Deeptech Startups

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Abstract

What explains the massive economic impact of venture capital backed startups? While the entrepreneurial finance literature has traditionally focused on the expertise of investors, our paper underscores the role of scientific knowledge within founding teams. Examining a comprehensive dataset of over 92,000 startups, we find that "deeptech startups" - those with at least one founder with a PhD degree - drive venture capital's remarkable performance despite representing only a small fraction of VC-backed companies. These science-based startups have a significantly higher likelihood of achieving a successful exit and generate important innovations for society's most pressing needs like healthcare and sustainability. The scientific excellence of founders measured by the citation counts of their academic research directly translates into the success of their startups. Our findings refine our understanding of value creation in entrepreneurial finance and highlight the crucial role of pairing strategic investors with scientific excellence to advance technological frontiers.

Keywords: Deeptech Startups, Venture Capital, Innovation
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1 Introduction

Venture capital (VC) established itself as the dominant source for financing innovative entrepreneurship (Kerr and Nanda (2015)). Despite funding less than 0.5% of new U.S. firms, VC-backed public firms account for 76% of public firms' market value, employ 43% of their workforce, and conduct 89% of their R&D (Lerner and Nanda (2020)). Prior literature mainly attributes these exceptional outcomes to the superior ability of venture capital investors (e.g.,Gompers and Lerner (1999); Hellmann and Puri (2002); Hochberg et al. (2007); Gompers et al. (2020)). We focus on the founding team. We examine VC-backed startups founded by individuals with PhDs and show how scientific excellence within founding teams drives exceptional performance. Our analysis reveals that venture capital produces remarkable outcomes when paired with scientifically accomplished founders, while venture-backed firms without scientific expertise, on average, do not overperform non-VC-backed companies.

Our findings refine the understanding of value creation in venture capital by isolating the critical role of scientific expertise. While venture-backed companies generate extraordinary economic impact, our research reveals this impact is not uniformly distributed but primarily stems from "deeptech startups" - ventures with at least one founder holding a PhD degree. These deeptech startups represent just 11.8% of all IPOs yet account for 41.17% of total R&D expenditures, 24.86% of aggregate enterprise value, and 26.77% of employment among public firms. Crucially, our counterfactual analysis shows that when excluding deeptech firms, the remaining venture-backed companies actually do not overperform non-VC-backed public firms, suggesting that exceptional economic outcomes attributed to venture capital primarily occur when VC funding pairs with scientific excellence.

Google provides an illustrative example. Today as one of the world's largest companies, Google succeeded as a startup with backing from prestigious venture capitalists (Sequoia and Kleiner Perkins). What is often overlooked is the founders' exceptional scientific background.

Both founders were Stanford PhD students whose research is cited over 40.000 times and became Google's foundation technology. While Google's success is typically attributed to its investors' guidance and mentorship, the founders' extraordinary scientific achievements prior to founding has received comparatively little attention.

Since the scientific background of founders in venture-backed startups has received limited attention, we begin by documenting stylized facts about startups with PhD founders, revealing their distinctive characteristics in early development. Using a comprehensive dataset covering over 92,000 startups between 2010-2024, we document that these scientifically-founded ventures, despite representing only about 5% of all VC-backed startups, generate disproportionate innovation, economic value, and market capitalization. First, deeptech startups are significantly more likely to achieve successful exits. Second, deeptech startups are overrepresented in fields tackling critical societal problems like healthcare, sustainability, and robotics. Third, deeptech startups not only begin with scientific founders but continue recruiting scientists, as the founders' academic experience helps identify and attract skilled researchers. Fourth, venture capital investors appear willing to commit larger investments at higher valuations to deeptech firms, suggesting they recognize the potential value of startups founded by entrepreneurs with scientific credentials.

An important question remains: Why are deeptech startups so much more successful? We investigate three key mechanisms that may explain this phenomenon. First, we observe that deeptech startups pursue more radical innovations than their peers. Analysis of patenting activity reveals fundamentally different innovation strategies compared to other venture-backed firms. While producing slightly more patents, the distinct value of deeptech innovation lies in its impact and originality. Deeptech patents receive nearly twice as many citations as those from other venture-backed companies, indicating substantially greater scientific influence and technological importance. Market reactions to patent grants further reveal that deeptech innovations generate higher economic value, with cumulative abnormal

returns significantly exceeding those of non-deeptech patents. Most tellingly, the variance in patent value is dramatically higher for deeptech firms, demonstrating their pursuit of high-risk, high-reward innovations that advance technological frontiers rather than resulting in incremental improvements. This pattern persists even after deeptech startups go public, contrasting with the general tendency of public companies to shift toward safer, incremental R&D.

Second, we find that deeptech startups are substantially more likely to receive support from established companies through corporate venture capital (CVC) investments compared to non-deeptech startups. Deeptech startups with CVC backing have a substantially higher likelihood of successfully exiting, especially through IPOs. The symbiotic relationship between deeptech startups and corporate partners appears beneficial for both parties: established companies gain access to cutting-edge innovations that might be difficult to develop internally due to organizational constraints (Arora et al. (2018)), while deeptech startups benefit from human capital, market knowledge, and credibility that corporate partners provide. This partnership may be especially valuable for translating academic knowledge into commercial applications, helping bridge the gap between scientific advancement and market implementation.

Finally, we investigate whether the scientific excellence of founders directly translates into entrepreneurial success. Using comprehensive data on founders' publication records and citation impact from OpenAlex, we find compelling evidence that scientific achievement predicts startup performance. An increase in a founder's citation count is associated with significantly higher capital raised and improved exit probabilities, even after controlling for numerous firm characteristics. This relationship suggests a key mechanism through which scientific training enhances entrepreneurial success: scientific training develops experimental skills that transfer effectively to the iterative nature of startup development (Kerr et al. (2014)); scientific credentials serve as a credible signal that mitigates information asymme-

tries between founders and investors; and the resilience required for scientific success fosters adaptability and persistence, which is valuable in entrepreneurial contexts.

Our results have important implications for entrepreneurial finance and innovation policy. They confirm that efforts to promote academic entrepreneurship and strengthen the bridge between scientific research and commercial application could produce enormous economic and social benefits (Lerner et al. (2024). However, establishing a venture capital-friendly financial system is not a shortcut to innovation and technological progress. Venture capital needs to be paired with scientific excellence to achieve optimal outcomes. Furthermore, our findings challenge the widespread narrative about successful high-growth entrepreneurs being young, adventurous college dropouts like Mark Zuckerberg. While prior literature has documented that the average successful tech founder is 45 years of age (Azoulay et al. (2020)), we demonstrate that the average most successful tech founder has a PhD and generated significant scientific achievements before becoming a startup founder.

2 Data

This paper examines the economic impact of deeptech startups with a focus on how scientific expertise translates into entrepreneurial success. Although there are various definitions of deeptech startups [1], we employ a simple, tractable definition: A startup is classified as deeptech if at least one founder started a PhD degree and the firm has received at least one round of venture capital financing. This definition allows us to directly investigate the link between scientific expertise and startup performance.

Our primary data source is Crunchbase, which provides detailed information on founders' educational and professional backgrounds through web scraping methods and self-reported

[1] Wikipedia Definition: "Deep technology (deep tech) or hard tech typically refers to organizations with the objective of providing technology solutions based on substantial scientific or engineering challenges, requiring lengthy research and development and large capital investment before successful commercialization."

information. This dataset allows us to classify startups into deeptech and non deeptech startups. The final sample, which covers the period from 2010 to 2024, consists of 4,631 deeptech startups and 88,177 non-deeptech startups, indicating that only 4.99% of all venture capital-backed startups in our sample have a founder with scientific background. While Crunchbase offers comprehensive coverage of pre-exit startup characteristics, including funding rounds, exit outcomes, founder backgrounds, investors, and early founding teams, it lacks data in several dimensions necessary for understanding the full economic contribution of deeptech firms. Therefore, we augment the Crunchbase data with several additional sources.

First, we combine Crunchbase data with Refinitiv's SDC Platinum Database to obtain comprehensive information on IPO outcomes. This addition is particularly important as it allows us to examine IPO exit outcomes of deeptech startups.

Second, we incorporate Capital IQ data to assess the importance of deeptech startups and their contribution to the aggregate economy after their IPOs relative to other publicly traded firms. This data includes key financial variables such as enterprise value, market capitalization, employee count, revenue, net income, and R&D expenditures.

Third, we utilize the Patent-CRSP permco match from Stoffman et al. (2022) to analyze the patenting activity of deeptech firms post-IPO, providing insights into their innovation productivity.

Fourth, we employ OpenAlex data to gather detailed information on the scientific background of founders of deeptech startups. For each founder, we collect information on their academic affiliation, citation count, publication record, and years spent in academia. This allows us to examine the relationship between scientific productivity and startup outcomes.

Finally, we use Crunchbase Research Access to create a comprehensive dataset of corporate venture capital (CVC) transactions. A significant challenge in analyzing corporate venture capital is linking specific funds to their ultimate parent companies. For example, Google operates several corporate venture capital arms (Google Ventures, Google Accelera-

tor, Google for Startups) and is itself a subsidiary of Alphabet. We address this challenge by fully tracing the structure of venture capital funds and their relationships to public firms, resulting in a dataset of 88,474 international corporate venture capital transactions. To our knowledge, this is the most comprehensive dataset on CVC transactions in the literature to date.

By combining these data sources, we construct a unique dataset that enables a comprehensive analysis of deeptech startups and their impact on aggregate economic activity and innovation. This integrated approach allows us to track deeptech firms from their founding stage through venture financing and potentially to accessing public capital markets stage, while also capturing their innovation activities through patents and the scientific contributions of their founders.

In the following section, we present descriptive statistics that characterize our sample and highlight the distinctive role of deeptech startups in the broader economy.

3 Stylized Facts on Deeptech Startups

As the role of deeptech startups in the economy is understudied, we begin by providing a systematic overview of key descriptive facts.

1. Deeptech Startups only represent about 5% of all venture capital backed startups Figure 1 shows the relative shares of deeptech versus non-deeptech startups in our sample from 2010 to 2024. While venture capital-backed startups themselves constitute merely 0.5% -1% of all new firms formed annually in the U.S., deeptech startups represent an even smaller subset of this already selected group. Our data indicate that over the past 14 years, only around 5% of newly formed venture capital-backed startups in the U.S. have at least one founder with a PhD degree, as illustrated by the blue line in Figure 1. This

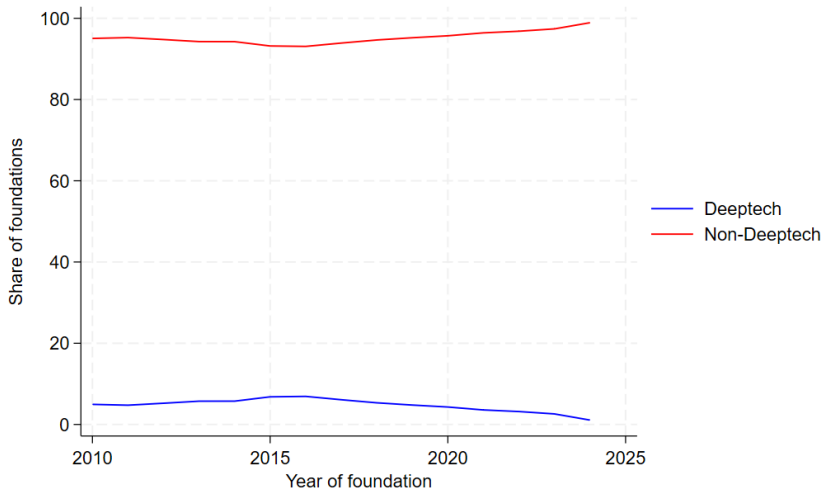


Figure 1: Relative Shares of US Startup-Foundations by Company Type after 2010

proportion has remained relatively stable throughout our sample period, with some cyclical variation but no clear upward trend. The persistent scarcity of deeptech startups likely explains why these firms remain understudied in the academic literature. However, this underrepresentation masks their outsized economic significance. As exemplified by Google or Rivian, some of the largest IPOs in U.S. history - representing revolutionary innovations and massive economic value creation - originate from a relatively small number of deeptech startups. Despite constituting just a small fraction of venture-backed companies, these firms have yielded disproportionate contributions to technological advancement, job creation, and market capitalization. This striking contrast between their rare occurrenceand economic impact underscores the importance of investigating deeptech startups, their aggregate economic influence, and the determinants of their success.

2. Deeptech Founders hold PhD Degrees in STEM Fields We now examine the academic backgrounds of their founders to better understand the knowledge base from which these ventures emerge.

Figure 2 presents the distribution of PhD fields among deeptech startup founders in our

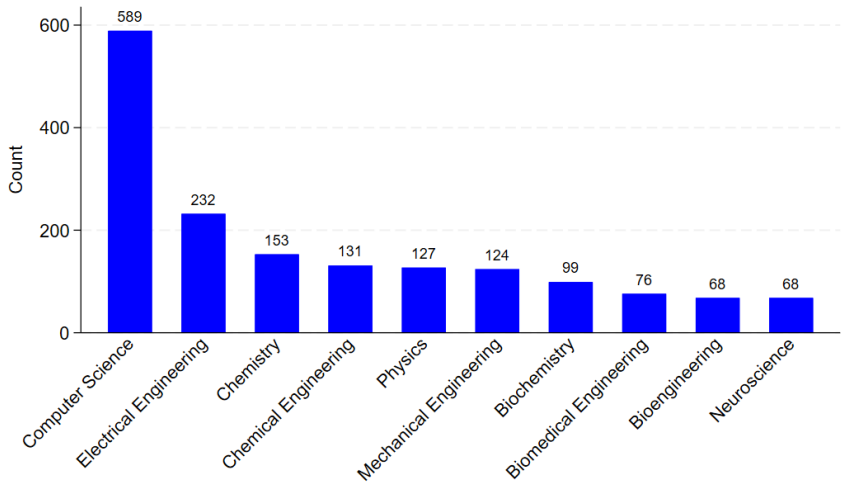


Figure 2: Top 10 PhD Fields of Deeptech Founders

sample. An examination of these disciplines yields two important insights into the formation and success drivers of deeptech ventures. First, the data reveal that deeptech founders overwhelmingly come from STEM (Science, Technology, Engineering, and Mathematics) backgrounds rather than business-oriented disciplines such as Economics, Finance, or Law. Computer Science dominates with 589 founders, followed by Electrical Engineering (232), Chemistry (153), and Physics (127). This pattern is significant because it suggests that the success of deeptech startups is not primarily driven by superior value creation by the venture capital industry, but rather by specialized scientific knowledge in hard sciences that directly translates into industrial applications. Second, a closer inspection of the specific fields indicates that deeptech founders' scientific specializations closely mirror major societal challenges. The prominence of Computer Science reflects the digital transformation of the economy, while the strong representation of various engineering disciplines, chemistry, biochemistry, and molecular biology corresponds to founders working on solutions for pressing issues such as climate change and medical advancements. This evidence suggests that deeptech founders operate at the technological frontier, leveraging their specialized scientific training to create radical innovations that address humanity's most significant challenges.

Their scientific backgrounds enable them to translate cutting-edge research into commercial applications with the potential for substantial welfare improvements. This may explain the outsized economic impact of deeptech startups despite their relatively small numbers in the venture capital ecosystem.

3. Deeptech Startups are pushing the technological frontier on the most pressing Societal Issues A persistent criticism of the venture capital industry concerns its industrial focus (Lerner and Nanda (2020)). Critics argue that while the VC model generates exceptional financial outcomes, it often diverts capital toward incremental innovations with questionable societal value, rather than addressing humanity's most pressing challenges such as cancer research, climate change, or space exploration. This misallocation stems partly from the limited time horizon of limited partners of most VC funds, which favors innovations that can be scaled and commercialized quickly. Additionally, conventional VC investors often lack the scientific expertise to evaluate complex technological innovations adequately, as exemplified by high-profile failures like the Theranos scandal.[2]

However, our analysis reveals that deeptech startups deviate significantly from this narrative. Table 1 shows the representation of deeptech firms across key innovation domains of major societal relevance. The results are striking: although deeptech startups represent only around 5% of all startups in our sample, they constitute 20.28% of startups working on cancer-related technologies, 20.91% of biotech ventures, and 20.70% of startups addressing disease. Their overrepresentation extends to other critical domains including medicine (17.57%), robotics (13.00%), and renewable energy (7.69%). This concentration in socially important sectors persists and even intensifies post-IPO. Among public companies in our

[2]The Theranos scandal in 2018 involved a healthcare startup that raised over $700 million from investors despite its blood-testing technology being scientifically infeasible. The case exemplifies how venture capitalists lacking specialized scientific knowledge failed to conduct adequate technical due diligence, allowing the company to reach a $9 billion valuation before investigations revealed the technology never worked as claimed.

Keyword	**Startups**	**IPO's**
Cancer	**20.28%**	**29.57%**
	(1,854)	(186)
Medicine	**17.57%**	**28.46%**
	(1,753)	(123)
Health	**6.54%**	**11.44%**
	(11,508)	(201)
Robotics	**13.00%**	**27.27%**
	(646)	(11)
Renewable	**7.69%**	**20.00%**
	(806)	(25)
Sustainable	**5.52%**	**12.50%**
	(2,339)	(40)
Climate	**9.20%**	**0%**
	(511)	(4)
AI	**5.36%**	**13.19%**
	(45,606)	(675)
Disease	**20.70%**	**28.93%**
	(3,367)	(318)
Biotech	**20.91%**	**30.46%**
	(1,511)	(151)
Environment	**6.21%**	**12.12%**
	(4,747)	(66)
Full Sample	**5.20%**	**15.40%**
	108,416	1,552

Table 1: Share of Deeptech-Startups and Deeptech-IPOs inheriting specific keywords

Note: This table shows the shares of Deeptech in all Startups and IPO's whose descriptions contained the specified keyword, based on data from Crunchbase. The percentages reflect the proportion of Deeptech-startups and -IPOs matching each keyword. Numbers in parentheses represent the total number of matches.

sample, deeptech firms account for 29.57% of those focused on cancer research, 30.46% of biotech firms, 28.93% of disease-related companies, and 28.46% of those working in medicine. Other notable areas with strong deeptech representation among public companies include robotics (27.27%), space exploration (25.00%), and renewable energy (20.00%).

These patterns suggest that deeptech startups largely escape the usual criticism of the venture capital industry. Rather than merely promoting information technologies with ambiguous societal benefits, they disproportionately tackle fundamental scientific and technological challenges with a clear positive social impact. The scientific backgrounds of deeptech founders appear to equip them not only with the technical expertise to pursue ambitious innovations but also with the vision to address consequential problems. This orientation toward pressing societal issues represents another distinctive feature of deeptech ventures that contributes to their economic and social significance.

4. Deeptech Founders are more likely to hire employees with a PhD degree. Having established the academic profile of deeptech founders, we now examine how this scientific orientation extends beyond the founding team into the broader organizational structure of these ventures.

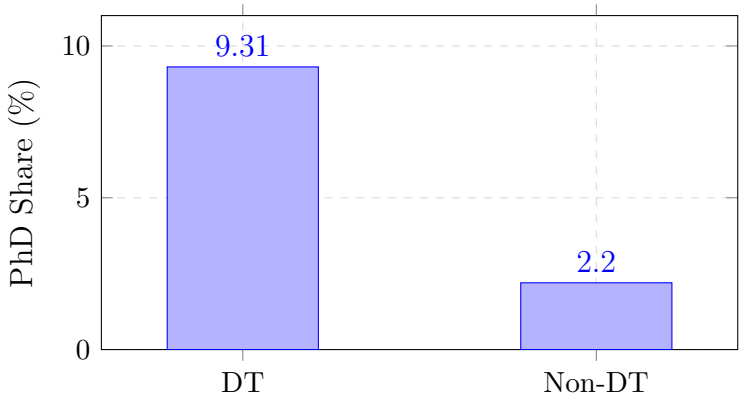


Figure 3: Percentage of Employees with a PhD by Startup Type

Developing commercially viable innovations from scientific research requires more than

just founders with strong academic backgrounds. Prior literature has documented the critical importance of early team composition for startup success (e.g.Choi et al. (2021)). Our data reveal a striking pattern: deeptech startups not only begin with scientific founders but continue recruiting scientists. As Figure 3 demonstrates, the proportion of PhD's among non-founding employees at deeptech ventures (9.31%) is more than four times higher than that at their non-deeptech counterparts (2.20%). This finding suggests an important mechanism behind deeptech startups' economic impact. The academic backgrounds of deeptech founders provide two advantages: their scientific knowledge translates into innovative ideas, and their academic experience helps them identify and attract other skilled researchers. The founders thus build strong teams of scientists whose collective expertise drives the development of valuable innovations. This scientific knowledge base persists even after these companies go public, as we will demonstrate in subsequent analyses. The ability to build and maintain teams with strong academic credentials represents a distinctive feature of deeptech ventures.

5. Deeptech Startups are more capital intensive, and attract larger investment capital Beyond their distinctive human capital composition, deeptech startups also exhibit notable differences in their financing patterns compared to non-deeptech ventures.

Metric	Deeptech	Non-Deeptech
Raised Amount per Round	17,800,000	10,700,000
Post Money Valuation	633,000,000	370,000,000
Total Funding	60,400,000	21,000,000
Num Funding Rounds	3.22	2.06
Investor Count	2.74	2.19

Table 2: Mean Values in USD of Key Company Metrics by Company Type

Table 2 reveals that deeptech startups raise substantially more capital than their non-deeptech counterparts. The average raised amount per funding round for deeptech firms ($17.8 million) is nearly twice that of non-deeptech ventures ($10.7 million). Similarly,

deeptech firms secure higher post-money valuations ($633 million versus $370 million), receive more total funding ($60.4 million versus $21 million), participate in more funding rounds (3.22 versus 2.06), and engage with more investors per funding-round (2.74 versus 2.19).

These financing patterns reflect two important dynamics. First, deeptech startups are inherently more capital intensive, requiring substantial resources to transform scientific discoveries into commercially viable products. Second, and perhaps more interestingly, venture capital investors appear willing to commit larger sums at higher valuations to deeptech firms, suggesting they recognize the potential value of startups founded by entrepreneurs with scientific credentials. This financing behavior can be viewed through the lens of information asymmetry problems in venture capital markets. Founders typically have private knowledge about the potential of their innovations that they cannot easily convey to investors. This problem is particularly pronounced for radical innovations that advance the technological frontier and demand sophisticated scientific understanding. In extreme cases, such information asymmetries can lead to market failures where investors decline to fund potentially transformative innovations due to uncertainty about their feasibility and commercial potential. In this context, a founder's PhD degree and publication record serve as credible signals that mitigate these information asymmetries. By demonstrating the founder's scientific expertise and the technical merit of the underlying innovation, these credentials help venture capitalists assess technological risk more accurately. Thus, the scientific background of deeptech founders may play a crucial role in overcoming market failures and enabling the financing of radical innovations that might otherwise go unfunded.

6. Deeptech Startups are more likely to exit successfully, especially through IPOs Having established that deeptech startups attract more capital, we now examine their exit outcomes, which further highlight their distinctive economic trajectory.

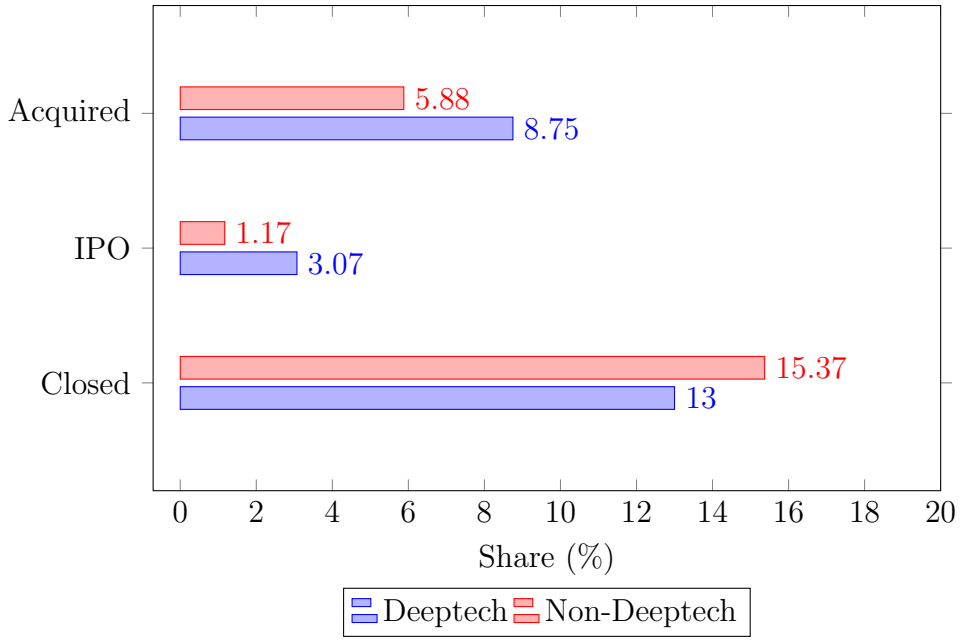


Figure 4: Percentage Share of Exits by Company Type

A concern regarding deeptech startups might be that while they can lead to extraordinary successes like Google, they could also entail greater risk due to the radical nature of their innovations and the unpredictability of their commercial potential (Nanda and Rhodes-Kropf (2013)). However, our data provide no support for this hypothesis. Rather, the evidence points in the opposite direction: deeptech startups are significantly more likely to achieve successful exits. As Figure 4 illustrates, deeptech startups are almost 1.5 times more likely to be acquired than regular venture capital-backed startups (8.75% versus 5.88%) and a remarkable 2.6 times more likely to go public (3.07% versus 1.17%). These differences translate into a striking representation disparity: while only 4.99% of venture capital-backed startups in our sample have a founder with a PhD, 12.1% of venture-backed public companies have a PhD founder. This raises an important question: how do these seemingly high-risk ventures achieve such superior exit outcomes? A key part of the explanation, as we will demonstrate in subsequent analyses, involves the role of established companies. Deeptech startups have a significantly higher probability of receiving support from established companies through

corporate venture capital investments. This symbiotic relationship - combining the business expertise and resources of established firms with the innovative capacity of deeptech startups - appears to contribute substantially to their unusually high success rates. This pattern is exemplified by both Google and Rivian, where Amazon (or Jeff Bezos personally) provided early financial backing. Such corporate involvement may offer not only monetary capital but also complementary assets such as R&D expertise, market access, and strategic guidance that enhance the commercialization prospects of scientifically advanced innovations.

4 The contribution of Deeptech Firms to the aggregate Economy

The stylized facts have established the distinctive characteristics of deeptech startups during their early development. We now turn our attention to their long-term economic impact - specifically, the value these firms generate after transitioning to public capital markets.

The disproportionate economic contribution of venture capital-backed startups has been well-documented in the literature. As Lerner and Nanda (2020) demonstrate, although VC-backed startups represent less than 0.5% of firms born each year in the U.S., they account for 76% of the market value of all public firms, employ 43% of all public firm employees and conduct 89% of total R&D spending among public companies. This outsized economic impact underscores why studying the venture capital ecosystem remains a central theme in entrepreneurial finance.

Our analysis makes an important refinement to these findings: the outsized economic value attributed to VC-backed firms is not evenly distributed across all such ventures. Rather, this impact is disproportionately driven by a small subset of deeptech startups with founders with PhD's.

We begin our analysis by replicating the results of Lerner and Nanda (2020), comparing

	VC-backed IPOs	All IPOs	VC-backed as a % of all
Total number of non-financial IPOs between 1995 and 2024	2,658	7,839	33.91%
Number of firms still public at 10/29/2024	762	1,992	38.25%
Share of IPOs that were still public at 10/29/2024	28.67%	25.41%	
thereof: Number of Firms with Complete Financial Data Available in Sample	562	1,059	53.07%
Key statistics as of October 29, 2024 for firms still public (all figures millions USD, except number of employees.)			
Total Enterprise Value	5,763,359	9,284,735	62.07%
Total Market Capitalization	5,589,006	8,415,761	66.41%
Global Employees	2,801,000	6,973,000	40.17%
Total Revenue	1,219,748	2,803,101	43.51%
Net Income	8,130	84,011	9.68%
R&D-Expenditure	210,963	289,670	72.83%

Table 3: Comparison of Publicly Traded Firms in the United States, based on whether backed by Venture Capital Investors

Note: This table reports statistics for the sample of publicly traded firms that had an initial public offering (IPO) between 01/01/1995 and 10/29/2024 and were still public on October 29, 2024, 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. The data is sourced from Refinitiv's SDC Platinum Database for IPO information (accessed on October 29, 2024) and company-level statistics from Standard and Poor's Capital IQ Database (accessed on October 29, 2024).

VC-backed and non-VC-backed IPOs without differentiating between deeptech and non-deeptech firms. To ensure comparability while extending the time horizon, we employ the same data sources (Refinitiv's SDC Platinum for IPO data and Capital IQ for company metrics) but extend the analysis period up to the most recent observations. As Table 3 shows, our extended timeframe yields results consistent with the original study. Among IPOs with complete financial data, venture capital-backed startups contribute disproportionately to aggregate enterprise value (62.07% of the total), market capitalization (66.41%), and—most notably—R&D expenditures (72.83%). These metrics confirm the established understanding that VC-backed firms generate exceptional economic value relative to their numerical

representation.

Next, we incorporate information on the deeptech status of firms by identifying those with at least one founder holding a PhD degree. This refinement seperates public companies into three distinct categories: VC-backed deeptech firms, VC-backed non-deeptech firms, and non-VC-backed firms. These three categories represent 11.8% (Deeptech), 44.57% (VC-backed), and 43.63%(Non-VC-backed) of our sample, respectively. When we compare the aggregate economic contribution of deeptech public firms to the total for all public companies (Table 4), we observe that the economic impact of deeptech firms far exceeds that of the average VC-backed company.

	DT IPOs	All IPOs	DT as a % of all
Number of non-financial IPOs between 1995 and 2024 that are still public at 10/29/2024 and have complete Financial Data available	-	1,059	-
thereof: Number of Firms with Available Deeptech-Status	113	958	11.80%
Key statistics as of October 29, 2024 for firms still public *(all figures millions USD, except number of employees.)*			
Total Enterprise Value	2,158,122	8,680,534	24.86%
Total Market Capitalization	2,056,506	7,908,144	26.00%
Global Employees	1,691,000	6,316,000	26.77%
Total Revenue	690,962	2,607,870	26.50%
Net Income	19,134	78,293	24.44%
R&D-Expenditure	114,633	278,445	41.17%

Table 4: Comparison of Publicly Traded Firms in the United States, based on Deeptech-Status

Note: This table reports statistics for the sample of publicly traded firms that had an initial public offering (IPO) between 01/01/1995 and 10/29/2024 and were still public on October 29, 2024, further conditioning on those that were founded after 1980 and were not financial firms. It compares statistics for firms that are considered as Deeptech with those that are not.The data is sourced from Refinitiv's SDC Platinum Database for IPO information (accessed on October 29, 2024), company-level statistics from Standard and Poor's Capital IQ Database (accessed on October 29, 2024), and Deeptech status derived from Crunchbase data (accessed on April 29, 2024).

Although deeptech public firms constitute only 11.8% of all IPOs in our sample, they account for a remarkable 41.17% of total R&D expenditures across all public firms. Furthermore, they represent 24.86% of aggregate enterprise value, 26.00% of market capitalization, 26.77% of employment, and 26.50% of revenue. To put these figures in perspective: deeptech startups account for merely 0.025% to 0.05% of all newly formed businesses in the U.S., yet they conduct almost half of the total R&D activity among U.S. public companies.

A natural concern with these findings is that they might simply reflect industry composition - perhaps deeptech firms concentrate in R&D intensive sectors rather than exhibiting inherently greater innovative activity. To address this potential confounding factor, we conduct a multivariate regression analysis that controls for a wide range of characteristics.

Table 5 presents regression results that control for numerous observable characteristics, including industry fixed effects and indicators for founders with STEM degrees but without PhD (representing technical training without extensive scientific experience). Our specification includes controls spanning the firm's lifecycle: characteristics at the startup phase (founder count, total funding, number of funding rounds), IPO characteristics (stock exchange, IPO year), and public company metrics (total assets, employee count, revenue). The richness of our data yields an R-squared of 0.952, which effectively rules out unobservable factors as significant drivers of our findings. Most importantly, even after accounting for this comprehensive set of controls, the deeptech status of the founding team maintains a highly statistically significant effect on R&D expenditures. In the absence of all other factors, public firms with a PhD among their founders invest an average of $47.6 million more in R&D annually compared to industry peers.

To further emphasize the distinctive role of deeptech startups, we replicate the analysis of Lerner and Nanda (2020) while excluding deeptech startups from the VC-backed sample. The results, presented in Table 6, reveal a striking pattern: when deeptech firms are excluded, VC-backed companies no longer demonstrate the disproportionate economic impact

Table 5: Regression Results - R&D-Expense (millions USD)

	(1) Base Regression	(2) With Industry-Fixed Effects
Deeptech	52.272***	47.622***
	(17.938)	(18.226)
Has STEM-founder	-7.358	-7.886
	(14.590)	(14.731)
VC-backed (1 vs. 0)	36.758**	31.074**
	(14.250)	(15.036)
Firm age (years)	-2.553***	-2.105**
	(0.893)	(0.941)
Time since IPO (years)	0.446	0.401
	(1.139)	(1.167)
Assets - Total	0.007***	0.008***
	(0.001)	(0.001)
Enterprise value	-0.017***	-0.018***
	(0.003)	(0.003)
Employees	-8.907***	-9.026***
	(0.638)	(0.642)
Net Income (Loss)	-0.230***	-0.230***
	(0.023)	(0.023)
Revenue - Total	0.111***	0.112***
	(0.004)	(0.004)
Market Value - Total - Fiscal	0.031***	0.031***
	(0.003)	(0.003)
American SE	25.849	17.878
	(47.481)	(48.294)
NASDAQ	51.503***	47.244***
	(15.744)	(17.275)
Number of funding rounds	3.147**	2.929**
	(1.448)	(1.465)
Total funding (USD)	-0.000***	-0.000***
	(0.000)	(0.000)
Founder count	-3.933	-2.200
	(4.861)	(4.973)
PhD-share employees	28.516	11.947
	(45.888)	(46.893)
Number of Observations	5,752	5,752
R^2	0.951	0.952

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

	VC & Non-DT IPO's	All IPO's	VC & Non-DT as a % of all
Number of non-financial IPOs between 1995 and 2024 that are still public at 10/29/2024 and have complete Financial Data available	-	1,059	-
thereof: Number of Firms with Available Deeptech-Status	427	958	44.57%
Key statistics as of October 29, 2024 for firms still public (all figures millions USD, except number of employees.)			
Total Enterprise Value	3,412,592	8,680,534	39.31%
Total Market Capitalization	3,339,631	7,908,144	42.23%
Global Employees	1,081,000	6,316,000	17.12%
Total Revenue	513,277	2,607,870	19.68%
Net Income	-8,185	78,293	-10.45%
R&D-Expenditure	90,548	278,445	32.52%

Table 6: Comparison of Publicly Traded Firms in the United States, Based on Whether Backed by Institutional Venture Capital Investors, excluding Deeptech-Firms.

Note: This table reports statistics for the sample of publicly traded firms that had an initial public offering (IPO) between 01/01/1995 and 10/29/2024 and were still public on October 29, 2024, 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 and are not considered as Deeptech with non VC-backed IPOs. The data is sourced from Refinitiv's SDC Platinum Database for IPO information (accessed on October 29, 2024), company-level statistics from Standard and Poor's Capital IQ Database (accessed on October 29, 2024), and Deeptech status derived from Crunchbase data (accessed on April 29, 2024).

documented in prior research. In fact, non-deeptech VC-backed firms underperform relative to the broader IPO market across multiple dimensions. This finding fundamentally reshapes our understanding of the economic value created by venture capital. Our analysis indicates that not all VC-backed startups generate extraordinary economic value after going public. Rather, this outcome is primarily driven by the small subset of ventures founded by individuals with PhDs. This insight represents an important refinement to the entrepreneurial finance literature and provides a more nuanced understanding of venture capital's role in the

economy.

Overall, our findings suggest that the remarkable economic benefits typically attributed to venture capital more broadly are, in fact, primarily realized when VC funding is paired with scientific excellence. Deeptech startups - representing the intersection of venture financing and advanced scientific knowledge - emerge as the true engines of innovation and economic value creation in the public capital markets. This pattern highlights the critical importance of scientific knowledge transfer from academia to industry. By supporting entrepreneurs with deep scientific expertise, venture capital facilitates the commercialization of academic research in ways that generate substantial economic returns. Without this scientific foundation, the extraordinary economic impact typically associated with venture capital appears significantly diminished.

5 Radical vs. Incremental Innovation in Deeptech Firms

Our previous analysis established deeptech firms as important drivers of aggregate economics R&D expenditures. This finding naturally raises a question about the nature and quality of this research: Do these substantial R&D investments translate into meaningful innovations with scientific and economic value, or do they represent less impactful incremental advances? This question is particularly relevant given the ongoing debate about productivity losses in R&D activity (Bloom et al. (2020)) and concerns that public markets may discourage breakthrough innovation (Bernstein (2015); Ferreira et al. (2014)). However, our evidence on deeptech startups suggests a potential counterpoint to this narrative.

To investigate the innovative output of deeptech firms, we analyze patent data by combining our dataset on public firms with patent information using the CRSP Permco match developed by Stoffman et al. (2022).

We begin by examining descriptive statistics on patenting activity and citations for public

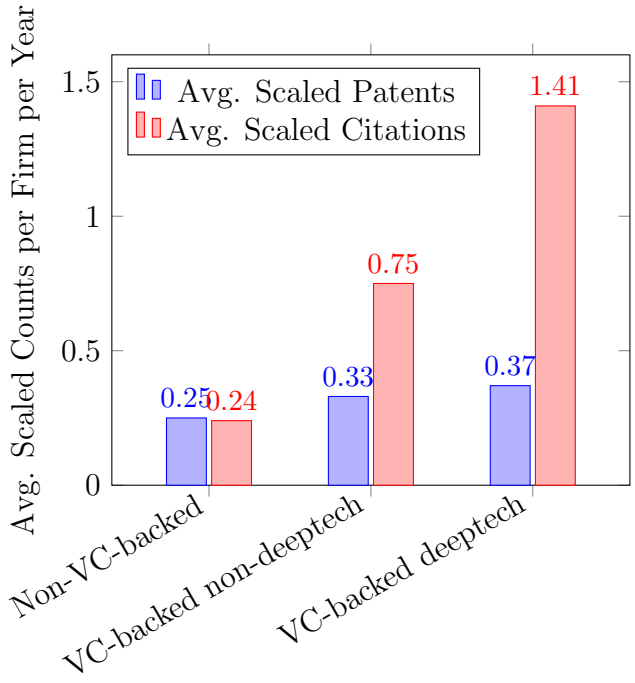


Figure 5: Average Patents and Average Citations by Deeptechand VC-backed Status weighted by Valuation at IPO

firms, dividing our sample into the three categories: deeptech VC-backed firms, non-deeptech VC-backed firms, and non-VC-backed firms. For each company, we identify the year it went public and analyze its patenting activity over the subsequent 10-year period, weighting this activity by the firm's market value at the IPO to control for size differences. Looking first at patent quantity, we find that deeptech public firms produce approximately 12.1% more patents in an average year compared to other VC-backed firms and 48% more compared to non-VC-backed public firms (Figure 5). While this difference is notable, what is substantially more striking is the disparity in patent quality as measured by citations. Deeptech patents receive almost twice as many citations. Specifically, deeptech firms' patents receie an average of 29.33 citations per year compared to 15.45 for non-deeptech VC-backed firms and just 4.01 for non-VC-backed firms. This citation advantage indicates that deeptech firms generate innovations with substantially greater scientific impact and influence on sub-

sequent technological development. These findings align with our intuition that founders with scientific backgrounds produce innovations with larger scientific value. Rather than pursuing quantity alone, deeptech firms appear to focus on developing higher quality, more fundamental innovations that advance the technological frontier.

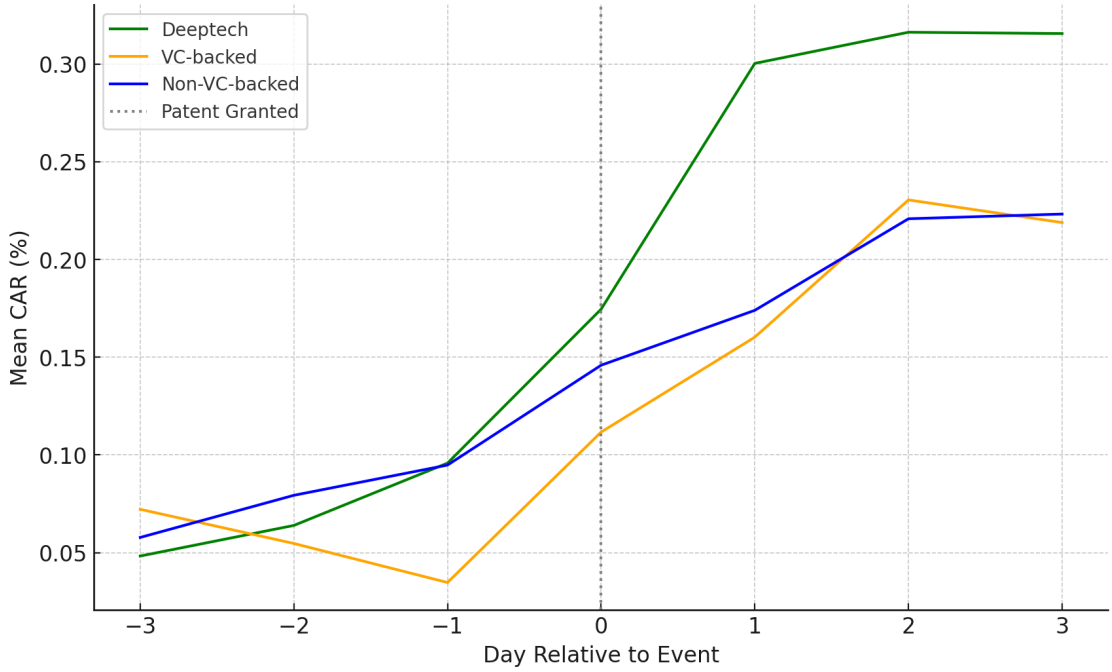


Figure 6: Mean CAR of Patents by Firm Type

Beyond scientific impact, we also examine whether deeptech innovations translate into private economic value for the firms that produce them. Following the methodology of Kogan et al. (2017), we analyze the cumulative abnormal returns (CAR) around patent grant dates. The results confirm that the stock market places higher value on deeptech patents (Figure 6). Three days after a patent is granted, the CAR for deeptech patents is approximately 40% larger than for patents from non-deeptech firms (both VC-backed and non-VC-backed).

When we convert these market reactions into dollar values, we observe another interesting pattern in the distribution of patent values. While the mean value of deeptech patents ($128 million) is only modestly higher than that of VC-backed non-deeptech patents ($120

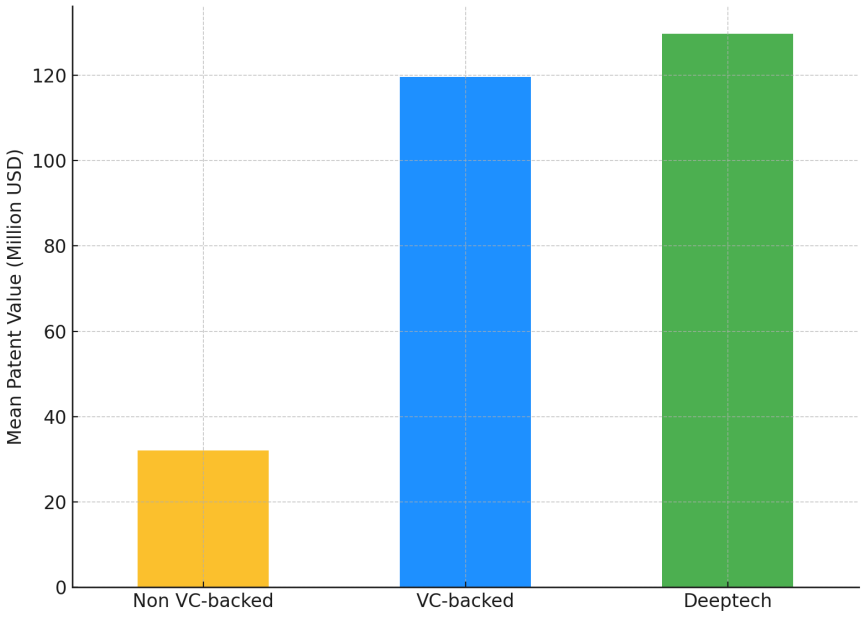


Figure 7: Mean Patent Value by Firm Type (in Million USD)

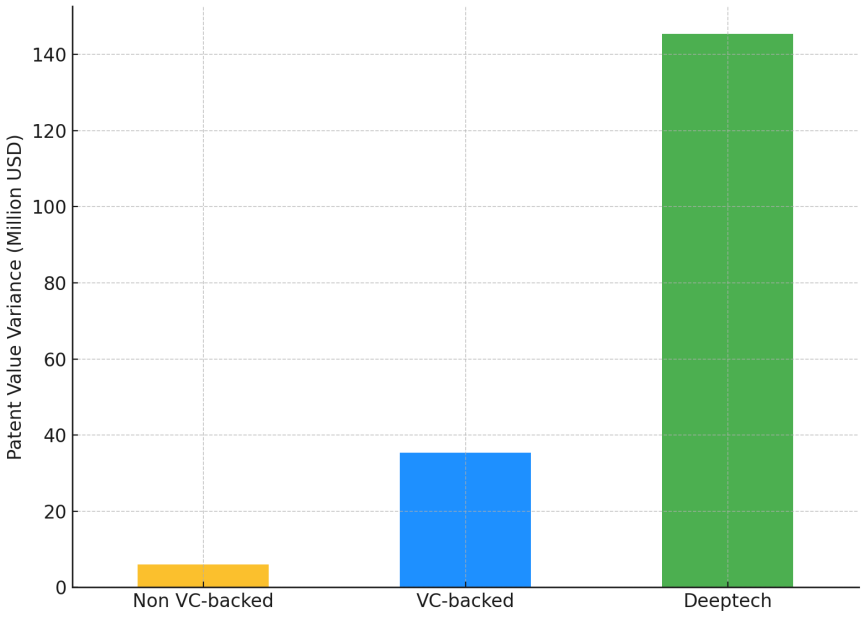


Figure 8: Patent Value Variance by Firm Type (in Million USD)

million), the variance in value is dramatically larger for deeptech patents (Figure 8). This higher variance indicates that deeptech firms pursue more high-risk, high-reward innovations - a strategy consistent with attempting more radical, path-breaking advances rather than incremental improvements.

Collectively, these patent analyses provide compelling evidence that deeptech firms maintain their commitment to fundamental innovation even after going public. Unlike the general pattern documented in prior literature where public companies trend toward incremental R&D, deeptech firms continue to produce innovations with greater scientific impact and market value. This persistence of innovative capacity likely stems from the scientific orientation embedded in these organizations by their academically trained founders, creating a corporate culture that values and pursues fundamental research even amid public market pressures.

6 Corporate Venture Capital and Deeptech Success

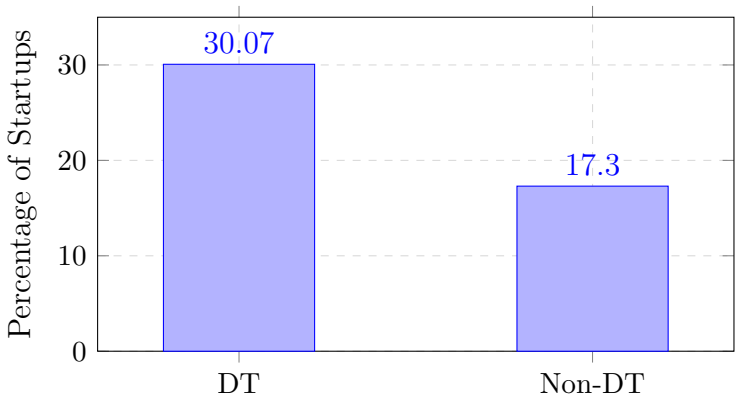


Figure 9: Share of Startups receiving CVC

After documenting the superior performance and innovation quality of deeptech startups, we now investigate a key mechanism that may contribute to their success: the role of corporate venture capital (CVC). CVC represents investments made by established corporations

in startups, often providing not only financial resources but also strategic guidance, market access, and human capital. Our sample includes 1,497 deeptech startups that received CVC funding (representing 1.97% of our total sample), alongside 3,380 deeptech startups without CVC backing (4.45%), 12,253 non-deeptech startups with CVC backing (16.14%), and 58,767 non-deeptech startups without CVC backing (77.43%).

Figure 9 reveals a striking pattern: deeptech startups are substantially more likely to receive corporate venture capital investments than non-deeptech ventures. Specifically, 30.07% of deeptech startups in our sample received CVC funding, compared to just 17.3% of non-deeptech startups. This pattern suggests that established corporations disproportionately seek out ventures with academically credentialed founders, perhaps recognizing the distinctive value of these firms' scientifically-grounded innovations.

The exit outcomes of startups further underscore the importance of CVC involvement, particularly for deeptech startups. Deeptech startups with CVC backing show markedly better outcomes than those without such support (Figure 10). Among deeptech startups with CVC backing, 13.76% achieve an IPO and 2.53% reach unicorn status (valuations exceeding $1 billion), compared to just 2.21% and 0.059%, respectively, for deeptech startups without CVC support. The performance gap is similarly pronounced for acquisitions: 25.05% of CVC-backed deeptech startups are acquired, versus 15.59% of non-CVC-backed deeptech ventures. Non-deeptech startups show similar patterns but with less dramatic differences, suggesting that the combination of scientific founder credentials and corporate backing is especially powerful.

These descriptive patterns suggest corporate venture capital may serve as a critical catalyst for deeptech success. To investigate this relationship more rigorously, we conduct multivariate regression analyses that control for various firm characteristics and external factors.

Table 7 presents regression results examining the relationship between corporate venture

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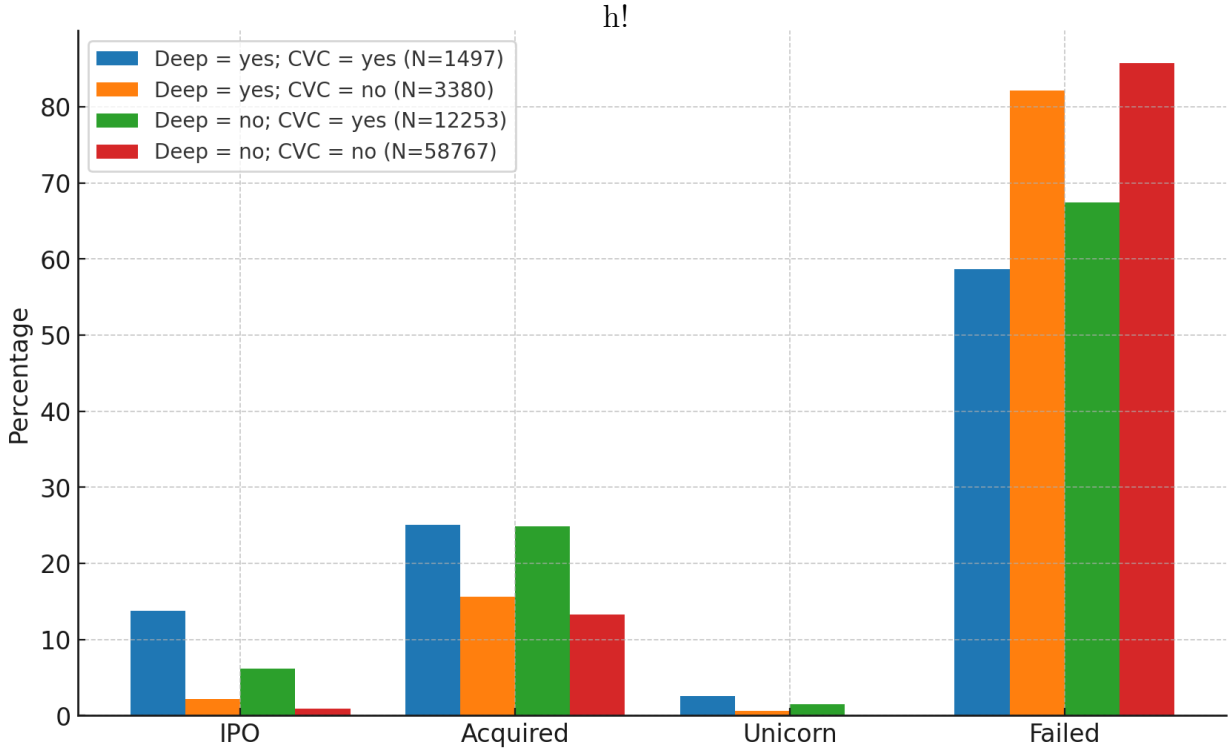


Figure 10: Startup Exit Outcomes by Firm Type

capital, deeptech status, and exit outcomes. After controlling for funding rounds, founder count, investor numbers, location effects, and foundation-year effects, we find that deeptech startups with CVC backing have a 3.6 percentage point higher probability of achieving an IPO compared to the reference category (non-deeptech, non-CVC startups). This effect is highly significant and substantially larger than the 1.6 percentage point increase for non-deeptech startups with CVC backing. Interestingly, deeptech startups without CVC backing show a 1.4 percentage point lower IPO probability, highlighting the critical importance of corporate support for these science-based ventures. The pattern for acquisitions differs, with CVC backing providing similar benefits to both deeptech and non-deeptech startups, suggesting that corporate partners may be particularly valuable for the complex commercialization challenges of scientifically intensive ventures attempting to reach public capital markets.

	(1) IPO	(2) Acquired	(3) Unicorn
Deeptech-CVC	**0.036*****	0.001	-0.001
	(0.007)	(0.015)	(0.003)
Non-Deeptech-CVC	**0.016*****	**0.018****	**-0.003***
	(0.003)	(0.008)	(0.002)
Deeptech-No-CVC	**-0.014*****	-0.018	**-0.008*****
	(0.005)	(0.012)	(0.003)
Number of Funding Rounds	**0.018*****	**-0.016*****	**0.008*****
	(0.001)	(0.001)	(0.000)
Number of Founders	**0.004*****	**0.025*****	**0.001***
	(0.001)	(0.003)	(0.001)
Total Number of Investors	**-0.001*****	0.000	**0.001*****
	(0.000)	(0.000)	(0.000)
Observations	22,668	22,668	22,668
R-squared	0.352	0.369	0.240
Adjusted R-squared	0.207	0.229	0.071
City FE: Yes			
Foundation-Year FE: Yes			

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 7: The Effect of Corporate Venture Capital and Deeptech Status on Startup Exit Outcomes

The symbiotic relationship between deeptech startups and corporate partners appears to benefit both parties. Established companies gain access to cutting-edge innovations that might be difficult to develop internally due to organizational constraints, while deeptech startups benefit from the human capital, market knowledge, and credibility that corporate backers provide. This partnership may be especially valuable for translating academic knowledge into commercial applications, helping to bridge the gap between scientific advancement and market implementation. This pattern is exemplified by firms like Google and Rivian, both of which received early backing from corporate investors or their principals (notably Jeff Bezos/Amazon). These cases illustrate how combining scientific excellence with corporate strategic support can yield transformative commercial outcomes. The prevalence of these

corporate-academic partnerships and their association with superior outcomes suggests they represent a valuable model for fostering innovation with substantial economic impact.

7 Scientific Expertise and Entrepreneurial Success

Throughout our analysis, we have documented the superior performance of deeptech startups along multiple dimensions: fund raising success, exit outcomes, innovative output, and economic impact. We now examine more directly the core mechanisms that underlies these findings - namely, that the scientific expertise of founders explains both the initial success of these ventures and their continued innovativeness after going public.

Google's founders provide an illustrative example of this phenomenon. Both were PhD dropouts who, during their doctoral studies, published two scientific papers that later became the foundation for Google's search technology. These papers have accumulated over 40,000 citations, underscoring the direct translation of academic research into commercial innovation.

While the relationship between academic skills and entrepreneurial success has received limited direct attention in the literature, several theoretical arguments suggest it may be a significant factor. First, prior research has demonstrated that startups employing more experimental approaches tend to be more successful (Kerr et al. (2014)). Given that experimentation lies at the heart of scientific training, founders with scientific experience may be better equipped to implement such approaches in commercial settings. Second, as previously discussed, academic success may mitigate information asymmetries between founders and investors. This explanation would account for the larger funding amounts raised by deeptech startups at the earliest stages, when credible signals about venture quality are typically scarce. Third, resilience and adaptability are critical founder characteristics in venture success. The competitive and dynamic nature of academic careers plausibly develops pre-

cisely these traits in scientific researchers, who must navigate peer review, research setbacks, and evolving knowledge landscapes.

To investigate this relationship more systematically, we gather information on the scientific output of deeptech founders from OpenAlex, obtaining publication, citation, and affiliation data. Using names and affiliations, we successfully identify the scientific output of 4,064 deeptech founders. For our primary analyses, we use founders' total citation counts as a proxy for scientific excellence, given its straightforward interpretation and established use in the scientific community. For robustness, we also construct a multidimensional measure of scientific success incorporating other metrics such as publication count, h-index, i10-index, and active years in research.

We first examine how founders' scientific success relates to their startups' ability to raise capital. Table 8 presents regression results with the total funding raised and first-round funding amounts as dependent variables, and the logarithm of founder citations as our key independent variable of interest. Importantly, we control for exit outcomes to eliminate the possibility that our results simply reflect investors' ability to predict successful ventures.

The results show highly significant effects of citation counts on capital raised, both in early funding rounds and across the startup's entire lifecycle. These findings suggest that scientific excellence is a credible signal that helps overcome information asymmetries between founders and investors. This signaling value likely proves especially critical for radical innovations that push technological boundaries and require deep scientific understanding - precisely for thoseventures where information problems might otherwise lead to market failures in the form of underinvestment due to adverse selection.

We next investigate whether scientific success translates into superior exit outcomes. Table 9 presents average marginal effects from logistic regressions examining the relationship between citation counts and the likelihood of successful exits (IPOs or acquisitions). Again, we find statistically significant effects. A 1% increase in citations is associated with a 0.5

	Total Funding (millions USD)	Raised Amount (millions USD)
STEM (1 vs. 0)	13.4	0.24
	(14.9)	(0.21)
PhD (1 vs. 0)	-54.8**	-0.82***
	(24.8)	(0.26)
Log Cited-by count	16.7***	0.27***
	(4.37)	(0.08)
Organization Status		
Acquired	-48.1***	0.18
	(17.5)	(0.20)
Closed	-7.7	-0.16
	(9.87)	(0.20)
IPO	372.0***	0.01
	(62.0)	(0.91)
Number of non-founder PhDs	-0.68	0.62***
	(0.72)	(0.19)
Log Firm Age (years)	-35.2***	-5.39***
	(8.82)	(0.43)
Number of funding rounds	15.1***	-0.22***
	(2.34)	(0.04)
Log Employee count	75.8***	0.53***
	(9.79)	(0.09)
Constant	-222.0***	12.5***
	(43.1)	(0.87)
Observations	4,064	1,431
R^2	0.2204	0.2758
Root MSE	3.6e+08	4.6e+06
Prob > F	0.000	0.000
Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.		

Table 8: Regression Results - Effect of Deeptech-Founders' Scientific Success on Raised Amount in the first Seed-Round and Total Funding in million USD

percentage point increase in IPO probability and a 1.2 percentage point increase in acquisition probability, holding other factors constant. While these marginal effects may appear modest in absolute terms, they represent economically meaningful increases relative to the baseline exit rates in our sample. For context, the overall IPO rate for deeptech ventures in our sample is 4.12%, making the citation effect substantial in relative terms.

	(1) IPO	(2) Acquired
STEM (1 vs. 0)	-0.006	0.008
	(0.007)	(0.011)
Phd (1 vs. 0)	-0.009	-0.039**
	(0.008)	(0.015)
Log cited-by count	0.005***	0.012***
	(0.002)	(0.003)
Total funding (USD)	2.44e-11	-5.62e-11**
	(1.51e-11)	(2.47e-11)
Number of Employees with PhD	0.002	-0.001
	(0.001)	(0.001)
Firm age (years)	-0.0004	0.006**
	(0.0006)	(0.003)
Number of funding rounds	0.008**	0.003
	(0.001)	(0.002)
Employee count	1.21e-06	2.64e-06
	(3.10e-06)	(6.48e-06)
Observations	4,064	4,064
Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.		

Table 9: Marginal Effects of Scientific Success on IPO and Acquisition Probabilities

Together, these findings provide compelling evidence that scientific excellence translates into entrepreneurial success. The academic skills developed through scientific training - rigorous experimentation, hypothesis testing, adaptation to feedback, and persistence through setbacks - appear to transfer effectively to the entrepreneurial domain. Moreover, the credibility conferred by scientific accomplishment helps overcome the significant information challenges that might otherwise impede investment in scientifically intensive ventures.

These results have important implications for our understanding of both innovation dynamics and entrepreneurial skill development. They suggest that deeper integration between academic research and entrepreneurial activity could yield significant economic benefits, particularly for innovations that push technological frontiers. Furthermore, they highlight the value of scientific training as preparation for entrepreneurial careers—a pathway that may

deserve greater emphasis in both academic institutions and public policy discussions around innovation.

8 Conclusion

This paper has documented the outsized economic impact of deeptech startups in the venture capital ecosystem. Our analysis reveals that these science-based startups, despite representing only 5% of VC-backed companies, drive venture capital's remarkable performance through higher exit rates, greater innovation output, and substantial contributions to critical societal challenges.

Our findings significantly refine our understanding of how value is created in entrepreneurial finance. While prior literature has emphasized the expertise of venture capital investors, we have demonstrated that scientific excellence within founding teams is equally, if not more, critical. When excluding deeptech startups from the sample, the remaining venture-backed companies actually underperform non-VC-backed public firms - suggesting that the exceptional economic outcomes attributed to venture capital primarily occur when VC funding pairs with scientific excellence.

These results open several important directions for future research. First, our understanding of deeptech founders themselves remains incomplete. What distinguishes scientists who successfully commercialize their innovations from those who do not? Prior work on academic entrepreneurship has primarily focused on institutional factors and technology transfer offices, but our findings suggest that individual-level factors - such as the scientist's citation impact, publication record, and academic network - may play crucial roles in determining entrepreneurial entry and success. Exploring these characteristics could yield valuable insights for universities and policymakers seeking to encourage more scientists to translate their research into commercial applications.

Second, our work points to the need for a more nuanced understanding of the two-sided matching process between scientific founders and strategic investors. While we have shown that corporate venture capital is disproportionately important for deeptech ventures, many questions remain: How do scientifically accomplished founders select their investors? What screening mechanisms do VCs employ when evaluating science-based startups? And how do investor characteristics (such as scientific training or industry expertise) affect their ability to identify promising deeptech opportunities? Investigating these matching dynamics could illuminate how to optimize the allocation of venture capital to maximize both financial returns and societal benefits from scientific innovation.

Third, given the substantial societal impact of deeptech startups in areas such as healthcare, sustainability, and robotics, future research should examine the welfare implications of these ventures. What policy interventions might most effectively encourage more scientists to pursue entrepreneurship? How can the benefits of deeptech innovation be more widely distributed? And what role might public funding play in supporting the earliest stages of deeptech development, before venture readiness?

Finally, our work raises important questions about entrepreneurial skill development. If scientific training fosters valuable entrepreneurial capabilities - such as experimental thinking, hypothesis testing, and resilience - how might entrepreneurship education incorporate these elements? Can the experimental methods common in scientific research be more deliberately taught to non-scientific entrepreneurs? Exploring these questions could enhance entrepreneurship education and potentially increase innovation success rates more broadly.

In conclusion, our findings challenge conventional narratives about successful high-growth entrepreneurs and venture capital's role in innovation. Rather than young college dropouts, the most economically impactful founders are often scientifically accomplished PhDs whose academic achievements directly translate into entrepreneurial success. Rather than venture capital alone driving extraordinary innovation outcomes, it is the combination of venture

funding with scientific excellence that yields the most significant economic and social returns. By further exploring this powerful combination, future research can help unlock even greater innovation potential at the intersection of science and entrepreneurship with profound implications for technological progress and economic growth.

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A Appendix