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Improving Patent Incentives and Enforcement: The Impact of Patent Thickets, Renewal Fees and Litigation Insurance

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1. Introduction

It will not be news to you that the number of patent applications in the U.S. and EU has grown sharply over the last few decades, and especially since the early to mid 1990's. This holds for most technology areas, but particularly in high-tech sectors such as biotechnology, software, semiconductors, and scientific and medical instruments (Other Health), as Figure 1 illustrates for the EU.

[Figure 1 here]

Is this good news, or is it a public policy concern? Does it warrant major reform of the patent system and, if so, what specific changes are required?

The growth in patenting is good news if it reflects growing innovation. But it could be cause for concern if, as many now claim, patenting itself has become an impediment to innovative activity, rather than the incentive it was originally designed to be. Several reasons have been advanced. First, the growth in patenting may have created patent thickets -- fragmented property rights that require a firm to secure license agreements from many patentees in order to undertake R&D, making innovation more difficult and costly. Second, greater patenting may raise the costs of enforcing patent rights once they have been secured, and thus discourage innovation in the first place. And third, the dangers associated with 'patent trolls' – patent-holders who do not work their patents but rather use them to 'hold-up' later innovators -- may become more severe.

In this lecture I discuss these issues, provide empirical evidence, and suggest remedial policies. My analysis is guided by a central principle: the importance of maintaining innovation incentives, preserving effective competition among innovators, and using market-based (rather than government) solutions whenever possible.

2. Patent Renewal Fees for Screening

I begin with the issue of patent screening. Patents are screened at different stages. *Ex ante screening* is what occurs by the patent office examiner in the granting process. If a patent is granted, it is then subject to two forms of *ex post screening*. The first is patent litigation by private parties – both infringement suits

and patent challenges. The second form of *ex post* screening may surprise you: patents are self-screened through the patent renewal mechanism. In nearly all countries, patent renewal fees are required to maintain patent protection. Failure to pay means that the patent expires, and most patents drop out long before statutory expiration.

In this lecture I want to discuss both forms of ex post screening, renewal fees and litigation. For reasons of space, I will not discuss patent office reforms that may improve *ex ante* screening.[1]

I begin with the appropriate use of *ex post* (self) screening through patent renewal fees. To start, I want to clear up a common misconception. It is often said that, under the TRIPS Agreement[2], countries are now subject to a uniform patent life of twenty years. This is wrong for two reasons. First, TRIPS imposes no maximum patent length, only a statutory minimum. Second, and more important, TRIPS does not restrict the renewal fees countries choose to impose. In every country that has been studied, we have found that patent holders voluntarily choose to let their patents lapse long before the statutory limit is reached. The renewal patterns vary across technology fields and countries, but typically more than half of patents expire by age ten. Research by Pakes and Schankerman (1986, 1998) and Lanjouw (1993) show that the renewal decision is sensitive to economic considerations, including renewal fees, size of the market, and the threat of litigation.

In short, renewal fees induce very substantial variation in *de facto* patent lives. Moreover, since TRIPS does not in any way constrain renewal fee schedules, countries have wide discretion on how they choose to differentiate patent lives. They are free to shorten or lengthen (even beyond 20 years) the patent duration, provided they do it through renewal fees.

Because the renewal decision is sensitive to the renewal fees, governments can and, in my view should, use renewal fees as an active instrument of patent policy to increase the effectiveness of *ex post* screening. That is not done currently: fees are basically set to defray the operational costs of the patent offices. But they can do much more than that.

First, raising renewal fees substantially will help to weed out the low (private) valued-patents. This should help mitigate the problems associated with the proliferation of patent rights. It might also help with the problem of patent trolls, by making it much more costly to sit on 'submarine patents' for an extended period of time. These are patents that are not worked by the patentee, but are kept in force solely for the purpose of subsequently extracting money from firms after they have begun production, by the threat of injunctive relief for infringement.

Second, and most importantly, recent research has shown that patent renewal fees can be used to improve the innovation incentives generated by patent rights. In particular, if designed appropriately, these fees can tilt the incentives to give greater reward to patents that are more valuable, in the realistic context of asymmetric information, where the government has no information on which patents are more and less valuable.[3] Since firms have better (even if not perfect) information about the private value of their own patents, we need to differentiate the reward in a decentralized way that exploits that private information, and renewal fees allow us to do that. I will now explain how that can work.

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[1] For a good discussion of these issues and proposals for reforms, see Jaffe and Lerner (2004).

[2] TRIPS stands for the Trade-Related Intellectual Property System.

[3] See Cornelli and Schankerman (2001) and Scotchmer (2001).

In all countries, renewal fees share two common features: they begin at very low levels, and they rise with the age of the patent. Even in Germany (which has one of the highest renewal fees) the fee at age twenty is less than 3,000 Euro. As I discuss next, economic analysis indicates that existing fees should be much higher and should rise much more sharply with the age of the patent.

It is useful to think about renewal fees as a tax on the property right conferred by a patent. It is natural, then, to try to compute the tax implied by existing renewal fees as a percentage of the private value of the patent protection which is being taxed.[4] What does this 'patent tax' look like? Is it progressive or regressive? That is, is the tax rate implied by existing renewal fee schedules higher or lower for more valuable patented inventions? Does it vary substantially across countries?

Figure 2 shows the answers for three leading countries: France, Germany and the U.K. The results are very striking.[5] Notice that the tax rate is much higher for patents which expire at an earlier age. These are the less valuable patents (those for whom the private value of patent protection is not high enough to warrant renewal). In other words, Figure 3 shows that renewal fees constitute *a sharply regressive tax:*the implied tax rate on high-valued patents is much lower than for low-valued patents in each country.

[Figure 2 here]

In general we do not think taxes should be regressive, based on the grounds of ability-to-pay. But in the context of patents, there is a more basic and compelling reason that the tax on patent protection should be progressive. I turn next to this line of argument, which is based on the underlying economic rationale for allowing patents in the first place. I now develop this line of argument.

Let's begin with an assumption: Patents that are more valuable are also more costly (or risky) to generate, on average. Of course, this does not rule out some role for luck (even for the same cost, some patents just turn out more valuable). Under this supposition, it is *socially desirable* to provide greater *ex post reward* to such patents. Does the current patent system do that? Yes, because more valuable (and costly) patents will earn greater profit period, and thus a larger total return, even if we provide the same statutory lifespan for all patents. But is it enough?

To see the answer, we first need to recognize that patentees only capture a small fraction of the social benefit that their innovations generate. This is true both for important and less important innovations. From an economic perspective, government should be concerned with the social (not just private) value of innovation. The key question is this: Does the fraction of the social value that patentees can capture depend on the importance of their inventions, and if so, which way?

If the fraction of social value they capture does *not* vary with the importance of the patent, then society has no reason to tilt the private incentives toward the more valuable patents by differentiating patent lives. But if that ratio is smaller for more important patents, then private incentives are distorted toward the lower valued patent, *relative to the socially optimal incentives.* In that case, differentiating patent lives helps to redress the misalignment between private and social incentives.

[4] The mechanics of how to do this are somewhat complicated, and are described by Cornelli and Schankerman (1999).

[5] The U.S. first introduced renewal fees in 1982, much later than other industrialized countries. It may now be possible to do similar analysis on the U.S. patent renewal data, but this is for future research.

There is no available evidence on this point, but the most reasonable assumption here is that *firms are able to capture a smaller fraction of the full social gains on the more important inventions*. There are good economic reasons to believe this: demand for really important inventions are typically less price sensitive, and in these cases firms are usually able to appropriate less of the social gains, by which I mean the consumer surplus generated by their inventions. Think of a minor variation on an existing drug versus a dramatic breakthrough on an AIDS drug. The assumption I am making here is that the inventing firm gets a larger percentage of the total social gain in the first case than in the second.

If this assumption is right, it is in society's interest to provide longer patent lives for patented inventions that are more valuable. Developing this line of reasoning formally, Cornelli and Schankerman show how one can compute a 'socially optimal' (welfare maximizing) fee schedule. Using simulation analysis, they suggest that, under a range of reasonable assumptions, the *'socially optimal' fees should be much larger than existing fees, sufficiently so as to make the fee schedule a sharply progressive tax on patent rights*, as Figure 3 illustrates. Comparing the actual tax rates in Figure 2 with the optimal tax rates suggested by Figure 3, we observe that renewal fees should probably be at least two to three times higher at later ages than they currently are.

[Figure 3 here]

It is also interesting to see, as shown by Figure 3, that the optimal fees for patents older than twenty are not infinite. This is another way of saying that we should allow patent rights to last longer than twenty years, provided that we 'price' these property rights correctly.

In short, if governments used renewal fees as an instrument to maximize economic welfare (which I think they should), the conclusion is that the level of renewal fees should be raised very substantially, that they should rise much more sharply with patent age than the existing schedules, and that patent lives beyond the current 20 year maximum should be allowed.

Of course, small firms and individual patent holders will surely object to higher renewal fees, mainly on the argument that they are cash-constrained. This may be true, though even a small firm with a valuable patent (which can be used as a collateral asset) should be able to borrow from banks, venture capital, or other sources to cover the renewal costs. Moreover, while economic analysis does not justify it, if the politics of introducing higher renewal fees require the compromise, the government could choose to differentiate fees by firm size as was done in the U.S.

3. Patent Enforcement

Economic research on the enforcement of patent rights is relatively recent, despite the importance of the topic. Understanding these issues is important because they affect the effectiveness of the R&D incentive provided by the patent system, strategic patenting decisions by firms that influence their ability to enforce their patent rights, and the feasibility of rationally pricing patent litigation insurance.

The central point I want to emphasise is that litigation exposure is extremely heterogeneous. It varies widely across characteristics of patents and patent owners, including technology field, the importance of the patent, the size of the owner's patent portfolio, and the structure of the technology markets in which the firm operates. I begin by presenting some stylised facts about patent suits, based on comprehensive evidence for the U.S., developed in research I have done with Jean Lanjouw.[6]

[6] For more extensive discussion , see Lanjouw and Schankerman (2001, 2004).

3.1. Stylized Facts of Patent Litigation

When we average over all patents within a given technology field, the striking fact is that patent suits do not appear to be especially frequent. Table 1 shows that, in the aggregate, only 1.9 percent of patents are involved in any patent suits *over their lifetime.* Yet we see significant variation across technology areas. In the more established fields – chemicals, electronics and mechanical technologies – the litigation rates are much lower than in the newer fields such as pharmaceuticals, computers, biotechnology and medical instruments.

[Table 1 here]

Moreover, these litigation rates have been fairly stable over time.[7] The *number of patent suits* has certainly grown dramatically, but this reflects the overall growth in patenting, and not growth in the *number of suits per patent.* Thus, if there is a problem, its source is the rise in patenting activity.

The problem is that the average rate of patent suits hides tremendous variation across patents within any given technology field, and is thus not very informative. Patents are very heterogeneous and litigation is not randomly distributed across them. First, not surprisingly, litigation targets the more valuable patents. When we break down patents according to the number of claims and the number of forward (future) citations per claim – as proxy measures for value – we see that the patents which are involved in suits are higher value patents (Table 2).[8] This is true both for patents held by individuals and firms.

[Table 2 here]

Moreover, litigation rates are very different across characteristics of the patent-holder. Table 3 shows the variation in litigation rates and in settlement rates for four categories of patentees: individuals, domestic unlisted (generally small) firms, domestic listed firms, and foreign firms. The results are striking, and at first blush, counterintuitive. Individuals and small firm patentees have much higher average litigation rates, about four times higher than for domestic listed firms, and ten times higher than foreign firms patenting in the U.S. Yet the post-suit settlement rates are nearly identical for all types of patent-holders.

Contrary to conventional wisdom, large firms are thus much *less likely* to be involved in patent suits than individuals or smaller firms. This evidence also shows clearly the disadvantage smaller firms face in enforcing patent rights. They are much more exposed to litigation risk, yet no better able to settle after the suit is filed.

[Table 3 here]

Why is this so? It reflects two basic factors. The first is that smaller firms typically have smaller patent portfolios and, as we will see, this makes a huge difference in the ability of a firm to settle disputes without recourse to the courts. The second is that larger firms encounter other large firms repeatedly and in many different arenas. This makes them more able to find "tacitly cooperative" arrangements for dispute resolution.

In Table 4, I present the average number of patent suits per 100 patents for firms that hold total patent portfolios of various sizes. The striking fact is that the probability of a patent suit falls monotonically with the size of the firm's patent portfolio. The decline is especially sharp up to a portfolio size of 100

[7] Interestingly, the available evidence indicates that patent litigation rates as far back as the mid-19th century were roughly similar (Khan, 2005).

[8] This finding is consistent with the predictions of both of the leading economic models of litigation -- 'divergent expectations model' (Priest and Klein, 1984) and the 'asymmetric information model' (Spier, 1992).

patents. What this means is that the litigation risk associated with any given *individual patent* is much smaller when that patent is part of a *larger portfolio of patents*. In an important sense, there are positive externalities across patents in the enforcement process. Moreover, this finding is not just an artefact of firms with larger patent portfolios having higher valued patents. In fact, there is no such relationship between value and portfolio size in the data. There really is something that makes it easier for firms with larger portfolios to resolve disputes without resorting to the courts.

[Table 4 here]

Patent portfolios are the 'chits' that a firm brings to the table in negotiations to resolve disputes. When a firm has more of them (relative to the other disputant), it has stronger bargaining power and thus manages a better settlement outcome. This is one aspect of the incentive for strategic patent accumulation.

When both disputants have large war chests of patents ('size plus symmetry'), there is a real, if implicit, threat of future suits going both ways. This credible threat of subsequent retaliation using other patents in its portfolio facilitates bargaining in disputes. In such settings of repeated strategic interaction, it is well known that firms often find "tacitly cooperative" dispute resolution arrangements, including mutual forbearance. [9] This is a second strategic aspect of the incentive to accumulate patents.

Further support for the role of tacit cooperation is provided by Lanjouw and Schankerman's finding that litigation is less likely when the firm is patenting in technology areas which are more concentrated – i.e. where the share of patenting accounted for by the top four firms is higher. In such areas, the leading patenting firms expect to interact with each other on a repeated basis, and are more able to develop tacitly cooperative mechanisms for resolving disputes without going to court.

The evidence I have shown thus far is based on simple comparisons, not controlling for other factors. But the findings about heterogeneous litigation risk and its determinants also hold when we include a wide range of control variables. A simple way of summarizing the huge variations in litigation exposure is given in Table 5. For domestic, unlisted firms with portfolios of fewer than 600 patents, the median litigation risk over the patent life is 2.1%. For the top 1% of patents (in terms of this risk), it is *seven times as large*, at 14.4%. At the other extreme, for large domestic listed firms with portfolios greater than 600 patents, the lifetime risk is only 0.4% for the median patent, and ten times as large for the top 1% of patents. Thus there is tremendous variation in litigation exposure both across types of patent holders and across patents for a given type.

[Table 5 here]

I now turn to society's concerns in all this. The public policy concern is that enforcement costs can dilute the innovation incentives that patents are designed to provide. Most obviously, litigating disputes can be very costly, if they are not settled quickly. However, the evidence indicates that the vast majority is settled before trial, and usually much earlier. Only about five percent of patent suits ever reach the trial stage (that is, 5% of 1.2%).

But while this is good news, in that it economises on social resources spent in the litigation process, it does *not* mean that litigation has little effect on non-litigating patent-holders. In any negotiation on the licensing or sale of patents, the settlement terms are set in the shadow of litigation and thus will reflect any advantages firms would have in the litigation process. Even if litigation never occurred, the threat of it will affect the distribution of innovation rents between firms. Both a firm's ability to resolve disputes

[9] An extreme form occurs when firms cross-license large parts or all of their patent portfolios. For a theoretical and empirical analysis of cross licensing arrangements, see Galasso (2007).

without patent suits, and its ability to prevail if litigation does arise, is likely to influence its R&D investment decisions – both how much to spend and where to innovate – in ways that do not reflect pure comparative advantage in innovation. The dynamic efficiency costs to the economy can be large, even if they are 'hidden' and hard to measure.

For example, Joshua Lerner at the Harvard Business School provides supportive evidence that litigation risk can shape firms' innovation decisions. Specifically, he showed that small biotech firms are much less likely to patent in technology subfields in which large firms dominate. Large-scale surveys of small and medium sized firms in European countries confirm this conclusion.[10]

3.2. Making Patent Enforcement Accessible to All

We do not want to discourage "cooperative" mechanisms for dispute resolution. There are private and social gains from firms using these informal mechanisms. The problem is that the data show that small firms – or at least those with small patent portfolios – are genuinely disadvantaged in that they are not positioned to exploit these mechanisms. What can be done about it? How can we most address this problem most efficiently – that is, with least damage to innovation incentives?

Let me first dismiss "solutions" to this problem that I believe would be very damaging, if they were widely applied. The first is *compulsory licensing* on the so-called 'reasonable and non-discriminatory' terms. The problem here is that the government regulatory body is in no position to determine such rates, especially for the huge number of patents involved and the dynamic environment in which these firms operate. The high probability of getting it wrong, and the social costs associated with that error (undermining innovation incentives) are just too high to risk this centralized approach.

The second ill-advised policy change is a significant reduction in the scope of patenting, either in terms of a restriction of patentability for specific types of innovation (e.g. software and business method patents) or a major increase in the inventive step required for patentability. In my view, this would amount to throwing the baby out with the bathwater. While there undoubtedly have been lapses in enforcing the 'non-obviousness' requirement, and granting trivial patents, this has more to do with adequate information on prior art, especially for new technology areas rather than the standard itself.

So what might improve the "playing field" for patent enforcement, at minimum risk to innovation and competition? I believe one of the best hopes is the use of market-based patent litigation insurance. A number of companies have offered it, and some continue to do so. But take-up by firms, especially small firms, has been very limited. One of the main reasons is that it is extremely expensive, far more so than is justified by the empirical relationship between litigation risk and observable features of patents and patent-holders, as we described above.

The reason is that insurance companies have not used such models to price such insurance 'rationally', allowing them to differentiate risks. It is as if medical insurers could not charge clients differently according to their age, existing health, and mortality-related behavior. Pooling creates adverse selection, whereby only those patentees most at risk choose to insure. In the extreme case, adverse selection can actually kill the market entirely, by making it too costly to ensure the high risk patents that are the only ones willing to be ensured at that price.

Let me provide two examples of how distorted the current pricing of patent litigation insurance is. First, the insurance is overpriced. The average insurance premium is about *6% of the coverage per year*. Yet

[10] See William Kingston (2000).

based on our empirical models, the predicted litigation risk for the top 1% of patents (in terms of risk) is about *7.9% over the lifetime of the patent.* Second, the current price structure is distorted. Prices are typically set per claim – so that the total premium is proportional to the number of claims -- but our models predict that litigation risk rises much less than proportionally with the number of claims. The empirical models developed by economists can be used to price litigation risk on a more actuarial basis. This would help establish a feasible market for patent litigation insurance.

But is such insurance really a good idea? In particular, would the use of such insurance simply produce more litigation which, while it may help small firms, would impose greater social costs? I want to argue that the main effect of such insurance would not be to increase litigation, but rather to increase the relative bargaining power of smaller firms in the settlement of disputes.

The decision of a firm to infringe a patent (assuming it is deliberate), and subsequently to settle any such dispute, are taken in the shadow of what would happen if the dispute goes to court. If a patentee can commit *ex ante* to litigating a dispute – by taking up patent litigation insurance – the original infringement will be less likely to occur, and settlement (via licensing) will be more likely to be reached. In other words, in equilibrium litigation will be discouraged, not increased, by the use of such insurance. This initially counter-intuitive result has been confirmed by recent theoretical work, and it is robust to a variety of settings, including the allocation of legal costs which differs between the US and Europe.[11]

But as with any type of insurance, the ability to insure fully creates a 'moral hazard' of bad behaviour, which in this context takes the form that the patentee will litigate excessively – i.e. even when the benefits fall short of the costs. As recent research shows, this problem can be solved by imposing suitable co-payment requirements.[12]

Is there any role for government intervention in developing an effective market for patent litigation insurance? The two main instruments would be tax credits to promote use of litigation insurance and direct government provision of insurance. The European Commission and individual member states are currently considering various schemes. But is there an important externality that needs government to address?

I am not so sure. There may be a case for tax credits to promote uptake by users, or provision by private companies, on the grounds that firms have little experience to date. But these should be strictly time-limited, only long enough to provide the necessary 'demonstration effects' to both sides of the market. And they should certainly not be tied to any particular set of users or providers, as this would undermine effective competition in this market. Finally, since firms should be able to make use of the empirical model of litigation risk I discussed earlier to make pricing structures more reflective of actuarial risk, I believe the market can work in this area.

In short, I find no compelling rationale for direct government provision of patent litigation insurance. Moreover, I believe it is ill-advised for government to impose mandatory insurance, especially under "non-discriminatory" (uniform) pricing requirements. This is the direction of some European initiatives.
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[11] See Llobet and Suarez (2006).

[12] Other mechanisms might work too, such as allowing some decision rights to the insurer over when to accept a settlement offer. Some existing policies actually use such covenants, though they are rather vague on the precise decision rights and this can expose firms to *ex post* 'hold-up' by the insurer. Discussion of the appropriate mix of instruments is beyond the scope of this lecture.

4. Patent Thickets and Settlement of Patent Disputes

Fragmentation of patent rights is widely viewed as an impediment to innovation. The classic statement of the problem goes back to Mark Heller and Rebecca Eisenberg, with particular focus on the biomedical field.[13] There are two distinct issues involved here. The first is that patent thickets raise transaction costs, and create delays in settling disputes and reaching licensing agreements. This is important because it directly affects the rate of technology diffusion. The second issue is that uncoordinated bargaining with different licensors creates a 'royalty stacking' problem that can lead to bargaining failures.

These costs and risks associated with downstream licensing make it more difficult to undertake R&D without risk of infringement. This is particularly so in sectors characterized by 'complex' technologies where many disparate components are needed to innovate, and in highly cumulative technology areas where R&D builds heavily on earlier innovation, such as software and biomedicine.

These dangers are real and need to be watched. There is some econometric evidence that fragmentation of patent rights has affected patenting, R&D and stock market value of semiconductor and software firms Though there is no shortage of Casandras with dire forecasts, my reading of the available survey and econometric evidence thus far is that these problems are not yet seriously threatening R&D, even in the biomedical field where one might expect it most.[14]

Moreover, the argument about transaction costs is incomplete. Fragmentation of patent rights actually has two distinct effects on patent dispute settlement delays. The first, and most obvious, is that it increases the number of licensors with whom bargains have to be struck, and this increases overall delay. This is what observers and scholars have focused on. But there is a second, countervailing effect: fragmentation reduces the value at stake in each individual settlement negotiation lower, and this makes settlement and licensing easier to reach. Thus on a priori grounds, we cannot tell whether fragmentation increases or reduces total settlement delay.

Using comprehensive data on patent suits in the U.S. for the period 1978-99, a recent econometric study of mine examines how fragmentation affects the time it takes patent suits to settle (Galasso and Schankerman, 2008). To begin, notice first that the average dispute duration (after a suit is filed) for the whole period was about 19 months but there is huge variation across disputes, as Figure 4 shows.

[Figure 4 here]

Our study shows that, after controlling for other relevant factors (including measures of patent value and age, the involvement of serial infringers and patentees), patent suits do indeed take less time to settle when the alleged infringer is using patents in technology areas where ownership is more fragmented. Table 6 summarizes the effect of fragmentation in a simple way, both for the pre- and post-CAFC regimes. Two things should be noted here. First, greater fragmentation reduces settlement time per dispute, on average. Second, this effect is much larger in the absence of CAFC (that is, when uncertainty over enforcement of patent rights is greater).

The study also shows that the introduction of the centralised federal court of appeals (CAFC) had a powerful effect in reducing the settlement times of cases filed in the lower (district) courts. The average

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[13] See Heller and Eisenberg (1996).

[14] For econometric evidence on semiconductors and software, see Ziedonis (2004) and Noel and Schankerman (2006), respectively. For evidence on the biomedical sector, see Walsh, Cho and Cohen (2005a, 2005b).

delay before CAFC (1982) was about 29 months and only 17 months after CAFC. I interpret this reduction as a consequence of the greater clarity of property rights (the 'pro-patent bias' of the centralised appellate court). When disputants bargain in the shadow of appeal with less uncertainty, they settle faster.

[Table 6 here]

What do these findings imply about how patent thickets affect *total settlement delay*? This turns critically on the sequencing of settlement negotiations. If licensees negotiate with the different patentholders at the same time, then even if they have more to negotiate with, the expected total delay will be smaller because fragmentation reduces the delay per dispute. However, if they negotiate sequentially, then there are two countervailing effects: more patentholders to negotiate with increases total delay, but fragmentation reduces delay per dispute. Our computations suggest that, even if negotiations are conducted sequentially (the worst case scenario), it appears that total delay may have been reduced by fragmentation in some technology fields but not in others, at least before CAFC was instituted.

We know almost nothing about the timing of actual licensing negotiations. We are badly in need of case study evidence on this issue. This discussion also underlines the importance of finding ways and means to facilitate concurrent settlement negotiations. But I have little to say on how one might do that.

Finally, this work emphasises the importance of maximum clarity in enforcing property rights. This by itself says nothing about whether we should favour patentholders more or less strongly (that is a more complicated, though critical issue), only that we need to have a steady and well understood judicial stance toward such rights.

5. Concluding Remarks

In closing, let me just say that there are problems with the patent system which need fixing. But in doing so, we need to preserve the essential innovation incentives which patent property rights were originally designed to provide and to formulate reforms that recognize the informational limitations under which government patent offices will inevitably operate. I hope some of the suggested directions for reform I have discussed in this lecture will prove helpful – namely:

1. To raise patent renewal fees substantially to generate a progressive tax on patent rights
2. To encourage development of effective, market-based patent litigation insurance
3. To encourage development of multi-lateral licensing mechanisms and clarity of patent enforcement

Figure 1. Patent applications in EU by sector

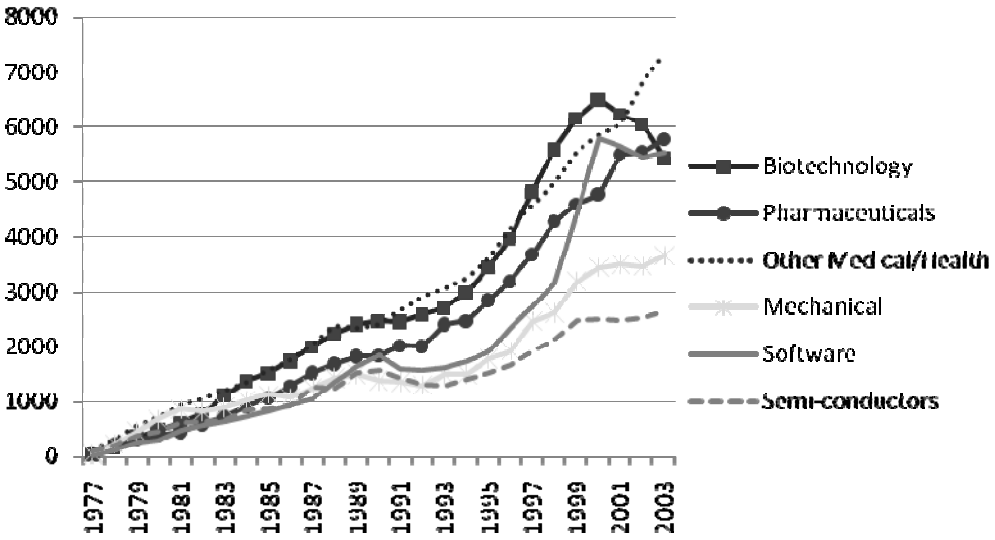
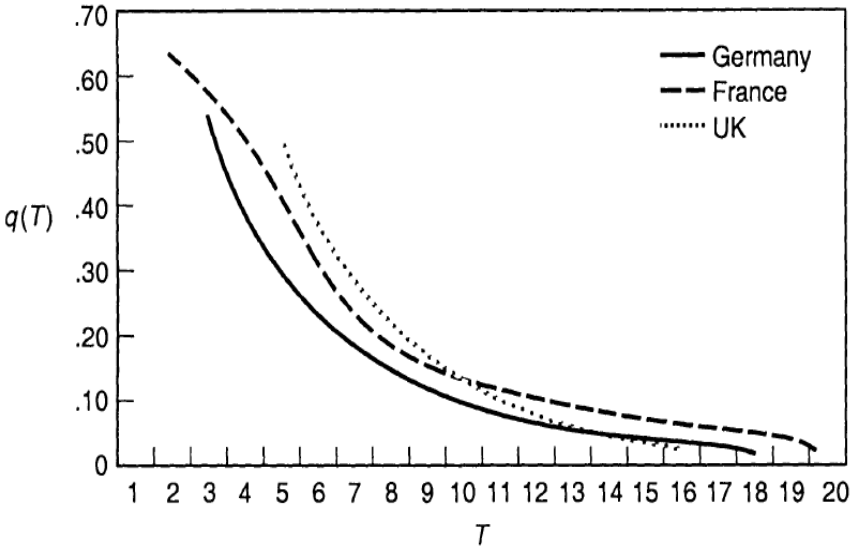
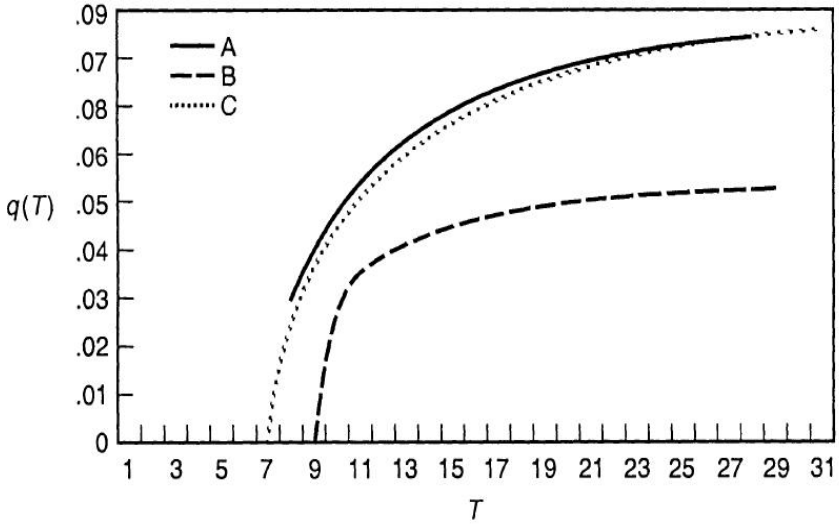


Figure 2. Patent Tax Rates Generated by Actual Fee Schedules



Horizontal axis = age of the patent.
Vertical axis = patent tax rate generated by actual renewal fees

Figure 3. Patent Tax Rates Implied by Socially Optimal Fee Schedule



Horizontal axis = age of the patent.
Vertical axis = patent tax rate generated by'optimal' renewal fees

Table 1
Patent Suits per hundred patents, 1978-95

Aggregate	1.9
Pharmaceuticals	2.2
Medical Instruments	3.5
Chemicals	1.2
Electronics	1.5
Mechanical	1.7
Computers	2.6
Biotechnology	2.8

Table 2
'Value' of Litigated and Non-litigated Patents

	Patent Suits	*Control Group*
Individuals		
No. patent claims	14.2	11.0
Citations per claim	1.6	0.8
Domestic Listed Firms		
No. patent claims	18.8	13.1
Citations per claim	2.2	1.0

Table 3
Patent Suits by Type of Patentee

	Patent Suits per 100 patents	*Settlements per 100 suits*
Individuals	3.5	94.7
Domestic Unlisted Firms	4.6	94.0
Domestic Listed Firms	1.0	94.1
Foreign Firms	0.4	94.5

Table 4
Lifetime Probability of Patent Suit by Portfolio Size

Portfolio Size	*Patent Suits per 100 patents*
1-10	1.71
11-100	1.20
101-200	0.52
201-300	0.43
301-600	0.39
601-900	0.34
900+	0.26

Table 5
Lifetime Probability of Patent Suit
By Type of Patentee and Portfolio Size

	Percentile in distribution		
	Top 50%	Top 5%	Top 1%
	Domestic unlisted firm		
Portfolio < 600	2.1	6.3	14.4
Portfolio > 600	0.7	2.4	6.8
	Large domestic Listed firm		
Portfolio < 600	0.9	2.6	5.4
Portfolio > 600	0.4	1.5	4.1

Figure 4
Distribution of Dispute Duration (in months)

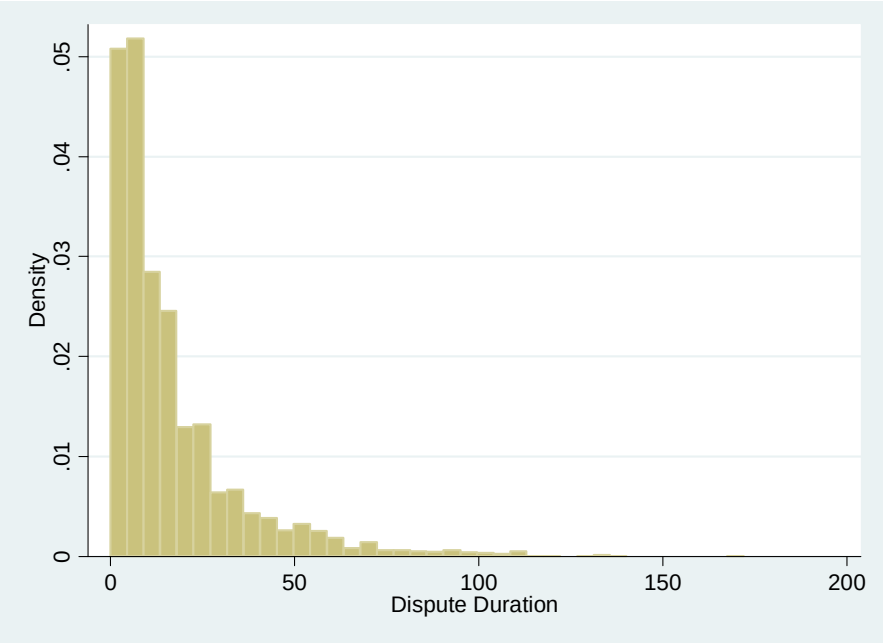


Table 6
Fragmentation, CAFC and Patent Dispute Duration

	Fragmentation Below Median	Fragmentation Above Median
Whole Period, 1975-2000	19.6	17.6
Before CAFC, 1975-81	33.0	27.7
After CAFC, 1982-2000	18.3	16.4

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