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Locating Innovation: The Endogeneity of Technology, Organizational Structure, and Financial Contracting

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ESSAY

LOCATING INNOVATION: THE ENDOGENEITY OF TECHNOLOGY, ORGANIZATIONAL STRUCTURE, AND FINANCIAL CONTRACTING

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There is much we do not understand about the "location" of innovation: the confluence, for a particular innovation, of the technology associated with the innovation; the innovating firm's size and organizational structure; and the financial contracting that supports the innovation. This Essay suggests that these three indicia are determined simultaneously and discusses the interaction among them through four examples of innovative activity whose location is characterized by tradeoffs between pursuing the activity in an established company, in a smaller, earlier-stage company, or some combination of the two. It first considers the dilemma faced by an established company in deciding whether to keep an employee's innovation or allow the employee to pursue the innovation through a startup. It next takes up a very different relationship between an established company and an earlier-stage company: the development by the smaller company of a "disruptive" innovation that displaces the industry's dominant companies. This Essay then considers an established company's instrumental use of the startup market to outsource development of a particular innovation to a technology race. Finally, this Essay examines a form of innovation located between an established and earlier-stage company: the pattern of joint ventures between large pharmaceutical companies and smaller biotechnology companies.

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INTRODUCTION

There is much we do not understand about what I will call the "location" of innovation: the confluence, for a specific innovation, of the technology associated with the innovation; the size and organizational structure of the firm in which the innovation is pursued; and the financial contracting that supports the innovation. Why do certain technologies match with certain financial contracts and certain organizational structures? For example, why are innovative drugs increasingly developed through joint ventures between capital-heavy large pharmaceutical companies ("pharmas") and smaller but technologically savvy biotechnology ("biotech") firms, rather than completely within large pharmas? Also, why did so much of Cisco's 1990s development of networking infrastructure take place through the acquisition and quick integration of hundreds of startup firms with relevant premarket technologies? Why didn't Cisco itself simply develop those technologies? The same questions arise with respect to the location of any innovation, including those with the highest public profile: venture capital-backed startups, which have given rise to companies such as Intel, Apple, and Google.

The gaps in our knowledge are not from lack of effort. Few matters of commerce have so captured the energy and resources of so many in business, academia, and government. This attention is unsurprising; after all, innovation represents the source of future economic growth and, in a global economy, holds the prospect of economic success based on something other than wage competition. And, indeed, we have much to show for these efforts. For example, there is now extensive literature analyzing the financial contracting forms associated with venture capital and the organizational structure of both venture capital funds and the startups in which they invest.[1] There are also assessments of the conditions

1. The literature began with a flurry of groundbreaking studies by Paul Gompers and Joshua Lerner, writing together and separately. This work is compiled and extended in Paul Gompers & Josh Lerner, The Venture Capital Cycle (2d ed. 2004). Steven Kaplan and Per Strömberg extended this work by analyzing a data set of 213 venture capital investment contracts. Steven N. Kaplan & Per Strömberg, Financial Contracting Theory Meets the Real World: An Empirical Analysis of Venture Capital Contracts, 70 Rev. Econ. Stud. 281, 281 (2003) ("In this paper, we attempt to inform theory by describing in detail the contracts between VCs [venture capitalists] and entrepreneurs."). More recently, Amar Bhidé has broadly examined the effect of globalization on domestic venture capital financing. Amar Bhidé, The Venturesome Economy: How Innovation Sustains Prosperity in a More Connected World (2008).

necessary to the success of the venture capital market,[2] and the potential role for the government in creating such a market.[3] This literature is characterized by a vibrant interaction between theory and empirical investigation, with the particular advantage that investigators have worked directly with actual transaction documents.[4] Theory is brought to bear on what those individuals and firms engaged in innovative work actually do, and how the organizations that pursue innovation are actually structured.[5]

But venture capital, while certainly important in its own right, is just a drop in the innovation bucket. In 2006, the four largest U.S. corporate research and development (R&D) programs alone invested more than five times what the entire U.S. venture capital industry put into seed, early-stage, and startup investments, the areas where the focus on innovation is most intense.[6] And even large R&D programs do not capture the full picture of the location of innovation. Indeed, we see R&D carried out in a virtual Cambrian explosion of organizational forms. In addition to venture capital and the in-house research efforts of major companies, innovation is at the core of, among others, angel-financed startups operating earlier in the life cycle than venture capital is available;[7] joint ven-

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2. See, e.g., Bernard S. Black & Ronald J. Gilson, Venture Capital and the Structure of Capital Markets: Banks Versus Stock Markets, 47 J. Fin. Econ. 243 (1998) and sources cited therein.

3. See, e.g., Ronald J. Gilson, Engineering a Venture Capital Market: Lessons from the American Experience, 55 Stan. L. Rev. 1067 (2003) [hereinafter Gilson, Engineering Market] and sources cited therein.

4. See, e.g., Gompers & Lerner, supra note 1, at 30 ("[W]e examine compensation terms in 419 venture partnership agreements and offering memoranda for funds formed between 1978 and 1992."); Kaplan & Strömberg, supra note 1, at 281 (explaining each venture capital firm studied provided "contractual agreements governing each financing round in which the firm participated" and, if available, "the company's business plan, internal analyses evaluating the investment, and information on subsequent performance").

5. See, e.g., Gompers & Lerner, supra note 1, at 127–54; Kaplan & Strömberg, supra note 1, at 281–82.

6. In 2006, total U.S. seed, startup, and early-stage venture capital investments amounted to some $5.5 billion. PricewaterhouseCoopers & Nat'l Venture Capital Ass'n, Money Tree Report, available at https://www.pwcmoneytree.com/MTPublic/ns/nav.jsp?page=historical (select "startup/seed" for "stage"; then select "early stage" for "stage"; then add all figures) (last visited Feb. 10, 2010) (on file with the *Columbia Law Review*). The combined 2006 R&D spending of Pfizer, Ford, Johnson & Johnson, and Microsoft was approximately $30 billion. Barry Jaruzelski & Kevin Dehoff, The Customer Connection: The Global Innovation 1000, at 10 (2007), available at http://www.strategy-business.com/media/file/sb49_07407.pdf (on file with the *Columbia Law Review*).

The attraction of venture capital-based companies is in their disproportionate success in innovation. See Samuel Kortum & Josh Lerner, Assessing the Contribution of Venture Capital to Innovation, 31 RAND J. Econ. 674, 691–92 (2000) (reporting venture capital-backed companies produced close to three times their proportional amount of patents based on R&D spending).

7. See, e.g., Darian M. Ibrahim, The (Not So) Puzzling Behavior of Angel Investors, 61 Vand. L. Rev. 1405, 1416–20, 1452 (2008); Brent D. Goldfarb et al., Does Angel

tures between large companies that combine research efforts in a particular field;[8] joint ventures between large and small companies, especially prevalent in the pharmaceutical industry;[9] and collaborative innovation between adjacent parties in the vertical supply chain.[10]

While each of these individual examples has been the object of academic attention, they have by and large been treated separately, as standalone silos of innovation rather than as different solutions to the same overall problem. The features of each location are mapped, but less attention is paid to why particular types of innovative activity take place in different locations corresponding to different combinations of technology, the organizational structure in which the technology is developed, and the financing mode. In this preliminary framing of the problem, I will suggest that technology, organizational structure, and financing are determined simultaneously, each dependent on the others. In this sense, in the location of innovation, there is no independent variable.

My approach to this problem is found at the "T" intersection of (1) Ronald Coase; (2) Franco Modigliani and Merton Miller; and (3) Oliver Williamson and the property rights literature initiated by Sanford Grossman, Oliver Hart, and John Moore. Coase tells us that frictions determine the organizational location of productive activities: Whether a product will be produced entirely within a single company or whether elements of it will be acquired by contract across a market is determined by the transaction costs (particularly the cost of information) associated with the alternative modes of production. In the absence of frictions, the organizational form in which an innovative activity is carried out is irrelevant to firm value—all silos are the same.[11]

Participation Matter? An Analysis of Early Venture Financing 3 (Roger H. Smith Sch. of Bus., Working Paper No. RHS-06-072, 2009), available at http://ssrn.com/abstract=1024186 (on file with the *Columbia Law Review*) (reporting study results indicating firms financed by angel investors alone are more likely to survive than other firms).

8. For example, Pioneer Hi-Bred, a developer of bio-engineered seed stock, and DuPont, a leading producer of plant pesticides, combined large parts of their research efforts in a joint venture focused on developing genetically engineered seeds. Bloomberg News, DuPont to Invest $1.7 Billion in Pioneer Hi-Bred, N.Y. Times, Aug. 8, 1997, at D3.

9. See, e.g., David T. Robinson & Toby E. Stuart, Financial Contracting in Biotech Strategic Alliances, 50 J.L. & Econ. 559, 559–60 (2007) [hereinafter Robinson & Stuart, Financial Contracting] (describing pharmaceutical joint ventures between small biotech companies and mature pharmas).

10. See Ronald J. Gilson, Charles F. Sabel & Robert E. Scott, Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration, 109 Colum. L. Rev. 431, 450–58 (2009). Even the examples given are limited to commercial locations of innovations; university and government-based research projects are not mentioned.

11. See Ronald Coase, The Nature of the Firm, 4 Economica 386, 390–91 (1937).

Modigliani and Miller,[12] reframed in the spirit of Coase,[13] tell us that frictions also determine a firm's capital structure—how the assets on the left side of the balance sheet are financed by the contributions on the right—and the terms of the financial contract associated with particular capital structure instruments.[14] In the absence of transaction costs, the particular sources of financing and the financial contract that governs their provision also are irrelevant to firm value.

Williamson steps behind the no-transaction-costs veil and addresses the types of transaction costs that shape organizational structure and financial contracting in the real world, where frictions are pervasive and information is costly and unequally distributed among the necessary parties. When information differentials are combined with specific investment, the potential for opportunism—"self-interest seeking with guile" as Williamson puts it—arises.[15] Grossman, Hart, and Moore build on the contract theory literature to explain firm boundaries (the distribution of asset ownership) as a means to address problems of incomplete contracting motivated by information problems, and the financial structure that supports asset ownership.[16]

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12. Franco Modigliani & Merton H. Miller, The Cost of Capital, Corporate Finance and the Theory of Investment, 48 Am. Econ. Rev. 261 (1958) [hereinafter Modigliani & Miller, Cost of Capital].

13. Coase was explicit that liability's location was irrelevant only in a transaction-cost-free world; his point was that because the world was so messy, the study of frictions should be at the core of the agenda. R.H. Coase, The Problem of Social Cost, 3 J.L. & Econ. 1, 43 (1960). Miller reports having the same point in mind. Writing thirty years after the irrelevancy propositions were first published, Modigliani & Miller, Cost of Capital, supra note 12, Miller stated that "[l]ooking back now, perhaps we should have put more emphasis on the other, upbeat side of the 'nothing matters' coin: showing what *doesn't* matter can also show, by implication, what *does*." Merton H. Miller, The Modigliani-Miller Propositions After Thirty Years, J. Econ. Persp., Fall 1988, at 99, 100 [hereinafter Miller, The Modigliani-Miller Propositions]. Of course, that implication drove a significant research agenda in financial economics over the thirty years following its publication. See, e.g., Bengt R. Holmstrom & Jean Tirole, The Theory of the Firm, *in* 1 Handbook of Industrial Organization 61, 78–86 (Richard Schmalansee & Robert Willig eds., 1989).

14. As Miller put it in 1988, capital structure irrelevance was simply "an implication of equilibrium in perfect capital markets." Miller, The Modigliani-Miller Propositions, supra note 13, at 99.

15. Oliver Williamson, The Economic Institutions of Capitalism 47 (1985) (defining opportunism).

16. Sanford J. Grossman & Oliver D. Hart, The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration, 94 J. Pol. Econ. 691, 693–95 (1986); Oliver Hart & John Moore, Property Rights and the Nature of the Firm, 98 J. Pol. Econ. 1119, 1152–53 (1990) ("[W]e have ignored issues having to do with the dissemination of information and with how coordination takes place between individuals with different sources of information but possibly similar goals. . . . [W]e believe that our analysis has identified some of the forces determining the boundaries of the firm."). Both the transaction cost and property rights literatures are surveyed in Francine Lafontaine & Margaret Slade, Vertical Integration and Firm Boundaries: The Evidence, 45 J. Econ. Literature 629, 649–62 (2007).

As framed by the complementary irrelevancy propositions, the location of innovation—each combination of technology, organizational form, and financial contracting that defines a characteristic pattern of investment in innovation—reflects a particular combination of transaction and information costs that tie the organizational form (Coase) and financial contracting (Modigliani and Miller) to the particular technology. We can explain the variety of innovative activities across organizational structure and financial contracts, then, as the interaction of endogenous variables: Technology influences informational asymmetries and transaction costs, which in turn—theory tells us—influence organizational form. A fully formulated account should therefore be able to predict which forms of innovation generally will take place, for example, within startup companies financed by venture capital, within the research labs of existing large companies, or through cooperation among separate entities.[17]

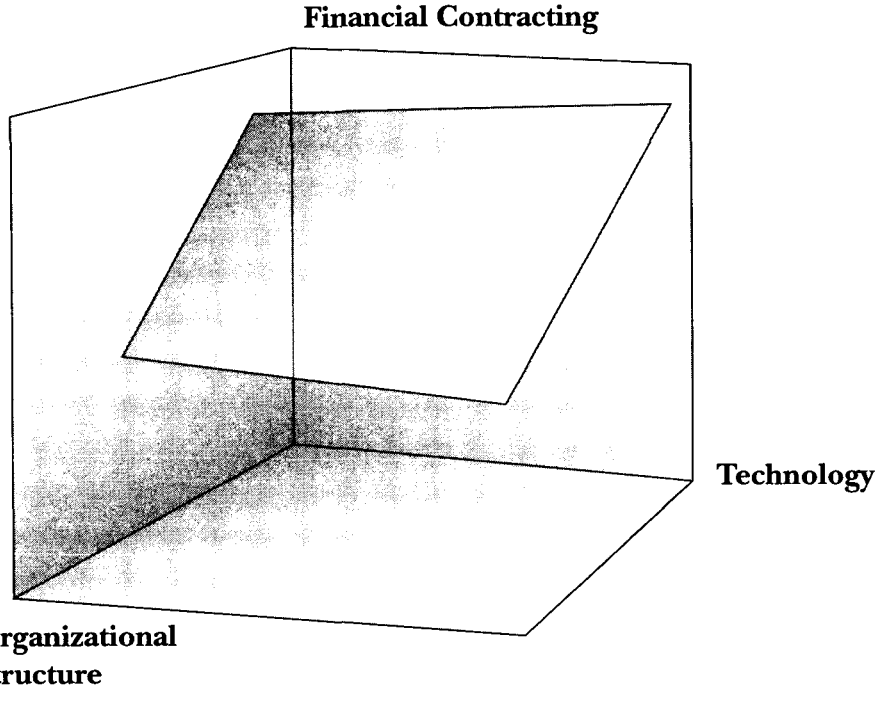
The goal here is to contribute to the understanding of innovative activity distribution across different types of organizations, in different industries, and using different financial contracts. My ambition at this initial stage of a very large undertaking is limited. I will consider a small segment of the three-dimensional locational distribution of innovation. Figure One illustrates the relationship between each dimension: A particular innovation is developed in a setting that reflects a particular combination of technology, organizational structure, and financial contracting.

Each of the four examples I use represents a different set of transaction and information costs underlying the three determinants of the innovation's location. Thus, the result is not a continuum, since each location represents not a linear relationship between two factors, but something three-dimensional. The transaction costs associated with technology, organization, and finance combine to dictate, for example, the need for and ability to design intense incentives, the capacity of managers and investors to monitor the objects of those incentives with comparable intensity,[18] and the level of information costs that influences the parties' ability to determine their counterparties' characteristics in financing an innovation. The transaction costs also dictate the observability and verifiability of opportunistic behavior and the array of factors necessary to support a reputation market that both supplements and supports the explicit contracts between innovative capital providers and those needing

17. Sharon Belenzon, Tomer Berkovitz, and Patrick Bolton make a similar point, stressing a Coasean perspective in assessing the allocation of R&D between business groups and conglomerates. Sharon Belenzon et al., Intracompany Governance and Innovation 23–37 (Nat'l Bureau of Econ. Research, Working Paper No. W15304, 2009), available at http://ssrn.com/abstract=1463897 (on file with the *Columbia Law Review*).

18. Paul Milgrom & John Roberts, Economics, Organization and Management 221–28 (1992) [hereinafter Milgrom & Roberts, Economics, Organization & Management] (discussing correlation between incentive and monitoring intensity).

FIGURE 1: THE INNOVATIVE PLANE



capital. All of these factors, in turn, determine the actual location of particular innovative activity.

Here I take up four clusters of innovative activity characterized by tradeoffs between pursuing an innovation in an established company, a smaller earlier-stage company, or some combination of the two. Part I considers the dilemma faced by an established company in deciding whether to retain an employee's innovation or to stand back and allow the employee to pursue the innovation in a startup company backed by third-party venture capital. In light of the advantages held by an established company, the question is why we ever see startups in this situation. Part II then addresses a very different relationship between an established company and an early-stage company: the early-stage company's development of an innovation that "disrupts" existing industry patterns by devaluing the skills and experience of the industry's dominant companies. Here we confront the question of "organizational ambidexterity": Can the same organization and financing arrangements successfully support development of the dominant technology while simultaneously supporting development of the technology that will supplant the dominant technology and devalue the organization's expertise associated with it? Part III takes up an established company's instrumental use of the startup market—that is, the company's decision to outsource the development of particular innovations to a technology race between startup and early-

stage companies, with the intention of acquiring the race's winner. Finally, Part IV addresses a form of innovation located somewhere between a large and small company: the pattern of joint ventures between large pharmas and small, earlier-stage biotech firms through which a growing amount of pharmaceutical research takes place.

Of course, focusing on these four clusters affecting established and early-stage companies ignores other locations that account for a large proportion of total innovation. Most important, it ignores the research labs of established companies, where research is financed by cash flow and the company's credit, and is organized within an existing corporate structure. For now, however, these four examples, which illustrate the complexity of the locational decision even within the narrow choice of the host entity's size and maturity, are sufficient to demonstrate the value of a comparative analysis that helps explain how technology, organizational structure, and financial contracting combine to influence the location of innovation.

I should also note that the interaction between technology, organizational structure, and financing underlying the innovative activity highlighted here is preliminary, with no small risk of apophenia. In this respect, it is something of a five-finger exercise, proposing rough hypotheses for what appear to be regularities among the attributes associated with the locations of different innovative activity. The taxonomy thus invites both expansion to other regions of the innovation three-dimensional space, and further analytic and empirical testing of the hypothesized relationships, which may then falsify some of the hypotheses and refine others. Nevertheless, I am far more confident that the premise that gives rise to the effort is correct: We will not understand where innovation takes place—in which organizations and with what kind of financing—without understanding the endogeneity of the innovative technology, the financial contracting that feeds it, and the industrial organization that supports it.

Two final introductory matters remain to be considered, the first a qualification and the second a further justification of the effort. The qualification concerns the static character of the analysis, in which fixed clusters of characteristics place innovative activity at fixed locations. Of course, innovation and its organizational shelter and financing are dynamic, not static; endogeneity itself implies the prospect of change. Venture capital, for example, is much different and much more important than it was when American Research and Development, the first venture capital fund, was conceived immediately following World War II.[19] The capital market has changed, transaction and information costs have changed, and the technologies that must be financed have changed.

19. See David H. Hsu & Martin Kenney, Organizing Venture Capital: The Rise and Demise of American Research & Development Corporation, 1946–1973, at 14 Indus. & Corp. Change 579, 580 (2005).

Rather than a point in three-dimensional space, perhaps the better metaphor is the three wheels on a slot machine, one for technology, one for organizational structure, and one for financing, each turning independently and at different speeds, that coincide for a time, until the lever is pulled again. Nonetheless, by understanding how the characteristics interact in their present alignment, we learn something about how future changes will affect the organizational outcome.

This above point concerns the normative, rather than the positive, payoff to the analysis. Professionals, often (but not limited to) lawyers, design organizational form and financial contracts. I have elsewhere referred to such professionals in general, and business lawyers in particular, as "transaction cost engineers."[20] The original structure of venture capital arrangements in Silicon Valley—the venture capital limited partnership that defines the arrangement between investors and venture capital professionals, the range of agreements between the venture capital fund and the portfolio company, and the fit between the two contractual relationships[21]—was the product of lawyers engineering a structure that accommodated their clients' needs.[22] Precisely because of the endogeneity of technology, organizational form, and financial contracting, as well as the dynamic character of innovation, positive theory helps transaction professionals structure the arrangements through which innovation takes place. Put differently, some combination of other people, other entities, and someone else's money stand between an innovator's idea and an innovation reaching the market. Engineering those arrangements is not the only thing business lawyers do, but it is perhaps the most interesting. Understanding the endogeneity of the location of innovation will help lawyers do it better.[23]

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20. Ronald J. Gilson, Value Creation by Business Lawyers: Legal Skills and Asset Pricing, 94 Yale L.J. 239, 243 (1984) [hereinafter Gilson, Value Creation].

21. See, e.g., Gompers & Lerner, supra note 1, at 65–90 (providing extended analysis of current research); Gilson, Engineering Market, supra note 3, at 1070–76 (detailing structure).

22. See Mark C. Suchman & Mia L. Cahill, The Hired Gun as Facilitator: Lawyers and the Suppression of Business Disputes in Silicon Valley, 21 Law & Soc. Inquiry 679, 690–91 (1996) (exploring role of lawyers in developing venture capital structure); Mark C. Suchman, The Contracting Universe: Law Firms and the Evolution of Venture Capital Financing in Silicon Valley 31–33 (Jan. 2006), available at http://www.ssc.wisc.edu/~suchman/drafts/kuniverse.web.pdf (unpublished manuscript, on file with the *Columbia Law Review*) (same).

23. Recently, a number of articles have taken aim at the characterization of a lawyer's role reflected in the text above. See, e.g., George W. Dent, Jr., Business Lawyers as Enterprise Architects, 64 Bus. Law. 279, 286–95 (2009); Steven L. Schwarcz, Explaining the Value of Transactional Lawyering, 12 Stan. J.L. Bus. & Fin. 486, 487, 498–99 (2007). While I am flattered that this formulation of a business lawyer's role still commands attention after twenty-five years, the thrust of the criticism warrants comment. First, commentators suggest that applying theory to engineer the organizations and contracts of innovation is only one, perhaps small, part of a transaction lawyer's role. In short, as Professor Dent puts it, my approach—what he calls the "received model"—"is too narrow." Dent, supra, at 281. He has in mind "a fuller vision showing that business lawyers perform a greater range of

I. WHY STARTUPS? THE DIFFERENTIAL EFFECT OF INTENSE INCENTIVES IN ESTABLISHED AND STARTUP COMPANIES

The classic Silicon Valley story involves an engineer leaving an established company with no more than an idea and determination, securing venture capital, and becoming fabulously wealthy either through an initial public offering or a sale of the company. As Willie Nelson sang, in the United States, our "heroes have always been cowboys."[24] Startup entrepreneurs are the cowboys of the high-tech world. The puzzle, however, is why we ever observe them.

Understanding the existence of startups illustrates the endogeneity of financing, technology, and organizational structure. There is a logic to why innovative technology conceived of by large-company engineers may become the crown jewel of venture capitalists. The technology, the organizational structure of the small firm, and the staged financing offered by venture capitalists are endogenous variables. Each component tells a vital piece of this story.

As a starting point, one might expect that innovation would be located largely within established firms. Such firms have a number of inherent advantages. External financing of high-risk future growth options is extremely expensive; the information asymmetry between capital providers and the funded company should make internal financing a far cheaper alternative.[25] Moreover, a successful company that knows its customers and its industry should have better information than a new firm about what industry customers want now and, perhaps more important, what they will want in the future. As a result, their capital budgeting for

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activities using a larger set of skills than in the received model." Id. Second, the critics point out, as did I, that other professions can do the very same thing. I agree with both points. Compare Schwarcz, supra, at 487 (arguing "the same types of value . . . could be added in business transactions by any sophisticated party, not necessarily one specially trained as a lawyer"), with Gilson, Value Creation, supra note 20, at 295 ("There is nothing traditionally 'legal' about the role I have described business lawyers as playing, nor are there any special requirements peculiar to lawyers necessary to play this role."). Business lawyers do many other things; transaction engineering is merely the most interesting and challenging. However, I take the broader theme of my now slightly dated claim to be largely accepted by the commentators, and I would happily substitute the following for the received model: A lawyer creates value by taking serious theory developed elsewhere in academia and bringing it to bear on the practice of law. Much theory has been developed since I wrote in 1984. For instance, the notion of teaching law students the tools to create value has given rise to successful courses in "Deals" at Columbia, Stanford, and the University of Pennsylvania Law Schools, among others. On occasion, these courses are taught jointly by the law school and business school. See Victor Fleischer, Deals: Bringing Corporate Transactions into the Law School Classroom, 2002 Colum. Bus. L. Rev. 475, 490–92 (discussing Deals courses).

24. Willie Nelson, My Heroes Have Always Been Cowboys, *on* Soundtrack: The Electric Horseman (Columbia Records 1984).

25. See Stewart C. Myers, The Capital Structure Puzzle, 39 J. Fin. 575, 589–90 (1984) (describing how cost of capital is function of information asymmetries).

supporting innovation should be less error-prone.[26] To the extent R&D will lead to extensions of existing products or markets, innovation by established companies should benefit from economies of scale or scope—for example, shared production, distribution, and marketing facilities, as well as the opportunity for shared general overhead expenses—that cannot be duplicated by a startup. Finally, the U.S. tax code subsidizes R&D by existing successful companies by allowing losses from failed attempts at innovation to offset otherwise taxable income from other activities.[27] Since startups have no other income against which their losses from a particular project may be set off, the government in effect gives established companies with a stable source of income an R&D tax subsidy that is not available to a startup entity.

And yet, significant innovation does occur within these seemingly disadvantaged startup or early-stage companies.[28] This Part takes up the puzzle by assessing the relative advantages and disadvantages of mature and startup companies. The conclusion is that mature employer companies rationally choose to let some employees with valuable innovations leave for startups.

A. *Why Startups?*

To see why any innovation takes place within startups, it is helpful to characterize the venture capital process as an auction: The employee innovator offers to sell an ownership interest in the intellectual property represented by her innovation.[29] While venture capital firms can participate in the auction, so too can the employer. And on a first cut, the employer should always win because the opportunity should be worth more to the employer, for the reasons discussed below.[30]

The employer's first advantage is more favorable tax treatment. As stated above, in the United States an investment made by an established company that has past income and can expect future income is subject to symmetric tax treatment: Gains are taxed, and losses are offset through beneficial tax reductions. Since innovation is risky, the ability to reduce

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26. Part III, infra, takes up a circumstance when the established firm will be at a disadvantage.

27. See Joseph Bankman & Ronald J. Gilson, Why Start-ups?, 51 Stan. L. Rev. 289, 293–95 (1999) (reviewing tax treatment of startups).

28. Research shows that such companies, fueled by venture capital, produced almost three times their proportional number of patents relative to their share of overall R&D spending in the first decade of the venture capital boom. Kortum & Lerner, supra note 6, at 675.

29. This formulation assumes that the engineer, rather than the employer, has the property rights in the idea, despite the fact that the innovation was typically conceived while the engineer was an employee. For a discussion of the engineer's property rights, see Ronald J. Gilson, The Legal Infrastructure of High Technology Industrial Districts: Silicon Valley, Route 128, and Covenants Not to Compete, 74 N.Y.U. L. Rev. 575, 597–609 (1999) (discussing legal protections of employee knowledge and inventions).

30. Part I.A draws on Bankman & Gilson, supra note 27.

taxes by the amount of losses from unsuccessful efforts is significant. In contrast, the startup's future tax treatment is asymmetric: While gains are taxed, losses provide no tax benefit because the failed startup has no past income and will have no future income.[31]

The employer also has a range of informational advantages. If the innovation has some relation to the employer's business—a reasonable assumption given the innovation's development during the employee's tenure—the employer should have better information than a venture capital firm about the innovator's talents, the innovation itself, and the potential market. Writ large, the argument reflects the pecking order theory of capital structure:[32] The spread between the costs of internal and external capital will increase as the information asymmetry between the company and providers of outside capital (like the venture capitalists) increases.

Finally, as previously noted, the employer's informational advantage shades into scope and scale economies. To the extent that the innovation complements the employer's business, commercialization of the innovation can benefit from shared customers, distribution channels and marketing, and perhaps some elements of manufacturing.

So why do we ever observe startups? Under these circumstances, something about the transaction and information costs of both the established employer and the venture capital-backed startup's organizational structure must result in efficiency advantages for the startup form that offsets the employers' tax, informational, scale, and scope advantages. There are two categories of explanations for the presence of startup ventures: first, problems that the employer has in taking advantage of the innovation, and second, advantages of the venture capital-backed startup form. In the case of startups, the technology favors locating the innovation in the employer; however, that advantage is trumped by the transaction and information cost differences between a large established employer and a single project startup.

B. *Problems with Employer Implementation*

The literature identifies a range of problems with employer implementation of the employee's innovation. Because these problems would not burden a startup, venture capitalists can often outbid employers in the metaphorical auction for innovations. A number of scholars have focused on the risk to the employee of merely disclosing the innovation; by doing so, the employee will compromise her intellectual property. The danger that the employer will misappropriate the innovation if it is disclosed in order to "bid" against the venture capitalist may cause the employee to favor a startup even if the innovation would be worth more if

31. The tax analysis is set out in more detail in Bankman & Gilson, supra note 27, at 293–95.

32. See Myers, supra note 25, at 581–85 (describing pecking order theory).

implemented by the employer.[33] Presumably, the venture capitalist does not present a misappropriation risk.

Although neither is wholly satisfactory, two elements arguably reduce the potential that the venture capitalist will misappropriate an innovation disclosed in a submitted business plan. The first, and less significant, is that because the venture capitalist is not an operating company, it has less reason than the employer to misappropriate the innovation: The employer can use the innovation in its own business, while the venture capitalist cannot. This analysis ignores, however, the fact that the particular startup will not be the venture capitalist's only investment. Even though the venture capitalist cannot itself use the employee's innovation, it will have ongoing investments in other startups, to which the employee's innovation might be valuable. The temptation to profit from misappropriated innovation by giving it to another portfolio company—in which, because of multiple financing rounds, the venture capitalist has a much larger investment—provides the venture capitalist a motive for misappropriation, especially if the venture capitalist has a specialized portfolio that overlaps with the innovator's technology.

The second and more persuasive protection against venture capitalists misappropriating an employee's innovation is that venture capitalists operate in a reputation market.[34] Venture capital markets are local, and rich information about venture capitalists' conduct spreads very quickly. As a result, misappropriating an innovation in the course of its evaluation would be punished in the venture capital market.[35] But while more plausible, this explanation exaggerates the difference in position between the employer and the venture capitalist. Employers also are constrained by a reputation market, albeit an internal one.

Although it is not misleading to frame the employee's decision to pursue her innovation through a startup as an auction, it also is important to realize the limits of the metaphor. The employer actually bids for a portion of the employee's innovation not ex post through a venture capital-like bid when the innovating employee has decided to leave, but ex ante through the company's incentive compensation structure. For example, the employer's compensation structure may contemplate that an innovative employee receives an equity participation in an employer

33. Most of the literature addresses the misappropriation problem not with respect to the employer company, but with respect to the prospect of corporate venture capital—for example, the innovating employee taking financing from Microsoft rather than a traditional venture capitalist. See, e.g., James J. Anton & Dennis A. Yao, Start-ups, Spin-offs, and Internal Projects, 11 J.L. Econ. & Org. 362, 370–71 (1995) (analyzing risk of misappropriation through competitor financing). Here the concern is with misappropriation that occurs through the corporate investor's post-financing involvement with the portfolio company. In the case of the employee/employer interaction, the feared misappropriation takes place through pre-bid disclosure.

34. Gilson, Engineering Market, supra note 3, at 1092.

35. See id. (discussing operation of reputation market in connection with venture capital).

subsidiary—"intrapreneurship"—if she has a great idea. She may also receive a large bonus. The employer misappropriates the innovation by not making the anticipated payoff. But the employer, just like the venture capitalist, is a repeat player in an information-rich context, and the conditions necessary for an internal reputation market concerning the treatment of employee innovations will also operate to constrain misappropriation.[36] Thus, the argued difference between an employer's and venture capitalist's incentives to misappropriate is overstated.

The more persuasive barriers to the employer's bidding to retain an employee's innovation come when the costs of internal conflicts outweigh the benefits of the innovation. Thomas Hellmann has argued that employees whose positions would be threatened by the innovation may act to undermine its further development.[37] In a related vein, Paul Milgrom and John Roberts note that there are opportunity costs when employees divert their efforts from productive activities to protecting their positions by trying to influence company decisionmakers against the innovation.[38] If these opportunity costs are sufficiently high, the employer will prefer to push the "threatening" innovation out the door and into the hands of waiting venture capitalists.

Finally, Bankman and Gilson highlight the measurement problems that flow from giving employees a powerful incentive to develop the innovation.[39] In order for an internal incentive to reward innovative employees, the employer must identify, after the fact, the employees to whom an innovation belongs. The necessity of allocating an innovation's ownership may have significant costs. To see the problem, assume that R&D is most efficiently carried out in teams. Further assume that the research process has economies of scope—there is a benefit from continuously sharing research among teams—and that the more ongoing research is

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36. In the context of the labor market, the role of a reputation market is framed in terms of "implicit contracts." For a model in which employer misappropriation is central to the process, see generally Mariagiovanna Baccara & Ronny Razin, Curb Your Innovation: On the Relationship Between Innovation and Governance Structure (N.Y.U. Stern Sch. of Bus., Working Paper No. CLB-06-010, 2006), available at http://ssrn.com/abstract=1291578 (on file with the *Columbia Law Review*).

37. Thomas Hellmann, A Theory of Corporate Venture Investing 5–7 (Stanford Univ. Graduate Sch. of Bus., Working Paper No. 1452, 1998), available at http://strategy.sauder.ubc.ca/hellmann/pdfs/tcorpven.pdf (on file with the *Columbia Law Review*).

38. Paul Milgrom & John Roberts, An Economic Approach to Influence Activities in Organizations, 94 Am. J. Soc. S154, S156–57 (1988) [hereinafter Milgrom & Roberts, Economic Approach]. Bengt Holmström stresses differential measurement and monitoring costs between innovation and other employee activities. If measuring the employee's efforts at innovation is more difficult than measuring her efforts in more routine activities, it may be desirable to restrict the employee's activities. Bengt Holmstrom, Agency Costs and Innovation, 12 J. Econ. Behav. & Org. 305, 311–12 (1989); Bengt Holmstrom & Paul Milgrom, Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design, 7 J.L. Econ. & Org. (Special Issue) 24, 25–26 (1991).

39. Bankman & Gilson, supra note 27, at 301–03.

shared, the more difficult it is for any single individual or team to establish property rights in a single invention. Under these circumstances, employees have a powerful incentive to perfect their property rights by hoarding research results, a strategy that will be costly to the employer for at least two reasons. First, any time spent on concealment reduces the time the employee spends on productive activities. Second, and more important, this concealment restricts economies of scope by reducing other employees' productivity, since their performance would have been better had information been shared rather than hoarded.

So what is an employer to do? Both the benefits and costs of the employer's bid—its internal incentive system that rewards innovative employees—increase with the intensity of the incentive. The higher the incentive, the more employees will turn the innovation over to the employer rather than found a startup. But the higher the incentive, the more employees are motivated to hoard research to protect their property rights, and the larger the cost the employer's bidding imposes on its overall R&D effort. In equilibrium, the employer will set the intensity of the incentive at the point where the costs to the entire research effort associated with the increase in incentives necessary to keep one additional employee are higher than the expected value from one more retained innovation. At the margin, some innovative employees leave for startups, while others remain in-house.[40] This outcome is consistent with observed experience: Established technology companies both perform substantial amounts of innovation and lose employees to startups.[41]

The outcome also is consistent with another observation concerning the distribution of innovation between established companies and startups. One would expect that established companies are best suited to incremental innovation, while startups are better at discontinuous innovation. This is due in part to the lower payoffs to, and consequently more limited external financial market for, incremental innovation. Thus, established companies need to offer less intense internal incentives to retain incrementally innovative employees. But it is also due to the reduction in the influence costs, identified by Milgrom and Roberts,[42] and a

40. John Roberts reports how 3M tried to manage innovation in the face of the incentive problems raised in the text: "Performance measurement for subgroups or individuals, however, tended to involve subjective evaluations or milestones achieved, not the financial numbers generated. Rewards had large non-monetary elements, especially personal autonomy and professional recognition . . . ." John Roberts, The Modern Firm 259 (2004). In other words, 3M dramatically reduced the intensity of the incentives.

41. The time it takes to go from being an early-stage company to an established employer concerned about losing innovative employees to startups seems to be shrinking. See Jessica E. Vascellaro, Google Searches for Ways to Keep Big Ideas at Home, Wall St. J., June 18, 2009, at B1 ("Google Inc. is revamping how it develops and prioritizes new products, giving employees a pipeline to the company's top brass amid worries about losing its best people and promising ideas to start-ups.").

42. See Milgrom & Roberts, Economic Approach, supra note 38, at S156–57 (enumerating costs imposed on organizations by members' "influence activities").

corresponding reduction in the innovation hoarding that results from the need to perfect property rights in the innovation.

Masahiko Aoki makes this point in an interesting way.[43] Aoki stresses that the genius of Japanese manufacturing is the enormous emphasis on teamwork and information sharing, both horizontally and vertically. Such sharing is the opposite of employee property rights perfection associated with the intense incentives necessary to retain the innovations that otherwise would migrate to venture-backed startups. The Japanese result—counterintuitive by American standards—is supported by low intensity incentives: a commitment to lifetime employment and lockstep compensation. Aoki argues that these low intensity incentives encourage employees to invest in firm-specific human capital, and not to hoard information at the expense of other teams and the firm's capacity to receive and use new information. Aoki also notes, however, that these attributes make the Japanese system very effective when innovation is incremental, as in process innovation, and not very effective when innovation is discontinuous and powerful incentives matter much more.[44] Thus, the balance is sensitive not only to organizational structure and incentives, but also to the character of the technology associated with an innovation. As argued above, organizational structure and technology are simultaneously determined. In Japan, the organizational structure of flat hierarchies and the "technology" of process innovation illustrate the endogeneity hypothesis. The nature of structural incentives in established companies and venture-backed startups do the same.[45]

C. *Advantages of Startups*

So far we have focused on the factors that influence the size of the employer's bid to retain an employee with an innovative technology. We turn now to the determinants of the venture capitalist's bid. What are the

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43. Masahiko Aoki, Toward an Economic Model of the Japanese Firm, 28 J. Econ. Literature 1 (1990).

44. Id. at 9. Peter Hall and David Soskice make a similar point but extend the analysis to include a discussion of how the Japanese political structure complements the organizational structure of larger incrementally innovative companies. Peter A. Hall & David Soskice, An Introduction to Varieties of Capitalism, *in* Varieties of Capitalism: The Institutional Foundations of Comparative Advantage 1, 50–51 (Peter A. Hall & David Soskice eds., 2001).

45. While the text does not refer to the role of financial contracting within the Japanese firm, Aoki stresses the role of the Japanese banks as the primary source of industrial capital during the period when his description was most accurate. Aoki, supra note 43, at 14. Put briefly, the banks provided a buffer from market forces that would have destabilized the incentive structure at the heart of the structure of the Japanese firm. See Hugh Patrick, The Relevance of Japanese Finance and Its Main Bank System, *in* The Japanese Main Bank System 353, 388–408 (Masahiko Aoki & Hugh Patrick eds., 1994) (discussing lessons from Japanese post-war financial development); Juro Teranishi, Loan Syndication in War-Time Japan and the Origins of the Main Bank System, *in* The Japanese Main Bank System, supra, at 51, 79 (noting ties between Japanese banks and conglomerates insulated managers from market forces).

value consequences of developing the innovation within a venture capital-backed startup?[46]

Here we benefit from a large literature that addresses the financial contract between a venture capital firm and a portfolio company,[47] and the fit between that contract and the financial contract between the venture capital fund and its investors. All financial contracts respond to three central problems: uncertainty, information asymmetry, and agency costs. In early-stage technology financing, these three problems are presented in extreme form. The early stage of the venture magnifies uncertainty; almost all important decisions concerning the company remain to be made, and all of its value depends on uncertain future growth. That uncertainty expands the information asymmetries between the investor and the entrepreneur: The entrepreneur's intentions and abilities are less observable than actions already taken and the actual operation of a business, neither of which is available for many entrepreneurs seeking venture financing. And because the entrepreneur's interest in a startup funded by venture capital is fairly characterized as an option, in some circumstances there will be significant agency costs: The entrepreneur's interests and those of the capital provider will sharply diverge, especially with respect to post-financing decisions concerning the duration and riskiness of the venture.

The organizational and contractual structure of the U.S. venture capital market responds directly to this trio of problems. That response also influences the difference between an innovation's value if developed within a venture capital-backed startup or developed within an established company. For our purposes, one characteristic of this response is critical: Very powerful *incentives* for all participants—investors in venture capital funds, general partners of the funds, and entrepreneurs—are coupled with very intense *monitoring* of entrepreneurs by venture capitalists, and monitoring of venture capitalists by the capital market.[48]

Consider first the incentives for the entrepreneur—our engineer leaving her employer with an innovation in mind. The first element of the entrepreneur's incentive structure comes from the fact that the initial venture capital investment typically will be insufficient to fund the startup company's entire business plan. The investment will instead be "staged." A particular investment round will provide only the capital the business plan projects as necessary to achieve specified milestones set out in the

46. This section draws on Gilson, Engineering Market, supra note 3.

47. See supra note 1.

48. This is consistent with Milgrom and Roberts' "monitoring intensity principle," which predicts that because intense incentives give rise not only to incentives to perform but also to incentives to cheat, intense incentives require a significant investment in monitoring. Milgrom & Roberts, Economics, Organization & Management, supra note 18, at 226–27.

business plan.[49] While first round investors expect to participate in subsequent investment rounds,[50] typically they are not contractually obligated to do so even if the business plan's milestones are met; the terms of later rounds of investment are negotiated at the time the milestones are met, and the prior investment exhausted. The result is to give the venture capitalist the power to decide whether the project (and the startup company) goes forward. This structure gives the entrepreneur a powerful incentive to perform, while also giving the venture capitalist the means to monitor that performance.

The powerful incentive provided by staged financing also reduces the information asymmetry between the venture capitalist and the entrepreneur concerning the entrepreneur's talents. Every incentive has an information-related flipside that responds to adverse selection problems. In deciding which startups to finance, the venture capital fund has to distinguish between good and bad entrepreneurs under circumstances in which an entrepreneur has better information about her own skills than does the investor. Because the incentive created by staged financing is more valuable to a good entrepreneur than a bad one, an entrepreneur's willingness to accept an intense incentive is a signal of the entrepreneur's less visible skills. The signal is particularly important for early-stage and high-tech portfolio companies because the absence of a performance history and the technical nature of the projects make the entrepreneur's skills particularly difficult to observe.[51] In comparison, the entrepreneur's employer will have had substantial opportunity to observe her performance. To some extent, the screening function of the venture capital incentive structure overcomes some of the employer's informational advantage.

The entrepreneur next faces the portfolio company's compensation system. Perhaps more starkly than with any other organizational or contractual technique, the portfolio company's compensation structure creates extremely high-powered performance incentives that serve to align the incentives of the portfolio company management and the venture

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49. See Paul A. Gompers, Optimal Investment, Monitoring, and the Staging of Venture Capital, 50 J. Fin. 1461, 1461–62 (1995) (explaining operation of staged financing).

50. See William A. Sahlman, The Structure and Governance of Venture-Capital Organizations, 27 J. Fin. Econ. 473, 475 (1990) (reporting venture capital funds invest one-third of their capital in new investments and two-thirds in later round financing of companies already in their portfolios).

51. Conceptually, the signal can support a separating equilibrium in which only high quality entrepreneurs will accept the incentive. Low quality entrepreneurs, whose alternatives are more valuable to them than an incentive contract that requires more talent than they have in order to be profitable, will not. See Edward Lazear, Salaries and Piece Rates, 59 J. Bus. 405, 413 (1986) (describing separating equilibrium where least able workers prefer salary firm, while most able workers prefer piece-rate firm); Sahlman, supra note 50, at 502 ("The governance structure also helps potential investors distinguish between good venture capitalists and weak ones. . . . [G]ood venture capitalists are more likely . . . to accept . . . a compensation system heavily dependent on investment returns.").

capital fund. In essence, the overwhelming percentage of management's compensation is dependent on the portfolio company's success. Low salaries are offset by the potential for a large increase in the value of the entrepreneur's stock, and by the award of stock options to other management members. The performance incentive is further heightened by requiring the entrepreneur and other members of management to accept a staged vesting requirement on some or all of their stock or stock options.[52] The vesting requirement gives the portfolio company the right to purchase a portion of the entrepreneur's or other management's stock, at a favorable price, if employment terminates prior to a series of specified dates. It also restricts exercise of options until after the manager has worked at the firm for a specified number of years, following which an additional number of options become both exercisable and no longer subject to forfeiture if employment terminates.[53]

While aligning the interests of the venture capital fund and entrepreneur in some circumstances, the intensity of these incentives can also lead to agency costs in others. In particular, the option-like characteristics of the portfolio company's compensation structure can lead the entrepreneur to increase the risk associated with the portfolio company's future returns, because the venture capital fund will bear a disproportionate share of the increased downside but share only proportionately in the upside. Thus, the intensity of the performance incentives created by the compensation structure requires the venture capital fund to monitor the portfolio company's performance.

The entrepreneur's high-powered incentives to perform are matched by the venture capital fund general partner's incentives to monitor. The bulk of the general partner's (GP's) compensation comes in the form of a carried interest—20% of the venture capital fund's ultimate profits is a common figure—distributed to the GP when realized profits are distributed to the investor limited partners.[54] In effect, the GP receives an option on 20% of the gain in the portfolio company's value. Given the high variance associated with startup company performance, that option will be very valuable. Most important, by monitoring the entrepreneur, the GP can influence the outcome of the events on which he has an option. Thus, the structure of the GP's incentives provides an

52. See Thomas Hellmann, The Allocation of Control Rights in Venture Capital Contracts, 29 RAND J. Econ. 57, 58 (1998) (explaining pattern of staged vesting). Kaplan and Strömberg report that 41% of a sample of early-stage financings contained entrepreneur vesting requirements. Kaplan & Strömberg, supra note 1, at 292 (finding also 48% of first venture capital financings contain founder vesting requirements).

53. Lee F. Benton et al., Portfolio Company Investments: High-Tech Corporation—Getting to the Term Sheet, *in* Venture Capital & Public Offering Negotiation 6-1, 6-19 (Michael J. Halloran et al. eds., 3d ed. Supp. 2009); Sahlman, supra note 50, at 507.

54. See Gompers & Lerner, supra note 1, at 91–92 & fig. 5.1 (demonstrating "profits received by general partners of venture capital fund").

intense incentive to monitor, which balances the entrepreneur's intense incentive to perform.[55]

The term structure of the venture capital limited partnership also gives GPs an incentive to monitor the entrepreneur's performance. The partnership typically has a fixed term, usually ten years, after which the fund's assets are distributed to the investors. The result is that at predictable intervals, the investor can assess the GP's performance when deciding whether to reinvest the funds distributed with the GP. The success of portfolio companies is the most visible indicium of the GP's performance.[56]

D. *Assessment*

The employer of an innovative employee and a venture capital fund have different capabilities and therefore different assessments of the value of the innovation that the employee has offered at auction. We have seen that the employer bids by means of its internal incentive structure.[57] But this structure is not monotonic; at some point increasing the internal incentives in order to retain an additional engineer and her innovation creates costs to employer's R&D that are greater than the innovation's value. At that point, overall firm performance decreases as the intensity of incentives increases. And perhaps in many companies, the inflection point may come at very low levels of incentive intensity because the cost of too-high incentives will be spread over the company's entire R&D effort, while the benefit will be limited to retaining discrete innovations. This likely explains the infrequent use of intrapreneurship strategies, an arrangement by which an employer locates an employee's innovation in a newly created subsidiary and, by giving the employee an ownership interest in the subsidiary, effectively matches the intensity of the incentive that the employee would confront through the venture capital financial contract.[58]

By contrast, in venture capital-backed startups, where the GP's intense incentives to monitor match the entrepreneur's intense incentives to perform, and where the startup company typically has a single project on whose success the incentives are based, there is no need for property right perfection. As a result, there are none of the barriers to spillovers to other projects that plague the use of intense incentives in established

55. See Gilson, Engineering Market, supra note 3, at 1083–84 (explaining incentive structure of venture capital incentives).

56. This point originates with Michael C. Jensen, Eclipse of the Public Corporation, 67 Harv. Bus. Rev. 61, 68–70 (1989) (analyzing structure of private equity limited partnership agreements).

57. See supra Part I.B.

58. Denis Gromb & David Scharfstein, Entrepreneurship in Equilibrium 1–2 (NBER, Working Paper No. 9001, 2002), available at http://www.nber.org/papers/w9001.pdf (on file with the *Columbia Law Review*).

companies. For the startup, overall performance is increasing in the intensity of incentives.

In the end, this analysis leads one to expect specialization in the location of innovation of the sort we observe anecdotally. As Aoki concluded with respect to Japanese manufacturing, incremental innovation, such as process improvements in manufacturing that depend on teamwork and information sharing, responds to gentler incentives, like stable employment and predictable compensation.[59] In contrast, intense incentives matched by intense monitoring fit better with single project efforts, especially in fast-moving technology markets where the first mover advantage may mean that the race for the next generation of technology has only one winner. While more detailed study is warranted, this allocation of innovative activity illustrates the need to understand how the intersection of an innovation's technology, organizational structure, and financing directs the project's location.

II. Disruptive Innovation

In an influential book, Clayton Christensen describes a quite different interaction between established companies and early-stage companies with respect to the location of innovation.[60] Christensen focuses on why established industry leaders fail to anticipate an innovation that devalues their skills and products, and as a result dilutes their dominant position. Christensen calls such an innovation a "disruptive" technology. The problem is not that the industry leaders are bad managers. Indeed, these companies are extremely well managed, in that they are attentive to their customers' needs, continuously improve the quality and reduce the prices of their products, and usually anticipate what their customers will want before the customers know it themselves.[61]

Instead, the problem arises precisely because the industry leaders are so good at what they do. Rather than simply extending the existing method of production, a disruptive technology reflects so sharp a break with existing products that neither a leading producer nor its sophisticated customers initially see the technology's potential. And because the market for the disruptive technology is initially so small, a rational manu-

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59. See supra text accompanying notes 44–45 (discussing Japanese success at incremental innovation).

60. Clayton M. Christensen, The Innovator's Dilemma (2000).

61. Id. at ix. For example, in a report that addressed IBM's failure to effectively enter new markets, the diagnosis highlighted IBM's single-minded focus on serving its existing customers: "The company is preoccupied with current served markets and existing offerings. Processes were designed to listen intently to existing customers and to focus on traditional markets. This makes us slow to recognize disruptive technologies and to recognize new markets." Charles A. O'Reilly III et al., Organizational Ambidexterity: IBM and Emerging Business Opportunities 20 (Stanford Graduate Sch. of Bus., Working Paper No. 2025, and Rock Ctr. for Corporate Governance, Working Paper No. 53, 2009), available at http://ssrn.com/abstract=1418194 (on file with the *Columbia Law Review*) [hereinafter O'Reilly et al., Organizational Ambidexterity] (emphasis omitted).

facturer would ignore the innovation, sensibly concluding that the returns on an investment would not be worth the effort. As a result, a disruptive technology takes root in secondary markets of no interest to the industry leaders. Later, developments in the disruptive technology allow it to be generalized to the industry core; dominant firms are then displaced because they cannot respond quickly enough to the change in the architecture of production.[62]

In Part I we considered one circumstance in which established firms chose to allow an innovation to go to a startup—the employer sets its internal incentives at a level such that some employees will pursue their innovations through a startup. There, however, the problem was not that the employer did not appreciate the value of the innovation. Rather, the employer recognized that the incentive intensity necessary to assure that all employee-inspired innovations remained with the company would reduce the overall efficiency of its existing R&D capacity by more than the value of retaining the marginal innovation. Such firms made a clear-eyed calculation that allowed some of their employees to seek financing through a venture capital firm. In the case of a disruptive technology, an established firm's decision not to pursue the disruptive technology is also rational, but only because the innovation's value is not visible when the decision is made. Put differently, a dominant company passes on many innovations because it concludes, based on its experience, that they are not valuable. Sometimes the dominant company turns out to be very wrong.[63]

Christensen's solution for an established company is interesting in that it acknowledges that for some types of innovation, organizational form is critical. In effect, Christensen recommends that the established company hedge the potential that a technology is disruptive by creating a separate unit that is matched to the smaller market available to the technology at that time, at a sufficient distance that the incentive problems

62. Christensen examines examples of the phenomenon in connection with disk drives, electric arc or mini-mill steel producers, and hydraulically activated earth-moving equipment. Microsoft's reaction to search-based advertising appears to have tracked Christensen's pattern. In 2000, before Google had perfected the technique, Microsoft had an early version of the same technology called Keywords. Microsoft shut the product down after two months out of fear of cannibalizing existing revenue streams. See Robert A. Guth, Microsoft Bid to Beat Google Builds on a History of Misses, Wall St. J., Jan. 16, 2009, at 1.

63. A related phenomenon involves companies that recognize that a competing technology has potential; they try to straddle the two technologies, but fail at the task of simultaneously pursuing the existing technology while embracing the new. Michael L. Tushman & Charles A. O'Reilly III, Ambidextrous Organizations: Managing Evolutionary and Revolutionary Change, Cal. Mgmt. Rev., Summer 1996, at 8, 9–10, offer the example of the transition from vacuum tubes to transistors. The leading vacuum tube manufacturers either never entered the transistor market or did enter and failed. The ultimate winners in the transistor market were, as Christensen would predict, the new companies that worked only with the new technology.

discussed in Part I are minimized.[64] If the technology ultimately proves disruptive, the established company has the resources to grow the small separate unit quickly.

Other management scholars are more optimistic. Although recognizing the problem Christensen poses, they envision an "ambidextrous" firm that can "exploit existing assets and positions in a profit producing way and simultaneously . . . explore new technologies and markets" without the resigned separation Christensen recommends.[65] But regardless of whether firms can be taught to be switch hitters,[66] at this point we are back to the problem confronted in Part I: How does an established company manage the general problem of keeping innovations without destabilizing the internal incentives for the rest of its business?

Christensen does not specifically address this issue, but the fact that his recommendation highlights it provides support for the effort under-

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64. Christensen describes the strategy as "a policy of implanting projects to commercialize disruptive innovations in small organizations that will view the projects as being on their critical path to growth and success, rather than as being distractions from the main business of the company." Christensen, supra note 60, at 138.

65. See, e.g., O'Reilly et al., Organizational Ambidexterity, supra note 61, at 17–21 (describing successful effort by IBM to address both markets).

66. At the conference where the paper that gave rise to this Essay was first presented, comments by Charles Sabel and Bengt Holmström succinctly demonstrated the pessimistic side. Taking their views together, they argued that firms are good at pursuing known tasks through hierarchical organizations, but that a hierarchy is not good at reprogramming itself. Put differently, the dilemma is that either there is no way to systematize nonincremental innovation—that is, nonincremental innovation is a non-organizational task—or the firm must figure out a way in which the innovation is not disruptive. Bengt Holmström & Charles Sabel, Remarks in Response to Ronald Gilson's Working Paper, *Locating Innovation*, at the Business Law and Innovation Conference (Oct. 31, 2008).

O'Reilly, Harreld, and Tushman offer IBM as an example of a successfully ambidextrous company that took a very different tack than the "skunk works" strategy Christensen recommends. O'Reilly et al., Organizational Ambidexterity, supra note 61, at 19–21. IBM saw the problem as new businesses being marginalized, so it appointed the head of its software group, a multi-billion dollar business, as vice chair of the corporation and the full time head of the new business initiative. IBM's senior vice president for technology then succeeded this individual. In turn, the individuals chosen to lead a particular new business initiative are not younger managers, but according to IBM "are very experienced people, who have built big businesses." Id. at 25–26. For example, the individual chosen to run the new business had previously run IBM's Unix business that had $4 billion in sales. Id. at 26.

General Electric Chief Executive Officer Jeffrey R. Immelt similarly describes GE's efforts at ambidexterity. Jeffrey R. Immelt et al., How GE Is Disrupting Itself, Harv. Bus. Rev., Oct. 2009, at 56. Like IBM's efforts to assign very senior managers to run new, potentially disruptive projects, GE seeks to elevate the financial and managerial commitment to the disruptive project, for example by having the project leader "report to someone high in the organization." Id. at 64.

While this approach may work for IBM or GE, one would be skeptical of whether it can generalize to other companies, few of whom will have the management depth to move the head of major businesses to a startup business, or the discipline to assure a reporting relationship far enough up the corporate hierarchy. Successfully ambidextrous companies, and switch hitters like Mickey Mantle, may not come along very often.

taken here. The location of innovation within an alternative firm, or within an ambidextrous firm whose internal organization is radically refigured, is endogenous, reflecting the particular confluence of transaction costs, financial contracting techniques, and the substance of the technology. Christensen identifies another instance where the location of the technology and the corresponding financing of its development are outside the universe of established firms. Again, the confluence of technology, organizational structure, and financial contracting is central to the tradeoff between established firms and early-stage startup firms.

III. An Established Company Using a Technology Race Among Startups: The Cisco Systems' Strategy in the 1990s

We now consider a third intersection between an established company and a startup firm, which may provide an established company a different way to avoid Christensen's innovator's dilemma. During the 1990s, Cisco Systems confronted a difficult problem. Cisco specialized in the hardware and software that supported local and wide area networks.[67] The company was extremely successful, having grown in fourteen years from a startup to a point where 65% of LAN networks used Cisco routers. However, network technology grew in power very quickly and changed just as quickly—a product life cycle was estimated to be eighteen months and it was expected that new solutions would double performance at the same price.[68] At any given point, it was hard to predict the path the technology would take; while the problems that would need to be solved were visible, a variety of technological solutions were possible. And because markets for network hardware often rewarded the winner of the technology race with significant first mover advantages, being quick was the best way to avoid being dead. But any single company has limited internal R&D capacity; it can do some things well and not others, and it can only do so much.[69] The limited visibility of the direction of the market and the short product lead time—said to be six months from when the company knew it needed to bring a product to market—meant that Cisco did not have the time needed to develop all required innovation internally. And the further away an innovation was from Cisco's core technology, the greater the risk that the company would lack the organizational capacity to develop it. Making the wrong bet on the solution in the face of significant first mover advantages could be far more costly than the company was willing to bear.

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67. See generally Charles A. O'Reilly, Cisco Systems: The Acquisition of Technology Is the Acquisition of People (Stanford Graduate Sch. of Bus., Case No. HR-10, 1998) [hereinafter O'Reilly, Acquisition of Technology].

68. Id.

69. Cisco is said to have done 70–80% of its product development through internal R&D, although the engineers who had developed many of these products joined Cisco as a result of an acquisition. Id. at 5.

Startup and growing early-stage companies provided a way for Cisco to deal with the need for expertise that it might not already have in-house. The lack of visibility of the direction of technology reflected the fact that different solutions were possible to most problems. This is where early-stage and startup companies provided an opportunity. If venture capitalists funded startups that pursued alternative solutions to the technology problem, then Cisco could acquire the company that won the technology race in time to have a product to market when it was needed.[70] To be sure, the price for the winner would be high; competitors might bid, and an initial public offering could provide the winner's venture capitalists an alternative liquidity event. Cisco's large market share and its extensive marketing and distribution system, however, gave it advantages that the focused winner of the technology race could not match on a standalone basis.[71] For the same reasons, Cisco could be expected to pay more to exercise the real option that its strategy entailed: to wait and see which technology was best and then acquire it.

For present purposes, the interesting point of the Cisco example is that it frames a different question concerning the efficient location of innovation as between a startup and an established company. In Part I, innovation was allocated between an established company and a startup based on the differential operation of intense incentives in the two environments. Here innovation is allocated based on technological imperative—the ability of the venture capital market to finance a range of alternative solutions to a technology problem and make use of the incentive intensity of a startup structure, neither of which Cisco could match internally. Consistent with this confluence of technology, organizational structure, and financial contracting, Cisco developed the ability to quickly and

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70. John Chambers, Cisco's CEO then and now, described the process in this fashion:

> Our ideal acquisition is a small startup that has a great technology product on the drawing board that is going to come out 6 to 12 months from now. When we do that, we are buying the engineers and the next-generation product. Then we blow the product through our distribution channels and leverage our manufacturing and financial strengths.

Glenn Rifkin, Growth by Acquisition: Cisco's John T. Chambers, The Case of Cisco Systems, Strategy & Bus., Second Quarter 1997, at 91, 100; see Nicole Tempest, Cisco Systems, Inc.: Acquisition Integration for Manufacturing 5 (Stanford Graduate Sch. of Bus., Case No. OIT-26, 2004), available at http://gsbapps.stanford.edu/cases/documents/OIT26.pdf (on file with the *Columbia Law Review*) ("Cisco viewed acquisitions as a means to ensure that it was offering the 'best of breed' product technology.").

71. John Chambers described Cisco's first acquisition in 1993 of Crescendo as follows: "We took Crescendo's networking product, and within 18 months we had a $500 million run rate. No small company can go from $10 million to $500 million in 18 months. They just can't scale. But we could scale because of our distribution, financial, and manufacturing strengths." Gerry Yemen et al., Cisco: Early if Not Elegant (A) 8 (Univ. of Va., Case Study UVA-BP-0446, 2003), available at http://ssrn.com/abstract=907938 (on file with the *Columbia Law Review*).

effectively integrate new acquisitions.[72] In effect, Cisco outsourced R&D to market-based technology races between startups to achieve the basic innovation, but took on the task itself of commercializing the innovation.

IV. Joint Ventures Between Large Pharmaceutical Companies and Biotechnology Companies

In this Part we consider the pattern of joint ventures between small biotech companies and large pharmas to develop new drugs.[73] As in the Cisco case, this final example allocates innovation to a small company and commercialization to an established company. It differs in that the Cisco strategy contemplated sequential cooperation, the acquisition occurring only after the technology is developed, with the incentive structure driving that development supplied by the early-stage company and the market. The large pharma/small biotech joint ventures, however, contemplate a cooperative arrangement from the beginning, which requires developing an organizational structure to govern that cooperation.

Two important background facts place the large pharma/small biotech joint ventures in context. These concern the costs and risks associated with developing a new drug and the very large change in technology that gave rise to the new generation of biotech firms. Consider first the costs and risks associated with new drug development.[74] The initial screening of potential drug candidates and the work that precedes the commencement of clinical trials takes some three to six years. During that period, the number of compounds examined runs from 5,000 to 10,000, which ultimately yields a small number that warrant scientific and animal testing. An application for an Investigational New Drug is then filed with the FDA. If approved, clinical testing on humans can begin, which takes another six to seven years. That period is broken down into three test phases, the first involving fewer than 100 persons, the second between 100 and 500, and the third between 1,000 and 5,000. If the drug passes these tests, the sponsoring company files a New Drug Application ("NDA"). FDA review of the NDA can take another six months to two years. If the FDA approves the NDA, the drug can be brought to market. Out of 5,000 to 10,000 compounds that are initially screened, it is estimated that only 250 survive preclinical testing,[75] and the FDA ultimately

72. The ability to integrate was particularly necessary for the Cisco incentive system. The need for integration is stressed in O'Reilly, Acquisition of Technology, supra note 67, at 7–9; Tempest, supra note 70, at 15; Yemen et al., supra note 71, at 15.

73. See generally Robinson & Stuart, Financial Contracting, supra note 9 (describing pharmaceutical joint ventures between small biotech companies and mature pharmas).

74. This account of the approval process draws on Gilson, Sabel & Scott, supra note 10, at 468 (describing new drug approval process), and Patricia Danzon et al., Productivity in Pharmaceutical-biotechnology R&D: The Role of Experience and Alliances, 24 J. Health Econ. 317, 318 (2005) (same).

75. Nat'l Inst. of Health, Dep't of Health & Human Servs., A Plan to Ensure Taxpayers' Interests Are Protected, pt. D, § 1 (2001), available at http://www.nih.gov/news/070101wyden.htm (on file with the *Columbia Law Review*).

approves only about 20% of drugs that begin human testing. After receiving this approval, the drug's commercial success can finally be determined.[76]

The expense of the process is consistent with its length. The average cost of drug development, from initial R&D through FDA approval, but excluding commercialization costs, was estimated in 2003 at $802 million, using even earlier data.[77] Taking into account the time value of money, the scientific risk associated with securing approval, and the commercial risk that even approved drugs will not have sufficient sales to provide a return on investment, new drug development presents a daunting challenge.

The second background fact that puts large pharma/small biotech firm alliances in context is the dramatic change in the underlying science that gave rise to them. By the early 1980s, it became apparent that advances in biotech required large pharmas to develop skills quite different than the chemistry-based science that had previously driven pharmaceutical research.[78] Those skills were found in small, early-stage firms, typically formed by university-affiliated scientists.[79] Forming alliances with these smaller, research-oriented companies provided quicker access to this knowledge than the pharmas developing the capabilities in-house[80]

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76. Joseph A. DiMasi et al., The Price of Innovation: New Estimates of Drug Development Costs, 22 J. Health Econ. 151, 165 (2003).

77. Id. at 166.

78. See, e.g., Sean Nicholson et al., Biotech-Pharmaceutical Alliances as a Signal of Asset and Firm Quality, 78 J. Bus. 1433, 1434 (2005) ("[B]iotech firms pioneered new drug discovery technologies . . . whereas traditional pharmaceutical companies have superior expertise in chemistry . . . ."); Walter W. Powell, Inter-Organizational Collaboration in the Biotechnology Industry, 152 J. Institutional & Theoretical Econ. 197, 202 (1996) [hereinafter Powell, Inter-Organizational Collaboration] ("But Biotech proved to be, in Schumpeterian terms, a competence-destroying innovation because it built on a new science base (molecular biology and immunology) that differed significantly from the knowledge base (organic chemistry and its clinical applications) of the mature pharmaceutical industry." (citation omitted)); Nadine Roijakkers & John Hagedoorn, Inter-firm R&D Partnering in Pharmaceutical Biotechnology Since 1975: Trends, Patterns, and Networks, 35 Res. Pol'y 431, 444 (2006) (noting growth in alliances "primarily caused by the need of large pharmaceutical companies to access a recent explosion of biotechnological knowledge"); see also Louis Galambos & Jeffrey L. Sturchio, Pharmaceutical Firms and the Transition to Biotechnology, 72 Bus. Hist. Rev. 250, 260–76 (1998) (recounting big pharmas' move into biotechnology).

79. See Powell, Inter-Organizational Collaboration, supra note 78, at 199–201 (describing distribution of expertise); Walter W. Powell et al., Organizational and Institutional Genesis: The Emergence of High-Tech Clusters in the Life Sciences, *in* The Emergence of Organization and Markets (J. Padgett & W. Powell eds., forthcoming 2010) available at http://academic.reed.edu/sociology/faculty/whittington/Powell_Packalen_Whittington_2010.pdf (manuscript at 14–15, on file with the *Columbia Law Review*) [hereinafter Powell et al., Institutional Genesis] (same).

80. See, e.g., Powell, Inter-Organizational Collaboration, supra note 78, at 203 (describing expertise in small biotech companies).

and, in turn, took advantage of the pharmas' experience and capabilities at conducting human testing and running the FDA licensing gauntlet.[81]

The large pharma/small biotech joint ventures nicely illustrate how the intersection of technology, organizational structure, and financial contracting dictate the location of innovation. The development of new drugs based on biotechnology required a combination of skills—biotech on the one hand and commercialization and FDA experience on the other—that could not be found in either mature pharmas or in the early-state biotech. While the new biotech was potentially "disruptive" in the Christensen sense,[82] it was not an unexpected success. The potential of biotech was plainly evident, so large pharmas did not ignore this avenue of research. Rather, the question was how to secure it.

Here the Christensen analysis is relevant. At least at the outset, the pharmas did not believe they could be ambidextrous. The characteristics of biotech research more closely resembled university-based research than research within the large pharmas.[83] Whether the two research styles, employing scientists who moved between universities and industry and often straddled the two, could be housed in the same organization was thought problematic.[84] In this respect, the analysis tracks our earlier analysis of the different incentive structures of established and startup companies.[85]

Consistent with this concern, when the Swiss pharma Roche acquired 56% of Genentech, the iconic biotech company co-founded by academics Herbert Boyer and Paul Berg, Roche both committed not to buy the rest of the company without a majority vote of the minority shareholders and left Genentech's headquarters and operations in the San Francisco Bay Area rather than integrating the biotech company with its other operations. When Roche bid to acquire the remainder of the shares in 2008 over Genentech's objection, concerns about the impact of the acquisition on Genentech's "culture" were widespread, and Roche

81. See, e.g., Nicholson et al., supra note 78, at 1434 (citing large pharmas' capabilities with FDA process as cause of alliances).

82. See supra Part II (discussing Christensen's argument that inability to recognize disruptive technology's potential contributes to industry leader displacement).

83. See Powell, Inter-Organizational Collaboration, supra note 78, at 199–200 (describing this resemblance).

84. For example, in 1986, Eli Lilly, a large Midwestern pharma, acquired Hybritech, a San Diego-based early-stage biotech company, for $300 million. The outcome of the acquisition was described as follows: "Within one year, no Hybritech employees remained with Lilly, but more than 40 San Diego biotech firms were subsequently founded by former Hybritech employees. . . . A senior scientist at Hybritech quipped that the merger 'was like "Animal House" meets "The Waltons."'" Powell et al., Institutional Genesis, supra note 79 (manuscript at 29–30) (citations omitted).

85. See supra Part I.C.

again committed to leave Genentech in San Francisco rather than integrating, to the end of retaining Genentech's culture.[86]

The same kinds of concerns also may have counseled against a Cisco-like strategy. Recall that Cisco's strategy was to rely on the market to motivate a technology race. But once having bought the winner, Cisco would quickly and fully integrate the acquired company, including replacing the acquired company's incentive system with that of Cisco.[87] In the case of biotech, especially in the early years, the culture gap, including differences in the incentive structures of biotech and large pharmas, was too large for the Cisco acquisition and integration strategy.[88]

If the technology differences between biotech and large pharmas made acquisitions generally unattractive, then the capabilities of the two types of companies would have to be combined outside both of the existing entities. This meant that the organization of the joint venture would be contractual. The problem of crafting the contract was daunting. As Gilson, Sabel, and Scott put it, "The inability of the parties to specify ex ante the nature of the product to be produced or its performance characteristics means that the terms of performance will be determined by the very governance process the contract creates."[89] The result is a structure that contemplates collaboration through a joint committee that shapes the research agenda and resolves disputes, but without specifying legally enforceable provisions that delineate the parties' actual conduct or the course of the research.

That pattern shifts once the research effort identifies a drug candidate and uncertainty is reduced. Instead of contractual provisions that are directed at process rather than outcome, we then observe explicit allocation of property rights in the drug compound through a set of nested options: The pharma has the option to go forward with clinical testing at its expense, and if the tests are successful, the biotech firm receives a royalty right. If the pharma does not go forward with the testing, the biotech firm regains the technology. Thus, we observe a braiding of implicit contracts supported by an explicit governance arrangement that allows the parties to learn about each other's capabilities and capacity for cooperation. The parties can then carry out the research design developed through that initial cooperation and explicit options on the tech-

86. See, e.g., Lex Column, Roche Bottom Prices, Fin. Times (Asia), Jan. 31, 2009 ("[B]y going hostile [Roche] might also damage the culture and risk alienating, and so losing, some of the independently minded scientists who built Genentech.").

87. See O'Reilly, Acquisition of Technology, supra note 67, at 7–9 (describing Cisco's integration strategy).

88. Cisco's strategy relied on quick and thorough integration of the acquired early-stage company into Cisco to allow Cisco to commercialize the acquired company's technology through Cisco's product lines—as the CEO of Cisco put it, to "blow the product through our distribution channels and leverage our manufacturing and financial strengths." Rifkin, supra note 70, at 100.

89. Gilson, Sabel & Scott, supra note 10, at 435. The authors discuss in detail the structure of a particular large pharma/small biotech company joint venture. Id. at 467–71.

nology once a drug candidate is identified.[90] In turn, the same governance provisions develop both parties' reputations for the capacity to successfully collaborate in these relationships, which facilitate their entering into similar arrangements with other companies.[91]

Finally, the financial contracting arrangements observed in large pharma/small biotech company joint ventures reflect the simultaneous determination of organizational structure and financial contracting in light of the technology involved. Lerner and Merges suggest that, during the 1990s, more funding was provided to biotech companies through joint ventures and strategic alliances than from venture capital, initial public offerings, or secondary offerings of stock.[92] This allocation is hardly surprising. Equity financing through venture capital provides a sensible form of financial contracting for early-stage biotech companies while research efforts identify drug candidates. At that stage, uncertainty makes it difficult to base payment to the biotech company largely on performance. The biotech company also needs assurance that the large pharma will have the proper incentives when they decide whether to incur the large costs associated with pursuing FDA approval. In turn, the FDA approval process, especially regarding human testing, involves levels of costs and time that are inconsistent with the venture capital funding structure. Recall that the investment required for a single compound to get through the process was on average $800 million based on pre-2003 data, an amount too large for venture capital funds to provide, and that the process takes some twelve years, too long to be feasible for a venture capital fund whose term is typically limited to ten years.[93] Thus, we observe a combination of venture capital and joint venture financing that reflects the nature of the technology being financed and the organizational structure through which the product is carried out.

CONCLUSION

The effort here has been to describe the combination of forces—technology, organizational structure, and financial contracting—that, refracted through the prism of transaction and information costs, combine to influence the allocation of innovation either to an established com-

90. See id. at 492–94 (discussing braiding of explicit and implicit contracts in large pharma/small biotech joint ventures).

91. See David T. Robinson & Toby E. Stuart, Network Effects in the Governance of Strategic Alliances, 23 J.L. Econ. & Org. 242, 243 (2007) (discussing how reputation, measured by centrality within network of companies, affects contractual arrangements between joint venture partners).

92. Josh Lerner & Robert P. Merges, The Control of Technology Alliances: An Empirical Analysis of the Biotechnology Industry, 46 J. Indus. Econ. 125, 128 tbl.1, 129 tbl.2 (1998). The authors also report that joint venture/alliance funding in 1995 exceeded the sum of the next three largest sources of funds for biotech companies. Id.

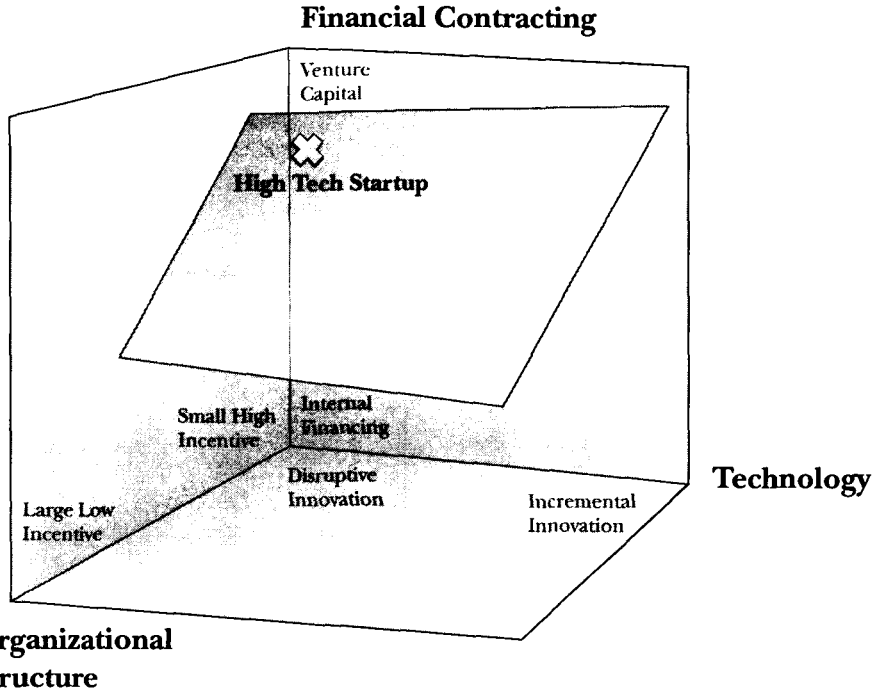
93. See Gilson, Engineering Market, supra note 3, at 1071 (noting typical ten-year term); supra notes 74–77 and accompanying text (describing prohibitive time and cost associated with FDA approval).

pany to be financed by retained earnings or the company's credit, to an early-stage company with financing provided through venture capital, or to a joint venture of early-stage and established companies. The goal is to develop a better understanding of how innovative activities are distributed across the economy. We considered four patterns where developing an innovation is at the interface of established and startup or early-stage companies: (1) when an established company employee with an innovation will pursue the innovation through a startup; (2) when an established company may face the threat of a disruptive technology pursued by a smaller company; (3) when an established company outsources particular R&D projects to a technology race among venture capital-funded early-stage companies; and (4) when an innovation is located between an early-stage biotech company and a large pharma through a joint venture or strategic alliance. In the past, scholarship has largely focused on the arrangements associated with a particular location of innovation. Here the focus has been on the determinants of the allocation of innovation across locations, with the hope that positive understanding of that allocation leads to normative implications for those charged with engineering the transactions giving rise to innovation.

Figure Two depicts a preliminary characterization of our effort to endogenize the location of innovation by labeling the axes on the Innovative Plane in Figure One. The axes now reflect the central elements that animated the discussion of each of the innovations whose location posed a choice between a small early-stage company and a large mature company. The "Organizational Structure" axis reflects the relationship between organizational size and incentive intensity: Smaller, focused companies can sustain more intense incentives. The "Technology" axis reflects the difference between incremental and disruptive innovation. Finally, the "Financial Contracting" axis moves between internal financing and venture capital financing. As an illustration, Figure Two shows a high-tech startup at a plausible location on the Innovation Plane—small firm, intense incentives, less incremental innovation, venture capital financing. Even so simple a depiction highlights this Essay's thesis: understanding the interaction among technology, organizational structure, and financial contracting is central to understanding the location of innovation.

In concluding, it is important to note three limits to the effort. First, the range of innovation patterns discussed is quite limited. I believe that the same framework—the endogeneity of technology, organizational structure, and financial contracting on the allocation of innovation—will have broader application than the interface between early-stage companies and established companies considered here. Nonetheless, that inquiry, as well as the more detailed examination of the locations of innovation we did consider, remains to be undertaken. For example, I have limited my analysis here to settings that share the common characteristic of the choice between locating innovation in a mature or early-stage com-

FIGURE 2: LABELING THE AXES



pany. I expect the same analysis could be applied to the interface between university- and commercially-located innovation.

Second, at any given point in the locational space, there will be overlap. No response to a particular cluster of attributes is exclusive; depending on the particular characteristics of an individual company and the nature of the particular technology, a range of organizational techniques may work. For example, some companies will successfully manage intense incentives without negative spillovers to its existing R&D efforts even though the central tendency will push in the direction of letting some innovations go.[94] Thus, the goal is to understand the forces that underpin the observed central tendency, which then can be employed to understand the variance in practice.

Finally, the analysis has been largely static, even though the market for innovation is, tautologically, dynamic. For example, the vertical disin-

94. Bengt Holmström and John Roberts make this point in a more general fashion. From their perspective, the boundary of the firm is dictated by a mix of problems and responses, which will differ depending on particularized circumstances. Bengt Holmström & John Roberts, The Boundaries of the Firm Revisited, 12 J. Econ. Persp. 73, 75 (1998) ("[O]wnership patterns are responsive to, among other things, agency problems, concerns for common assets, difficulties in transferring knowledge, and the benefits of market monitoring.").

tegration of the supply chain[95] allows a startup to outsource capital-intensive functions like manufacturing and assembly to contract manufacturers and chip fabricators. This outsourcing dramatically reduces the amount of capital that must be raised, and thereby provides another source of financing for innovation. Similarly, the evolution of biotech may come to broaden the range of organizational structures in which it can be effectively carried out. The Roche acquisition of Genentech and other acquisitions of biotech companies by large pharmas will test this conjecture.

95. See Gilson, Sabel & Scott, supra note 10, at 438–44 (describing reduction in levels of vertical integration in manufacturer supply chain).