Economics of Research Exemption

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Abstract

We provide an economic analysis of two types of research exemptions: (1) experimentation and research on the patented subject matter, and (2) academic (or non-commercial) research with the patented invention. We find that exemption for research on improving or inventing-around the subject matter makes good economic sense in the context of perpetual R&D competition, although it may not in the context of pioneer-follower innovation framework. The best approach might be to provide broad research exemption on the research on subject matter (more generally exemption for research using the knowledge disclosed in the invention that is useful for improving its subject matter), while stronger protection is provided for a pioneering invention in the product market in terms of the breadth of claims. Exemption for experimentation on the subject matter for the purpose of verification of inventions also is sensible. On the other hand, we find that research exemption is a blunt tool for promoting academic research, with a negative effect on the development of research tool. In addition, it is not clear whether research exemption is necessary for efficient and coordinated price discrimination in favor of academic researches.

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1 Introduction

Whether and how research use of patented inventions should be exempted from infringement has become an important issue in recent years. Increasing patenting of research tools and upstream technologies, which were part of the public domain in the past, and related legal disputes in recent years have triggered the close examination of this issue. For instance, when Integra Lifesciences Ltd. sued Merck KGaA for using its cyclic RGD peptide, Merck's defense was U.S. Patent Law section 271(e)1 which exempts for certain experimental activities using patented process or material for purposes reasonably related to the development and submission of information for FDA approval (Integra vs. Merck). When Duke University defended its use of laser facility without license from its former employee, physicist John M.J. Madey (Madey vs. Duke), it claimed that its academic research institution status allowed for research exemption.[1] The goal of this paper is to provide an economic analysis of research exemption as innovation incentive.

In some respects, the issues regarding research exemption are not different from the traditional issues discussed in the optimal patent design literature in sequential innovations. Exemption reduces patent protection, eliminating market power. This will improve static or short-run welfare as with any reduction in patent protection. And as with any patent protection, it may have a negative dynamic or long-run effect by reducing incentive to investment in technology covered by the exemption.

There are however issues specific to research exemption. First, it is important for us to consider if the legal distinctions between research on the invention and research with the invention make sense or not. An invention has two related but distinct uses: using the knowledge or information disclosed in the invention for its further progress vs. using the invention for the technical utility for which the patent is applied for. In the case of research tool, the first use is for using the knowledge disclosed for further improving the research tool and the latter use is for using that

[1] In case of Integra vs. Merck, the Supreme Court has upheld Merck's claim (125 S.Ct. 2372, June 2005) although Court of Appeals for the Federal Circuit had found Merck not exempt because 'the term "reasonably related" does not embrace all activity related to the development and submission of information for FDA approval (June 2003). In case of Madey vs. Duke, CAFC over turned a lower court decision and found infringement because Duke used the patented equipment in the pursuit of its legitimate business objectives, "including educating and enlightening students and faculty," as well as securing "lucrative research grants," thus was not entitled to the experimental use defence (307 F.3d. 1351, October 2002). The Supreme Court has refused to hear the case, making this decision final (June 2003).

research tool for the direct use as a tool, which may results in scientific and technical progress in other fields but not in this field. Second, academic research generates simultaneously significant knowledge externality and very low profit. The combination of the two might pose a question of whether we can justify a special consideration for exempting academic research with the invention.

What is research exemption?

Research exemption is a legal concept and we first need to give an economic characterization. We focus on the following two types of exemptions:

(1) Experimentation and research on the subject matter, and

(2) Academic (non-commercial) research with the patented invention.

The first rule focuses on the *objective of the research* using the patented technology and by definition is independent of who is doing the research. Experimental research on the subject matter are done for the purpose of :

- Challenging the validity of the patent
- Confirming the value of a patent for the purpose of licensing
- Experimentation for the purpose of improving the invention or finding its use
- Experimentation for inventing-around the invention.

The second exemption rule uses the academic or non-commercial *nature of the researcher* (individual or organization) as the criterion. This rule can be reinterpreted to include non-commercial research, assuming this can be well-defined, by commercial institutions, not just by an academic institution. The recent US court decision on Duke vs Madey, however, made clear that the distinction by a user was not intended by the case law of the USA. Such distinction does not exist in EU and not in Japan.

	Academic Use	Commercial Use
Verification of the invention	Exempted in all regions	
Research on subject matter for its improvement or inventing around	Exempted in EU and Japan (unclear in US)	
Other use	Probably infringement in all regions	Infringement in all regions

Table 1: The two rules of research exemption

The use of the invention for verifying the invention and for its improvement is exempted in EU[2] and in Japan. Verification is legal in all regions, while the improvement is not. Exemption is limited to verifying the patented matter in the U.S. This is summarized in Table 1.

In the following sections, we will provide an economic analysis of each rule. To the best of our knowledge, the only full fledged economic analysis of research exemption is provided by Scotchmer (2004) which uses a two stage innovation model. We not only generalize her analysis by incorporating the possibility that research exemption facilitates inventing around, but also add the analysis in the context of perpetual innovation process.[3] The latter analysis seems to be very important for analyzing the economic effect of exemption of the research on subject matter.

2 Exemption for research on improving subject matter

Let us begin with an exemption for research on improving subject matter. It is important to note that we cannot differentiate the improvement and inventing-around motivations ex-ante since there is uncertainty in research on the subject matter. The product market implementation of the improved invention may or may not infringe the original patented invention, depending on how far the new invention is located with respect to the original invention. In examining the economic

[2] In Germany and United Kingdom, experimental use is exempt even for commercial purposes while it is restricted to non-commercial use in France.

[3] After completing the draft of this paper, we have found that Gans(2005) also considers how research exemption affects innovation in the context of perpetual innovation process, using the framework of Segal and Whinston (2005) as we do. Our analysis, however, is quite different from his analysis, including the conclusion. In his formulation, the firms expect to reach licensing agreement in the future, contingent on the success of the research of the current entrant, and the current incumbent (the future entrant) pays the current entrant (the future incumbent) the licensing fee to conduct research, independent of whether the former succeeds or not.

effect of exempting research on improving subject matter, we use two models of sequential innovation. The first model (we call it as the pioneer and follower research model) is a two stage innovation model, which is often used in industrial organization literature. The second one is perpetual R&D competition model, which is often used in endogenous growth literature.

2.1 Pioneer and follower research model

We call the invention the production application of which will infringe the first patent as an improvement, and the invention the production application of which will not infringe the first patent as inventing-around. When an exemption for research on improving subject matter does not exist, the follower *must* obtain a license before undertaking research, i.e., obtain an ex-ante license. Then the pioneer can coordinate the second stage research.[4] On the other hand, when there is exemption for research on improving subject matter, the follower may not always find ex-ante licensing beneficial.

Let us consider the following specific model, which builds on Scotchmer (2004). The follower invests x in follow-up research. It will succeed with probability p and fail with probability $1 - p$. When it succeeds, the invention will be an improvement which enhances the value of pioneer's patent by v from v_0 to $v_0 + v$ with probability θ, or it will invent-around the first patent and achieve value $v_0 + w$, $w > v$, while the value of pioneer's patent will drop from v_0 to zero with probability θ. We assume here that the invention is drastic when invent-around takes place, so that competition between the old and new technology does not matter in the determination of the value of the second technology.

An ex-ante license will be negotiated before the follower invests. If there is no ex-ante license, then the follower must obtain an ex-post license if the outcome is an improvement. If an invent-around is achieved, then there is no need for an ex-post license. The sequence of events is summarized in Figures 1 and 2 for the cases without and with research exemption.

Without research exemption (Figure 1), there cannot be any investment by the follower without an ex-ante license. Thus the threat point is $(v_0, 0)$. The research of the follower will generate

[4] We assume that the pioneer licenses to the follower since only the follower invests in the follow-up research.

the following expected joint profit,

$$\pi_{joint} = p\{(1-\theta)(v_0+v)+\theta(v_0+w)\}+(1-p)v_0-x = (1-\theta)pv+\theta pw+v_0-x. \quad (1)$$

Profits with ex-ante license will be,

$$\pi_1^{ex-ante*} = v_0+\frac{1}{2}\left\{p\left((1-\theta)v+\theta w\right)-x\right\}, \quad \pi_2^{ex-ante*} = \frac{1}{2}\left\{p\left((1-\theta)v+\theta w\right)-x\right\}. \quad (2)$$

The $*$ indicates that it is the payoff without research exemption (Fgiure 1). The second stage research will essentially become a joint venture between two firms.

Now we turn to the case where there is research exemption. Then firm 2 is able to invest without an ex-ante license. It needs an ex-post license only when it improves, instead of inventing-around. We start with ex-post licensing which is necessary when there is improvement (the lower right rectangle in Figure 2) even when there is research exemption. The threat-point is $(v_0, -x)$ since production is not possible without a license. With such an ex-post license, the follower gains only half of the enhanced value of the first patent, v, while it will bear the full cost of research. On the other hand, the follower can gain all the monopoly profit v_0+w when it invents-around the pioneer.

The expected profits of firms when the follower obtains ex-post license when necessary (Figure 2), instead of an ex-ante license, are given by

$$\pi_1^{ex-post} = \left(p(1-\theta)+(1-p)\right)v_0+\frac{vp(1-\theta)}{2}, \quad \pi_2^{ex-post} = \frac{vp(1-\theta)}{2}+\theta p(v_0+w)-x.$$

Note that the follower will invest only if

$$\pi_2^{ex-post} > 0 \quad \Leftrightarrow \quad p\left((1-\theta)\frac{v}{2}+\theta(v_0+w)\right) > x. \quad (3)$$

For the ex-post license to yield positive value for the follower, x must be sufficiently small, the probability of success and the profitability of inventing-around sufficiently large (recall $w > v$).

For ex-ante negotiation,[5] the threat point is either $(v_0, 0)$ if there is no investment with only ex-post licensing or is $(\pi_1^{ex-post}, \pi_2^{ex-post})$ if there is investment. When the threat point is $(v_0, 0)$, we still have ex-ante licensing with payoff equal to those of equation (2). When the threat-point is the ex-post licensing ((3) holds and there is investment), then there is no gain from ex-ante licensing since π_{joint} (see (1)) is equal to $\pi_1^{ex-post} + \pi_2^{ex-post}$.

We make the following observation:

Lemma 1. *With research exemption, there will be ex-ante licensing only when the follower will not investment otherwise.*

That is, even with research exemption, ex-ante licensing is useful for sharing the cost to induce the follower to invest. When ex-post licensing occurs, research exemption benefits the follower only when the likelihood of inventing-around is large,

$$\pi_2^{ex-ante*} < \pi_2^{ex-post} \quad \Leftrightarrow \quad \theta > \frac{x}{p(2v_0 + w)}. \tag{4}$$

If such probability is small, in particular, if it is zero, research exemption hurts the follower, as pointed out by Scotchmer (2005), because its profit defined by the threat point (i.e. ex-post licensing) is small.

The follower will invest without research exemption only when

$$\pi_2^{ex-ante*} > 0 \quad \Leftrightarrow \quad p\left((1-\theta)v + \theta w\right) > x. \tag{5}$$

This condition coincides with the social efficiency condition when the private incremental values of the innovations (v, w) coincide with social incremental values (the increase of the willingness to pay). Without research exemption, the follower appropriates only half of the incremental value from innovation. On the other hand, with research exemption, the follower is able to appropriate the total value, $v_0 + w$ when it successfully invents-around.

Research exemption always leads to more innovation by the follower since it has the same payoff without research exemption when (3) does not hold, while (3) may still hold even if (5)

[5] Such negotiation may not infringe competition law, since it does not constrain product market competition

does not hold. In particular, the follower invests only with research exemption when the following condition is satisfied:

$$\frac{(1-\theta)pv}{2} + \theta p(v_0 + w) > x > p\left((1-\theta)v + \theta w\right). \tag{6}$$

The necessary condition for this is,

$$\theta > \frac{v}{2v_0 + v}. \tag{7}$$

When the probability of inventing around is sufficiently large, the prospect of sharing innovation with the pioneer due to ex-post licensing is small, which encourages investment by the follower.

The welfare effect of research exemption is ambiguous, even if we focus on the efficiency of the follow-up invention. As we just observed, the follower may have an excessive incentive (condition (7) holds) to undertake the second stage research when there is exemption. Even if the incremental value of follow-up research is negative, it may still wish to invest since it does not internalize the loss of the pioneer due to the inventing-around (*business stealing effect*). On the other hand, such investment may not be excessive once we take into account a possible consumers' gain when inventing-around takes place. A clear result from our analysis is that the level of R&D by the follower is higher under research exemption since ex-ante agreement will always fill the gap when ex-post agreement is not chosen.

Proposition 1. *Research exemption always enhances the investment by the follower. It enhances follower's profit and reduces the pioneer's profit when the probability of inventing around is sufficiently large ((4) holds). It can reduce economic welfare by discouraging efficient ex-ante contracting in the context of a pioneer and a (non-competing) follower research context.*

These results complement the analysis of the oft cited analysis of ex-ante licensing and research exemption (Scotchmer's (2004)), which, however, rules out the possibility of inventing-around. Without the possibility of inventing around, the follower always loses from research exemption because the denial of ex-ante licensing forces the follower to bear the full innovation cost. However, with the possibility of inventing around, research exemption can benefit the follower, since there is no need to obtain a license if inventing-around is the outcome. With research exemption, a significant possibility of inventing around can make the ex-post licensing a bargaining outcome. Thus, we do in fact observe ex-post licensing.

2.2 Perpetual R&D competition model

In many industries, innovation is perpetual in the sense that any innovation depends on past innovations as its knowledge basis, and it in turn contributes to future innovations. There is no beginning and no end in the innovation process. In this kind of an innovation process, exemption for research on improving subject matter does make sense, since it can not only avoid transaction costs of licensing for research on the subject matter and the inefficiency of double marginalization but also enhance innovation by increasing the difference between the return from the new innovation and that from the old innovation.

We consider a perpetual stochastic R&D innovation process, where each firm is leap-frogged by a drastic innovation by another firm, and compare the equilibrium investments of the stationary Markov equilibrium with and without research exemption, using the framework of Segal and Whinston (2005). There are two firms, an incumbent (I) and an entrant (E). We denote the continuation values by V_I and V_E. The incumbent monopolizes the product market and gets profit π^m.

When the entrant succeeds in research and obtains a patent, it now becomes the monopolist but must pay a fixed proportion, a, of its monopoly profit to the patent owner (previous incumbent). The parameter a depends on the scope of research exemption. Since the monopoly profit is also a parameter in our model, it does not make difference whether the payment for research license depends on the profit level or not. In addition such licensing payment reduces the profit available for the firms by the proportion $1 - \ell$ due to transaction cost and double marginalization. (We assume that such costs is born by a licensee for simplicity.) We assume a is not very large, so that the current profit of the monopoly producer is larger than that of the patentee. No patent licensing for research due to research exemption would be characterized by the combination of $a = 0$ and $\ell = 1$. When the entrant is not successful, it can collect patent licensing revenue of $a\pi^m$ from the incumbent. The entrant will successfully innovate with probability ϕ.[6] An entrant's

[6]We are assuming that patent royalties are contingency based, i.e., paid only when the innovation is successful.

expected profit is, thus,

$$\phi(\ell - a)\pi^m + (1-\phi)a\pi^m + \delta\left\{\phi V_I + (1-\phi)V_E\right\} - c(\phi),$$

where $c(\phi)$ is the research cost of the entrant choosing ϕ with $c'(\phi) > 0$ and $c''(\phi) > 0$ and $\delta < 1$ is the discount factor. Parameter ℓ ($2a < \ell \leq 1$) accounts for the transaction cost or the cost of double marginalization of patent licensing. The assumption $\ell > 2a$ guarantees that profit of the monopoly producer (licensee) is larger than profit of the patentee (licensor). An entrant chooses ϕ to satisfy

$$\phi = \Phi(w) = \arg\max_{\phi\in[0,1]} \left\{\phi w - c(\phi)\right\}, \tag{8}$$

where w is the entrant's gain from innovation,

$$w = (\ell - a)\pi^m - a\pi^m + \delta(V_I - V_E).$$

Given w the innovation supply function (Segal and Whinston(2005)) $\Phi(w)$ depends only on $c(\phi)$. Given our assumptions on $c(\phi)$, it is an increasing function.

With the optimal ϕ, the following relationships hold,

$$V_I = \phi a\pi^m + (1-\phi)(\ell - a)\pi^m + \delta\left\{\phi V_E + (1-\phi)V_I\right\}, \tag{9}$$

$$V_E = \phi(\ell - a)\pi^m + (1-\phi)a\pi^m + \delta\left\{\phi V_I + (1-\phi)V_E - c(\phi)\right\}. \tag{10}$$

The "innovation benefit curve" (Segal and Whinston (2005)) is given by substituting V_I and V_E by the solutions of equations (9) and (10):

$$\begin{aligned} W(\phi, a, \ell) &= (\ell - a)\pi^m - a\pi^m + \delta(V_I - V_E) \\ &= (\ell - 2a)\pi^m + \delta\frac{(1-2\phi)(\ell - 2a)\pi^m + c(\phi)}{1 - \delta + 2\delta\phi}. \end{aligned}$$

We are interested in how it depends on the parameters. It is evident that $W(\phi, a, \ell)$ is increasing

The effect of research exemption is independent of whether the payment is contingent or not although the optimal rate will differ.

in ℓ. As for the derivative with respect to a,

$$\frac{\partial W(\phi, a, \ell)}{\partial a} = -2\pi^m + \delta \frac{-(1-2\phi)2\pi^m}{1-\delta+2\delta\phi} = \frac{-2\pi^m}{1-\delta+2\delta\phi} < 0.$$

The first term is negative, since research licensing penalizes the innovation by the entrant through reducing the current profit. The second term is also negative if $\phi < 1/2$, since research licensing equalizes the continuation values of the incumbent and the entrant.

The equilibrium innovation is determined as the intersection of the innovation supply and innovation benefit curves in (ϕ, w) space. Innovation supply curve is increasing in w, therefore upward sloping, while $W(\phi, 0, 1) > W(\phi, a, \ell)$ for all $0 < a < 1$ and $\ell < 1$. This means the equilibrium innovation is unambiguously larger when there is research exemption, given the stability conditions of an equilibrium.

Proposition 2. *Research exemption increases innovation not only by reducing the transaction cost and the inefficiency of double marginalization but also by increasing the difference between the return from new innovation and that from the old innovation.*

Note that research exemption will also result in lower price for consumers for each stage of innovation in a perpetual R&D competition, since a firm can avoid incurring transaction cost for research licensing and the inefficiency of double marginalization.

Although the above argument was for only two firms, the result can be generalized to more entrants. It is shown in the Appendix that research exemption leads to greater innovation in the case of three firms.

The case for research exemption becomes further strengthened when cross-industry knowledge flow is important for industrial research. This is because, when there are more licensors from whom a firm has to obtain a license, both the cost of licensing transaction as well as the inefficiency due to double, triple or more marginalization become higher as the number of licensees increase. In the presence of cross-industry knowledge flow research exemption must be expanded from the exemption of research on subject matter to that of research using the knowledge disclosed in the invention that is useful for improving its subject matter, since such knowledge can be useful for the other technology areas as well.

The proceeding analysis also highlights the difference between research exemption and shorter leading breadth (O'Donoghue (1998), Hunt (2004)) although they are both forms of weakening patent protection. (Here we ignore transaction costs and double marginalization for research exemption.) Research exemption may be interpreted as a way of weakening forward protection. Both forward protection and exemption changes the distribution of profits from the second innovation between the first and second innovators. In the case of leading breadth, however, shorter breadth allows innovator to collect profit only for shorter periods of time meaning the size of total profits as well as distribution of profit is effected. The change in marginal benefit and change in total profit means leading breadth can be too long or too short. Research exemption, on the other hand, has no effect on the total profit itself. Since each firm is both first and second innovator (on the average), total profit is unchanged but research exemption increases the marginal benefit of innovation. Research exemption will always increase innovation.

The above discussions suggest that the economic effects of exemption for research on improving or inventing-around the subject matter depend critically on the innovation process. Such exemption makes good economic sense in the context of perpetual R&D competition, since a firm can avoid incurring transaction cost for research licensing and the inefficiency of double marginalization, while it enhances the value of new innovation relative to that of the old innovation. On the other hand, research exemption can reduce economic welfare by discouraging efficient ex-ante contracting in the context of a pioneer and a (non-competing) follower research context. The best approach might be to provide broad research exemption on the research on subject matter (more generally exemption for research using the knowledge disclosed in the invention that is useful for improving its subject matter), while stronger protection is provided for pioneer invention in terms of the breadth of claims in the product market. The availability of broad protection of a pioneer patent encourages efficient ex-ante licensing, while broad research exemption on the research on the subject matter will eliminate the inefficiency of multiple licensing in the perpetual innovation process and encourage new innovation.

3 Other justifications for research exemptions

3.1 Exemption for research on verifying subject matter

The case for exempting the experimentation on subject matter for verification of the patented invention with respect to patentability standard or its value seems to be strong. It would help invalidating patents which do not meet patentability standard. Such invalidation has positive externality, since it eliminates market power without merit, while the challenging firm can appropriate only a small part of the introduction of competition, given that all the other potential users of such invalidated patent will also gain. The availability of such investigation would have the effect of encouraging a patent applicant to avoid filing low quality patent applications and to provide adequate disclosure. In addition, confirming the value of a patent for the purpose of obtaining a license would reduce information asymmetry between a potential licensor and a licensee. This will reduce the probability of breakdown of negotiations between a patentee and a potential licensee, so that the technology market will expand.

3.2 Exemption for academic or non-commercial research use of a patent

First we start with interpreting what constitutes a non-commercial or academic use. The phrase "merely for amusement, to satisfy idle curiosity or for strictly philosophical inquiry"[7] suggests that non-commercial use means there is no pecuniary return from the experiment or research. Returns can be absent because it is not possible to appropriate the returns, even if its applications are marketable, due to great spillover.

With the proceeding characterization of non-commercial or academic use, we analyze three potential justifications for the exemption for academic research use: spillover effect of academic research, lower level of willingness to pay of those engaging in academic research and the coordination problem in avoiding enforcing patents toward academic institutions. The first potential justification is a significant spillover effect of academic research. What separates academic or non-commercial research from commercial research is that the former research output is freely available for the public. Given this, the return from academic research is difficult to appropriate

[7] Madey vs Duke University, 307 F.3d 1351 (Fed.Cir.2002)

commercially and it needs to be funded in some other way. However, it is important to note that the source of externality in this context is the research output and not the use of a patent for the research purpose per se.

There are two firms and a university. Suppose only firm 1 has a patent for a research tool. Using this tool, a university can invest x_U and realize revenue $R_U(x_U)$. Firm 1 itself can benefit from the university research and by investing x_1, it can realize revenue $R_1(x_1+\alpha x_U)$. Firm 2 also benefits from university's investment, $R_2(x_2+\alpha x_u)$. We consider firm 2 as a representative firm of many firms which gain from the spillover, so that it is not possible for the university and firm 1 to have a contract with firm 2. α ($0<\alpha<1$) measures the extent of spillover from university to the firms.[8] For the university, revenue may be from non-market sources such as research funding which increases with publications which in turn is an increasing function of research investment x. We assume $R'>0$ and $R''<0$ for both revenue functions.[9] Profits are,

$$\pi_i(x_i, x_U) = R_i(x_i+\alpha x_U) - x_i,\ i=1,2, \quad \pi_U(x_U) = R_U(x_U) - x_U.$$

We have $\partial\pi_i/\partial x_U = \alpha R_i' > 0$.

With research exemption, university is able to use the research tool and it invests $\hat{x}_U$ and firm i invests $\hat{x}_i = \beta(\hat{x}_U)$, where $\hat{x}_U$ maximizes $\pi_U(x_U)$ and β_i is firm i's best-response correspondence. Denote the corresponding profits by $\hat{\pi}_i$ and $\hat{\pi}_U$. University will invest a positive amount with research exemption and this benefits the firms through spillover, $\hat{\pi}_i > \pi_i^m$. π_i^m denotes the profit with no university research. However the level of university research is inefficiently low, since the university does not internalize the spillover. That is,

$$\frac{\partial}{\partial x_U}\left(\pi_1+\pi_2+\pi_U\right)|_{x_U=\hat{x}_U} = \alpha\left(R_1'+R_2'\right)|_{x_U=\hat{x}_U} > 0.$$

Without research exemption the university is unable to use the technology without a license. Without license, $x_U=0$ and the firms choose investment x_i^m, which maximizes $\pi_i(x_i,0)$. Since

[8]Innovation with investment x can be process or product innovation. Revenue function can be profit from Cournot competition given cost $c(x)$ where investment x reduces marginal cost, i.e., process innovation (Suzumura, 1992) Revenue may be profit from Hotelling product differentiation where investment x increases intrinsic value of a good $v(x)$, i.e., product innovation.

[9]This is consistent with possible underlying structures in previous footnote.

the best-response correspondence is downward sloping,

$$x_i^m > \hat{x}_i, \text{ while } \pi_i(x_i^m, 0) < \pi_i(\hat{x}_i, \hat{x}_U).$$

If licensing is possible, research exemption enhances the university research and generates the spillover to the firms.

A contract for coordinating firm 1's and university's investments can be negotiated with or without research exemption. Even with exemption, both parties still have incentive to contract because research exemption does not internalize the spillover from the university to firm 1. However the threat points will differ: threat point is $(\hat{\pi}_1, \hat{\pi}_U)$ with exemption and it is $(\pi_1^m, 0)$ without. Note that firm 1 has better threat point allocation with exemption ($\hat{\pi}_i - \hat{\pi}_U$ is likely to be smaller than π_i^m.)

The optimal contract will aim at achieving x_U^0 and x_1^0 which are the investment levels that solve,

$$\max_{x_1, x_U} \pi_1(x_1, x_U) + \pi_U(x_U).$$

The spillover between firm 1 and the university is internalized with joint profit maximization and we have,

$$\hat{x}_U < x_U^0 \text{ and } \hat{x}_1 > x_1^0.$$

Although firm 1 benefits from the coordination $\pi_1^0 > \hat{\pi}_1$, the university is worse off by itself. Firm 2 benefits from the spillover although the university investment level is still too low.

From the proceeding simple example we can see that even if research exemption is relevant due to the contracting difficulty between a firm with research tool and the university, it still does not guarantee jointly optimal level of investments by firms and the university. Other methods, such as subsidies directly targeted to the spillover would be more effective than research exemption to induce the right amount of University research. For instance, the input subsidy s should be set to satisfy,

$$s = \alpha \left(R_1' + R_2' \right),$$

ignoring the consumer surplus since we have not modelled the product market explicitly. Providing exemption for academic research clearly harms the incentive of upstream research for research tools, while it is only a very partial means for encouraging academic research.

The second potential justification of exemption for academic or non-commercial research is lower level of willingness to pay of those engaging in academic research. They may not be well-funded. They may be more eager to develop a do-it-yourself solution. Charging lower price, including zero, can be justified as a form of price discrimination, as in the case of academic discount of software for instance. Although social welfare implication of price discrimination is generally ambiguous, it may well increase social welfare when the difference of willingness to pay is very significant between academic users and commercial users of a technology. However, a patentee has an incentive to price discriminate voluntarily, since it serves its own interest. Exemption, on the other hand, prevents the patentee from appropriating any return from the academic community. The efficient price discriminating price for the academic price is probably not zero, meaning the zero price constraint is a distortion. Thus, price-discrimination justification for exemption does not seem to be tenable.

The third potential justification of exemption for academic or non-commercial research is to solve the coordination problem in avoiding enforcement of patents against academic researchers. A patentee may be willing to provide free access to its patents for academic research, if its competitors follow suit. If competitors do not, it will face competitive disadvantage in R&D competition due to its lower appropriation capability. Such collective commitment among patentees for non-enforcing patents to academic researchers will enhance the level of academic research by saving licensing fees, transaction costs, and by eliminating uncertainty with respect to potential infringement of academic research. The enhanced research will in turn benefit commercial firms as a whole, the extent of which may be larger than the forgone licensing revenues. If this is the case, academic research exemption may work as an efficient collective commitment device not to enforce patents toward academic research. However, if academic research is well-funded and transaction costs are small, the intervention of creating academic use exemption would not be necessary. In addition, firms may voluntarily collaborate in creating “patent commons” for academic research, such as a SNP (Single nucleotide polymorphisms) consortium.

4 Conclusion

We have examined economic rationale of two types of research exemptions. The first exemption targets research on subject matter. We find that the economic effects of exemption for research on improving or inventing-around the subject matter depend critically on innovation process. Such exemption is socially beneficial in the context of perpetual R&D competition, since a firm can avoid incurring transaction cost for research licensing and the inefficiency of double marginalization, while research exemption can promote innovation by enhancing the return from new innovation and reducing the return from old innovation. On the other hand, research exemption can reduce economic welfare by discouraging efficient ex-ante contracting in the context of a pioneer and a follower research context. The best approach might be to provide broad research exemption on the research on subject matter (more generally exemption for research using the knowledge disclosed in the invention and which is useful for improving its subject matter), while stronger protection is provided for pioneer invention in product market in terms of the breadth of claims. We also find that exemption for experimentation on the subject matter for the purpose of verification of inventions make good economic sense.

The second exemption targets academic or non-commercial researches. The cases for such exemption are large spillover of academic research, low willingness to pay and coordination mechanism. We find that these arguments are not very persuasive. Research exemption is a very blunt tool for encouraging academic research and such exemption has a clearly negative effect on the development of research tool. There are more efficient policy choices, such as the combination of subsidies on academic research and cost-based licensing commitment of grantees, which can be tailored better for the purpose. In addition, it is not clear whether research exemption is necessary for efficient and coordinated price discrimination in favor of academic researches, given that we see extensive use of academic discounting and recent attempts to creating ”patent commons” for academic research, such as the SNP (Single Nucleotide Polymorphisms) consortium.

In evaluating the two rules we did not consider the cost of enforcement. Explicitly defining what constitutes research ”on” subject matter may be feasible. On the other hand defining exemption by the non-commercial or academic status of the researcher may be problematic.

We also did not examine the ”non-commercial use” doctrine which is the term used in U.K. and Germany. It is conceivable that something that started as a pure intellectual pursuit result in something with very high commercial value. The situation is different from the subject matter exemption analyzed in section 2.1 since here successful development triggers patent protection. Such an implementation of exemption will have the same option effect as the subject matter exemption.

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Appendix

We can generalize the perpetual R&D competition to more than two firms. Two non-incumbent firms own the patent for which the incumbent must pay royalty. We consider three firms and three states that each firm are in, Incumbent (I), Predecessor ($E1$), and Entrant ($E0$). We assume only the Entrant innovates. If $E0$ succeeds, then $E0$ will be the next incumbent, I will become the next $E1$, and $E1$ will become the next E_0. If unsuccessful, all types remain the same type. The incumbent pays royalty to two generations of proceeding technologies.

The values satisfy,

$$V_0 = \phi(1-2a)\pi^m + (1-\phi)a\pi^m + \delta\left\{\phi V_I + (1-\phi)V_0\right\} - c(\phi),$$

$$V_I = \phi a\pi^m + (1-\phi)(1-2a)\pi^m + \delta\left\{\phi V_1 + (1-\phi)V_I\right\}, \tag{11}$$

$$V_1 = \phi a\pi^m + (1-\phi)a\pi^m + \delta\left\{\phi V_0 + (1-\phi)V_1\right\}. \tag{12}$$

We substitute (12) into (11). Then we solve for V_0 and V_I. We can find the innovation benefit of $E0$, $w = (1-2a)\pi^m + \delta(V_I - V_0)$ (which is a very complicated expression). The innovation supply curve is the same as with only one entrant. To determine the effect of research exemption on innovation , we are interested in how w changes with a.

$$\frac{dw}{da} = -\frac{3(-\delta+\delta\phi+1)\pi^m}{-3\delta^2\phi+3\delta^2\phi^2+\delta^2+3\delta\phi-2\delta+1}.$$

This is negative for all $\phi \in (0,1)$ and $\delta > 0$ not too large. In particular, it is negative for some $\delta > 1$. Research exemption will increase innovation and the result does not depend on the "front loading" unlike Segal and Whinston (2005). That is, it is not the ability to collect benefits earlier that makes research exemption beneficial, as would be the case for shorter leading breadth.

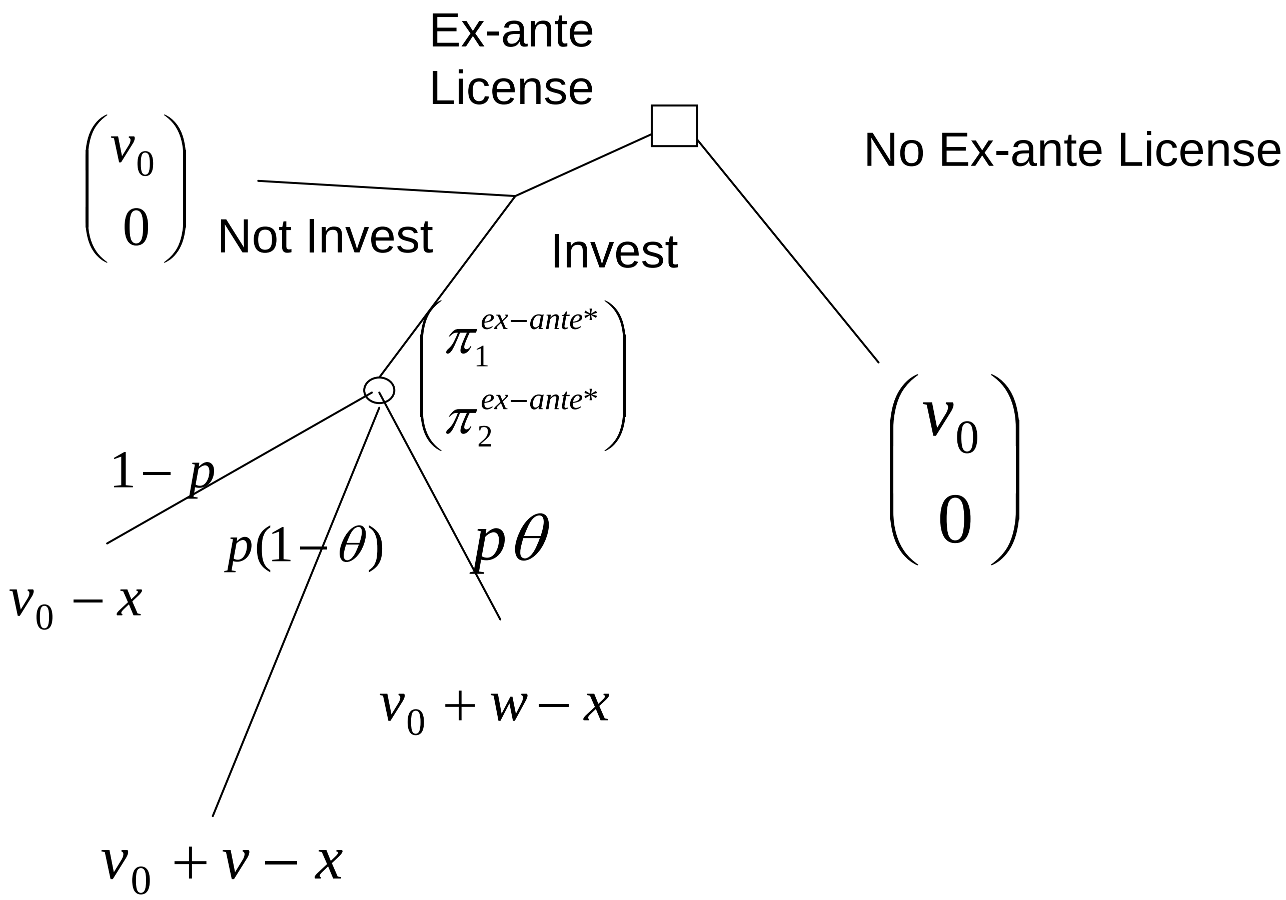

Fig 1: No Research Exemption

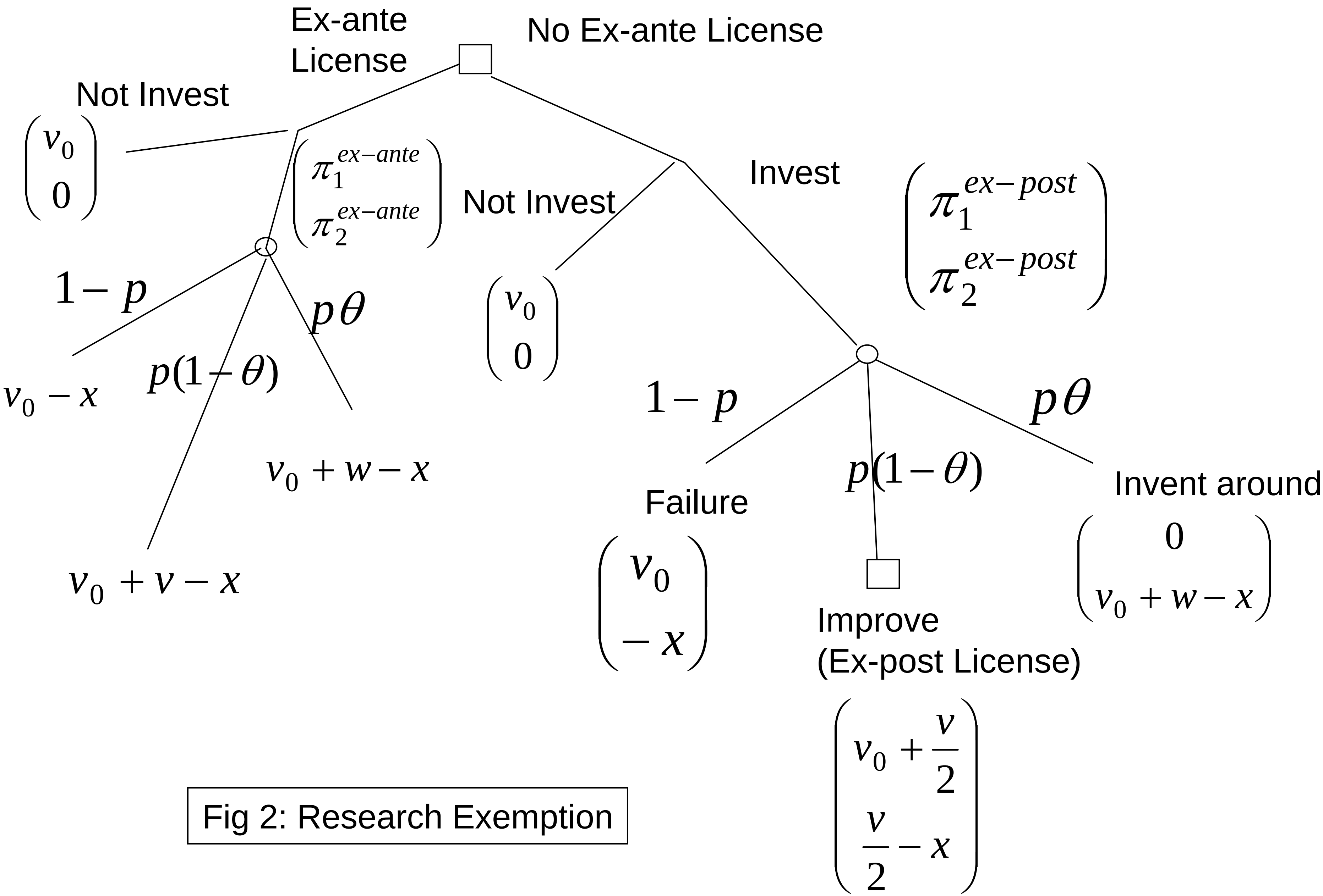

Fig 2: Research Exemption