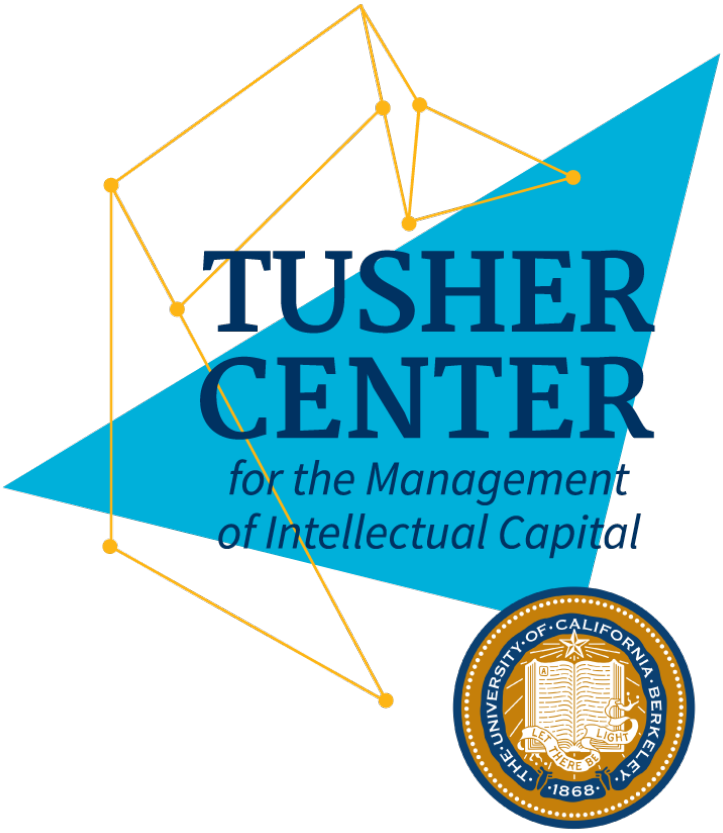

WORKING PAPER SERIES

No. 1

Patent Thickets: An Economic Appraisal

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INTRODUCTION:

This article is a companion piece to the "Patent Thickets: A Taxonomy of Definitions" (Egan and Teece 2014) article that one of us co-authored.[3] This article addresses the question: what economic issues are raised by different types of patent thickets?

The Patent Thickets: A Taxonomy of Definitions ("PTTD") article differentiated among four different main types (or main taxa) of patent thickets. Type I was diversely-held complementary input thickets. These are characterized by (a) multiple patents reading on some product, which are (b) held by multiple patent holders, and which are (c) complementary to one another (the implementer needs to use multiple patents in order to make commercially-viable products). Type II patent thickets added the complications caused by "concurrent right" thickets. Type III patent thickets involve "suspect"/"spurious" patents – those that (intentionally or otherwise) undermine the rationale behind the patent system-- while Type IV patent thickets involve saturated innovation spaces.

The presence of patent thickets raises two important main issues. The first is the possibility of "royalty stacking," the prospect that an implementer may have to pay royalties to multiple patent holders in order to make and sell its products. The concern frequently expressed is that, while the royalties for any single patent license may be acceptable, the cumulative "royalty stack" for all of the necessary licenses may not be. The second involves the transaction costs associated with identifying relevant patents and negotiating any necessary patent licenses; the concern expressed by some is that it is costly to negotiate multiple licenses with multiple patent holders, and that the transaction costs may prevent otherwise-societally-beneficial deals from being reached.

ROYALTY "STACKING" AND TANGIBLE INPUT THICKETS: DO DIFFERNCES MATTER?

Tangible intangible "stacks"

We believe that insights can be gained by comparing and contrasting the situation involving "patent thickets," which involve (intangible) patent rights, with the situation which we might term ""tangible input thickets," in which a firm needs to assemble multiple physical inputs from multiple suppliers in order to make a complex product.

The idea that implementers who use multiple patented technologies need to pay royalties to multiple patent holders is similar to the innocuous idea that implementers who use multiple tangible inputs need to pay their suppliers for those inputs, so that (*ceteris paribus*) the greater the number of inputs used, the greater the total paid to all suppliers. That is, the concept of "royalty stacking" is analogous to the

[3] Edward Egan and David Teece, "Patent Thickets: A Taxonomy of Definitions," unpublished working paper, 2014.

concept of "input cost stacking." The difference is that, with patented technology, the inputs are intangible IP, whereas with tangible inputs they are tangible.

The existence of "input cost stacking" is not usually seen as a "problem": it obviously costs more to make a jet airplane with millions of parts than it does to make a bicycle with hundreds of parts. Yet for some reason there are widespread concerns about "royalty stacking." One puzzle is to understand why concerns are frequently raised in the context of multiple patents (intangible inputs), while similar concerns are rarely expressed in the analogous context of multiple tangible inputs.

In our experience, it is extremely rare that, in the case of "tangible input thickets," the buyer does not know that it needs certain components. That can be contrasted with the patent thicket case, where an implementer may not be aware (or may dispute) that it is using another's patented technology. Put another way, both the title to, and the use of, tangible inputs is not "probabilistic" in the way that patent rights and their use are.

Monopoly power issues?

In part, the difference in the level of concern in the two contexts may be due to the fact that each patent holder generally[4] has a legal "monopoly" over the use of its own patented technology, although this does not imply monopoly power over a market, unless somehow the patent is (most likely) incorrectly conflated with a market

If there are competing technologies, whether patented or public domain, implying that the patent holder does not have a "monopoly" in a relevant technology market. With tangible products, as some (though not all) tangible inputs (or functional equivalents[5]) are available from multiple suppliers.

Transaction costs?

There are clear transaction costs associated with contracting with multiple suppliers, whether of tangible inputs or intangible IP. Those transaction costs are higher than they would be if the firm used fewer suppliers. But that is inherent in the market situation, just as is the fact that using more components costs more (*ceteris paribus*) than using fewer components.[6]

[4] The patent holder may have granted others the right to sublicense the technology, but otherwise licenses are only available from the patent holder. That said, in some contexts there is widespread infringement of the patented technology, so that others are (effectively) supplying the technology without paying for it.

[5] For example, only Ford can supply Ford automobiles, so in one sense Ford has a "monopoly" on the supply of Ford cars. But Ford cars compete with cars from other car manufacturers. Fords are not identical to cars from other manufacturers, but they are sufficiently close substitutes, so Ford does not have a "monopoly" over cars more generally. The same may or may not be true with respect to patented technology.

[6] It might be argued that the need for licenses to some patent is often contingent on gaining access to other patents, whereas demand for different tangible inputs is not. We are not so sure about the latter claim. If an implementer needs multiple tangible inputs to make a product, it does the implementer no good to secure supplies of only a subset of the necessary inputs.

In many cases, a given physical input (or a fungible alternative[7]) is available from multiple competing suppliers. Competition among suppliers lowers prices. It can also reduce transaction costs relative to the world in which an input is available only from a single supplier. And the availability of competitive alternative inputs reduces the degree to which the buyer is "locked-in" to any given supplier. That may not be the case with patented technology (at least once the product is designed to use a particular technology, though the implementer may be able to redesign its product to use a rival technology instead), where generally only the patent holder has the ability to grant licenses.

Non self-enforcing notions of patent rights

Another difference between patent thickets and tangible input thickets is that patent rights are not self-enforcing. Once a patent issues (or the patent application is thrown open), the information disclosed in the patent is available for all to review. Unlike the suppliers of physical inputs, who can physically withhold delivery if not paid, patent holders have to resort to costly, time-consuming, risky and uncertain litigation to enforce their rights. It is not generally possible for patent holders to rely on "self-help" (*e.g.*, the functional equivalent of locks on warehouse doors, which work together with legal protection to prevent others from simply taking tangible inputs) to prevent unauthorized use of patented technology. This can be contrasted with the situation with trade secrets, in which innovators can try to protect their secret information by restrictions on availability or access and other steps to keep the information confidential (such as NDAs).

As a result, in the patent context it is all too common for implementers to simply ignore patent rights unless and until forced to do so by being sued.[8] Put another way, one option for "cutting through" a patent thicket open to implementers is to ignore it, especially if the implementer has patents of its own that it can assert against (some of [9]) those that may seek to assert their patent rights against the implementer. The same strategy simply does not work for tangible input thickets. Talk of "having" to "clear" a "patent thicket" largely misses the point when infringement is commonplace, and especially when infringement is widespread. Infringement can often be difficult to detect, especially for process patents.

[7] For example, while a particular product may have been designed to use (say) a power supply available only from one supplier (in the sense that power supplies from rival suppliers cannot simply be "dropped into" the product without some redesign), alternative power supplies may be available from rival suppliers (though there may be some switching costs associated with changing over to a rival supplier). The same may or may not be true of patented technology. For example, if there are competing circuit designs that yield functionally equivalent outcomes, a product that uses one of the designs may be redesigned to use a rival circuit, albeit with some switching costs for redesign.

[8] See Lemley, "Ignoring Patents," 2008 *Mich. St. L. Rev.* 19-34.

[9] "Mexican standoffs" (in which one firm does not assert its patents against another firm that it believes is using its patented technology because it knows that the other firm has patents of its own that it can assert against the first firm's products) are commonplace. But such a "mutually assured destruction" strategy will not work against "non-practicing" patent holders that do not themselves make or sell products and thus do not need in-licenses to use others' patents.

Widespread infringement causes licenses that pay to be disadvantaged

A more pernicious reason why potential licenses become challenged by their infringement of multiple patents, or even a single patent, is related to the ono self-enforcing point raised above. Since products which are use patented inventions of others can be placed for a time in the domestic market without barriers (the inventor is unable and not allowed to physically remove them— it requires a court injunction to legally block the sale of unlicensed products) there is a tendency for multiple unscrupulous manufactures (or manufacturers who might genuinely believe they don't infringe, or manufacturers who know they infringe but are willing to run the risk they won't get caught) to sell infringing product. Because of the doctrine of willful infringement, infringers are better off staying infringed of other people's products to the extent that they are not taking the long view, will drive prices down to manufacturing costs plus a competitive return. From this starting point, the potential licenses see the payment of any royalty as throwing them into an unprofitable position, which is clearly unattractive. If they are unable to have confidence that other infringers will also pay and then be forced to raise prices too, paying a royalty to an inventor almost seems discriminatory, and is likely , despite the fact that it is fully appropriate and necessary to support continued investment in innovation. This point is almost always overlooked despite its prevalence and practical relevance.

Taking advantage of patent exhaustion doctrine

One potential way of dealing with a patent thicket reading on a given product is to buy off-the-shelf licensed components. For example, smartphones contain memory chips, which rely on patented technology. But firms that have patents relating to memory license memory chip suppliers, not smartphone sellers.

The smartphone manufacturer can ignore the existence of memory patents if it buys licensed memory, because of the "patent exhaustion doctrine," a legal doctrine that says (loosely speaking) that if a patent holder has granted a patent license to some firm(s), it cannot assert its patents (or collect royalties) from those "downstream" from its licensee(s) in the "value chain." In some contexts, this is not a feasible alternative for implementers, but where it is, it does help "downstream" firms cut through the patent thicket.

ECONOMIC ISSUES WITH TYPE I PATENT THICKETS

There are a number of policy issues associated with Type I patent thickets. The first involves identifying all of the potentially relevant patents. It is often the case that an implementer does not know of the existence of potentially relevant patents. It is possible to engage in search to identify such patents, but such search costs can be significant, and there is no assurance that even a diligent search will reveal all relevant patents.

It is widely acknowledged that the presence of search costs alone is not the sole determining factor. Firms have a positive disincentive to search for potentially relevant patents, as they face the potential of liability for up-to-treble damages for "willful infringement" if they have actual knowledge (as contrasted with constructive notice) of others' patents. This discourages firms from seeking information about

potentially-relevant patents that might read on their products.[10] Again, we do not think that this has any analogue in the context of "tangible input thickets," where firms have a positive incentive to seek out alternative sources of supply.

Even when potentially relevant patents have been identified, there are often disputes as to issues of patent scope, validity, and infringement. Disputes about claim construction are endemic, and often cannot be resolved until the issue is litigated and the court issues a Markman claim construction ruling. Even after patent claims have been construed, parties can disagree as to whether the patent is valid and infringed by a given product. Validity and infringement are inversely related; *ceteris paribus,* the more broadly the patent is construed, the more likely it is that a given product will be found to be infringing, but the less likely that the patent will be found valid as against the prior art or on enablement grounds.

As noted above, there are transaction costs associated with negotiating multiple licenses, so that total transaction costs will be higher in the context of patent thickets than in situations where there are fewer licenses to be negotiated.

Another concern involves the structure of royalties. Patent royalties often take the form of a percentage of the selling price of the licensed products. There are significant pro-competitive economic reasons why licenses are often crafted using percentage-based running royalties (having to do with alignment of incentives between the parties, ease of administration, and automatic adjustment for inflation/deflation). But such royalties can cause problems: it may be feasible to pay each of 200 input suppliers a price of $1/unit for their inputs, as that just means that the cost of the physical inputs is $200. But it is not economically feasible to pay 1% royalties to each of 200 patent holders, as the total royalties might in (before prices increased) exceed the licensee's revenues. There is no analogue of this situation with tangible input thickets; pricing of physical inputs is generally not on a percentage of the selling price of the end-product basis, but rather on a dollars-per-unit-of-input basis, which are more comparable to cents-per-unit running royalties than to percentage-based running royalties. Moreover, with input thickets, credit for use before is usually 30 or 60 days, not an

In many if not most cases, licenses for a given patent are available only from the patent holder (directly or indirectly via firms allowed to sublicense the technology), though if there is widespread infringement, others are using the patented technology without paying for it, and others may supply rival comparable technology. That said, users may be protected via the "patent exhaustion doctrine" if they buy and use licensed components and may not themselves need licenses.

One widely-cited concern with "patent thickets" is what economists call the Cournot complements issue, which arises when two or more complementary inputs are each supplied by a monopoly supplier.[11] When setting its royalty rates, each patent holder takes account of the effect of a higher rate on the quantity of licensed products sold (and thus the royalties it will earn), but will not take account of the effect of its royalty rate on the royalties that others will receive. In other words, the royalty rate decisions of different patent holders are independently made, but have an interdependent effect. The

[10] See Lemley and Tangri, "Ending Patent Law's Willfulness Game," 19 *Berkeley Tech. L. J.* 1085 (2003).
[11] Lemley and Shapiro, "Patent Holdup and Royalty Stacking," 85 *Texas L. Rev.* 1991 (2007).

effect of this is similar to the well-known "Prisoner's Dilemma" situation: all patent holders would be better off if they coordinated the royalty rates they seek to yield a lower cumulative rate, but such a coordinated outcome is unstable (and would not be an equilibrium), as in such a situation each patent holder has an incentive to raise its own rates given the rates that others are charging.

This is a natural consequence of the coming together of two factors: (a) decisions that are independently-made-but-have-interdependent-outcomes and (b) diverse ownership of patent rights. However, one potential "cure" (consolidating ownership of patent rights in a single entity, so as to avoid the "Cournot complements" issue with its Prisoner's Dilemma-like outcomes) can be worse than the disease, as it may eliminate competition between patent holders. It can be difficult to know whether two patented technologies are substitutes or complements (the answer may depend on the context, since patent A may be a complement to patent B in context X but a competitor to patent B in context Y). Coordination of decision-making is desirable for complements, but not for substitutes.

We also know that some solutions (*e.g.*, patent pools) have evolved to deal (to some extent) with both the "high transaction costs" and the "Cournot complements" issues. Moreover, for firms with their own patent portfolios to "trade" for cross-licenses, cross-licensing is one way of cutting through patent thickets. Firms can use their own portfolios to "barter" for the in-licenses they need. One of the key features of cross-licensing is that a patent portfolio can be used to barter for multiple licenses with multiple counterparties, whereas cash royalties paid to one patent holder cannot be paid to another patent holder. This of course is of little consolation to a firm with no patents of its own to cross-license, but that is one reason why firms patent their own technology or (in some cases) have acquired patent portfolios originated by others. But the prevalence of cross-licensing, or of informal "Mexican standoff" or "mutually assured destruction" situations (in which one firm does not seek to enforce its own patents against another firm because it knows that the other firm has its own patents that read on the first firm's products), is an important feature that is often underemphasized in discussions of "patent thickets."

The Cournot complements potential problem is in practice further dramatically diminished by a number of other considerations. First, as indicated earlier, widespread infringement and the overly high bar required for an injunction post e-bay means that patent owners are forced to discount their technology in order to get it financed. Second, most of the licensors expect numerous future transactions, so extracting any Cournot type profits is not just difficult but unlikely. To the extent that the licensor is also a licensee from the same entity also produces incentives to act fairly

ADDITIONAL ISSUES RAISED BY PROBABILISTIC PATENTS/QUESTIONABLE PATENTS

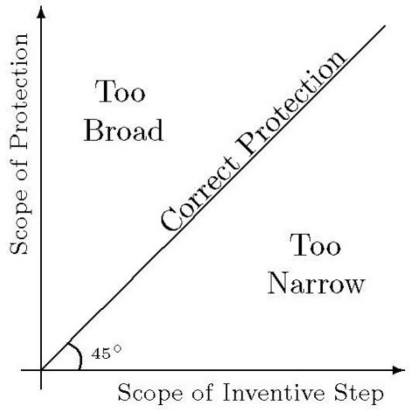
Another taxa in our patent thicket taxonomy adds the complications caused by probabilistic and questionable patents. There can be disagreement about whether a license is required in the first place

(a phenomenon which has no analogue in the "tangible input thicket" situation, in which ownership of different tangible inputs is largely undisputed[12]).

Typically, patents are "probabilistic," in the sense that, if challenged, there would be only some probability that the patent would be found valid and infringed by a given product.[13] "Probability" here is best interpreted in the subjectivist (Bayesian) sense, not the frequentist sense (think horse races, not roulette wheels); different entities can and do assess the probabilities differently. Disagreements can be exacerbated by disputes about claim construction, but even following a claim construction ruling, disputes about probabilities of success can persist.

A common concern involves the quality of patents. Many have expressed concerns that the real issue is not the sheer number of patents or the sheer number of patent holders, nor the raw probability of a finding of validity and infringement *per se*, but the (alleged) low quality of issued patents In our view, the real problem in this regard is not patent breadth *per se* – depending on the scope of the invention in question, either a broad or a narrow patent grant can be appropriate – but rather a "mismatch" between the scope of the patent grant and the scope of the invention actually made. Figure 1 illustrates the concern. Along the horizontal axis is the scope of the patent as granted. Along the vertical axis is the scope of the invention actually made by the inventor. Points along the 45-degree line represent a good "match" between the scope of the invention actually made and the scope of the patent grant. Points above the 45-degree line represent the situation where the scope of the patent as granted *exceeds* the invention actually made; in these situations, the patent grant is "too broad." Points below the 45-degree line represent the situation in which the scope of the patent as granted is *narrower* than the invention actually made; in these situations, the patent grant is "too narrow."

Figure 1: Unmerited breadth or narrowness of patent claims



[12] There can be disputes with respect to pollution and other externalities. Moreover, the ownership of certain tangible assets may be sufficiently fragmented that it is unclear whose permission is needed to use the assets. See Heller, "The Tragedy of the Anti-Commons: Property in the Transition From Marx to Markets," 111 *Harvard L. Rev.* 621-688 (1998).

[13] See Lemley and Shapiro, "Probabilistic Patents," 19 *J. Econ. Perspectives* 75-98 (2005). Note that a patent may be infringed by one product but not infringed by another, so that the probability can vary from product to product.

Similarly, we think attention should be paid, not only to the raw probability of a finding of validity and infringement *per se*, but also to the probability of both what statisticians call Type I (false positive) errors – finding a patent valid and infringed when it should not have been – and Type II (false negative) errors – finding a patent invalid and/or not infringed when it should have been found valid and infringed. The probabilities of such errors are not well measured by the raw probability of a finding of validity and infringement; though that may be what the patent holder and the accused infringer care about, it is not what should matter from an overall societal perspective.

Reaching agreement is complicated enough if the parties agree about the probability that the patent, if challenged, would be found valid and infringed by some product. It is more difficult if the parties disagree about the probabilities, especially if each party does not know the other party's subjective probability. The parties are more unlikely to be able to reach agreement if the patent holder is more optimistic (assigns a higher probability) about its chances of prevailing than the accused infringer is, as in such a situation there may not be any mutually-acceptable deal (the minimum amount the patent holder wants for a license may exceed the licensee's maximum willingness to pay).

TYPE IV PATENT THICKETS

Type IV of our taxonomy of patent thickets involved a "saturated Invention Space." To determine whether the invention space is "saturated" with patents, one needs to look, not at the number of issued patents alone, but whether there are unpatented alternatives (either already known or potentially discoverable with a reasonable degree of effort) for achieving the desired result. If the invention space is not saturated (along some particular dimension of the product's design), an implementer can design around the patented technology. So despite the fact that there may be multiple patents reading on the implementer's current product, the implementer could redesign its product using an unpatented alternative. In effect, it could sidestep the "thicket" rather than having to negotiate licenses. Conversely, if the invention space is saturated, that is not a viable option; the implementer has to deal with some patent holder, even though it may in some cases be able to "play off" one patent holder against another.

OVERALL CONCLUSIONS

As stated in the "Taxonomy" paper, different types (or taxa) of "patent thickets" raise somewhat different economic issues. The need to acquire access to complementary inputs belonging to multiple suppliers arises both in the "patent thicket" context and in the "tangible input thicket" context, which is endemic in many industries. We propose comparing and contrasting the "patent thicket" situations with (somewhat) analogous situations involving "tangible input thickets," concluding that there are some similarities but also some significant differences. The key differences have to do with (a) the inability of patent holders to physically withhold their patented technology from others, but instead having to rely on the legal system, together with (b) the incentives implementers have to ignore others' patent rights unless and until sued for infringement, (c) the "probabilistic" nature of patents, (d) the

degree of competition (or lack thereof) in the relevant technology and tangible input markets, and (e) the structure of royalty pricing.