# BIOMEDICAL STARTUPS & PATENTING: 17 YEARS SINCE THE BERKELEY PATENT SURVEY

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In 2008, researchers (including the author of this chapter) at the Berkeley Center for Law and Technology (BCLT) conducted what was then—and continues to be—the most comprehensive survey of technology startups in the United States to examine how these companies engage with and are affected by the patent system.[1] A principal objective of the study was to identify the aspects of the patent system that meaningfully advance or hinder entrepreneurial activity, with particular attention to startups in the Internet, computer software and hardware, medical device, and biotechnology sectors.

The study resulted in multiple major findings regarding startups and patenting, particularly for biomedical startups. It revealed that, although patents are more prevalent among technology startups than earlier research had suggested, company managers perceived that patents serve as weaker incentives for key innovation-related activities, including invention and commercialization, than expected, even among biomedical startups. Based on other survey questions and interviews, part of this view was driven by the belief that the patent system served larger companies much more effectively than smaller ones. At the same time, the study showed that startups hold a greater number of patents and pending applications than previously recognized in the literature—a discrepancy largely explained by the survey's broader approach to identifying startup-held intellectual property—including patents acquired from founders and other external sources that earlier studies did not capture. Biomedical startups hold an especially large number of patents and applications.

Another key theme emerging from the study's findings is how patents are used by, and prove valuable to, technology entrepreneurs varies significantly based on industry-specific factors. Notably, the study found that patents serve as an important tool for many startups to establish and maintain a competitive position, particularly in the biomedical sectors. The study's findings also

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[1] *See* Stuart Graham, Robert Merges, Pam Samuelson & Ted Sichelman, *High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey*, 24 BERKELEY TECH. L. REV. 1248 (2010) [hereinafter, Graham et al., *High Technology Entrepreneurs*]. Follow-on articles reporting on the study's results include Stuart J.H. Graham & Ted M. Sichelman, *Patenting by Entrepreneurs: An Empirical Study*, 17 MICH. TELECOMM. & TECH. L. REV. 111 (2010) and David S. Levine & Ted M. Sichelman, *Why Do Startups Use Trade Secrets?*, 94 NOTRE DAME L. REV. 751 (2018).

provide insight into startups' rationales both for pursuing patents and for opting not to patent significant innovations. When deciding to seek patent protection, startup executives most commonly cited the goal of deterring imitation, with reputational and financial considerations—such as facilitating a successful exit through acquisition or public offering—playing a secondary role.

Additionally, the study highlighted an often-overlooked function of patents in assisting startups to obtain various forms of entrepreneurial financing, including not only venture capital and angel investment, but also funding from "friends and family" and commercial lenders. Equally significant is the observation that the costs associated with prosecuting and enforcing patents constitute a considerable obstacle for technology entrepreneurs in accessing the patent system. Moreover, the reasons for not pursuing patents appear to vary by industry: for example, executives at biotechnology firms were far more likely than those in other sectors to express concern about the disclosure requirements inherent in the patenting process. The study also revealed nuance in how startups navigate patents within their business environments as well as in their managers' perceptions of the patent system. The licensing of third-party patents was also found to be relatively frequent, both to acquire know-how and to avoid potential suits.

This chapter focuses on the study's results for biotechnology and medical device companies, providing a few results not previously reported. Additionally, the chapter surveys related studies since 2008, suggesting avenues for further research. With this context in mind, Part I briefly describes key research questions addressed by the survey, how the samples were selected, and some key profile characteristics of our respondents. Part II discusses the key survey results for biomedical technology startups. Part III surveys recent studies on patenting among biomedical startups and concludes with some suggestions for future studies.

## I. THE GENESIS AND METHODOLOGY OF THE BERKELEY PATENT SURVEY

Several key research questions that had been explored in the context of large companies but not so much for startups were the focus of the Berkeley Patent Survey. Some key research questions concerned the drivers of patenting by startups, such as, "Do startups apply for patents to protect their innovations and is this a successful strategy? Do they apply for patents for other reasons, e.g., to attract investors or for cross-licensing to obtain the right to use another company's patents?" Other questions concerned patents and financing, including "What role do actual or potential patent rights play in decisions to invest in startups? In what circumstances is strong patent protection a prerequisite to investment? In what circumstances are patent rights less important than other factors?"

Additional questions focused on how effective patents are compared to alternative mechanisms for capturing returns from innovation, such as "Once entrepreneurs have initial funding, are patent rights more important to entrepreneurs than to more established companies, which can rely on manufacturing, distribution and marketing capacities, brands and other reputation qualities, and their existing customer base to protect their market position?" The research team also asked about

patent licensing, the costs of patenting and litigation, and the significance of patents in shaping exit strategies. Given the wide scope of the issues under investigation, we adopted a methodological approach aimed at producing robust empirical insights.[2]

In light of the limited empirical evidence available at the time regarding how entrepreneurs navigate intellectual property decisions in practice, we concentrated on the concrete, observable choices made by innovators within active firms, rather than on the intentions or expectations of would-be entrepreneurs. Notably, unlike prior European studies of startups that primarily examined firms with existing patents,[3] our approach included a broader sample of U.S. startups.

We chose to survey firms in the software, biomedical, and hardware sectors founded in the United States within the past ten years. Although startups in other industries also rely on patents,[4] the majority of patenting and venture capital activity among small firms is concentrated in these sectors.[5] We used data from Dun & Bradstreet (D&B) data to construct a sample of 10,500 D&B-listed companies, which represents the "general population" of tech startups, as well as Thomson's VentureXpert data, which reportedly covers a substantial share of venture-backed firms in the United States.[6] Merging the D&B and VentureXpert datasets yielded a final target list of more than 15,000 distinct companies.

## II. KEY FINDINGS OF BERKELEY PATENT SURVEY, ESPECIALLY FOR BIOMEDICAL STARTUPS

This section presents the major findings of the Berkeley Patent Survey, particularly for biomedical startup companies, as well as several findings not previously reported.

### A. *Profiling the Respondent Companies*

The median respondent—defined as the firm at the 50th percentile within each relevant category—was a self-identified startup founded in April 2002 that had neither undergone an initial public offering (IPO) nor been acquired. The firm employed nine individuals, approximately half of whom were scientists or engineers. Its reported revenue for 2007 was $300,000, and its founders

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[2] In using the terms "we" and "our," I refer to the entire Berkeley Patent Survey research team, Stuart J.H. Graham, Robert Merges, Pamela Samuelson, and myself.

[3] *See* Stuart J.H. Graham & Ted M. Sichelman, *Why Do Start-Ups Patent?*, 23 BERKELEY TECH. L.J. 1063, 1091-92 (2008) (reviewing these studies).

[4] While the vast majority of our respondents fell into these four industry classifications, about 12% came from other sectors. Approximately 7% fell into medical technologies that did not include either "biotechnology" or "medical devices," and another 5% fell completely outside our technology definitions.

[5] *See* Robert E. Hall & Susan E. Woodward, *The Incentives to Start New Companies: Evidence from Venture Capital* 3 (Nat'l Bureau of Econ. Research, Working Paper No. 13056, 2007), https://www.nber.org/papers/w13056.

[6] VentureXpert, About Us, http://vx.thomsonib.com/NASApp/VxComponent/VXMain.jsp (last visited Oct. 1, 2009). Today, the VentureXpert database is part of the LSEG Workspace. LSEG Data & Analytics, https://www.lseg.com/en/data-analytics/products/workspace (last visited May 15, 2025).

had prior entrepreneurial experience. Geographically, the company was located west of the Mississippi River. With respect to financing, the median firm in the Dun & Bradstreet (D&B) sample had secured funding from "friends and family," at least one angel investor, and a commercial bank, but had not received capital from venture capital firms, investment banks, or other corporations.

Excluding pre-test responses, a total of 1,332 unique companies completed the survey, yielding an overall response rate of 8.7%. However, this unadjusted rate does not account for firms that were unreachable due to inaccurate contact information, business closures, or significant organizational changes. After adjusting for these factors, the corrected response rate was 10.6% for the Dun & Bradstreet (D&B) sample and 17.9% for the VentureXpert sample. The highest corrected response rate was for biomedical firms, at 23.7%, suggesting that the findings for this sector are the most robust. To assess potential response bias, we compared respondents and non-respondents across multiple variables, including company size, revenue, and patent ownership, and found no significant differences apart from a slight geographic skew favoring companies located in the western United States.

### B. *Patent Holding Among Startups is Common but Not Omnipresent*

Prior to our study—and even afterward—researchers have typically relied on matching granted patents in the U.S. Patent & Trademark Office (USPTO) database to company names using information from the "assignee" field.[7] This method tends to undercount patents because it often overlooks patents that were assigned to the company from the founders or otherwise acquired. By directly asking respondents to report the number and origin of their patents and applications, our survey provided a more accurate view of the patenting behavior of startups.

Studies matching to the USPTO database had reported average patent holdings for *venture-backed* startup companies in the range of 0.5-6.0 patents,[8] but our expanded approach revealed that ordinary startup companies in the "population" of firms (as proxied by D&B) held well over four (4.7) patents and applications (Table 1). Among the venture-backed firms in our survey—which provide a more direct comparison to prior studies—the average company held just under nineteen patents and applications (18.7). However, this figure is somewhat misleading. Within the D&B respondent group, more than six in ten firms (61%) reported holding no patents at all. Additionally, the average is skewed by a handful of firms with exceptionally large portfolios. One D&B respondent, for example, reported holding 260 patents and applications across all sources, while a single venture-backed firm reported owning 570.

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[7] *See, e.g.*, Bronwyn H. Hall, Adam Jaffe & Manuel Trajtenberg, *Market Value and Patent Citations*, 36 RAND J. ECON. 16, 20 (2005).

[8] *See* Ronald J. Mann & Thomas W. Sager, *Patents, Venture Capital, and Software Start-ups*, 36 RES. POL'Y 193, 197 (2007).

Although patent ownership is more common among technology startups than previously assumed—especially among those backed by venture capital firms—it is by no means the norm across the broader population of entrepreneurial firms. A substantial proportion of early-stage technology companies appear to forgo participation in the patent system altogether. With that said, biomedical companies exhibited the highest incidence of patents and applications, with a rate of 75-76% for D & B companies and 94-97% for venture-backed companies in these sectors. Biomedical firms also showed a significantly higher rate of acquiring patents from third parties than startups in other sectors.

Table 1: Patents and Applications Held by Startup Companies[9]

| Source / Industry | All respondents | Biotechnology | Medical Devices | Software/Internet | IT Hardware‡ |
|---|---|---|---|---|---|
| Population of companies (Dun & Bradstreet sample) | | | | | |
| Companies holding patents/applications (share) | 39% | 75% | 76% | 24% | — |
| Average # patents/applications held (all companies) | 4.7 | 9.7 | 15.0 | 1.7 | — |
| Average # filed by company (patent holders only) | 8.1 | 8.5 | 13.0 | 5.0 | — |
| Average # from founders (patent holders only) | 1.9 | 2.0 | 3.0 | 1.2 | — |
| Average # acquired (patent holders only) | 2.1 | 2.4 | 3.7 | 0.9 | — |
| Venture-backed companies (VentureXpert sample) | | | | | |
| Companies holding patents/applications (share) | 82% | 97% | 94% | 67% | 91% |
| Average # patents/applications held (all companies) | 18.7 | 34.6 | 25.2 | 5.9 | 27.4 |
| Average # filed by company (patent holders only) | 15.8 | 22.9 | 16.1 | 7.1 | 23.6 |
| Average # from founders (patent holders only) | 2.5 | 3.8 | 3.8 | 0.7 | 3.1 |
| Average # acquired (patent holders only) | 4.2 | 9.0 | 6.5 | 0.7 | 3.5 |

‡ Available only for *VentureXpert* listed companies.

### *C. Patents May Offer Only Mixed to Weak Incentives to Engage in Innovation*

Given that the exclusive legal rights conferred by patents are typically justified as a means of incentivizing innovation, we were surprised by how weakly this rationale resonated with the technology startup executives in our survey. To assess the incentive value of patents, our questionnaire asked all participants to rate—on a scale from 1 (not at all) to 4 (strong incentive)—

[9] All tables and figures in this chapter are drawn from Graham et al., *High Technology Entrepreneurs*, *supra* note 1.

how strongly patents influenced four specific innovation-related activities: (a) inventing new products, processes, or services; (b) conducting early-stage research and development; (c) developing internal tools or processes to support implementation; and (d) assuming the risks and costs associated with commercialization, including making, selling, and marketing products. In general, executives reported that patents served as only slight to moderate incentives for engaging in each of these innovation stages.

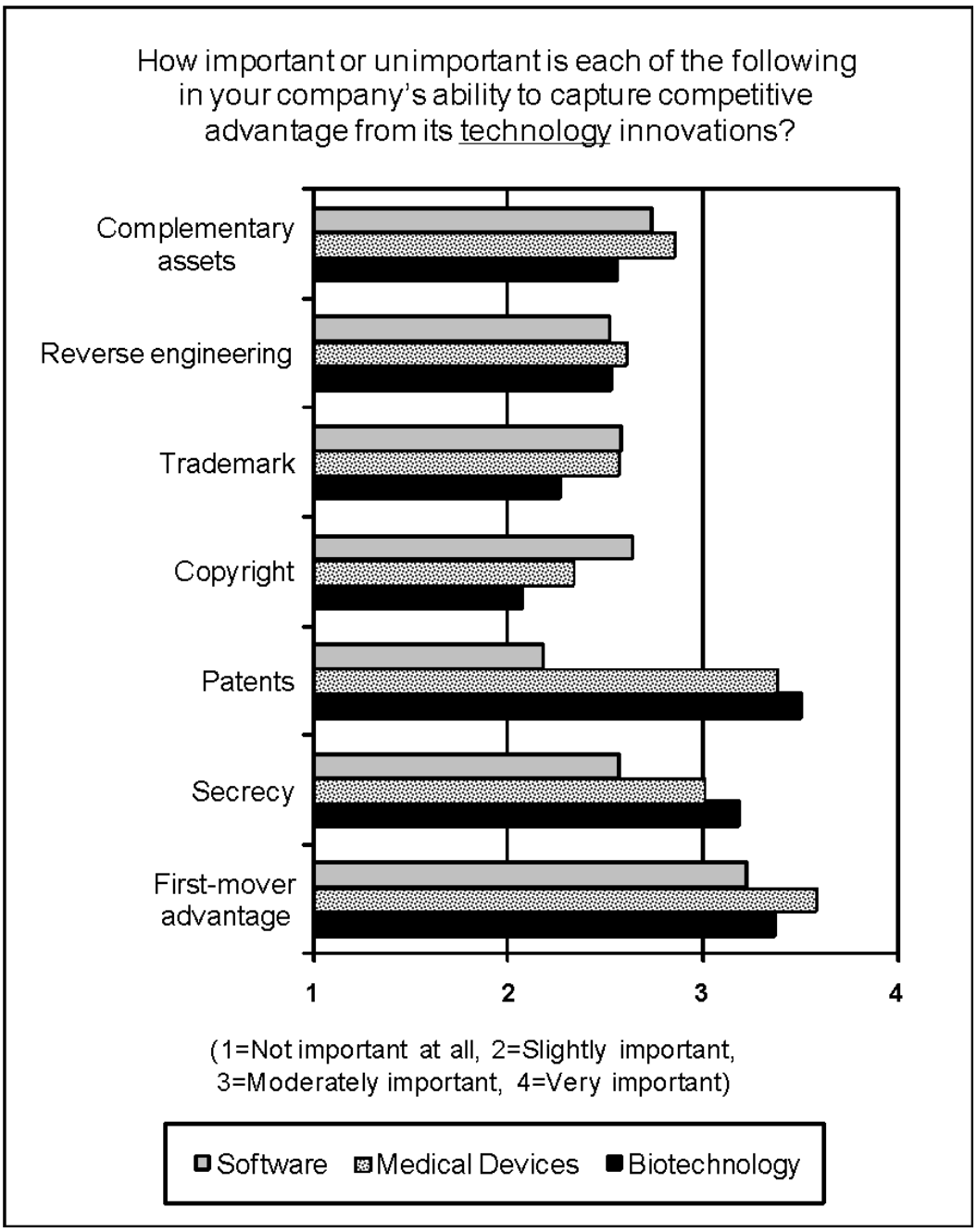
An important qualification to our overall findings is the notable variation in the perceived incentive value of patents across different industries. For instance, biotechnology firms generally rated patents as offering "moderate" incentives throughout the innovation process, whereas software companies typically rated them as offering no more than "slight" incentives. This pattern aligns with the inter-industry differences in patent ownership and portfolio size noted earlier. While these results are broadly consistent with widely reported anecdotes from the software sector, we were somewhat surprised that biotechnology firms did not report a stronger perceived link between patent protection and innovative activity.

Nonetheless, it is very possible that startup company executives answering the survey did not fully understand the extent of incentives provided by patents to engage in innovative activity. Indeed, in interviews, multiple executives were puzzled by investors' insistence on patenting, with some executives even arguing that their investors overestimated the role of patents in promoting startup innovation. Yet, given that startup investors typically deal with many different companies whereas founders and executives have quite limited experience with IP, arguably the reverse claim is true—that the investors were the savvy ones regarding the value of patents rather than the executives.

### D. *Patents Can Serve to Promote Startups' Competitive Advantage*

One of the key findings from our survey—and a partial explanation for the prevalent use of patents by technology-based startups—relates to the strategic role patents play in enabling these companies to compete effectively with their innovations. For some time, theory has posited that formal intellectual property rights are essential for preserving the lead-time benefits enjoyed by fast-moving innovators. Our results lend empirical support to this view, showing that for a substantial number of high-tech startups, patents contribute meaningfully to capturing competitive advantage from their technological advancements. Importantly, however, this effect is not uniform across all contexts. To explore this further, our survey asked respondents to assess the significance of seven distinct mechanisms—often referred to as appropriability strategies—for securing competitive gains from their innovations. These included: maintaining a lead over competitors through early market entry (first-mover advantage); protecting know-how through secrecy; using patents, copyrights, and trademarks; relying on the inherent difficulty of reverse engineering; and leveraging unique production, implementation, or marketing capabilities.

Figure 1: Capturing Competitive Advantage from Technology, by Industry[10]




For firms in biotechnology, medical devices, and IT hardware, patenting ranks among the most critical mechanisms for securing returns on innovation (see Figure 1). Among biotechnology

[10] Average of all responses within industry reported.

companies, patents are identified as the most important appropriability strategy. For medical device startups, patents are ranked second, following the advantage associated with being first to market.

### *E. Startups Have Differing Motives for Patenting*

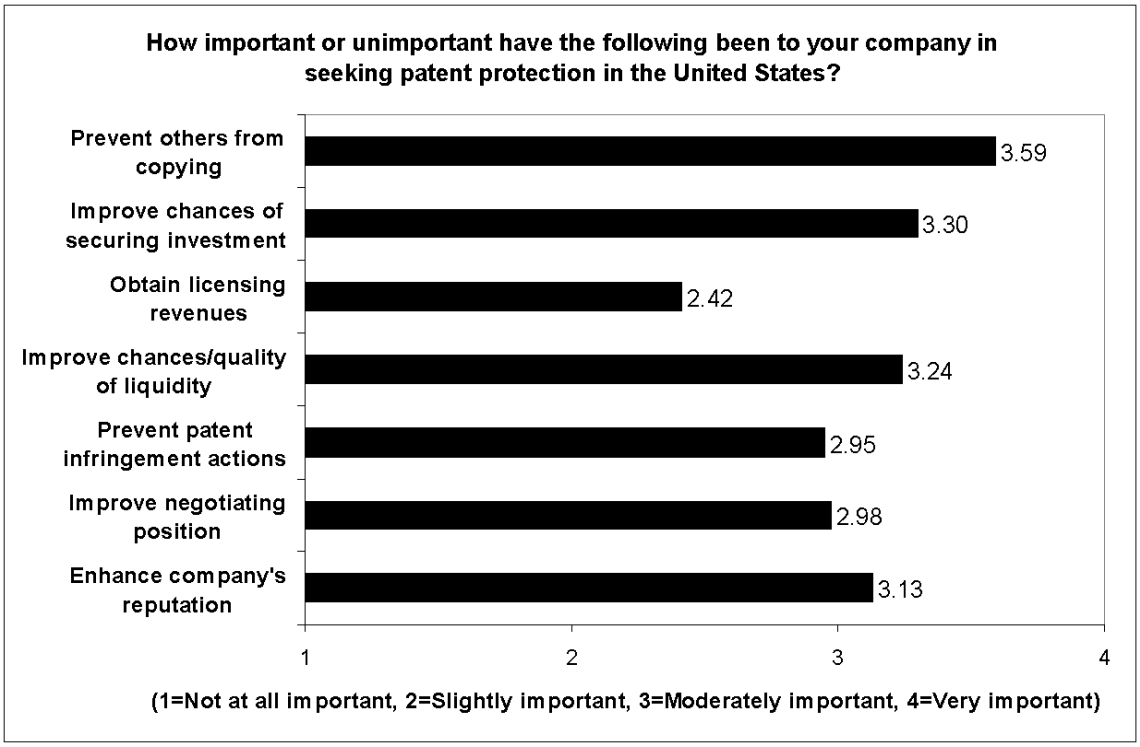
Our findings indicate that technology entrepreneurs pursue patent protection for a range of reasons, which are often distinct yet complementary. As one illustrative example, the CEO of a biotechnology company—whose firm holds more than 150 patents—offered the following perspective during our interview:

> We have a patent committee that decides, within a complex framework of factors, whether it is important to patent, whether competitors will copy the technology regardless of IP protection, and whether the patent will have foreseeable future value . . . . Patents also tend to legitimate [our product]. A patent can also provide a source of supplementary income and can be a badge, a branding, of a successful innovative high-tech company.[11]

In order to assess the various reasons firms patent, we asked whether the company had filed at least one patent, and among those answering in the affirmative, we inquired into the importance of these several motivations for patenting.

[11] Interview with anonymous company founder, *supra* note 130.

Figure 2: Motivations for Patenting – All Startups Filing Patents



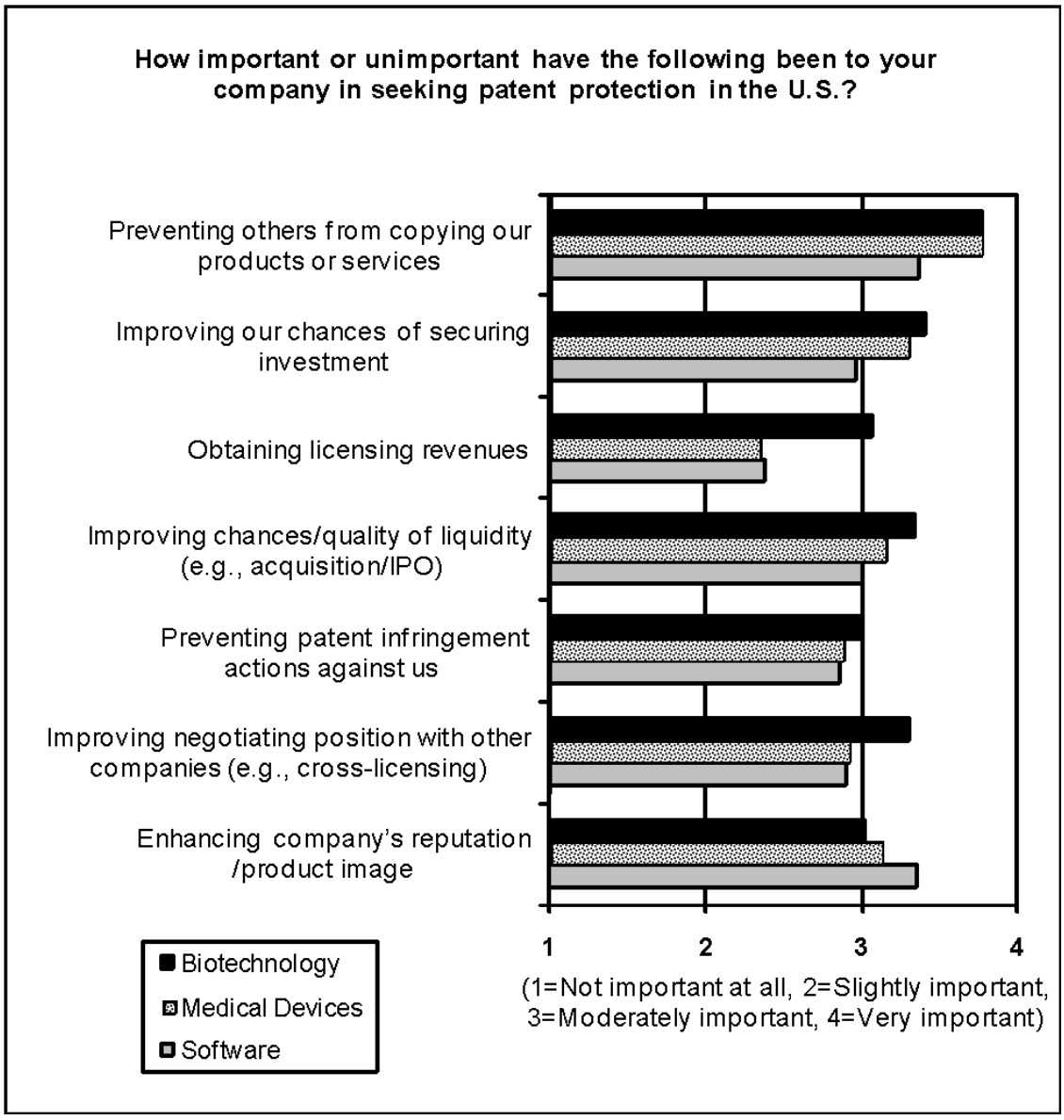

The above question was asked of those reporting that their company had filed for at least one U.S. patent (Averages reported).

These findings stand in contrast to earlier surveys on the role of patents for large firms, such as the widely cited study by Wesley Cohen, Richard Nelson and John Walsh, in which respondents typically regarded patenting as relatively unimportant for securing capital. However, our results align with evidence from these surveys, which found that smaller firms were considerably more likely than their larger counterparts to view patenting as an important means of enhancing firm reputation.[12] Our findings also aligned with prior research indicating that patenting contributes positively to firm valuation, both during fundraising rounds and at the point of exit for venture-backed companies.[13]

[12] Wesley M. Cohen, Richard R. Nelson & John P. Walsh, *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (Or Not)*, 31 RESEARCH POL'Y 1439 (2002); Richard C. Levin, Alvin K. Klevorick, Richard R. Nelson & Sidney G. Winter, *Appropriating the Returns from Industrial Research and Development*, 18 BROOKINGS PAPERS ON ECONOMIC ACTIVITY: MICROECONOMICS 783 (1987).

[13] *See* Iain M. Cockburn & Megan J. MacGarvie, *Patents, Thickets, and the Financing of Early-Stage Firms: Evidence from the Software Industry*, 18 J. ECON. & MGMT. STRATEGY 729 (2009); David H. Hsu & Rosemarie H. Ziedonis, *Patents as Quality Signals for Entrepreneurial Ventures*, 2008 ACAD. MGMT. PROC. 1.

Figure 3: Motivations for Seeking Patent Protection, by D&B Industry




Question asked of those reporting that their company had filed for at least one U.S. patent (averages reported).

### F. *Startups' Motivations to Seek Patents Differ by Industry*

Our data also reveal substantial variation across industries in the motivations for seeking patent protection (see Figure 3). Firms in the health and life sciences sectors—specifically biotechnology and medical devices—exhibit closely aligned patterns in how they rank the importance of various motives for patenting. Statistically, the average responses from

biotechnology and medical device companies are nearly indistinguishable, with two notable exceptions: biotechnology firms rate "obtaining licensing revenues" and "improving negotiating position" as significantly more important than their medical device counterparts.

Both biotechnology and medical device respondents identify "preventing copying" as an especially important motive, with average ratings approaching "very important." In contrast, software firms place less emphasis on this rationale, although it still ranks between "moderately" and "very" important on average. Moreover, the use of patents to attract investment and to enhance the likelihood or quality of a liquidity event is viewed as considerably more important by biotechnology and medical device firms than by software companies. Finally, biotechnology firms stand out in the degree to which they prioritize patenting for the purpose of generating licensing revenue—surpassing not only software firms but also medical device companies in this regard.

In general, the relative importance of patents to biomedical startups compared to other industries aligns with the findings of the prior landmark studies of large companies, which generally found that patents were considered highly effective in the pharmaceutical industry, contrasting sharply with industries like machinery, electronics, and chemicals, where lead time, learning curve advantages, and secrecy were rated as more important.[14]

### G. *Patents Serve an Important Function in the Financing of Startups*

Another important finding from our study is the central role that patents play in the financing of many startup firms—both in their early stages and throughout subsequent development, including at the point of a liquidity or "exit" event. Startups frequently encounter significant obstacles in securing the capital needed for growth and long-term viability. These challenges stem in large part from their typically small scale and limited managerial or operational track record. Further complicating matters, early-stage ventures often lack tangible indicators of success, possessing few assets and little or no operating history. This scarcity of information introduces considerable uncertainty for prospective investors, who are then compelled to rely on alternative, more observable signals—such as the presence of patent protection—when evaluating the quality and future earning potential of these firms.[15] Departing from prior research, our survey explored a broader range of startup financing sources and found that patenting plays a more influential role in facilitating various forms of entrepreneurial capital investment than previously recognized.

Our survey explicitly investigated the role of patents in securing investment by asking respondents about six distinct sources of startup capital: friends and family, angel investors, venture capital firms, corporate investors (i.e., corporate venture capital), investment banks, and commercial banks providing credit or loans. For each of these categories, respondents were asked

[14] See Cohen et al.& Levin et al. studies, supra note 12.

[15] *See* Toby E. Stuart, Ha Hoang & Ralph C. Hybels, *Interorganizational Endorsements and the Performance of Entrepreneurial Ventures*, 44 ADMIN. SCI. Q. 315 (1999).

whether their company had engaged in funding negotiations and whether it ultimately received financing from that source. In addition, we requested that respondents indicate whether any of these funding sources had identified the startup's possession of patents as an "important factor" in their decision to provide funding.

According to our respondents, patents play a more substantial role in attracting investment than has been commonly assumed. While it is generally accepted that venture capital investors consider patents in their funding decisions, the underlying rationale remains somewhat ambiguous. One prevailing view is that patents serve as a valuable "signal" of quality in the face of investment uncertainty. By relying on the examination conducted by the Patent Office, investors may be able to mitigate information asymmetries that typically exist between early-stage firms and potential funders.[16] A related variant of signaling theory suggests that, even if the substantive judgments of the Patent Office carry limited weight, the act of filing for patents nonetheless conveys important information. Specifically, the decision to pursue patent protection may signal that startup managers possess the awareness and capability to navigate the intellectual property system—an indication of managerial sophistication. This is particularly relevant in contexts where tacit knowledge must be codified effectively to support commercialization and strategic planning.[17]

An alternative explanation emphasizes the functional value of patents in securing "freedom to operate." In this view, patents are not merely symbolic but serve a practical purpose by reducing the risk of infringement and enabling startups to develop and bring early-stage products to market with greater confidence. This protection can be especially critical in technology-intensive sectors, where overlapping rights and complex patent landscapes pose significant barriers to entry.[18] Another theoretical perspective holds that investors may insist on startups securing patent rights in order to preserve value in the event of failure. Under this view, patents function as residual assets—intellectual property that investors, as residual claimants, can potentially leverage, license, or sell if the venture does not succeed.[19]

While our data did not allow us to directly assess the validity of the various theoretical explanations, they do offer insight into how patents are perceived in the context of startup financing. Specifically, we reported the proportion of respondents who indicated that a given funding source (e.g., "friends and family") with whom they had negotiated viewed the possession of patents as important to the funding decision. Among D&B companies that engaged with venture capital firms, 67% reported that patents were cited as a significant factor. This figure was even higher among our venture-backed sample, where 76% of respondents indicated the same. Substantial variation also emerges across technology sectors. Within the D&B sample, 60% of software startups reported that venture capital investors considered patents important, compared

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[16] *See* Hsu & Ziedonis, *supra* note 13, at 5.

[17] *See* Graham & Sichelman, *supra* note 3, at 1078-79.

[18] *See* Gideon Parchomovsky, *Publish or Perish*, 98 MICH. L. REV. 926, 930 (2000).

[19] *See* Graham & Sichelman, *supra* note 3, at 1078.

to 73% of biotechnology firms and 85% of medical device companies. The greater perceived importance to biomedical startups could very well stem from the longer R&D and commercialization periods, as well as the significant testing costs, for these firms' products relative to those for software firms.

As with other aspects of patenting by startups, the industry differences in the reported importance of patents to investors are of note. Among D&B biotechnology firms, for instance, respondents were much more likely to reveal that commercial banks considered patenting by the target firm important (43%) than D&B software firm respondents (13%). This difference is also notable among "friends and family," who considered patents to be important for more than half (55%) of D&B biotechnology firms, but less than one-quarter (23%) of D&B software companies. There are also significant differences for angel investors (71% for biotechnology and 53% for software), venture capital (73% and 60%, respectively), "other companies" as investors (64% and 42%, respectively), and investment banks (62% and 36%, respectively). Clearly, across all funding sources, respondents declare that potential investors view patenting as much less important for software and for Internet as for biotechnology companies.

In sum, our survey respondents report that patents are being widely demanded by different sources of entrepreneurial capital, though that demand does not extend to all funding negotiations and the incidence of interest is highly variable.

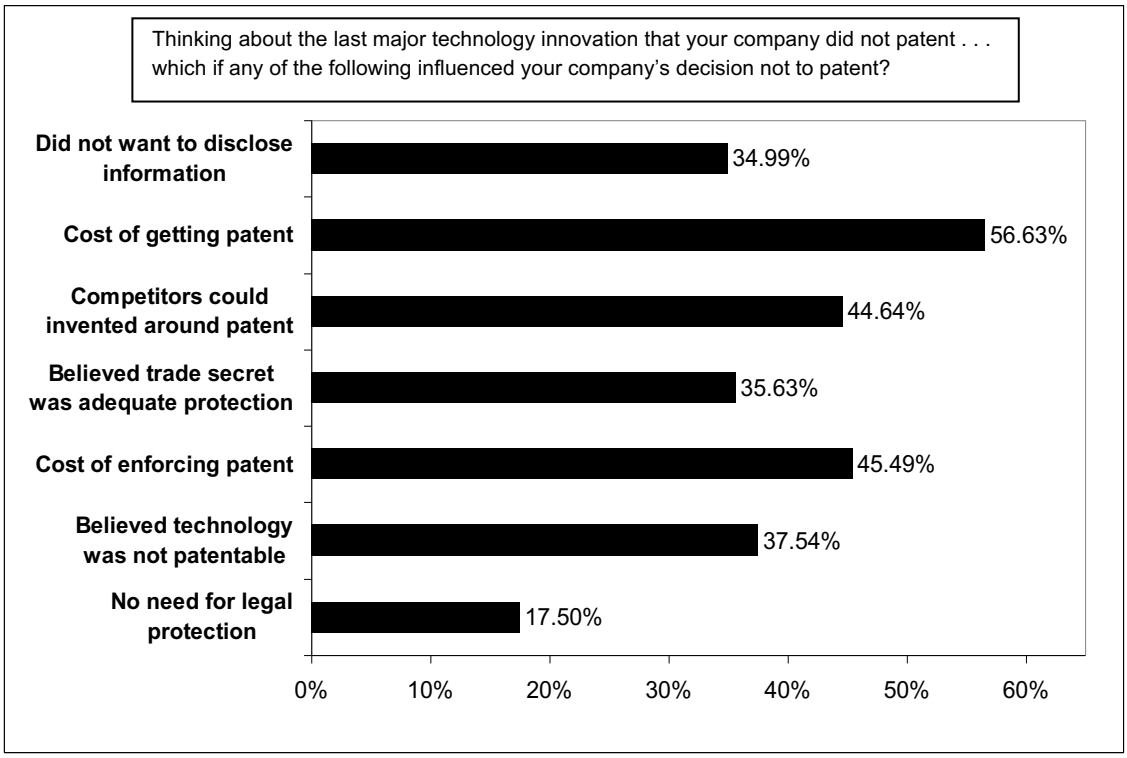
### *H. Technology Entrepreneurs Have Various Reasons Not to Seek Patents*

Startup firms may choose not to pursue patent protection for a variety of reasons, including doubts about the patentability of the technology, concerns over the high costs of obtaining and enforcing patent rights, and skepticism regarding the strength of protection in the face of potential reverse engineering. Additional deterrents include fears surrounding disclosure of proprietary information and the availability of alternative protective strategies. To move beyond the limited perspective gained from surveying only non-patenting firms, we sought to explore the subtleties behind decisions to forgo patenting—even among companies actively seeking patents for other innovations. Accordingly, all respondents were asked to indicate whether their most recent unpatented major technology innovation was a product, a process, or neither, and to specify the factors that influenced their decision not to pursue patent protection.

Our findings indicate that, among technology startups, the most frequently cited reason for not pursuing patent protection for a major innovation is the cost associated with obtaining a patent. As shown in Figure 4, this concern outweighed other commonly mentioned factors. The figure presents the distribution of reasons provided by respondents for opting not to patent their

company's most recent significant technological development.[20] Cost considerations emerge as a dominant factor in decisions not to patent, with both the expense of prosecuting a patent and the anticipated costs of enforcement cited more frequently than any other rationale. These financial concerns are followed closely by the perception that competitors could readily invent around the patent, thereby diminishing its practical value as a protective mechanism.

Figure 4: Reasons for Startups to Forgo Patent Protection on Major Technologies




Respondents were asked to indicate all the reasons that applied
(share of respondents indicating that the option influenced the decision is reported).

Additional evidence from our survey suggested that smaller firms' heightened sensitivity to patenting costs cannot be attributed solely to capital limitations. In response to a separate question, firms reported that the average out-of-pocket expense incurred to obtain their most recent patent exceeded $38,000.[21] The average expense incurred by biotech startups was even higher. Specifically, the Dun & Bradstreet biotech respondents reported an average of $52,000 and the VentureXpert biotech firms, $62,000. These figures are significantly higher than the averages for patent prosecution reported by firms of all sizes, which varied from a low of $10,000 to a high of

[20] This question could be answered by respondents regardless of whether they had filed for a patent. The percentages for each reason do not add up to 100% because respondents could check one or more of these selections.

[21] We asked this question only of those respondents who reported that their company had both filed and been granted a U.S. patent.

$30,000 in 2007.[22] In one of our unstructured, hour-long interviews, an executive at a venture-backed semiconductor company observed that startups frequently incur higher patent prosecution costs than established firms. According to this executive, several factors contribute to this disparity: startups are more likely to patent inventions central to their core business model, typically rely on outside rather than in-house counsel, and often lack the internal capacity to effectively oversee external legal costs. These insights are reinforced by our broader survey data. Approximately 10% of respondents identified cost as the sole barrier to filing a patent, selecting no other reason from the list of options provided. Moreover, when asked to indicate the most important reason for forgoing a patent filing, over one-third of respondents cited the cost of acquiring or enforcing the patent.

## I. *Startups' Reasons to Forgo Patenting Differ by Industry*

One of the key findings of our study is the variation in patenting motivations across technology sectors. Specifically, biotechnology companies most frequently cited a reluctance to disclose proprietary information as the primary reason for not seeking patent protection, whereas software firms most commonly pointed to the costs associated with patent prosecution. To explore these patterns in greater detail, we segmented responses by technology type and presented the findings in Table 2. Notably, biotechnology firms were more than twice as likely as software firms to report concerns about disclosure as a reason for forgoing patents (59% versus 25%). Medical device firms similarly viewed disclosure (45%) as a key driver of forgoing patenting. Additionally, biotechnology respondents were more likely to view trade secrecy as a sufficient form of protection, with 49% endorsing this view compared to 29% of software firms. A large share of medical device firms (45%) viewed trade secrecy as sufficient.

In this regard, in a follow-up study on trade secrecy and startups using the Berkeley Patent Survey data, David Levine and I found that trade secrets may serve both as economic substitutes and complements for startup patenting.[23] Specifically, biotechnology startups often forgo patenting when they can readily maintain their inventions as trade secrets. Yet, much less recognized in the literature, patents and trade secrets can co-exist beneficially. First, startups often deploy both trade secrecy and patents to protect the *same* underlying ideas or information, depending on which form of protection is more effective at a particular stage of development (e.g., R&D vs. commercialization). Second, because a patent does not require disclosure of all information related to an invention, companies can protect different aspects of the *same* invention through a combination of patent and trade secret law. Finally, a company holding a "data-generating patent" may patent the method of data collection while simultaneously using trade secrecy to protect the resulting data itself.[24]

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[22] *See* AM. INTELLECTUAL PROP. LAW ASS'N, REPORT OF THE ECONOMIC SURVEY 2007 78-81 (2007).
[23] *See* Levine & Sichelman, *supra* note 1.
[24] *See* Brenda M. Simon & Ted M. Sichelman, *Data-Generating Patents*, 111 NW. U. L. REV. 377 (2017).

Table 2: Reasons for Not Seeking Patent Protection – Selected Industries

Thinking about the last major technology innovation that your company did not patent . . . which if any of the following influenced your company's decision not to patent?

| Reason Category | All respondents | Biotechnology | Medical Devices | Software | Difference (Biotech vs. Software) | Test of difference |
|---|---|---|---|---|---|---|
| Did not want to disclose | 35% | 59% | 45% | 25% | + 34% | ** |
| Cost of filing | 55% | 43% | 54% | 64% | - 21% | ** |
| Ease of inventing around | 44% | 42% | 48% | 46% | - 4% | |
| Trade secret was adequate | 36% | 49% | 45% | 29% | + 20% | ** |
| Cost of enforcing | 44% | 36% | 43% | 52% | - 16% | ** |
| Did not believe patentable | 38% | 28% | 26% | 42% | - 14% | ** |
| Did not need protection | 17% | 17% | 14% | 20% | - 3% | |
| | | | | | | |
| Total responses | 1,057 | 136 | 69 | 589 | | |

** Differences noted, significant at the 95% confidence intervals. Tests for differences in means were conducted between columns, within rows.

### *J. Technology Entrepreneurs Must Reckon with Patents Held by Others*

Our study aimed not only to understand how entrepreneurial firms utilize—or opt out of—the patent system, but also how they navigate patents held by others operating in the same technological space. From the perspective of innovation, patents can function as barriers, creating a "minefield" that complicates the trajectory from invention to development and, ultimately, to commercialization. In addition to these structural challenges, the presence of third-party patents introduces the risk of disputes, which, if unresolved through negotiation, can escalate into costly litigation. Startups may be especially vulnerable in this regard, as limited financial and managerial

resources often constrain their ability to respond to infringement claims. At the time of our study, the median cost of litigating a patent dispute through appeal was estimated between $2.5 million and $5 million per party (surprisingly, these amounts are similar today)—a burden that few startups are equipped to handle.[25]

Patents held by others in the market environment are not universally viewed as obstacles by startups; they can also offer distinct advantages. In particular, patents may facilitate the development of technology markets by enabling firms to specialize in the creation and transfer of technological assets—an arrangement reminiscent of Adam Smith's concept of the division of labor. In this context, patents function as formalized, tradable claims that help overcome many of the challenges associated with transacting in intangible knowledge assets. By rendering technology and know-how more definable and transferable, patents can support more efficient exchanges of information, reduce uncertainty in negotiations, and foster collaborations between firms with complementary capabilities.[26] In light of these contrasting—though not inherently incompatible—perspectives on the roles that externally held patents may play in the startup ecosystem, we developed a set of survey questions designed to shed light on how early-stage firms respond to the presence of such patents in their competitive environment.

Specifically, we sought to understand how frequently startups license patents from third parties and, more importantly, the motivations underlying those licensing decisions. In particular, we aimed to distinguish between licenses obtained to access technology, information, or know-how, and those acquired primarily for defensive purposes—such as avoiding litigation or ensuring freedom to operate. The responses revealed that licensing activity among startups serves both functions, though with differing emphasis depending on context.

Overall, 37% of the D&B biotech firms and 30% of the D&B medical device firms had reported licensing in a patent. This compares to just 8% of the D&B software firms. A substantial majority of D&B biotechnology startups—81%—reported that their most recent patent license was motivated, at least in part, by a desire to acquire technology, information, or know-how. At the same time, approximately 30% of these firms indicated that their licensing decision was driven, at least in part, by a desire to avoid a patent dispute or to address related defensive concerns. For the D&B medical device firms, 79% reported licensing the patent to acquire the technology, whereas 25% reported their decision was driven in part to avoid or settle a suit. Importantly, among the biotechnology, medical device, and software companies in the D&B sample, fewer than 10% stated that their sole reason for licensing a patent was to resolve or avoid a dispute, suggesting that while defensive licensing does occur, it is rarely the exclusive driver of such transactions.

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[25] *See* AM. INTELLECTUAL PROP. LAW ASS'N, REPORT OF THE ECONOMIC SURVEY 2007 25 (2007) (reporting that patent litigation suits with over $1 million at stake cost roughly between $2.5 million and $5 million); *See* AM. INTELLECTUAL PROP. LAW ASS'N, REPORT OF THE ECONOMIC SURVEY 2023 61 (2023) (reporting that patent litigation suits with over $1 million at stake cost roughly between $2.1 million and $5.7 million).

[26] *See* Ashish Arora & Robert P. Merges, *Specialized Supply Firms, Property Rights and Firm Boundaries*, 13 INDUS. & CORP. CHANGE 451, 454 (2004).

Among venture-backed companies, biotechnology startups were again far more likely to license patents than software firms, with 72% of biotech respondents reporting at least one in-license, compared to just 13% of software startups. Nearly nine in ten of the licensing biotechnology firms indicated that their most recent license was taken, at least in part, to gain access to technology, information, or know-how. About two in ten reported that the license was motivated, at least in part, by the need to settle a dispute. Importantly, only two of sixty-three firms (3%) stated that avoiding or settling a dispute was the sole reason for taking the license. These results suggest that, in general, biotechnology startups are not being pressured to license patents unrelated to their technological focus. Rather, they appear to be licensing patents that contribute meaningful knowledge or capability to their innovation efforts.

## III. EMPIRICAL STUDIES ON BIOMEDICAL STARTUP PATENTING SINCE THE BERKELEY PATENT STUDY

Seventeen years later, the Berkeley Patent Survey remains the most comprehensive study to date on the role of patents among tech startups. Nonetheless, there have been multiple studies addressing the topic, falling into two main categories: (1) surveys and interviews; and (2) empirical studies driven by available data sets. Here, I summarize these studies in the context of the findings of the Berkeley Patent Survey, suggesting avenues for further research.

### *A. Surveys and Interviews on Patenting and Startups*

Unfortunately, there have been no comprehensive surveys of startups and patenting since the Berkeley Patent Survey. However, several studies have conducted small-scale surveys or interviews, particularly among biotech and medical device startups.

For example, a study by Weidong Zhu and Shehzad Raj offers a detailed examination of how leaders within biotech startups perceive and navigate the patent system, highlighting the central role that intellectual property plays in this sector.[27] Drawing on semi-structured interviews with 25 founders, CEOs, and senior managers, the researchers identified patents as essential tools for biotech startups seeking to survive and grow in capital-intensive, research-driven markets. Participants described IP, particularly patents, as foundational to securing funding, protecting innovation, and maintaining a defensible market position. In particular, and consistent with the findings of the Berkeley Patent Survey, venture capitalists and private equity firms were said to demand strong patent portfolios before investing, often treating IP rights as a proxy for technical merit and commercial potential.

[27] *See* Weidong Zhu & Shehzad Raj, *Attitudes Towards Patent Law Among Biotech Startups*, 3 INTERDISC. STUD. SOC'Y, L. & POL. 4, 4–10 (2024).

The study also underscores how patents are strategically deployed beyond mere protection. Biotech startups frequently license their patents to larger pharmaceutical companies, using such agreements to generate revenue while shifting the burden of expensive clinical trials and regulatory navigation to more experienced players. Though patents offer clear advantages, such as enabling temporary market exclusivity and boosting valuation during exits, respondents also reported challenges in the form of high legal costs and the complexity of satisfying novelty and utility requirements. As the authors note, and again consistent with the findings of the Berkeley Patent Survey, IP in the biotech space is not merely a legal tool, but a critical asset whose management can determine a startup's trajectory in the competitive and high-stakes landscape of life sciences.

In her study on the role of patent law in shaping startup behavior, Brenda Simon examines how startups, including biotech and medical device firms, navigate the strategic and ethical tensions surrounding intellectual property protection. Drawing on qualitative interviews with founders and senior management, Simon finds that patents are simultaneously vital and problematic.[28] On the one hand, patents are viewed as critical for securing venture capital, attracting licensing partners, and bringing new technologies to market. Participants in the study repeatedly noted that, without strong IP protection, their companies would struggle to justify the high costs of product development and regulatory approval. On the other hand, Simon recounted concerns with the power that patents confer—especially when exclusivity might restrict access to life-saving diagnostics or treatments. These concerns were particularly acute for startups working in underserved or global markets, where cost and availability barriers could have real-world health consequences.

Carolin Haeussler, Dietmar Harhoff, and Elisabeth Müller investigate how patenting activities influence the timing and likelihood of venture capital financing for biotechnology startups in Germany and the UK.[29] Drawing on survey and patent data from 190 bio-pharmaceutical companies, along with interviews of VCs, the authors find that patent applications—particularly when numerous or of high quality—significantly increase the probability and speed of securing VC funding. Filing just one patent application reduces the time to first VC investment. Importantly, VCs are found to rely heavily on the information embedded in the patenting process—not only to verify technological maturity but also to assess commercial potential. Patent citations (used as a proxy for quality) are associated with quicker financing, indicating that VCs can anticipate patent value even before citations accumulate or patents are formally granted.

The study further shows that certain events in the patenting lifecycle—such as oppositions filed by competitors—positively influence funding likelihood, signaling high commercial stakes. However, final patent grants and examiner reports had minimal impact, suggesting that VCs form

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[28] *See* Brenda Simon, *Patents, Information, and Innovation*, 85 BROOK. L. REV. 727 (2020).

[29] Carolin Haeussler, Dietmar Harhoff & Elisabeth Müller, *How Patenting Informs VC Investors – The Case of Biotechnology*, 43 RES. POL'Y 1286 (2014).

early and independent assessments of patent quality. Interviews confirm that VCs consider patent applications as strong signals of diligence and technological legitimacy, often employing experts to evaluate IP portfolios in detail. The findings suggest that for biotech startups, the act of patenting itself—especially early and strategically—is a critical element in overcoming the "liabilities of newness" and attracting capital in high-uncertainty environments. Patents serve not just as legal instruments of protection but as vital communicative tools that reduce information asymmetries between founders and investors.

Daniel Hoenig and Joachim Henkel's study offers a comparative analysis of how venture capitalists assess startups across different high-tech industries, with a particular emphasis on biotechnology. In a survey involving 187 European and U.S. VCs, the authors identify granted patents as the most critical screening criterion for biotech startups in assessing the quality of a startup's technology.[30] Specifically, among the biotech VCs, patent protection was substantially more important than the presence of research alliances, sales alliances, and management experience.

Sebastian Hoenen, Christos Kolympiris, Wilfred Schoenmakers, and Nicholas Kalaitzandonakes investigate how biotechnology startups strategically deploy patents during the early stages of venture financing, focusing on the nuanced signaling role patents play in attracting investor interest.[31] The study reveals that prior to securing external capital, biotech startups file multiple patent applications. This early filing behavior underscores the perceived importance of patents not only as legal safeguards but also as critical signals of technological credibility in a capital-intensive and high-risk industry. Importantly, the authors distinguish between patent quality and quantity, noting that high-impact patents—measured by forward citations—correlate more strongly with favorable early outcomes, such as VC interest, strategic partnerships, and acquisition potential.

### *B. Empirical Studies Drawing Upon Existing Datasets*

Next, there are several studies that draw upon large datasets to examine the role and value of patenting among biomedical and other startups. Patrick Gaulé's study offers rare causal evidence on the effect of patents on startup success by exploiting the quasi-random assignment of patent examiners at the USPTO, who vary significantly in their approval tendencies.[32] Using a sample of 2,191 U.S. startups that filed for patents within two years of receiving their first venture capital round, Gaulé finds that patents significantly increase the likelihood of "success"—defined as an

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[30] *See* Daniel Hoenig & Joachim Henkel, *Quality Signals? The Role of Patents, Alliances, and Team Experience in Venture Capital Financing*, 44 RES. POL'Y 1049 (2015).

[31] *See* Sebastian Hoenen, Christos Kolympiris, Wilfred Schoenmakers & Nicholas Kalaitzandonakes, *The Diminishing Signaling Value of Patents Between Early Rounds of Venture Capital Financing*, 43 RES. POL'Y 956 (2012).

[32] Patrick Gaulé, *Patents and the Success of Venture-Capital Backed Startups: Using Examiner Assignment to Estimate Causal Effects*, 66 J. INDUS. ECON. 613 (2018).

IPO or a high-value acquisition—for firms in the life sciences sector, but not for those in information technology. The study reveals that the first patent is especially impactful. By using examiner leniency as an instrumental variable, the study isolates the impact of patent grants from the underlying quality of the firms, offering strong evidence that patents causally influence positive exit outcomes in biotech and medical startups—corroborating but also deepening earlier findings on patents as crucial financing and signaling tools in capital-intensive R&D environments.

In an important follow-on to the Gaulé study, Joan Farre-Mensa, Deepak Hegde, and Alexander Ljungqvist provide some of the most compelling causal evidence to date on the economic value of patents for startups. Again, exploiting the quasi-random assignment of patent applications to examiners at the USPTO, the authors use this "patent lottery" as an instrumental variable to isolate the effect of the patent per se from the value of the underlying inventions for over 34,000 U.S. startups.[33] Startups fortunate enough to be assigned to more lenient examiners are significantly more likely to receive their first patent and the downstream effects are substantial.

Specifically, the study finds that receiving a first patent increases startup employment by 55% and sales by 80% over five years, relative to observationally similar startups whose patents were rejected. Moreover, a granted patent raises the likelihood of securing venture capital by 47%, bank financing (with the patent as collateral) by 76%, and going public via IPO by 128%, though firms in the biochemical sectors experienced no significant increases. Indeed, these effects are most pronounced for startups founded by inexperienced entrepreneurs and those located in capital-constrained regions. For such firms, patents serve as powerful substitutes for more traditional signals of credibility, allowing them to bridge early-stage information gaps and attract external financing. Like Gaulé, the researchers distinguish between the effects of a startup's first patent and subsequent ones. While additional patents do enhance innovation metrics—such as follow-on patenting and citation counts—they do not drive comparable increases in employment or revenue. This suggests that the first patent functions as a catalytic asset, critical for initiating growth, whereas later patents primarily reinforce an established innovation trajectory.

In yet another "patent lottery" study, Deepak Hegde, Alexander Ljungqvist, and Manav Raj examine how patent scope (breadth) and grant timing affect U.S. startups.[34] Analyzing over 22,000 startups that received their first patent between 2001 and 2013, the authors find that delays in patent examination significantly reduce startup growth, survival, external financing (especially IPO likelihood), and follow-on innovation. According to the authors, "a one-year increase in examination time reduc[es] the average startup's growth in employment and sales by 12.8 and 20.4 percentage points over five years, respectively, equivalent to 13.5 fewer person-years of employment and a cumulative loss in sales of $2.6 million over five years." Conversely, broader

[33] *See* Joan Farre-Mensa, Deepak Hegde & Alexander Ljungqvist, *What Is a Patent Worth? Evidence from the U.S. Patent 'Lottery'*, 75 J. FIN. 639 (2019).
[34] *See* Deepak Hegde, Alexander Ljungqvist & Manav Raj, *Quick or Broad Patents? Evidence from U.S. Startups*, 35 REV. FIN. STUD. 2705 (2021).

patents (measured by independent claim count) boost growth, innovation, and IPO odds among surviving startups but reduce the likelihood of survival—possibly because they make firms more attractive acquisition targets. These findings suggest that quickly issued patents with a large number of independent claims yield substantial benefits in IP-intensive fields.

A joint study by the European Patent Office (EPO) and the European Union Intellectual Property Office (EUIPO) examined the role of patent and trademark applications in influencing access to venture capital and successful exits (IPOs or acquisitions) for over 29,000 European startups, with a particular focus on IP-intensive sectors like biotechnology, healthcare, and engineering.[35] The study found that startups with patent filings had a 6.4 times greater likelihood of receiving early-stage VC funding compared to those without, and this effect increased to 10.2 times when firms filed both patents and trademarks. Biotech firms showed the highest IP intensity, with 48% holding patent filings and 47% holding trademark filings. Additionally, startups with both patent and trademark filings received significantly higher median seed funding amounts (over €900,000) compared to those without IP filings (approximately €260,000). Finally, startups with patent filings were more than twice as likely to experience a successful exit, particularly when those patents were at the European level.

Sebastian G. Huayamares, Melissa P. Lokugamage, Alejandro J. da Silva Sanchez, and James E. Dahlman performed a detailed investigation into the characteristics of 60 biotech startups that completed IPOs in the first half of 2021, with a particular emphasis on the role of intellectual property. Notably, the authors find that startups with larger patent portfolios were significantly more likely to achieve higher market valuations at IPO.[36] Many firms had amassed over 100 patents prior to going public, and while trademarks were tracked, they showed minimal variation and little correlation with valuation. The findings suggest that in biotech, patents serve as strategic assets that signal technological credibility and market potential to public investors. Notably, most companies had already initiated at least one clinical trial before their IPO, indicating that robust patent portfolios likely support successful fundraising efforts to advance R&D prior to entering public markets.

Erika Lietzan, Kristina M.L. Acri, and Evan Weidner explore the strategic importance of patents in the medical device sector, particularly for startups navigating the complex early stages of product development.[37] Drawing upon industry and patent data, the authors offer a nuanced

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[35] European Patent Office & European Union Intellectual Property Office, Patents, Trade Marks and Startup Finance: Funding and Exit Performance of European Startups (Oct. 17, 2023), https://link.epo.org/web/publications/studies/en-patents-trade-marks-and-startup-finance-study.pdf. Note that this study has not been published in a peer-reviewed or other journal.

[36] *See* Sebastian G. Huayamares, Melissa P. Lokugamage, Alejandro J. da Silva Sanchez, & James E. Dahlman, *A Systematic Analysis of Biotech Startups That Went Public in the First Half of 2021*, 4 CURRENT RES. BIOTECHNOL. 392 (2022).

[37] *See* Erika Lietzan, Kristina M.L. Acri & Evan Weidner, *The Case of the Missing Device Patents, or: Why Device Patents Matter*, 33 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 409 (2023).

view of how IP strategies intersect with regulatory realities. The study finds patents are foundational tools for securing exclusivity, attracting investment, and enabling licensing and acquisition deals—critical for startups operating under tight capital and competitive pressure. A narrow but interesting finding is the strikingly low utilization of patent term restoration by medical device companies: only 13% of eligible devices benefitted from restoration, compared to significantly higher rates in pharmaceuticals. The study attributes this disparity to three factors: some devices lack patent protection entirely; many innovators are unaware of the restoration option; and others find the application process too costly or complex to justify.

Lili Zhang, Ying Guo, and Ganlu Sun examine how patent characteristics influence venture capital (VC) investment in China's bio-pharmaceutical startup sector.[38] Drawing on a hand-collected dataset of 457 Chinese bio-pharma startups from 1992 to 2017, the study finds that patenting increases both the likelihood and magnitude of VC funding. The findings suggest that in China's emerging bio-pharma ecosystem, where informational asymmetries are acute, patents function less as legal shields and more as credibility signals that reduce perceived investment risk and help secure financing.

Annamaria Conti, Jerry Thursby, and Marie Thursby explore how patents function as financial signals in the context of startup financing, particularly when founders seek external capital but face information asymmetries with investors.[39] The authors first develop a theoretical model in which patents serve a dual role. Consistent with our reflections in the Berkeley Patent Survey, patents not only confer appropriability but also act as costly, credible signals of technological quality. Startups with high-quality inventions are more likely to bear the expense of patenting to distinguish themselves from lower-quality ventures. The model further predicts a "positive matching" equilibrium, wherein high-quality startups attract investors who can provide substantial non-financial value—such as technical expertise, industry knowledge, or reputational capital—beyond just funding.

Using a unique dataset of 787 Israeli startups with external financing between 1994 and 2011, Conti, Thursby, and Thursby then test these predictions empirically. They find that the number of patents filed by a startup is positively associated with the arrival of new investors in subsequent funding rounds, and that this relationship holds only for new investors—not existing ones. This pattern supports the hypothesis that startups strategically increase patent activity to attract fresh capital, particularly from venture capitalists known to offer value-added services. Notably, the signaling effect is absent in initial funding rounds, suggesting that early-stage patents reflect intrinsic R&D activity, whereas later filings are more likely designed to influence investor behavior. The authors also find that startups in sectors requiring greater technological disclosure—

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[38] *See* Lili Zhang, Ying Guo & Ganlu Sun, *How Patent Signals Affect Venture Capital: The Evidence of Bio-Pharmaceutical Start-ups in China*, 145 TECH. FORECASTING & SOC. CHANGE 93 (2019).

[39] *See* Annamaria Conti, Jerry Thursby, & Marie Thursby, *Patents as Signals for Startup Financing*, 61 J. INDUS. ECON. 592 (2013).

such as life sciences and medical devices—are more likely to engage in patenting activity, consistent with their theoretical model.

In another study of Israeli startups, Gili Greenberg examines how patents influence the ability of young, non-software startups—including biomedical firms—to attract venture capital. Using panel data from 317 companies that underwent more than 980 financing or exit rounds, Greenberg finds that while both patent applications and granted patents are associated with higher valuations, the impact of patent grants is particularly pronounced for younger startups (under six years old) and during early financing rounds.[40] For these firms, a single patent application was associated with a median valuation increase of approximately $4.2 million, while a granted patent conferred an additional $5.8 million boost—together accounting for nearly half the median firm valuation of $22.4 million.

The study attributes this enhanced value to the role patents play in mitigating information asymmetries between entrepreneurs and investors. Early-stage biomedical firms often lack track records and tangible assets, making it difficult for investors to evaluate their innovations without risking expropriation of proprietary knowledge. A granted patent not only signals technological legitimacy but also enables safer disclosure of tacit know-how during investor negotiations. For older firms, however, the added value of a granted patent disappears—suggesting that established ventures rely more on reputational mechanisms and commercial progress than on formal IP to secure funding.[41] Notably, the findings support targeted patent examination acceleration for young ventures to ease early-stage financing frictions.

Fatima Shuwaikh and Emmanuelle Dubocage analyze how different types of venture capital—corporate (CVC) versus independent (IVC)—affect the patenting outcomes of U.S. biotechnology startups, using an unbalanced panel of 1,547 firms founded between 1998 and 2013.[42] The study finds that CVC-backed firms tend to produce more patents than their IVC-

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[40] *See* Gili Greenberg, *Small Firms, Big Patents? Estimating Patent Value Using Data on Israeli Start-Up Firms' Financing Rounds*, 10 EUR. MGMT. REV. 183 (2013).

[41] For other valuable studies on the signaling function of patents, see Paul A. Gompers, Anna Kovner, Josh Lerner & David Scharfstein, *Performance Persistence in Entrepreneurship*, 96 J. FIN. ECON. 18 (2010) (finding that holding patents is associated with a higher likelihood of success, but prior entrepreneurial success is a significantly stronger predictor than any firm-specific variable); Jerry X. Cao & Po-Hsuan Hsu, *The Informational Role of Patents in Venture Capital Financing* (Nat'l Bureau of Econ. Res., Working Paper No. 16788, 2011) (finding that patenting activity correlates positively with subsequent VC funding amounts and the number of investing funds); Andrea Conti, Marie C. Thursby & Frank T. Rothaermel, *Show Me the Right Stuff: Signals for High-Tech Startups*, 22 J. ECON. & MGMT. STRATEGY 341 (2013) (concluding that patents significantly signal technological quality, especially to VCs); David H. Hsu & Rosemarie H. Ziedonis, *Resources as Dual Sources of Advantage: Implications for Valuing Entrepreneurial-Firm Patents*, 34 STRATEGIC MGMT. J. 761 (2013) (investigating 370 venture-backed semiconductor firms and finding that patents serve as valuable signaling assets that attract premier VCs, improve financing terms, and enhance IPO valuations); Massimo G. Colombo, Massimiliano Guerini, Karin Hoisl & Nico M. Zeiner, *The Dark Side of Signals: Patents Protecting Radical Inventions and Venture Capital Investments*, 52 RES. POL'Y 104741 (2023) (finding that patents on radical inventions send strong but risky signals in first rounds of investment).

[42] *See* Fatima Shuwaikh & Emmanuelle Dubocage, *Access to the Corporate Investors' Complementary Resources: A Leverage for Innovation in Biotech Venture Capital-Backed Companies*, 175 TECH. FORECASTING & SOC. CHANGE 121374 (2022).

backed peers, with some evidence of increased citation impact. The authors identify three moderating factors that enhance the positive effect of CVC on innovation: absorptive capacity (measured by prior patent stock and past R&D), business similarity (shared SIC codes between the startup and investor), and geographic proximity. Startups exhibiting these characteristics are better positioned to leverage the corporate investor's complementary resources—such as technical knowledge and R&D infrastructure. The study suggests that CVC funding embeds startups within the corporate sponsor's innovation ecosystem, amplifying their capacity to generate valuable intellectual property.

Federico Caviggioli, Alessandra Colombelli, Antonio De Marco, and Emilio Paolucci analyze how the structure and quality of patent portfolios influence the amount of venture capital raised by young innovative companies, with a particular focus on technology-intensive sectors such as biotechnology and healthcare.[43] Using a large dataset of over 1,000 European startups that received VC funding between 2010 and 2014, the study matches patent records from the PATSTAT dataset with firm-level financial data. The authors find that the size of a startup's patent portfolio—measured by number of patent families—is strongly associated with greater total VC investment, especially in IP-intensive industries like biotech. Interestingly, the study reveals that the importance of patent quality increases in later financing rounds, suggesting that investors become more discerning over time. Nonetheless, in biotech and medical device sectors—where patents are central to competitive advantage—portfolio size alone continues to be a robust signal of value even in later stages.

Ernest Solé Udina, Susana Domingo-Perez, and Oriol Amat examine how patent activity influences the likelihood of securing initial venture capital financing among biotechnology startups in Spain.[44] Using panel data from 210 firms over a ten-year period, the authors find that the stock of published patents is a statistically significant and positive predictor of receiving first-round VC investment. The study highlights that patents function as important signals of innovative capability and helps mitigate information asymmetries between startups and investors. Although Spain's venture capital market is relatively underdeveloped, the findings underscore that patenting remains a critical factor in attracting early-stage funding in the country's broader biotechnology sector.

Carlos J. Serrano and Rosemarie H. Ziedonis explore the "salvage value" of patents from failed VC-backed startups, including those in the medical device sector. Drawing on a novel dataset of 1,514 U.S. utility patents from 264 firms that went out of business between 1987 and 2008, they find that a majority of patents—64%—were successfully redeployed post-failure.[45]

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[43] *See* Federico Caviggioli, Alessandra Colombelli, Antonio De Marco & Emilio Paolucci, *How Venture Capitalists Evaluate Young Innovative Company Patent Portfolios: Empirical Evidence from Europe*, 26 INT'L J. ENTREPRENEURIAL BEHAV. & RES. 695 (2020).

[44] *See* Ernest Solé Udina, Susana Domingo-Perez, & Oriol Amat, *Biotechnology Firms, Signals, and Venture Capital Investment*, 18 INTANGIBLE CAP. 350 (2022).

[45] *See* Carlos J. Serrano & Rosemarie H. Ziedonis, *Do Patent Assets Have a Second Life When Startups Fail? An Analysis of the Redeployment Likelihood and Mode of Transfer*, 46 STRATEGIC MGMT. J. 82, 82–113 (2024).

While medical device firms showed somewhat lower resale rates than semiconductor and software firms, over 60% of their patents still changed hands, indicating an active secondary market even for highly regulated technologies. Most redeployments (87%) involved sales of patents as standalone assets, while the remaining 13% included co-mobility transfers, where patents moved alongside one or more original inventors to the acquiring company. This latter channel was especially important for medical device patents, which often embody firm-specific knowledge that is difficult to transfer without personnel continuity.

A central contribution of the study is its analysis of what drives whether and how these patent assets are redeployed. Patents with higher "firm-specificity"—proxied by the share of self-citations in subsequent patents—were significantly less likely to be sold as standalone assets but more likely to transfer via "co-movement" (specifically, movement of the inventors to the purchasing firm). For example, a one standard deviation increase in firm-specificity decreased the likelihood of a standalone sale by 7.1 percentage points and increased the chance of co-mobility by 2.4 points. Conversely, more generic patents with lower firm-specificity were more readily resold as standalone assets. The findings are particularly relevant for medical device firms, which often develop integrated technologies reliant on tacit knowledge. Indeed, in the medical device subsample, co-mobility transfers occurred more frequently than in software, underscoring the importance of preserving human capital to realize the value of complex innovations.

The role of secondary market liquidity is also pivotal. The same study finds that more active patent markets substantially increase the chances of asset recovery. A one percentage point increase in patent market liquidity raises the likelihood of a patent sale by 5.4 points and co-movement by 2.2 points. These effects are stronger for different modes of transfer depending on asset specificity: liquidity boosts standalone sales when firm-specificity is low and favors co-mobility when it is high. In high-specificity contexts—like many medical device startups—a one-point increase in liquidity increased the chance of co-mobility by 9.5 percentage points. These findings suggest that well-functioning secondary markets can enhance exit value for distressed ventures and reduce innovation waste.

Christian Helmers and Mark Rogers examine the link between patenting and asset growth among UK-based high- and medium-tech startups, including those in the biomedical sector.[46] Their key finding is that patenting is associated with significantly higher asset growth: startups that patented in their founding year or shortly thereafter experienced 8% to 27% higher annual growth in total assets compared to their non-patenting counterparts. Patenting was also positively correlated with firm survival, suggesting that IP protection may confer resilience in early-stage markets. However, the authors caution against overly causal interpretations. They acknowledge that patenting may not directly cause growth, but could serve as a signal to investors, facilitate financing, or enhance negotiation leverage with partners and suppliers. Even so, the magnitude and robustness of the effects, especially among small firms—in conjunction with other key studies

[46] *See* Christian Helmers & Mark Rogers, *Does Patenting Help High-Tech Start-Ups?*, 40 RES. POL'Y 1016 (2011).

recounted above, such as the one by Farre-Mensa, Hegde, and Ljungqvist—offer persuasive evidence that IP protection, especially when employed early, can materially improve the asset trajectory of technology-intensive startups.

## CONCLUSION

Seventeen years since its publication, the Berkeley Patent Study remains the most comprehensive analysis of patenting among startups, including those in biotechnology and medical device sectors. Since then, researchers have conducted smaller-scale surveys and empirical analyses to examine the role of patents in startup activity. These subsequent studies have largely confirmed the Berkeley Study's findings, suggesting that despite legislative and economic changes since 2008, the role and impact of patenting among startups have remained largely similar, including for biomedical startups. Table 3 summarizes these findings.[47]

Table 3: Summary of Findings of the Berkeley Patent Survey and Follow-on Studies

| **Berkeley Patent Study Finding** | **Follow-on Studies** |
|---|---|
| Patent holding among startups is common, especially among biomedical firms, but not omnipresent | One follow-up study concluded that biotech startups funded by corporate venture capital versus independent venture capital firms tended to produce more patents (Shuwaikh & Dubocage (2022)). |
| Patents are perceived to offer only mixed incentives to engage in innovation, though more so for biomedical startups | |
| Patents can serve to promote startups' competitive advantage, especially for biomedical firms, relative to other appropriability mechanisms | |
| Startups have differing motives for patenting, from preventing copying to fundraising and exit to defensive purposes, particularly for biomedical firms | Several follow-on studies confirm this finding for growth and exit events, plus provide additional findings regarding the importance of patents to startups (e.g., Helmers & Rogers (2011), Gaule (2018), Farre-Mensa, Hegde & Ljungqvist (2019), Simon (2020), Deepak Hegde, Ljungqvist & Raj (2021), Sebastian G. Huayamares, Lokugamage, da Silva Sanchez & Dahlman (2022), Lietzan, Acri & Weidner (2023), Serrano & Ziedonis (2024), Zhu & Raj (2024)). |

[47] For several findings, I could not locate any follow-on studies, which are left blank. For a few findings, I have included studies that are not summarized above.

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|---|---|
| Startups' motivations to seek patents differ by industry | |
| Patents serve an important function in the financing of startups, especially for biomedical startups | Numerous follow-on studies confirm this finding (e.g., Hoenen, Kolympiris, Schoenmakers & Nicholas Kalaitzandonakes, (2012), Conti, Thursby & Thursby (2013), Greenberg (2013), Haeussler, Harhoff & Müller (2014), Hoenig & Henkel (2015), Zhang, Guo & Sun, (2019), Caviggioli, Colombelli, De Marco & Paolucci (2020), Simon (2020), Udina, Domingo-Perez & Amat (2022), European Patent Office & European Union Intellectual Property Office (2023), Zhu & Raj (2024)). |
| Technology entrepreneurs have various reasons not to seek patents, including costs, reluctance to disclose, and the availability of trade secret protection | |
| Startups' reasons for forgoing patenting differ by industry | |
| Technology entrepreneurs must reckon with patents held by others, but mainly to acquire technology for biomedical firms | Several studies have examined licensing among tech startups (e.g., de Rassenfosse (2012),[48] Pereira, Leitão & Tessaleno (2015),[49] Shane, Dolmans, Jankowski, Reymen & Romme (2015),[50] Belingheri & Leone (2017)[51]). |

That said, recent studies have largely overlooked several important changes in the intellectual property landscape that have emerged in the years since the Berkeley Patent Study. For instance, researchers have yet to examine how the expansion of post-issuance patent challenges at the USPTO has affected startups—particularly those that rely on patent licensing as a primary revenue source, including many biotechnology startups. In addition, judicial shifts in substantive patent law have significantly curtailed the patentability of certain categories of inventions, such as medical diagnostic tests. To date, no study has explored how this curtailment in patentable subject matter has affected startups.

[48] Gaétan de Rassenfosse, *How SMEs Exploit Their Intellectual Property Assets: Evidence from Survey Data*, 39 SMALL BUS. ECON. 437 (2012).
[49] Dina Pereira, João Leitão & Tessaleno Devezas, *Do R&D and Licensing Strategies Influence Start-Ups' Growth?*, 25 INT'L J. ENTREPRENEURSHIP & SMALL BUS. 148 (2015).
[50] Scott Shane, Sharon A. M. Dolmans, Joseph Jankowski, Isabelle M. M. J. Reymen & A. Georges L. Romme, *Academic Entrepreneurship: Which Inventors Do Technology Licensing Officers Prefer for Spinoffs?*, 40 J. TECH. TRANSFER 273 (2015).
[51] Paola Belingheri & Maria Isabella Leone, *Walking into the Room with IP: Exploring Start-Ups' IP Licensing Strategy*, 55 MGMT. DECISION 1209 (2017).

The rapid rise of artificial intelligence (AI) across all technological sectors also introduces new and complex challenges for patenting—especially for AI-driven startups in the biomedical space. Another valuable line of inquiry would be to follow up on the firms surveyed in the original Berkeley Patent Study. For example, did companies with extensive patent portfolios fare better in terms of survival and growth than comparable firms without such portfolios? Hopefully, future research will address these and other critical developments in the evolving role patenting plays in startups.