 = r_1^{max} = F - \theta$$