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Why Start-ups?

Joseph Bankman* and Ronald J. Gilson**

The prototypical start-up involves an employee leaving her job with an idea and selling a portion of that idea to a venture capitalist. In many respects, however, the idea should be worth more to the former employer. The former employer can be expected to have better information concerning the employee-entrepreneur and the technology, have opportunities to capture economies of scale and scope not available to a venture capital-backed start-up, and will receive more favorable tax treatment than the start-up should the innovation fail. In connection with an auction of the idea, the former employer should have both a more accurate estimate of its value and receive an element of private value not available to the venture capitalist. In turn, this should give rise to a powerful winner's curse: each time a venture capitalist wins the auction, it will have paid more than a party that has better information and receives an element of private value. The puzzle, then, is why do we ever observe start-ups? Professors Joseph Bankman and Ronald J. Gilson suggest three interrelated explanations. First, the venture capitalist may have superior information with respect to some subset of employee innovations. Second, employer bids on employee innovation can create an incentive for employees to establish internal property rights in their research efforts that may reduce the future output of the employer's research and development efforts. Finally, employees are not homogenous. The attractiveness of venture capital financing depends critically on employee personal characteristics, such as risk aversion. The employer sets the internal payoff to discovery—its bid—to equalize the marginal benefit of retaining employees who might otherwise leave to the marginal cost of establishing unfavorable incentives for future research and development for those employees who do not find venture capital financing a close substitute for continued employment. In some cases, this calculus might lead to a "no bid" policy. In virtually all cases, the pay-off will be set too low to retain all employees, and start-ups ensue.

Communities are defined by their mythology. In Silicon Valley, the defining myth takes as its stage David Packard's or Steve Jobs' garage. Palo Alto's Roland is the engineer who, with nothing but an idea and strength of character, leaves his job with an established company, starts a firm that be-

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comes an industry leader, and in the process becomes fabulously wealthy. In this community, the myth is taken seriously. Over and over again, people set out on the path of heroes: They leave their comfortable, secure jobs, and start from scratch.¹ In this article, we seek to better understand the economic foundation for the high-tech start-up phenomenon.

The task is interesting because, as a matter of culture, high-tech entrepreneurs are the cowboys of our age. In the United States, as Willie Nelson has told us, our heroes have always been cowboys.² More to the point of our inquiry here, the presence of start-ups poses an intriguing puzzle as a matter of industrial organization. Each time an engineer leaves her established employer and organizes a venture capital-backed start-up, an alternative was also available: The employer could have paid the engineer to stay with the company and develop the new idea there. The puzzle arises because, on a first run-through, it is easy to show that the employer's proposal should be successful every time. Characterizing the initial transaction as an auction by the engineer of a share in her intellectual property, the idea should be worth more to the employer than to a venture capitalist who would fund the start-up. Accordingly, the employer should always win the auction. The puzzle, then, is how do venture capitalists ever win the auction? Why do we ever observe start-ups? Our analysis suggests that venture capitalists win, and we observe start-ups at all, at least in part because employers limit the circumstances in which they bid.

In Part I, we motivate the analysis by demonstrating the employer's bidding advantage. In addition to information and scope economies available to the employer but not a start-up, we stress that the asymmetrical character of the corporate income tax favors an established profitable company (the employer) over a start-up as a vehicle for developing the employee's innovation. In Part II, we canvas a range of explanations for why the employer might decline to bid for ideas that are worth more to it than to the next highest bidder. We note that, for a certain subgroup of innovations, the employer's bidding advantage is offset by certain skills possessed not by it but by venture capitalists. In addition, a practice of establishing large rewards to those employees who develop an idea that could be sold to a venture capital-

1. For the now-standard account of the sociology of the Silicon Valley high technology industrial district, see generally ANNALEE SAXENIAN, *REGIONAL ADVANTAGE: CULTURE AND COMPETITION IN SILICON VALLEY AND ROUTE 128* (1994). She reports, for example, that Hewlett-Packard "executives alone were responsible for starting more than eighteen firms between 1974 and 1984, including notable successes such as Rolm, Tandem, and Pyramid Technology." *Id.* at 116. Amar Bhidé provides some empirical support for the prevalence of the phenomenon, reporting that 71% of the founders of 100 of the 1989 *Inc. Magazine's* 500 fastest-growing companies had "[r]eplicated or modified an idea encountered through previous employment." Amar Bhidé, *How Entrepreneurs Craft Strategies that Work*, 72 HARV. BUS. REV., Mar.-Apr. 1994, at 150, 151.

2. See WILLIE NELSON, *My Heroes Have Always Been Cowboys*, on *SOUNDTRACK: THE ELECTRIC HORSEMAN* (1979); see also SAXENIAN, *supra* note 1, at 38 (reporting that "[t]he culture of the Valley accorded the highest regard to those who started firms").

ist may have dramatic effects on the employer's overall research and development effort. In order for the employee to have a property right that can be sold externally, and thereby trigger a bid by the employer, the employee must have established an *internal* property right. The behavior resulting from the employees' incentive to create internal property rights gives rise to costs for an employer that participates in the venture capital auction. In Part III, we note that the attractiveness of venture capital funding to an employee depends critically on certain employee characteristics, such as risk aversion, or the desire to be one's own boss. For employees with these characteristics, venture capital financing and employment with an established firm are not close substitutes. Employers have only a rough idea of the dispersion of these characteristics among employees. Employers will adopt a bidding strategy that balances overpaying to retain employees who do not find venture financing a close substitute for continued employment, and establishing unfavorable research and development incentives for this class of employees, against the benefits of retaining employees who find venture capital funding more attractive.

I. THE EMPLOYER'S ADVANTAGE: WHY WE SHOULD NOT OBSERVE START-UPS

To set up the puzzle, assume that we have a risk-neutral, established employer and a group of risk-averse engineers. Each of the engineers is competent at pursuing the employer's ongoing business—normal science—and each has a positive probability of developing an innovation that would give rise to a new business. Neither the engineers nor the employer can identify *ex ante* which of the engineers actually will develop the innovation.³ The obvious risk-sharing arrangement is for the employer to hire all the engi-

3. If each engineer accurately knew her own probability of making a discovery, then the employer could devise alternative contracts that would induce engineer self-selection—that is, each engineer's hidden information concerning her own abilities would be credibly revealed by her choice of contract. The assumption that the engineers cannot accurately assess their own ability is supported by survey evidence showing that engineers systematically over value their performance, a phenomenon we will call the "Lake Wobegon effect." See GARRISON KEILLOR, LAKE WOBEGON DAYS (1985) (noting that all of the children in the town of Lake Wobegon were better than average). Todd Zenger reports that, of a random sample of Silicon Valley engineers, more than one-third rated their performance among the top 5% of all engineers, and nearly 90% placed their performance in the top quartile. See TODD R. ZENGER, COMPENSATING FOR INNOVATION: DO SMALL FIRMS OFFER HIGH-POWERED INCENTIVES THAT LURE TALENT AND MOTIVATE EFFORT? (John M. Olin School of Business Working Paper No. 96-24, 1996). Less than 1% of the sample believed their performance was below average. See *id.* Such cognitive misassessment makes a successful separating contract difficult to imagine. For a more general treatment of managerial overconfidence in assessing risk, see Daniel Kahneman & Dan Lovallo, *Timid Choices and Bold Forecasts: A Cognitive Perspective on Risk Taking*, in FUNDAMENTAL ISSUES IN STRATEGY 71 (Richard P. Rumelt, Dan E. Schendel & David J. Teece eds., 1994) (arguing that "decision makers are excessively prone to treat problems as unique, neglecting both the statistics of the past and the multiple opportunities of the future").

neers, pay each the mean expected value of the group, and receive in return the engineers' contribution to the employer's ongoing business and all discoveries made by any of them.

Of course, once the uncertainty is eliminated—when the passage of time reveals which engineers have won the innovation lottery—the engineers' attraction to ex ante risk sharing gives way to an incentive for ex post opportunism. The winning engineer wants to keep the discovery for herself. Thus, the risk-sharing arrangement must have some characteristics that protect it from the corrosive effect of learning which engineer wins. And it should be apparent that, whatever the arrangement, it is not perfect. There must be a problem in prospectively transferring ownership of the engineers' discoveries to the employer. If the property rights could be fully specified and transferred ex ante, we would not observe start-ups. Thus, the puzzle is premised on a contracting failure.⁴

However, contracting failure alone is insufficient to account for the existence of start-ups. Even if the employee retains some property right in her discovery, commercializing the idea requires starting a business. In return for some portion of the future earnings from the innovation, other parties still must put up the factors of production the employee lacks: (1) capital; and (2) managerial, manufacturing, and marketing expertise. A conventional solution to this problem is venture capital financing. A venture capital fund contributes capital to the start-up as well as noncapital contributions such as management consulting, monitoring, and reputation, in return for an ownership stake in the start-up.⁵ But suppose we recharacterize the venture capital

4. This assessment seems especially plausible with respect to Silicon Valley. California Business and Professions Code § 16600 makes post-employment covenants not to compete unenforceable. See CAL. BUS. & PROF. CODE § 16600 (West 1997). Because a post-employment covenant is likely the most effective way to assure transfer from employee to employer of the property right in future discoveries, its unavailability is sufficient to explain the incomplete specification of property rights. See RONALD J. GILSON, THE LEGAL INFRASTRUCTURE OF HIGH TECHNOLOGY INDUSTRIAL DISTRICTS: SILICON VALLEY, ROUTE 128, AND COVENANTS NOT TO COMPETE 40-42 (Olin Program on Law and Economics, Stanford Law School, 1998). The welfare consequences of this incompleteness are ambiguous. While traditional property rights analysis suggests that incompleteness gives rise to inefficiently reduced incentives to invest in innovation, Gilson suggests that the incompleteness gives rise to an externality, see *id.* at 43 (describing how CAL BUS. & PROF. CODE § 16600 solves a collective action problem in Silicon Valley), that supports the maintenance of an industrial district of the sort described by Saxenian. See SAXENIAN, *supra* note 1, at 116 (describing how Silicon Valley firms allow free movement of employees and concomitant information sharing).

5. For accounts of the venture capital fund/portfolio company relationship, see generally Bernard S. Black & Ronald J. Gilson, *Venture Capital and the Structure of Capital Markets: Banks Versus Stock Markets*, 47 J. FIN. ECON. 243 (1998) (explaining and comparing the relationship in the United States, Germany, and Japan); Paul Gompers & Josh Lerner, *The Use of Covenants: An Empirical Analysis of Venture Partnership Agreements*, 39 J.L. & ECON. 463 (1996) (focusing on relationships "between investors and venture capitalists and between venture capital firms and the ventures in which they invest"); and William A. Sahlman, *The Structure and Governance of Ven-*

process as an auction. The engineer leaving her position with the employer is selling off a portion of her innovation to the highest bidder. When all else is equal, the employer has advantages—tax, information, and scope—that should result in it consistently winning the auction.

A. *The Employer's Tax Advantage*

Under current law, the tax treatment of corporate investment depends on the tax history of the organization making that investment. An investment made by a company with sources of past or present income is subject to a symmetrical tax regime: The expenses of the investment are deductible and produce tax savings, while the gains from investment are subject to tax. An investment carried out by a start-up, in contrast, is subject to an asymmetrical tax regime: Gains are fully taxed, but losses may be deducted only against future income. As discussed in more detail below, this difference in tax regime operates in the circumstance of interest here to provide a substantial subsidy for an employer's efforts to develop an employee's innovation internally.⁶

Under Internal Revenue Code (I.R.C.) § 172, a start-up may deduct expenses only against income—expenses in excess of current income (a net operating loss) may generally be carried forward for fifteen years and deducted against future income.⁷ In contrast, a company with sources of past or present income from other activities—we will call it an “established company”—may deduct expenses of the start-up activity that exceed start-up activity income as they are incurred: The expenses of the start-up activity are set off against the income from other activities. The significance of the divergent tax treatment of innovation expenses incurred by established companies on the one hand, and start-ups on the other, depends on the timing for tax purposes of expenses and income. For a number of reasons, the consequences of this divergent tax treatment are likely to be particularly important for start-ups.

First, a significant number of start-up companies never earn profits.⁸ For these companies, the limitation on deductibility amounts to a permanent loss

ture-Capital Organizations, 27 J. FIN. ECON. 473 (1990) (analyzing 140 venture fund partnership agreements).

6. See generally Joseph Bankman, *The Structure of Silicon Valley Start-ups*, 41 UCLA L. REV. 1737 (1994) (providing a more complete description of the tax treatment of traditional start-up ventures and that of alternative structures).

7. See I.R.C. § 172 (West Supp. 1998).

8. Empirical evidence indicates that one-third of venture capital investments result in losses. See Christopher B. Barry, *New Directions in Research on Venture Capital Finance*, 23 J. FIN. MGMT. ASS'N, Autumn 1994, at 3; Sahlman, *supra* note 5, at 483-84. According to one study, 16% of venture capital-backed companies liquidate or go bankrupt. See Paul A. Gompers, *Optimal Investment, Monitoring, and the Staging of Venture Capital*, 50 J. FIN. 1461, 1472-73 (1995).

of the tax benefit. For more successful start-ups that ultimately do earn profits, the combination of staged financing,⁹ often involving new investors at each round,¹⁰ and the exercise of employee stock options, likely will result in an identifiable group of five percent shareholders increasing their ownership interests by at least fifty percentage points within a three-year period. This triggers a change of ownership under I.R.C. § 382 which, in turn, sharply restricts the value of the net operating loss.¹¹ Even companies that reach profitability within the carry forward period and escape the change of ownership limitation still require many years before generating sufficient taxable incomes to take full advantage of early losses. Thus, the tax benefit of the eventual deduction is limited by the loss of value inherent in deferral.¹²

For new ventures carried out by established companies the tax picture is quite different. Such companies face no special limitations on otherwise deductible expenses, and the availability of tax credits and deductions for research and development ensures that most expenses of internally developing an innovation can be immediately offset against income from other activities. Expressed in terms of net present value, the effect of the tax differential is quite stark. Consider, for example, an investment that costs \$100 in year one and has the following probability distribution of returns: a 40 percent chance of returning nothing; a 40 percent chance of returning \$100 in year ten; and a 10 percent chance of returning \$700 in years six through twelve. At a discount rate of 15 percent (quite conservative in light of the 40 to 60 percent rate said to be applied by venture capitalists),¹³ the investment has a net present value of approximately \$141.

Now assume that the combined state and federal tax rate is 40 percent; that an established company is able to deduct the investment ratably over three years; and that the company is able to gross up the investment by the

9. Venture capital financing is typically staged with initial funding being significantly less than necessary to carry out the start-up's business plan. If the start-up performs well in the first stage, additional stages of financing occur. See Gompers, *supra* note 8, at 1474 (reporting that the average venture capital portfolio company in his sample had 2.7 rounds of financing).

10. See Joshua Lerner, *The Syndication of Venture Capital Investments*, 23 J. FIN. MGMT. ASS'N, Autumn 1994, at 16, 19-20.

11. Where a change in ownership occurs, the start-up may use its past losses to offset current income in any carry forward year only to the extent of the value of the firm at the time of the change in ownership multiplied by the long-term tax exempt interest rate. This operates to significantly reduce the value of the carry forward. See I.R.C. § 382 (West Supp. 1998); Robert L. Parker, *The Innocent Civilians in the War Against NOL Trafficking: Section 382 and High-Tech Start-Up Companies*, 9 VA. TAX REV. 625, 639-40 (1990).

12. The tax history of Sierra Semiconductor is typical. The company began operations in 1984 and since that time it has grown dramatically. However, as late as 1991, the company had not yet received the tax benefit of all the losses incurred in its early years. See SIERRA SEMICONDUCTOR CORP., 1991 ANNUAL REPORT 16, 26 (1992) (noting federal net operating loss carry forwards of about \$30 million).

13. See Sahlman, *supra* note 5, at 511-12 (noting that venture capital discount rates usually range from 40% to 60%).

present value of the tax savings. The investment now shows an after-tax present value of approximately \$135. The relatively small reduction in present value as a result of the 40 percent tax reflects that the value of deducting the venture's losses in the first few years offsets most of the future tax on the later occurring venture income. In contrast, a start-up loses the entire deduction on the investments that never generate profit, and loses most of the present value of the deduction for break-even and successful investments. As a result, the after-tax net present value of the investment to the start-up is only \$95—\$5 less than its cost, and \$40 less than the value of the same investment to an established company.¹⁴

Our analysis thus far has focused only on the corporate tax. A more complete analysis would also include the tax paid by shareholders of start-ups on the proceeds from the sale of their stock.¹⁵ In general, taking the shareholder-level tax into account would lessen the start-up's disadvantage. For unsuccessful start-ups, the inability to deduct expenses would exacerbate losses on the corporate level and lead to greater losses on the shareholder level; for successful start-ups, the deferral of deduction at the corporate level would reduce gains at the shareholder level. In either event, the result would be a reduction in shareholder-level tax. Tax savings at the shareholder level, however, would be of second-order magnitude. At best, given a 40 percent combined state and federal tax rate, shareholders would recoup only 40 percent of the tax disadvantage experienced by the corporate start-up. In all cases, this partial recoupment of the tax disadvantage would require disposal of the underlying stock. For unsuccessful investments, such recoupment would be hampered by I.R.C. limitations on deduction of capital losses.¹⁶

B. *The Employer's Informational Advantage*

While the employer's tax advantage, amounting to a government subsidy available for the most part only to new ventures carried out by an established

14. The impact of the differential tax treatment of established companies and start-ups can also be expressed in terms of the cost of capital. Assuming that the tax rate from the text example applies (40%), that expenses incurred in the first year of a new venture can be deducted by an established firm ratably over the first three years, and that the value of certain tax deduction is discounted at an annual rate of 6%, then the present value of the cost of a \$1 investment to an established firm is approximately \$0.64. The start-up can deduct the cost of the investment only against future income. It is reasonable to assume that only half of start-ups will ever show sufficient income to take advantage of their deductions, and that for tax purposes, even successful start-ups will take a decade to generate sufficient income to offset the investment. Since the value of the deduction depends on the realization of income, it is appropriately discounted at a rate that reflects the riskiness of the investment. Using the same 15% rate as in the text example, the expected present value of the deduction is less than \$0.06. The after-tax cost of the \$1 investment to the start-up is thus \$0.97—roughly 50% more than the \$0.64 cost of the venture to the established company.

15. See Bankman, *supra* note 6, at 1746 (providing a more detailed discussion of shareholder level income tax).

16. I.R.C. §§ 1211, 1212 (1994 & West Supp. 1998).

company, appears to be of a magnitude sufficient to assure an employer's success in the auction of an employee's innovation, it is not the employer's only advantage. In two important respects, the employer also has an informational advantage over venture capitalists in assessing the value of the employee's innovation.

The first advantage involves information concerning the employee himself. It is commonplace that venture capital investors place enormous emphasis on the personal characteristics of the individual in whose innovation they invest. This is hardly surprising. Because of the uncertainty associated with the venture's success, and because the venture's value depends on investment in future growth options that, tautologically, are highly dependent on future managerial decisions, the marginal value of a "better" entrepreneur is considerable. Unlike established companies where most income derives from existing businesses whose value is less sensitive to future decisions, a new venture's business is almost entirely dependent on the entrepreneur's judgment. Thus, the entrepreneur's talents, independent of the character of the innovation, influence a much larger percentage of the venture's value than in a more mature businesses.

Because of the importance of the entrepreneur's character, assessment of the entrepreneur is critical to the venture capitalist's valuation of the innovation on which he will bid. And because of the limited opportunity for the venture capitalist to make a direct assessment, self-selection plays an important role in the venture capitalist's response to the hidden information problem. From this perspective, the high-powered incentives associated with the entrepreneur's arrangement with the venture capitalist—low salary, stock-based compensation that is subject to vesting requirements, the venture capitalist's power to replace the entrepreneur, and the provision of financing in stages¹⁷—also operate as a separating contract, serving to identify those entrepreneurs who have sufficient confidence in their skills to subject themselves to the highly incentivized environment of early-stage venture capital financing.

But however clever the incentive arrangements, their separating properties remain an imperfect substitute for direct observation of the employee's characteristics. While the employer can seek to duplicate the venture capitalist's incentive structure, the venture capitalist cannot duplicate the employer's direct experience with the employee. This difference should be of special importance here because of the inherent limitations on the operation of a separating contract in the start-up setting. Using contractual terms to generate a separating equilibrium requires that those who are offered the

17. The structure of the entrepreneur's incentives in a standard venture capital transaction is described by Black and Gilson. See Black & Gilson, *supra* note 5, at 259; see also Sahlman, *supra* note 5, at 506-14; Gompers, *supra* note 8, at 1461.

contract know their type. Survey evidence suggests that engineers in high-tech companies systematically overestimate the quality of their skills and performance: one-third rate their performance in the top five percent; ninety percent place themselves in the top quartile; and less than one percent rate their performance below average.¹⁸ If entrepreneur-engineers share this characteristic with engineers generally, then the separating contract will fail to distinguish between engineers whose positive self-assessment is accurate, and those who view themselves too favorably. So long as the problem is self-serving self-assessment rather than adverse selection, further increasing the power of incentives will not improve the result. Increased incentives will generate increased risk-bearing costs and, under the incentive intensity principle, greater expenditures on monitoring,¹⁹ but in the absence of more accurate self-assessment, no improvement in separation. The employer's direct observation over time of the employee's characteristics should allow the employer to make a more accurate assessment of the employee's skills than will the separating properties of the incentive contract alone and, hence, allow the employer to make a more accurate assessment of the value of the entrepreneur's managerial potential.

The employer's second informational advantage concerns the innovation itself. For this purpose, it is reasonable to assume that the innovation grows out of the employee's experience with the employer's business.²⁰ Bidding for a portion of the employee's innovation requires valuing the innovation. Here the employer should have an informational advantage that results from its experience with precisely the technology and market out of which the innovation grows. To be sure, this advantage can be more easily offset by venture capitalists than can the information asymmetry favoring the employer with respect to assessing the employee's personal characteristics. Due diligence investigations and venture capitalist specialization by industry should largely limit the employer's absolute valuation advantage to circumstances that involve *firm*- as opposed to *industry*-specific information. Nonetheless, the cost of gaining industry-specific information to the venture capitalist is sunk to the employer. The employer's marginal advantage with respect to industry-specific information, together with the benefit of firm-specific information concerning the innovation's value, provides a measure of the employer's overall information advantage in valuing the employee's innovation.

18. See note 3 *supra*.

19. See PAUL MILGROM & JOHN ROBERTS, *ECONOMICS, ORGANIZATION, AND MANAGEMENT* 221-22 (1992).

20. See note 1 *supra*.

C. *The Employer's Scope Advantage*

Analytically, the employer's firm-specific information concerning the value of the employee's innovation shades into advantages of scope economies. To the extent that the innovation builds on the employer's existing technology, it is quite likely that the employer can achieve economies of scope in connection with the innovation's commercialization, manufacturing, and marketing. Compared to starting from scratch, complementarities in manufacturing techniques between those required to produce the innovation and those required to produce the employer's existing products may reduce the cost of commercializing, and ultimately producing, the innovation compared to a stand-alone venture. Similarly, the closer the relation between the employer's existing technology and the innovation, the more likely that there will be an overlap between the company's existing customer base and potential customers for the innovation. Thus, the potential for scope economies gives the employer a cost advantage, and therefore a bidding advantage, compared to a venture capital-backed start-up that must undertake commercialization, manufacturing, and marketing from scratch.

D. *The Outcome of the Auction*

We can now return to the hypothetical auction between the employer and a venture capitalist for an interest in the employee's innovation. The advantages enjoyed by the employer should allow it to be the highest bidder in every auction. First, the employer begins with a significant tax subsidy: In expected value terms, the riskier the innovation, the more valuable the employer's ability to immediately deduct losses associated with the innovation.²¹ Second, the employer's informational advantages with respect to both the employee and the innovation give it an advantage in pricing the innovation. Finally, the potential economies of scope available to the employer in taking the innovation to market transform the structure of the auction to the employer's advantage. While the innovation has largely common value with respect to a venture capitalist, it has additional private value for the employer.

Thus, a venture capitalist bidding against an employer for a former employee's innovation should anticipate a serious winner's curse. Each time the venture capitalist is the highest bidder, it must realize that it has just outbid a party who receives a government subsidy, has better information concerning the innovation's value, and for whom the innovation has private value as well as common value. Because the venture capitalist can anticipate

21. To see this, think of the employer holding an option that allows it the right to put 40% of the losses to the government. From option pricing, we know that the value of an option increases with increases in the riskiness (variance) of the value of the underlying asset.

this analysis, it should never bid. Accordingly, we should not observe auctions, and we should not observe start-ups. Employers would develop the employee's innovation in a structure designed to capture the incentive benefits of start-up organizations.

There is at least anecdotal evidence in support of this analysis. Thermo Electron appears to exemplify the employer who never loses an auction of an employee's innovation to a venture capitalist. The company consists of a holding company and eleven publicly traded subsidiaries in which the holding company or a first-tier controlled subsidiary (with public ownership) owns a majority of the outstanding stock.²² These subsidiaries are created when an employee comes up with a new idea for a business. At that time, the employee is given an entrepreneur's equity stake in the venture. If the subsidiary is successful, it is ultimately taken public with the holding company retaining a majority interest. Indeed, the company has been called a "publicly traded venture capital group. . ."²³ For our purposes, the critical point is that Thermo Electron wins the auctions for its employees' innovations. Consistent with our analysis thus far, the company represents that it has never lost an employee innovation to a venture capital-funded start-up.²⁴ Because Thermo Electron's winning "bid" for employee innovations is embedded in its internal incentive structure, the auction never occurs.

II. WHY START-UPS? EXPLANATIONS FOR WHY THE EMPLOYER DOES NOT BID

Having demonstrated that elephants can't fly, what accounts for Dumbo? The fact is that early stage venture capital-backed start-ups founded by employees leaving an established company are a familiar part of the high technology landscape. Indeed, annoyance at the difficulty of keeping employees from defecting with their innovations in response to the blandishments of venture capitalists has led the chairmen of Intel Corporation and Applied Micro Devices to refer to venture capitalists as "vulture" capitalists,²⁵ led Andrew Grove, the president of Intel, to call them the "financial equivalent of ambulance chasers,"²⁶ and led some scholars to argue that the phenome-

22. See Jeffrey W. Allen, *Capital Markets and Corporate Structure: The Equity Carve-Outs of Thermo Electron*, 48 J. FIN. ECON. 99, 101 (1998). The company also owns nonpublic subsidiaries. See *id.*

23. John R. Wilke, *Innovative Ways: Thermo Electron Uses an Unusual Strategy to Create Products*, WALL ST. J., Aug. 5, 1993, at A1. For a chart of the company's structure, see Allen, *supra* note 22, at 104.

24. According to founder George Hatsopoulos, "[n]o developer or entrepreneur has ever left Thermo Electron." Norm Alster, *Making the Kids Stand on Their Own*, FORBES, Oct. 9, 1995, at 49, 54.

25. See WILLIAM D. BYGRAVE & JEFFRY A. TIMMONS, *VENTURE CAPITAL AT THE CROSSROADS* 288 (1992).

26. *Id.*

non is a barrier to United States competitiveness with Japan.²⁷ In this Part, we consider what factors offset employers' sizable tax and other advantages.

The existing literature has discussed related problems, although largely in the context of explaining more generally the perceived advantage of small firms in pursuing innovation, rather than our more focused concern here on employees and start-ups: the employer's ability to win an auction for the right to purchase equity in an employee's innovation. For example, Anton and Yao analyze the adverse selection problems confronting an employer seeking to contract with an employee for an innovation, where the absence of property rights exposes the employee to a risk of expropriation on revelation of the innovation to the employer. Under the limiting assumptions of their model, Anton and Yao show that these barriers to contracting will sometimes lead the employee to organize a start-up even when joint employer/employee profits would have been greater if the employer pursued the innovation.²⁸ Anand and Galetovic also examine the impact of imperfectly specified property rights, extending the analysis to consider the problem in the context of multiple rounds of financing for development and commercialization.²⁹ Finally, Hellmann focuses on the barriers to established companies, as opposed to venture capitalists, to providing financing to entrepreneurial companies.³⁰ In Hellmann's model, pursuit of innovation within established companies faces political challenges from employees with a stake in current practices.³¹

Problems with an established company may be informational, as well as political. Earlier we noted that the established company has greater knowledge of the entrepreneur and the product. Henderson and Clark point out that the established company may be hamstrung by routinized ways of thinking that are ill-suited to new products.³² A related possibility is that

27. See *id.* (citing Charles Ferguson as an academic who has accused venture capital-backed start-ups of hurting America's ability to compete with Japan). See generally RICHARD FLORIDA & MARTIN KENNEY, *THE BREAKTHROUGH ILLUSION: CORPORATE AMERICA'S FAILURE TO MOVE FROM INNOVATION TO MASS PRODUCTION* (1990) (presenting academic articles dealing with how firms make strategic decisions affecting their competitiveness).

28. See James J. Anton & Dennis A. Yao, *Start-ups, Spin-offs, and Internal Projects*, 11 J.L. ECON. & ORG. 362, 362 (1995). Steven N. Wiggins presents a related model in which the difficulty of enforcing the employer's promise of compensation to the employee if the innovation is successful leads to a start-up venture. See Steven N. Wiggins, *Entrepreneurial Enterprises, Endogenous Ownership, and the Limits to Firm Size*, 33 ECON. INQ. 54, 58-63 (1995).

29. See Bharat N. Anand & Alexander Galetovic, *Weak Property Rights and Hold-up in R&D* 10-20 (1997) (unpublished manuscript, on file with the *Stanford Law Review*).

30. See THOMAS HELLMANN, *A THEORY OF CORPORATE VENTURE INVESTING* 9-26 (Stanford University Graduate School of Business Research Paper No. 1452, 1997).

31. See *id.* at 5-9.

32. See Rebecca M. Henderson & Kim B. Clark, *Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms*, 35 ADMIN. SCI. Q. 9, 10-13 (1990) (defining architectural innovation and noting the difficulty of pursuing it in an established firm). Where the informational advantage involves the employer's existing technology, and the innovation, while growing out of that technology, requires a different skill set to implement, the

venture capitalists may have greater expertise in marketing and developing new products. These information-related factors may explain a consistent story of innovation given by employees who in fact become entrepreneurs: that their decision to leave was triggered in part by the decision of their former employer to drop a promising product because it did not fit within the employer's focus and expertise.

A final explanation for the ability of venture capitalists to outbid established companies for innovation revolves around the difficulty of setting the proper incentives within an established employer. Large and small firms have different capacities for providing employees incentives to discover an innovation. Here, existing literature stresses three themes.

First, Milgrom and Roberts stress the problem of "influence activities" by employees.³³ Where a decisionmaker requires information from employees to make a decision which has consequences for the employee, and where the employees' allocation of their efforts cannot be observed, the employee will have an incentive to expend effort to influence the employer's decision rather than in productive activity. Such influence activities result in increased costs to the employer both from the employee's decreased productivity and from the self-serving character (decreased accuracy) of the information the employee provides to the decisionmaker, with a resulting decrease in the quality of the decision.

Second, Holmstrom emphasizes differential measurement and monitoring costs. Where measuring the employee's performance in innovative activity is more difficult than measuring her performance in more routine activities, restricting the range of the employee's activities is desirable.³⁴ When coupled with increased monitoring costs, both factors favor carrying out innovative activity in smaller organizations.

A final theme focuses on the perception of unfairness resulting from wide pay disparities within a single organization. Given employees' marked tendency to overestimate their own performance, providing intense incentives achievable by only some employees can result in a perception of unfairness by other employees. This results in decreased productivity by the

employer actually may be at a disadvantage to a start-up. If the innovation requires the employer to unlearn precisely the information and routines that made it a success with the existing technology, a form of innovation styled "architectural," the venture capitalist may have an advantage in valuing the new technology. See *id.* at 18.

33. See generally Paul Milgrom & John Roberts, *An Economic Approach to Influence Activities in Organizations*, 94 AM. J. SOC. S154 (1988) (explaining "influence activities," their negative effects on firms, and possible response strategies).

34. See Bengt Holmstrom, *Agency Costs and Innovation*, 12 J. ECON. BEHAV. & ORG. 305, 312 (1989). See generally Bengt Holmstrom & Paul Milgrom, *Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design*, 7 J.L. ECON. & ORG., Special Issue 1991, at 24 (developing a model that explains how the principal-agent problem influences the allocation of tasks to employees).

demoralized workers.³⁵ Lazear makes a similar argument, but stresses the incentive for employees who compete for a prize to sabotage each other's efforts.³⁶ Both accounts credit the unintended consequences or perverse incentives of relative incentive pay as explaining the broad incidence of wage compression—the lack of strong pay-for-performance incentives—in U.S. industry. Smaller firms, where there is less heterogeneity among employees, where employees are better able to observe each other's performance, and where there is less need to differentiate among employees in devising incentives, are said to have lower costs of providing strong performance incentives.³⁷ This facility at providing the intense incentives necessary to motivate innovation thus helps explain why small firms outperform large firms in this area.

Our analysis here extends the internal incentive literature in explaining the employee-founded, venture capital-backed start-up phenomenon despite the employer's tax, information, and scope advantages in the auction of an employee's innovation. In particular, we stress the cost of a particular kind of employee influence activity that would result from the expectation of the employer's participation in the auction of the employee's innovation, one that goes directly to the character of the research and development process.

The employer's decision to participate in the venture capital auction serves, in effect, to create a powerful internal incentive: employees who discover an innovation of a character significant enough to generate outside venture capital offers are rewarded with an internal entrepreneurial payoff that, because of the employer's multiple advantages, will be set to marginally exceed the expected venture capital offer. The barrier to employer adoption of this arrangement—that is, why we nonetheless observe start-ups in the face of employer bidding advantages—is not fully captured by the themes in the existing literature. First, the difficulty of measurement costs should be less significant in this setting because the incentive arrangement pays off on an observable output: an innovation that can attract outside funding. Second, concerns over the costs of perceived unfairness should be tempered for the same reason. Since the payoff is on an observable output, it also should be observable to other employees: the requirement of an externally validated innovation acts as a barrier to widespread misperception of abilities. Indeed, a very high payoff to an infrequent but observable outcome is consistent with the wage compression reported by Lazear—the bulk of employees are lumped into a few broad categories where most of the compensation variance

35. See Todd R. Zenger, *Explaining Organizational Diseconomies of Scale in R&D: Agency Problems and the Allocation of Engineering Talent, Ideas, and Effort by Firm Size*, 40 *MGMT. SCI.* 708, 710-11 (1994).

36. See Edward P. Lazear, *Pay Equality and Industrial Politics*, 97 *J. POL. ECON.* 561, 562 (1989).

37. See Zenger, *supra* note 35, at 711-12.

is explained by seniority, but with small highly positive and highly negative rewards at the top and bottom of the distribution.³⁸ Third, observability of the output that triggers the incentive payoff dampens the incentive to engage in core influence activity. Because the payoff is on an observable output keyed to an external evaluation (the desirability of the innovation to venture capitalists), the importance of the employees' knowledge to the decision-maker is reduced and, it follows, so is the incentive to engage in influence activities. Finally, the employer's determination that a particular innovation warrants an entrepreneurial reward is more credible than a determination under more subjective incentive plans because the employer commits not only to making the award to the employee, but also to putting up its own capital to fund development of the innovation. In effect, the employer signals to other employees the credibility of its assessment of the winning employee's innovation by putting its money behind its measurement.

Our analysis of the cost that offsets employer tax, information, and scope advantages in a venture capital auction focuses on a different problem with the incentive structure that is created by the employer's bidding. Even in the absence of measurement problems with respect to the *value* of the innovation, the employer may still confront measurement problems concerning the *ownership* of the innovation—that is, determining the identity of the employees who are entitled to share in the entrepreneurial payoff of employer venture capital-like financing. Even in the absence of incentives for employees to engage in influence activities with respect to whether an innovation warrants an entrepreneurial payoff, measurement problems still may give employees a significant incentive to engage in a special kind of influence activity with respect to who is entitled to receive the entrepreneurial payoff at all.

In particular, employees will have an incentive to engage in activities that perfect an *internal property right* to the innovation that warrants the incentive payoff. In Part I, we motivated our analysis by assuming that the employer cannot fully perfect its property right with respect to the engineer who wins the innovation lottery. The employer must still determine, however, *which* employees have retained the property right to an innovation, a task that may be quite difficult where the research is a team, rather than an individual, effort. The potential ex post ambiguity concerning ownership of the internal property right to the innovation in turn creates an ex ante incentive for employees to engage in a particular kind of influence activity whose intensity is a function of the size of the entrepreneurial payoff. Because these auction-induced activities may impose substantial ex ante costs on the employer's entire research enterprise, they operate to restrict the employer's ex post participation in the venture capital auction.

38. See Lazear, *supra* note 36, at 563-63.

To see these relationships, assume that research and development is most efficiently carried out in teams. Further assume that the activities of any single team may create economies of scope when shared with members of other teams pursuing related research. Finally, assume that the total entrepreneurial reward to the employee with the internal property right to the innovation is fixed: an increase in the number of employees holding the property right reduces the per employee return. Under these not unreasonable assumptions, employees will have a powerful incentive to perfect their internal property rights by hoarding their information, both from actual and potential team members and from other teams whose own research might benefit from access to the first team's information. Such property-rights-perfecting activities have the capacity to be especially costly because not only do they divert the employee's own efforts from productive activity but, more importantly, they also reduce the productivity of many other employees who are part of the employer's research and development activity by denying them access to full team participation or to complementary information.³⁹ Property-rights-perfecting activity thus has a negative multiplier effect: It serves to reduce the output of a wide range of research participants.

Two anecdotes from an academic research setting illustrate the problems arising from the need to establish internal property rights in innovations. In the early 1970s, Professor Piccione, a physicist at the University of California at San Diego, sued Emilio Segre and Owen Chamberlain for having stolen from him the idea that led to their receipt of the Nobel Prize in physics for the discovery of the anti-proton. Segre and Chamberlain's decision about how to allocate responsibility for their experimental research among participants in the effort (which included Piccione) served to allocate a property right internal to the academy which came to have substantial value. The litigation was resolved in favor of Segre and Chamberlain in an unreported opinion of the California Court of Appeals for the First District (one of the authors participated in Segre and Chamberlain's defense).

The same phenomenon also operates more generally and at lower academic stakes. By the mid-1980s, disputes over who should be listed as an author, and in what order, on scholarly publications—the academic internal property right—became quite serious. Academic success and future research funding depended on the number of a researcher's publications and on the

39. Other work has noted the impact of incentives on teamwork and cooperative effort among employees. Lazear argues that where cooperation among employees is important, we should see less wage differential among employees, that is, we should see lower power incentives. *See id.* at 563. Holmstrom and Milgrom make a similar point: "[W]here individuals spend part of their efforts on individual projects and part on team production, and assuming that individual contributions to the team effort are difficult to assess, it would be dangerous to provide incentives for good performance on the individual projects." Holmstrom & Milgrom, *supra* note 34, at 35. Our analysis here differs in its emphasis on the employee's incentive to engage in property-rights-perfecting activities.

nature of the attribution. The problem became sufficiently controversial that the president of Stanford University issued a report suggesting guidelines governing research attribution. The perfecting of internal property rights to innovations is a serious matter with respect to academic research. Commercial research is likely to be just as internally divisive when the stakes are high.⁴⁰

It is important to note that the costs of property-rights-perfecting behavior are not due entirely to employer-provided incentives or payoffs. Some employees may engage in this form of behavior to perfect property rights to sell to an external bidder—here, the venture capitalist. The reason why property-perfecting behavior may nonetheless be viewed primarily as a marginal cost to an existing employer is discussed in Part III.

III. EMPLOYER'S BIDDING STRATEGY

To this point, our analysis has stressed a previously unemphasized factor that helps explain start-ups: the costs to the employer's research and development program associated with employee efforts to perfect internal property rights induced by employer bidding.⁴¹ We have omitted any discussion of an additional important and, in some sense obvious, explanation for start-ups: Employees do not regard venture capital entrepreneurship as an identical substitute for continued employment. Employees have different utility func-

40. Donald Kennedy, *President Kennedy's Statement on Academic Authorship*, in STANFORD UNIVERSITY RESEARCH POLICY HANDBOOK 28 (1989). Kennedy's report captures a sense of the measurement problem:

There is a cluster of questions about authorship and intellectual "ownership" that includes these, among others: What level of contribution by the various parties to a research enterprise qualifies for (co)authorship of the product? What circumstances entitle one to independent or first publication or to the use of data in another publication or project without attribution? In considering these, I am struck by the seamlessness that often characterizes collaborative research

[T]he original inspiration may defy reconstruction by the time the project is completed. One member of an experimental team . . . may provide an absolutely critical skill, without which the entire venture could not proceed; one contributor to a scholarly project may have had an idea that was essential to the working out of the problem The more interactive the process, the less we can retrospectively divide the work into parts corresponding to particular roles or contributions.

Id. at 30-31.

41. Naomi Lamoreaux and Kenneth Sokoloff report that employers like Western Electric recognized early in the 20th century that paying employees bonuses for inventions "'put a tremendous incentive' on employees to work 'at counterpoints to their own associates,' creating a situation where 'men would not work with each other . . . [though] the problem which was before us was a problem which required team action.'" Naomi R. Lamoreaux & Kenneth L. Sokoloff, *Investors, Firms and the Market for Technology in the Late Nineteenth and Early Twentieth Centuries* 52 (1997) (unpublished manuscript, on file with the *Stanford Law Review*) (citing *Pooling of Patents: Hearings on H.R. 4523 Before the House Comm. on Patents*, 74th Cong. 276 (1936) (testimony of Dr. Frank Baldwin Jewett, Vice President of AT&T Co. and President of Bell Telephone Laboratories)).

tions and for that reason they differ in the value they place upon venture capital funding. Employers take advantage of those differences in their bidding strategy.

In what way do employees differ in their evaluation of an offer to join or head a start-up? The most obvious example is risk aversion. The entrepreneurial return to employees on their innovations is risky: Empirical evidence reports that approximately one-third of venture capital investments result in losses,⁴² some sixteen percent of venture capital backed companies are liquidated or go bankrupt,⁴³ and a significant percentage of would-be entrepreneurs never secure venture capital funding at all. Assume that employees exhibit varying degrees of risk aversion, associated with their personal tastes and circumstances.⁴⁴ For some employees, then, a less-intense-but-less-risky internal incentive will be preferred to a more-intense-but-more-risky entrepreneurial incentive offered by venture capitalists. Not only will the employee's risk aversion reduce the expected direct cost necessary for the employer to retain the employee and her innovation relative to what the venture capitalist would have to pay, but the less-intense incentive also will reduce the employee's corresponding incentive to engage in costly property-rights-protecting activities.

Risk aversion, however, is not the only personal taste bearing on an employee's choice between remaining with the employer and pursuing her innovation through a venture capital-financed start-up. For example, an employee may positively value the opportunity to be her own boss, as well as the favorable cultural image of an entrepreneur.⁴⁵ For these employees, the employer's incentive would have to be more intense than that offered by the venture capitalist in order to offset the imputed income associated with a start-up.

Differences in employee characteristics interact in an interesting way with property-rights-protecting costs. As noted above, such costs cannot be avoided entirely by an employer: An employee who thinks she is likely to receive a more desirable offer from a venture capitalist may engage in such behavior even if she does not expect her current employer to bid.⁴⁶ Assume

42. See Barry, *supra* note 8, at 3; Sahlman, *supra* note 5, at 483-84.

43. See Gompers, *supra* note 8, at 1472-73.

44. Holmstrom stresses the importance of risk aversion in setting the employee's contingent compensation. See Holmstrom, *supra* note 34, at 310. Robert P. Merges argues that an employee's ability to leave with her innovation free of a property right in her employer is greater the earlier in the development process it occurs. The earlier in the process the employee must decide, however, the riskier is the start-up option. See Robert P. Merges, Property Rights Theory and Employee Inventions 37 (1997) (unpublished manuscript, on file with the *Stanford Law Review*).

45. See SAXENIAN, *supra* note 1, at 38.

46. There is reason to believe, however, that property-rights-protecting costs will be lower when the payoff is made by a venture capitalist, than when made by the employer through an internal incentive program. Recall that the potential for influence costs arises from an information

that the ex ante incentives for such an employee are identical, with or without the competing bid. Assume also that employees know in advance whether they are likely to find venture capital funding particularly attractive. If each employee's utility function is different but known to the employer, internal-property-rights-perfecting behavior would not be a factor in the employer's bidding strategy. The employer would only bid, or set internal incentives at a level, to retain those employees who (because of relative lack of risk aversion or desire to engage in entrepreneurial activity) would otherwise leave. These employees would engage in property-rights-perfecting behavior anyway. No marginal costs with respect to such behavior would be triggered by the employer's bid. In fact, of course, employers cannot know, or can only imperfectly know, how attractive a given employee finds the entrepreneurial world of start-ups. A uniform, internal payoff structure high enough to retain all valuable employees and their innovations will reward even those employees who would have stayed absent the payoff. Employees in this latter (risk averse) class now have an incentive to engage in property-protecting behavior. Thus in setting the level of internal payoff, employers balance the gains from retaining valuable employees and innovations with the costs incurred from paying employees who would not otherwise leave. These costs include both the payoff amount and the ex ante incentives to engage in property-rights-protecting behavior established for this class of employees. Employers will rarely find it worthwhile to set the payoff amount high enough to retain all valuable employees. Many employers will find it desirable to set a firm "no-bid" strategy with respect to those employees who the internal incentive system will not retain. Valued employees are allowed to leave, and start-ups ensue.

CONCLUSION

In this article we have added to the factors explaining the existence of start-ups by stressing the costs imposed by employee efforts to perfect internal property rights to innovation. We argued that where research is a team effort with potential economies of scope, the impact of employee efforts to perfect internal property rights to innovations on an employer's research and development program will limit the extent to which an employer, through its internal incentives for innovation, will bid against a venture capitalist in an

asymmetry between the employee and the employer: the employer cannot observe the employee's allocation of effort, thereby allowing the employee to provide the employer self-servingly inaccurate information concerning the employee's productivity. See text accompanying note 31 *supra*. When the payoff is made by a venture capitalist, who shares in the reward is determined in large part not by the venture capitalist, but by the employees themselves through their decision of who will be part of the new venture. Because employees will be better able than the employer to directly observe whose contribution to the new venture will be most productive, the potential for property-rights-protecting activity is limited.

auction for the right to participate in an employee's innovation. Because property-rights-perfecting costs will be a positive function of the intensity of the incentive, the employer will take into account the personal tastes of employees in crafting its internal incentive structure. Where the cost of increased property-rights-perfecting activity associated with an increase in incentive necessary to retain an employee would exceed the benefit of retaining the innovation, an employer will prefer that the employee pursue a venture capital-backed start-up. Thus, we will observe start-ups by departing employees despite the significant tax, informational, and scope advantages of an employer over a venture capital-backed start-up.