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THE ROLE OF INTELLECTUAL PROPERTY IN JOINT INNOVATION AND DEVELOPMENT

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Abstract
This paper focuses on the role of intellectual property (IP) in structuring and governing innovative ventures between independent firms. The issue is particularly important given the tendency towards vertical disintegration in business firms whereby once integrated firms focus on core activities, while devolving residual aspects to independent suppliers and collaborators. In a world of fast changing technology, this also means that innovation takes place across firm boundaries and raises issues about the ownership of resulting intellectual property. This paper examines the routes available to firms for allocating such intellectual property to suggest that neither the default rules of US patent law, nor the types of agreements firms have struck as between each other provide adequate protections from appropriation while at the same encouraging seamless cooperation and sharing. This would suggest some caution about the appropriateness of the IP regime for the current innovation environment even in industries such as the pharmaceutical industry where patents are thought to be appropriate to recoup R&D investments and where the risk of standard patent hold up is thought to be low.

Keywords
Intellectual property, vertical integration, joint research and development.

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Introduction
The IP regime is said to promote the progress of sciences and useful arts by providing innovators limited terms of exclusivity as a reward for their inventions.

Formal IP regimes, providing for exclusivity in the exploitation of inventions, emerged during the Renaissance period. The Venetian patent statute of 1474 as well as earlier isolated grants of exclusivity in both Venice and Florence are the first examples of states providing IP protection, in the form of patents, in a systematic way for individuals who brought a new product to market. The emergence of patent protection regimes in this period is consistent with the key intellectual development associated with the Renaissance, namely the emphasis on the contribution of the individual, particularly as compared to the Middle Ages, a period during which the individual’s contribution and genius was de-emphasized.1

The conception of IP protection as societal recognition of, and reward for, the contributions of individual genius continued past the Renaissance origins of IP systems through the Industrial Revolution and up to today. Thus, the most significant discoveries associated with the first Industrial Revolution, and subsequently, were associated with individual named inventors on the resulting patents, e.g., Watt (the steam engine), Bell (the telephone), Morse (telegraph), the Wright brothers (the airplane). Additionally, many jurisdictions retain a view that an IP right is a legal embodiment that reflects the individual’s moral right to the invention as a product of her genius. Even in the Anglo-American tradition, where the moral rights view is not as firmly established and where IP is viewed as a utilitarian tool to advance industrial progress, only natural persons (as opposed to a legal entity) can be named as an author or an inventor of a patentable invention.

However, the process of innovation is not limited to invention, but also the commercialization of an invention so that it benefits society. Particularly since the industrial revolution, the business firm has become the main locus of productive activity and both the development and the commercialization of innovations. To the extent that the fundamental elements of the patenting regime have not changed much over the centuries, we might be interested to ask how appropriate and responsive they continue to be to a changing underlying productive environment. Thus, for example, some in recent times have posed the much broader question about the extent to which IP protection is necessary to provide an incentive for continued innovation in the industries of the new economy.2 Those authors have argued that since the tools of innovation in the Internet age are increasingly within the reach of more individuals and since other motivations can be sufficient to spur them to innovate, the prospect of an IP right need not be the key drive for their innovative activity.

This paper is interested in a somewhat different problem – namely, taking the patenting regime as given and assuming that it does provide incentives for continued innovation in the new economy, what are the effects of the procedures for the grant and delineation of patent rights to inventors on the ability of collaborating firms to structure, govern or, if necessary, abandon joint innovation projects. This issue is particularly important in light of the tendency towards vertical disintegration in the business organization observed in the past few decades, which implies that product improvement involves communication and coordination with independently owned and operated suppliers.3 Similarly, both in the pharmaceutical and in the computer software and applications industries, firms have sought out collaborations with smaller, often start-up firms as a

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source of innovative ideas as a way of bringing together the respective advantages of larger and smaller organizational forms.

The discussion in the paper proceeds in parts. Part I outlines a number of trends towards the disintegration of the organization of production that have taken place over the past couple of decades, by outlining new forms of productive relationships and some of the reasons for the emergence of collaborative innovation. Part II provides a few examples of decentralized collaborative relationships that have been described in the literature, in which firms are engaged in joint design, production and innovation. A specific focus of the discussion will be the sources of innovation in the new business organization and the governance problems that could inhibit decentralized production relationships. Part III examines the ways in which the prospect or the grant of IP rights, such as patents and the current default rules on the allocation of patents, may either help to resolve some of those problems and remove “innovation bottlenecks” or ways in which they exacerbate such bottlenecks. Of particular interest are the reasons that parties participating in such collaborations might perceive the allocation of IP rights to present a problem in the structuring or the governance of the relationships. Part IV examines some of the contractual mechanisms used by firms to allocate patent rights in joint innovation settings, arguing that those mechanisms are themselves imperfect in stimulating frank and open communication between the parties.

Finally, I elaborate two normative take-away points that follow from this discussion. First, it is not clear that there are any realistic law reform proposals that would provide an adequate response to this problem given the substantial heterogeneity in these relationships and what the parties bring to them. From the perspective of the Coasian intuition, this would not be of particular concern since in the setting of collaborating commercial firms the notion that “collaborators can structure their relationships for themselves” and “tailor their agreement to their particular needs” seems particularly apposite. Yet, due to the substantial uncertainty that characterizes these relationships, ex ante negotiated solutions (i.e. prior to the commencement of the relationship) are unlikely to be optimal (from the perspective of maximizing the joint surplus and thus in turn society’s gain in the form of useful innovations). Thus, to the extent that the Coasian intuition holds, it would be due to ex post mechanisms the parties use to resolve allocation issues in the course of the collaboration. This suggests a potential area for further research. We should note that to the extent that such ex post mechanisms are effective, we should observe a proliferation of collaborations and an absence of reported or litigated disputes. This presents a serious problem with respect to sources, because an absence of litigated disputes can also be consistent with collaborations not being exploited to their full potential or ending prematurely due to concerns about collaborator probity and allocation problems. If the contracts themselves, or reported disputes, do not present adequate evidence of any ex post mechanisms, this would suggest that only more probing direct interview research could uncover whether such mechanisms exist or whether concerns about IP allocation lead to suboptimal levels of collaboration and disclosure in these relationships.

I. Vertical disintegration in production
In recent decades we have observed a trend towards the decentralization of production, reversing the previous dominance of the Fordist firm in which various stages of production were vertically integrated within the boundaries of a single firm. For much of the 20th century the dominant firms in

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4 Thus, Dreyfuss is correct when she expresses pessimism about the prospects of the EU project for a model collaboration contract (Dreyfuss 2000). At the same time, however, the modest law reform proposals she proposes are unlikely to be particularly helpful in the setting of collaborations across firm boundaries.

5 Dreyfuss (2002: 401). Dreyfuss persuasively argues that the Coasian solution is inappropriate in the context of collaboration within the firm or within university settings, where transaction costs, information and bargaining asymmetries may affect the negotiation process in significant ways.

The Role of Intellectual Property

key industries (such as steel, automobiles, electric machinery, food processing) were characterized by use of techniques of mass production to deliver standard products to market. This was the result of the employment of “dedicated machinery” in the process of production, which required very large investments in plant and equipment only suitable for producing a particular type of good and which would be valueless if not used for the dedicated purpose.

The trend towards vertical integration was a natural consequence of the reliance on the techniques of mass production. Specifically, vertical integration refers to the process of bringing upstream and downstream activities within the boundaries of the single firm, so that not only sources of inputs, but even downstream distribution networks become part of a single organization rather than being provided by independent firms. In the Fordist firm, the tendency towards vertical integration was described as a response to the threat of disruption. Namely, if production is disrupted when a supplier or distributor is unable or unwilling to fulfill its functions – the consequences for the firm could be disastrous. This is because the firm had to make a large investment in the equipment necessary for mass production, which is useless if not used for the specific dedicated purpose. Such investments could only be recouped over long periods of time, where the machinery was continuously used to supply the standard products, preferably to known and stable markets. Therefore, any interruption to the flow of production could be ruinous: and both upstream and downstream collaborators would be aware of such a fact leaving the firm vulnerable to the opportunistic conduct of its collaborators.

A way to minimize the risk of such disruptions would be to source inputs (or distribute outputs) through more than one firm. Yet in the context of mass production, this route might not be feasible if the processes or location of a supplier must be specifically matched to the firm’s own process of production. In such cases of “asset-specificity,” the investments by each of the independent firms are specific to the relationship and might not be used outside of the relationship. This further raises the risk of opportunistic “hold-up” – once one side has made the investment in equipment (or location) specific to the relationship, the other side would be tempted to withhold cooperation in order to extract more favorable terms for itself.

Vertical integration can therefore be seen as an alternative, and attractive, solution to the hold-up problem: bringing upstream and downstream suppliers and distributors within the firm and making them subject to the managerial hierarchy, the potential for logjam can be eliminated.

Within this paradigm of production, IP rights, such as patents, can also play a supportive role. The firm lays out a substantial investment in the means of mass production at the outset, which investment has to be recouped over long periods of time by selling standard goods. The production technology may embody a technical invention developed by an in-house team dedicated to R&D. If patentable, the invention would receive a patent grant giving the firm a period of exclusivity over exploiting the invention. The grant of a patent right therefore increases the firm’s ability to appropriate the gains and recoup its original investment.

Moreover, the logic of vertical integration was extended to the process of invention or innovation as well. Namely, vertically integrated firms were characterized by large in-house R&D departments and laboratories. In-house researchers and scientists worked within corporate R&D teams to produce systematic improvements to currently used technologies that could be incorporated within current production methods to continue to deliver the standard product to relatively stable markets of repeat customers. Arguably, this is the period during which the rhetoric of IP changes from

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7 Gilson, Sabel and Scott (2009).
8 Ibid.
9 Ibid.
10 The stability of markets could be guaranteed by both structural barriers (such as transportation costs or even the outlays necessary to enter at a sufficient scale, together with tacit coordination where there are only a small number of players) or artificial ones (government tariffs or trade barriers, as well as explicit collusion).
11 Gilson, Sabel and Scott (2009).
the prior emphasis on the inventiveness, genius, spark of the individual, towards the idea that the grant of an IP right is a return on the expenditure of the IP owner in improving the technology.

Invention in the vertically integrated firm is clearly a collaborative process. Many of the technological improvements to production processes or to products (such as pharmaceutical compounds for example) would not ordinarily be developed by a lone researcher working at home or a small lab. Instead, firm R&D is undertaken by large teams working within in-house labs. However, given that the entire economic benefit of the invention process was to be appropriated by the firm employing the inventors, the collaborative nature of the invention process does not present difficult allocation or governance problems. Contractual mechanisms, whereby rights to all inventions were assigned to the corporation together with some internal procedure to select, often somewhat arbitrarily, the persons involved in perfecting the invention to be named as the patent inventor(s), would be sufficient. Thus, with only minimal adjustments the patenting regime could continue to play a supportive role within this paradigm of production.

One such adjustment to the patent laws to deal with the collaborative in-house nature of innovation was the amendment to 35 U.S.C. § 103 (c) to ensure that the work of other researchers within the firm could not be used to invalidate as non-novel or obvious the work of other researchers working within the same organization (which is the ultimate assignee of the patent). This amendment therefore recognized that the firm is the instigator, financier and beneficiary of innovative research that occurs within its boundaries.

In the past couple of decades, the foregoing stylized description of the process of production and innovation has increasingly come under strain. Specifically, the tendency for the organization of production has been away from vertical integration. The language of disintegration in the business organization has become part of popular economic and policy discourse. We speak of firms focusing on their “core” activities and ridding themselves of “non-core” assets. In turn, firms’ non-core activities are “outsourced” or contracted-out to independent entities, specializing in provisions of input products or services, starting from basic functions such as cleaning of premises, or receiving customer telephone calls, or developing specific software applications for a platform etc.

While the trend towards contracting out or outsourcing is often seen through the lens of cost-cutting, through overcoming some of the agency costs associated with hierarchy, there have been other sources of market instability that have undermined the vertically integrated model of production. For example, technological change triggered by the information revolution as well as the opening up of markets to global competition have undermined the stability of markets that is required for the vertically-integrated firm to recoup large relationship-specific investments by selling standard products over long periods of time.

Such instability both makes innovation in product development a key aspect of continued success, but also has implications about how the firm can innovate. Rapid shifts in technology and greater openness to global competition makes it much more difficult to rely on planning as a tool, since firm actors cannot simply assume the stability (or predictability) of demand for the current product. Such shifts result in “innovation cascades,” which increase substantially the level of unpredictability or uncertainty in the firm’s environment.

The turbulence of the environment makes it very risky for the firm to rely only on a single strategy of development for the future, because the environment can change in ways that are both rapid and unpredictable. If the firm limits itself to investing in a single in-house development project, and that project is unsuccessful or becomes superseded by other developments in the market, the outcome for the firm can be ruinous. Moreover, as product complexity increases and technology is

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13 Of course, as Dreyfuss has pointed out, such modalities of allocation within the firm are not always seamless, may reflect substantial bargaining disadvantages, and need not be socially efficient either (2002: 402-04).

14 Gilson, Sabel and Scott (2009) describe one manifestation of innovation cascades as follows: “increases in computational power led to improvement in the tools for design of microprocessors as well as more sophisticated materials and manufacturing techniques to realize those new designs. This in turn leads to improvements in the resulting computers and their computational power, which in turn leads to a repetition of the cycle”
fast-moving, it becomes more and more difficult for managers at the top of the hierarchy to maintain
top expertise and supervisory capacity so that a single firm could maintain cutting edge capacity across all
technologies necessary for product development.

Therefore, outsourcing of production need not be only a cost-cutting tool. Disintegration can also be an important strategy for maintaining the capacity to innovate through collaborating with multiple partners. As Clayton Christensen has shown, it is not necessary to assume that firms are badly managed or inefficient to support this conclusion. Incumbent producers who rely on the currently dominant technology can become so expert and efficient at serving current customers and developing linear improvements (“sustaining innovation”) that they are entirely blind to innovation alternatives with a disruptive potential. Christensen has suggested firms spinning off independent units to tap the potential of disruptive technologies currently unattractive to their main customers. But of course, collaboration in the development of new products and processes can be one way to tap alternate opportunities and sources of knowledge, including the knowledge of upstream firms and downstream users.

Similarly, von Hippel has argued that centralized incumbent driven models of product development and innovation leads to standardized products. Within the mass production paradigm it is difficult to cater to more heterogeneous needs of customers, or for that matter to tap the knowledge of users who are best placed to develop customized improvements that cater to their needs. This is so even if the tools of innovation are within the grasp of users and if user-developed innovations could be easily fed into the production process.

These models of innovation suggest that size and incumbency can be a burden in a more unstable environment and collaboration with independent entities is one way for the firm to try to accommodate divergent pressures, whereby it can maintain leading edge capability in its core capacities, while being able to reach knowledge and possibilities outside of the boundaries of the organization as one way of ensuring that it is not limiting itself to a single future project.

Moreover, even if the original impetus for outsourcing were simply to cut costs, once control over a component technology is relinquished, product development becomes a task that necessarily takes place across the organizational boundaries: an improvement in the product requires coordination and respective improvements in inputs, or even in the distribution channels.

Product development in such a production setting could be the result of a process of joint innovation, which might include multiple parties. The design of each component of the product will influence the design of other components and the process is iterative and multidirectional. Instead of designing a staple product (with a long lifecycle) in the central laboratory and issuing specifications to in-house units, each supplier has to offer a design for their own component, which may require adjustments to be made to the designs by others and so on, the cycle continues. Innovation is a joint rather than uni-directional process centered in the in-house R&D lab. It is based on alliances, which might be long term, but are often ad hoc and project specific. Moreover, both the project and the nature of the relationship may need to be more flexible and adaptable exactly because it is impossible to make dependable predictions about future states of the world.

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15 According to Christensen, a disruptive technology is a superior alternative to the currently dominant technology in a certain field that completely devalues the skills and know-how of the current incumbent. It usually gets a foothold in a segment of the market currently ignored or left unserved by the incumbent. This enables the disrupting firm to emerge and to develop its product without triggering a response from the incumbent, but once the product is developed it can be generalized and accepted by the incumbent’s customers. It is because the innovation is not a linear improvement on the current technology, that even sophisticated producers and users of that technology are blind to its potential. Clayton Christensen, (2003) The Innovator’s Dilemma.

16 Id.


18 Dreyfuss (2000: 1170) (“Collaboration is, of course, not a pool: parties are not agreeing to long-term arrangements that will survive future developments in the field.”)
II. Examples of joint development relationships and IP problems

Gilson, Sabel and Scott have offered the following examples of cross-organizational collaboration give an idea of their characteristics and of some of the problems that might result in managing the IP rights that result from such relationships.\(^{19}\)

One example of a supplier-purchaser relationship is that between John Deere and Standyne. John Deere produces machinery used in agriculture and construction, while Standyne produces precision engine components that are incorporated in Deere’s machinery. A supply contract signed in 2001, which was to last for 5 years, did not specify quantities or prices, at least in part out of recognition that Deere’s products would change in the course of 5 years and that therefore new parts will have to be co-developed jointly by the parties in ways that could not be pre-specified. Instead, the contract set out that Standyne would participate in Deere’s program for supplier relationships called “Achieving Excellence,” which is used to measure and monitor performance of suppliers semi-annually in categories such as quality, delivery, technical support, cost management and “wavelength” which results in a ranking of suppliers.\(^ {20}\)

Another classic example of disintegration in production, where the parties become supplier-purchaser relationship was Apple’s sale of its manufacturing facility for personal computers to SCI in 1996. Contrary to the logic of vertical integration, this sale occurred at a time of growing demand when Apple was unable to keep up production with such demand. As part of the sale of the facility, Apple agreed to purchase a certain percentage of the personal computers it required from SCI for the following 3 years. Yet the parties also recognized that change in this industry is very rapid, so the specifications for the products could not be set out in the contract, committing themselves instead to co-designing the products to be supplied over the 3 years. SCI had an obligation to provide product plans and changes to product specifications to respond to technology changes that were to be developed collaboratively so that either party could find and suggest a potential improvement to a component, material or process.

Both of the above examples involve supplier-buyer relationships in which much innovative activity occurs at the boundary between the independent firms. To the extent that each of the firms maintains control over the physical assets and product development plans, we might argue that no IP allocation issue arises. To the extent that adjustments are small and incremental, they may not even be eligible for patent protection due to the obviousness doctrine.\(^ {21}\) Moreover, given the short time horizons of the products contemplated and the possibility for inventing around, it may well be that being first to market is the key appropriability mechanism and that IP rights are not as important in such settings.

A final example, however, is particularly important to this paper and describes a relationship that is increasingly common in the pharmaceutical industry, and one that has the specific goal of developing a patentable invention. Large pharma companies have, for the past couple of decades, faced rapid rates of patent expiry on blockbuster drugs together with an absence of candidate compounds for development coming from their own internal R&D laboratories. At the same time, however, large pharmaceuticals possess large libraries of chemical compounds, developed in the course of research, even if unsuccessful, for candidates that target particular illnesses. Moreover, they have the capacity to conduct clinical trials as part of the onerous regulatory procedures needed for approval of new drugs, as well as large sales and the promotion forces necessary for the commercialization of new drugs.

As a result, it has become increasingly common for large pharmaceutical companies to partner with smaller specialized pharma or biotech company to conduct joint R&D of drug compounds. Small biotech firms usually bring deep experience and proprietary methods for searching for compounds that work through specific metabolic pathways in the body, but may also have some potential candidate

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\(^{19}\) These contracts were chosen as “exemplars” of collaborative innovation relationships by Gilson, Sabel and Scott (2009). I use their “spectrum” of examples in order to point to the kinds of IP concerns could emerge in these relationships.

\(^{20}\) Gilson, Sabel and Scott (2009).

\(^{21}\) 35 U.S.C. §103(a).
compounds that they have investigated on their own. Big pharma companies can bring to the table large (also proprietary) compound libraries, as well as depth of experience in performing the clinical testing necessary to develop a pharmaceutical drug which will ultimately be approved by the FDA, as well as sales and marketing infrastructure in case of successful identification of an effective and safe drug compound.

As others have argued, relationships such as these ones cannot be governed by a fully specified state contingent contract. Even a provisional initial research or product development plan often becomes obsolete quickly either due to the progress of research or due to developments in the market. As a result, these relationships would seem to be profoundly fraught not only due to the turbulence and uncertainty faced by the parties, but also because each is specialized in a particular aspect of the design process and specialization tends to obscure understanding of the activities of other collaborators. Moreover, while it would be difficult for the small firm to replicate either the regulatory or the marketing capacities of the large firm, with sufficient knowledge of the other side’s proprietary knowledge it is not inconceivable that at a certain point, either of the collaborators might be capable of finalizing the search process on its own.

Both the selection of partners and the maintenance of trust in such relationships is difficult, principally because firms are extremely vulnerable to opportunistic conduct by their partner. Not only can partners obscure information about costs, capacities or progress or engage in classic hold-up (demanding re-negotiation on more favorable terms), in addition, collaboration often makes it necessary to engage in sharing of deeply intimate information about product plans or costs, which firms would ordinarily not do across organizational boundaries for fear of being competitively undermined. Alternatively, a collaborating firm, such as a big pharmaceutical company can try to use the collaboration to learn about the technology of its biotech partner and then go on to develop its own product.

The problem is illustrated by the paradigmatic case of *EliLilly v. Aradigm*,22 which involved a potential collaboration between a large pharmaceutical company with a library of proprietary chemical compounds (Lilly) and a smaller company specialized in the delivery of drug compounds via the inhalation of aerosols. The parties contemplated a collaboration, whereby Lilly would supply insulin compounds and Aradigm would provide the method of aerosolizing and inhalation to improve insulin drug delivery through inhalation. While the meetings came to nothing and no collaboration was ultimately formed, both parties subsequently proceeded to seek a patent on lispro, one of Lilly’s proprietary insulin compounds, in aerosolized form resulting in “relative bioavailability greater than twice that seen after the inhalation of a similar amount of” ordinary insulin, and Aradigm in fact obtained such a patent.

While this particular case presents a peculiar situation (in the sense that the parties only had a number of preliminary meetings23), it shows how potentially fraught these relationships can be: both parties may bring something to the table, yet the benefit of the collaborative effort may be determined in part by a race to the patent office.24 And where such relationships are commenced, technological improvements may arise due to contributions from both sides, which are difficult to disentangle, and yet as further progress is made, the temptation for each firm to try to continue on its own would become more pronounced.

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22 376. F.3d 1352 (Fed. Cir. 2004).
24 While there was no evidence that Aradigm had not considered lispro as a candidate prior to the meetings with Lilly, the result in the case, with Aradigm as the sole inventor, was heavily influenced by the fact that Aradigm had managed to obtain the patent first (while Lilly had a pending patent on the same invention), which in turn under 35 U.S.C. § 282, required Lilly to prove joint inventorship with clear and convincing evidence.
Given the difficulty of writing fully contingent contracts and the enormous potential for disputes, the vertical integration literature would suggest these are relationships ripe for integration, and yet the entities often remain independent perhaps in an attempt to garner the benefits of both organizational forms. The interest of this paper is in the question whether the IP regimes help or hinder the structuring of such relationships.

This question has received some public policy attention as well. A recent report by the International Expert Group on IP is animated by similar concerns, recognizing that the role of IP must be reassessed by reference to the entire innovation system. The expert group also recognizes the growing importance of collaboration in the process of innovation and, in that context, the need to build and maintain trust between different participants in the innovation system, the importance of effective and speedy dispute resolution that allows parties to solve problems and continue their collaboration. The expert group goes so far as to advocate for what it calls “new IP,” without providing much of a flavor of what this “new IP” would look like or how the existing regimes need to be reformed to get to “new IP.” Moreover, to the extent that the IP provisions on inventorship simply provide only default ownership rules, if there are adequate private mechanisms that overcome the IP regime’s limitations, investing in law reform may be unnecessary.

III. Intellectual Property in Collaborative Innovation Relationships

There has been considerable writing devoted to the question of the role of IP in the “new economy.” For instance, some have questioned whether the classic forms of IP protection are at all appropriate in the current production and innovation environment. Innovation is driven by rapidity of change and the fact that key to success is to be first to deliver a new product to market. The idea of long-term recoupment of investments in R&D is difficult to sustain in some sectors. It is not clear whether IP incentives play a role in spurring innovation, given that product cycles are much shorter than the terms accorded under various IP rights (Deare-Standyne and Apple-SCI were 5 and 3 year contracts respectively and in both cases the future products could not be specified).

Moreover, a literature has emerged on anticommons problems, which in the rapidly changing innovation-oriented sectors can result in patent thickets, whereby patent ownership of minor technological components of complex products can be used as a strategic tool to hold-up the bringing of new products to market.

My concern here is more narrow. My focus is on aspects of the current patenting regime that hinder the creation of collaborative innovation relationships or that present either problems, or possibly solutions, to the governance of such relationships.

For instance, one obstacle to the creation of collaborative innovation relationships presented by patent rights has to do with the due diligence that the parties perform in the process of negotiating a collaborative innovation agreement. Namely, since the parties perceive the goal of the joint work to be the development of products over which they will have a period exclusivity, the process of due diligence ordinarily involves each party assuring itself that the existing IP portfolio that the collaborator brings to the project is solid and impregnable. This task is made difficult by the fact that the grant of a patent right by the PTO does not in fact guarantee the validity of the exclusivity right, since every patent is vulnerable to an ex post challenge in court, based on any of the patentability conditions, as well as inequitable conduct. Inequitable conduct can be established in a case where, after the fact, the inventor can be said to have omitted to submit pertinent information to the examiner.

As a result, the process of performing due diligence on the patent portfolio of a collaborating party is not a matter of simply checking off boxes for the satisfaction of certain formalities. Instead, it essentially involves a party performing a re-examination of the patent grant process, relying not only on the data and material provided in the public file, but also potentially material that was not submitted to the US Patent and Trademark Office (“PTO”) and that the patent-holder might regard as competitively sensitive. It is also worth noting that this process occurs at a time when the parties are

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not already committed to each other as future collaborators, which further exacerbates the disclosure paradox problem outlined earlier. Thus, there have been examples of parties using collaboration negotiations to simply obtain sensitive information from the purported partner or setting up internal innovation projects parallel to the collaborative project.26

This brings us to the question of the sharing of intimate information and the question of allocation of inventions that result from the collaborative work. As we have already seen, a key impediment to the creation and maintenance of collaborative innovation efforts across organizational boundaries is the fear that one side will appropriate all the joint fruits of the collaboration. To the extent parties cannot write contracts ex ante that set out the duties and obligations in every contingency, property rights can provide an alternative assurance to each party that it will have a share in the resulting project.

(a) The current default rules under US Patent Law

The inventorship principles that determine the named inventors on a patentable invention under the present Patent Act are only partially responsive to this problem. Under the inventorship rule of the US Patent Act, any natural person who has contributed towards the conception of a patentable invention has to be named as an inventor on the patent application.27 Failure to name the correct inventors could result ultimately in a finding that an otherwise valid patent is unenforceable. Moreover, the default rule under the patent statute, as interpreted by the courts, is that each named inventor is an equal pro-rata “owner” of the invention, irrespective of the magnitude of their contribution towards the invention.28

The above inventorship rule presents both some protections and some problems for collaborating parties. The principle that anyone who contributes towards the mental conception of the invention is entitled to be named as an inventor, together with the equation of inventorship with the right to ownership as a matter of default, offers assurance to collaborating parties that one collaborator would not be able to completely appropriate the fruit of the collaboration for itself. Yet, as Aradigm illustrates, the assurance is not perfect since getting to the patent office sufficiently early (to be the first to obtain a patent), combines with the rule that clear and convincing evidence is needed to prove joint ownership or to invalidate a granted patent, to make it more difficult for the second party to establish its own right. To the extent that this exacerbates the incentive to break off the relationship earlier to be the first to be named sole inventor, it could lead to the non-commencement or premature termination of collaborations. In this context, the Federal Circuit’s holding in PerSeptive Technologies v. Pharmacia Biotech29 (Fed. Cir. 2000) is an important supplement to Aradigm. In PerSeptive, the Federal Circuit held that where a patent-holder obtained a patent without disclosing the fact that they worked with and relied upon the technology of a collaborator, this would be a basis for a finding of inequitable conduct, resulting in the patent being held unenforceable. Importantly, this result would follow even if the collaborator is not eventually entitled to be named as joint inventor. As such, the PerSeptive principle can contribute towards ensuring that any collaboration issues are thrashed out in the prosecution procedure, which is otherwise a private conversation between the PTO and the applicant.

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26 Eli Lilly & Co. v. Emisphere Technologies Inc., 408 F. Supp. 2d 608 (S.D. Ind. 2006) (holding that Lilly, by setting up its secret parallel program, had violated an implied covenant not to use the information exchanged with Emisphere outside the scope of the collaboration agreement).
27 Conception is the completion of the mental idea of the invention rather than its distillation into a working prototype. Buroughs Wellcome v. Bar Labs (Fed. Cir. 1994).
28 35 U.S.C. § 116 (a joint inventor need not contribute to every claim of the patent); Ethicon v. US Surgical Corp., 135 F.3d 1456 (Fed. Cir. 1998) (a joint inventor is a pro-rata owner of all claims of the patent).
29 225 F.3d 1315 (Fed. Cir. 2000).
While this default rule is protective of the inventorship interests of all collaborators, at the same time the rule is quite expansive and one might argue overly generous – in that it gives each named inventor the right to ownership of the resulting patented invention, including all claims of the patent, irrespective of their relative contribution to the invention. Such a generous default rule raises at least two possible concerns.

First, there is the problem due to the possibility of disproportionate entitlement when we take into account the relative contributions of the parties. Again, the default rule might make parties cautious in their exchanges with their collaborators out of fear that all claims of a particularly valuable invention would potentially be shared equally with a collaborator who has made only a “small” contribution towards the conception of one claim. This concern might be particularly acute if we believe that parties also tend to view their own contributions to joint projects as more significant than those of other collaborators.31

A second stems from the possibility of hold up in the use and commercialization of the invention post-patenting (due to multiple owners of the resulting patentable invention). One co-owner would not be able to prevent the other from using and exploiting the patented invention as they see fit. However, there are nonetheless other possibilities for holdup. Thus, according to Dreyfuss the balance of authority of US courts holds that each owner does not have a duty to account to the other patent co-owners, as such the value of the invention can be competed down to zero.32 In addition, enforcement of the patent becomes more difficult as the courts have required all owners to be named as plaintiffs, and they have been reluctant to add unwilling co-owners to the proceedings as plaintiffs.

(b) Alternative default rules
While many have criticized this default rule as it relates to ownership, it is not clear that a better default rule would be possible to develop. Given the heterogeneity of situations in which invention is the result of a collaborative process, it would be difficult to produce a catalogue of default rules that might appropriately deal with each possible situation that might arise.

In her discussion of a broader set of collaborative relationships that might result in IP rights, Dreyfuss has argued for the incorporation of a principle of proportionality in the determination of authorship/inventorship. Thus, in patent law, she argues that “under a proportionality approach to inventorship and ownership, anyone who makes the statutorily required contribution to an invention would continue to be named as an inventor” with “each contributor’s rights … limited to the claim to which that participant contributed as an inventor.”34 Notably, under this proposal for incorporation of a proportionality principle, “compensation would be determined by private negotiation or arbitration”.35

The problem with adopting a proportionality principle for ownership of inventions resulting from joint innovation is that proportionality is an \textit{ex post}, rather than an \textit{ex ante} principle. As such, it is not really a rule of ownership, as much as an adjustment principle only available to the parties \textit{ex post}, after their relative contributions are more or less established and the invention complete. In light of the fact that the proportionate contributions of the parties to individual patent claims would be largely unverifiable – and I would argue equally unverifiable to the patent office, to the courts or to private arbitrators standing outside the collaboration – the effectuation of the principle depends upon

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30 The assumption of the patent law that a complete mental conception of an invention is possible prior to testing its operability or building a prototype, thus distinguishing conception from testing, may itself be problematic in the current innovation environment, but that issue can be left for another day.

31 In the management literature, this is sometimes referred to as the “not made here” phenomenon.

32 Dreyfuss (2000).

33 See Newman, J.’s dissent in Ethicon, where she argued for a separation of the concepts of inventorship and ownership under the patent law.


35 Id. at 1221.
the parties’ ability to negotiate with each other ex post. If they fear ex post negotiations or the ability to effectively demonstrate their contribution to the project to a court or tribunal, they will be reluctant to collaborate.\footnote{36}

I would argue that we may view the patent law rules on inventorship and ownership, as elaborated by the courts, as an information-forcing default rule.\footnote{37} Their generosity precisely can be viewed as protective of all inventors who have contributed to a patentable invention. And yet given that the default gives each inventor an equal right, irrespective of the contribution and creates possibilities for hold-up among multiple inventors, it also provides (following the Coasian intuition) a strong reason for the parties, who are much better informed about the nature of their collaboration, to negotiate the allocation of the rights to the resulting IP themselves. While parties cannot, of course, circumvent the inventorship provisions of the patent statute (all the inventors who contributed to the invention must always be named on the patent application), they can by their own agreement assign, the ownership of patents or the rights to resulting royalties. Moreover, they can do so \textit{ex ante} in an agreement that provides for the details of their mutual collaboration. Perhaps parties have provided for more creative ownership allocation rules, that more appropriately reflect their own circumstances.

\textbf{IV. Negotiated allocation rules}

Before examining some of the principles that parties have used to allocate IP rights in agreements that set out joint innovation projects, it is worth emphasizing that in the context of particular interest for this paper, parties have particularly strong incentives to get the solution to this problem right. \textit{Ex ante}, both parties can hope to have much to gain from working together, both in improving the tools they bring to the collaboration and also from the commercialization of a successful invention. Moreover, unlike the collaborative settings examined by Dreyfuss, where one of the parties (such as an individual employee, scientist or faculty member) may be subject to a bargaining disadvantage, or an information asymmetry or bounded rationality, or suffer “cultural aversions to lawyers and legal matters”\footnote{38}, parties to inter-firm collaborative innovation arrangements do not suffer from the same constraints (at least not to the same extent). Therefore, they are both more interested and more capable to develop allocation principles that would (i) provide adequate incentives for seamless collaboration and information-sharing; (ii) allocate the invention to the party best able to commercialize or otherwise use it and (iii) do so irrespective of whether the collaboration is ultimately successful or not.

As demonstrated by Gilson, Sabel and Scott, collaborating parties have been quite creative in crafting solutions to the problem of patent right allocation in negotiating collaborative agreements.\footnote{39} In fact, as suggested by the incomplete contracts literature, parties have used the allocation of control rights over patentable invention in order to resolve the governance problems that can result due to the incompleteness of collaboration agreements (i.e. by allocating decision rights to the party that is vulnerable to opportunism at various points in the relationship). For example, precisely in the pharmaceutical industry collaboration context, contracts governing collaborative innovation have used a so-called “nested options” mechanism, to allocate the rights of exploitation of a patented invention as between the parties. In the pharmaceutical context, such a mechanism is feasible in part because the resulting invention is a compound/active ingredient that targets a particular illness. As such, a patent can be obtained over such a compound as a “composition of matter”\footnote{40} ensuring the holder an exclusive right to exploit such a compound. Moreover, such a right is particularly valuable given that no one

\textit{\footnote{36} Moreover, as we see in the next section, when parties do negotiate allocation rules as part of their agreements they more often tend to adopt rules that would allocate ownership, or decision rights, over an invention to one party or the other, rather than opting for joint ownership of inventions.\footnote{37} Ayers, Ian & Robert Gertner, (1989) “Filling Gaps in Incomplete Contracts: An Economic Theory of Default Rules”, Yale Law Journal 99: 87.\footnote{38} Dreyfuss (2000: 1173).\footnote{39} Gilson, Sabel and Scott (2009).\footnote{40} 35 U.S.C. § 101.}
can exploit the same compound for the exclusivity period and, given the difficulty and length of the regulatory approvals with the FDA, inventing around the patented compound can be both difficult and lengthy. As Gilson et al. argue, if a successful development compound results from the collaborative work of the parties, the contract can use a nested options mechanism to give the parties alternating decision rights as to whether to proceed with developing the compound commercially into a drug candidate, which could attenuate hold-up concerns. For example, the large pharma company would ordinarily have the first option to decide whether to take the compound into development. If the large pharma company decides not to proceed with development, the decision-right would switch to the smaller partner, who then has the option to decide to proceed with development and commercialization of the product, either alone or with another partner.

The foregoing is precisely the kind of contractual solution that sophisticated and well-advised commercial parties might resort to in the face of the patent law default rule. Note however that the above mechanism is contingent upon the collaborators having identified a potential development candidate compound, which demonstrates activity against a particular disease, as part of their joint research. In other words, it is a solution for a collaborative venture that achieves some degree of success. But what about the common case where the collaboration does not succeed along the identified objective, so that even after extensive mutual exploration, no development candidate is identified? At this point, we should recognize that the mere fact that no drug development candidate has been identified by the parties in their collaboration does not mean that the collaboration would not result in any patentable inventions. Through the joint work, the smaller or biotech firm might have developed improvements in the search technology targeting the particular receptor or even developed analogous technology to target other receptors. Similarly, the original portfolio of compounds brought forward by the large pharma company might be substantially increased and variations in chemical structure identified that could be helpful in the future, even in research areas possibly unrelated to the original project. To the extent that the smaller firm also began with a set of investigation compounds, it might have learned principles for altering the structure of those compounds, or to isomerise them, so as to improve efficacy or reduce toxicity. Particularly in situations where the parties cannot count on the bounty of the multi-billion dollar drug, the respective rights to these intermediate innovations can be perceived as quite important.

One option might be for the parties to avoid getting enmeshed in costly negotiations and to simply deal with such inventions on the basis of the patent law default rule for inventorship, namely that each person who contributed towards conception is a named inventor (with their respective ownership right being assigned, ordinarily through contract, to the employing company). The problem, as outlined in the previous section, is that the default principle, i.e. an inventor is anyone who contributes towards the mental conception of the invention, provides a threshold that is both imprecise and quite low. Therefore it would be conducive to both free riding and the generation of disputes among the collaborating parties. Moreover, the parties would continue to be enmeshed with each other well beyond the contemplated scope or duration of the original collaboration in a scenario that would be very vulnerable to hold up. Where the inventions involve patents, the parties might be particularly reluctant to end up as joint owners, in light of the absence of a duty to account to co-owners which would mean that co-owners can compete the value of the invention down to cost.

A review of contracts for collaborative innovation reveals that parties attempt to use other allocation devices for the rights to inventions resulting from collaborative work.

One such principle is to assign IP rights resulting from the collaborative work according to the initial “endowments” of the parties. Namely, under this allocation rule, each party would be the owner of improvements in the technology that it brought to the collaborative venture. A variation of the same theme is the allocation principle found in some agreements, which proposes that each party

41 E.g., Glaxo Agreement.
42 Pharmacopoeia Agreement
43 Kraft Agreement
would be the owner of the IP right that was developed by its own employees.\textsuperscript{44} These approaches may appear attractive because they aim to more clearly delineate the allocation of rights to one of the parties, so that exploitation of inventions following the end of the collaboration would be easier. Yet it is not clear that these allocation rules are easily administrable – whether it would be possible to allocate a patented invention to the technology or the employees of one or the other party very much depends upon the nature of the collaborative work and the degree of interaction between the parties. Moreover, this approach provides a reason for the parties to be guarded in their interactions with each other, mindful of the way in which the allocation rule assigns ownership of any resulting inventions. Thus, such a rule could be a disincentive for the parties to be completely candid and forthcoming in their mutual interactions, particularly at a time when the eventual success of the collaboration (either by way of identification of an invention that can be commercialized or in terms of their mutual fit) is highly uncertain. Collaborating companies might be tempted to use (or hide) information strategically so that if the collaboration breaks-up they can still have residual rights over inventions that they can commercialize either alone or with other partners. In a similar vein, if each party does not have to share ownership of inventions related to its own technology or contribution or one developed by its own employees, this may result in a strategy whereby each of the parties attempts to learn as much as possible from the collaboration, while attempting to ring-fence the inventive activities of its employees to focus them on inventions over which it would have the sole right and ownership. As such, this type of an allocation rule seems to encourage the type of behavior identified in \textit{Aradigm} and in \textit{Emisphere}, instead of delivering seamless cooperation between the parties throughout the joint project.

A yet further example is a mechanism that, apart from an allocation rule for any resulting inventions, also gives the other party a cross-license to use the any inventions resulting from the collaborative work, including those allocated to the other collaborating party. While such a mechanism does raise the parties’ costs of switching away from the existing partner, much turns on whether an invention is deemed to have resulted from the joint work or from the individual work, which would also seem to encourage strategic use of information in the relationship.

The foregoing description of some of the contractual principles that can be used to allocate patentable inventions as between parties to a collaboration illustrate an important dilemma. The parties often view IP rights over the invention, which could subsequently be exploited commercially with exclusivity, as a key objective of the collaboration. Where such an invention results from the collaboration, the definition of a property right over that invention, can be used as an instrument to control opportunism, with decision rights over the invention being allocated to the party most vulnerable to hold up. However, much of the innovative activity in a joint development project can result prior to the identification of an invention that can be commercialized. There is substantial evidence that, at least in the pharmaceutical industry, many development projects end in failure. Yet intermediate improvements in technology or the expansion of candidate libraries could prove useful in other projects or could be commercialized later, even with other partners. For such improvements, the default rule of patent law protects any inventor who contributed towards the conception, but does so imprecisely, which would ordinarily encourage the parties to come up with a better allocation principle in their negotiations. However, as the discussion in this part has demonstrated, the allocation rules are rarely ideal and there is no candidate that is generally dominant.

From the perspective of the parties, the ideal allocation rule would be precise – in the sense that it would clearly allocate the right to each invention to one of the parties based on a criterion which is easily observable and verifiable – so as to guarantee exclusivity and minimize the extent to which the parties are enmeshed with each other following the end of the collaboration. At the same time, the rule should not act as a disincentive for the parties to be fully forthcoming and candid in their interactions, which would maximize the likelihood of success in the joint inventive project. This is in line with the observations of some practitioners\textsuperscript{45} noting that IP-related issues, including specifically

\textsuperscript{44} Conor Agreement

\textsuperscript{45} Author’s Notes from ACA Meeting on Collaborative Agreements in the Pharmaceutical Industry (November 2008, New York City).
the question of allocation of IP rights resulting from a collaboration, present among the more difficult aspects of the negotiation of such agreements. Allocation principles that give stronger incentives for the parties to be forthcoming in the collaboration might be viewed as more vulnerable to hold up problems, while allocation principles that attempt to more clearly allocate rights to either party are likely to produce strategic behavior within the collaboration. While no allocation principle appears to be clearly dominant, collaborative innovation relationships seem to proliferate. This suggests either that these collaborations deliver suboptimal levels of cooperation or alternatively that parties use other mechanisms to overcome allocation problems or resolve allocation disputes \textit{ex post}.46

The fact that none of the \textit{ex ante} mechanisms for allocating IP rights seems entirely satisfactory in the context of collaborative innovation means that the modalities for dispute resolution used by parties become crucially important. Disputes stemming from collaborative innovation relationships in dynamic settings share a number of important characteristics: (1) they arise out of deeply intimate interactions between the collaborating parties; (2) the relationships can often involve highly-complex technologies; (3) the written contracts are particularly vague with respect to specific outcomes, given that at the time of the preparation of the contracts the parties have no more than a provisional plan about the future progress of the work. Therefore disputes arising in such relationships present particularly serious observability and verifiability problems if litigated before standard dispute resolvers, such as generalist judges and juries. Thus, while participants claim that disputes often arise in these relationships, leading to litigation and even break down, reported cases dealing with such breakdowns are very few in number. This would suggest that parties either attempt to resolve disputes in the relationship themselves, or that they rely on private dispute resolution mechanisms, such as arbitration. While arbitration might seem to be an attractive alternative to courts in resolving these types of disputes, it is not clear that the verifiability issue is much easier if an arbitrator who is completely independent and an outsider to the collaboration is used. Moreover, the issue of IP rights presents a unique problem in this context, since the existence and validity of such rights are not merely the result of private agreement: they are conferred by the government and are invested with the public interest. Therefore, a purely private mechanism for resolving disputes among collaborating parties might resolve an imminent dispute as between the parties. However, even if the parties by virtue of their agreement are prevented from resorting to the public dispute resolution system to question an arbitral award, such an arbitral award but might not be binding vis-à-vis third parties, who would still be able to rely on the PTO or the courts to re-ventilate some of the issues addressed in the arbitration.

\section*{V. Conclusion}
In his seminal contribution on the nature of the firm, Coase\textsuperscript{47} postulated that the firm is used as a vehicle for production where the costs of relying on market exchange are excessive. In the subsequent literature that picks up this argument, the problem of hold-up in settings involving relationship-specific investments had been identified as the key to explain the vertically integrated nature of the Fordist firm, which relied on the methods and tools of mass production. Vertical integration (including of firm R&D and innovation) in stable markets can be seen as a tool for minimizing the potential for disruption, so that the investments in the tools of mass production can be recouped.

However, once the stability of markets was undermined, firms’ strategies for survival in the new environment would have to foster greater flexibility – investing too much in the in-house version of the future could be disastrous. One way to introduce flexibility and outside knowledge into strategy

\textsuperscript{46} Thus, some parties resort to mechanisms similar to those used for managing the on-going collaboration and have applied them to the management and allocation of joint IP rights. Thus, some collaboration agreements establish a joint committee for management of IP rights resulting from collaborative work, which seems to be an attempt to sidestep both the \textit{ex ante} contractual mechanisms for allocating property rights, to rely instead on some future (\textit{ex post}) relational accommodation. MedicoSystems Agreement: “regulatory committee to oversee and make recommendations”; Pharmacopoeia Agreement: “joint committee” on patents and inventions.

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formulation is for the firm to collaborate with external partners and a growing literature now examines the modalities of cooperation in the post-Chandlerian decentralized setting. In the new setting, there are concerns over hold up, but also other types of collaborator opportunism, including the possibility of appropriation of the fruits of the collaboration.

This paper examines the role that intellectual property rights, such as patents, could play in these collaborative settings. In particular, they can be used to control opportunism, by guaranteeing continued access to collaborators to the joint product of inventive activity, but also by allowing collaborators to allocate property or decision rights over specific inventions so as to control opportunism. As we saw, the patent law default rule on inventorship and ownership is partially responsive to such concerns: while it protects contributing inventors, it is quite crude in doing so. As such, it provides a strong incentive to the collaborating parties to provide ex ante a more tailored allocation formula. Following the intuition of Coase\textsuperscript{48}, the negotiation of the collaboration agreement provides the parties with a “Coasian moment” where “expectations can be thrashed out, and rights to credit, royalties, or future creative opportunities exchanged for other forms of compensation”\textsuperscript{49}.

A review of some of the exemplars of allocation rules for IP rights used in collaboration agreements suggests that these ex ante rules are not particularly well-tailored to achieving the multiple objectives of the parties: to provide a clear criterion for allocation, which is easily observable and/or verifiable to an external enforcer, while at the same time fostering communication and interaction between the parties. While we might think that these parties are sophisticated, relatively well-advised and best informed about the nature and prospects of the collaboration, the radical uncertainty of the environment they are facing, in both the technological and competitive landscape, makes it difficult to tailor allocation rules ex ante, particularly with respect to intermediate advancements whose commercial potential may not be immediately apparent.

The apparently unsatisfactory nature of the ex ante allocation rules, together with the dearth of reported litigated cases suggests a few possible scenarios about the role of IP rights in the post-Chandlerian environment. One possibility is that given the uncertainty about future allocation, parties in these relationships engage with each other at an insufficiently deep level, treating information strategically, and as a result ultimately delivering suboptimal levels of collaboration and joint innovation. Another possibility is that in the absence of effective ex ante allocation rules, such collaborative relationships result in disputes over the ownership and right of exploitation of inventions that are resolved either through mutual settlement or through private dispute resolution mechanisms, such as arbitration. A final, more optimistic, possibility is that parties have used the mixture of formal and informal relational mechanisms of adjustment, including joint research committees and specialized alliance managers, not only to manage the daily business of joint development, but also to manage ex post the allocation and exploitation of the resulting patentable inventions. Which of these scenarios most closely resembles outcomes of collaborative innovation remains an open question.


\textsuperscript{49} Dreyfuss (2000: 1201-02).