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Intellectual Property as a Law of Organization

Jonathan M. Barnett*

*University of Southern California, jbarnett@law.usc.edu

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Abstract

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Abstract:

The incentive thesis for patents is challenged by the existence of alternative means by which firms can capture returns on innovation. Taking into account patent alternatives yields a robust reformulation of the incentive thesis as mediated by organizational form. Patents enable innovators to make efficient selections of firm scope by transacting with least-cost suppliers of commercialization inputs. These expanded transactional opportunities reduce the minimum size of the market into which any innovator—or the supplier of any other technological or production input—can attempt entry. Disaggregation of the innovation and commercialization process then induces the formation of secondary markets in disembodied technology inputs. These organizational effects over transactional, firm and market structure generate specialization economies that minimize innovation and commercialization costs, which in turn exerts incentive effects consistent with the standard thesis and market growth effects that extend beyond it. Conversely, the absence of patents, and the resulting obstacles to bargaining over ideas, can compel innovators to select integrated structures that inflate commercialization costs, resulting in distorted R&D investment and product output. These proposed relationships are broadly consistent with organizational patterns in selected historical and contemporary technology markets, as illustrated in particular by disintegration processes in the "fabless" segment of the semiconductor market.

Conventionally patents are understood to be critical instruments for supporting innovation. This incentive thesis is the basis for most legal, policy and judicial discussions and applications of patent law. Hence, it is problematic (to say the least!) that empirical support for this thesis is mixed across a range of markets, periods and jurisdictions.[1] In large part, those results may reflect the fact that innovators[2] often have access to alternative mechanisms by which to capture returns on innovation: take away patents and innovators often fill the gap through non-patent substitutes. In this Article, I offer an alternative account of the patent system that explicitly recognizes the "IP-unfriendly" fact that patents are often not a unique instrument by which to capture innovation returns. In lieu of the traditional incentive thesis, I adopt an alternative approach that examines how patents influence innovation behavior by influencing organizational behavior. This approach pursues a two-part hypothesis: (i) patent strength[3] sometimes influences the organizational forms that entrepreneurs, firms and other entities select in order to undertake innovation and commercialization activities and (ii) those organizational effects influence entrepreneurs', firms' and other entities' innovation incentives.[4] Organizational effects proxy for innovation effects: where patents alter organizational behavior, they alter innovation behavior; otherwise, patents are redundant as an incentive device. Contrary to other attempts to provide a sounder

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1 *See infra* note [14] and accompanying text.

2 By "innovator", I refer broadly to any individual, entrepreneur, firm or other entity that is involved in generating and commercializing new technologies. This encompasses but extends beyond the traditional category of the inventor, who is not involved in commercialization. For the original source of the distinction, see JOSEPH A. SCHUMPETER, THE THEORY OF ECONOMIC DEVELOPMENT (Redvers Opie trans., Harvard University Press 1934) (1911) [henceforth SCHUMPETER, THEORY OF ECONOMIC DEVELOPMENT].

3 By "patent strength", I refer to the multiple factors that influence the strength of patent protection, including (among other things) duration, scope, cost of enforcement, anticipated damage awards, etc.

4 This approach builds upon and generalizes arguments set forth in Ashish Arora & Robert P. Merges, *Specialized supply firms, property rights and firm boundaries,* 13 IND. & CORP. CHANGE 451, 472 (2004). For other relevant contributions, see *infra* note [9].

basis for the patent system without reference to any incentive function[5], I exploit patents' effects on transactional, firm and market structures as a basis for reinvigorating the incentive thesis, as applied in mediated form to a targeted set of innovation environments. The result is a nuanced reformulation of the incentive thesis: contrary to unqualified IP-abolitionism, it anticipates circumstances where patents exert marginal incentive effects, but contrary to unqualified IP-advocacy, it anticipates circumstances where patents do not exert such effects.

To develop this proposition, I pursue the intellectual equivalent of a pruning strategy: I remove contestable or disputed propositions and assumptions in order to build the least controversial basis for a revised formulation of the incentive thesis. First, I intentionally overstate empirical evidence that casts doubt on patents' incentive effects by assuming that reverse-engineering barriers or other non-patent mechanisms sufficiently delay imitation in the goods market. Second, I constrain the scope of application of the incentive thesis to limited circumstances where patents enable innovators to accrue returns through weakly-integrated entities that contract with third parties to implement the commercialization process. That "zone of certainty" tracks a well-supported position that small firms and individual inventors most clearly depend on the patent system[6], a view that has a strong historical pedigree in the U.S. patent system[7] and is reflected in several existing policy commitments.[8] Third, I move beyond this proposition by arguing that first-order effects over the innovation behavior of weakly-integrated entities imply higher-order effects over supply chain configurations, entry conditions and market

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5 *See* Paul J. Heald, *A Transaction Costs Theory of Patent Law,* 66 OHIO ST. L. J. 473 (2005) (arguing that, independent of any exclusionary function, patents reduce transaction costs of organizing and monitoring team production of R&D and other innovation assets); Clarisa Long, *Patent Signals,* 69 U. CHI. L. REV. 625 (2002) (arguing that, independent of any exclusionary function, patents perform a signaling function that relieves informational asymmetries, especially between firms and investors).

6 On relevant evidence, see *infra* notes __.

7 On the emphasis the U.S patent system has historically placed on small-firm inventors, see B. ZORINA KHAN, THE DEMOCRATIZATION OF INVENTION: PATENTS AND COPYRIGHTS IN AMERICAN ECONOMIC DEVELOPMENT, 1790-1920 (2005).

8 There are several examples: the PTO's reduced fee schedule for small entities; the Small Business Innovation Development Act; the Small Business Technology Transfer Research Program (as administered by the Small Business Administration); and, in the case of academic research institutions, the Bayh-Dole Act of 1982 (see University and Small Business Patent Procedures Act, codified at 35 U.S.C. § 200-212 and implemented by 37 C.F.R. 401).

formation that encompass a far broader range of firm types (in fact, all but perhaps the most highly-integrated entities). In particular, patents' localized incentive effects over R&D suppliers are symptomatic of a generalized bargaining process that continuously reallocates supply chain functions among the least-cost combination of external and internal providers. The specialization gains resulting from this division of labor in turn yields effects on market growth that extend beyond the conventional link between "more IP" and "more innovation". For the incentive thesis, less is more. Initially confining the thesis to the firm categories and market settings where it is most robust ultimately reinstates it as an empirically grounded account of the manner in which patents can exert far-reaching effects over firm and market structure. That in turn yields incentive effects consistent with the standard rationale and market growth effects that go beyond it.

This project builds upon work by legal and management scholars, and economic historians, who have pioneered inquiry into the interactions between intellectual property, transactional design, firm boundaries and market structure.[9] Examining the patent system through the lens of organizational form yields surprising insights that challenge current skepticism among some economists, academic lawyers, judges and other policymakers

[9] Prof. Asish Arora and colleagues in the management literature, Prof. Robert Merges in the legal literature, and Profs. Kenneth Sokoloff and Naomi Lamoreaux in the economic history literature have pioneered this line of inquiry. *See* ASHISH ARORA ET AL., MARKETS FOR TECHNOLOGY: THE ECONOMICS OF INNOVATION AND CORPORATE STRATEGY (2001); Arora & Merges, *supra* note 3; Robert P. Merges, *A Transactional View of Property Rights*, 10 BERKELEY TECH. L. J. 1477 (2005) [henceforth Merges, *Transactional View*]; Robert P. Merges, *Intellectual Property Rights, Input Markets and the Value of Intangible Assets* (Working Paper 1999) [henceforth Merges, *Input Markets*]. For contributions in the economic history literature, see *infra* notes [77-80] and accompanying text. For other contributions in the legal literature on intellectual property and firm structure, see Oren Bar-Gill & Gideon Parchomovsky, *Firm Boundaries in Technology-Intensive Markets,* 157 U. PA. L. REV. 1649 (2009), and Dan. L. Burk & Brett H. McDonnell, *The Goldilocks Hypothesis: Balancing Intellectual Property Rights at the Boundary of the Firm,* 2007 U. ILL. L. REV. 575, and, on intellectual property and market structure, see MARTIN J. ADELMAN, CASES AND MATERIALS ON PATENT LAW 38 (2d ed. 2003); Martin J. Adelman, *The Supreme Court, Market Structure and Innovation: Chakrabarty, Rohm and Haas,* 27 ANTITRUST BULL. 457 (1982) [henceforth Adelman, *Supreme Court*]. Inquiry into the relationship between intellectual property and firm structure traces back to the seminal contribution by: David J. Teece, *Firm Organization, Industrial Structure and Technological Innovation*, 31 J. ECON. BEHAV. & ORG. 193 (1986). This Article advances these bodies of scholarship in several respects: (i) it views specialized R&D suppliers (the focus of much of the existing literature) as a subset of a general case where patents enable the efficient allocation of innovation and commercialization functions among least-cost providers; (ii) it provides a consolidated framework that identifies links between the entry of upstream R&D suppliers, the unraveling of downstream portions of the supply chain and the formation of secondary markets in supply chain inputs; (iii) it exploits these relationships in order to isolate the circumstances where patent coverage exerts marginal incentive effects; and (iv) it moves beyond theoretical argument by identifying organizational tendencies in technology markets that are consistent with these relationships.

over patents' incentive function. These insights are grounded in two uncontroversial observations that are familiar to the inventors, investors, lawyers and business people that participate on a day-to-day basis in technology markets. First, firms must commercialize innovations in order to realize any payoff on their R&D investment (and, more generally, for everyone else to realize a social payoff on the firm's R&D investment), which in turn necessitates executing capital-intensive and skill-intensive actions to reach market. Any practically compelling theory of intellectual property must therefore show how it supplies incentives to fund the commercialization process. Second, as Kenneth Arrow observed long ago, innovators face an inherent obstacle in commercializing new technologies. That is because bargaining over an intangible resource is frustrated by a "chicken and egg" problem: negotiation to agree upon valuation necessitates disclosing the invention, which allows the listener to seize it at will.[10] That means that innovators who have an idea may have difficulty getting it to market: expropriation threats preclude outsourcing commercialization functions without risking forfeiture of the innovation. Any practically compelling theory of intellectual property must address this obstacle to market release.

This shift in focus to the commercialization stage that lies between invention and market release—a reorientation of perspective promoted by other patent scholars in recent work[11]--is the key to identifying the role that patents can play in influencing innovators' configuration of the supply chain by which innovations reach market, which in turn can promote innovation consistent with the conventional thesis. Recall the starting assumption: an "IP-unfriendly" environment where reverse-engineering barriers or other extra-patent mechanisms delay imitation in the goods market. That would appear to threaten patents with redundancy. But expropriation risk persists at any point in the commercialization process at which innovators must disclose information to external providers of the functions that must be implemented in order to reach market. It

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10 *See* Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, in THE RATE AND DIRECTION OF INVENTIVE ACTIVITY 614-16 (1962).

11 Prof. F. Scott Kieff in particular has emphasized this point. *See* F. Scott Kieff, *IP Transactions: On the Theory and Practice of Commercializing Innovation,* 42 HOUS. L. REV. 727, 736-37 (2005); F. Scott Kieff, *Property Rights and Property Rules for Commercializing Innovations*, 85 MINN. L. REV. 697, 703-04, 707-712 (2001). *See also* Ted M. Sichelman, *Commercializing Patents,* STANFORD L. REV. (2009) (recognizing the costs of commercialization but arguing that the patent system in its current form can frustrate commercialization efforts). The recent focus on commercialization revives themes promoted by Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J. L. & ECON. 265 (1977).

is precisely at this stage that patents can be critical. Without patents, innovators must integrate forward so as to implement commercialization independently and minimize interaction with third parties. That would appear to resolve the expropriation threat (which would *again* appear to threaten patents with redundancy). But integration can impose a subtle but important cost. Where expropriation risk compels an innovator to select higher levels of integration than it would otherwise have preferred, the innovator forfeits specialization gains that could have been accrued by allocating one or more supply chain functions to lower-cost providers. In the extreme case, those specialization losses are so great that entry is no longer cost-feasible. Even in the moderate case where the innovator reaches market, it—and society in general—has still suffered a loss in the form of inflated commercialization costs. Patents mitigate expropriation risk and therefore enable innovators to select freely among organizational forms in order to capture specialization gains through relationships with lower-cost suppliers. Contrary to standard commentary that laments patents' entry-preclusive effects, the organizational approach identifies circumstances where patents enable entry (and the absence of patents *dis*ables entry) by specialized providers of technological and production inputs along the supply chain running from idea to market.

In short: transactional, firm and market structures sometimes look much different under stronger or weaker patent protection and these organizational effects sometimes matter—as I will argue, *usually* matter—for the underlying objective of supporting innovation.[12] This is not to say that strong patents do not give rise to opportunistic litigation and other social costs that may ultimately recommend against them "on net" in any particular market. The organizational approach is ambitious as a positive matter but modest in its normative aspirations. It simply identifies on a gross basis an important set of social gains generated by the bargaining processes secured by patents. These social gains encompass but extend beyond the R&D suppliers—individual inventors, technology start-ups and other independent research entities—that most clearly depend on the patent system. First, the same specialization logic that drives upstream R&D firms

[12] Properly speaking, the underlying objective is to induce efficient (not maximal) allocation of resources to innovative activity, relative to all alternative activities. Consistent with most economic and all legal commentary on intellectual property, I will, as a matter of shorthand, often refer to the objective of "promoting" or "supporting" innovation, it being understood that there must exist some upper bound to the socially optimal level of innovative investment.

to outsource downstream production functions can induce—actually, by competitive pressure, it will compel—ongoing adjustments throughout the supply chain. This division of labor exerts positive feedback effects by reducing costs and expanding output, which in turn increases the size of the market and induces further entry by suppliers of technological and production inputs. Second, breaking up the supply chain among least-cost providers forms the basis for assembling the transactional infrastructure required to support a "market in ideas" that has the potential to operate akin to a trading market in tangible goods. Disaggregation multiplies supply chain providers and inputs, which gives rise to informational complexities that induce re-intermediation by transactional entrepreneurs that facilitate trade in intangible goods.

These relationships between patent strength on the one hand and firm scope and market structure on the other hand extend intellectual property analysis toward micro-level issues of supply chain design and macro-level issues of market structure and growth that have received little attention from legal scholars.[13] The "micro" and the "macro" are linked: intellectual property influences market structure and growth by regulating the opportunity set of transactional and organizational choices available to the suppliers of complementary technology and production inputs. To be sure, the virtuous circle of strong patents, adaptive supply chains and specialization economies does not tell the whole story of the patent system. But it represents an important and overlooked part of the story that recurs in industries and periods characterized by intensive adoption and enforcement of patents. In particular, the organizational approach identifies an important role that patents appear to play in the widespread disintegration of supply chains in technology markets that had formerly been dominated by vertically integrated firms. This process—a fundamental change in industrial organization—is described in detail through a case study of the "fabless" segment of the semiconductor market. Over roughly the past 15 years, this patent-intensive market, which develops designs for chips widely used in computing, communications and other electronic devices, has migrated from almost exclusive reliance on integrated structures to substantial use of disintegrated structures where "fabless" firms that specialize in chip design contract with "foundries" that specialize in production. Vertical disintegration has in turn induced re-

[13] For exceptions, see *supra* note [9].

intermediation by entities that facilitate transactions in design components. This transformation of firm and market structure offers a robust (if still incomplete) realization of a market in ideas, which has otherwise largely remained the subject of theoretical design. Importantly, it provides a counterfactual to the frequently asserted (but rarely documented) claim that intensive patenting, and the resulting fragmentation of intellectual resources, impedes innovation in technology markets. To the contrary: the fabless chip market, and the challenge it has mounted to incumbents, almost certainly could not have arisen without it.

Organization proceeds as follows. In Part I, I situate the innovation process within the supply chain context and explore the extent to which innovators can mitigate expropriation risk through contractual, reputational and organizational solutions. In Part II, I describe how patents promote specialization gains and reduce entry costs by enabling innovators to select least-cost organizational forms. In Part III, I illustrate these relationships through evidence on organizational tendencies in technology markets in general and the fabless semiconductor market in particular.

I. The Commercialization Dilemma

Incentive-based discussions of the patent system typically focus on expropriation risk in the goods market, which in turn yields underinnovation in the absence of legal protections against imitation. But empirical evidence tells a more complex story. Outside of the pharmaceutical and chemical industries (important exceptions to be sure), moderate to large-sized firms often have other effective means—reverse-engineering barriers, technology and contract—by which to delay imitative entry.[14] Even if we over-

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[14] The leading evidence is found in survey studies covering large U.S. manufacturing firms, which find that, among legal and extralegal mechanisms for appropriating returns from R&D projects, firm managers (outside of the pharmaceutical and chemicals industries) usually report that patents are among the least effective instruments and are rarely the "but for" condition for proceeding with an R&D project. *See* Wesley M. Cohen et al., *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patents (or Not)* (Nat'l Bureau of Econ. Research Working Paper No. 7552) (2000) (surveying R&D managers randomly drawn from a sample of all R&D labs in the U.S. operating as part of a manufacturing firm); Richard C. Levin et al., *Appropriating the Returns from Industrial Research and Development,* in 3 BROOKINGS PAPERS ON ECONOMIC ACTIVITY: SPECIAL ISSUE ON MICROECONOMICS 783 (Martin Neil Bially & Clifford Winston eds. 1987) (surveying R&D managers in all publicly traded firms in the U.S. with substantial R&D expenses); Edwin Mansfield, *Patents and Innovation: An Empirical Study,* 32 MGMT. SCI. 173 (1986) (surveying R&D managers of 100 randomly chosen U.S. firms from 12 industries). Note that none of these studies address the value placed by small firms on patent protection;

generously accept this body of evidence without qualification[15], expropriation risk still confronts innovators before a consumption good embodying the innovation reaches the market.[16] In an early contribution, Kenneth Arrow drew attention to this sensitive juncture—post-invention but pre-commercialization—by describing a dilemma that has since become known as "Arrow's Paradox" or the "disclosure paradox".[17] Absent a property right to block unauthorized usage, innovators will not disclose an idea to counterparties for the purpose of purchasing the idea or otherwise assisting in its commercial development. The reason is simple: the idea buyer cannot credibly commit against copying the idea if it believes the idea is commercially valuable, in which case the idea seller would lose any ability to profit from it. By anticipation, the innovator declines to invest in generating the idea and underinnovation ensues—even if expropriation risk could have been controlled upon release in the goods market. This proposition implies a broad scope of application for patents to support the commercialization process. However, it is important to observe that innovators are not helpless: even without patents, expropriation risk in precontractual bargaining can sometimes be limited through some combination of reputation effects, graduated disclosure and organizational integration. If we take into account these imperfect but often meaningful defenses, we can then define more precisely the set of circumstances where the disclosure paradox—and the resulting impediments to efficient bargaining—will yield underinnovation.

A. Intellectual Property Meets Supply Chain Management

Invention means little without commercialization: an entire millennium lagged between the invention of the water mill and its widespread adoption.[18] Societies that

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that is an important limitation, as will become apparent in the ensuing discussion. For a survey of small firms that reaches largely contrary results in selected industries, see *infra* note 52.

15 Elsewhere I have reviewed in detail this evidence and other related studies, which shows substantial industry-specific and firm-specific variation. *See* Jonathan M. Barnett, *Do Patents Matter? Empirical Evidence on the Incentive Thesis,* in LAW, INNOVATION AND GROWTH (ed. Robert Litan) (forthcoming 2010). For a review of extra-legal substitutes for patents, see Jonathan M. Barnett, *Private Protection of Patentable Goods,* CARDOZO L. REV. (2004).

16 Unless otherwise specified, I generally use the term, "users", rather than "consumers", given that products or services that embody innovations are often sold to intermediate users rather than end users.

17 *See supra* note __.

18 *See* NATHAN ROSENBERG, INSIDE THE BLACK BOX: TECHNOLOGY AND ECONOMICS 19 (1982).

have supported innovation by reward and subsidy systems often have been relatively successful at inducing innovation but relatively unsuccessful at embodying those innovations in consumption goods. Both medieval China and the Soviet Union conformed to this tendency: invention was forthcoming but dissemination was stalled.[19] Any practically meaningful inquiry into the patent system must therefore assess how it supports the long path that runs from idea generation through the various tasks that must be completed to embody an idea in a consumption good. Research is typically only a portion, and usually the far smaller portion, of the capital-intensive and knowledge-intensive activities that must be undertaken in order to bring an innovation to market.[20] Innovation and commercialization costs for some of today's most important innovations reach infrastructural proportions: these amounts exceed a billion dollars in the case of a new pharmaceutical product[21] and several billion dollars in plant construction costs alone in the case of a new semiconductor chip.[22] Absolute cost outlays are magnified by the long "dry period" that typically runs from invention to market release, which ranges from several years to several decades in the case of some of the most important innovations.[23] Without some mechanism by which to fund and implement commercialization tasks

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19 On Soviet innovation, see Maurizio Iacopetta, *Dissemination of Technology in Market and Planned Economies,* THE B.E. JOURNAL OF MACROECONOMICS (2004). On both the Soviet and Chinese examples, see William J. Baumol, *Toward Analysis of Capitalism's Unparalleled Growth: Sources and Mechanism,* in ENTREPRENEURSHIP, INNOVATION AND THE GROWTH MECHANISM OF THE FREE-ENTERPRISE ECONOMIES 164-65 (eds. Eytan Sheshinski et al. 2007).

20 *See* OFFICE OF TECHNOLOGY ASSESSMENT, INNOVATION AND COMMERCIALIZATION OF EMERGING TECHNOLOGY 49-50 (1995). *See also* Edwin Mansfield, *Industrial Innovation in Japan and the United States,* SCIENCE, Sept. 30, 1988, p. 1770 (based on products introduced in 1985 by 100 U.S. and Japanese firms in the chemicals, machinery, electrical, electronics, rubber and metals industries, finding that applied research constitutes 18% of applied research costs for U.S. firms and 4% for Japanese firms with remainder of costs attributable to commercialization tasks). This evidence confirms long-standing anecdotal observations. *See, e.g.,* SCHMOOKLER, *supra* note __, at 3 (1966); JOHN JEWKES, DAVID SAWERS & RICHARD STILLERMAN, THE SOURCES OF INVENTION 200 (1958).

21 *See* Joseph DiMasi, Henry G. Grabowski & Ronald W. Hansen, *The price of innovation: new estimates of drug development cost,* 22 J. HEALTH ECON. 151 (2003) (for drugs that underwent the FDA approval process in the 1990s, estimating average costs of $800 million from molecule identification through testing (as calculated on a fully capitalized basis in 2000 dollars)). This figure does not include production, distribution or marketing costs; hence, total capitalized costs almost certainly exceed $1 billion as stated above.

22 *See infra* note __.

23 For an extensive listing of the commercialization timelines of leading inventions, see Kitch, *supra* note __.

during this prolonged gestation period, innovator firms will decline by anticipation to invest in the R&D that gets the process started.

To reflect this commercialization imperative, I consistently situate the innovation process within the supply chain that an innovator (or any entity that controls an innovation) must implement as it moves from generation of the intangible asset to its embodiment in products distributed to intermediate or end users, which in turn generates the revenue stream that supports by anticipation the initial R&D investment. The Figure below presents a generic supply chain comprising a number of functions and inputs—including intangible technological inputs, tangible production inputs, and (not shown in the Figure) capital inputs—required to deliver an innovation to market. As indicated on the left-hand side of the Figure, an innovator may elect to contract with third parties for some, all or no functions and inputs in the supply chain. This corresponds to what the "theory of the firm" literature calls the "make/buy" decision: that is, with respect to any task, a firm must elect to implement that task internally or purchase it externally.[24] Where the innovator does not elect to contract for any particular function or input ("buy"), it must integrate forward and implement that function or generate that input independently ("make"). To the extent that precontractual bargaining (or infracontractual interaction in the course of performance[25]) at any point on the supply chain necessitates disclosure of information that can then be used or transferred by the counterparty to the innovator's disadvantage, the disclosure paradox may block efficient outsourcing transactions. That in turn inflates commercialization costs and by anticipation discourages the initial R&D investment. The remainder of this Part is devoted to identifying the conditions under which that bargaining failure is likely to arise.

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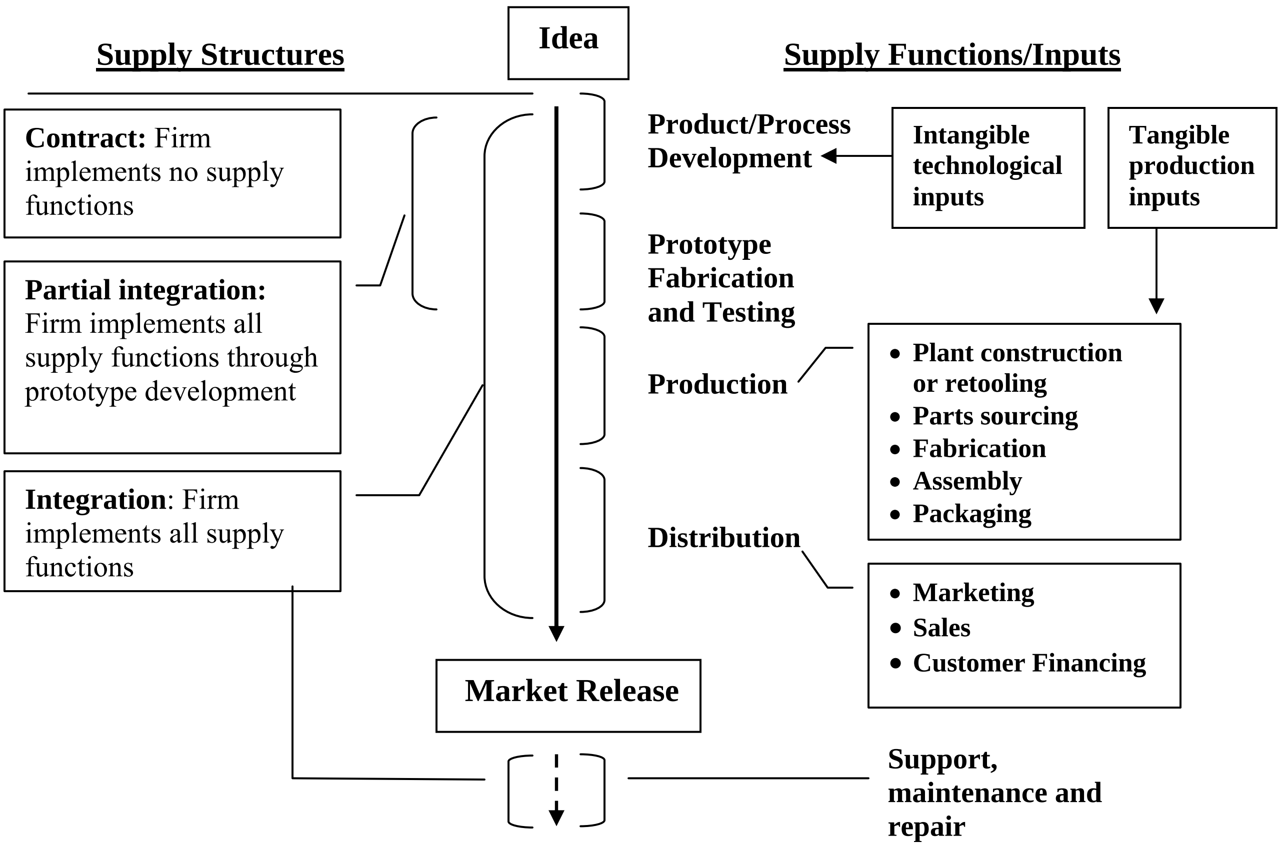
[24] For the classic sources, see Ronald H. Coase, *The Nature of the Firm*, 4 ECONOMICA N.S. 386-405 (1937), republished in THE NATURE OF THE FIRM: ORIGINS, EVOLUTION AND DEVELOPMENT (eds. Oliver E. Williamson & Sidney G. Winter) (1993); Oliver E. Williamson, *The Logic of Economic Organization*, in THE NATURE OF THE FIRM: ORIGINS, EVOLUTION AND DEVELOPMENT (eds. Oliver E. Williamson & Sidney G. Winter) (1993). In the transaction cost economics literature, the make/buy distinction is often referred to as the hierarchy/market distinction. I will refer to it as the integration/contract distinction, which is largely synonymous.

[25] Even if the innovator enters into a contract to outsource a commercialization function, it is still exposed to knowledge leakage during the course of performance of the contract, assuming an incompletely-specified contract that does not address all possible expropriation opportunities.

Figure I: Generic Supply Chain



B. Contractual Solutions

It is important to understand why contractual solutions cannot reliably overcome the disclosure paradox. Suppose the typical scenario where an inventor has formulated an idea and wishes to sell it to a large integrated firm. As Arrow observed, the idea seller will decline to bargain with the idea buyer given the buyer's rational unwillingness to purchase an idea without disclosure. Non-disclosure agreements ("NDAs") can not resolve this dilemma adequately. As practicing lawyers are widely aware, that is because NDAs typically protect against subsequent disclosure by the idea buyer to third parties but not *use* by the idea buyer.[26] No idea buyer will covenant against use since the idea

[26] Personal knowledge based on author's experience in drafting and negotiating NDAs in legal practice. Even if an NDA includes some prohibition on use, it is usually heavily diluted by multiple exemptions and qualifications demanded by the idea recipient. *See* Stuart J.H. Graham & Ted Sichelman,

buyer may already possess the idea, in which case it would be exposed to expropriation by the idea *seller*. Buy-side expropriation risk explains why NDAs often include language precluding the disclosing party from making any state-law trade secret or misappropriation claims against the recipient party[27], why venture capitalists and many large firms typically refuse to sign *any* form of NDA[28], and why, given exposure to state-law misappropriation claims, Hollywood studios generally refuse to receive unsolicited idea submissions.[29] Rational unwillingness by buyers and sellers to enter into idea transactions reflect an underlying drafting constraint: parties cannot write a contract that precludes precontractual expropriation by the idea buyer without simultaneously facilitating postcontractual expropriation by the idea seller.

Writing a contract contingent on post-disclosure appraisal of the idea (e.g., "Buyer agrees to pay Seller $X for Buyer's idea if it is good and not already within the Buyer's possession prior to disclosure of the idea") is not feasible because any adjudicative agent (or any other third-party expert) will have poor information to determine its value or novelty. Writing an "earnout" contract contingent on an objective metric (e.g., revenues from use of the idea) that reveals the value of the innovation over time is problematic if the application of any such metric is either inherently nonverifiable, or, as is endemically the case in exclusive dealing contracts, subject to moral hazard by the idea buyer to the extent that revealed valuation depends on investments by the idea

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Why Do Start-Ups Patent?, 23 BERK. TECH. L. J. 1063, 1082 (2008); Merges, *Transactional View, supra* note __, at 1498.

27 Personal knowledge based on author's experience in drafting and negotiating NDAs in legal practice. For similar observations, see Kitch, *supra* note __, at 278 n.35 (noting that large firms often require idea submitters to sign agreements limiting their rights to a small dollar sum and rights under patent law); Steven N. S. Cheung, *Property Rights in Trade Secrets,* 20 ECON. INQUIRY 40 (1982) (noting that "firms in the United States seldom consider an unpatented idea unless the outside inventor signs a waiver form before revealing the idea").

28 *See* THERESE H. MAYNARD & DANA WARREN, BUSINESS PLANNING: FINANCING THE START-UP BUSINESS AND VENTURE CAPITAL FINANCING 400 (2010). In an even more extreme version of this non-acceptance policy, Apple states that it will not accept unsolicited ideas and, in the event an idea is nonetheless submitted, provides that the idea submitter is understood to agree that all submitted ideas immediately become the property of Apple without any compensation owing to the idea submitter! "Apple's Unsolicited Idea Submission Policy", avail. at http://www.apple.com/legal/policies/ideas.html (last visited August 13, 2009).

29 Personal knowledge; confirmed in discussion with entertainment industry executive.

buyer.[30] It is possible to devise other contracts that might mitigate expropriation risk.[31] But these (mostly theoretical) fixes usually require some entrepreneurial wealth that must be put at stake in order to signal idea quality to outside financiers, who otherwise face a severe information asymmetry.[32] Trade secret protections (outside of the typical cases where these are customarily waived by the idea submitter), which effectively supply implied contractual terms for confidential communications, are even shakier. These protections can be easily lost if (among other things) a court determines that the recipient did not use the information[33] or that the disclosing party failed to undertake reasonably effective measures to maintain secrecy (or, in the words of one court, failed "to exercise eternal vigilance" in protecting its trade secret).[34]

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30 For the classic case that addresses this defect in earnout mechanisms, see *Bloor v. Falstaff Brewing Corp*., 601 F.2d 609 (2d Cir. 1979). The same difficulty afflicts financing contracts, except in that case the financier is exposed to moral hazard on the part of the idea seller, who has an incentive to distort or misrepresent revenue flows. *See* MARTIN RICKETTS, THE ECONOMICS OF BUSINESS ENTERPRISE 125 (3d ed. 2002)

31 A small economics literature is occupied with that task. In the most well-known contribution, Profs. Anton & Yao have proposed that the idea seller can protect against expropriation by the idea buyer, firm *A,* by threatening to provide its idea to rival firm *B*, who will then extract rents that would have been enjoyed by firm *A*. *See* James J. Anton & Dennis A. Yao, *Expropriation and Inventions: Appropriable Rents in the Absence of Property Rights,* 84 AMER. ECON. REV. 190 (1994). This argument relies on two assumptions. First, it must be the case that the idea seller can credibly commit to either firm *A* or *B* that it will not subsequently resell the information to other parties. Second, it must be the case that firms *A* and *B* can preserve duopoly rents on products embodying the disclosed technology; if that were not the case, the innovator would have no credible threat against *A,* who would anticipate that *B* would pay nothing for an innovation that (given *A*'s knowledge) could not deliver a supracompetitive return. I note that the latter contingency appears to be illustrated by the phenomenon in Hollywood where "shopped-around" scripts are rejected by multiple studios, who then develop related concepts, resulting in the release of multiple films with similar storylines, which in turn depresses revenues as expected. *See* Gans & Stern, *Market for Ideas, supra* note __, at 18-19. Note that even in cases where this "solution" applies, it is still limited to exclusive transfers of knowledge assets; by contrast, property-protected knowledge assets can be non-exclusively licensed to an unlimited class of interested parties.

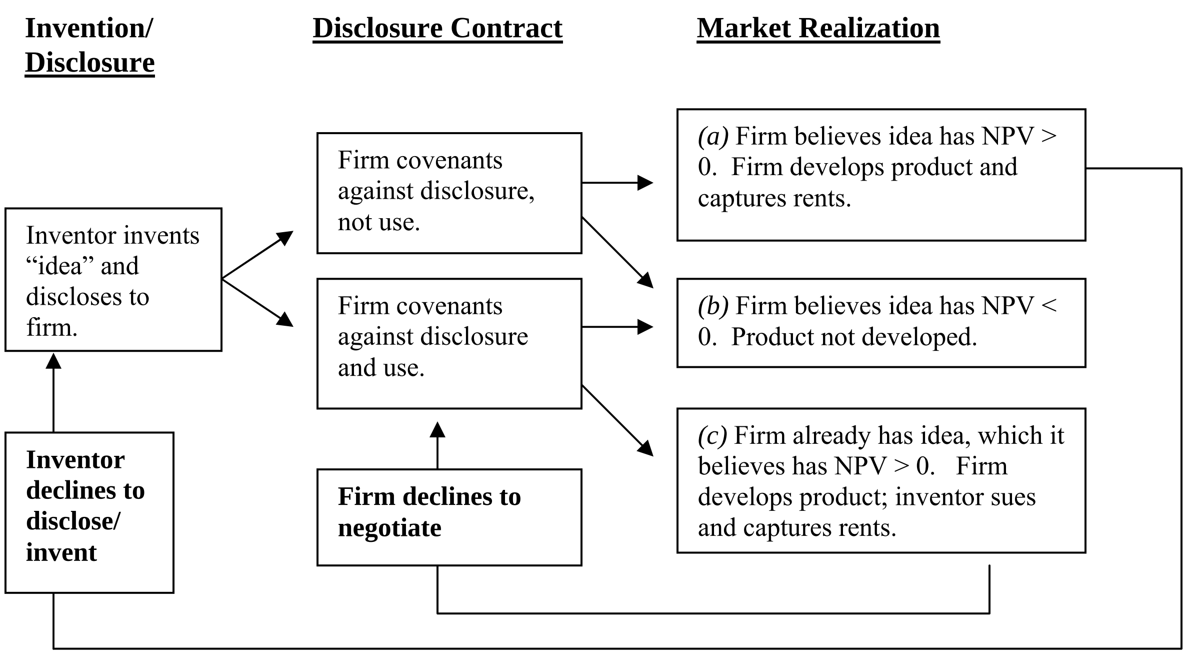
32 *See, e.g.,* James J. Anton & Dennis A. Yao, *The Sale of Ideas: Strategic Disclosure, Property Rights, and Contracting,* 69 REV. ECON. STUD. 513 (2002) (presenting model where idea seller can extract value from sale of idea through partial disclosure mechanism but noting that result is dependent on seller wealth, which can be used as a bond to signal the value of the to-be-disclosed portion of the idea).

33 *See* MELVIN F. JAGER, TRADE SECRETS LAW §4.2 (Vol. III).

34 *See* D.B. Riley, Inc. v. A.B. Engineering Corp., 977 F.Supp. 84, 91 (D. Mass. 1997), *citing* J.T. Healy & Son, Inc. v. James Murphy & Son, Inc., 260 N.E.2d 723, 730-31 (Mass. 1970). To appreciate the weakness of trade secret protection, consider the following recent case. Silicon Image, a semiconductor chip designer, regularly required its licensees to enter into "NDAs" and operate under various technological constraints to protect against unauthorized distribution and use of the licensed designs. A competitor allegedly misappropriated its designs. The court nonetheless denied a preliminary injunction on the ground that even Silicon Image's diligent precautions were potentially insufficient. *See* Silicon Image, Inc. v. Analogk Semiconductor, Inc., No. 07-cv-00635 JCS, 2008 WL 166950 (N.D. Cal., Jan. 17, 2008). For a

In short: both buy-side and sell-side opportunism, coupled with the absence of any reliable contractual or trade secret protections, frustrates or complicates any idea transaction. Moreover, this risk increases as the value of the idea increases. By anticipation, expropriation risk may deter the initial investment required to generate the idea. As shown in the Figure below, whether or not this two-sided expropriation threat yields a net social loss depends on the net present value of the suppressed idea. In both case *(a)* (which reflects buyer opportunism) and case *(c)* (which reflects seller opportunism), contracting failure yields a real social cost: new ideas with positive net present value are not realized. Case *(b)*, which anticipates no social loss as a result of inability to contract, is included for completeness.

Figure II: The Disclosure Paradox



C. Extra-Contractual Solutions

Absent some meaningful resolution, the disclosure paradox results in two adverse effects on idea markets (defined generally as markets in legally-unprotected technological know-how and other intangible resources). First, on the supply side, it discourages

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fuller discussion of cases that illustrate the uncertainty of trade secrecy protections in precontractual negotiation, see Merges, *Transactional View, supra* note __.

investment by prospective sellers in generating new ideas, given the difficulty of contracting with any buyer. Second, on the demand side, it discourages investment by prospective buyers in identifying new ideas, given the difficulty of contracting with any seller. These bargaining obstacles account for common observations that idea markets are illiquid, suffer from lack of pricing transparency, and are slow to develop.[35] But this unqualified picture is overstated: scholars have documented informal exchanges of professional know-how in settings where intellectual property is largely absent.[36] This confirms casual empiricism: practicing lawyers engage in "shop talk" over transactional solutions and, with specific waivers of any contractual or statutory protections (as noted above), unpatented business proposals are pitched to venture capitalists in Silicon Valley, and unprotected movie ideas are presented to production executives. It would be an exaggeration to contend that these informal markets operate with the liquidity and sophistication of a formal trading market in tangible goods. As I have shown elsewhere, unprotected idea exchange tends to emerge most robustly in specialized settings that demand low levels of capital investment, are populated by close-knit professional communities and/or provide some capacity to constrain access to the most valuable ideas or complementary assets.[37] But it would be unwarranted to dismiss these practices as insignificant anomalies. So it must be the case that some extralegal mechanism sometimes mitigates expropriation risk, thereby allowing positive but limited levels of idea exchange even without property rights.

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35 This point has long been recognized. *See* JEWKES ET AL., *supra* note __, at 256 (noting that the "market for new inventive ideas is imperfect" and subject to various deficiencies). For recent similar observations, see Mark A. Lemley & Nathan Myhrvold, *How to Make a Patent Market*, 102 HOFSTRA L. REV. (2009); Joshua S. Gans & Scott Stern, *Is There a Market for Ideas?*, J. ECON. LIT. (2009); Joshua S. Gans & Scott Stern, *The Product Market and the "Market for Ideas": Commercialization Strategies for Technology Entrepreneurs,* 32 RES. POL'Y 333 (2003) [henceforth Gans & Stern, *The Product Market*].

36 *See, e.g.,* Gerda Gemser & Nachoem Wijnberg, *Effects of Reputational Sanctions on the Competitive Imitation of Design Innovations,* 22 ORG. STUD. 563 (2001) (documenting exchange of technical and style information among designers in luxury European custom furniture industry); Eric von Hippel, *Cooperation between rivals: informal know-how trading,* RES. POLICY (1987) (documenting reciprocal exchange of know-how among engineers in the steel minimill industry). Elsewhere I discuss a large number of other examples. *See* Jonathan M. Barnett, *The Illusion of the Commons,* BERKELEY TECH. L. J. (forthcoming 2010) [henceforth Barnett, *Illusion of the Commons*].

37 *See* Barnett, *Illusion of the Commons*, *supra* note __.

1. *Informational Opacity*

The disclosure paradox presumes that the seller's idea is transparent upon disclosure, implying that the buyer's expropriation costs are nominal to zero. That is a highly contingent proposition in technologically sophisticated markets. Often the disclosed idea may be informationally opaque: that is, it cannot be fully implemented as an operational matter without further know-how being provided by the idea seller.[38] If that is the case, then the seller can at least partially protect against expropriation by tying a graduated disclosure schedule to a graduated payment schedule. That is: the seller makes incremental disclosures of know-how (which, in a typical arrangement, may include implementing the idea as an employee of the buyer) in exchange for incremental payments by the buyer. Note, however, that, even if we assume a contracting arrangement that can feasibly implement this objective, this solution is still incomplete: it resolves expropriation by the buyer at the cost of facilitating expropriation by the seller. Assuming the disclosed technology is difficult to implement without supplemental know-how, the seller will withhold the final know-how installment in order to expropriate value from the buyer. By anticipation, the proposed transaction must either fail or proceed at some discount to protect against sell-side opportunism. Hence, the disclosure paradox may substantially persist—but without entirely blocking idea exchanges—even in settings where technology is substantially opaque.

2. *Reputation Effects*

The disclosure paradox presumes that the idea buyer is a one-shot player who places no value on accumulating reputational capital that can be deployed to lower the cost of future idea acquisitions. Where that is not the case, reputation effects may enable idea buyers to credibly commit against expropriation so long as idea sellers believe that a repeat-player firm will seek to maintain a reputation for fair dealing in order to attract future idea submissions. Hence, a venture capitalist forfeits single-period gains from expropriation in order to maximize multi-period gains from the future flow of high-value

[38] This often seems to be the case. *See* David J. Teece, *Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-How*, 87 ECON. J. 242, 245-47 (1997) (studying 26 international technology transfer projects and finding that transfer costs vary widely ranging from 2% to 59% of total project costs, and averaging 19%).

idea submissions. But reputation effects can be overstated as a panacea for opportunistic behavior in the absence of contract. As a practical matter, a number of factors limit (but do not extinguish) the disciplining effect of reputational capital. These include: (i) reputation effects are ineffective against one-shot or first-time entrants into an idea market; (ii) "noise" in the reputation market can mute reputational penalties (in particular, sellers' expropriation claims may be perceived as non-credible "sour grapes"); (iii) agency costs may drive a buyer's agent to expropriate an idea submission even if doing so depletes the principal's reputational capital; and (iv) buyers may have access to a variety of discrete mechanisms by which to siphon value from sellers short of outright expropriation.[39] Most importantly, reputational penalties—which often fall short of the irreversible exit posited by game-theoretic models of indefinite repeat-play behavior—may be insufficient to restrain counterparties who expropriate an especially valuable idea in order to accrue extraordinary one-time gains. In short: reputation effects can mitigate, but can not eliminate, expropriation risk in idea transactions. Hence, the disclosure paradox may substantially persist—but without entirely blocking idea exchange—even where idea buyers would appear to have long-term incentives to decline short-term expropriation opportunities.

D. Organizational Solutions

The standard incentive thesis anticipates that intellectual property is a universal precondition for intellectual production. But that proposition is overstated to the extent that two assumptions are satisfied: (i) reverse-engineering costs and other imitation barriers limit expropriation risk in the goods market and (ii) reputation effects and informational opacity limit expropriation risk in the commercialization process.[40] Let's

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[39] Elsewhere I have discussed at length the infirmities of relying on reputation effects to discipline opportunistic behavior. *See* Jonathan M. Barnett, *Certification Drag: The Opinion Puzzle and Other Transactional Curiosities,* 33 J. CORP. L. 97, 100-06 (2007). For an optimistic view of the ability of reputation effects to facilitate bargaining over ideas, see Burk & McDonnell, *supra* note __, at 602. For a more nuanced view, see Gans & Stern, *The Product Market, supra* note __, at 344 (noting that some technology companies have acquired strong reputations for fairness in the acquisitions market but noting that even companies that make efforts to acquire such reputations are still sometimes accused of expropriation).

[40] The second sub-proposition is consistent with empirical evidence showing that the extent to which patent grants facilitate consummation of licensing transactions is strongest in environments where

suppose a market where the former but not the latter assumption is satisfied. That is: expropriation risk is largely absent in the goods market but persists in the commercialization process that precedes it. This is a high-risk contracting environment where disclosed ideas are transparent and recipients are immune to reputation effects. As a result, expropriation risk blocks arm's-length negotiation, innovators can not achieve commercialization and, by anticipation, decline to innovate. But even in this hostile setting, property rights are a possible but not *unique* remedy to bargaining failure and the associated underinnovation result. Strictly speaking, the disclosure paradox simply implies that one particular route by which an innovation can reach market—commercialization through contracting with third parties—will be frustrated without patents. However, that does not preclude the innovator from independently implementing the commercialization process and thereby avoiding disclosure to third parties.[41]

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reputation effects are weakest (or the technology lifecycle is long); and *vice versa. See* Joshua S. Gans, David H. Hsu & Scott Stern, *The Impact of Uncertain Intellectual Property Rights on the Market for Ideas: Evidence from Patent Grant Delays,* 54 MGMT. SCI. 982 (2008).

41 Arrow noted this possibility, stating that property rights in information may be held through patents *or* "in the intangible assets of the firm if the information is retained by the firm and used only to increase its profits". *See* Arrow, *supra* note __, at 617. Later commentators have made similar observations. *See* Bar-Gill & Parchomovsky, *supra* note __, at 1664 (noting that a "research group" can protect against expropriation by a "customer" through vertical integration); Richard Zeckhauser, *The challenge of contracting for technological information,* 93 PROC. NAT'L ACAD. SCI. USA 12743, 12744 note (e) (1996) (noting integration as alternative means by which to protect against knowledge leakage). It might be objected that integration is an imperfect defense against expropriation risk insofar as entrepreneurs are still exposed to expropriation by employees who can depart for rivals or set up competing operations. *See* Burk & McDonnell, *supra* note __. That is certainly an important contingency, although a firm can use a variety of means, including confidentiality agreements, reputation effects in the labor market, internal organizational practices, deferred compensation and equity-based incentive schemes, acculturation methods and threats of dismissal, by which to constrain employees from expropriating information. Critically, a firm can condition employment on entry by the prospective employee into an invention assignment contract whereby the firm obtains prospective ownership rights in the idea stock generated by the employee during his or her tenure at the firm. (Note that I do not mention either trade secrecy protections or non-compete agreements, both of which are difficult to enforce as a practical matter.) These instruments are not perfect but, in the aggregate, would seem to offer a more potent set of tools by which to control expropriation risk relative to arm's-length interactions with unrelated third parties. For similar views, see OLIVER E. WILLIAMSON, MARKETS AND HIERARCHIES: ANALYSIS AND ANTITRUST IMPLICATIONS 10 (1975); Julia Porter Liebsekind, *Knowledge, Strategy and the Theory of the Firm,* 17 STRATEGIC MGMT. J. (1996); Michael H. Riordan & Oliver E. Williamson, *Asset Specificity and Economic Organization,* 3 INT'L J. IND. ORG. 365 (1985); *see also* Arora & Merges, *supra* note __, at 452 (noting that "greater control over disclosure of internal information is a well-recognized feature of the employment relationship, as compared with independent contractor status"). Moreover, employees may have reduced incentives to expropriate an employer's intangible assets if they anticipate facing the same "external" expropriation risk in seeking to commercialize those assets independently or alternatively, anticipate competing with their employer (in which case no supracompetitive rents would be available). At a bare

If we take into account this organizational remedy, then we can appreciate more precisely the implications of the disclosure paradox for the scope of application of the incentive thesis. Properly understood, the disclosure paradox does not describe how expropriation risk distorts innovation behavior. Rather, it describes how expropriation risk distorts organizational behavior, which in turn may have effects over innovation behavior. This change of perspective modifies the set of circumstances over which the incentive thesis applies, eroding it further in some cases but strengthening it in other cases.

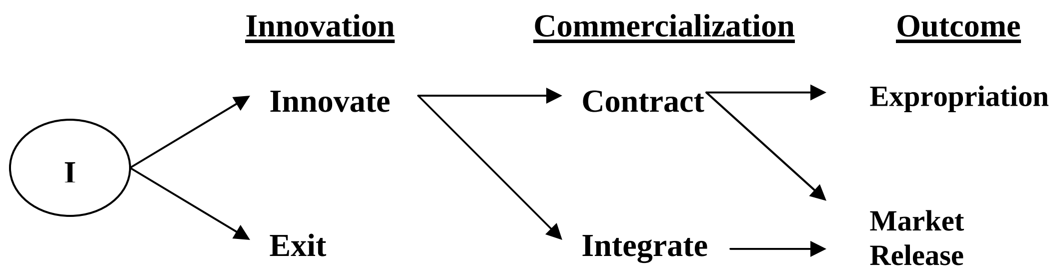
1. Organizational Selection

Conventionally legal and economic analysis focuses on the connection between patent protection and an innovator's decision whether or not to invest in R&D. Realism, however, demands that the innovator's decision process take into account the full sequence of R&D *and* commercialization activities that will be required to reach market and realize any positive payoff. To capture both stages, we can construe the innovator's decision process as follows. The innovator selects the organizational form by which to deliver an innovation to market, which implies a certain commercialization cost, which, when added to the initial R&D cost and set off against expected revenues, determines whether it elects to make the innovation investment. The Figure below depicts this sequence, where the innovator (denoted by "I") can elect among two organizational options, *Contract* or *Integrate,* which, by anticipation, determines its choice among two investment options, *Innovate* or *Exit.* By *Integrate*, I mean that an innovator implements a given set of supply chain functions independently; by *Contract,* I mean that an innovator initiates arm's-length bargaining with a third party to implement those supply chain functions, which necessitates disclosure of the idea. *Integrate* imposes zero expropriation risk and yields positive revenues at market release. *Contract* imposes a certain positive level of expropriation risk: if negotiations do not yield a binding contract, the counterparty can commercialize the disclosed information and, by assumption, the

minimum, so long as firms can control internal expropriation risk at some lower cost relative to controlling external expropriation risk, then, relative to contract-based outsourcing, integration offers a preferred mechanism by which to accrue innovation returns in the absence of patent protection.

innovator accrues zero revenues at market release.[42] The innovator therefore faces a choice set consisting of three action pairs: [*Innovate/Contract; Innovate/Integrate;* or *Exit*].

Figure III: The Innovator's Decision Sequence



Let's assume that the innovator seeks to maximize expected profits, which is constituted by expected revenues upon market release (discounted by the probability of third-party expropriation), less commercialization costs and less R&D costs.[43] Absent expropriation risk, the innovator will always elect the lowest-cost organizational form by which to deliver the innovation to market. Assuming a competitive market of external suppliers of supply chain functions and inputs, an innovator's outsourcing costs (equivalent to the commercialization payment it must make to a third party provider) must approximately equal the costs that would be incurred by the provider to supply the given supply chain function or input. That is: any provider is a "price taker" and therefore can not demand more than the cost of its commercialization services plus a

[42] In greater detail, if an innovator elects *Contract,* two outcomes are possible: (i) the innovator enters into a binding contract with the third party, in which case I assume the product will be commercialized and the innovator will receive positive revenues at market release; or (ii) the innovator fails to enter into a binding contract with the third party, in which case I assume that full disclosure has been made, the counterparty commercializes the idea and the innovator accrues none of the revenues earned at market release, leaving it with a net loss equal to its R&D costs. The latter outcome assumes that the innovator can not independently commercialize the idea (or, more plausibly but equivalently, can not independently commercialize the idea at the same or lower cost as the counterparty).

[43] Formally: the innovator seeks to maximize $R_{(1\text{-}w)} - K_c - K_r,$ where: R denotes revenues earned on market release; w (where $0 \leq w \leq 1$) denotes expropriation risk; K_c denotes commercialization costs; and K_r denotes R&D costs. Note that $w = 0$ under two scenarios: (i) *Contract* under patent protection (which I assume for simplicity can be enforced at zero cost), and (ii) *Integrate* irrespective of patent protection. As the strength of patent protection declines, w increases in value, approaching unity (in which case expropriation is certain); as the strength of patent protection increases, w declines in value, approaching zero (in which case expropriation risk disappears).

competitive return.[44] Hence, in making its organizational election, an innovator assesses the positive difference between its "own-commercialization" costs and the commercialization costs of the least-cost external provider. Any observed supply chain configuration (which is constituted by the innovator's *Contract/Integrate* elections at each point of the supply chain) therefore reflects the comparative cost advantages of external and internal providers of the supply chain functions and inputs required to deliver an innovation to market. If own-commercialization costs exceed the commercialization costs of the least-cost external provider, then the innovator will elect *Contract*; if the values are reversed, it will elect *Integrate.* Both actions are contingent on the assumption that at least *Innovate/Contract* or *Innovate/Integrate* yields anticipated net positive returns after subtracting R&D and commercialization costs from expected revenues. Where that assumption is not satisfied, there is no feasible commercialization option and the innovator by anticipation elects the remaining option of *Exit* and declines to innovate.

2. Organizational Distortion

The innovator's ability to select organizational forms so as to minimize commercialization costs rests on a critical predicate: namely, there is no expropriation risk in transferring information to outside providers of supply chain functions or inputs. That predicate is not satisfied in the high-risk contracting environment where the disclosure paradox is most severe: suppliers pose a competitive threat through the use or transfer of disclosed information and no combination of reputation effects and/or informational opacity sufficiently protects against that threat. In that environment, withdrawing patent protection has a dramatic effect on an innovator's organizational choice set: the *Contract* option is precluded and the innovator's options reduce to

[44] Assuming a competitive market for third-party supply inputs (one innovator with a unique technological input, multiple suppliers with homogenous production or capital inputs) distinguishes this construction from other contributions that construe the "integrate/contract" choice faced by an innovator firm following the "property rights" approach to firm boundaries, which assumes a bilateral negotiation between the firm (often called the "research unit"), which has generated an idea, and the counterparty (often called the "customer"), which wishes potentially to acquire the idea and commercialize it. In that construction the parties must agree on some division of the joint surplus generated through each party's nonsalvageable investments in the relationship. *See, e.g.,* Arora & Merges, *supra* note __; and Bar-Gill & Parchomovsky, *supra* note __, who extend a model developed by Philippe Aghion & Jean Tirole, *The Management of Innovation,* 109 Q. J. ECON. 1185 (1994).

[*Innovate/Integrate; Exit*]. This distortion is critical: there is no longer any assurance that observed supply chain configurations reflect the comparative cost advantages of external and internal providers of the supply chain functions and inputs required to deliver an innovation to market. Contrary to the standard formulation of the incentive thesis, however, this does not necessarily mean that innovative output ceases or even declines in the absence of patent protection. That is because innovators may protect against expropriation risk by adopting integrated structures that minimize interaction with third parties prior to market release. In short: withdrawing patent protection induces substitution toward increased integration.

These substitution effects might be viewed as grounds for rejecting the incentive thesis. Even in high-risk contracting environments, firms still close shortfalls in patent coverage and achieve commercialization by migrating to non-patent alternatives. But that would be a hasty conclusion. Even if innovators can close shortfalls in patent coverage through non-patent substitutes on a cost-feasible basis, they will still be worse off whenever they must incur incremental costs in electing *Integrate* over *Contract*. Those incremental costs will depend on whether the innovator or the market is the least-cost provider with respect to any given supply chain function or input. If the market is the least-cost provider at even a *single* point on the supply chain, then incomplete patent coverage prevents the innovator from reaching market at the lowest possible costs. Inflated commercialization costs constitute a private loss that translates into at least one and potentially two social losses: (i) with certainty, it is productively inefficient to the extent it depletes net social returns by overallocating resources to deliver an innovation to market; (ii) depending on supply elasticity, it is "innovatively" inefficient to the extent the firm reduces its R&D expenditures in anticipation of reduced profits; and (iii) depending on demand elasticity, it is allocatively inefficient to the extent that inflated commercialization costs are reflected in higher prices or reduced output for intermediate users or end users.[45] Where it is not the first-best organizational option, the integration

[45] On these three types of economic efficiency, see F.M. Scherer, *Antitrust, Efficiency and Progress,* 62 N.Y.U. L. REV. 998, 1012 (1987); Joseph F. Brodley, *Consumer Welfare and Technological Progress,* 62 N.Y.U. L. REV. 1020, 1025-27 (1987). Note the surprising implication of the third efficiency loss: the *absence* of patent protection imposes deadweight losses by preventing efficient transactions that would have taken place under a lower-cost commercialization path.

"solution" to controlling expropriation risk becomes an integration "problem": it distorts R&D investment in the upstream market, commercialization expenditures in the intermediate market and product output in the downstream market.

3. The Incentive Thesis Revisited

The conventional formulation of the incentive thesis is discontinuous: with patent protection, innovation proceeds; without it, innovation halts. Taking into account organizational substitutes for patent protection yields a more nuanced proposition. *Reductions in patent coverage yield a continuous range of disincentive effects that differ across innovators and markets as a function of any innovator's own-commercialization costs relative to the commercialization costs of the market's least-cost combination of external providers.* To illustrate this proposition in a stylized setting, I envision three innovator types that operate under various levels of patent protection and experience different organizational and innovation effects given the existing level of expropriation risk, which is the *same* across innovators, and incremental "integration" (that is, own-commercialization) costs, which *differ* across innovators. The set of innovator types and the proposed level of marginal integration costs corresponding to each type are shown below. Marginal integration costs are assumed to be a function of the innovator's existing level of supply chain integration: i.e., where an innovator already has an established integrated supply chain, its marginal integration costs are low; where it does not, those costs are high. The Table and subsequent discussion set forth a simple relationship: as marginal integration costs increase, reductions in patent coverage exert stronger disincentive effects; as those costs fall, reductions in patent coverage exert weaker or even no disincentive effects.

Table I: Disincentive Effects as a Function of Integration Costs

Type	Existing Integration Level	Integration Costs	Disincentive Effect
Large Firm A	Complete	Low	Zero
Large Firm B	Limited	Moderate	Partial
Small Firm	None	High	Complete

Large Firm A (Zero Disincentive Effect): *Integrate* is not costly; *Contract* is more costly. Suppose a large integrated firm that has lower commercialization costs than any combination of external providers. For example, it may have in place a worldwide production, marketing and distribution infrastructure. The firm will therefore always elect *Integrate* as its first-best organizational form irrespective of available patent coverage and resulting level of expropriation risk. Patents make no difference: the firm's organizational choices and innovation incentives are constant.

Large Firm B (Partial Disincentive Effect): *Integrate* is moderately costly; *Contract* is less costly. Suppose another large firm that has higher commercialization costs than any combination of external providers with respect to some portion of the supply chain. For example, it may have strong R&D capacities but a limited production and distribution infrastructure that could be extended at some significant cost to produce and distribute the relevant innovation. It will therefore elect *Contract* as its first-best organizational option. However, as patent protection declines and expropriation risk rises, the *Contract* option ceases to be feasible and the firm must elect *Integrate* as its second-best organizational option. Relaxing patent protection yields a *partial* disincentive effect: *Integrate* is a cost-feasible but not cost-minimizing organizational option relative to *Contract*. That inflates the firm's commercialization costs and reduces, but does not extinguish, its innovation incentives.

Small Firm (Complete Disincentive Effect): *Integrate* is extremely costly; *Contract* is much less costly. Suppose a start-up that has exceptionally higher commercialization costs relative to any combination of external providers. For example, it may have no production or distribution infrastructure and would incur exorbitant costs to implement commercialization independently. Or its innovation may constitute an improved component or addition to a larger and more complex good (e.g., an intermittent windshield wiper for an automobile) that it has no capacity to produce, distribute or support independently. That means its organizational choices are always restricted to *Contract*. As patent protection declines and expropriation risk rises, there is no longer any feasible organizational option. By anticipation, the innovator must elect *Exit*.

To summarize: reductions in patent protection yield a range of entity-specific organizational effects, which in turn translate into a corresponding range of entity-specific innovation effects. Maintaining the standing assumption that expropriation risk is sufficiently controlled in the goods market, these organizational and innovation effects reduce to a function of the difference between own-commercialization and market commercialization costs over the required set of supply chain functions and inputs. Innovation effects follow from organizational effects. When patent protection "makes a difference" in a firm's organizational behavior, it "makes a difference" in a firm's innovation behavior. Otherwise it "makes no difference". For highly-integrated entities (and any other entity that has equal or lower commercialization costs relative to the market), the disclosure paradox and the resulting obstacles to interfirm contracting are immaterial. Even in the highest-risk contracting environment, it will elect *Integrate* as its first-best commercialization option. For more weakly-integrated entities (and any other entity that has higher commercialization costs relative to the market), the disclosure paradox and the resulting obstacles to interfirm contracting can matter to a substantial extent and sometimes to a catastrophic extent. In the highest-risk contracting environments, an innovator must elect *Integrate* as a second-best option or, in the case of the most weakly-integrated entities with exorbitant commercialization costs, it must elect *Exit.*

II. Innovation as Organization

The discussion so far can be reduced to a single proposition. *Without intellectual property, the expropriation risk inherent to contracting over ideas (which varies as a function of reputation effects and informational opacity) can distort innovators' organizational choices (which vary as a function of relative commercialization costs), which in turn exerts disincentive effects of varying magnitudes on innovation activity.* Following this revised formulation of the incentive thesis, patents exert three efficiency gains—each corresponding to an organizational effect—over a broad set of innovation types that includes both the "easy" case of the specialized R&D supplier (where the incentive thesis clearly applies) and the "harder" case of more highly-integrated entities (where the incentive thesis otherwise does not clearly apply). First, the contracting environment secured by patents enables innovators—both weakly *and* strongly integrated entities—to adjust firm scope without reference to expropriation risk. That allows innovators to extract specialization gains by transacting with lower-cost suppliers of any required commercialization input, and conversely, allows suppliers to extract specialization gains by transacting with lower-cost innovators of R&D inputs. Second, firms' ability to narrow firm scope to any portion of the supply chain lowers entry costs by reducing, perhaps dramatically, the minimum size of the market into which any innovator (and more generally, any supplier of any other technological or production input) must attempt entry. Third, the resulting pool of disembodied technology and other supply-chain inputs induces entry by intermediaries that provide transactional technologies to reduce the costs of trading and evaluating those inputs. This virtuous triplet of firm-level and market-level organizational effects translate into innovation effects through the same mechanism. Interfirm bargaining over intellectual resources—which would be precluded without property rights in high-risk contracting environments—yields efficient adjustments to supply chain configurations, which minimize innovation and commercialization costs, which in turn facilitate secondary markets in stand-alone intellectual resources. Together these organizational effects promote R&D investment consistent with the standard rationale and positive effects on market turnover and growth that go beyond it.

A. Organizing Firms

So far I have proposed a loosely inverse correlation between patent strength and firm scope. Everything else being equal, weaker patents tend to induce integration in order to protect against expropriation risk and stronger patents enable innovators to extract specialization gains by transacting with outside providers. But these organizational effects are a matter of indifference from a social point of view unless they translate into adverse effects over innovation behavior. This will necessarily occur in every case where weak or zero patent coverage compels an innovator to incur commercialization costs that it would not otherwise bear under lower levels of expropriation risk. Inflated commercialization costs impose a subtle but potentially profound social cost that can distort the entire supply chain running from idea to market.

To appreciate this point requires application of the basic principle of division of labor. As originally set forth in Adam Smith's famous "pin factory" argument[46], the division of labor within a single enterprise promotes efficiency gains through individual-level specialization of tasks. This claim can be re-construed in terms of innovation incentives. Specialization induces productivity gains by encouraging workers to invest in task-specific process innovation.[47] As modern commentators subsequently observed, this same logic anticipates efficiency gains through specialization of tasks across firms within a single industry or across firms within multiple industries.[48] Firm-level division of labor yields specialization gains by facilitating disaggregation of the supply chain among the least-cost combination of internal and external suppliers. But there is a crucial obstacle to achieving those specialization gains. To the extent that firm-level specialization necessitates precontractual negotiation (and/or infracontractual interaction in the course of performance), it is inherently constrained in any setting where contractual and reputational technologies cannot sufficiently control expropriation risk. An innovator will be reticent to disclose information to suppliers, who may exploit that information to integrate forward or share it with the innovator's competitors, while a supplier will be reticent to disclose information to innovators, who may exploit that information to integrate backward or share it with the supplier's competitors.[49]

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[46] *See* ADAM SMITH, THE WEALTH OF NATIONS (Book 1, Ch. 1), esp. p.8 (1776).

[47] Smith was aware of the connection between specialization and invention incentives. *See id.*, at 13 (noting that concentration of effort on a single task encourages workers "to discover easier and readier methods" of completing the task). Elsewhere, Smith explicitly extends the concept of division of labor to "philosophers, or men of speculation" (that is, inventors). *See, id.,* at 8.

[48] *See* George Stigler, *The division of labor is limited by the extent of the market,* 59 J. POL. ECON. 185 (1951). Stigler's thesis builds upon ideas set forth in Allyn Young, *Increasing returns and economic progress,* 38 ECON. J. 527 (1928). Smith himself made similar suggestions, *see id.*, at 9-10 (noting specialization advantages across trades, regions and countries). For other discussion of the division of labor across technology industries, see ARORA ET AL., at §1.2.3; Ashish Arora & Alfonso Gambardella, *The Changing Technology of Technological Change: General and Abstract Knowledge and the Division of Innovative Labor,* 23 RES. POL'Y 523 (1994).

[49] It is important to appreciate that supply chain configurations can sometimes easily shift: suppliers of downstream production functions can backward integrate into upstream innovation functions, while suppliers of upstream technological inputs can forward integrate into production functions. As an illustration, consider that Apple has just undertaken this backward integration strategy with respect to the iPad device, for which it developed a customized semiconductor chip. *See* Ashlee Vance & Brad Stone, *A Little Chip Designed by Apple Itself,* N.Y. TIMES, Feb. 2, 2010. For further discussion, see *infra* note __ and accompanying text.

This contracting obstacle yields a fundamental social cost of weak patent coverage: it suppresses specialization gains that could be accrued through transactions between least-cost providers of technology and production inputs required to bring an innovation to market. In the "easy case" of the technology start-up, these specialization losses have a catastrophic effect: commercialization is blocked and both private and social payoffs fall to zero.[50] But even in the "harder case" where a firm can protect against expropriation risk by using integrated structures to reach market (at which point, by our standing assumption, time advantages or some other barrier delay imitative entry), this cost persists to some extent at every point on the supply chain where integration would not otherwise be the least-cost commercialization option. This characterization substantially expands the set of circumstances where incomplete patent coverage is likely to result in adverse but non-catastrophic—that is, partial disincentive—effects over innovation behavior. That in turn narrows considerably the remaining case of the large incumbent that always prefers integration, and therefore suffers zero disincentive effects, if patent protection is reduced or withdrawn. Even the largest firms suffer a loss whenever expropriation risk precludes contracting opportunities with lower-cost suppliers of technology, production or other inputs required to generate an innovation or deliver it to market. By positive implication, it follows that patent protection confers gains over a broad if not complete range of innovator types whenever it enables contractual relationships that result in specialization gains that would otherwise be forfeited under higher levels of expropriation risk. The special case of the weakly-integrated firm—to which the incentive thesis clearly applies—turns out to be a general case.

Specialization economies arising from patent-enabled transactions most immediately translate into social gains by reducing the total costs incurred to generate and commercialize a given stream of innovative output. That is an uncontroversial

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[50] That may explain why, in the most extensive survey to date, small firms in selected industries rank patents as among the most important appropriability devices. *See* Stuart Graham et al., *High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey*, BERKELEY TECH. L. J., Fig. 1 (2010). Specifically, the authors report that biotechnology firms rank patents as the most important appropriability device and medical device firms and venture-backed IT hardware firms rank patents as the second most important device after first-mover advantage. More generally, the authors find that patenting among start-ups and other small entities in these industries is "widespread but not ubiquitous", although it is more common among venture-backed start-ups and in the biotechnology and medical device industries and much less common among non-venture-backed start-ups and in the software industry.

increase in social wealth that frees up scarce resources for alternative uses. But, more importantly, specialization economies translate into a *compounding* stream of social gains that promote innovative entry by promoting market expansion. This follows from the basic principle (again, derived from Smith) that "the division of labor is limited by the extent of the market".[51] This can be illustrated in the simplest manner as follows. Suppose a market where there are economies of scale in production: that is, average cost declines as output increases. Any innovator that integrates forward into production in order to protect against expropriation risk is likely to forfeit specialization gains that could have been obtained by contract with outside suppliers. That is because any specialized provider of that production function can spread its fixed costs over the unit volume of the entire pool of technology inputs, whereas the individual innovator can only spread those costs over its own unit volume.[52] These specialization economies[53] promote a future stream of innovative output by positive feedback effects. As downstream specialization lowers production costs, prices for finished goods in the target user market fall, which in turn pushes up demand, which in turn induces further upstream entry by innovators to generate technological inputs to be embodied in consumption goods for the target market.[54]

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51 For the classic exposition, see Stigler, *supra* note __.

52 It can be objected that the specialization gains arising from economies of scale could be accrued within an integrated organization that sells its excess output to third parties, which would similarly internalize the economies of scale and/or scope by providing inputs to multiple firms. This objection is less than fully compelling, however, because the single firm would face a credible commitment problem with respect to any outside buyers that operate in the same market, who would fear that the firm-supplier would cut off production in order to serve the firm's larger competitive objectives. For similar reasoning, see WILLIAMSON, *supra* note __, at 18-19. This explains why the U.S. military sometimes requires that suppliers "second-source" production in order to protect the government buyer against expropriation by the private-sector supplier. On the "sell side", this explains why large firms sometimes spin off profitable specialized divisions, which can then credibly disclaim any expropriative intent to prospective buyers.

53 For sake of brevity, I have omitted a number of other types of vertical specialization gains, including: (i) economies of scope, where a specialized provider realizes cost savings by spreading the fixed costs of a technology, production or distribution input over a set of related but different products, and (ii) *dis*economies of scale: that is, costs decline as output declines (for example, R&D productivity may increase in smaller organizations). For further discussion of the latter possibility, see *infra* notes ___.

54 That same feedback effect can result in greater product variety as the costs of specialized inputs can be spread over a greater and increasing number of units. That is: a specialized upstream firm may produce niche components in higher volumes because it services the entire market, whereas no individual producer would find it profitable to do so for its own purposes. *See* Paul Romer, *Growth based on increasing returns due to specialization*, 77 AMER. ECON. REV. 56 (1987). For a nontechnical discussion,

Critically, this process of cost minimization, output expansion and increased entry can not get started—or, strictly speaking, can not get started in high-risk contracting environments—without a property-rights infrastructure by which to induce investment by innovators at the top of the supply chain and suppliers at all downstream points on the supply chain. Without patents, we therefore can not observe the counterfactual world that would potentially elicit entry by firms at any number of points on the supply chain to deliver discrete R&D, production or other supply chain functions at some cost lower than that which is currently being incurred by integrated firms. This proposition has a subtle but crucial implication for innovation policy. Weak or no patents can have adverse effects on innovation even if it appears that the relevant market "adequately" supports innovation by recourse to integration. Partial disincentive effects may therefore constitute a hidden (and perhaps, the most widely distributed) cost of weak or zero patents: concentrated markets consisting of large firms that perform substantial R&D but operate at excessive levels of integration in order to eliminate expropriation risk. While integration may enable those firms to accrue returns sufficient to cover even substantial R&D costs, they may still be forfeiting specialization gains that could be accrued under contract-based organizational forms that would be feasible under lower levels of expropriation risk.[55] And the most weakly-integrated firms that would have existed under stronger forms of patent protection can not be observed at all.

This is a generalized form of survivorship bias that can profoundly distort policy conclusions. Without patents, we observe only the organizational structures that can support an integrated innovation and commercialization process and only the firms that

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see RICHARD N. LANGLOIS & PAUL L. ROBERTSON, FIRMS, MARKETS AND ECONOMIC CHANGE: A DYNAMIC THEORY OF BUSINESS INSTITUTIONS 71-72 (1995).

55 This is not to say that all large firms are worse off under "excessive" levels of integration. But the reason why large firms may (sometimes) prefer excessive integration is socially immaterial. An incumbent may prefer weak patent protection that increases entry barriers for specialist providers that threaten the incumbent's primary market, even if this increases the incumbent's costs. This is equivalent to adoption of a bundling strategy—innovation functions are bundled with all other functions in the supply chain—by a generalist firm for the purpose of deterring entry by specialist innovators who can not bear the costs of that strategy. *See* Jay Pil Choi & Christodoulos Stefanadis, *Bundling, Entry Deterrence, and Specialist Innovators,* 79 J. BUSINESS 2575 (2006). That in turn applies a more general predation rationale: an incumbent will rationally adopt strategies that inflate its costs if doing so makes entry more difficult by raising rivals' costs, thereby reducing short-term profits (in this case, by forfeiting specialization gains through relationships with outside suppliers) but maximizing long-term profits by extending the incumbent's tenure.

can fund those structures. Even in markets where integrated firms appear to support substantial innovation (that is, there is no complete disincentive effect), we still can not exclude the possibility that efficient investments in innovation—and entire classes of innovator entities—are being lost along with the precluded portion of the organizational choice set (that is, there is still a partial disincentive effect). In short: underprotection sometimes yields overintegration, which yields underinnovation.

B. Organizing Markets

Patents yield organizational effects over firm scope by lowering the costs of contracting over intellectual resources, which yields innovation effects by allocating supply chain functions among the cost-minimizing combination of internal and external providers. These firm-level organizational and innovation effects in turn provide the basis for drawing a link at a higher level of generality between patent strength and market structure, which in turn anticipates innovation effects from the market-level organizational effects of patent protection. This proposition can be stated as follows. *Absent reputational or contractual technologies by which to discipline precontractual expropriation, patent protection sometimes decreases the cost of entering markets for firms that have relatively higher commercialization costs*; *the absence of patent protection sometimes increases the cost of entering markets for that same class of firms.*

This claim follows directly from the firm-level organizational effects of patent coverage. By expanding the organizational choice set, patents enable an innovator to use contractual instruments in order to enter the market at just those points on the supply chain at which it enjoys a comparative cost advantage. Without patents, the contracting option is foreclosed and, in the most extreme case where expropriation risk is endemic, the innovator must enter the market at every point on the supply chain, even where it bears an exorbitant cost disadvantage. Contrary to natural intuitions, a market with stronger patents will sometimes induce greater entry (and therefore pose a greater threat to incumbents) than a market with weaker or no patents by reducing the minimum size of the market into which entry can be feasibly attempted. Conversely, a market with weak or no patents will sometimes discourage entry (and therefore shelter incumbents) by inflating the size of the market—potentially dramatically—into which entry can be feasibly attempted.[56]

These relationships run counter to the common argument that intellectual property—in particular, the increase in patent strength by U.S. courts and patent issuance by the Patent & Trademark Office over the past few decades—ties up innovation within the transaction-cost web of contractual negotiation and dispute resolution, thereby discouraging innovation; by implication, markets from which intellectual property is removed would unleash a free flow of knowledge, thereby encouraging innovation.[57] But this view implicitly assumes that firms have no means other than patents by which to restrain unauthorized imitation. Paradoxically, taking into account those alternative means *strengthens* the incentive case for the patent system. If firms will respond to

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[56] It is worthwhile to address an obvious objection. It may be argued that raising the minimum cost of entry makes no difference in regulating entry barriers given that outside capital markets will fund any positive net present-value project. That is: commercialization costs are not a barrier to entry assuming perfectly efficient capital markets. For arguments to this effect, see Robert H. Bork, *Vertical Integration and Competitive Processes,* in PUBLIC POLICY TOWARD MERGERS 139-49 (eds. J. Fred Weston & Sam Peltzman 1969). That is no longer the case, however, once we reasonably drop the assumption of perfectly efficient capital markets. There are (at least) three uncontroversial reasons to believe external capital markets for R&D are substantially imperfect. First, discussions with potential investors and lenders that necessitate disclosure of technological information restore expropriation risk to some extent. This may be mitigated to the extent that a financing entity lacks operational expertise or legal capacity to commercialize the underlying innovation or is subject to reputational pressures that discourage expropriation. Second, in the absence of a secure property right, all lending is unsecured, which substantially inflates the cost of capital. Third, this argument requires perfect information on the part of lenders and complete contracts on the part of lenders and borrowers. Otherwise adverse selection will require that lenders or investors discount all claims by entrepreneurs as to technological quality so as to reflect uncertainty over the entrepreneur's claims. As it turns out, start-ups appear to use *patents* to alleviate this problem by signaling underlying value to venture-capitalist investors. For further discussion, see JACK HIRSHLEIFER, INVESTMENT, INTEREST AND CAPITAL 200-01 (1970); Oliver E. Williamson, *The Vertical Integration of Production: Market Failure Considerations,* 6 AMER. ECON. REV. 112 (1971), *reprinted in* FIRMS, MARKETS AND HIERARCHIES: A TRANSACTION COST ECONOMICS PERSPECTIVE Ch. 2 (1999) (eds. David Teece & Oliver E. Williamson); Comanor, *supra* note __, at 260. For empirical evidence on the signaling value of patents to start-ups, see Graham et al., *supra* note __. Even more importantly, perhaps, even if internal and external capital costs *were* equivalent, it seems quite clear that newcomers in a large number of industries would have difficulty replicating the accumulated knowledge capital required to implement large-scale production and distribution enterprises. This is cited as the key barrier to entry in historical studies of oligopolistic industries. *See* Alfred D. Chandler and Takashi Hikino, *The large industrial enterprise and the dynamics of modern economic growth,* in BIG BUSINESS AND THE WEALTH OF NATIONS 24-57 (eds. Alfred D. Chandler et al. 1997).

[57] For the leading expression of the anticommons thesis, see Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets,* 111 HARV. L. REV. 621 (1998), which stated that excessively fragmented property rights can generate net social losses by impeding, rather than facilitating, innovation (or, in a broader real property context, other) investments; Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCIENCE 698 (1998), which advanced the same thesis with respect to gene patents.

reductions in patent coverage by migrating to integrated organizational forms, there is no longer any certainty that weakening patents expands access or improves incentives. Even the contrary outcome can result: that is, weak patents can make it *harder* to enter a market. The rationale is straightforward but overlooked. Weak patents restore expropriation risk and therefore induce firms to adopt consolidated structures that can control that risk. That in turn raises entry costs, which cultivates concentrated markets consisting of highly-integrated entities that can independently fund and implement the commercialization process.[58] Conversely, strong patents mitigate expropriation risk and therefore enable firms to negotiate contractual relationships in order to capture specialization gains. That lowers entry costs, which cultivates substantially disintegrated markets consisting of weakly-integrated providers of technology and production inputs.

This is not to say that strong patents necessarily trigger vertical disintegration; rather, strong patents are one of a set of legal and non-legal conditions that must be satisfied in order to enable firms to accrue specialization gains through disintegrated structures. Where these non-legal conditions are satisfied, patents act as the catalyst that sets off a two-step sequence of increasing vertical disintegration: (i) patents facilitate entry by specialized suppliers of research functions located in upstream portions of the supply chain, which in turn (ii) facilitates entry by specialized suppliers of production functions located in downstream portions of the supply chain. To illustrate a possible scenario where this disintegration sequence may be realized, I will suppose a market characterized by the non-legal characteristics set forth below.

(a) *Downstream Economies of Scale.* Downstream production and distribution functions are the most capital-intensive activities, require a physical and administrative infrastructure that demands considerable time and resources to establish and maintain, and are characterized by economies of scale and low levels of firm differentiation.

(b) *Upstream Diseconomies of Scale.* Upstream R&D functions require lower resource allocations, rely on highly-differentiated human and intellectual resources, and are characterized

[58] In an important contribution, Prof. Martin Adelman observed that patents substitute for the entry barriers that allow for recoupment of R&D costs in concentrated markets (and conversely, the absence of patents requires market concentration to restrain imitative entry). *See* Adelman, *Supreme Court, supra* note __, at 458, 463, 466.

by *dis*economies of scale. The latter assumption reflects evidence that smaller firms often exhibit superior R&D performance as reflected by a number of factors.[59]

(c) *Technological Interface.* No technological constraint bars segregation of design and production functions as a practical matter. This assumption will be most clearly satisfied in markets that have developed interfaces that enable firms to work independently on modular components or to work on design of a component without being involved in its production.[60]

(d) *Rich or Immature Market.* No incumbent has a patent portfolio that covers all technological entry points into a given market and would *rationally* refuse to license it to entrants.[61] This assumption will be most clearly (but not exclusively) satisfied in technologically immature markets that have not yet settled on a dominant design or technologically rich markets that offer abundant research and development opportunities.[62]

These characteristics ensure that (i) there exist specialization gains that firms can extract through supply-chain disaggregation, and (ii) there does *not* exist any technological constraint that bars extraction of those specialization gains. The Figure

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59 Small firms outperform larger firms in R&D performance on several measures: (i) small firms obtain, on average, more highly-cited patents and more patents per employee, *see* CHI RESEARCH, INC., SMALL SERIAL INNOVATORS: THE SMALL FIRM CONTRIBUTION TO TECHNICAL CHANGE (report prepared for Small Business Administration, Office of Advocacy), Feb. 27, 2003 [henceforth CHI RESEARCH 2003]; (ii) produce more innovations per employee, Zoltan J. Acs and David B. Audretsch, *Innovation in Large and Small Firms: An Empirical Analysis,* 78 AMER. ECON. REV. 678 (1988); and (iii) otherwise exhibit higher measures of innovative output relative to R&D dollars, see FREDERIC M. SCHERER & D. ROSS, INDUSTRIAL MARKET STRUCTURE AND PERFORMANCE 654-56 (1990); Richard Caves, *Industrial Organization and New Findings on the Turnover and Mobility of Firms,* 36 J. ECON. LIT. 1947, 1969-1970 (1998); Zoltan J. Acs and David B. Audretsch, *Innovation as a Means of Entry*, in INNOVATION AND TECHNICAL CHANGE: AN INTERNATIONAL COMPARISON (eds. Zoltan J. Acs and David B. Audretsch, 1991).

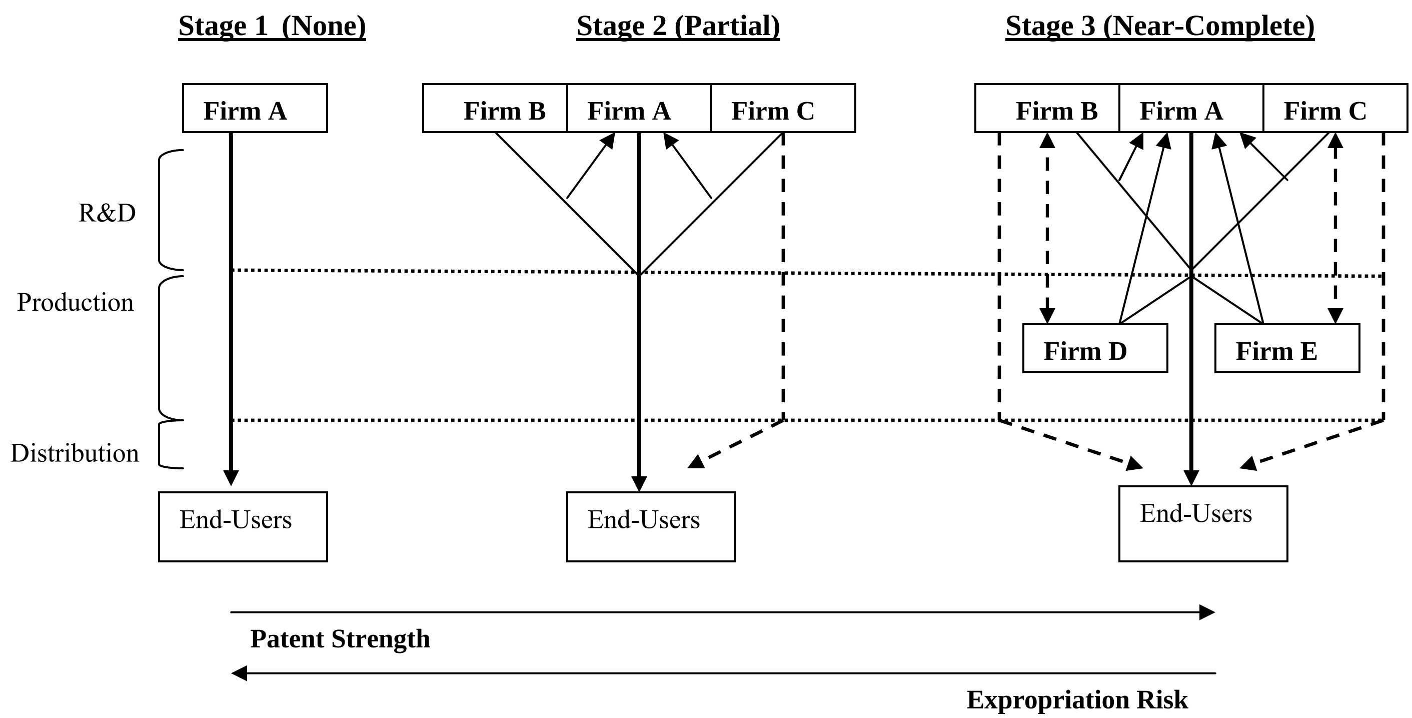
60 For extensive discussion, see CARLISS Y. BALDWIN & KIM B. CLARK, DESIGN RULES: THE POWER OF MODULARITY (2000).

61 The "rationality" qualifier substantially narrows the set of circumstances where a patent forecloses entry into a technology market. Even in mature markets where a patent position controls a dominant design or basic process or product technology, the patent holder may have a rational incentive to license it widely in order either (i) to generate licensing revenue or (ii) to protect its position in a market for platform goods that derive value from third-party suppliers of complementary goods and services. As I have shown elsewhere with respect to markets for operating systems and other platform technologies, even the most dominant firms often give away access at a zero or even negative fee. *See* Jonathan M. Barnett, *The Host's Dilemma: Voluntary Forfeiture in Platform Markets for Informational Goods* (Working Paper 2010).

62 David Adelman emphasizes this point with respect to the biotechnology market, which he notes is rich in opportunities and therefore not easily susceptible to preclusion by patented positions. *See* David E. Adelman, *A Fallacy of the Commons in Biotech Patent Policy,* 20 BERK. TECH. L. J. 985 (2005).

below (which assumes a simplified supply chain consisting of R&D, production and distribution functions) depicts the resulting disintegration sequence and I will refer to it periodically in the discussion below.

Figure IV: Disintegration Stages



1. *Partial Disintegration*

As shown in *Stage 1*, where patents are weak or absent, incumbent *Firm A* must (at least in the extreme case) select *Integrate* with respect to every supply chain function in order to bring its innovation to market without bearing the expropriation risk inherent to bargaining with third parties. Conversely, patents restore the possibility of *Contract* and allow *Firm A* to interact with lower-cost providers of upstream supply chain functions (*Firms B* and *C*) (or equivalently, allow *Firms B* and *C* to interact with providers of downstream supply chain functions). As shown in *Stage 2*, precontractual negotiation within the security of patents enables *Firm A* to adopt a disaggregated structure that allocates the upstream portion of the supply chain to lower-cost providers. The possibility of contracting between the incumbent (*Firm A*) and external providers induces entry by firms that have a cost advantage in design and research services but a cost disadvantage along the remainder of the supply chain. The result (as shown in *Stage 2* in *Figure IV*): partial disaggregation of the supply chain into an upstream cluster of stand-alone R&D enterprises, *Firms B* and *C*, who provide technological inputs to *Firm A*, which continues to perform independently all other downstream product-delivery functions (and, by assumption, retains some R&D functions so that it can "backward integrate" (or credibly threaten to do so) in some cases).[63] Relative to *Stage 1*, a competitive supply of upstream design functions lowers total innovation and commercialization costs, thereby increasing expected profits and encouraging innovation.

2. *Nearly Complete Disintegration*

Disaggregation of the R&D-intensive upstream portion of the supply chain precipitates disaggregation of the capital-intensive downstream portion of the supply chain. Consider that stand-alone upstream firms (*Firms B* and *C*) may be viewed not only as suppliers of R&D services to downstream firms but as *purchasers* of production and distribution services required to bring an innovation to market. Any upstream firm seeks to maximize profits by minimizing the cost of obtaining production and distribution services from external providers. To do so, it seeks alternatives to selling solely to *Firm A* (as is the case in *Stage 2*), which, as a monopsonist purchaser of R&D inputs, will exercise disproportionate bargaining power, take the lion's share of user revenues and have limited competitive pressures to minimize product-delivery costs. It therefore follows that the competitive supply of R&D services by firms at the upstream portion of the supply chain (*Firms B* and *C*) in turn elicits entry at the *downstream* portion of the supply chain by firms that have a cost advantage in production and distribution functions (*Firms D* and *E*). Downstream suppliers of "stand alone" production functions enable upstream suppliers of technological inputs to reach market without incurring the exorbitant fixed costs of forward integration *and* without relying solely on the production capacities of the existing incumbent. As shown by the dashed lines, *Firms B* and *C*

[63] As indicated by the dashed line running from *Firm C* to end-users, I suppose that some stand-alone R&D firms that enter at the upstream segment of the supply chain may develop limited forward integration capacities (in part, to preserve bargaining power in negotiations with *Firm A* over the division of joint surplus from end-user revenues).

generate technological inputs that can then be embodied in consumption-ready products through contractual relationships with *Firms D* and *E*, which then return the finished goods to *Firms B* and *C* for distribution to end-users, thereby bypassing *Firm A* entirely if so desired.[64] Assuming a substantially homogenous goods market, vertical disintegration by upstream technology suppliers in turn compels the integrated incumbent, *Firm A*, to pursue the same outsourcing relationship with *Firms D* and *E* in order to replicate its competitors' cost structure. The logic behind this "universal outsourcing" outcome is simple. To the extent an outside provider can achieve economies of scale in any given supply chain function superior to those achieved by any single firm, competitive pressures in homogenous goods markets will compel *every* firm to outsource *every* supply chain function in order to replicate the same cost structure.

C. **Making Markets**

So far I have proposed a targeted reformulation of the incentive thesis. Patents enable firms to calibrate organizational structures in order to maximize specialization gains, which in turn induces innovative entry consistent with the standard thesis as applied in mediated form. In this Part, I identify social gains that derive from these organizational effects but cannot be captured by the conventional relationship between "more IP" and "more innovation". In particular, the segregation of research, production and other functions to match providers' comparative advantages along the supply chain supports the emergence of secondary markets for trading, licensing and valuing intellectual resources. That is: patents not only organize markets but *make* new markets. It is now possible to describe the full sequence of organizational effects that can flow from property rights that mitigate expropriation risk in the commercialization process. Where (i) intellectual property enables innovators to select organizational forms that would not be feasible under higher levels of expropriation risk, then (ii) it enables the extraction of specialization gains through transactions between holders of complementary technology and production inputs, which (iii) expands entry opportunities into capital-

64 The Figure contemplates that *Firms B* and *C* continue to sell some technological inputs to *Firm A*.

intensive technology markets, and, as will now be discussed, (iv) promotes the formation of secondary markets that trade in disembodied supply chain functions and inputs.

1. *The Disintegration Problem*

The classical integrated enterprise can be construed as a middleman who matches the suppliers of raw inputs, unfinished goods or finished goods with the buyers of those goods, earning a return on the spread between the price of inputs purchased and the price of goods sold, less all intervening production, distribution and transaction costs.[65] It may therefore be expected (as is often asserted) that vertical disintegration implies disintermediation. Suppliers can interact directly with buyers and avoid paying the premium assessed by now-redundant middleman. Hence, in *Stage 3* in *Figure IV*, I indicated the possibility that *Firms B* and *C* may bypass *Firm A* (equivalent to the classic middleman) to reach the target user market. However, fuller consideration shows that roughly the contrary is the case: the monolithic super-middleman that occupies a single node of the supply chain is replaced by smaller-scale middlemen that operate at multiple nodes of the supply chain. Disaggregated supply chains must be *re*-intermediated in order to address the transactional complexity induced by moving the procurement of supply chain functions and inputs from an internal market governed by managerial fiat (equivalent to *Integrate*) to an external market governed by a contractual network of third parties (equivalent to *Contract*).[66] Assuming some substantial level of supply chain disaggregation, end-users, intermediate users and suppliers would otherwise face a formidable matching and search problem, resulting in exorbitant identification, valuation, and negotiation costs in order to assemble the inputs required at each step of the supply

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[65] *See* DANIEL F. SPULBER, MARKET MICROSTRUCTURE: INTERMEDIARIES AND THE THEORY OF THE FIRM (1999).

[66] This increase in complexity can be illustrated by comparing the fully integrated supply chain set forth in *Stage 1* of *Figure IV* with the substantially disintegrated supply chain set forth in *Stage 3*. In the former case, third-party transactions are limited to distribution of the final product by *Firm A* to end-users, which rely on *Firm A* to locate, evaluate and assemble all product components. In the latter case, the set of third-party transactions includes both (i) existing interactions between *Firm A* and the end-user population, (ii) additional interactions between *Firms B* and *C* and the end-user population, and (iii) multiple intermediate transactions between one or more purchaser-firms (*Firms A*, *B* or *C*) and one or more supplier-firms (*Firms B, C, D* or *E*).

chain.[67] Re-intermediation is therefore the final and necessary step in the disaggregation process that is enabled by secure patents: without it, the transaction costs of decentralized exchange would deplete the specialization gains from disaggregated design, production and distribution functions.

2. *The Re-Intermediation Solution*

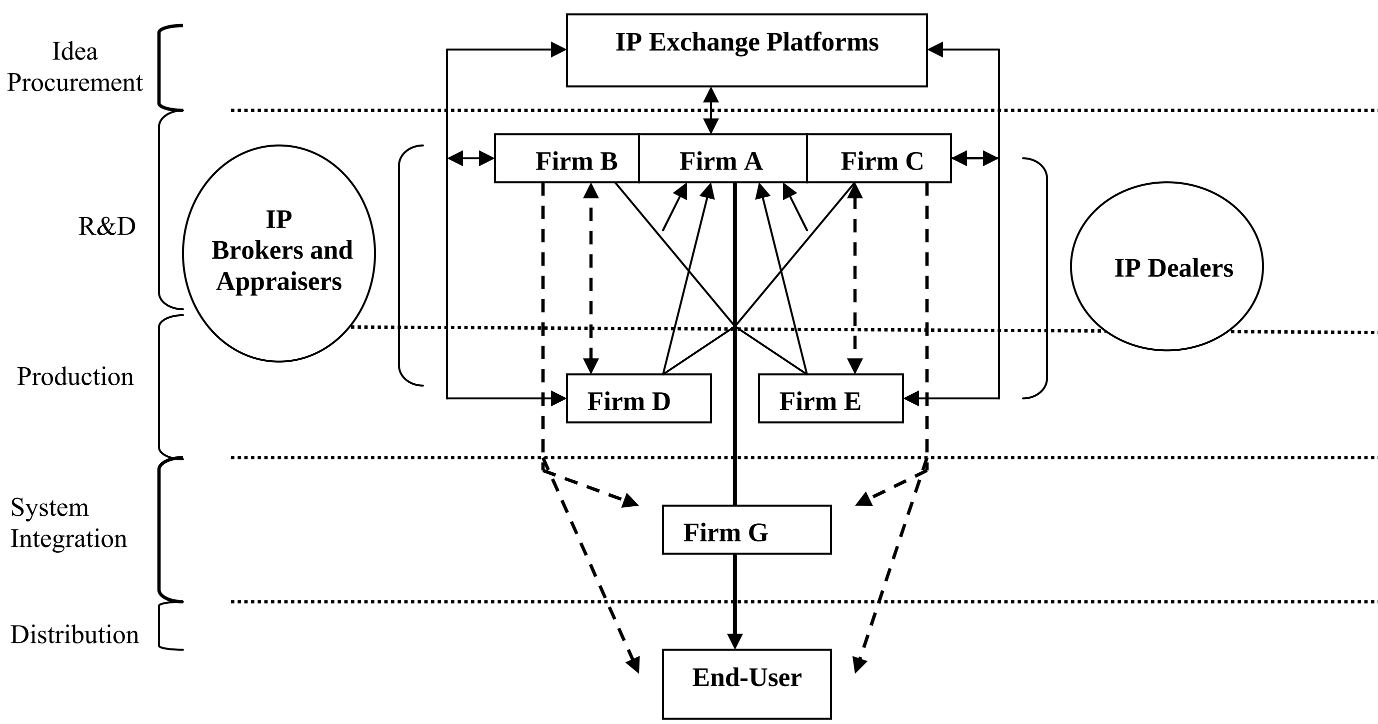
The increased complexity inherent to supply-chain disaggregation necessitates transactional structures that facilitate exchanges among buyers and sellers of supply chain functions and inputs. Just as competitive pressures drive firms to locate the least-cost external provider of any supply chain function, which in turn induces entry by specialized suppliers of discrete supply chain functions, competitive pressures drive firms to adopt the most effective transactional technologies to lower the cost of locating and evaluating least-cost providers, which in turn induces entry by specialized suppliers of transactional solutions. This re-intermediation process is illustrated graphically in the Figure below, which expands upon *Stage 3* of *Figure IV* to reflect the new "market in ideas" that results from re-intermediation of a disaggregated supply chain. In particular, several new market segments and populations have emerged: (i) systems integrators (see *Firm G*), who assemble components from Firms *A, B* and *C* into product bundles for user consumption, thereby relieving search and evaluation costs for producers, intermediate users, and end-users[68]; (ii) "IP dealers", who purchase and warehouse intellectual assets for resale to other entities, thereby relieving search costs for producers and intermediate users; (iii) "IP brokers", who facilitate exchanges of intellectual resources between producers and intermediate users, thereby relieving search, evaluation and negotiation costs; and (iv) "IP exchange platforms", which offer venues or technologies for exchanging intellectual

[67] Under the rubric of transaction costs, we may include the costs entailed in reaching agreement among multiple suppliers of complementary inputs so as to avoid a collectively harmful "royalty stacking" outcome (equivalent to the more general problem of double marginalization), where each input holder demands excessive licensing fees, resulting in input costs that prevent commercialization. Transactional intermediaries can alleviate these problems both through matching services that lower negotiation costs and marketing complementary inputs as a single bundle. On royalty stacking (and the paucity of evidence for its existence), see Damien Geradin et al., *The Complements Problem within Standard Setting: Assessing the Evidence on Royalty Stacking* (Working Paper 2008).

[68] Note that the Figure contemplates that Firms *A*, *B* and *C* may also distribute component bundles to users directly through in-house assembly services.

assets, thereby relieving search and evaluation costs for producers and intermediate users. Some of these entity types may appear to be somewhat unusual fixtures in intangible-goods markets but should sound familiar in any developed market for tangible-goods markets and, subject to the unique definitional costs of intellectual property rights, have the potential to yield similar pricing and liquidity efficiencies. Where these markets can be successfully implemented, secondary trading and valuation entities further lower firms' innovation and commercialization costs and, by a positive feedback effect, expands the market into which these firms can expect to sell their innovations, which in turn induces further innovative entry.

Figure V: The Re-Intermediated Supply Chain
(Blueprint for an Ideas Market)



D. Summary: Learning Through Bargaining

The loosely inverse relationship between patent strength and supply chain integration is not intended to support either the positive claim that markets will always disintegrate under strong patents or the normative claim that markets will always maximize innovation investment under disintegrated structures. *A priori,* concentrated markets dominated by a small number of highly-integrated firms may support innovation to the same or even greater extent than unconcentrated markets characterized by a large number of weakly-integrated firms that transact through various intermediaries.[69] Several decades of indeterminate research on the optimal firm size and market structure for R&D activity counsel against adopting any broad generalizations.[70] But it is precisely the impossibility that any outside observer (or court, regulator or legislature) could determine optimal firm and market structure that supplies the strongest efficiency case for secure patents, at least as a matter of gross social cost-benefit analysis.[71] Without secure property rights by which to guard against expropriation risk, *the market has no opportunity to learn through bargaining the supply chain configuration that*

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69 A prominent stream of economic thought once promoted this view. *See* JEWKES ET AL., *supra* note __, at 248 (noting, as of 1958, the "modern, and by now widely held, opinion that monopoly encourages, and may even be a condition precedent to, innovation"). For the original source for this "Schumpeterian Hypothesis", see JOSEPH A. SCHUMPETER, CAPITALISM, SOCIALISM, AND DEMOCRACY 131-34 (5th ed. 1975). In his earlier work, Schumpeter advocated the contrary position, identifying the central catalyst of innovative development as the individual entrepreneur who disrupts the dominant position of incumbent firms. *See* SCHUMPETER, THEORY OF ECONOMIC DEVELOPMENT, *supra* note __, at 128-56.

70 For reviews of the literature and competing positions, see ZOLTAN J. ACS & DAVID B. AUDRETSCH, INNOVATION AND SMALL FIRMS 38-45 (1990); MORTON I. KAMIEN & NANCY L. SCHWARTZ, MARKET STRUCTURE AND INNOVATION 75-104 (1982); Wesley M. Cohen & Steven Klepper, *The Tradeoff Between Firm Size and Diversity in the Pursuit of Technological Progress,* 4 SMALL BUS. ECON. 1 (1992).

71 Note that this Article's framework does not address two social costs of patent protection that would be reflected in a net welfare analysis: (i) transaction costs that impede subsequent innovation (provided that any subsequent innovation still would have taken place under weaker levels of intellectual property), and (ii) deadweight losses incurred by consumers as a result of supracompetitive pricing. On transaction costs, it must be noted that decreases in patent protection generate *another* set of transaction costs captured by the disclosure paradox, which, as discussed at length, generate negative effects on innovation incentives. For further discussion, see *infra* Part III.D. Deadweight losses are unlikely to change any normative inference in favor of the property-rights solution, for two reasons. First, where reduced patent protection forces firms to select more costly integrated structures, then prices rise, constraining output relative to an environment where firms could select less costly contract-based structures. Second, even assuming the standard positive correlation between patent strength and deadweight losses, consumers may *still* be better off: if it is true, as economic commentators widely agree, that dynamic efficiency gains in technological advance are likely to far outweigh any static efficiency losses in the form of constrained output, then (setting aside distributive concerns) consumers should collectively prefer incurring supracompetitive pricing over the short term in order to enjoy an accelerated rate of technological advance over the long term. *See, e.g.,* Phillip Areeda, *Antitrust Law as Industrial Policy: Should Judges and Juries Make It?,* in ANTITRUST, INNOVATION AND COMPETITIVENESS 31 (ed. Thomas M. Jorde & David J. Teece 1992) (noting widespread view among economists that "innovation has been thought to contribute far more to our well-being than keeping prices closer to costs through competition").

minimizes innovation and commercialization costs. This process of learning through bargaining, and resulting optimization of the supply chain to reflect comparative firm advantage, provides the fundamental link between organizational effects and innovation effects. Weak patent coverage predetermines a market structure that compels highly-integrated organizational forms, which may depress innovation relative to more weakly-integrated organizational forms that innovators would have selected at some lower level of expropriation risk. Where it is not the first-best organizational option, the integration "solution" for controlling expropriation risk becomes an integration "problem" that inflates commercialization costs, which can depress upstream R&D investment and distort downstream product output. Even in the case of moderate to large-sized firms with established production and distribution infrastructures, weak patent coverage may still yield partial disincentive effects. Innovation proceeds forward at some positive level but the firm is unable to accrue specialization gains by contracting with lower-cost providers of technological and other inputs. So moderate to large-sized firms make some positive level of innovation investment but do so at a reduced intensity relative to an environment with stronger property rights. In the case of small or weakly-integrated innovators that have limited ability to finance integrated structures, the disincentive effects of weak patents are catastrophic: the firm must exit and underinnovation ensues.

III. Organizational Transformations

To gain greater confidence in the proposed relationships between patent strength, firm scope and market structure, it will be necessary to test those relationships by application to specific markets and periods. As a preliminary matter, however, these relationships appear to be broadly consistent with organizational developments in capital-intensive technology markets characterized by intensive adoption and enforcement of patents. In particular, patents appear to play a vital role in an organizational development of capital importance: namely, the large-scale re-allocation of innovative activity from large integrated firms funded by internal cash flow—the classic integrated enterprise of the 20th-century U.S. industrial landscape[72]—to smaller weakly-integrated firms funded

[72] For the classic account, see ALFRED D. CHANDLER, JR., THE VISIBLE HAND: THE MANAGERIAL REVOLUTION IN AMERICAN BUSINESS (1977). For additional discussion, see ALFRED D. CHANDLER, JR.,

by venture capital and other external sources of capital. Since the increased adoption and enforcement of patent rights in the early 1980s and continuing through the present, leading technology markets have undergone substantial transformations in industrial organization, moving from vertically integrated to substantially disaggregated structures populated by specialized suppliers of technology and production inputs.[73] That in turn has coincided with the growth of secondary markets in trading and licensing intellectual assets.[74] A variety of non-patent factors certainly drive this organizational transformation in any particular industry; however patent strength appears to act as an important input in the re-configuration of integrated supply chains and the resulting trade in intellectual assets. In this Part, I review some of these developments generally and then look in particular at patents' organizational effects in the "fabless" semiconductor market.

A. **Old Idea Markets**

The vertical disintegration of technology markets and the emergence of secondary markets in patented assets recalls an historical precedent that occurred roughly a century earlier. As documented in great detail by economic historians[75], the widespread adoption

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SCALE AND SCOPE: DYNAMICS OF INDUSTRIAL CAPITALISM (1990); Chandler & Hikino, *supra* note __, at 24-57.

73 For relevant discussion in the economic and management literatures, *see, e.g.,* Richard N. Langlois, *The Vanishing Hand: the Changing Dynamics of Industrial Capitalism,* 12 IND. & CORP. CHANGE 351 (2003); Naomi R. Lamoreaux et al., *Beyond Markets and Hierarchies: Toward a New Synthesis of American Business History,* 108 AMER. HIST. REV. 404 (2003). In the legal literature, see Erica Gorga & Michael Halberstam, *Knowledge Inputs, Legal Institutions and Firm Structure: Towards a Knowledge-Based Theory of the Firm,* N.W. UNIV. L. REV. (2007); Ronald Gilson et al., *Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration,* 109 COLUM. L. REV. __ (2009); Merges, *Transactional View, supra* note __; Merges, *Input Markets, supra* note __. For a collection of writings by economics and management scholars on disaggregation processes in various industries, see THE BUSINESS OF SYSTEMS INTEGRATION (ed. Andrea Principe et al. 2003).

74 *See* Merges, *Input Markets, supra* note __; Feng Gu & Baruch Lev, *Markets in Intangibles: Patent Licensing* (Working Paper 2001). Estimates of the value of the market for the licensing, sale and trading of patented technology vary substantially. *See, e.g,* ARORA ET AL., *supra* note __, at 40 (estimated value of $35-50 billion per year); Ashby H. B. Monk, *The emerging market for intellectual property: drivers, restrainers and implications,* 9 J. ECON. GEOGRAPHY 469 (2009) (citing estimates of $500 million in 2006 in the U.S. but noting that precise estimates are not available); Gu & Lev, *supra* note __ (noting data showing that revenues from patent licensing rose from $15 billion in 1990 to more than $110 billion in 1999).

75 *See* Naomi R. Lamoreaux & Kenneth L. Sokoloff, *Inventors, Firms, and the Market for Technology in the Late Nineteenth and Early Twentieth Centuries,* in LEARNING BY DOING IN MARKETS, FIRMS AND COUNTRIES (eds. Naomi Lamoreaux et al.) 19-57 (1999) [hereinafter Lamoreaux & Sokoloff, *Inventors*]; Naomi Lamoreaux & Kenneth L. Sokoloff, *The Market for Technology and the Organization of*

of patents in the middle to late 19th-century United States supported a network of "patent dealers" and other intermediaries that facilitated trading in patented inventions. This market operated to the mutual benefit of individual inventors who could not otherwise support independent commercialization and large firms who did not have strong R&D competencies. In turn, this secondary market induced the emergence of professional inventors who could rely on revenues from licenses and assignments to large corporations.[76] Tellingly, as courts increased the rates at which patents were invalidated in the 1930s[77], the individual inventor was eclipsed by the corporate R&D department, after which patenting rates per capita initiated a long decline that persisted until the early 1980s.[78] These organizational tendencies are consistent with this Article's theoretical expectations. As the value and use of patents declined, firms substituted toward higher integration as an alternative device by which to secure innovation returns. Reduced patent protection, and the resulting rise in contracting risk, selected against individual inventors and other weakly-integrated entities and selected for larger firms that could operate under the integrated structures required to capture returns on innovation in the absence of any legal instrument by which to do so.

B. **New Idea Markets**

In today's ongoing debates over the potentially excessive strength of patent protection, it is sometimes forgotten that the federal courts and antitrust regulators

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Invention in U.S. History, in ENTREPRENEURSHIP, INNOVATION AND THE GROWTH MECHANISM OF THE FREE-ENTERPRISE ECONOMIES (eds. Eytan Sheshinski et al. 2007) [henceforth Lamoreaux & Sokoloff, *The Market for Technology*]. See also KHAN, *supra* note __, at 60-61 (stating that in the late nineteenth-century, U.S. inventors regularly traded patents, which facilitated raising outside capital, which was in turn reinvested in inventive effort), 95-96 (citing data showing an extensive antebellum market in trading of patents) and 204-06 (noting that the assignment or sale of patents to antebellum investors often resulted in great profits).

76 *See* Lamoreaux & Sokoloff, *Inventors, supra* note __, at 29-30, citing data in Kenneth L. Sokoloff & B. Zorina Khan, *The Democratization of Invention During Early Industrialization: Evidence from the United States, 1790-1846,* 50 J. ECON. HIST. 363 (1990).

77 Invalidation rates of patents involved in infringement suits in federal appeals courts were 33% in 1925-29, as compared to 51% in 1935-39 and 65% in 1945-49. *See* SCHMOOKLER, *supra* note __, at 31.

78 *See* Lamoreaux & Sokoloff, *The Market for Technology, supra* note __, at 236 (noting rise of corporate R&D department, decline in patenting rates and decline of the individual inventor); SCHMOOKLER, *supra* note __, at 30-31 (observing that, starting in the 1930s, corporations reduced patenting rates, which may be attributed to the increased rates at which courts invalidated patents, increased exposure to antitrust liability for alleged patent misuse, and a general political animus toward patents at the time).

implemented a weak patent policy for a long period extending from at least the 1930s through the early 1980s. It may not be a coincidence that the prevailing organizational form during this period was the integrated (and often overextended) conglomerate[79]: without secure patents, managers expanded firm scope to control expropriation risk during the commercialization process. Increased vertical integration implies increased capital requirements, which tends to yield concentrated markets: as late as the 1970s, some of the nation's leading sponsors of industrial R&D, such as AT&T, DuPont, IBM, Kodak and Xerox, earned the substantial portion of their revenues in markets in which they had shares of 80% or more.[80] The restoration of secure patent coverage, and the widespread adoption and enforcement of patents, since the early 1980s (with the establishment of the Court of Appeals for the Federal Circuit)[81] have coincided with a remarkable reversal in these organizational tendencies for conducting innovation. In 1981 (immediately prior to the establishment of the Federal Circuit), small firms performed 5% of industrial R&D in the United States; in 2003, small firms performed 25% of industrial R&D.[82] Not coincidentally, that same period has witnessed the rise of venture-capital financing: between 1980 and 2007, venture capitalists invested $550 billion in U.S.-based start-ups[83], thereby fulfilling the financing function that is satisfied by internal capital in integrated firms.

The combination of patent-shielded commercialization and external financing from venture capital and other sources has proliferated throughout technology markets.

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79 *See supra* note __.

80 *See* Rosenbloom, Richard S. and William J. Spencer, *Introduction: Technology's Vanishing Wellspring*, in ENGINES OF INNOVATION (eds. Richard S. Rosenbloom and William J. Spencer 1996), at 4.

81 During the period 1983-2002, the number of patents issued tripled, representing an annual rate of increase of about 5.7% per year, which compares to an annual rate of increase of 1% per year from 1930 until 1982 (the year in which the Federal Circuit was established). *See* ADAM B. JAFFE AND JOSH LERNER, INNOVATION AND ITS DISCONTENTS: HOW OUR BROKEN PATENT SYSTEM IS ENDANGERING INNOVATION AND PROGRESS, AND WHAT TO DO ABOUT IT (2004).

82 *See* Rosemarie H. Ziedonis, *On the Apparent Failure of Patents: A Response to Bessen and Meurer,* 22 ACAD. OF MGMT. PERSPECTIVES 21, 25 (2008), *citing* NSF Surveys of Industrial Research and Development, avail. at www.nsf.gov/statistics/industry.

83 *See id.*, citing data from Venture Economics. It might be thought that venture capital-funded technology start-ups do not always, or do not even usually, own patents. Evidence suggests otherwise: in industries where patents are clearly available, VC-backed firms widely patent and, as is widely reported, VCs generally insist that firms' technology assets are protected by patents. On the former point, see Graham et al., *supra* note __ (based on survey evidence for start-ups in the medical device, biotechnology, IT hardware and software markets).

The most widely-discussed example is the biopharmaceutical market: since the extension of patent rights to genetically engineered life forms by the Supreme Court in 1980[84], the industry has adopted a substantially disintegrated structure that largely allocates research-incentive functions to specialized R&D suppliers and the remaining set of downstream functions to integrated pharmaceutical companies.[85] But information technology markets have pursued even more advanced levels of vertical disaggregation. Not only have VC-backed firms entered the upstream R&D segment but large established firms have moved *up* the supply chain by diverting resources from production activities to design and research activities. This process has transformed leading technology companies from traditional integrated enterprises that manufacture most of their own inputs into substantially disintegrated licensing and consulting entities that contract out most production and other non-R&D functions to a network of outside suppliers.[86] Consider the following examples:

- Starting in the early 1990s, IBM (the world's leading patentee for the past 10 years) has converted much of its business into an outsourcing operation that licenses internally-developed technologies to third parties for manufacturing, distribution and/or service functions. IBM's patent and technology licensing revenues increased from $345 million in 1993 to $640 million in 1994 and exceeded $1 billion by 2000.[87] As of 1988, IBM spent less than 28% of its revenues on outside suppliers; by 1999, that figure had increased to almost 54%.[88]

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84 *Diamond v. Chakrabarty*, 447 U.S. 303 (1980).

85 This is a simplification: some biotechnology start-ups have integrated forward to some extent and all large pharmaceutical firms maintain some upstream R&D capacities in biotechnology. For further discussion of these structures, see ARORA et al., *supra* note __, at §3.4.2-.3; Gary Pisano, Weijan Shan & David Teece, *Joint Ventures and Collaboration in the Biotechnology Industry,* INTERNATIONAL COLLABORATIVE VENTURES IN U.S. MANUFACTURING (ed. David Mowery 1988); Jonathan M. Barnett, *Cultivating the Genetic Commons: Imperfect Patent Protection and the Network Model of Innovation,* 37 SAN DIEGO L. REV. 987 (2000).

86 *See* AnnaLee Saxenian, *The origins and dynamics of production networks in Silicon Valley,* 20 RES. POL'Y 423, 425 (1991). For extensive discussion, see Langlois, *supra* note __.

87 *See* Deepak Somaya & David J. Teece, *Patents, Licensing, Entrepreneurship: Effectuating Innovation in Multi-invention Contexts,* in ENTREPRENEURSHIP, INNOVATION AND THE GROWTH MECHANISM OF THE FREE-ENTERPRISE ECONOMIES 198 (eds. Eytan Sheshinski et al. 2007).

88 *See* DAVE NELSON, PATRICIA E. MOODY & JONATHAN STEGNER, THE PURCHASING MACHINE: HOW THE TOP TEN COMPANIES USE BEST PRACTICES TO MANAGE THEIR SUPPLY CHAINS (2001), at xi.

- In 1999, Qualcomm (which began life as a scientist-founded start-up), the world's originator of the "CDMA" standard for wireless telecommunications (the leading standard in the U.S. market), sold its manufacturing operations and converted its business into what is largely a licensing and chipset design operation founded on a portfolio of over 11,000 granted and pending U.S. patents and over 54,000 granted and pending foreign patents.[89]

- Large technology firms such as Apple, Philips, AT&T, Hewlett-Packard, Sun Microsystems (acquired by Oracle), Sony and Cisco Systems contract out production and even distribution functions to third-party suppliers, mostly located in Asia.[90] In 2006, the market leader in contract manufacturing in the electronics industry, Hon Hai Precision, based in Taiwan, reported annual revenues of over $40 billion and employed over 200,000 people.[91]

The organizational transformation of technology markets has yielded a rough convergence of organizational form: the special case of the dedicated R&D firm—for which patents almost certainly provide an incentive function—has *in fact* become the general case. That is: even the largest technology firms are often substantially disintegrated entities that rely on the ability to contract over intellectual resources with lower-cost suppliers. This organizational metamorphosis follows the logic of specialization. Economies of scale drive rivals to outsource production and other downstream functions to a limited set of least-cost providers, thereby driving down commercialization costs throughout the supply chain and, following "size of the market"

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89 *See* QUALCOMM, QUALCOMM BUSINESS MODEL: A FORMULA FOR INNOVATION AND CHOICE (January 2008); DAVE MOCK, THE QUALCOMM EQUATION 145 (2005) (describing sale as part of settlement with Ericsson concerning patent infringement dispute). Number of patents is as reported in Qualcomm's annual report for fiscal 2009, avail. at http://investor.qualcomm.com/secfiling.cfm?filingID=950123-09-57827 (last visited June 8, 2010).

90 *See* Timothy J. Sturgeon, *Turnkey Production Networks: The Organizational Delinking of Production from Innovation,* in NEW PRODUCT DEVELOPMENT AND PRODUCTION NETWORKS: GLOBAL INDUSTRIAL EXPERIENCE 76 (ed. Ulrich Jurgens 2000). On outsourcing by Sun, Apple and Sony, see Gary P. Pisano & Paul Y. Mang, *Collaborative Product Development and the Market for Know-How*, in ROBERT A. BURGELMAN & RICHARD S. ROSENBLOOM, RESEARCH ON TECHNOLOGICAL INNOVATION, MANAGEMENT AND POLICY, Vol. 5, p112 (1993).

91 *See 2007 Electronic Business Top Contract Manufacturers*, as published in Sept. 2007 on EDN.com.

effects, inducing further upstream entry. Those outsourcing transactions are in turn promoted by intellectual property rights, contractual instruments, technological protections, and reputation effects that guard against expropriation risk. Paradoxically, propertization of the upstream pool of intellectual resources drives collectivization of the downstream functions required to embody those resources into consumption goods.

To be sure, vertical disintegration is in part, and often in large part, a function of an abundance of non-patent factors--labor costs, tariff barriers, communications and transportation costs--in any particular case.[92] But the strengthening of patent rights starting in the early 1980s and the consequent rise in patenting rates (as well as the extension of patent rights worldwide through implementation of the 1994 Agreement on Trade-Related Aspects of Intellectual Property Rights[93]) appear to have played a role in reducing the expropriation risk that otherwise distorts interfirm exchanges of knowledge assets. Empirical evidence is consistent with this view: in industries or jurisdictions where intellectual property rights are weak, firms reduce technology transfer in general and/or implement technology transfer through joint ventures, subsidiaries or other firm-like arrangements.[94] Tellingly, economists and management scholars once commonly argued that technology transfer risk necessitated conducting innovation by integrated firms in concentrated markets[95], which in turn often promoted the conclusion that patents

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92 *See supra* note __.

93 The Agreement on Trade-Related Aspects of Intellectual Property Rights is formerly Annex IC of the Marrakesh Agreement of the World Trade Organization, signed on April 15, 1994, and binds all 144 members of the World Trade Organization (WTO), subject to certain exceptions and phase-in caveats.

94 *See* Bharat Anand & Tarun Khanna, *The Structure of Licensing Contracts,* 48 J. IND. ECON. 103 (2000) (based on sample set of 1612 technology licensing agreements, finding that, in industries with weak intellectual property rights, there was a lower incidence of licensing activity but firms continued to execute technology transfer in the form of joint ventures, cross-licensing or licensing to known parties); Joanne Oxley, *Institutional Environment and the Mechanisms of Governance: The Impact of Intellectual Property Protection on the Structure of Inter-Firm Alliances,* 38 J. ECON. BEHAV. & ORG. 283 (1999) (finding that firms tend to use joint ventures or similar arrangements in jurisdictions with weak intellectual property rights and arm's-length contractual relationships in jurisdictions with strong intellectual property rights). *See also* Ashish Arora et al., *Trading Knowledge: An Exploration of Patent Protection and Other Determinants of Market Transactions in Technology and R&D,* in FINANCING INNOVATION IN THE UNITED STATES: 1870 TO THE PRESENT (eds. Naomi Lamoreaux & Kenneth L. Sokoloff 2007) (finding, based on survey of 1,478 manufacturing units, that, in industries where patents are "stronger", there is greater licensing of new technological knowledge by smaller firms (or firms that specialize in R&D) but that no such effect is observed in the case of larger firms).

95 *See* Pisano & Mang, *supra* note __, at 112; Langlois, *supra* note __. These views were ultimately founded in the "Schumpeterian Hypothesis" that monopoly or oligopolistic conditions were optimal for innovation. *See supra* note __. As late as 1985, a Department of Commerce report predicted that "Japan

had little role to play in supporting innovation.[96] With the benefit of hindsight, that position appears to be an artifact of a weak patent regime that may have *compelled* firms to conduct innovation under integrated structures. That organizational response to weak patents obscured an alternative scenario. If firms could rely on patents to safely contract over intellectual assets with third parties, then integrated structures would not be necessary in order to capture innovation returns. The forgotten invention markets of the 19th century had already suggested such a possibility, albeit in settings characterized by substantially lower capital requirements. The thriving innovation by weakly-integrated and patent-dependent firms—both large and small—in some of the 21st-century's most capital-intensive technology markets has now confirmed that possibility with far greater force.

C. **Case Study: "Fabless" Semiconductor Market**

To illustrate in greater detail the interaction between patents and organizational form, I will now examine patents' organizational effects over roughly the past two decades in a selected segment of the semiconductor market. Consistent with theoretical expectations, patents, together with favorable technological developments, appear to have facilitated a transformation of firm and market structure that challenges the industry's historical model of integrated research, production and distribution.[97] In particular, entry

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will rapidly become more competitive with the U.S. and Europe [in biotechnology] because much of the commercialization . . . is being carried out by large established companies", which were assumed to have superior expertise and financing capacities. *See* Martin Fransmann, *Biotechnology: generation, diffusion and policy,* in TECHNOLOGY AND INNOVATION IN THE INTERNATIONAL ECONOMY 66 (ed. Charles Cooper 1994), *citing* U.S. DEPARTMENT OF COMMERCE, BIOTECHNOLOGY IN JAPAN, UNPUBLISHED REPORT, U.S. DEPT. OF COMMERCE, p. xviii (1985). That prediction is obviously false: today Japan (and Europe) lag far behind the U.S. in biotechnology.

96 *See* Naomi R. Lamoreaux & Kenneth L. Sokoloff, *Afterword,* in FINANCING INNOVATION IN THE UNITED STATES: 1870 TO THE PRESENT 471 (eds. Naomi Lamoreaux & Kenneth L. Sokoloff 2007).

97 For prior commentary on this segment by management scholars, see CLAIR BROWN & GREG LINDEN, CHIPS AND CHANGE: HOW CRISIS SHAPES THE SEMICONDUCTOR INDUSTRY Ch. 3 (2009); Greg Linden & Deepak Somaya, *System-on-a-chip integration in the semiconductor industry: industry structure and firm strategies,* 12 IND. & CORP. CHANGE 545 (2003). *See also* Ludovic Dibiaggio, *Design complexity, vertical disintegration and knowledge organization in the semiconductor industry,* IND. & CORP. CHANGE (2007); Jeffrey T. Macher & David C. Mowery, *Vertical Specialization and Industry Structure in High Technology Industries,* 21 ADVANCES IN STRATEGIC MANAGEMENT 317, 330-337 (2004); Jeffrey T. Macher, David C. Mowery & Timothy S. Simcoe, *E-Business and the Semiconductor Industry Value Chain: Implications for Vertical Specialization and Integrated Semiconductor Manufacturers,* East-West Center Working Papers, No. 47, May 2002 [henceforth Macher et al., *E-Business*].

by patent-intensive R&D firms has been accompanied by the disintegration and multiplication of markets: (i) downstream disaggregation of capital-intensive production functions to stand-alone manufacturing firms, (ii) secondary markets in the provision of design tools and other services to facilitate upstream R&D, and, at an emergent level, (iii) tertiary markets in the trading of supply chain functions and inputs. This is a remarkably close (if still imperfectly-developed) realization of a market for ideas in an industry that stands at the heart of our information-based economy.

1. Industry Background

The semiconductor industry is of paramount importance. The market is economically significant by any measure (worldwide revenues of $226 billion in 2009[98]) and, more importantly, provides the backbone for a broad set of information and communications technology industries: semiconductor chips are used in all manner of communications, computing and electronics products. Described simply, a semiconductor chip consists of an integrated circuit[99] engraved on a silicon wafer using photolithographic technology. Integrated circuits in turn are categorized by function: memory chips, logic chips, and microprocessor chips (the latter being characterized by the fact that chips can be programmed to perform a set of instructions).[100] Advances in miniaturization technology (that is, increases in the number of transistors that can be placed on an integrated circuit) have allowed the memory, logic and processing functions to be embedded on a single chip in order to implement a customized application. These advances have enabled the development of application-specific integrated circuits or "ASICs") (often known as "system on a chip" or "SoC" devices), which are widely used in multimedia mobile phones, flat-screen televisions, digital cameras and a variety of

[98] Semiconductor Industry Association, Industry Fact Sheet. Avail. at http://www.sia-online.org/cs/industry_resources/industry_fact_sheet (last visited June 4, 2010).

[99] For simplicity, an integrated circuit might be understood as a "computer on a chip" consisting of hardware (input/output and memory units) and software containing operating instructions that cause the hardware to implement the desired tasks.

[100] *See* GALE GROUP, SEMICONDUCTORS AND RELATED DEVICES (viewed May 20, 2008).

multimedia, video and graphics applications.[101] This market segment had 2009 worldwide revenues of approximately $82 billion[102] and will be the focus of the discussion below.

2. **Organizational Evolution**

Recall the core framework: assuming property rights that mitigate the expropriation risk inherent to precontractual and infracontractual interaction, opportunities to extract specialization gains will induce disaggregation of the supply chain, which in turn induces entry by providers of supply chain functions and inputs, which in turn induces entry by intermediaries that facilitate trading in those functions and inputs. This theoretical sequence closely tracks the actual reconfiguration of supply chains in the fabless market.

a. *Integration*

For several decades, the semiconductor industry largely operated on a vertical integration model where each firm independently carried out research, product development, production, distribution and support functions.[103] During this postwar period, patents were generally weakly enforced by the courts and semiconductor firms tended to follow an industry norm against aggressive enforcement of patents.[104] In the early 1980s, this environment changed as a result of several events: the emergence of low-cost Japanese competitors in the memory chip ("DRAM") market, stronger enforcement of patents since the establishment of the Federal Circuit, passage of *sui*

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[101] Note that ASIC devices can be divided into two categories: (i) off-the-shelf devices that can be programmed by the user to implement certain functions as desired, and (ii) customized devices supplied by an integrated circuit manufacturer. *See* RAKESH KUMAR, FABLESS SEMICONDUCTOR IMPLEMENTATION 67 (2008). This discussion focuses on category (ii), which in turn encompasses a number of sub-categories (which are generally not distinguished in the remaining discussion).

[102] *See infra* note __ and Figure VII and accompanying text.

[103] *See* Macher et al., *E-Business, supra* note __, at 3. Distribution was sometimes outsourced with the manufacturer retaining some "captive" distribution capacities. Some distributors also provided basic support services. *See* PORTER, *supra* note __, at 4-7, 13. For an extensive history of the industry, see BO LOJEK, HISTORY OF SEMICONDUCTOR ENGINEERING.

[104] *See* DAVID P. ANGEL, RESTRUCTURING FOR INNOVATION: THE REMAKING OF THE U.S. SEMICONDUCTOR INDUSTRY 38-43 (1994); CHRISTOPHE LECUYER, MAKING SILICON VALLEY: INNOVATION AND THE GROWTH OF HIGH TECH, 1930-1970, at Ch. 7.

generis legislation to protect chip designs[105], substantially increased rates of patenting by all firms[106] and aggressive patent litigation by some firms.[107] The chart below shows the dramatically increased rates of U.S. patenting by semiconductor firms during this period, a growth rate that exceeds the overall increase in U.S. patenting during the same period.[108] Following standard views, these developments might be depicted as a case where an industry that once thrived without strong patents has been saddled with an unnecessarily aggressive patent regime. As we shall see, several factors challenge this interpretation.

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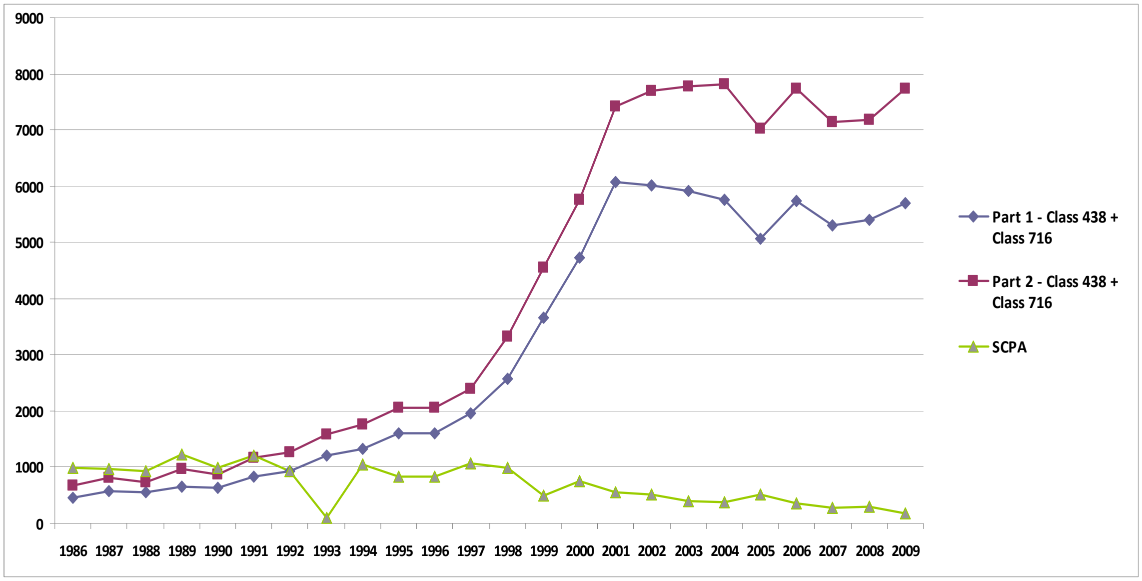
105 Semiconductor Chip Protection Act of 1984, Pub. L. No. 98-620, tit. III, 98 Stat. 3347 (codified at 17 U.S.C. §§ 901-914 (Supp. II 1984)).

106 Adjusted relative to R&D dollars, this rate (i.e., the *propensity* to patent) doubled during 1982-1992. *See* Bronwyn H. Hall & Rosemarie Ham Ziedonis, *The Effects of Strengthening Patents on Firms Engaged in Cumulative Innovation: Insights from the Semiconductor Industry*, *in* 13 ENTREPRENEURIAL INPUTS AND OUTCOMES (2001).

107 In particular, Texas Instruments is (in)famous for having broken from the industry norm of underenforcement of patents. *See* Bronwyn H. Hall, *Exploring the Patent Explosion*, in ESSAYS IN HONOR OF EDWIN MANSFIELD: THE ECONOMICS OF R&D, INNOVATION AND TECHNICAL CHANGE 201-02 (eds. Albert A. Link and Frederic M. Scherer 2005).

108 *See* Hall & Ziedonis, *supra* note ___. Note that the Figure also depicts registration rates for "mask works" covered under the Semiconductor Chip Protection Act; as is evident, the Act has been underused. This is generally attributed to technological developments that have frustrated third-party imitation that relies solely on reverse engineering the layout design. *See* Leon Radomsky, *Sixteen Years After the Passage of the U.S. Semiconductor Chip Protection Act: Is International Protection Working?*, 15 BERKELEY TECH. L.J. 1049, 1077-79 (2000).

Figure VI: Semiconductor Patenting Rates (1986-2009)[109]



b. *Disintegration*

The onset of vigorous patent adoption and enforcement in the semiconductor industry has been followed by organizational changes. Some firms have migrated away from the uniform practice of vertical integration toward an increased diversity of organizational forms. The largest firms that still conform to the integrated model in this segment now compete in the most design-intensive segments with "fabless" companies, which constitute roughly 30% of the worldwide semiconductor chip market and enjoyed revenues of $56.6 billion in 2009.[110] Design firms license proprietary chip designs to production-only foundries that specialize in wafer fabrication.[111] The fabless firm then

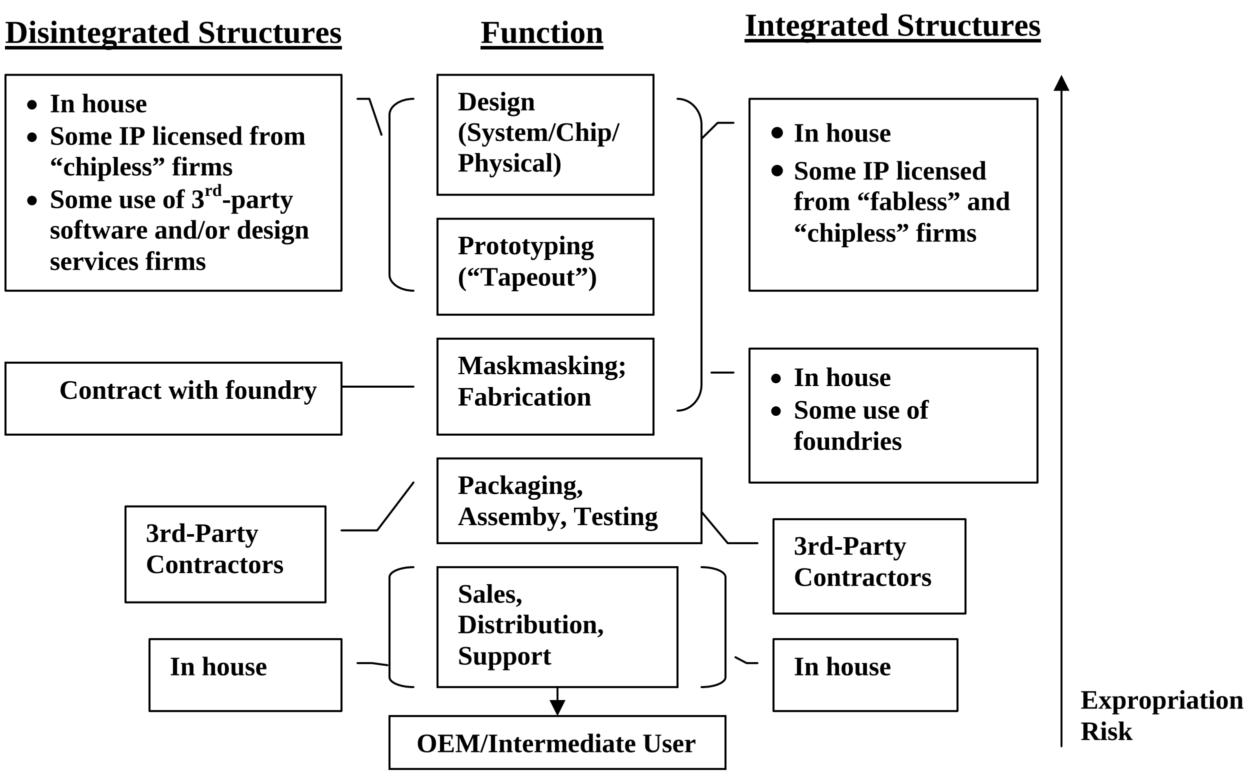
109 Note that the "higher" curve for patent rates is based on the number of issued patents classified under Class 438 and Class 716 of the Patent Classification System as a matter of both original classification and "cross-reference" classification. The "lower" curve only includes patents so classified based on the original classification. Total figures for "mask work" registrations under the SCPA are based on the 2007 annual report of the Copyright Office; figures for 2008 were calculated directly from registration data available through the Copyright Office website.

110 *See* Global Semiconductor Alliance ("GSA"), avail. at http://www.gsaglobal.org/resources/industrydata/facts.asp (last visited June 4, 2010).

111 In somewhat greater detail: the design firm typically provides the foundry with a "specification" (an electronically-deliverable prototype) for purposes of testing conformity to fabrication process

recovers the wafers for testing, assembly and packaging (technical functions that are outsourced to third parties) and, finally, distribution and marketing to intermediate users (usually, component manufacturers or system integrators).[112] As shown below, the result of these contractual relationships is a substantially disaggregated supply chain that departs sharply from incumbents' substantially integrated supply chains.

Figure VII: Supply Chain Structures in the ASIC/SoC Market[113]



parameters, after which the foundry can undertake "mask-making" (equivalent to producing a mold in traditional manufacturing) and a full-scale production run.

112 *See* Hall & Ziedonis, *supra* note __, at 136; Raja Attia, Isabelle Davy & Roland Rizoulieres, *Innovative Labor and Intellectual Property Market in the Semiconductor Industry,* in TECHNOLOGY AND MARKETS FOR KNOWLEDGE: KNOWLEDGE CREATION, DIFFUSION AND EXCHANGE WITHIN A GROWING ECONOMY 145-46 (ed. Bernard Guilhon 2001); Wim Roelandts, *Programmable Logic: Enabling the Digital Revolution,* in INSIDE THE MINDS: THE SEMICONDUCTOR INDUSTRY 57-58 (2001).

113 Note that system design, chip design ("spec") and physical design ("layout") constitute distinct stages in the chip development process, which in turn cover multiple technical steps that require specialized expertise to execute successfully. Note further that the Figure does not reflect the fact that foundries sometimes backward integrate by providing fabless firms with physical design ("layout") services or IP modules or design libraries. For further discussion, see RAKESH KUMAR, FABLESS SEMICONDUCTOR IMPLEMENTATION Figs. 4.8-4.10, 6.1,6.4, 6.8 (2008); Linden & Somaya, *supra* note __, at 569-70. As discussed elsewhere, highly sophisticated intermediate users have occasionally integrated backward into the fabless market by procuring design inputs from 3rd-party suppliers and contracting with foundries for production. *See infra* note __ and accompanying text.

Together with fundamental technological and standardization advances that facilitated segregation of the design and/or production functions along the supply chain[114], the opportunity to contract with foundries enables design firms to contest incumbents' market share by avoiding the exorbitant investment required to set up a fabrication plant. The math is simple: "fab" construction cost can run into several billions of dollars[115]; design costs run into the tens of millions of dollars.[116] The cost savings from vertical disaggregation inherently come at the price of expropriation risk, which is highest in the design stages of the supply chain.[117] Design firms must therefore rely on a combination of technology, contract, and intellectual property rights in order to control knowledge leakage at each point of technology transfer. This explains why fabless firms tend to adopt aggressive patent acquisition and enforcement strategies[118],

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114 Two developments were of particular importance. First, in 1979, a technical achievement in semiconductor design methodology, known as "VLSI" (Very Large Scale Integration), enabled assembling working prototypes of chip design at relatively low cost and without any involvement in the far more costly fabrication process. For further discussion, see BALDWIN & CLARK, *supra* note __, at 77-88; Nathan Rosenberg & W. Edward Steinmuller, *The economic implications of the VLSI revolution,* in NATHAN ROSENBERG, INSIDE THE BLACK BOX: TECHNOLOGY AND ECONOMICS (1982). Second, in the 1980s, the industry converged on silicon-based "CMOS" (complementary metal oxide semiconductor) as the dominant design in semiconductor process technology. This facilitated standardization of the interfaces that allow design modules to be designed independently by multiple providers. *See* Linden & Somaya, *supra* note __, at 555. For fuller explanations of these technological developments, see BALDWIN & CLARK, *supra* note __, at 77-88.

115 As of 2007, a new plant required a $3.5 billion investment, as illustrated by Intel's newest plant in Israel. *See* Tuomi, *supra* note __, at §6.2. These costs are compounded by the fact that plant technology is usually obsolete within a few years due to technological advances. *See* Hutcheson, *supra* note __, at 35-14.

116 In total, design costs of an ASIC device have been estimated as high as $45 million. *See* KUMAR, *supra* note __, at §7.3.3. Other sources give estimates of up to $80 million for a highly-customized design. *See* Ernst, *supra* note __, at 8 n.21 (citing various industry sources) or up to $120M for the latest-generation chip designs, see Tuomi, *supra* note __, at Figs. 23-24.

117 The logic behind the second assumption is that products or prototypes delivered at production stages of the supply chain tend to embody private knowledge without making it fully transparent to the recipient; this tends not to be the case in upper portions of the supply chain. For this reason, fabless firms are often reluctant to provide "soft" design modules (i.e., chip designs that have not yet been embodied in an informationally opaque physical prototype) to foundries that can be more easily adapted to customer uses, due to the risk of reverse-engineering. *See* Linden & Somaya, *supra* note __, at 559-61.

118 *See* Adam B. Jaffe, *The U.S. Patent System in Transition: Policy Innovation and the Innovation Process*, 29 RES. POLICY 531, 540 (2000) (stating that semiconductor patents held by small "design" firms are disproportionately the subject of patent litigation); Rosemarie H. Ziedonis, *Don't Fence Me In: Fragmented Markets for Technology and the Patent Acquisitions Strategies of Firms*, 50 MGMT. SCI. 804, 817-18 (2004) (finding that large vertically-integrated semiconductor firms tend to cross-license patents while small design firms tend to adopt more litigious and exclusionary strategies). *See also* Hall & Ziedonis, *supra* note ___, at 137, 159 (finding that firms that entered the semiconductor industry after 1982 patent more intensively than pre-1982 entrants, where 1982 is used as a "marker" for strengthened patents

which contrast with the cooperative practices of vertically-integrated incumbents, who engage in limited enforcement as a general matter[119] and have widely entered into cross-licensing and even cooperative R&D arrangements with peer competitors.[120] Incumbents' cooperative behavior, and entrants' aggressive behavior, reduces to a simple function of marginal integration costs. Larger firms are inherently protected against expropriation risk through integrated structures and therefore have a reduced need to expend resources on patent enforcement to achieve that objective. Precisely the opposite state of affairs applies to more weakly-integrated firms.

Historically the "fab/foundry" model arose in response to the interest of design specialists in bypassing the incumbent bottleneck on wafer fabrication facilities.[121] The symbiosis between knowledge-intensive fabless firms and production-intensive foundries[122] has resulted in a flowering of design firms that challenge incumbents who would otherwise be protected by the capital costs required to fund a fully-integrated supply chain. There are currently more than 1800 fabless firms worldwide[123], located predominately in the United States (with substantial additional presence in Israel, Taiwan and the United Kingdom), who outsource manufacturing functions to a concentrated

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based on creation of Federal Circuit; in particular, finding that small firms are *five times* more likely to patent than all other firms in the sample, which excludes, however, some of the largest diversified semiconductor manufacturers).

119 Controlling for increases in the number of patents held and/or amount of R&D spending, large firms have not *initiated* more patent litigation since the early 1980s. *See* Hall, *supra* note __.

120 *See* TEECE, *supra* note ___, at App. A; John H. Barton, *Antitrust Treatment of Oligopolies with Mutually Blocking Patent Portfolios,* 69 ANTITRUST L. J. 851 (2001); GRINDLEY & TEECE, *supra* note ___. Some of the leading integrated firms are members in the SEMATECH research consortium, which pools member resources to develop manufacturing technologies. *See* SEMATECH, 2005 ANNUAL REPORT, avail. at www.sematech.org.

121 More specifically, the leading foundry, TSMC, was founded as a result of pressure exerted on the Taiwanese government by local integrated circuit design firms, who demanded a local specialized chip foundry that would provide superior service relative to foreign integrated manufacturers. *See* ALICE H. AMSDEN & WAN-WEN CHU, BEYOND LATE DEVELOPMENT: TAIWAN'S UPGRADING POLICIES 166-67 (2003).

122 More precisely: "production-mostly". To secure manufacturing contracts, some foundries have integrated backwards to a partial extent, offering brokering services, module libraries and limited design services to facilitate development of system-on-a-chip designs by upstream suppliers.

123 Source: Global Semiconductor Alliance ("GSA"), avail. at www.gsa.org. The top 20 fabless firms account for almost 70% of total revenues. Author's calculation based on 2009 revenue figures available at http://www.icinsights.com/news/bulletins/bulletins2010/bulletin20100119.html (last visited June 9, 2010).

group of wafer foundries, located principally in Taiwan and Singapore[124] (of which the top three firms hold a 75% market share).[125] The largest design firms (often backed by venture capital investors) pose a competitive threat to large integrated firms in the ASIC market[126], who themselves obtain some design inputs from upstream fabless firms and contract some production to outside foundries.[127] Unburdened by the overhead of a production and distribution infrastructure, fabless firms can devote a disproportionate share of revenues to R&D. In 2007, leading publicly-traded fabless firms substantially exceeded the semiconductor industry average ratio of R&D expenditures to sales (approximately 15%): Qualcomm devoted 21% of its revenues to R&D; Broadcom devoted 36%; and LSI Corp. devoted 25%.[128] As shown below, the fab/foundry business

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[124] On the geographic distribution of semiconductor design firms and foundries, see Macher & Mowery, *supra* note __, at 334-35. On Taiwanese and Chinese foundry activity, see THOMAS R. HOWELL ET AL., CHINA'S EMERGING SEMICONDUCTOR INDUSTRY (report prepared by Dewey Ballantine LLP for the Semiconductor Industry Association) (Oct. 2003). Some readers have expressed surprise that design houses would transfer technology to Asian jurisdictions where patent protections are generally thought to be insecure. Two observations largely moot this concern. First, even if patent protections are insecure, expropriation opportunities are limited by the fact that the target markets for the ultimate consumption goods would bar entry of any products made using unlicensed patented components. Second, contrary to common belief, Asian jurisdictions do not uniformly have insecure patent rights. Taiwan, the chief location of the largest foundries, explicitly adopted a policy of strongly-enforced patents in 1986, consisting principally of increased infringement awards and creation of a specialized court to hear patent disputes. (The same is true of Korea since roughly the same time.) That almost precisely coincides with the rise of the foundry industry and provides highly suggestive evidence consistent with this Article's core thesis: strong intellectual property rights (both as a formal and effective matter) enabled Taiwanese foundries to commit credibly against expropriation, enabling mutually efficient technology-transfer transactions with Western (mostly U.S.-based) design houses to go forward. *See id.,* at 111. This point is extensively argued by Shih-Tse Lo, *Strengthening Intellectual Property Rights: Experience from the 1986 Taiwanese Patent Reforms* (Working Paper 2008), who describes the reforms and documents the positive effects both on domestic innovation by R&D-intensive Taiwanese firms (as measured by R&D investment and patenting in the U.S.) and foreign direct investment into Taiwan.

[125] Author's calculation based on revenue figures available at http://www.isuppli.com/Semiconductor-Value-Chain/MarketWatch/Pages/Foundries-Play-Semiconductor-Survivor-in-2010.aspx (last visited June 9, 2010). The leading firms and market share are: TSMC (based in Taiwan; 50% share); UMC (based in Taiwan; 16% share); Chartered (based in Singapore; 9% share); and Globalfoundries (based in U.S., 6% share). In Q4 2009, Globalfoundries acquired Chartered.

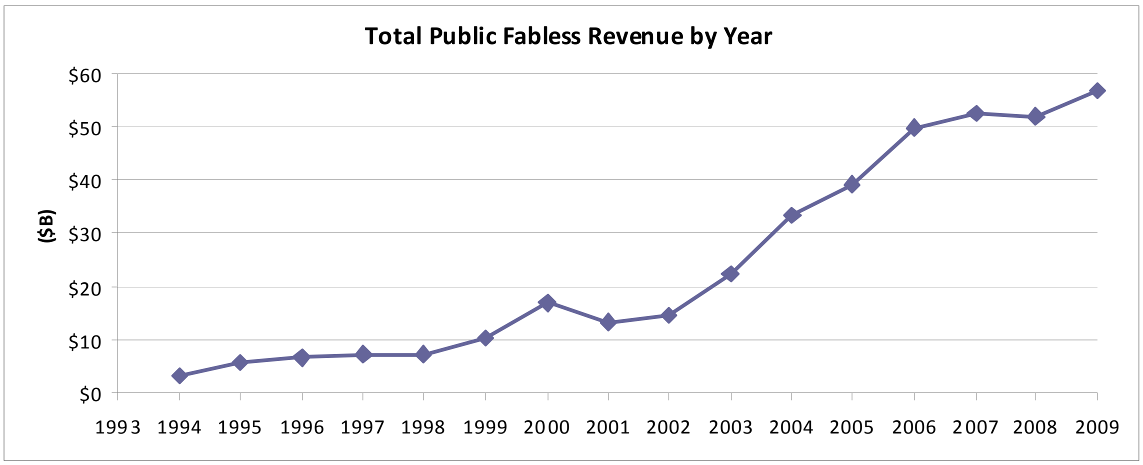
[126] *See* Linden & Somaya, *supra* note _, at 555 n.14.

[127] *See* HOWELL ET AL, *supra* note __, at 44 (noting that leading Taiwanese foundries have collaborative relationships with large Western semiconductor and other electronics firms); Ernst, *supra* note __, at 20-21 (noting that formerly integrated semiconductor firms are moving out of fabrication and specialization into higher-level design and system specification tasks); HURTARTE ET AL, *supra* note __, at xvii-xviii (noting that most major integrated manufacturers today have adopted outsourcing to some extent).

[128] OECD, OECD INFORMATION TECHNOLOGY OUTLOOK 2008, at pp161-62, Tbl. 3.4 (2008).

model has experienced rapid success, reaching almost $60 billion in worldwide revenues for publicly-traded fabless firms in 2009 (which compares with $226 billion in worldwide revenues for the semiconductor industry as a whole in 2009).[129]

Figure VIII: Growth of "Fabless" Semiconductor Firms[130]



The fabless threat has induced dramatic organizational responses from integrated firms, who are forced to match the specialization advantages achieved through contractual outsourcing. Consistent with general tendencies in information technology markets, this has resulted in a rough convergence of organizational form: that is, even the largest firms have adopted some elements of the fabless model. In 2007, IBM established the Common Platform Alliance, a joint project with Samsung, another integrated manufacturer, and Chartered Semiconductor, a foundry, that is intended to provide a package of services for designing and producing "SoC" chips for systems integrators and other intermediate users.[131] In 2009, AMD, the world's second largest microprocessor chip firm, spun off its manufacturing arm into an independent foundry entity

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129 Source: Global Semiconductor Alliance ("GSA"), avail. at www.gsa.org.

130 Source: http://www.gsaglobal.org/resources/industrydata/facts.asp (last visited June 4, 2010).

131 For further information, see "Common Platform—About Us", avail. at http://www.commonplatform.com/about/manufacturing_partners.asp (last visited May 26, 2010); and IBM Corporation, "Common platform technology" (2006), avail. at http://www.commonplatform.com/newsroom/collateral/benefits_of_collab.pdf (last visited June 6, 2010).

(Globalfoundries, which acquired Chartered Semiconductor in early 2010), thereby converting the remainder of the company into what is now the world's second largest fabless firm.[132] These "top-down" organizational movements toward vertical disintegration imply some cost or quality advantage of specialized design-only and production-only firms relative to the integrated model. The market is apparently rewarding firms that select disintegrated forms of implementing commercialization, which, absent countervailing advantages or transactional frictions, ultimately must result in a universal outsourcing outcome that compels all firms to pursue similar organizational strategies.[133]

c. Re-Intermediation

The re-organization of firm and market structure follows a "Humpty Dumpty" logic. After the firm supply chain is broken apart, the market supply chain must be put back together. Disaggregation of the design and production functions of the supply chain and the resulting multiplication of the number of sources of, and increased variety of, supply chain functions and inputs, result in informational complexities that in turn induce entry by intermediaries that offer transactional technologies that lower search and evaluation costs for buyers and sellers of functions and inputs. This re-intermediation process forms the basis for an emerging market in licensing and trading design modules and design tools that support disaggregated processes for the design and production of ASIC devices.

Three principal firm types promote the development of this market: (i) software tool providers; (ii) standardization consortia; and (iii) IP aggregators. These can be described briefly as follows.

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[132] *See* Mark LaPedus, *AMD foundry spinoff open for business,* EETimes, March 4, 2009 (avail. at http://www.eetimes.com/showArticle.jhtml?articleID=215800352); Tuomi, *supra* note __, at §4.1.2.3.

[133] Certainly not all market segments. The integrated model is still the predominant business structure in the microprocessor and memory chip markets and often has certain advantages, including sometimes superior performance as a result of proprietary interfaces and superior coordination with in-house fabrication capacities. *See* Linden & Somaya, *supra* note __, at 571-72; Macher et al., *E-Business, supra* note __, at 6.

- *Software Tool Providers.* Software tool providers are indispensable in permitting disaggregation of design and production functions in the supply chain. These firms provide software[134] that allows design firms to simulate the function of the circuit being designed, which facilitates the transmission of design information from fabless firms to foundries.[135] That in turn facilitates vertical disintegration by limiting interdependency between design and production functions.

- *Standardization Initiatives.* Industry consortia consisting principally of fabless firms, "EDA" software providers, design services firms, systems integrators and other participants, have emerged that seek to promote standardized design, trading and/or licensing protocols. Standardization alleviates informational asymmetries relating to buyer concerns over the performance of modules consistent with the buyer's chip architecture, which can frustrate trading in design modules. While substantial obstacles remain, these consortia have achieved some progress in achieving this objective.[136]

- *IP Suppliers.* Since the early 1990s, the fabless market has witnessed the emergence of a tertiary market segment consisting of "IP suppliers" or aggregators (also known as "chipless" firms). These firms, which accrued estimated revenues of over $2 billion in

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134 *See* Linden & Somaya, *supra* note __, at 568. Note that some EDA firms have moved further up the supply chain by acquiring design modules and then licensing them out together with support services. *See id.*, at 569. For further description of third-party design services, see KUMAR, *supra* note __, at 142.

135 For more detailed discussion, see Chesbrough, *supra* note __, at 194 n.4; von Hippel, *Sticky Information, supra* note __, at 70-71; ARORA ET AL., *supra* note __, at 79; Linden & Somaya, *supra* note __, at 568-69.

136 Almost concurrently with the emergence of the "system on a chip" market, software companies, fabless chip companies and other entities established the VSI Alliance (disbanded in 2008) in order to establish standardized interfaces for the transmission of design modules from fabless firms to foundries and the circulation of design modules among chipless and fabless firms. *See* Grant Martin, *The History of the SoC Revolution: The Rise and Transformation of IP Reuse,* in WINNING THE SOC REVOLUTION: EXPERIENCES IN REAL DESIGN 4-5 (ed. Grant Martin & Henry Chang 2003). Other leading standardization initiatives are as follows: (i) OCP International Partnership, which provides an openly-licensed socket ("IP core interface") (OCP 2.2), www.ocpip.org; (ii) the SPIRIT consortium, which provides a "metadata" standard for describing design modules (IP-XACT 1.4), www.spiritconsortium.org; (iii) Accellera (to merge with SPIRIT in 2010), which provides design and verification standards, including hardware design language (SystemVeriLog; VHDL), www.accellera.org; (iv) Open System Initiative, which provides an open industry standard for system-level modeling, design and verification (SystemC 2.2) and interface standard enabling interoperability of models at transaction level (TLM Standard 2.0), www.systemc.org; and (v) Silicon Integration Initiative, which provides open interface standards for producing integrated silicon systems, www.si2.org. On obstacles to achieving greater standardization in the semiconductor market, see Macher et al., *E-Business, supra* note __, at 11-16.

2008[137], accumulate libraries of performance-tested "IP blocs" or "IP modules"[138] for licensing to chip design firms, foundries and integrated manufacturers.[139]

Let's take a closer look at ARM Holdings, the current market leader (2009 revenues of $489.5 million, market capitalization of approximately $1.9 billion) in the emerging IP supplier market.[140] ARM derives royalty revenues from licenses of its patented "RISC" processor designs to integrated and fabless semiconductor firms as well as systems integrator firms in the computing and telecommunication industries, which then create SoC devices based on the licensed designs. This model has resulted in impressive levels of market penetration: as of year-end 2009, ARM-based processors are used in over 75% of all mobile phones (its principal market), 75% of portable media players, 60% of digital cameras, 65% of hard disk drives, 60% of printers and 30% of digital TVs and set top boxes.[141] Like other IP suppliers, ARM maintains an inventory of design modules that can be reused across a variety of applications, and, through planning and estimation tools, alleviate valuation obstacles to licensing transactions. Design reuse reduces substantially the costs of designing a new chip, which in turn lowers licensees' development costs and facilitates entry by fabless entrants as well as sophisticated systems integrators.[142] This entry-enabling effect is illustrated by Apple, which

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137 *See* Ikka Tuomi, *The Future of Semiconductor Intellectual Property Architectural Blocks in Europe,* JRC SCIENTIFIC AND TECHNICAL REPORTS §2.1.1 (2009) (citing preliminary data from Gartner, Inc. reporting $1.486 billion in design IP licensing revenues and $586 million in semiconductor IP technology licensing).

138 Other terms include: "design blocs" or "SIPs", an abbreviation for "silicon intellectual properties". Note that "IP" is used in a broad sense in the industry and refers to cell libraries, input-output devices, memory devices, and analog mixed signal blocks, some but not all of which may be covered by patents or other forms of intellectual property. However, the "IP" is always licensed subject to contractual and/or technological restrictions.

139 *See* ARORA ET AL., *supra* note __, at 76-77; Linden & Somaya, *supra* note __, at 568-69; KUMAR, *supra* note __, at § 5.9.4, 9.4.2-3; Attia et al., *supra* note __, at 146, 165-67.

140 ARM Holdings plc, Annual Report (2009). Avail. at http://media.corporate-ir.net/media_files/IROL/19/197211/ARM_Annual_Report_2009.pdf (last visited June 7, 2010). To be precise, ARM is the market leader among "pure play" chipless firms. However, leading fabless firms (for example, Qualcomm and Rambus) also license out design modules and therefore participate in the chipless market as well.

141 *See id.*, at p.14.

142 *See* Ernst, *supra* note __, at 10 (citing industry sources stating that systematic design reuse can cut chip development costs in half in three years and by more than 70% in six years, relative to chip design without any reuse, principally because it reduces the amount of design resources devoted to verification).

temporarily entered the fabless market by licensing an ARM design and contracting with foundries to develop and manufacture a customized chip for the iPad device.[143] ARM and other IP suppliers provide an unusually well-developed illustration of a market in ideas, which relies on the security umbrella consisting of the property rights, technological protections and contractual instruments that safeguard the transmission of those ideas.

D. Implications: The Potential Virtues of Resource Fragmentation

It is widely asserted (but infrequently documented) that strong patents, and the resulting fragmentation of intellectual resources, preclude entry into technology markets or engender dispute-resolution and other transaction costs that impede innovation.[144] The fabless market provides a counterfactual to both propositions—and incidentally, suggests why, contrary to those repeated assertions, today's most patent-intensive technology markets show no signs of predicted slowdowns in innovative output after almost three decades of intensive patent adoption and enforcement. While the causality is not certain[145], there appears to be a strong connection between widespread adoption and enforcement of patents and positive effects over entry conditions in the ASIC market. Without patents, it is unlikely that R&D-intensive start-ups could have challenged integrated incumbents who were protected by the exceptional capital costs of the fabrication process. History supports this view: the fabless model was in part motivated by the unwillingness of venture capital firms to fund the fabrication portion of the supply chain.[146] To be clear, this does not imply—as the conventional formulation of the

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This observation effectively confirms an intuition advanced by Mark Lemley and Julie Cohen with respect to the software market. *See* Mark A. Lemley and Julie E. Cohen, *Patent Scope and Innovation in the Software Industry,* 89 CALIF. L. REV. 1 (2001) (arguing that patent rights over software may promote reuse of software by allowing firms to earn returns on programming concepts that would otherwise not be disclosed).

143 *See* Vance, *supra* note __.

144 *See supra* notes ___.

145 For an attempt to address this difficult causality question, see Jeff Thurk, *Market Effects of Patent Reform in the Semiconductor Industry* (Working Paper 2009) (running policy simulation to estimate effects of increased patent protection and increased market size (demand shock) on R&D investment and finding contribution of market size is greater; however, there are still significant effects of patent protection on licensing revenue and the number of fabless firms).

146 *See* Hutcheson, *supra* note __, at 35-14.

incentive thesis *would* imply—that the semiconductor market would have failed to sustain substantial innovation without strong patents. Most likely, the industry would have sustained innovation through the integrated structures and interfirm cooperative arrangements that had captured innovation returns for several decades. And the industry may have been spared the litigation costs inherent to the aggressive patent enforcement strategies of the fabless sector (see the widely-publicized litigations involving fabless firms such as Rambus, Broadcom and Qualcomm)[147] or the opportunistic litigation strategies of some patent acquisition firms.[148]

But it is important to keep in mind that the "peace and quiet" of weak patent regimes comes at a price. With occasional exceptions[149], legal (as well as most economic) scholarship tends to assume that a world without patents necessarily enjoys reduced transaction costs and lower access barriers. To the contrary: a patent-free world is plagued by the transaction costs that frustrate idea exchanges without property rights, which can then induce substitution toward integrated structures that protect the most highly-integrated incumbents that can more easily bear the cost of building and maintaining those structures. The result: transaction costs and access costs are lower for some firms but higher (potentially, much higher) for others—in particular, for R&D-dedicated firms that may pose the strongest threat to sheltered incumbents. Political economic behavior tends to support this view. Large-firm incumbents (along with dominant firms in other complex technology markets) tend to support legislative

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147 On Qualcomm's aggressive patent litigation strategy, see Annabelle Gawer & Michael A. Cusamano, *How Companies Become Platform Leaders,* MIT SLOAN MGMT. REV. 28, 31-32 (Winter 2008). On patent litigation between Qualcomm and Broadcom, see "Qualcomm to pay $891 million to settle litigation", April 27, 2009. Avail. at http://www.reuters.com/article/idUSTRE53Q08C20090427 (last visited June 4, 2010).

148 This refers to the so-called "trolls" phenomenon. The extent of the phenomenon remains unclear. For relevant studies, see Gwendolyn Ball & Jay P. Kesan, *Transaction Costs and Trolls: Individual Inventors, Small Firms and Entrepreneurs in Patent Litigation* (Working Paper 2008); Colleen V. Chien, *Of Trolls, Davids, Goliaths and Kings: Narratives and Evidence in the Litigation of High-Tech Patents*, 87 N. C. L. REV. (2009); John R. Allison, Mark A. Lemley and Joshua Walker, *Extreme Value or Trolls on Top? The Characteristics of the Most-Litigated Patents,* 158 U. PENN. L. REV. 1 (2009).

149 Steven Cheung once asked: "[E]conomists tend to overlook the crucial question: What would an inventor or innovator do if there were no patent protection?" Possible answer: not inventor or invent subject to secrecy. *See* Cheung, *supra* note __, at 40-41. *See also* Adelman, *Supreme Court, supra* note __, at 458, 463, 466 (observing that the absence of patents necessitates using other entry barriers in order to block imitation).

reforms[150] that would reduce (and have tended to supported judicial decisions that have reduced) patent coverage while fabless firms and venture capitalists tend to resist those changes.[151] Whether integrated firms' private interest in weaker coverage is consistent with the public interest is a net social welfare question that is extremely difficult to settle.[152] Ultimately, the policy choice between weaker and stronger patent regimes may reduce to a social choice between hierarchical and entrepreneurial innovation regimes (where, to be clear, weak patents result in the former scenario).[153] At a minimum, however, the revealed policy preferences of incumbents and entrants cast doubt as to whether relaxing patent coverage necessarily improves access for intermediate users or

[150] For the latest proposed bills, see Patent Reform Act of 2009, designated as S.515 (reported with amendments April 2, 2009) and H.R. 1260 (introduced March 3, 2009).

[151] For a fuller discussion of these tendencies, see Jonathan M. Barnett, *Property as Process: How Innovation Markets Select Innovation Regimes,* YALE L. J. (2009). For an example of support for the proposed reforms by a technology trade association that includes larger technology firms (including leading integrated chip manufacturers such as Intel and Micron), see Coalition for Patent Fairness, Letter to the President, Mar. 23, 2009. Avail. at http://www.patentfairness.org/pdf/CEO_letter.pdf (last visited June 8, 2010). The Innovation Alliance, which tends to represent smaller technology firms (including fabless firms, Qualcomm and LSI Logic), and the National Venture Capital Association, which represents venture capitalists, had previously opposed the reform effort but are now prepared to accept the legislation after considerable modifications (which is now *opposed* as being too weak by the Coalition for Patent Fairness, which tends to represent larger technology firms). For an example of small-firm and individual inventor opposition to the proposed reforms, see Letter from Small Business Coalition on Patent Legislation to Karen G. Mills, Administrator, Small Business Administration, Dec. 15, 2009. Avail. at http://patentdocs.typepad.com/files/coalition-letter-to-sba-dec-15-09.pdf (last visited June 8, 2010). On prior opposition by smaller technology companies, see Anne Broache, *Patent law overhaul: Bad for start-ups?,* cnet news, Sept. 20, 2007, avail. at http://news.cnet.com/Patent-law-overhaul-Bad-for-start-ups/2100-1028_3-6209223.html (last visited June 8, 2010) and by venture capitalists, see Anne Broache, *Tech companies, investors clash over patent law,* cnetnews, Mar. 29, 2007, avail. at http://news.cnet.com/Tech-companies%2C-investors-clash-over-patent-law/2100-1028_3-6171866.html?tag=mncol;txt (last visited June 8, 2010); on the changes in position with respect to the modified bill, see Kim Hart, *Tech industry splinters over patent reform proposal,* Hillicon Valley, March 9, 2010. Avail. at http://thehill.com/blogs/hillicon-valley/technology/85515-tech-industry-splinters-over-patent-reform-proposal (last visited June 8, 2010). For prior efforts by IBM in support of judicial decisions that reduce patent protection, see Brief of International Business Machines as Amicus Curiae in Support of Neither Party, *eBay, Inc. v. MercExchange, LLC*, 126 S.Ct. 1837 (2006) (arguing against Federal Circuit's "automatic" standard for permanent injunctions and in favor of traditional standard that permits greater use of equitable discretion); Brief of International Business Machines as Amicus Curiae in Support of Neither Party, *KSR Int'l Co. v. Teleflex, Inc*., 127 S.Ct. 1727 (2007) (arguing against Federal Circuit's standard for determining nonobviousness and in favor of standard that would make it easier for PTO to reject combination patent applications);

[152] For a brief review of the social costs of patents that would enter a full cost-benefit analysis, see *supra* note __.

[153] Reputation-based or norm-governed regimes may support non-hierarchical innovation under limited circumstances characterized by low capital intensities and other qualifying conditions. However, as I have argued elsewhere, even these regimes accrue returns through the use of property rights or other

expands output for end-users. If the dispute resolution costs inherent to the patent system are required to facilitate entry into capital-intensive technology markets, and are a precondition for *any* formal market in arm's-length trading in intellectual resources, sometimes that may reasonably be deemed a price worth paying.

Conclusion

The incentive justification for intellectual property is challenged. Bereft of compelling empirical support outside of selected markets, the incentive thesis in its conventional form has middling force against the view that the expensive apparatus for the legal protection of intangible goods is anything other than a generalized exercise in rent-seeking. This Article provides a basis for reinvigorating the incentive thesis even in the most "IP-hostile" environment where firms have access to powerful alternative technologies by which to capture innovation returns. *A fortiori* the incentive thesis is bolstered in all other environments. The key to this approach lies in construing intellectual property as an instrument for organizing intellectual production, not inducing it. Most precisely: *intellectual property typically regulates innovation incentives solely to the extent that it regulates the choices of organizational forms by which to implement innovation*. This proposition gives rise to two important implications. First, as a positive matter, it means that transactions, firms and markets "look different" under stronger or weaker levels of intellectual property. Strong patents provide firms with opportunities to disaggregate supply chains through contract-based relationships, which in turn give rise to trading markets in intellectual resources, whereas weak patents foreclose those options. Second, as a normative matter, adjusting firm scope and breaking up supply chains to extract specialization gains facilitates entry into capital-intensive markets that are otherwise sheltered against competitive threats—precisely due to the *absence* of patents. Subject to technological constraints, patents can generate efficiency effects by correcting for the natural selection bias against weakly-integrated enterprises that cannot bear the commercialization costs required to independently enter capital-intensive technology markets. These mediated effects over innovation behavior in turn can yield—and most

access controls over an allied set of complementary assets, which therefore degenerates into a hierarchical regime. *See* Barnett, *Illusion of the Commons, supra* note __.

likely have yielded—far-reaching effects on the organizational structures of technology markets that can ultimately result in the transactional milestone constituted by a reasonably well-functioning market in ideas. As an instrument for inducing even substantial levels of innovation investment, intellectual property may often or even typically have questionable added value outside of selected industries. As an instrument for supporting organizational choice that yields the most efficient levels of innovation investment, intellectual property may often or even typically be essential.