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Elves or Trolls? The Role of Non-Practicing Patent Owners in the Innovation Economy

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Abstract

Firm structure and the degree of vertical integration lie at the core of a key intellectual property concern currently under debate: "patent trolls." While court opinions and competition agency decisions have focused on "non-practicing" patent holders as the source of anticompetitive exclusion and hold up problems, this view of upstream specialists is far too narrow. In fact, patents in the hands of non-practicing entities can increase competition, lower downstream prices, and enhance consumer choice. We explain why and argue for more business-model-neutral policy when it comes to patent licensing. Clearly, patents are a complex subject that cannot be portrayed as either all good or all bad; tradeoffs will always be involved. Without a better understanding of the many complicated effects of patents in high technology markets, we run the very real risk of misguided policy decisions.

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1. Introduction

Firm structure and the degree of vertical integration lie at the core of a key intellectual property concern currently under debate. "Patent trolls"—those patent holders that prey upon manufacturers and other downstream firms by charging "supra-competitive" rates for their patents—have figured large in many of the latest theories of competitive abuse involving intellectual property licensing. Under a popular although highly controversial definition of a troll, the concern is that firms holding patents that they do not practice (i.e., "non-practicing" or "non-competing" firms) impose undue costs on downstream manufacturers by charging more in licensing fees than their patented technology justifies (Shapiro, 2006; for opposing definitions of a "troll" see Golden, 2007; McDonough, 2007; Lemley, 2007). The contrast under this theory is to practicing patent holders—that is, vertically integrated firms implementing their own patented technologies in a downstream market. According to this view, trolls are assumed to have an enhanced ability to hold up licensees with "too high" royalties because they do not operate in the downstream market and thus do not require cross licenses from competitors or other quid pro pros that might militate against unjustifiably high royalty rates. Without the constraint that cross licensing poses, so the argument goes, non-integrated patent holders are free to hold manufacturers' capital investments hostage in order to increase the imposed royalty rate.

Apprehension over patent trolls and their capacity to hold up downstream players has emerged as an important factor in a number of policy arenas. For instance, in the US Supreme Court's 2006 *eBay Inc. v. Mercexchange* decision related to injunctive relief for patent holders, Justice Kennedy's concurring opinion cautioned that in deciding whether or not to grant an injunction the lower courts should recognize that "An industry has developed in which firms use patents not as a basis for producing and selling goods but, instead, primarily for obtaining licensing fees." The subtext here is that the courts should consider denying injunctive relief to non-practicing patent holders, and in fact this is how many district courts appear to be interpreting *eBay* (Dauer and Cleffi, 2007). Likewise, in the US Federal Trade Commission's (FTC) 2003 report on promoting innovation, the

FTC focused on conduct by "non-producing entities" as the instigators of litigation because they were not subject to cross licensing constraints (FTC, 2003, at ch. 2, fn 220; ch. 3, pp. 38-41). The FTC called upon that same reasoning in their 2008 decision to bring a complaint against Negotiated Data Solutions, an upstream patent holder, for unfair business conduct (in violation of Section 5 of the FTC Act) stemming from Negotiated's apparent reneging of a prior licensing commitment made to a standard setting body. In the statement issued for that matter, the Commissioners for the majority observed that "conduct by 'non-practicing entities'—sometimes referred to as 'patent trolls'—may harm consumers when such firms force manufacturers to agree to licenses after the manufacturers have sunk substantial investments into technologies". Fears of patent trolls have also pervaded the policy decisions made by cooperative standard setting bodies. For example, in requesting business letter review from the US Department of Justice (DOJ) for significant changes to their intellectual property rights (IPR) policy, VITA argued that some members were demanding royalties that were "significantly higher than expected" (DOJ, 2006); that is, attempting patent hold up.

As the above examples illustrate, the theories surrounding patent trolls focus on the potential for detrimental effects to arise from the combination of patents and nonintegrated firm structure. We offer a counterpoint to this negative view. In particular, we argue that the definition of all non-practicing entities as patent trolls is far too broad and is unjustified by economic theory and evidence. We consider the positive effect that patents in combination with nonintegrated firm structure can have on competition and innovation. In other words, we consider the benefits that non-practicing patent holders can offer, demonstrating that the mere fact a patent holder does not practice its patent does not automatically imply the patent holder is a troll intent upon hold up. In fact, most non-practicing entities face a number of constraints aside from those presented by cross-licensing that limit their incentives and ability to practice hold up (Schmidt, 2006). Certainly genuine patent trolls, defined more narrowly as those entities unconstrained in their licensing demands (for whatever reasons), are a real concern. But we must move away from the overly simplistic association between non-practicing or non-competing entities and patent trolls in order to make effective policy decisions. As our analysis shows, non-practicing entities can play a decidedly pro-competitive role in an industry.

The paper proceeds as follows. We begin in Section 2 with a discussion of the beneficial role that patents can play in an industry. Most importantly, we explain how patents can increase competition in a downstream market *through* the presence of upstream specialists. In order to codify the chain of reasoning presented in Section 2, we present a very simple model in Section 3. The model, while a bare bones representation of high technology markets, helps to highlight the importance of comparative advantage inherent in specialization. It also demonstrates the impact of upstream specialists on industry structure, competition, and welfare—in both the short and long term. We conclude in Section 4 with the policy implications that emerge from the insights of our analysis.

The fact that patents can have far reaching positive implications for industry structure, competition, and social welfare—even when they are held by non-practicing entities—implies that the recent focus on the dangers of non-competing patent holders presents far too limited a view for policy analysis purposes. Clearly patents are a complex subject that cannot be portrayed as either all good or all bad; tradeoffs will always be involved. Without a better understanding of the many complicated effects of patents in high technology markets, we run the very real risk of misguided policy decisions—either because long term effects are not considered or because only one aspect of short term effects are considered. We posit that any policy proposal or court guidelines aimed at curbing patent trolls and hold up problems therefore should be evaluated both in terms of the direct effect on the perceived problem as well as any indirect (unintentional) detrimental impact on patent-facilitated competition and welfare-enhancing upstream specialization within the industry at hand.

2. The Positive Side of Patents

The focus in the literature has often been on a comparative advantage for vertical integration because such integration can help to reduce the double marginalization problem that can plague industries with goods composed of complementary components (Cournot, 1838). The complements problem, however, is but one aspect of complex firm structures and inter-relationships in high technology industries. Disintegration has positive effects of its own. Among these are the benefits arising from specialization. As

the economic literature reaching back past Adam Smith has well established, specializing enables firms to focus on what they do best, enhancing productivity and increasing output. Thus the mirror image of the comparative advantage for integration in terms of reducing potential complements problems is the fact that non-integrated upstream firms (or "pure" innovators) can have a comparative advantage in R&D and innovation. These upstream specialists can have superior skills and business acumen for a relatively narrow slice of the production process, even though (or perhaps because) they lack the interest, the ability, or the resources necessary for commercializing their innovations in-house.

Patents are a crucial factor making the separation of upstream and downstream functions possible.[2] The economics literature establishes that patents facilitate contracting between separate entities (Arora, Fosfuri, and Gambardella, 2001; Arora and Ceccagnoli, 2004; Arora and Merges, 2004). This follows from the inherent differences between tangible and intangible goods. When two parties are negotiating over some physical product, the owner of the product can threaten to take it away at any time if the other party does not live up to his end of the bargain. Thus people are evicted from apartments when they fail to pay the rent, restaurateurs receive no more deliveries of produce when they fail to remain current in their account, and semiconductor manufacturers obtain no more silicon when they fail to pay their suppliers. Intellectual property, on its own, allows no such threat of exclusion or removal. Once an idea has been shared, it cannot be taken away or unlearned. Without rights of some kind, then, recipients of intangible knowledge goods would be in the profitable position of taking the property without paying. As a result, inventors and IP holders are typically reluctant to share their innovations without some form of protection (Anton and Yao, 1994). This is where patents come in. By providing IP holders with an enforceable right, patents enable the sharing of information without the inevitable risk of appropriation. And when knowledge is tradable in this manner, various parties can coordinate and contract as necessary to produce a commercial product for a downstream market.

A key element in the argument that patents facilitate exchange and contracting is the point that patents lower the transaction costs of contracting (Arora, 1996). Since patents

[2] It is, of course, not the only factor, as a large literature on firm boundaries attests, but it is a very important one in high technology sectors.

bestow the right of exclusion—i.e., patent holders need not license their patents at all, or they may license exclusively to one or two licensees only—patents bring with them a standardized well understood enforcement mechanism. A contract over IP need not specify the consequences of deal-stopping problems such as appropriation or failure to pay; the parties understand that all of the traditional court resources for patent infringement will apply. The infrastructure surrounding patents and their enforcement therefore leads to simpler, and yet more complete, contracts, which in turn influences the decision to specialize upstream instead of vertically integrating.

A second key factor is that patents can facilitate funding for startup companies (Hellman and Puri, 2000; Hall and Ziedonis, 2001; Mann, 2005). This means that inventors with good ideas can do more than simply invent—they can try their luck in the marketplace. With venture capital backing, an inventor can enter a market as an upstream specialist, with a profit model based on licensing as opposed to manufacturing (at least initially). The benefits of entering a market as an upstream specialist should be obvious: it is far less costly to enter a market with a relatively small staff of researchers and perhaps a patent lawyer or two than it is to build a factory to manufacture the inventions covered by the firm's patent portfolio. Just consider the plethora of software startups in comparison to the far smaller number of new computer hardware makers to see this point translated in practice. Lower upfront costs mean lower barriers to entry. Patents can therefore be viewed as increasing entry and competition by lowering the cost of market entry for upstream specialists.

That patents are an important part of the decision to specialize is further corroborated in the literature on vertical integration and firm boundaries. This branch of the academic literature establishes that lower transaction costs involved in contracting between entities tend to lower the odds of vertical integration in favor of specialization (Lafontaine and Slade, 2007).

Combining, then, the points of easier contracting, the potential for comparative advantage in R&D and innovation, and the relative ease of entering a market as an upstream specialist, it becomes clear that patents have the potential to play a pivotal role in industry structure. In particular, patents can increase competition, and product quality in the process, as they facilitate entry by upstream specialists.

Indeed, in a number of high technology industries, where both complementary inputs and comparative advantage in certain inputs are likely to be important features, we have seen the rise of upstream specialists. According to Langlois (2003), "vertical disintegration and specialization is perhaps the most significant organizational development of the 1990s." He catalogs a host of industries, including automotive, electronics, pharmaceuticals, and semiconductors to illustrate how widespread the specialization trend has been. For example, specialist biotechnology firms emerged in force in the pharmaceutical-medical industry during the 1980s. A significant number of these firms focus on R&D and intermediate chemical inputs, leaving drug development and commercialization to larger pharmaceutical companies.[3] As Arora and Merges (2004) argue in relation to the chemical production industry, "Patents facilitate arm's-length trade of a technology-intensive input, leading to entry and specialization."

Semiconductors provide a particularly revealing case in point for our purposes. The industry experienced a seismic shift with the entrance of so-called "fabless" design shops in the late 1980s. Hall and Ziedonis (2001) explain that

> …the period associated with strong U.S. patent rights has witnessed significant entry into the semiconductor industry by design, or 'fabless', firms that specialize in innovative products but contract out the manufacture of their products to owners of wafer fabrication facilities.[4]

Hall and Ziedonis find that fabless chip firms are five times more likely to patent than their rival integrated semiconductor firms in the sample. Based on both interviews and empirical analysis, the authors conclude that "the importance of patents" lies in their function "as an imperfect but quantifiable measure of technology that enabled technology-based trades to be made in external markets, both in financial markets (venture capital) and with suppliers and owners of complementary technologies."

The semiconductor evidence, the chemical industry evidence, and the timing of the general trend toward specialization in other industries all point toward an important link between patents, firm organization, and industry competition.[5] In merging and extending

[3] According to the Economist, in 1998 roughly 18% of pharmaceutical R&D funds went toward outsourcing. Carr (1998), at 16.

[4] Hall and Ziedonis (2001) also observe that division of labor in this industry was further aided by a more standardized interface between chip design and the wafer fabrication process.

[5] The trend toward disintegration coincided with a number of policy changes that strengthened IPRs, including the passage of the Baye-Doyle Act in 1980, the creation of the Federal Circuit Court of Appeals

these separate strands of the literature, we weave together theories on IPRs with those on firm structure and industry evolution in order to assess both short- and long-term competitive effects. In particular, we take as already established that patents facilitate contracting and therefore act as enablers for firms to specialize instead of vertically integrate.[6] From this base, we then ask the impact that this process might have on innovation, competition, and consumer welfare immediately and over time.

Our argument can be summarized as follows. Patents can increase the probability that upstream firms obtain outside financing, which makes specializing a more commercially viable means of entering a market. Patents also make intangible products more easily traded by lowering the transaction costs entailed in technology contracts. Both of these effects increase the viability and attractiveness of disintegrating functions along the vertical production chain—that is, of creating specialists. Given the typically lower costs of entering a market as an upstream specialist, we can expect greater entry whenever specialization is possible. The upstream specialists will then seek downstream partners in order to earn a return on their patents through licensing; some of these downstream firms also could be specialists (that is, not vertically integrated but specializing in manufacture without significant R&D operations). As a result of increased entry, competition increases in downstream markets (as well as in upstream technology markets), and thus prices may fall and product quality and consumer choice may increase. In other words, the evolutionary paths for patents and industry structure are intertwined, so that patents enable greater degrees of specialization and therefore encourage new models of upstream R&D with accompanied downstream licensing that can then have a dramatic impact on the competition and innovation taking place within an industry, both in the short and long term.

In order to clarify this argument, in the next Section we present a very simple model that illustrates the dynamics of upstream specialization, increased entry, and competition. The simple framework also clarifies the evolutionary repercussions for industrial organization, opening a window on the potential for long term competitive benefits

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in 1982 to hear patent case appeals, and the decision in State Street in 1998, a case that opened the door to business method patents (see, e.g., Lerner, 2002).

[6] We recognize that all manner of factors can enter into the decision to integrate or specialize (see, e.g., Teece, 1988; Pisano et al., 1988; Hart and Moore, 1990). Our point here is simply that the presence of IPRs allows other motives to specialize to be acted upon.

stemming from patent protection. Beginning with a heterogeneous world in which vertically integrated entities coexist with specialists in each of the vertical layers of production, we show that patents that allow for contracting among specialists increase the competition facing vertically integrated firms. By lowering the barriers to entry, patents can also provide an effective entrée to an industry through a specialist niche which can then form the foundation for later vertical integration into other areas of the production process. That is, specialization can act as a stepping stone for firm expansion. As a result of these forces, patent-based contracting can increase the pool of talent from which an end product is created, meaning overall product quality and social welfare might increase.

3. A Simple Model of Firm Structure

Consider a high technology industry that produces some good x. In order to create a good that consumers are willing to purchase, assume that x must contain two complementary elements, A and B. With A only or B only, there is no commercial product x. We could interpret the components A and B in a number of different ways, such as two necessary physical inputs or as a product and its retail distribution, but in keeping with the argument presented above we will maintain a particular interpretation: A represents the necessary technology or innovation behind good x, with A emerging from the R&D process, while B represents the physical embodiment of technology A, created through the manufacturing process. According to this interpretation, A is the upstream component while B is the downstream component.

As the above discussion makes clear, many high technology industries comprise a range of firm types, from specialized to vertically integrated. To capture this fact within our simple framework, we consider three stylized firm types: upstream firms produce component A only; downstream firms produce component B only; while vertically integrated firms produce both A and B. Denote these three firm types as A, B, and AB, respectively.

Plainly, AB firms are the only ones with a ready commercial product x. The other two firm types, A and B, have only one of the two necessary components and thus have no commercial product x without combining their efforts in some way. That way is patent based contracting. Specifically, we assume that an A firm obtains a patent on its

component, which it then licenses to a B firm, so that the B firm can manufacture good *x* and offer it for sale on the downstream market.[7] Denote this patent contract enabled combination of entities as A-B, distinct from the vertically integrated combination AB.

Even without introducing any additional structure or assumptions to the simple model, we can already see some significant benefits that patent contracting enables. First, downstream competition can be increased. If the population of firms is such that we always expect at least some As, some Bs, and some ABs, then without patent licensing the production of *x* is limited to the AB firms only.[8] The upstream specialist firms either would not emerge, or would emerge but be relegated to non-profit niches, such as University labs. Likewise, downstream specialists either would not emerge, or only emerge as simple sub-contractors or foundries for the lowest value manufacturing aspects for the AB firms, such as off-shore outsourcers. Allowing the two complementary specialists to combine through contracting increases the number of entities supplying *x* on the downstream market, and thus stimulates price competition. If the good *x* is differentiated by upstream technology A, then having more suppliers could increase consumer choice as well. Patent contracting also increases the number of entities supplying the upstream component in a useable fashion, as the A component from AB firms now faces competitive pressure from the A specialists combined with the Bs in A-B contracts. Even if the vertically integrated firm AB does not offer either of the two components separately, the presence of the contracted specialist firm A-B can place competitive pressure on AB to increase the quality of its offering on the market.

We might expect all three firm types to occur naturally in a given industry for any number of reasons. For example, an entrepreneur inventor might have a breakthrough idea for a product but lack the financial means to invest in the plant and equipment necessary to bring that product to market. This reason is reminiscent of the

[7] Note that patent licensing is just one option. In some industries, the patents act as a protection mechanism, preventing appropriation, but are not explicitly licensed (Arora and Merges, 2004). The framework could also be extended to recognize that oftentimes contracting between specialists A and B represents a matching problem. As this issue is not central to our concerns here, we leave that point aside.

[8] Or, if the integrated firm also licenses its upstream component A at reasonable rates, then the downstream specialist B could obtain a license and produce *x* as well. Since B's *x* would compete directly with AB's, we would expect AB to set the licensing terms so as to maintain its market position and profit. Moreover, even AB licensed on terms equivalent to its own internal (implicit) price, all *x*s would be based on one technology, that held by AB.

semiconductor design shops discussed above, as it cost upwards of $6 billion to build a chip foundry in 2007. In this context, patent-based contracts can be seen as clearly lowering the barriers to entry.

Alternatively, a new invention might emerge as a byproduct from research on something else. In this case, the firm generating the new invention might not want to pursue its commercial development since the firm's core business lies elsewhere. For example, licensing non-core technologies has been an appealing alternative for biotech firms which often stumble upon valuable compounds outside of their concentration area.[9] If developing product *x* is seen as a distraction of resources from the firm's primary goals, then licensing the patent to another entity better equipped to develop the product, and thereby earning a return on the expense of the original R&D behind the new invention, can be a superior option to simply abandoning the idea. Patent licensing in this scenario increases the disclosure of new technologies that might otherwise have been shelved.

Universities and government-operated labs represent another source of upstream specialists. Policy changes in the 1980s (namely, the Bayh-Dole and Stevenson-Wydler Acts) encouraged scientists and professors to patent and then license their innovations in order to increase the dissemination of new ideas and to raise the odds that such ideas made it into the commercial sphere (Jaffe 2000). Sometimes these intellectual property rights are simply licensed by a university's technology transfer office; other times, they spur start up firms, such as when digital imaging firm CDM Optics grew out of research conducted at the University of Colorado at Boulder.[10]

Finally, an organization might simply be better at generating one component of *x* as compared to the other. The firm might have amassed the human capital necessary for A but have no competency in B at all. Alternatively, the firm might have established downstream facilities for another product market that can be readily extended to the market for *x*, but have little or no R&D capacity. This reason, comparative advantage, suggests another potential benefit from patent contracting: increased product quality. If the entities that are best at producing A devote their efforts toward A while the entities

[9] See, Good (2006).
[10] See the story on CDM Optics' website, http://www.cdm-optics.com/?id=5.

better suited to producing B focus on B, we should see the overall quality of product *x* improve as compared to that offered by integrated firms. Explained in another way, having to produce both A and B, as integrated firms AB do, could require compromises that lower the end product *x*'s quality. Or, the integrated firm AB might be better at producing one of components as compared to the other, so that the combination results in lower overall quality versus the product produced by two contracted specialists.

Set against these forces for specializing are countervailing forces for integration. For example, the production of *x* might entail economies of scale or scope that induce larger, more integrated firms. Or the complements problem might result in a double marginalization problem, meaning that integrated firms could offer lower priced products than two distinct contracted specialists, each trying to earn its own profit margin.

The question is then which forces will prevail? Will high technology industries tend to be dominated by specialists, integrated firms, or a combination of the two? The reasons behind specialization given above, and most likely others that have not occurred to us, suggest that any industry that involves complex products will induce the emergence of specialists, at least for some period of time. The ability or inability of these specialists to contract with one another will then dictate whether nonintegrated firms are observed in practice or whether they remain sub rosa, as potential entrants only. But even if the conditions allowing specialists to compete in a market do emerge, it is unclear whether a diversity of firm types will remain in the long term (assuming legislators and competition agencies do not intervene by disfavoring one or the other). That is, if it is reasonable to assume that specialists can emerge whenever products are complex and contracting enables the necessary combinations to create a commercial end product, will those specialists ultimately displace their vertically integrated rivals or will we continue to see a diversity of firm structures?

To address these questions and to put more structure on our discussion of the potential benefits arising from patent contracting and specialization, we consider next a series of individual cases, all based on the simple framework presented at the beginning of the section but intended to capture the essence of real world situations. We first consider uniform quality and production costs in components across firm types, as a benchmark case. This case initially abstracts away from any potential comparative

advantage for specialists or an advantage for integrated firms stemming from a solution to double marginalization. This special case provides a starting point to contrast with the other cases that follow. For the second scenario, we analyze comparative advantage for specialists in quality. Third, we consider competitive advantage for integration in terms of production costs. And finally, we consider a mixed case, where each firm type has its advantages and disadvantages.

3.1 Equal Quality and Costs across Firm Type

In the general framework presented above we ignored product quality and production costs; all *x*s were assumed to be identical. Here we make that assumption explicit for our benchmark case. In particular, let $x_i(\ell)$ denote good *x* produced by entity *i*, where *i* = AB or A-B, with quality ℓ, where ℓ=1 indicates high quality and ℓ=0 indicates low quality. Product quality translates into higher end prices.

Let $c(x_i)$ be the per unit cost of production for x_i (ignore fixed costs). Therefore, quality has no effect on production costs, so the implicit assumption is that firms with higher quality are able to achieve better products for given production costs. As noted above, for the time being we are assuming away any possible complements problem with double marginalization; we relax this assumption later.

Let $p(x_i(\ell))$ be the per unit price of $x_i(\ell)$ in the downstream market. Assume that $p(x_i(1)) > p(x_i(0)) \geq c(x_i)$, so that higher quality goods are able to command higher prices in the downstream market but the lower price level is still enough to cover costs. Otherwise, if the quality level is identical across products, the price is identical as well (that is, no other factors, say brand recognition, enable price differentials).

Denote $q(x_i(\ell))$ as the quantity of $x_i(\ell)$ sold in the downstream market. Assume that $q(x_i(1)) = q(x_i(0))$, so that end consumers are equally split in terms of consumers who prefer higher quality but higher priced goods versus consumers who prefer lower prices and are willing to settle on lower quality to get them. With this notation in hand, we can define firm profits as $\pi(x_i(\ell)) = q(x_i(\ell))\left[p(x_i(\ell)) - c(x_i)\right]$.

As our benchmark case, we first consider equal product quality across firm types, so that $x_{AB}(\ell) = x_{A-B}(\ell)$, with say $\ell = 1$. As a result, prices are equal across firm type (for the time being). Also assume for the time being that production costs are equal across the two firm types. To provide a stark case for the benchmark, normalize the distribution of firm types so that there is just one of each firm type, A, B, and AB. While this is an extreme assumption, it greatly simplifies the expository nature of the simple model. More importantly, the qualitative results from this setup easily extend to multi-firm distributions with the one exception of the other extreme market structure, a large enough number of AB firms to create perfect competition even without the entry of any A-B firms.

Under this set of assumptions, if contracting between A and B is not possible, then AB will be a monopolist, taking the entire market and setting the monopoly profit maximizing price $p^m\left(x_{AB}(1)\right)$. AB's monopoly profit is therefore given by

$$\pi^m\left(x_{AB}(1)\right) = q^m\left(x_{AB}(1)\right)\left(p^m\left(x_{AB}(1)\right) - c\left(x_{AB}\right)\right).$$

If, on the other hand, patents allow firm A to contract with firm B, then entity A-B can enter the downstream market. Clearly, AB can no longer charge the monopoly price. If it did, firm A-B could charge anything lower, say $p^m\left(x_{AB}(1)\right) - \varepsilon$, and capture all sales since no consumer would pay more for an identical product. With competition, we can expect prices from the two entities to be identical at $p^c\left(x(1)\right) < p^m\left(x_{AB}(1)\right)$.

Competition will also expand the quantity sold as price falls. To simplify things even further, we make the reasonable assumption that $q^c = 1 > q^m$. While different outcomes are possible, we can reasonably assume that the two firms will equally split downstream demand, so that firm AB and firm A-B each have 50% of the competitive market. In this case, firm profit becomes

$$\pi\left(x_{AB}(1)\right) = \pi\left(x_{A-B}(1)\right) = \pi\left(x(1)\right) = \tfrac{1}{2}\left(p^c\left(x(1)\right) - c\left(x\right)\right) < \pi^m\left(x_{AB}(1)\right).$$

Thus, the entrance of the A-B firm lowers the price consumers pay and reduces AB's market share. The vertically integrated firm is clearly worse off, but consumers are clearly better off. Moving from monopoly to competition lowers the price charged, increases the quantity sold, and eliminates the deadweight loss associated with

monopolies. These effects can be counted as indirect benefits of patents. Without patent enabled contracts, firm A-B would not have entered the market and AB would have remained a monopolist.

Even if we relax the assumption of just one firm of each type, so that AB does not begin as a monopolist but rather as an oligopolist competing with a handful of other vertically integrated firms, it is clear that the increased entry allowed by patent contracting increases competition in the downstream market and will lower prices, to the benefit of consumers. The benefits are not as dramatic but are strong nonetheless. An example of such a dynamic can be seen in the European mobile telecom industry. The second generation technology, GSM, has been dominated by handful of vertically integrated players (Bekkers et al., 2002). When upstream specialists entered the market for the third generation mobile technology, WCDMA, downstream competition increased significantly.

If we no longer assume away the potential for double marginalization, the above result could be softened but should nonetheless remain. That is, if double marginalization is a problem in the industry at hand, the vertically integrated firm (or firms) can have a cost advantage compared to contracted specialist firms. This follows because the B specialist will face a relatively higher price for the upstream input A than the implicit (transfer) price that AB charges itself. B could face higher costs of production in this case (i.e., $c(x_{AB}) < c(x_{A-B})$), although note that B also avoids the cost of running an R&D program.[11] Even so, as long as the double marginalization effect is less than the difference between the competitive price for *x* and the monopoly (or the oligopoly) price for *x*, the contracted specialists will still find it profitable to enter the market. This follows because firm A-B will still be able to undercut the monopoly price despite its potentially higher cost structure. Thus the specialists will still enter which will increase competition and reduce downstream prices. To see this in the context of the simple model, denote the double marginalization effect as *dm*, an additive cost of production. In the presence of such a double marginalization effect, firm profits are now given by

[11] Note that contractual means of solving double marginalization do exist, namely a 2-part tariff for patent licensing. Upfront fees, however, have the effect of shifting much of the risk downstream and so may be unpalatable to downstream firms. Risk sharing is, in fact, a key motivation behind royalty rates, which are only paid when downstream sales are made.

$$\pi^m\left(x_{AB}(1)\right) > \pi^c\left(x_{AB}(1)\right) = \tfrac{1}{2}\left(p^c\left(x(1)\right) - c(x)\right) > \pi^c\left(x_{A-B}(1)\right) = \tfrac{1}{2}\left(p^c\left(x(1)\right) - c(x) - dm\right).$$

Now let's add a time dimension to the problem to assess the long term competitive implications. Assume that in period one firm AB is a monopoly. Then in period 2 patent contracts emerge as viable so that the contracted specialist A-B enters the market as just described. What should we expect in period 3? Under the above assumptions, there is no reason to expect the vertically integrated firm AB to exit the market in the face of competition from the specialists. True, it earns less than the monopoly (oligopoly) profit it once earned, but it is still able to earn a competitive return. Nor is there any reason to expect the contracted specialist entity A-B to exit the market. It is able to capture half of the market for its product of equal quality. It might earn less of a return than the vertically integrated AB if double marginalization is an issue, but it too is able to earn a competitive return. Thus, when products are not differentiated and production costs are either identical or double marginalization is not so large as to eviscerate all returns for contracted specialists, we can expect the forces that create different firm types in the first place—comparative advantage, financing constraints, etc.—to maintain those different firm types in the marketplace as long as contracts are feasible.

As we observe above, this case is an extreme one, meant for benchmarking purposes. In most high technology markets we would not expect quality and costs to be identical. To the contrary, most high tech markets are distinguished by differentiated products. We therefore turn to more realistic scenarios next.

3.2 Comparative Advantage for Specialists

Let us now consider differentiated product quality. In particular, assume that for a given production cost the contracted specialist entity A-B produces a higher quality product than the vertically integrated firm, so that $x_{A-B}(1) > x_{AB}(0)$. This could occur because of a comparative advantage for specialists in either upstream R&D, downstream production, or both.

Again assume that in the first period the upstream specialist cannot obtain a patent and therefore cannot contract with the manufacturing specialist, so the integrated firm AB begins as a monopolist (or oligopolist) in the downstream market. In period two, patents

emerge and firm A is able to contract with firm B to produce $x_{A-B}(1)$, challenging the incumbent product. Because A-B's product is higher quality, the firm is able to charge more than it otherwise would in the face of competition from incumbent AB: $p\left(x_{A-B}(1)\right) > p\left(x_{AB}(0)\right)$. Assume (for now) that the production costs are the same: $c\left(x_{A-B}\right) = c\left(x_{AB}\right) = c(x)$. Recall from above that we assume an equal number of consumers prefer quality as prefer lower prices with lower quality. As a result, profits are given by

$$\pi\left(x_{A-B}\right) = \tfrac{1}{2}\left(p\left(x_{A-B}(1)\right) - c(x)\right) > \tfrac{1}{2}\left(p\left(x_{AB}(0)\right) - c(x)\right) = \pi\left(x_{AB}\right).$$

The comparative advantage for contracted specialists in higher quality products leads to clearly higher profits for the entrant as compared to the incumbent integrated firm after entry. But it also leads to lower prices and increased choices for consumers as compared to period one with the monopoly (or oligopoly). While its higher quality allows A-B to charge higher prices than its rival, those prices are still kept in check (i.e., they are lower than the monopoly price from period one) by the competitive pressure of the vertically integrated firm. Moreover, even if we relax the assumption regarding equal costs, allowing a cost advantage for vertical integration due to double marginalization, we again find that under very reasonable circumstances the contracted specialist will still find it profitable to enter the market. So again, patent enabled contracting increases market entry and lowers prices for consumers. In this case of a comparative quality advantage for specialists, patent enabled contracting also increases product choice and product quality available to consumers.

Whether the diverse market structure remains in period three is less clear under a specialist comparative advantage than in our benchmark case, however. Consider, for example, the incentive for firm AB to remain vertically integrated. Without a double marginalization advantage, AB's rival A-B is clearly earning greater profits. AB may therefore determine whether selling off one layer of its business (R&D or manufacturing) and thereby becoming a specialist will enable it to achieve an improvement over its current structure. In the real world, this would materialize as a "spin off"—a process seen not infrequently. For instance, a number of mobile telecom firms have spun off their semiconductor chip facilities (used in the production of handsets) over the past decade.

The most recent example of this trend is Motorola, which announced in March 2008 that it would be splitting into two separate publicly traded companies—one concentrating on non-handset operations and the other company purely focusing on handsets (Cheng, 2008).

The greater the advantage being specialized offers, the more likely we would see the industry disintegrate over time into contracted specialists. If the comparative advantage were modest, however, we could continue to see a variety of firm structures. For example, if the comparative advantage in upstream R&D and/or product quality were mitigated by increased downstream costs due to double marginalization, we would expect to see continued coexistence of both contracted specialists and vertically integrated firms. Regardless, the increased participation in the market that patent contracting enables would enhance competition, lower prices, and increase consumer choice.

3.3 Comparative Advantage for Vertically Integrated Firms

In the polar opposite case, suppose that the vertically integrated firm offers the higher quality product, along with lower production costs and higher end prices. The premise here is that vertically integrated firms may enjoy economies of scope. For example, having an upstream R&D operation could lead to a better understanding of the downstream product, with spillovers across divisions of the company that enable higher quality manufacturing. Alternatively, a downstream presence could increase the productivity of R&D, say because the integrated firm learns better what end customers want based on which products sell in the marketplace so that the integrated firm can tailor its product development accordingly (Grindley and Teece, 1997). Some firms in the food industry fit this description: they find using in-house R&D as the best way to quickly adapt to consumer preferences. In Voxant Fair Disclosure (2006), the CEO of Safe Harbor, a vertically integrated pork production company, explained the business model:

> Everything we do in the integrated model has to do with satisfying customer needs and the integrated model lends itself very well to customizing to meet customer needs. So everything from antibiotic free to different attributes and products that different customers want, the integrated model allows us to do it...

In this case, entry by the contracted specialist A-B still increases competition, raises the quantity sold, and therefore improves welfare. However, the two firm types reverse roles: it is AB that earns higher profits, having to lower its price from the monopoly one it charged before A-B entered but not by as much as it otherwise would have due to its superior product. The profit differential would only be reinforced by the presence of double marginalization (that is double marginalization now works in the same direction as comparative advantage).

The long term implications of this scenario are quite different than for the case with a specialist comparative advantage. Given the clear advantage that vertical integration has, both in terms of product quality and production cost, we should expect more integrated firms. Thus, instead of providing incentives for disintegration, A-B's entry into the market may be a first step toward integration. Consider, for instance, that the specialist firm A recognizes that a vertically integrated structure is preferable because it affords higher profits, but A is unable to obtain the financing necessary to produce its own technology. Contracting allows specialist A to parse entry into manageable steps: first develop the technology, contract with specialist B, then work toward merging with B or building out its own downstream operation so as to become a new integrated firm AB'. Alternatively, a B specialist might move into the market *x* from a related market, contract with specialist A, and then either merge with A or develop its own upstream operations. We see this kind of behavior in the real world as well, when one firm acquires or merges with another in a complementary field or when a manufacturer initiates R&D efforts. For instance, in mobile telephony a number of Asian handset manufacturers moved into the production of handsets conforming to the European standard from their base in manufacturing handsets for the Asian and US standard. After licensing the technology from upstream specialists, several of these firms have now begun to conduct their own R&D and are developing their own patent portfolios. [ADD SPECIFIC EXAMPLE]

If the comparative advantage were large enough, we should see greater integration over time, with any specialists tending to be the newer firms using specialization as an entry strategy. Even here, though, patents offer a distinct competitive benefit: patents allow for contracts that then provide a relatively lower cost entrée into the market, lowering barriers to entry by providing a stepping stone, so to speak (Choi and Stefanidis,

2001, illustrate the other side of this argument, that having to enter two markets at once, R&D and manufacturing, raises barriers to entry).

3.4 A Mixed Case

As our last scenario, consider particular advantages for each firm type. Suppose that vertical integration offers economies of scale and/or scope, so that larger operations lead to lower production costs for the incumbent, regardless of product quality: $c(x_{AB}) < c(x_{A-B})$. Suppose also that specialization offers a comparative advantage in R&D, which translates into higher product quality, so that $x_{A-B}(1) > x_{AB}(0)$ and $p(x_{A-B}(1)) > p(x_{AB}(0))$.

In this case, a comparison of profits across the firm types is ambiguous, depending on the degree of cost savings compared to the price premium, all in relation to the differential in quantities sold (which are driven by the price and quality differences). Given that each firm structure has something to recommend it, we would likely see a diversity of types remain in the market, without any clear trend toward either integration or disintegration.

Regardless of the ultimate firm structure however, the entry of specialists—just as in all of the cases above—increases competition and improves welfare. Some specialists might enter as part of a phased strategy to become an integrated firm; others might enter with the intention of remaining specialists, with a comparative advantage in product quality. The point remains that being able to enter as a specialist, because patents facilitate contracting and lower barriers to entry, increases competition in the downstream market to the benefit of consumers.

This finding is not dependent on our assumption of just one firm of each type. As noted earlier, as long as the market comprised of vertically integrated incumbent firms is not perfectly competitive—a relatively rare occurrence—then patent facilitated entry of specialists increases competition and lowers prices.

4. Policy Implications

In concluding their 2004 paper on patent enabled contracting, Arora and Merges note that their "intent is not to argue for stronger patent protection, but rather to point out an insufficiently appreciated benefit…stronger property rights translate into greater benefits indirectly." Several years later, it appears that the indirect benefits of patent protection are still "insufficiently appreciated". The continued emphasis on patent trolls, defined merely as "non-practicing entities", motivated our renewed look the dynamic relationship between patents, firm structure, competition, and innovation.

We find that the effects of patents in the hands of upstream specialists are far more complex than is typically recognized in the policy debate, by courts, by competition agencies, or in the academic literature. In fact, patents held by non-practicing entities can offer a number of pro-competitive benefits. First, patents assist the entry of specialists into a market, which has direct implications for the level of competition and therefore the prices that consumer pay. Second, as is well recognized, specialization can mean higher quality. This is true across the economy and is no less a factor in IP contexts among upstream or downstream specialists in high technology industries, where the motto is often "innovate or die". Third, when it is upstream, specializing can also translate into more innovation, as rival firms are pushed to innovate in order to remain competitive in the market.

The very simple model we use to discuss these pro-competitive effects also suggests useful real world tests. The continued presence of both vertically integrated firms and contracted specialists, after the Darwinian process of competition has eliminated the weakest competitors, has implications for testing the presence of comparative advantage and double marginalization. If vertically integrated firms have a comparative advantage in economies of scope or scale as well as in solving double marginalization problems that can accompany the production of multi-component products, then we should see specialist firms only in early start up phases. Rational players will use specialization as an entry strategy, given its lower upfront costs, but will strive for vertical integration over time in order to obtain stronger profits. If instead we see the long-term dominance of specialists, with vertically integrated firms exiting the market, then we can conclude that specialists offer a comparative advantage in quality and/or innovation. Specialization

must lead to more efficient or productive R&D and better innovations for upstream firms and/or lower costs or better production processes for downstream firms. The presence of double marginalization problems, which can be solved by vertical integration, could soften the benefit of specialists' comparative advantage. In this mixed case, we should see the coexistence of both vertically integrated firms and contracted specialists. Both firm structures would have some advantages and disadvantages and thus both would remain competitive in the market in the long term.

The importance of all of this is that policy—meaning legislation, court opinions, and competition agency decisions—should be careful not to view the effects of specialized patent holders too narrowly. The emphasis on patent trolls, and their incentives and ability to practice hold up, has relied on far too sweeping a definition of trolls. In light of the analysis presented here it is clear that we cannot provide such a simplistic definition for patent troll as all non-practicing entities. Instead, we need to recognize that specialization can enhance social welfare, even in the context of patent holders. It can boost competition, raise product quality, and increase consumer choice. These pro-competitive effects should be weighed when evaluating the potential for negative effects arising from the combination of patents and vertical disintegration. Ignoring these indirect benefits could lead to misguided and even harmful policy.

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