

Venture Capital's Role in Financing Innovation: What We Know and How Much We Still Need to Learn

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Venture capital is associated with some of the most high-growth and influential firms in the world. For example, among publicly traded firms worldwide, seven of the top eight firms by market capitalization in May 2020 had been backed by venture capital prior to their initial public offerings: Alphabet, Apple, Amazon, Facebook, and Microsoft in the United States, and Alibaba and Tencent in China. More generally, although firms backed by venture capital comprise less than 0.5 percent of firms that are born each year in the United States, they represent nearly half of entrepreneurial companies that graduate to the public marketplace.

Academics and practitioners have effectively articulated the strengths of the venture model. These include its strong emphasis on governance by venture capital investors through staged financing, contractual provisions, and active involvement with their portfolio companies. Indeed, Kenneth Arrow (1995) once opined that “venture capital has done much more, I think, to improve efficiency than anything.”

In many respects, the venture capital industry appears to be a bright spot in an increasingly troubled global innovation landscape (Bloom et al. 2020). Over the last decade, the amount of capital deployed worldwide by venture capital investors and the number of startups receiving funding have grown substantially. Entirely new financial intermediaries such as accelerators, crowdfunding platforms, and “super angels” have emerged at the early stage of new venture finance. Meanwhile, mutual

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funds, hedge funds, corporations, and sovereign wealth funds have deployed large sums of capital into more mature, but still private, venture capital-backed firms.

In this paper, we acknowledge the power of the venture capital in fomenting innovation. At the same time, despite the optimism articulated by Arrow and by many other academics and practitioners, we argue that venture capital financing also has real limitations in its ability to advance substantial technological change. While our ability to assess the social welfare impact of venture capital remains nascent, we hope that this discussion will stimulate discussion and research about these questions.

Three issues are particularly concerning to us: 1) the very narrow band of technological innovations that fit the requirements of institutional venture capital investors; 2) the relatively small number of venture capital investors who hold and shape the direction of a substantial fraction of capital that is deployed into financing radical technological change; and 3) the relaxation in recent years of the intense emphasis on corporate governance by venture capital firms. We believe these phenomena, rather than being short-run anomalies associated with the ebullient equities market from the decade or so up through early 2020, may have ongoing and detrimental effects on the rate and direction of innovation in the broader economy.

We begin this paper by tracing the growth of the venture capital industry over the past 40 years, noting how technological and institutional changes have narrowed the focus and concentrated the capital invested by venture capital firms as well as potentially contributing to a decline in governance. We then turn to some potential adaptations to the venture capital industry model that might enable a broader base of ideas and technologies to receive risk capital. In particular, we propose some possibilities for altering what seems to be a standard and inflexible contract between venture capital funds and their investors as well as potential approaches to manage venture investments in certain industries more effectively.

Our focus here will primarily be on the US venture capital industry. But we would be remiss if we did not note that the growth rate of global venture capital has exceeded that of the US economy. The National Venture Capital Association (2020) estimates, for instance, that the US share of world venture capital financing has fallen from about 80 percent in 2006–2007 to under 50 percent in 2016–2019.

A Brief Look at the Development of Institutional Venture Capital

Origins

Entrepreneurs sought funds to pursue their risky ideas for centuries before the modern venture capital industry emerged. Indeed, some of the key elements of today's venture capital industry, such as the use of risk-sharing partnerships, can be traced as far back as Genoese merchants in the 15th century and American whaling voyages in the 19th century (Astuti 1933; de Roover 1963; Lopez and Raymond 1955; Nicholas 2019).

Most business historians, however, trace the origins of the institutional venture capital industry to 1946, when Harvard Business School professor Georges Doriot

formed the American Research & Development Corporation with local Boston civic leaders to invest in young ventures developed during World War II.¹ Doriot articulated and practiced many of the key principles of venture investment that continue to this day. These guideposts include: the intensive scrutiny (and frequent rejection) of business plans prior to financing, the provision of oversight as well as capital, the staged financing of investments, and the ultimate return of capital and profits to the outside investors that provided the original funding.²

Several of the most prominent venture capital firms of today—such as Sequoia Capital, Kleiner Perkins, and New Enterprise Associates—were formed in the early to mid-1970s to invest in what would become the burgeoning semiconductor and computer industries. However, the industry did not take off until the early 1980s, when pension funds began to allocate some of their capital towards this relatively new asset class. Much of this change can be traced back to a clarification of an obscure rule in the Employment Retirement Income Security Act (ERISA). The rule had originally stated that private pension managers had to invest their funds' resources with the care of a "prudent man," which was interpreted as requiring only very low-risk investments. In early 1979, the Department of Labor ruled that pension fund managers could take portfolio diversification into account in determining prudence, which implied that the government would not view allocation of a small fraction of a corporate pension fund portfolio to illiquid funds like venture capital as imprudent, even if a number of companies in the venture capitalist's portfolio failed. While the allocations of corporate pension funds to venture capital in the 1980s were initially very modest, even a small allocation of such a large pool led to very rapid growth of the venture capital sector.

A decade later, US public pension funds also started investing in venture capital firms and were soon followed by pension and sovereign funds from around the globe. Initially, neither private nor public pension funds invested in a dramatically different manner than their predecessors. But their impact was important because of their sheer size, which dwarfed that of the early venture capital investors such as university endowments and insurance companies. In the subsequent 40 years, venture capital has come to be established as the dominant source of financing for high-potential startups commercializing risky new ideas and technologies.

Venture Capital's Impact

Table 1 highlights how venture capital is involved in financing startups that ultimately have become some of the largest and most successful firms in the economy. We looked at the 4,109 initial public offerings over the 1995–2018 period of

¹Our reference to "institutional" venture capital refers to the majority of the venture capital industry that raises money from and invests on behalf of "limited partners"—entities such as university endowments or pension funds that allocate some of their capital to the venture capital asset class. However, corporations, family offices, and pension funds also make direct investments into high-risk ventures.

²The reader desiring a more detailed perspective can study the several volumes on the industry's evolution, including Ante (2008) and Nicholas (2019). In an earlier *JEP* article, Gompers and Lerner (2001b) review the industry's first half century.

Table 1

Comparison of Publicly Traded Firms in the United States, Based on Whether Backed by Institutional Venture Capital Investors

	<i>VC-Backed IPOs</i>	<i>All IPOs</i>	<i>VC-Backed as a % of all</i>
Total number of non-financial IPOs between 1995 and 2019	1,930	4,109	47.0%
Number of firms still public at 12/31/2019	582	1,044	55.7%
Share of IPOs that were still public at 12/31/2019	30%	25%	
<i>Key statistics as of December 31, 2019 for firms still public (all figures millions USD, except number of employees)</i>			
Total enterprise value	4,844,717	7,129,838	67.9%
Total market capitalization	4,922,394	6,462,409	76.2%
Global employees	2,279,715	5,336,394	42.7%
Total revenue	1,157,679	2,171,239	53.3%
Net income	53,082	98,554	53.9%
R&D expenditure	148,388	167,442	88.6%

Source: IPO data from SDC Platinum (accessed 01/08/2020); company-level statistics from Standard and Poor's Capital IQ (accessed 04/24/2020)

Note: This table reports statistics for the sample of publicly traded firms that had an initial public offering (IPO) between 1995 and 2018 and were still public on December 31, 2019, further conditioning on those that were founded after 1980 and were not financial firms. It compares statistics for firms that were backed by venture capital firms prior to their IPO with those that were not. IPO data are drawn from Refinitiv's SDC Platinum database, with data for key statistics drawn from S&P's Capital IQ database. All attributes are measured as of December 31, 2019.

nonfinancial firms that were founded in 1980 or later. Table 1 (inspired by Gornall and Strebulaev 2015) shows that 47 percent (or 1,930) of these firms were backed by venture capital investors prior to their initial public offering. Of those 4,109 IPOs, 1,044 were still publicly traded at the end of 2019. The table compares the 1,044 firms—at the end of 2019—based on whether they were originally venture capital-backed (582 firms) versus not (462 firms). That is, 56 percent of the firms that had initial public offerings from 1995 to 2018 and were still alive at the end of 2019 were backed by venture capital. Considering that under 0.5 percent of firms in the economy receive venture capital financing (Puri and Zarutskie 2012), Table 1 highlights the disproportionate role firms backed by venture capital play in the US economy.

An important question relates to whether these differences arise purely due to venture capital firms selecting high-growth opportunities or whether these investors also play a causal role in improving the growth and performance of new companies. Discerning causality in this setting is tough, and much of the research has consequentially been more descriptive in nature. Chemmanur, Krishnan, and Nandy (2011) and Puri and Zarutskie (2012) examine the universe of firms using the Longitudinal Research Database of the US Census Bureau. They argue that the evidence is consistent with the proposition that venture capital increases firm sales and lowers the likelihood of firm failure.

Other papers have attempted to exploit discontinuities to identify the relationship between venture capital and innovation. Kortum and Lerner (2000) use the 1979 “prudent man” change in pension fund rules that increased venture capital funding as a natural experiment, along with several other approaches, to look for causality. They find that a rise in venture capital causes higher rates of patenting. Bernstein, Giroud, and Townsend (2016) examine the opening up of new airline routes that make it easier for a venture capital firm to visit one of its existing portfolio companies. They find that when it becomes easier for the venture capital firm to monitor, the portfolio firm performs better.

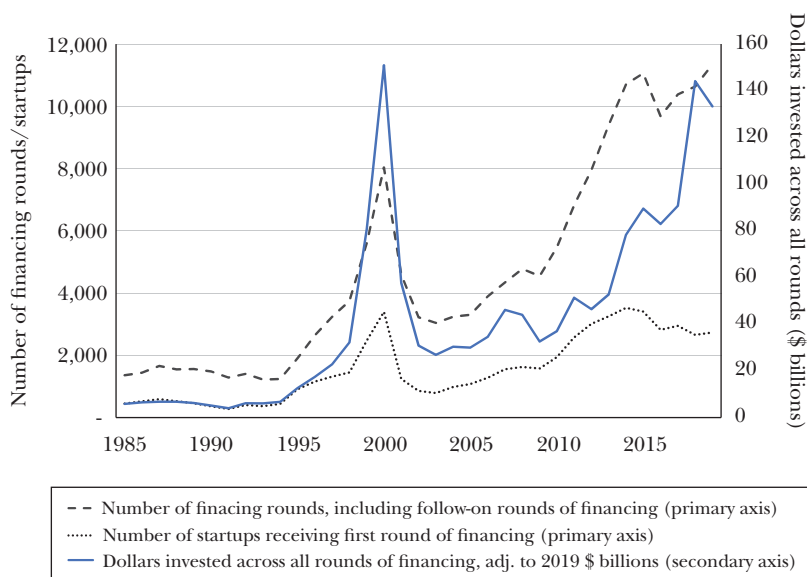
Other research has fleshed out the mechanisms that venture capital investors use. These tools include staged financing (Gompers 1995; Neher 1999), securities that have state-contingent cash flow and control rights (Hellmann 1998; Cornelli and Yosha 2003; Kaplan and Strömberg 2003, 2004), and the active role of venture capital investors on boards of portfolio companies (Hellmann and Puri 2000, 2002; Lerner 1995). The authors argue these approaches have an important impact on the success of portfolio companies. For a more thorough review of the extensive literature on venture capital, a useful starting point is Da Rin, Hellmann, and Puri (2013).

Looking back at Table 1, one can see that firms that were backed by venture capital prior to their initial public offering represent a similar share of revenues and profits as their proportion of surviving public firms (about 55 percent). On average, they are less labor intensive, more valuable in terms of market capitalization, and represent 89 percent of the recorded research and development expenditures by these firms in 2019.

The disproportionate share of recorded research and development expenditures by firms that were formerly backed by venture capital stems from two elements. First, 91 percent of public firms originally backed by venture capital recorded expenses related to research and development in 2019, compared to a much smaller 72 percent for firms not originally backed by venture capital. Second, among those that did report research and development expenses, the intensity of research and development, measured as a share of firm revenue, was higher.

The research and development intensity of publicly traded firms that were backed by venture capital relates to the role of venture capital in financing repeated waves of technological innovation: the semiconductor revolution and diffusion of mainframe computing in the 1960s; the advent of personal computing in the early 1980s; the biotechnology revolution of the 1980s; and the introduction of the Internet and e-commerce in the 1990s (which as seen from Figure 1, led to a sharp expansion in venture capital and venture capital-backed startups between 1995 and 2000). After a significant decline in 2000 and the subsequent “dot com bust,” the role of venture capital firms in financing technological revolutions continued in the 2000s, as exemplified by the widespread diffusion of “smart” mobile communications technologies and new businesses enabled by the rise of cloud computing. Consistent with this pattern, Howell et al. (2020) use US patent data over the 1976–2017 period to document that venture capital-backed firms were between two

Figure 1

Evolution of the US Venture Capital Industry from 1985–2019

Source: Data are drawn from the National Venture Capital Association’s Yearbooks and related publications.

Note: This figure reports the number of unique startups headquartered in the United States receiving an initial round of financing from institutional venture capital investors (left-hand axis), the total number of financing rounds associated with these startups, including follow-on rounds of financing (left-hand axis) and the total dollars invested across these rounds of financing in constant 2019 billions of dollars (right-hand axis) for each year from 1985–2019.

and four times as likely to have filed patents that were in the top percentiles of influence (as measured by citations, originality, generality, and closeness to science).

Venture Capital in the 2010s

Venture capital has boomed over the past decade, driven by new investment opportunities and greater availability in the supply of capital for this asset class.

On the demand side, there has been a plethora of attractive investment opportunities. Many venture-backed firms have focused on developing novel ways to apply information technology and the widespread diffusion of mobile communications. One manifestation has been platforms that connect and employ widely dispersed sellers of services and goods (frequently dubbed the “sharing economy,” and manifested by companies such as Airbnb and Uber). A second has been firms that substantially improve the efficiency of existing services at much lower price points: for example, the ways in which Salesforce.com and other companies provide “Software as a Service” to businesses, the rise of “fintech,” and the plethora of “Mobile Apps” available for consumers. Third, several companies replicated business models successful in the United States in other national markets, with the Chinese companies Alibaba and Tencent being the most dramatic exemplars. An important

consequence was the dramatic increase in venture capital investment in Asia over this period (a topic worthy of much closer study).

Another demand driver has been the substantially lower cost of starting a new business in the software and services sectors. As documented by Ewens, Nanda, and Rhodes-Kropf (2018), the much lower initial capital needed for new ventures in these sectors made it much cheaper to learn about their potential. This change led early-stage investors to be more willing to fund less proven (but potentially high-return) ideas and entrepreneurial teams in these sectors. One manifestation was an increase in a “spray and pray” investment approach, where financiers provide a small amount of funding and limited governance to a larger number of startups. As seen in Figure 1, the number of startups receiving a first round of venture capital financing rose substantially over this period.

Coinciding with the fall in cost of starting businesses and the entry of less-experienced founding teams has been the emergence of complementary institutions that fund and mentor very early-stage entrepreneurs. For example, the substantially smaller quantum of capital required to get a business off the ground has led to more opportunities for angel (or individual) investors. Not only did angel groups grow in size (Kerr, Lerner, and Schoar 2014), but some angel investors (the “Super Angels”) even began to raise small funds to finance startups at earlier stages than was typical for institutional venture capital investors. Further, using online platforms such as AngelList, groups of individuals could back a lead investor who aimed to replicate some of the systematic diligence and monitoring functions played by traditional venture groups (Agrawal, Catalini, and Goldfarb 2016). The contemporaneous rise of equity crowdfunding and initial coin offerings has had a more mixed legacy, enabling widespread participation in financing startups by the populace but also raising concerns about fraud (Howell, Niessner and Yermack forthcoming; Lin 2017; Zetzsche et al. 2018).³ The evolving early-stage market also created an increasingly important role for business accelerators, which sought to systemize the mentoring and development of the larger number of inexperienced, first-time entrepreneurs receiving financing (Gonzales-Uribe and Leatherbee 2017; Hochberg 2016).

The last decade has also seen substantial changes in the way that venture capital-backed firms grow and achieve exits for their investments. One element of this shift is the marked decline in the number of initial public offerings since the “dot com” bust in 2000. Instead, venture capitalists are far more likely to exit investments through acquisitions. Inasmuch as firms are going public, they are doing so at more mature stages in their life-cycle (Ewens and Farre-Mensa 2020).

Understanding the drivers for such shifts—and the more general reduction in the number of publicly traded US firms—is challenging. Potential explanations include technological shifts leading to a rise in platform (winner-take-all) businesses (Gao, Ritter, and Zhu 2013), regulations making it harder for small firms to

³A parallel literature has examined the rise of reward-based crowdfunding (Mollick 2014) and peer-to-peer *lending* platforms (Iyer et al. 2016) which we do not discuss here due to the focus on equity finance of technology-based ventures.

go public (Iliev 2010), changes in securities laws that facilitated the flow of more capital into private markets (Ewens and Farre-Mensa 2020), and monetary policy following the financial crisis.

But whatever the cause, the fact that firms that are more mature when they go public has also meant that they do so at substantially higher valuations. Investors that traditionally focused solely on the public markets saw that they were missing out on the capital gains that companies such as Facebook, LinkedIn, and Salesforce garnered while still private. These investors consequentially sought out opportunities in the private venture capital market.

As a result of this interest, the past decade saw an increase in the number of venture capital funds raising capital. The most conspicuous impact of this flood of capital into venture capital was the rise of “mega-funds,” which refers to venture capital funds that are substantially larger than historical averages. The most salient of these was SoftBank’s Vision Fund. At the time of its first closing on \$93 billion in May 2017 (with an anchor investment of \$45 billion from the Saudi Public Investment Fund), it was already 30 times larger than the previous largest venture capital fund raised (New Enterprise Associates’ 2015 Fund XV). SoftBank would ultimately go on to raise \$100 billion for its fund. This rapid increase in interest in venture capital also triggered traditional venture firms to raise very large funds, such as the \$8 billion Sequoia Capital Global Growth Fund III in 2018.

In addition, frustration with the high fees charged by venture capital firms led sovereign wealth funds, hedge funds, mutual funds, and other public market investors to begin making direct investments into firms backed by venture capital (Fang, Ivashina, and Lerner 2015; Lerner et al. 2018). Ewens and Farre-Mensa (2020) estimate that between 2014 and 2016, over three-quarters of the late-stage venture capital funding came from such non-traditional investors. Whether through large funds or direct investments, much of the capital from these later-stage investors has gone to “unicorns,” defined as privately held firms with nominal valuations in excess of \$1 billion.

This combination of new entrants deploying small amounts of capital at the early stage with the rise of mega-funds is reflected in fund size statistics. These changes are best illustrated by looking “peak to peak,” from 2007 to 2019 in Table 2. The size of the median fund raised by venture capital investors has fallen from \$133 million to \$80 million. Meanwhile, the number of funds with \$1 billion or more of capital rose from three in 2007 to eight in 2019 (NVCA 2020).

Venture Capital’s Limitations

The growth of the venture capital market in the past decade should not blind us to its limitations as an engine of innovation. Indeed, the changes delineated in the previous section will likely exacerbate these challenges. We lay out three distinct areas of concern about venture capital and its ability to successfully spur innovations. While the discussion must be inherently more speculative, given the relatively

Table 2

The State of US Venture Capital Funds in 2007 versus 2019

	2007	2019
Number of firms that raised funds in the prior 8 years	946	1,328
Number of VC funds raising money in that year	187	272
Number of funds greater than \$1 billion in size	3	8
VC capital raised (billions of \$)	35	51
Total VC AUM (billions of \$)	222	444
Median fund size (millions of \$)	133	80
Average fund size (millions of \$)	213	189

Source: Data are drawn from the National Venture Capital Association's 2020 Yearbook and accompanying supplemental data pack. Data for "number of funds greater than \$1 billion in size" are drawn from the PitchBook database.

Note: The NVCA includes in its fundraising data "only funds based in the United States that have held their final close," while its deals data include financings of companies headquartered in the United States but potentially from investors based outside the United States.

limited work done in this area, we suggest that these questions would benefit from scholarly attention in the years to come.

Optimized for a Narrow Slice of Technological Innovation

Despite the substantial growth of venture capital in the four decades since the revision of the "prudent man" rule for pension fund investment in 1979, venture capital touches only a tiny share of firms in the American economy. The estimated \$450 billion currently under management by US venture capital firms (NVCA 2020) remains small in comparison to the several trillion dollars managed by the broader asset class of all US private equity, not to mention the total of all US public equities, estimated at \$42.9 trillion at the end of 2018 (SIFMA 2019). Only a few thousand new firms each year raise institutional venture capital for the first time, as compared to over 600,000 annual business starts in the United States. Even among high-potential firms engaged in innovation, Farre-Mensa, Hegde, and Ljungqvist (2020) found that only 7 percent of firms that filed for a patent went on to raise institutional venture capital. These disparities are likely even more extreme in other nations, where the venture industry is less mature.

One reason for this is structural. Venture capital investors typically raise funds for a specific (usually a ten-year) period. This time frame implies that venture capitalists are naturally drawn to investment opportunities where the ideas can be commercialized and their value realized through an "exit" within a reasonably short period. Sudden market downturns, as occurred in 2000, 2008, and 2020, may disrupt plans to exit investments, creating more pressure to sell when market conditions permit, even if earlier than optimal for the firm. These constraints imply that venture capital investors often exit their investments well before growth opportunities are fully realized. As a result, they are often drawn to sectors with large uncertainty about an idea's potential that can nevertheless be resolved quickly.

What leads to variation in the degree to which uncertainty about the prospects of a young firm can be reduced quickly? An important element appears to be the

nature of uncertainty about demand for the new product or service. Put another way, can uncertainty about the viability of the offering and the market demand be resolved quickly? Software and service businesses—which are typically based on proven technologies, often have short development times and can benefit from quick market feedback—are amenable to this approach. Also, as noted above, technological changes over the past two decades have made it quicker and cheaper to learn about demand for a new software business. By way of contrast, many other sectors like clean energy, new materials, and others are less amenable to such rapid learning. The widespread interest among venture capital investors in the few exceptions, such as biotechnology startups, is tied to the drug approval and reimbursement system that enables investors to project the market value of a new drug accurately if it is successful in passing through clinical trials (Janeway 2018).

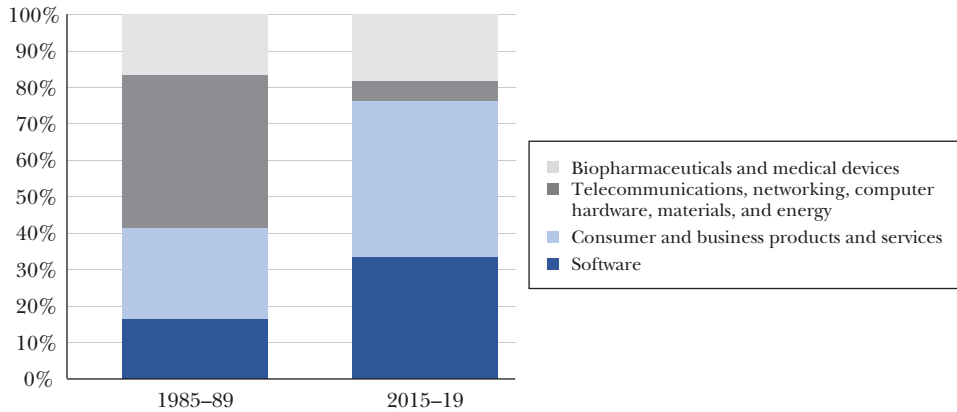
This suggestion is underscored by computations by Sand Hill Econometrics. This firm creates a series of indexes (described in Hall and Woodward 2004) that seek to capture the gross returns (that is, before management fees and profit-sharing) from investments in all active venture transactions in a given category. Their calculations suggest that an investment in the software deals between December 1991 and September 2019 would have yielded an annualized gross return of 24 percent per annum, far greater than investments in hardware (17 percent), healthcare (13 percent), or clean-tech (2 percent). This index further shows that the divergence in the performance of these categories has been particularly stark in the last decade.

These stark differences in economics have unsurprisingly led to shifts in the composition of venture capital portfolios. Examining the portfolio of a single venture group four decades apart demonstrates the extent of this focus and narrowing.⁴ Charles River Ventures was founded by three seasoned executives from the operating and investment worlds in 1970. Within its first four years, it had almost completely invested its nearly \$6 million first fund into 18 firms. These included classes of technologies that would be comfortably at home in a typical venture capitalist's portfolio today: a startup designing computer systems for hospitals (Health Data Corporation), a software company developing automated credit scoring systems (American Management Systems), and a firm seeking to develop an electric car (Electromotion, which, alas, proved to be a few decades before its time). Other companies, however, were much more unusual by today's venture standards: for instance, startups seeking to provide birth control for dogs (Agrophysics), high-strength fabrics for balloons and other demanding applications (N.F. Doweave), and turnkey systems for pig farming (International Farm Systems). Only eight of the 18 initial portfolio companies—less than half—were related to communications, information technology, or human health care.

The portfolio of Charles River Ventures looks very different in December 2019. Of the firms listed as investments, about 90 percent are classified as being related

⁴This example is drawn from Banks and Liles (1975) and “Charles River Ventures,” <http://www.crv.com/>.

Figure 2

Venture Capital Investment into US Startups between 1985 and 2019, by Sector

Source: Data are drawn from the National Venture Capital Association's yearbooks and related resources. Software refers to firms classified as being in the Software industry. Consumer and Business Products and Services refer to startups in the following categories: Business Products and Services, Consumer Products and Services, Financial Services, Healthcare Services, IT Services, Media and Entertainment and Retailing/Distribution. Telecommunications, Networking, Computer Hardware and Energy refer to startups in the following categories: Computers and Peripherals, Electronics/Instrumentation, Networking and Equipment, Semiconductors, Telecommunications, Industrial/Energy and Other. Biopharmaceuticals and Medical Devices refer to startups in the following categories: Biopharmaceuticals and Medical Devices and Equipment

Note: This exhibit reports investment by venture capital investors into US startups between 1985 and 2019, broken down by four distinct sectors.

to information technology comprising social networks, applications for consumers, and software and services related to enhancing business productivity. Approximately 5 percent of investments are classified as being related to health care, materials, and energy.

This shift in Charles River's portfolio reflects the patterns of the industry at large, as Figure 2 depicts. By way of preface, it should be noted that it is difficult to trace fine-grained industry categories over multiple decades. New categories of firms (such as social networks and digital media) have emerged. Moreover, firms do not always fit neatly into a single classification: for example, Uber is a software firm, a transportation firm, and a consumer service firm. With these caveats duly noted, in Figure 2 we categorize firms into four broad classifications that are reasonably comparable over time: computer software, hardware of many types (from energy to instruments to semiconductors), business and consumer products/services, and medical, including biopharmaceuticals.

Hardware dominated the investments made by venture capital in the period from 1985 to 1989, accounting for 42 percent of dollars invested into startups by venture capital. Software and service startups accounted for nearly the same share of investments made in 1985–1989, while biopharmaceuticals and medical devices represented most of the remainder. The figure also shows the large shift in focus

of venture capital firms away from hardware and towards software and service businesses. Biopharmaceutical and medical device startups have received approximately the same share of funding. However, the chart masks the fact that this investment now comes from a smaller share of venture capital firms specializing in this sector, as opposed to from many generalist venture capital firms.

The same concentration of investment on software and related businesses seen in Figure 2 is also seen in the patent data. Using data on the patents filed at the US Patent and Trademark Office over the period 2008–2017, we found that the top ten patent classes using the US Cooperative Patent Classification (CPC) system represented 48 percent of all venture capital patents filed over the 2008–2017 period, as compared to 24 percent for the top ten patent classes for patents not filed by venture capital-backed firms.

Thus, while venture funding is very efficacious in stimulating a certain kind of innovative business, the scope is increasingly limited. This concentration may be privately optimal from the perspective of the venture funds and those who provide them with capital. It is natural to worry, however, about the social implications of these shifts. For instance, promising startups developing renewable energy technologies and advanced materials, which might have broad societal benefits, may languish unfunded.

The reader might well raise eyebrows at this suggestion. If value-creating entrepreneurial investment opportunities exist, should some other investor step in? Certainly, we have seen corporations in sectors such as energy making investments in young firms. But as we will discuss in the final section, these efforts to date have been far from resounding successes.

The Disproportionate Role of a Few Deep-Pocketed Investors

Venture activity is concentrated. Yes, the National Venture Capital Association estimates that there were a little over 1,000 US venture capital funds in 2019. But a small number of large venture capital firms hold the vast majority of capital.

To illustrate this point, we created a list of all institutional venture capital investors that made at least one investment into a US-headquartered startup in 2018. For these investors, we examined the total funds they had raised from 2014 to 2018: approximately \$284 billion raised by 985 investors. Looking at the concentration in the capital raised by these investors provides a good proxy for the concentration in assets under management across institutional venture capital investors. The top 50 investors, or about 5 percent of the venture capital firms, raised half of the total capital over this period.⁵

The large inflow of capital in the last decade has further concentrated capital in the hands of top funds. The reasons for this are worth further inquiry but are likely, at least in part, due to strong persistence in the relative performance of the venture

⁵Taking into account non-traditional investors such as SoftBank increases the number of investors under consideration to 1,074. Among this larger set of investors, the top 50 investors accounted for 68 percent of the total capital raised by investors over this period.

capital funds (Kaplan and Schoar 2005; Harris et al. 2014).⁶ A small number of higher-performing venture capital firms have continued to raise ever-larger funds.

Moreover, these deep-pocketed investors can play a disproportionate role in driving where other investors put their money. Investors with smaller sums of capital under management typically focus on investments at the earliest stages of a startup's life, well before the startup is profitable or even has revenue. These early-stage venture capital investors often do not have the capital to continue financing startups across subsequent rounds to the point where the firm can be sold for an attractive valuation. Thus, they are dependent on their larger peers to step in and continue financing the firms they initially funded. Consequentially, a major worry for early investors is that an otherwise healthy startup might not be able to raise follow-up capital (Nanda and Rhodes-Kropf 2017). In this way, the preferences of large late-stage investors can shape where early-stage investors are willing to invest. Consistent with this suggestion, Howell et al. (2020) find that early-stage venture capital appears to be particularly sensitive to market conditions when examining recessions during the past half-century.

Concerns about a small number of financiers acting as gatekeepers may be particularly salient when considering the characteristics of these financiers. We highlight three dimensions. First, major venture funds are based in a handful of places. In the United States, National Venture Capital Association statistics suggest that three metropolitan areas—the San Francisco Bay Area, Greater New York, and Greater Boston—account for about two-thirds of the venture capital deployed by firms each year.⁷ The same phenomenon also seems to manifest itself globally, though good statistics are hard to find. For instance, a tabulation of PitchBook data between 2015 and 2017 by Florida and Hathaway (2018) concludes that the top 25 urban areas accounted for 75 percent of all disbursements globally. Given this concentration of capital, the startup community has rearranged itself to “follow the money.”

Why might the resulting geographic concentration be a cause for concern? After all, economists have long pointed out that there are increasing returns to scale in entrepreneurial and innovative activity. Regions like Silicon Valley have an abundance of resources for entrepreneurs, ranging from excellent engineers used to working long hours for risky stock options, knowledgeable patent attorneys, and of course, lots of financiers. As a result, there are real social benefits from geographic concentration of entrepreneurs.

On the other hand, the geographic concentration of venture capital has probably accelerated the “hollowing out” of innovative activities in many other parts

⁶Related work has examined the drivers of this persistence and the degree to which it might be a consequence of differences in skill across venture capital investors versus other factors such as sorting or preferential access to deal flow that may perpetuate initial differences in performance across investors (Sørensen 2007; Hochberg, Ljungqvist, and Lu 2007; Korteweg and Sørensen 2017; Ewens and Rhodes-Kropf 2015; Nanda, Samila, and Sorenson 2020).

⁷For details, see the National Venture Capital Association Yearbook at <https://nvca.org/wpcontent/uploads/2019/08/NVCA-2019-Yearbook.pdf> and earlier editions archived at https://nvca.org/pressreleases_category/research/.

Table 3

Characteristics of Key US-based Investment Professionals in the 50 Largest Venture Capital Firms

	<i>US-based partners</i>	<i>US-based partners with at least one board seat</i>
Total number of Partners	416	265
Share male	82%	92%
Share attended top universities	59%	72%
Share with MBA from Harvard	12%	15%
Share with MBA from Stanford	9%	13%
Share located in Bay Area	69%	69%
Share located in Greater Boston	9%	11%
Share located in New York City	14%	11%
Average number of board seats held		6.1
Median number of board seats held		5

Source: Data are drawn from the PitchBook database. We first restrict investment professionals in these firms to titles that are one of Managing General Partner, Managing Partner, Founding Partner, General Partner, Senior Partner, or Partner and further restrict them to individuals based in the United States. In column 2, we examine a subset of these individuals who also sit on at least one board seat, as some of the firms in our sample have a larger number of individuals with a “Partner” title than those who make investment decisions or are actively involved in governing startups.

Note: This table reports characteristics of the key US-based investment professionals working for the 50 largest venture capital firms reported in Exhibit 5.

of the world. Venture firms based in other cities might have chosen very different firms to invest in given their perspectives on their local economies. More generally, Glaeser and Hausman (2020) have documented in the United States the growing hubs of innovative activity in places far removed from the areas with the greatest economic need, a phenomenon that the growth of venture capital has accelerated.

Second, the background of individual decision-makers at venture firms remains far from representative of the general population. Table 3 focuses on the 417 individuals listed as US-based partners of the top 5 percent of venture capital firms noted above.⁸ Some firms give “partner” titles to a larger number of individuals than the true decision-makers in the partnership, so we also examine the subset of these individuals who sit on at least one corporate board. This restriction narrows the set of individuals to 265.

Table 3 documents the composition of this group. Eighty percent of partners are male; among the set of partners with at least one board seat, 91 percent are male. Three-quarters of partners with at least one board seat attended either an Ivy League school, or one of Caltech, MIT, or Stanford; moreover, nearly 30 percent

⁸We used data from the PitchBook database (<https://pitchbook.com/>) for this analysis. We restricted the investment professionals listed for each of these firms to those with the titles of Managing General Partner, Managing Partner, Founding Partner, General Partner, Senior Partner, or Partner. We further limited them to individuals based in the United States.

of these individuals are graduates of just Harvard Business School or the Stanford Graduate School of Business. In terms of location, 69 percent are based in the Bay Area alone and over 90 percent are based in either the Bay Area, Greater Boston, or New York.

The nonrepresentative nature of the decision makers at these firms is important because of the growing evidence that a lack of diversity among venture capitalists has an impact on what businesses get funded. For example, Gompers and Wang (2017) use the number of daughters of venture capital partners as an instrumental variable and show that it is correlated with a higher proportion of female partners and improved deal and fund performance. Ewens and Townsend (2020) document that male and female investors appear to have gendered preferences (or respond to different signals about potential cash flows) in terms of the companies they back. Understanding whether such frictions are consequential enough to influence the nature of innovations that are backed and the choice of products faced by consumers is an important question that we believe deserves more research.

A final concern, more difficult to document, relates to the criteria that these investors use to make decisions more generally (Gompers et al. 2020). While academics have spent a great deal of time seeking to understand the structure of venture investment agreements and post-deal involvement, the process before the transaction is much less understood. We understand that early-stage investors rely heavily on signals of entrepreneur quality (Bernstein, Korteweg, and Laws 2017), but know very little as to whether the emphasis on these signals is efficient. Recent work by Cao (2019), for example, shows that information frictions from early-stage platforms can lead to systematic downstream effects on firm funding. Given the increasing importance of venture capital for innovation and growth, understanding the way in which these investors acquire and aggregate signals of a venture's potential and the frictions in this process are important and promising areas of future research.

A Declining Emphasis on Governance?

The third concern we highlight here has to do with the seeming decline in active corporate governance by venture capital funds. Venture capital has traditionally been a tough business, with onerous agreements in which firm founders gave venture capital firms significant stock ownership in exchange for funding (Kaplan and Strömberg 2003). Moreover, this stock ownership was not just “paper rights”: frequent turnover of management driven by venture capital was traditionally the rule (Kaplan, Sensoy, and Strömberg 2009; Ewens and Marx 2018). These patterns have changed dramatically in the past decade. Across the board, “founder friendly” terms appear to have replaced the more onerous provisions traditionally demanded by venture capitalists.

Several potential explanations can be offered for this change. First, the intense competition between venture capitalists during the 2010s may have led to better terms for corporate founders. Even in less ebullient markets, the most promising entrepreneurs have a lot of discretion from whom they choose to receive funding (Hsu 2004): venture returns are very skewed, with a few deals generating the bulk

of the returns (Hall and Woodward 2010). This pattern has been especially true in the last few years, given the proliferation of mega-funds and the explosion in capital from non-traditional investors such as SoftBank, sovereign wealth funds, and corporations. In an intensely competitive market, some venture capital firms may be tempted to pitch entrepreneur-friendly contracts to founders in an attempt to get access to the most attractive deals (Eldar, Hochberg, and Litov 2020). Reflecting this competition, venture capital groups may have chosen to outdo each other in the extent of their hospitality toward company founders.

To an economist, however, this explanation raises new puzzles. If the intensive governance provided by venture capitalists is socially beneficial—as generations of academic analyses would suggest—why would groups choose to abandon it? Should not venture firms compete instead by offering entrepreneurs progressively higher valuations (and less dilution of their initial equity stakes), not by abandoning governance provisions? Does this explanation also imply that firm founders may underestimate the need for governance?

Other possible explanations for the decline in governance, however, may suggest deeper structural drivers of this trend. For example, a possible explanation reflects the changing dynamics of early- and later-stage investing discussed above. It has become far cheaper to start a new business. Perhaps the capital that firms need at the earliest stage is too small to make it worthwhile for venture capital firms to engage in active governance. Indeed, some venture capital firms have adopted the “spray and pray” investment strategy at the seed stage of financing, in which they focus on learning about the potential of a venture before spending time governing it (Ewens, Nanda, and Rhodes-Kropf 2018).

In addition, the massive inflow of venture capital from investors that usually focus on the public market may have changed the focus of contractual rights at later stages. A single fund manager in these entities may hold hundreds of separate firms and have little experience directly governing the firms in their portfolio. These passive investors are unlikely to have the capabilities to provide effective governance to the entrepreneurial ventures. As Chernenko, Lerner, and Zeng (2017) document, mutual funds seem far more concerned with ensuring that there is a path to liquidity, reflecting the short-term nature of the capital that they have raised from investors. The changing composition of the capital sources may have thus also led to a reduced focus on governance.

There is a reason to fear that even among traditional venture capital investors, governance may decline for structural reasons. As firms stay private longer, venture capital investors may end up sitting on a larger number of company boards. Put another way, the classic structure of venture funds may have begun to get overwhelmed by the flow of outside money, new financial intermediaries, and the associated change in practices. As a result, venture capital-backed firms may not be receiving the same degree of governance.

Whatever the causes, there are a number of high-profile examples in recent years in which the charismatic founder of a “unicorn” company has been ousted. The departures of founders and chief executive officers like Travis Kalanick at Uber,

Elizabeth Holmes at Theranos, and Adam Neumann at WeWork are quite different in their details. But overall, they illustrate some consequences of allowing entrepreneurs with limited prior management experience to raise enormous sums for new ventures with little in the way of formal oversight and governance protections. Understanding why traditional venture capital contractual provisions have faded in importance and their social welfare implications appears to be a promising area of future research for both theorists and empiricists alike.

New Approaches for Venture Capital

Venture capital has been a highly efficacious way to support certain kinds of innovation, as reflected in the importance of venture-backed companies in the stock market and in the economy as a whole. At the same time, the industry has important limitations. We now turn to some ideas that might help the venture capital industry to become more effective, with a recognition that these hypotheses may be of greater interest to those practitioners and academics interested in thinking “outside the box.” We highlight two sets of ideas: the first, which owes a heavy debt to Lerner (2012), relates to the organizational and incentive structure of venture capital partnerships; the second, to the way in which venture capital firms focus on managing their investments in more challenging sectors.

Rethinking Venture Capital Partnerships

Since the early days of the industry, venture capital funds have been eight to ten years in length, with provisions for one or more one- to two-year extensions. Venture capitalists typically have five years in which to invest the capital and then are expected to use the remaining period to harvest their investments.

The uniformity of these rules is puzzling. Funds differ tremendously in their investment foci: from quick-hit social media businesses to long-gestating biotechnology projects. In periods when the public markets are enthusiastic, venture capitalists may be able to exit still-immature firms that have yet to show profits and, in some cases, before they even have revenues. But as discussed above, there is tremendous variation in the maturation of firms in different industries. Certainly, within corporate research laboratories, great diversity across industries exists in terms of the typical project length. What explains the constancy of the venture fund lives?

One possible explanation is that a reasonably short fund life seems to have been the norm in limited partnerships of all types. For example, many of the other arenas where limited partnerships were employed in the 20th century, such as real estate, oil-and-gas exploration, and maritime shipping, all were reasonably short-lived. In the formative days of venture partnerships, the lawyers drafting the agreements may have gravitated to the relatively short fund lives that were common in other contexts. With the passage of time, such arrangements have then been taken as gospel by limited and general partners alike.

Another factor behind the persistence of the ten-year agreement has been the resistance of limited partners—that is, the investors in the venture capital funds—to longer fund lives. These investors may fear that if they give the funds to a sub-standard venture group for a longer period, they will be stuck paying fees until the end of time for very limited returns. This reluctance may tell us more about the outsized nature of the fees that venture funds receive than about the inherent desirability of a longer-lived fund.

Indeed, the manner in which venture capitalists are compensated has changed little, even as the funds have grown much larger. Venture groups typically receive a share of the capital gains they generate (typically 20 percent, but sometimes as high as 30 percent) and then an annual management fee (often between 1.5 percent and 2.5 percent of capital under management, though it often scales down in later years). Such fees are quite modest for a fund of only a few million dollars in size: it is likely to cover only a very modest salary for the partners once the costs of an office, travel, and support staff are factored in.

But this compensation structure has remained largely unchanged as funds have become substantially larger. Moreover, as venture capital groups begin managing hundreds of millions or billions of dollars, substantial “economies of scale” appear: put another way, as a group becomes ten times larger, expenses increase much less than tenfold. As a result, management fees themselves become a profit center for the firm. These steady profits may create incentives of their own which may not be very appealing to investors. For instance, there will be an incentive to raise a larger fund at the expense of lower returns, which in turn may be tied to the greater concentration of capital held by a few investors; an incentive to put funds to work quickly and with a subpar amount of vetting so that a new fund can be raised sooner; and an incentive to focus on excessively safe investments that will not have as much upside but will pose less risk of a franchise-damaging visible failure.

Just how large a temptation the venture capital compensation scheme can pose is illustrated in the work of Metrick and Yasuda (2010), who show that of every \$100 invested by the limited partners, over \$23 end up in the pockets of the venture investors. These sums might not be disturbing if the very substantial payouts to each partner reflected even larger returns being made by the limited partners in the fund. But profit sharing is not the most important source of compensation. Instead, almost two-thirds of the income (in time-adjusted dollars) is coming from the venture capital management fees, which remain fixed whether the fund does well or poorly. These incentives clearly may motivate groups to add capital in excess of the growth of partners, even if performance suffers somewhat.

Interestingly, an alternative model already exists: the way that venture capital groups used to operate. Early venture capital groups, beginning with the pioneering partnership of Draper, Gaither & Anderson, negotiated budgets annually with their investors. The venture capitalists would lay out the projected expenses and salaries and reach a mutual agreement with the limited partners about these costs. The fees would be intended to cover these costs, but no more. (A few “old school” groups such as Greylock still use such an arrangement.) Such negotiated fees greatly reduce

the temptation to grow at the expense of performance and ultimately are likely to lead to more successful and innovative startups.

What explains the traditional reluctance of the limited partners who invest in venture capital funds to push to change these compensation arrangements? Staff members may not really understand the economics of the funds, or they may fear that rocking the boat would limit their own ability to get a high-paying position at a fund or an intermediary in the future. Alternatively, the officers may worry that developing a reputation as an activist would jeopardize their organization's ability to access the funds with the highest returns. The last concern is a reasonable one. After the giant California Public Employees' Retirement System led a consortium of pension funds who pushed for an overhaul of private equity compensation in the mid-1990s, they were shunned by venture and buyout funds alike. In recent years, we have seen more collective discussion of these issues by limited partners in meetings of the Institutional Limited Partners Association. But many of their proposals have been modest half-measures, without addressing the more fundamental issues.

Yet another question is why such innovations are not adopted by newer venture firms as a way to differentiate themselves? It might be thought that such "LP-friendly" terms might attract new investors. While examples along these lines have occurred, anecdotal evidence suggests that many groups who have tried such an approach have found it to be tough sledding. In part, limited partners may interpret such concessions as an adverse signal, indicative of a lack of confidence on the part of the new fund managers in their ability to raise a fund. Additionally, even if the group responsible for private equity investments at the pension fund understands the advantages of the proposed alternative arrangement, the investment committee that ultimately makes the decisions at the pension fund may not. These information problems may lead to the persistence of a socially suboptimal fund structure.

New Approaches to Managing Investments

Venture capital firms face huge uncertainty about the ultimate potential of startup firms. Indeed, over half the investments of even the most successful venture capital investors fail, while the vast majority of returns are generated by a few extremely successful investments that are hard to predict upfront.

As noted before, venture capital investors are drawn to sectors in which this uncertainty can be reduced quickly. Staged financing is therefore not only valuable to venture capital investors as a governance tool, but also as a method of learning about the startup's potential through a sequence of investments over time. This approach to evaluating and governing ventures in software industries has been outlined in practitioner guides such as *The Lean Startup* (Ries 2011).

But the ability to learn quickly about the promise of new ventures is harder if there is substantial regulatory, technology, and market risk, which we suggest explains the poor performance and declining share of venture investment outside of software. For example, forecasting the unit costs associated with energy storage at scale using a new battery material can be extremely difficult, even if the technology works in a controlled laboratory environment. Because uncertainty about market

demand is tied to firms' ability to produce at a certain price point, forecasting demand in this setting is hard.

One promising response to these challenges is to rethink the organizational model for incubating and financing "tough tech" ventures. The venture approach entails entrepreneurs coming to venture capital firms to pitch them new ideas and the firms deciding whether to fund them. This approach has the benefit of enabling the investors to maintain an arm's length relationship from the entrepreneurial team, reducing the entrenchment that is sometimes associated with corporate research and development and internal capital markets.

An alternative approach that has begun to be used by some venture capital investors specializing in biopharmaceuticals (such as Third Rock Ventures and Flagship Pioneering) is to incubate and finance ideas in-house. This process has the benefit of reducing asymmetric information because much of the staff for the team of entrepreneurs comes from within the fund. It also enables the venture capital firm to fund what it might believe is the most promising idea or approach as opposed to selecting among the ideas that walked in the door. A related approach is illustrated by Breakthrough Energy Ventures, which has a team of in-house scientists who jointly make investment decisions with traditional investment partners. Such new approaches may hold promise for widening the scope of venture capital investment. Understanding the tradeoffs associated with bringing incubation inside the venture capital firm and organizing new ventures more like corporate research and development seems to be a promising area of academic research.

It is also natural to wonder whether collaboration with other parties—governments, non-profits, and corporations—might alleviate some of the barriers to financing new ventures in more difficult technologies. Of course, this suggestion is not new. Governments have been involved with the promotion of venture capital at least since 1946, when a consortium of the Bank of England and leading British banks combined to create the British firm 3i as a vehicle to make long-term investments in smaller firms. Corporations have been collaborating with venture capitalists since the 1960s. Universities and other nonprofits have been incubating, mentoring, and directly financing new ventures for much of the last half-century.

But the track record of these collaborative efforts has been quite mixed. There have been successes, such as the Israeli government's jump-starting of its venture industry through the Yozma program that leveraged public money to attract private investment, or the success of many pharmaceutical firms in responding to the biotechnology revolution through their venturing initiatives. At the same time, anecdotes abound of naïve officials making poor decisions. For instance, the leadership of Boston University put one-third of the university endowment into a single faculty-founded biotechnology company, Seragen, an investment that was ultimately sold for pennies on the dollar.⁹

⁹This account is drawn from Seragen's filings with the US Securities and Exchange Commission; the annual reports of the National Association of College and University Business Officers; the reporting of

The statistical evidence on collaborative efforts, while limited, does not seem inspiring. For instance, the Thomson Reuters (now Refinitiv) database suggests that between 1993 and 2013, corporate venture funds lost 4 percent per annum, at a time when US venture funds had annual returns of nearly 30 percent (for a more optimistic view, see Ma 2020).

We believe that these collaborations can be beneficial, but only if executed correctly. This caveat is important. As an example, we will highlight the role of US government in the venture market. The primary mechanism through which government policy interacts directly with new ventures is through the Small Business Innovation Research (SBIR) program. A striking study by Howell (2017) suggests that the initial Phase I awards under this program have very positive effects on new technology ventures, doubling the probability that a firm receives venture capital and boosting patenting and revenue. But these Phase I awards made up only 20 percent total of the \$2.8 billion spent on the program (US Small Business Administration 2018). The bulk of the funding goes to larger Phase II awards, which Howell argues have no positive impacts. Similarly, both Howell (2017) and Lerner (1999) document that a relatively small number of companies capture a disproportionate number of awards. These “SBIR mills” commercialize far fewer projects than those firms that receive just one or a handful of SBIR grants, but the repeat winners often have active staffs of lobbyists in Washington scouring for award opportunities. Despite these well-understood issues, the design of the program looks virtually identical to its initial manifestation in 1977. There has been almost no serious discussion in Washington regarding the idea of shifting more SBIR resources to Phase I grants or curtailing grants to “mills.” The experience of the SBIR program underscores the need for careful initial design, painstaking evaluation, and a willingness to redesign initiatives.

One promising area of recent growth has been the interest among philanthropic organizations in financing early-stage, high-risk research and development. The hope is that once sufficient development of the idea has taken place, private venture capitalists will be willing to step in. Such activities have been most visible of late in the early-stage financing of vaccines, including for COVID-19. Beyond health-care, efforts are also emerging to finance initial investments in sectors that have substantial potential societal benefits but large risks. Illustrations include the Prime Coalition’s funding of companies that combat climate change yet are sufficiently risky to deter traditional investors (at <https://primecoalition.org/what-is-prime/>) and the initiative from the Ford and Rockefeller Foundations to seed venture funds investing in regions that have traditionally not attracted such capital (as reported in Murray 2020; see also the Community Development Venture Capital Alliance at <https://cdvca.org/about-us/missionhistory>). While these efforts are likely to face substantial challenges, they also have real potential.

Barboza (1998); and the decision of the Court of Chancery of Delaware in *Oliver v. Boston University*, C.A. no. 16570-NC. (Del. Ch. Apr. 14, 2006).

Final Thoughts

The growth of venture capital in the past decade, both in the United States and worldwide, is an important validation of the underlying model. At the same time, the period has brought into sharp relief the structural challenges facing the industry.

Over the past decades, academics and practitioners alike have highlighted the strengths of venture capital. Understanding and articulating its limitations as well as how institutional innovations can address them, is an important challenge to both groups going forward.

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