# Irreplaceable Venture Capitalists*

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We provide causal evidence on how individual venture capitalists (VCs) add value to startups, using exogenous deaths of VC directors on startup boards. Losing a VC director increases the probability of startup failure, delays a successful exit, and reduces the IPO likelihood. Affected startups that raise capital after a director loss obtain a narrower investor base. These effects persist after the replacement of deceased VCs, indicating the importance of the original deal experts for startup survival, financing, and going public. In contrast, losing a VC director does not affect recruitment, product development, and CEO replacement, suggesting that these skills are replicable. Overall, a VC's network and reputation are key irreplaceable assets.

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Nearly every new firm starts as a private enterprise, and its future trajectory critically depends on the business decisions made early in its lifecycle. During this formative period, a firm defines its business strategy, develops its product portfolio, and attracts the key inputs of production: human capital and financial capital. The startup's board of directors —a team of the founders and external directors, such as angel investors, venture capitalists, and business advisers— makes these foundational decisions. Despite the importance of such decisions as a runway to the firm's development, we know little about individual directors' role in startup outcomes. First, the inner workings of startup boards are unobservable. Second, directors endogenously select startups, making it challenging to attribute any outcomes to directors' treatment effects rather than their selection of boards.

To study the contribution of an external director to firm outcomes, an ideal experiment would require either a random assignment of a director to a startup board or a random removal of a director with particular characteristics. Such an experiment would also require observing the complete composition of the startup's board, each director's characteristics, and startup outcomes.

This paper makes a step towards such an experiment. We study the real effects of individual directors on startup outcomes and the mechanisms through which directors achieve such outcomes. To do so, we exploit separations of individual directors from startup boards resulting from director deaths—the factors exogenous to the startup. We also provide evidence on how early-stage enterprises replenish their board's human capital and adjust the board structure, control rights, and internal governance in response to unanticipated shocks. To accomplish these goals, we reconstruct board composition for over 18,000 startups, collect the characteristics of individual directors, and combine them with administrative data from Social Security and vital records (with medical conclusions). This procedure identifies exogenous director removals for natural causes.

We focus on the external directors who invest in the firm—namely, venture capitalist (VC) directors. Ex-ante, the contribution of a VC director to a startup board is ambiguous. The effects of removing such a director could be insignificant, positive, or negative. They could also be nonmonotonic and may vary with director characteristics, board structure, and outcome type.

The null hypothesis predicts that removing a director has no significant long-run effects. Survey evidence shows that the most prevalent group of external directors—venture capitalists—single out the selection of startups as the dominant source of value creation, but "perhaps surprisingly, VCs do not cite their own contributions as a source of success or failure." (Gompers et al. 2020, p. 171). Similarly, using a decomposition of returns to VCs, Sorensen (2007) attributes most of the variation in performance to the selection of startups. While there is undoubtedly scope for venture capitalists to add value, the value-add mechanisms, such as access to financing, need not operate through the startup's board and need not rely on particular directors. Consistent with this view, Ewens, Nanda, and Rhodes-Kropf (2018) document a decline in VCs' involvement in corporate governance, which is replaced by a "spray and pray" investment approach of allocating minimal support to a greater number of startups.

An alternative hypothesis posits that losing a VC director could benefit a startup. Some external directors could induce friction in corporate decision-making if they prioritize the preferences of special interest groups or engage in a power struggle with entrepreneurs. In this case, losing such a director would facilitate consensus decision-making on the board and create a rare opportunity for a governance shakeup and a better director replacement in a traditionally sticky startup board. For example, external directors promulgated weak governance and condoled egregious violations in many private firms, such as WeWork and Theranos. These companies would likely benefit from a board shakeup and a replacement of external directors.

Finally, directors may add valuable firm-specific human capital by contributing their expertise, networks, and reputation across various outcomes, from recruiting human capital and product commercialization to operational discipline, capital funding, and financial exit. Expert external directors could also serve as the conduits of investors' voices because a higher likelihood of interaction between investors and the management improves monitoring (Bernstein, Giroud, and Townsend 2016). In this case, losing a director would have negative consequences, but only if external directors add unique resources in short supply that cannot be replicated by the efforts of investors, other board members, or director replacements. For example, Hochberg, Ljungqvist, and Lu (2007) find that a VC partnership's network helps explain performance differences in VC portfolios. Individual VCs may serve as crucial anchors in their firms' networks. However, the strong incentives for all parties to replace lost directors with the best candidates set a high bar for identifying the irreplaceable component of directors' human capital. These incentives also pose the question of which type of directors' firm-specific human capital is most valuable for the firm and most challenging to replicate.

Our main finding is that individual VC directors impose a sizeable positive effect on the startup. Their contributions improve the startup's likelihood of survival and transition to public capital markets. These effects are causal, incremental to deal selection, and economically important. Startups that lose a VC director experience a sharp downward shift in their business trajectory. An exogenous loss of a VC on a startup board increases startup failure rate by 6.7 percentage points (p.p.) over the next three years. This effect represents a 21.6% increase in the failure rate relative to the unconditional mean (31%).

The startups that remain in business after losing a VC director face diminished chances of a successful exit and a slower path to public capital markets. These effects are permanent and persist after the replacement of deceased VCs, indicating that the original deal experts provide unique value-add, and their contributions are difficult to replicate. The death of a VC director is followed by a 9.6 p.p. drop in the probability of a startup's successful exit—that is, an Initial Public Offering or a successful acquisition, defined as an acquisition with at least a median valuation multiple (2x). Finally, the startups that go public or become acquired take 18 months longer to reach this milestone, a 28% delay in their time-to-exit relative to the unconditional mean.

These economic estimates capture the incremental impact of one original VC director on startup outcomes over and above the effects of a VC partnership. To isolate the value-add of an individual director from the value-add of their VC partnership, we compare the startups that lose a VC director with other startups funded by the same VC partnership but unaffected by an individual's death. This approach—comparing startups within the investment portfolio of the same VC firm—also absorbs the effects of deal sourcing and deal selection on startup outcomes. The remaining variation captures the treatment effect of losing a VC director but retaining the relationship with the VC partnership and access to its resources.

We alert the reader to several caveats in interpreting the startup outcomes. Since the lost VC directors are replaced, the changes in startup outcomes do not equate to the value of a VC director. Instead, our estimates likely reflect the differential effect on startup outcomes between the departing VC (first match) and their best available replacement (second match) and the costs of such a replacement. Our experiment aims to identify the unique contributions of VCs to the startup that are difficult to replicate by other directors and that critically depend on the VCs' continued involvement, above and beyond their initial investment of human capital.

To interpret the director loss as exogenous, the director's death must be unrelated to the startup's future economic prospects immediately preceding the death event. To fulfill this condition, we focus on lethal events beyond an individual's control and orthogonal to startup characteristics. For example, we eliminate deaths by suicide (3.45% of events), as they could be correlated with expectations about the startup's economic prospects.

We also repeat our analyses with sudden deaths, such as accidents, strokes, heart attacks, and other premature deaths before age 70.

We also consider that a startup's underperformance may precipitate the deaths of its directors. To evaluate this scenario, we study the dynamics of startup outcomes before directors' deaths and find no significant pre-trends in startup performance, a pattern inconsistent with reverse causality. In contrast, losing a VC director affects the startup in the first year after death and generates persistent negative effects in the following years. Finally, we address the possibility that other firm-specific factors, such as a larger board or an older age of directors, may increase a startup's likelihood of losing a director. To account for such factors, we replicate our results in a stacked difference-in-differences framework by netting out firm-specific factors around the death events (first difference) and comparing the dynamics of treated startups to that of a control group of startups with similar characteristics (second difference). Our results generally persist in these specifications.

Our results suggest that the original VC directors improve startup outcomes via unique value-add mechanisms that other directors or VC partnerships cannot replicate. We investigate three such mechanisms: (1) financing, (2) professionalization, and (3) innovation. The financing mechanism posits that VC directors assist startups with raising follow-on capital by supplying expertise, certification, and investor connections. The professionalization mechanism indicates that VC directors help streamline startups' operations by recruiting talent, enhancing monitoring, and commercializing products. Finally, the innovation mechanism focuses on VCs' contributions to developing, patenting, and implementing new inventions and technologies.

We find the strongest evidence in support of the financing channel. The loss of a VC director reduces a startup's probability of raising follow-on capital, delays new financing rounds, and alters investor composition. After an exogenous director loss, a startup is 17% less likely to raise a new capital round relative to other startups in the portfolio of the same VC partnership with similar vintage and after controlling for the startup's existing capital stock. The startups that raise follow-on financing take four months (or 25%) longer to complete an investment round and attract significantly fewer new investors. These results suggest that individual VC directors are crucial for a startup's access to capital, and the directors' value-add likely relies on their non-transferable assets, such as reputation and networks. Consistent with this interpretation, the loss of a VC director leads startups to switch to alternative, non-VC sources of financing. A startup that loses a VC director is 9.6 percentage points more likely to seek capital from non-VC investors or obtain debt financing. These adjustments slow down the startup's capital growth by 22%.

We do not detect significant effects on the measures of professionalization. The loss of a VC director does not appear to affect the startup's launch of new products, registration of trademarks (unreported), or employee growth. We also do not find a significant change in CEO turnover. These results suggest that the board's monitoring and professionalization activities depend less on the unique human capital of individual VCs and can be replicated by other board members or the VC partnership.

Finally, we find suggestive but inconclusive evidence on the innovation channel. The loss of a VC director is associated with a uniform decline in the measures of new patent applications and patent grants. Still, the statistical significance of these effects varies across specifications. This mechanism requires further investigation with more granular measures of the innovation process.

Overall, our evidence indicates that individual VC directors create significant value for their portfolio companies beyond deal selection and the impact of the VC partnership. Such individual contributions have a large effect on the startup's business trajectory and ultimate success. They increase the probability of survival, improve the likelihood of a successful exit, and accelerate progression to critical milestones. The unique, irreplaceable source of directors' value-add is most significant for raising follow-on capital. The original deal experts on the startup's board likely serve as the firm's champions in funding future growth, and their reputation and networks are key irreplaceable assets.

The central contribution of this paper is to provide causal evidence on how individual VCs add value for startups. Our study departs from most prior work in two ways. First, this paper is one of the first to uncover the unique sources of individual directors' value-add and identify the irreplaceable components of their human capital. Second, while it is usually challenging to attribute startup performance to deal sourcing, selection, or value-add, we employ sharp identification to isolate VCs' treatment effects on various outcomes and provide individual-level inferences. Clean identification of the value-add mechanisms is essential to understand why entrepreneurs are willing to give up ownership stakes, control rights, and valuation premiums to attract reputable VCs (Hsu 2004).

Our paper adds to the literature studying how VC investors add value to startups. Several survey papers describe venture capitalists' views about their engagement with portfolio companies and self-reported channels of involvement (Gorman and Salhman 1989; Kaplan and Stromberg 2003; Gompers et al. 2020). Field studies find that VC-backed startups outperform their non-VC-backed peers on such outcomes as the formalization of business activities (Hellmann and Puri 2002), fundraising and recruiting (Bottazzi et al. 2008), scaling up business operations (Puri and Zarutskie 2012), and attracting human capital (Amornsiripanitch, Gompers, and Xuan 2019). Moreover, even within the subsample of VC-funded startups, those funded by well-connected VC partnerships outperform their peers (Hochberg, Ljungqvist, and Lu 2007).

Yet the causes of the VC-funded startups' outperformance remain elusive. Which of the startups' outcomes are attributable to the VCs' active contributions (value-add) rather than their access to promising ventures and selection of future outperformers? Chemmanur, Krishnan, and Nandy (2011) show that selection and value-add jointly explain the greater efficiency of VC-funded firms. Sorensen (2007) finds that selection explains the majority of performance differentials. Our identification strategy mutes the effects of deal sourcing and screening and isolates the value-add contributions of individual directors.

In its causal inferences on value-add, our paper adds to a recent Bernstein, Giroud, and Townsend (2016) study that uses sharp identification. The authors find that new airline routes, which facilitate travel between the headquarters of the VC firm and its portfolio companies, lead to improved innovation outcomes and successful exits of the portfolio firms. This paper exploits a shock at the level of a VC partnership-startup pair and remains silent on the underlying mechanisms. Our study complements this work by looking inside the VC partnership and studying the value-add skillsets of individual directors. We provide the first evidence of the irreplaceable component of directors' human capital that affects startup outcomes beyond the impact of the VC partnership. We also identify the underlying mechanisms through which VC directors affect a startup's success.

## 1. Institutional details and hypotheses

This section provides background on the institutional setting and sets up our testable hypotheses.

### 1.1. Institutional background

We ask whether VC investors add value to the startups after their initial investment. The academic literature and industry practice show that investor value-add can stem from the VC firms investing in the startup and/or the partners associated with the investment. We focus on the former by leveraging partner-level data with information about startup boards.[2] Director positions provide an unambiguous link to a general partner in a VC firm,

[2] It is also possible to connect VC partners to startups if there is no board seat connection. We are in the process of implementing this linkage by using lead investor and VC employee rolls.

permitting an analysis of partner-level activities (e.g., Ewens and Rhodes-Kropf 2015; Amornsiripanitch, Gompers, and Xuan 2019). The startup's board of directions is a central mechanism for VCs' control of their portfolio companies.

Board seats are specified by a financing contract between a startup and the syndicate of investors in the financing rounds. The contract—often called a term sheet—details cash flow and control rights, including election rights for board seats (Kaplan and Stromberg 2004). One investor in the syndicate will represent the investors and is called the lead investor. Lead investors typically source the deal, form the financing syndicate, and provide a larger amount of capital within the syndicate. An individual partner from the investing firm represents a lead investor. These partner-directors are the focus of this paper. Board election rights are available to the class of preferred shareholders (e.g., the Series A or Series B investors) where that class elects a member to represent them on the board. The lead investor's partner is the most common choice for the shareholder-elected directors (Amornsiripanitch, Gompers, and Xuan 2019). Thus, our study of VC directors is a study of partners intimately involved in deal sourcing, deal selection, and board activity for the VC investor.

What do startup boards and their directors do? Ramsinghani (2021) writes, "The boardroom is where the VC wields the greatest influence on a company's future growth." The board of directors is thus an ideal environment to study VC value-add. Ewens and Malenko (2022) document board composition over the startup lifecycle and the VC's role on the board. VCs tend to join the board in the first or second financing event. Investor directors typically do not hold the majority of board seats until later in the startup's life.

Control rights of the board take several forms. Ramsinghani (2021) provides the following description of directors' activities: "[They] are expected to provide support to the portfolio company's CEO in a number of ways—providing strategic inputs where necessary, access to networks of investors and customers, and identifying executives to build the management team." (p. 358). The board decides on C-level hiring or firing and approves exits, new share issuances, stock option plans, and annual budgets.

### 1.1.1 Director replacement

We exploit variation around the loss of VC directors, so it is natural to ask what happens to the board after such a loss. Conversations with practitioners and reviews of government filings of annual board membership of startups reveal that all lost VC board members are replaced. The incentive for a relatively quick replacement is the difficulty of operating a board without a member. Boards can only vote on major decisions if the class of shares has its representative available. A director's death does not change the voting composition of the financing syndicate, so it should not impact the lead investing firm's ability to elect a new director. Thus, interpreting the paper's results must incorporate the fact that the startup only briefly loses a director while the director's identity changes. In those cases where we do not observe the replacement (due to database limitations being rectified), we assume that the VC firm retains the seat of the lost director with another individual from the same VC firm.

### 1.2. Value-add predictions

Prior research suggests that VCs—whether firms or general partners—likely add value, but value creation mechanisms remain elusive. Similarly, whether these mechanisms are attributable to the VC firm or its individual partners is unclear. For example, the documented persistence in the performance of venture capital firms (Kaplan and Schoar, 2005; Harris et al., 2022) and investment-level returns (Cochrane, 2005; Korteweg and Sorensen, 2010; Ewens and Rhodes-Kropf. 2015) reveals that some time-invariant factors separate the best VCs from the worst. We thus expect the loss of a VC director—likely the lead investor who sourced the deal—to harm the startup, resulting in fewer IPOs, more failures, and lower-valued acquisitions. If there is such evidence, the question is *why* this effect exists.

#### 1.2.1. Capital raising

VC investors of all types provide their own fund's follow-on capital and have networks of other VCs they can tap for the startup's future capital raising (Hochberg et al., 2007). The Dotzler (2001) survey shows that entrepreneurs view "advice and introductions for financings" as a critical mechanism through which VCs add value to startups. Similarly, the Bottazzi et al. (2008) survey shows that fundraising support is a major part of VC activities. If access to capital resides with the individual VC partners, their loss should harm the startup's ability to raise more capital from both the focal VC and other VCs. If, instead, the networks reside at the VC firm or remain transferable to others (e.g., other board members or syndicate partners), there should be no change in startup capital raising.

The lower capital raising ability should translate into a lower probability of a funding round and, conditional on successfully raising, a smaller round of financing from a few investors that should take longer to close. It is also possible that because the lead investor from the focal VC is lost, the startup loses its "advocate" or "champion" (e.g., Malenko et al., 2023) from the firm. Thus, the startup may also be less likely to raise from the impacted VC.

### 1.2.2. Operational Improvements and Strategy

Survey evidence (Gompers et al., 2020) and previous work show that VCs facilitate startup growth. Professionalization (Hellmann and Puri 2002) includes implementing HR policies, introducing stock option plans, and hiring talent. Some of these impacts on the startup are at the extensive margin and occur at the time of the first VC financing, while others are inputs over the startup's life. All these activities aid the startup's ability to achieve product-market fit, expand the team, and grow revenues. Thus, we expect the startup's employment headcount, product completion, trademarking, and patenting to suffer after losing a VC director.

### 1.2.3. Managerial Oversight and Monitoring

A key role of the board is to oversee, monitor, and replace the CEO and top management (Lerner 1995). The first causal evidence for this role is Bernstein et al. (2016), which shows that exogenous increases in the cost of in-person visits worsen patenting productivity and exit outcomes. While the loss of a major VC investor is unlikely to impact the allocation of control on the board because of replacement, the loss could result in a different stance of investors relative to management. For example, the lost director may have advocated for the current CEO. We thus expect that losing a VC director will lead to a higher management turnover.

## 1.3. Interpreting Null Effects

Since lost directors are replaced, an adverse effect of a director's death on startup outcomes indicates that *specific* VC partners possess irreplaceable characteristics valuable to the startup. However, the replacement norms on boards mean that an insignificant effect of losing a director does *not* imply that VCs add no value. Instead, it means that the replacement director fully substitutes for the skillset of the lost director or that both directors add no value. Under the latter interpretation, the outperformance of VC-funded startups is attributable to deal sourcing and selection, which primarily benefit VC fund investors.

# 2. Data and Sample

Our analysis combines data on VC-backed startups, boards of directors, and director backgrounds. This section describes these data sources and presents summary statistics.

## 2.1. Directors and Startups

We start our sample construction with the universe of investors covered by VentureSource and Pitchbook from 1990 to 2023Q1. VentureSource (previously owned by Dow Jones, now CB Insights) and Pitchbook cover the

U.S. venture capital ecosystem with information on startups, financings, investors (firms, funds, and partners), management teams, and boards of directors. We use a merged database of VentureSource and Pitchbook, where the latter provides all the information for startups first financed after 2020Q1. A startup is included in the database if it raises at least some capital from a traditional VC investor. Conversely, our sample excludes startups funded exclusively by angel investors, banks, accelerators, or non-VC private equity firms. Both data sources track managers and partners at VC firms, often providing start dates and titles. Since the coverage of startup boards is primarily restricted to VC directors, we supplement this resource with data from Ewens and Malenko (2022).

We impose three sample filters (additional filters are applied in some regressions). First, since we focus on VC directors, we restrict the sample to individuals employed by venture capital firms with at least two investments in portfolio companies and at least one closed fund. Second, we require all investors in the sample to hold at least one board seat at a portfolio company during their career. Third, since our administrative vital records cover the United States, we restrict our sample to directors serving on the boards of U.S-based startups and employed by venture capital partnerships headquarters in the United States. After imposing these filters, we arrive at our initial sample of 11,599 investor-directors who serve on the boards of 18,535 startups.

**2.2. Death Events**

We hand-match directors to the Lexis Nexis Public Records (LNPR) database, using each individual's full name, contact information, and employment history in VentureSource. LNPR aggregates information on over 500 million U.S. individuals (live and deceased), traced throughout the database via a unique ID linked to one's social security number and employment records. Individual records in LNPR are linked via social security numbers to the administrative Death Master File of the Social Security Administration (SSA). This SSA database aggregates incoming death records from U.S. states into a central repository, updated weekly in LNPR. Examples of other records in LNPR include deed and tax assessment records, utility and telephone connections, criminal filings, and voting records. Prior studies have used LNPR to acquire personal information on CEOs (Cronqvist, Makhija, and Yonker 2012; Yermack 2014), fund managers (Pool, Stoffman, and Yonker 2012; Chuprinin and Sosyura 2018), securitization agents (Cheng, Raina, and Xiong 2014), and financial journalists (Ahern and Sosyura 2015).

Our paper is one of the first in financial economics to rely on administrative data from Social Security and state vital records to identify death events and classify death causes. This approach departs from most prior work that has relied on media searches and public announcements to identify death events (Nguyen and Nielsen 2010, 2014; Jenter, Matveyev, and Roth 2016; Borgschulte, Guenzel, Liu, and Malmendier 2021). Using administrative data linked via social security numbers allows us to avoid possible media biases, such as greater coverage of successful individuals, better coverage of recent events, and difficulties locating individuals with common names. In its reliance on administrative records and medical conclusions, our paper is similar to recent work on Scandinavian data by Bennedsen, Pérez-González, and Wolfenzon (2020), which documents the effects of CEOs' health events on the profitability and investment of Danish firms.

To identify death events, we manually match VC directors to LNPR and validate the accuracy of each match by ensuring that the director's employer, work email address, and title listed in the employment records in LNPR match the career history listed in VentureSource. Throughout this process, we identify 402 death events during our sample period that appear in the SSA Death Master File in LNPR. Using the combination of the individual's name, date of birth, and date of death from the SSA records, we further validate each death event by retrieving the corresponding obituary from two national databases: Legacy.com and newspapers.com. Legacy.com aggregates obituaries from over 3,500 funeral homes and over 1,500 media outlets, and Newspapers.com covers obituaries and articles from over 3,000 newspapers.

We also conduct a second validity check by verifying that the deceased individual's career background in the obituary matches their employment history in VentureSource. This criterion nearly eliminates the possibility of a spurious match (i.e., a false death event) by relying on the unique combination of an individual's name and employment history and validating them against the employment records of VC directors from two independent sources: LNPR and VentureSource. We find 435 death events for VC partners with and without board seats. Our primary sample includes only those death events where the individual was on the startup board at the time of the death. This sample contains 92 VC investor-directors.

Using obituaries, we also collect an individual's place of birth, place of death, and the cause of death. We augment these data with career progression from LinkedIn, Pitchbook, VentureSource, and director biographies to identify the director's final job title before death.

Panel A of Table 1 presents summary statistics on the characteristics of the deceased directors. The average director's death occurs at age 64.28. Over three quarters have an undergraduate degree, 60% were born in the United States, and 10% were formally retired from their VC firm at the time of their death (while still on the board). The table also shows that deceased directors sat on over ten boards at their death, active on 2.4 in the year of their death.

### 2.3. State Vital Records

We augment the death records from Social Security with detailed vital records from select states that granted access for this study: California[3], Connecticut, Florida, Massachusetts, North Carolina, and Ohio. During our sample period, these states account for 60–70% of the national venture capital investments, as measured by the headquarters of venture capital firms and the locations of VC-funded startups.

Using the individual's full name, date of birth, and date of death, we retrieve their case from state vital records. Vital records contain dozens of variables for each case, such as the residential address, occupation and industry, years of education, and close relatives of the deceased. Most importantly, these records provide the official medical conclusion regarding the death cause, a detailed classification of primary and secondary death factors, a distinction between natural and unnatural death events (such as accidents), and, for a subset of observations, the time interval elapsed between the primary death cause and the death event. We use these data for crosschecking and augmenting the death causes obtained from obituaries, inferring the approximate onset of a terminal disease, and identifying a subset of sudden and unanticipated deaths.

Panel B in Table 1 lists the primary death causes in our sample for the 51 directors with known death causes. Some of the common causes include cancer (45%), cardiovascular issues and heart attacks (14%), brain disease (9.8%), accidents (5.9%), lung disease (5%), and liver and kidney disease (4%). We eliminate observations with death events caused by suicide (7.4%) because they are plausibly endogenous to startup outcomes.[4] For example, poor startup outcomes—both realized and anticipated—could contribute to a director's decision to commit suicide.

Table 2 compares the characteristics of deceased and non-deceased VC directors. As expected, deceased directors are older and more senior. Thus, on average, they hold more board seats during their professional career and have an earlier start and end of their board service. One implication: differences by industry can be explained

[3] The State of California—Health and Human Services Agency Committee for the Protection of Human Subjects, IRB 2021-205 approved the use of California death records.
[4] This percentage of suicides is likely an upper bound as these extreme events are most likely to be reported.

by the fact that healthcare companies have larger boards formed earlier in a startup's life. Lastly, Figure 1 presents the characteristics of startups at the time of a director's death. Here we see that the average death occurs after the startup has raised five rounds of financing, has four investor-directors, and is about seven years old (since its first VC financing).

### 2.4. Startups

Using the information on board appointments from VentureSource and Pitchbook, we link directors to startups and obtain the complete composition of startup boards from Ewens and Malenko (2022) when available. For each startup, we collect the sources of financing and the amount of raised capital (VentureSource and Pitchbook), employee count and employment growth (VentureSource, Pitchbook, and LinkedIn), patent activity (PatentsView and USPTO), trademarks (USPTO), startup exit outcomes (IPOs, acquisitions, and failures), and exit valuation multiples (VentureSource and Pitchbook).

Panel A in Table 3 describes the sample of startups. The average startup was founded in 2003 and received the first round of VC financing within the first two years of its life. The average startup receives $5.97 million in investment capital (in 2012 dollars) in its first financing round. The first round of funds typically comes from an investment syndicate, and the average syndicate has more than two VC partnerships. Most startups (80%) lack a commercial product at the time of the first VC investment. The most common industries for the VC-funded startups in our sample include information technology (41%), healthcare (23%), and business and financial services (18%).

Panel B in Table 3 describes the director-startup-year sample, our primary panel data structure. Differences between statistics in this and Panel A reveal how tracking startups with boards and survivorship impacts the sample characteristics. For example, firms in the director sample take longer to exit, are more likely to be in healthcare, and have at least one patent. Reassuringly, these statistics do not differ on exit types.

## 3. Main Results

This section details the results of our analysis of the effects of VC partner loss on the startup.

### 3.1. Exit outcomes

We first ask whether the loss of a director affects the ultimate outcome of the startup. If we find no impact of VC loss at the exit stage, then it is not evident that we need to explore any effects on the startup before exit. We consider various outcome variables used in the venture capital literature (see Yimfor and Garfinkel 2023 for a review). We ask whether performance outcomes differ for startups that experience at least one VC director loss before exit (as of the end of the first quarter of 2020). Our preferred specification compares startups in a VC firm's portfolio with a VC fixed effects specification:

$$Y_{ij} = \beta_0 + \beta_1 \text{Board experienced death}_i + \beta_2 X_i + \alpha_j + \epsilon_{ij} \quad (1)$$

where $i$ represents the startup and $j$ is the VC investor. $Y_{ij}$ is an outcome such as IPO, failure, or log of exit valuation. *Board Experienced Death* $_i$ is a binary indicator that equals one for startups that experience at least one director death before exit and 0 otherwise. The control $X_i$ includes startup controls such as industry, year, and location fixed effect. The VC firm fixed effect $\alpha_j$ ensures that we compare the outcomes for startups held in the same VC investment portfolio.

Table 5 presents the results where the primary variable of interest, *Board experienced death*, is a binary indicator that equals one if a startup experiences a VC director death during our sample period and zero otherwise. The unit of observation is a startup-investor (see equation 1), where the investor has at least one board seat on the startup's board. To allow time for exits, the sample only includes startups first financed before 2020. To allow for time for a death event, we also require the startup to have at least two financing events (the results are robust to this condition).

The first column considers startup failure, using an indicator as the dependent variable. We follow Ewens, Nanda, and Stanton (2023) and assign failure to firms that have not raised capital in three years (as of the first quarter of 2023). An average failure rate of 31% is a conservative measure of failure because it does not include acquisitions with low valuations that are likely hidden failures (Puri and Zarutskie 2012). In this column and the next two, firms that have yet to exit by the end of the sample or had an exit (e.g., acquisition) are assigned the value of zero for their dependent variable. The coefficient estimate in column 1 implies that startups fail at significantly higher rates if one of their VC directors dies (over 20% relative to the mean). This higher failure rate is paired with a lower probability of IPO or acquisition: column 2 shows that director loss coincides with a 19% decline in the startup's exit probability. The next column, 3, conditions on any exit, where 0 is a failure. Again, death is related to lower success rates. Column 4 considers the sample of startup exits and asks whether the likelihood the startup is acquired or went public for more than two times capital differs by director death. Here we see an insignificant 4% lower probability relative to the sample mean. One challenge with dependent variables using valuations is the positive selection: high-quality startups are more likely to report their exit valuations. The negative coefficient is thus reassuring that investor results are likely lower when a death occurs.

Column 5 again conditions on exits. It shows that startups with director deaths take 29% longer to exit. This represents over 1.5 years relative to the sample average time to exit (all types). Finally, column 6 asks whether the non-failure valuations of exits differ. Again, we must caveat that this analysis suffers from sample selection: successful startups are likelier to disclose their valuation. Here we see an economically and significantly smaller coefficient. Further work is required to account for sample selection (e.g., Korteweg and Sorensen, 2010). While the negative sign is consistent with the other results in the table, we do not find a statistically significant difference.

Overall, the results in Table 4 show that director loss is detrimental to startup outcomes that likely lower investor *and* entrepreneur returns. Given that the lost director is replaced relatively quickly, this negative impact suggests that something unique about the lost director could not be replaced. Therefore, in the following analysis, we investigate what happens to the startup around the death event to isolate the specific VC partner activities that help startups.

### 3.2. Pre-exit startup outcomes

The next regressions explore the effects of VC partner loss on the startup during its lifecycle. We estimate a modified version of equation one, where we track the VC-startup pair over time, from the year the VC joins the board to when it gives up the seat (or the startup exits). The estimation equation is:

$$Y_{ijt} = \beta_0 + \beta_1 \text{Post-death}_{it} + \beta_2 Experienced\ death + \beta_3 X_{it} + \beta_4 Z_i + \alpha_j + \gamma_t + \epsilon_{ijt} \quad (2)$$

where, *i* represents the startup, and *j* is the VC firm. We track startup-director pairs from the date the VC director at VC firm *j* takes her board seat to either startup exit or when the VC gives up the board seat. The panel structure is annual since we are studying outcomes that can vary each year or only track startups in years when they raise capital. The primary variable of interest is $\text{Post-death}_{ij}$, which equals one for startup years on or after the death event. This variable definition implies that all VC directors active with the startup at the time of the director loss are "treated" regardless of whether the VC firm is associated with the lost director. Given that someone at the same VC firm likely replaces the lost director, we retain the startup-VC pair of the lost director after death.[5]

The control $X_{it}$ includes time-varying measures such as capital stock and financing round number fixed effects. The time-invariant control $Z_i$ includes startup location, industry, year of first VC financing, and year of founding fixed effects. Most models include VC firm fixed effects $\alpha_j$. All models include year (or financing year) fixed effects $\gamma_j$. The VC fixed effect specification means that we can control for time-invariant differences in VC quality or strategy and that the estimation compares the startup outcome within the VC portfolio. In some analyses, we estimate a startup-year version of equation 2 where we ignore VC-startup pairing and exclude VC firm fixed effects.

#### 3.2.1. Follow-on financing

The typical entrepreneurial firm backed by venture capital raises a new financing round every 12 to 18 months and is unprofitable. This staged financing (Gompers 1995) provides both an opportunity to expand or abandon but also means that the startup depends on periodic cash infusions to survive and grow. One explanation for the higher failure and lower IPO rates (Table 5) is the startup's struggle to raise capital. A VC director's death could cause this outcome in several ways. At one extreme, the lost partner is associated with a major investor who stops investing after the death. Relatedly, suppose the partner was viewed internally and externally as a critical asset of the firm that is difficult to replace. In that case, existing investors may abandon the startup, and new investors may stay away. The lost director could also have been an important networking source for external investors who tend to join all new financing rounds. If financing rounds' completion requires some minimum capital investment, losing the director's network of external financiers may lead to a higher likelihood of failed financing. Table 6 addresses these questions, again estimating equation 2.

The dependent variable is equal to one if the startup raised a new round of financing in that year, where we track the startup from first VC financing to exit year. The first column's unit of observation is the startup-year. Here we find a 7.6% decline in the probability of capital raising after a death event (relative to the sample mean).

[5] We are in the process of collecting more information about the exact replacements. The results are robust to assuming the affected VC firm does not retain their board seat.

The 12 to 18-month runway of capital, combined with the fact that most startups are unprofitable, implies that most firms without follow-on financings likely failed.

Column 2 uses the startup-director-year data structure (equation 2) that allows us to control for VC firm fixed effects. Unless we observe a director leave the board, they maintain their position from the start date to the startup's exit. We impose the industry convention that another partner at the same VC firm replaces the lost director. While the economic magnitudes are smaller (4.7%), we continue to find that the startup is less likely to raise a new round of financing after the death event. How much of this lack of capital raising explains the outcome results in Table 5? Table A2 in the Appendix excludes all startups that experience a director death and do not raise a follow-on round. The results are weaker, but we still see higher failure rates (economic magnitude is similar) and lower IPO probabilities. Thus, the exit outcomes in Table 5 could be explained by changes in the set of startups that successfully raised a new round of financing. We explore such changes below.

### 3.2.2 Financing round characteristics

The following two analyses investigate the financing characteristics of the startups that successfully raise a new financing round. Here we estimate equation 2 for years when the startup raises capital. The obvious first test is whether the successful follow-on financings are smaller. Smaller financings – all else equal – could limit the startup's growth and ability to take advantage of investment opportunities. A possible candidate for the outcome variable in Equation 2 is the capital raised in a financing round. Given startups' complex, unobserved capital demands, a regression of the (log) capital raised on a set of independent variables is difficult. For example, the interquartile range of capital raised is $1.2 to $10m, with a similar spread within industries. Across industries, the mean capital raised is 3 to 5 times the median. Thus, an individual startup's capital raise is a complex outcome of supply and demand, making it challenging to interpret coefficient estimates. We instead construct a dependent variable that effectively removes the startup fixed effect: the log of capital growth. This outcome variable provides a less ambiguous prediction for coefficient estimates because the staging of VC typically results in startups raising larger and larger financings over their life (see Figure 2). We thus expect the firms that experience the director death to experience slower capital stock growth.[6]

[6] The results are robust to regressing the log of capital raised and controlling for the log of capital stock as included in all other regressions. We prefer the capital growth regression as this alternative borders on a dynamic panel estimator.

This is indeed what we find in the last two columns of Table 6. Capital raising growth is 20 to 22% lower after losing a VC director. The negative effects hold across specification and sample, with our preferred VC firm fixed effects models showing a 20% lower capital raising growth.

Table 7 further investigates the capital raising challenges and hints at some of the mechanisms behind the previous two tables. Columns 1 and 2 ask whether the time to complete a financing round changes after losing a director. Completed financings after a death event take 10% longer, or about two months, relative to the average closing time. This delay likely negatively affects the startup's ability to hire talent and complete new products.

Next, columns 3-4 ask whether valuations change after death events. As with the level of capital raised, regressions of valuations are difficult to interpret. Unfortunately, sample selection leads to too many high-quality startup valuations and too few consecutive valuations to measure changes. Nonetheless, predictions about the effect of director loss are ambiguous: it may lower firm value because of expected worse outcomes realized in Table 5, or the loss of a director could shift bargaining power in favor of founders, increasing valuation. The results provide no conclusive evidence for either hypothesis.

### 3.2.3. Sources of capital

The most valuable network to the startup is the investor's external network of investors. Figure 2 shows that over 50% of financings across the startup lifecycle have at least one new investor. Access to new investors is critical for a startup to raise additional capital because existing investors are typically constrained in how much capital they can invest in the startup (10-15% of their fund). The literature provides suggestive evidence for the role of networks in startup outcomes. Hochberg et al. (2007) show a strong correlation between a VC firm's network position, VC fund returns, and startup-level outcomes. They find that the more networked a VC firm is, the more likely a startup can raise a follow-on financing and survive. Our analysis asks whether this relationship is causal and whether these relationships are unique to the individual VC partner.

The following regressions explore these questions using partner-level data – where networks are most likely to reside – and exploit exogenous variation in network positions. Recall that a partner at the same VC firm with a network similar to the deceased most likely replaces the deceased director. Thus, any negative effects in these regressions would show that the replacement network is an imperfect substitute for that of the lost investor.

Table 8 asks whether the loss of a director shuts down access to their capital networks. We consider outcome variables connected to syndicate formation. Columns 1 and 2 ask whether a financing round has at least one new investor, while columns 3 and 4 ask whether the financing is more likely to be sourced via debt or from non-traditional sources. The results in columns 1-2 suggest that losing the director leads to fewer new outside investors in successful financings. This decline in external investors is consistent with the director's network being no longer available to the startup.

The final two columns of Table 8 ask whether the startup is more likely to raise capital outside traditional networks. Many non-traditional investors, such as corporations, angel investors, private equity firms, and hedge funds, play a role in startup financing but are rarely the primary startup investors. Similarly, non-equity financing is another way a startup can substitute traditional VC financings when losing VC networks. To study these predictions, we consider an outcome variable that is one if the startup's new investors are non-tradition, non-VCs, or the financing round is debt. Columns 3 and 4 show a strong, positive effect on this likelihood. The coefficient estimate implies an almost 50% increase in the probability of such financings. This increase is consistent with the startup seeking capital outside traditional networks after losing the VC director.

### 3.3. Operations and Management

The venture capital literature documents investors' actions with startups that can add value: professionalization, aiding with talent searches, strategic advice, and monitoring (among many others). If the lost VC investor has an irreplaceable set of skills for these actions, we should observe worse outcomes. Unfortunately, observing these actions is difficult. Equally challenging is the task of connecting the actions to observable outcomes. We consider four outcomes that signal firm growth, management changes, and innovation. In each case, we expect the investor loss to negatively affect outcomes (if the skills are irreplaceable). Table 9 presents some results. Ewens and Marx (2018) show that VCs are active in replacing – often struggling – founders and that those replacements help the startup. The loss of a VC partner could impact the bargaining power of the remaining investors or lower the information available to them about managerial performance. The first two columns of Table 9 ask whether CEO turnover changes after the death event. The samples in these columns consider startups founded in years with higher quality replacement data (2000 and forward). We find a statistically significant change in CEO turnover in the startup-year data but weaker evidence in the director-year panel (column 2). This mixed evidence leads us to conclude that losing a VC partner does not impact the board or VC syndicate's ability to replace CEOs.

The following two columns of Table 9 study the startup's employee headcount. Amornsiripanitch, Gompers, and Xuan (2019) show that VC investors provide connections for startup hiring. Bernstein et al. (2022) provide causal evidence that the VC investor's reputation improves the startup's ability to attract high-quality talent. We would thus predict – assuming the individual partner's skills are irreplaceable – that losing a partner will harm employment growth. The results show a negative relationship, but we lack the statistical and economic significance to conclude that director loss impacts employment. The results are similarly weak if we switch to a dependent variable that is a binary indicator for any increase in employment.

Next, columns 5 and 6 ask whether the startup's completion of a product changes after the death. The sample only includes startups that did not have a completed product at the time of their first VC financing (so they have a chance of completing the project if treated). The results in Columns 1 and 2 show no statistically significant effect, with a relatively small coefficient (<5% of sample mean). In unreported regressions, we investigate whether a startup's trademark filing propensity changes. Again, we find no major impacts on this type of product development. This table suggests that the lost director's skills in helping the startup achieve a product launch are either small or easily replicable by the VC investor's firm.

Lastly, Table 10 studies the patenting activity of startups. Motivated by the Bernstein et al. (2016) study of VC monitoring's impact on startup patenting, we consider dependent variables that count the number of annual patent applications. If the lost VC's activities were instrumental in the patent application and approval process and her peers cannot replicate the process, then patenting rates should fall. Across specifications – Poisson counts in columns 1 and 2 or a dummy for whether the startup files any patent in the last two columns– we find some evidence of negative effects on patenting. While we lose significance in columns 2 and 4, the coefficients are consistently negative and economically meaningful. We interpret this as suggestive evidence of negative impacts on patenting that warrant further investigation.

### 3.4. The Financing Mechanism: Robustness and Dynamics

The results so far suggest that VC directors improve startup outcomes by facilitating access to financing and expanding the investor base for follow-on rounds. This section evaluates its temporal dynamics.

### 3.4.1 Differences by startup development stage

Having found the effects of director loss on startup capital raising and investor composition, we now explore effect heterogeneity. While it is empirically challenging (see Section 3.5) to explore the full spectrum of heterogeneity by director or startup characteristics, this section asks whether the development stage of the startup at the time of death impacts the effect size or direction. Observed differences can provide a window into the mechanisms by which VC directors are irreplaceable value. For example, younger startups with less capital, smaller boards, and few investors may experience relatively worse effects from director loss than their older peers. Younger startups have fewer assets, may not have a completed product, and are less likely to have internal funds to support themselves. These gaps leave ample opportunities for VC value-add. Alternatively, the fact that directors of late-stage startups have been on the board for several years means they have built a significant amount of match-specific capital and soft information. Here the loss of a late-stage director could be more detrimental. A third alternative is that the startup stage at the time of director loss has no additional prediction power because the VC continuously adds value over the startup lifecycle.

To test these predictions, we repeat the analyses in Tables 6,7,8 and 10 using two sub-samples. The "Early" sub-sample includes startups in their first four financing rounds, and the "Late" sub-sample tracks startups in all subsequent rounds. Startups can be in both sub-samples if they survive past their fourth financing. Table 11 presents the results of the capital raising outcomes.

Table 11 shows that changes in financing likelihood (columns 1 and 2) are primarily a late-stage phenomenon. One reason for the lack of extensive margin effects in the early stage may be that the main assets of an early-stage firm –its founders and employees – are unchanged after the death event. Similarly, the startup's early-stage investors may be less sensitive to death because uncertainty is not yet resolved with the startup, and deciding to cease financing implies firm failure. The remainder of the columns in this table condition on successfully raising capital. First, completed financings are significantly smaller than when a death occurs later in life (-30% vs. -18% in columns 3 and 4). The signs and economic magnitudes for the delay results in Columns 5 and 6 show that the timing challenges do not depend on when the death occurs. The final two columns provide suggestive evidence that early-stage startups may experience valuation declines when they experience death.

The results in Table 11 suggest that the early-stage startup demand for capital outweighs the negative effects of director death. However, younger startups that successfully raise capital bear the same or worse effects when deaths occur later in the startup's life. This shows that the VC director is relatively more important for the intensive margin of capital raising in the early-stage startup.

Next, Table 12 revisits the outcome variables related to investor composition and patenting. Columns 1-4 show weak evidence for differences by stage in the investor composition or financing type. We find no difference in the likelihood of a new investor (columns 1 and 2). While the coefficient in column 3 is insignificant, the sample is significantly smaller (i.e., lower power), and the economic magnitude is similar (33% relative to the sample mean) to that in column 4. Thus, losing a director appears to have similar negative effects on investor composition and the likelihood of non-traditional finance across the startup lifecycle. Finally, differences by startup stage emerge when we study patenting.[7] Negative effects are confined to the late-stage sample (columns 6 and 8). These differences suggest that the VC director's input or value-add for startup patenting matters later in the firm's life.

Overall, these heterogeneity tests reveal that not all director losses are created equal: a VC director's role in capital raising and innovation changes over the startup's life.

### 3.4.2 Dynamics in a stacked difference-in-difference estimator

The empirical strategy used above is close to a traditional difference-in-difference estimator, where treatment is the death event, the post-period is the years after the death, and the control sample is the set of portfolio companies in the same VC portfolio as the treated startup. Given that deaths in our sample occurred over 25 years and across over 200 startups, we must address the concerns about weightings in a staggered difference-in-difference. To formalize this empirical model and address concerns about both pre-trends and effect timing, we implement a version of a two-way fixed effect estimator following Cengiz et al. (2019).

Their stacked difference-in-difference estimator considers each treatment effect – here, a death – as a sub-experiment. For each sub-experiment, one constructs a control group where event time is centered around the death event. We implement this approach by considering each director's death a sub-experiment and the control group, the set of all never-treatment startups alive at the time of the death. Thus, the treated sample is all startups where the deceased director held a board seat at their death. One constructs each sub-experiment sample and "stacks" them in the same data structure. This structure, in turn, allows the inclusion of sub-experiment-unit (here, startup) fixed effects and sub-experiment-time (years around the death) fixed effects. While this method helps to

[7] Figure A1 in the Appendix shows that while the average patenting rate is approximately constant over the startup life, only in the early stages does the median startup patent.

address standard issues in staggered diff-in-diff estimators, it does not come without a cost. Baker et al. (2022) show that "stacked regressions can differ from the sample-average ATT, particularly when there is heterogeneity in treatment effects across cohorts or time." (page 384)[8] Thus, we must caveat the results that follow, as it is likely that death effects indeed differ in these dimensions. Future versions of the paper will implement alternative estimators where possible.

We estimate the following model for the capital raising outcomes and patenting variables studied above:

$$Y_{igt} = \beta_0 + \beta_1 \text{Treated}_{ig} * \text{Post}_{gt} + \beta_2 X_{igt} + \alpha_{ig} + \gamma_{gt} + \epsilon_{igt} \quad (3)$$

where $g$ is the sub-experiment associated with the death of an individual director, $i$ is a startup, and $t$ is sub-experiment time. The startup-sub-experiment fixed effect is $\alpha_{ig}$, and the $\gamma_{gt}$ are sub-experiment time. For each death event, let $t_g$ be the year of the death. Our event window is *s* years around $t_g$ *is* $E_g = [t_g - s, t_g + s]$. We have *G* death events represented by *g*. A control startup for event *g* is one that is alive at time $t_g$ , had at least one financing before $t_g$, and never experiences a death event (i.e., treated startups are never controls). The variable $\text{Treated}_{ig}$ can be split into event time to create dynamic event time graphs for diagnosing observable pre-trends and effect timing. Before discussing the results, it is essential to consider one more caveat. Our data is unique compared to traditional settings where units being studied are public firms, municipalities, states, or individuals: startups often die and do not have financing activity every period. This survivorship issue and periodic dependent variables challenge a fixed effect estimator as the estimator will provide more weight to the units that survive longer. For example, treated startups with small or zero impacts from death – and thus survive longer – will get more weight in the fixed effects regression.

Table 13 presents the estimation results of equation (3). We see that the adverse effects on capital raising probability, capital raising amounts (here in log levels because of the startup fixed effect), and time to financing remain as above. The signs on the new investor (column 4) and raising non-traditional finance are as expected, but we lack the statistical significance to show a meaningful effect. While these results are weaker than those in the VC firm fixed effects model, they reveal a similar story.

[8] Time-varying treatment effects are possible in the venture capital setting when bargaining power changes, the supply of capital shifts dramatically, or technology changes.

Finally, a significant benefit of the estimator in (3) is the ability to produce event time coefficient estimates to diagnose pre-trends in observables and effect timing. Figure 3 presents the estimates for the six dependent variables in Table 13, where the year before death is excluded. Across all variables, there is little visual evidence of pre-trends. The figures also tell us something about whether the effects persist or revert. Panel (a) suggests that the probability of capital raising permanently shifts down, while Panel (b) suggests that the level of capital raising – if successful – eventually mirrors controls. Finally, Panel (c) suggests that the impact on financing timing takes at least one year and may last 3-4 years after the death event.

Overall, the results in Table 13 and Figure 3 suggest, at the least, that the effects on capital raising – ability, amount, and timing – are robust and unlikely to be driven by anticipatory effects. Additional work is required to estimate models that allow for time-varying treatment effects and refine the selection of control startups.

### 3.5. Summary of effects on startups

Our results show the unique, irreplaceable skills that VC partners provide to their startups. Individual VC directors are critical information sources and advocates for the startup's follow-on financing, likely via their networks. While we find no adverse effects on operations from director or partner loss, this does not imply that VCs add no value to these dimensions because our experiment replaces one VC with another rather than replacing VC with no one. A null effect means that the value-add is small or that other VC partners can substitute for the lost director.

### 3.6. Challenges with Studying Heterogeneous Effects

A natural question is whether the results documented above vary by startup, board, or director characteristics. These tests are challenging as they reintroduce deal flow and matching issues. For example, suppose that we believe that the effects of the director depend on the size of the board of directors, splitting the sample by small versus large boards. Larger boards could be associated with older startups—introducing survivorship bias—or larger boards are situations where VC investors had significant bargaining power. Similarly, we could split by director age at death as a proxy for experience or networks. Again, this split would introduce new confounds. Suppose that older VCs are of higher quality than their younger counterparts. If there is any assortative matching between startups and investors at the match stage, then splitting by age is a split by startup quality. For these reasons, we only exploit variation from the average death event.

### 3.7 Effects on the venture capital firm

The startup that lost a VC director is not the only impacted entity after the death. The lost director's VC firm is also likely affected. Firstly, the worse outcomes found in Table 5 will impact the VC fund's performance, which could impact future fundraising. Secondly, VC firms are small, typically with 3-4 partners selecting and managing investments. Thus, the loss of one partner could impede the firm's operations. Contracts between VC funds and their investors (limited partners) incorporate such risk through "Key Person" provisions. This contract features state that in the event of the loss of a predetermined individual(s) of the VC fund, the fund must halt investments in new startups. These provisions can require the VCs to receive the majority of LP approval to continue operating the fund. Importantly, these contracts allow the VC fund to continue investing and managing investments made before the partner loss. The existence of key person provisions suggests that LPs believe the human capital of the VC fund is critical to its success. We investigate whether the VC firm – and its funds – experience any adverse effects after losing a partner.

Table 14 reports regression results using a VC firm-year panel that tracks fundraising and investment performance. "Post-death" is a dummy variable for years after a partner's death. All the regressions include fixed effects for year, the number of funds the VC has raised, and the VC firm. We stop tracking VC firms five years after their last fund, assuming they shut down if no new fund is raised. Column 1 of Panel A asks whether the VC firm's fundraising success changes after the loss, which we would expect if the LPs invested in a team of partners. VC fundraising falls in the year after death. The coefficient implies a 22% decline in the annual probability of successful fund close (relative to the sample mean). Column 2 considers years with a successful fundraise. Here we find no change in fund size after death.

The remaining columns of Panel A of Table 14 study whether VC fund performance falls after death (columns 3 to 5) and whether investment activity changes (columns 6 and 7). Besides a negative coefficient on exit valuations in column 3, we find no statistically significant effect on the VC firm's performance or operations. Of course, these estimations effectively require the VC firm to continue operations after the death, so it is more likely that the lost director was not a key person.

Panel B of Table 14 repeats the analysis of Panel A for the deaths of likely key persons: partners or managing directors. The economic magnitudes are larger, and statistically significant results emerge for performance effects. We find that the count of IPOs falls, along with deal volume proxied by number and dollars (columns 6-7). These results are consistent with top venture partners at VC firms being critical assets for their firms.

## 4. Robustness

The results above are robust to a host of robustness tests.

### 4.1. Sudden Deaths

The primary analysis has relied on the full sample of deaths of directors serving on a startup's board at the time of death. Some directors likely had diseases or were old enough that death was anticipated. Including these death events only attenuates our results. If the board anticipates a director's death and believes the director's loss will harm the startup, all parties are incentivized to minimize such effects. Our first robustness test considers only death events where the individual was younger than 70 years old and not retired at the time of the death (retired VCs can keep their board seats from before retirement).[9] In unreported results, we rerun all the tables and find no qualitative or quantitative change in the results.

### 4.2. Failure and Lack of Capital

VC partner loss leads to significantly higher failure rates and the firm's ability to raise a follow-on financing round. The latter could cause most of the former. We exclude all startups that experience a VC partner loss and fail to raise a new financing round after the death. Table A2 reports this subsample. The coefficients on failures and IPOs are similar to those found in Table 5, suggesting that failed follow-on financings explain only a tiny portion of the cross-sectional effects.

### 4.3. Key Person Clauses at VC Partnerships

Subject to the standard key person arrangements (see Section 3.5), a VC partnership can continue investing in the startup if the lost director is considered a key person in the VC firm, according to its partnership agreement. Therefore, we assume that the VC firm associated with the lost director keeps the board seat after her death. In this robustness test, we stop tracking the VC-startup pair for these investors, thus studying treatment effects for

[9] We lose 18 startups in the main cross-sectional tests in Table 4.

directors that serve on the same board but represent a different investor. We re-estimate all the regressions related to capital raising, operations, and management (unreported) and find similar results.

## 5. Conclusion

This paper studies how individual venture capitalists add value to startups. Our findings show that VC directors contribute unique skills that increase a startup's chances of survival and ultimate success beyond the influence of the VC partnership and other board members. Such skills are difficult to replicate, particularly when funding the startup's growth and raising new rounds of venture capital. Our findings highlight the critical role of the original investors on the board as the startup's champions in the capital raising process and suggest that their networks and reputation are irreplaceable assets.

Our study makes a step towards understanding the role of individual VCs in the governance of early-stage enterprises. While most prior work has viewed VC partnerships as the primary unit of observation in their interaction with startups, our evidence shows that value-add mechanisms' efficacy depends critically on the individual VCs on the startup's board. A loss of even one original investor on a startup board undercuts the startup's chances of survival and long-term success, despite the VC partnership's resources and strong incentives of investors, other directors, and entrepreneurs to replenish the lost human capital. We hope that the growing interest in constructing a complete picture of individual directors' involvement on startup boards will continue to expand our understanding of the inner workings of early-stage enterprises. The subsequent versions of this paper will refine our evidence on directors' skill sets and study how startups replace their lost directors.

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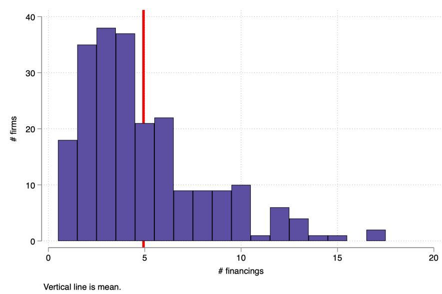
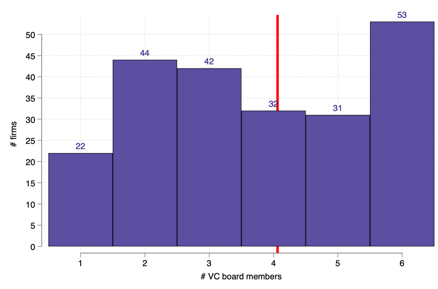
# Figures and Tables

Figure 1: Startup characteristics at the time of director deaths

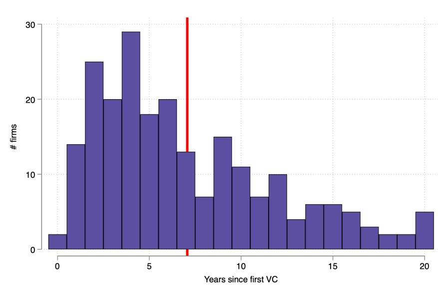
Notes: The figure reports the characteristics of startups at the time of director death for the 92 director deaths in 224 startups (these are all startups in any regression analysis below). Panel A reports the number of financings raised at the time of death. Panel B reports the number of investor-directors (including the deceased) at the time of director death. Panel C reports the number of years since first VC financing at the time of director death.




(a) Panel A: Number of financings at time of director death.




(b) Panel B: Number of investor-directors at time of director death.




(c) Panel C: Age of startup (since first VC financing) at the time of director death.

Figure 2: Average dollars raised and likelihood of new investors

Notes: The figure reports the average dollars raised by financing round and the fraction of each round that have at least one new investor in the syndicate.

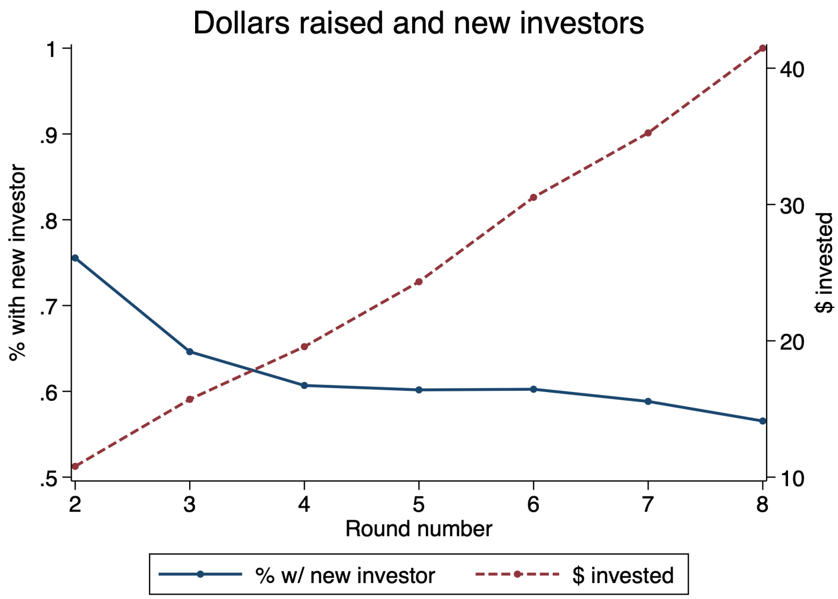
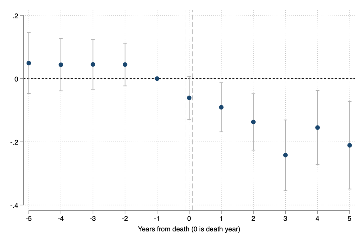


Figure 3: Event study graphs: capital raising, capital ramp, and time since last financing

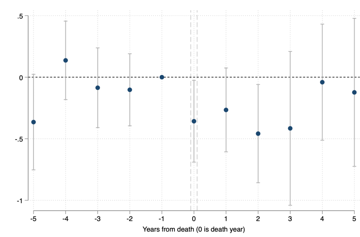
Notes: The figure reports the event time coefficients $\hat{\beta}_k$ for six dependent variables using the stacked diff-in-diff specification found in Table 13 and estimated using a modified version of equation (3):

$$Y_{igt} = \beta_0 + \sum_{k=-5}^{k=-2} \beta_k \text{Treated}_{ig} * \mathbb{1}\{\tau_g = k\} + \sum_{k=0}^{k=5} \beta_k \text{Treated}_{ig} * \mathbb{1}\{\tau_g = k\} + \beta_2 X_{igt} + \alpha_{ig} + \gamma_{gt} + \epsilon_{igt}$$

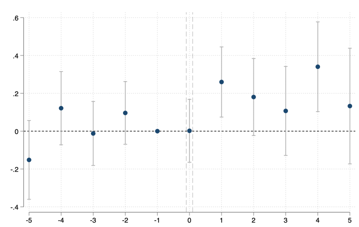
where $\tau_g$ is the set of event time around the death event in sub-experiment $g$. .



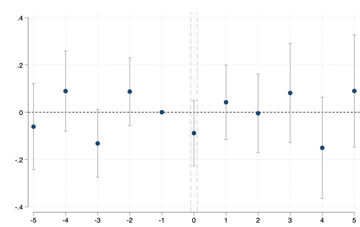

(a) Raised new round?



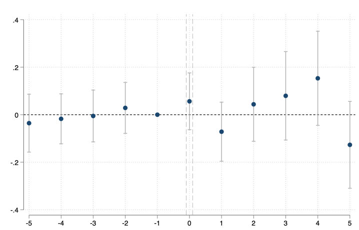

(b) Log capital raised



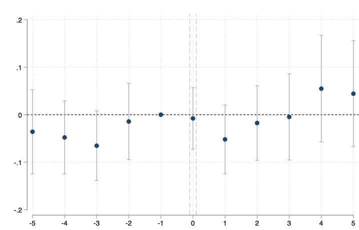

(c) Time since last round




(d) New investor?




(e) Non-traditional round




(f) Had a patent?

Table 1: Characteristics of deceased directors at the time of death

Notes: The table reports summary statistics for deceased directors at the time of their deaths on the board (if the individual was on the board in the year of the death event). Panel A reports individual characteristics and investment experience variables. Panel B reports the causes of death when available. The "Other causes" category includes "illness," "injuries," "natural causes," "disease," "covid-19," "malnourishment" and "suffocation."

Panel A: Deceased director characteristics

| | Mean | SD | Min | Med. | Max | N |
|---|---|---|---|---|---|---|
| Death year | 2011.64 | 7.08 | 1994.00 | 2012.00 | 2022.00 | 92 |
| Birth year | 1947.17 | 12.05 | 1910.00 | 1948.00 | 1972.00 | 90 |
| Age at death | 64.28 | 13.71 | 31.00 | 64.00 | 94.00 | 90 |
| Had undergrad degree | 0.78 | 0.41 | 0.00 | 1.00 | 1.00 | 88 |
| Had graduate degree | 0.75 | 0.44 | 0.00 | 1.00 | 1.00 | 75 |
| Born CA | 0.03 | 0.18 | 0.00 | 0.00 | 1.00 | 92 |
| Born in U.S. | 0.60 | 0.49 | 0.00 | 1.00 | 1.00 | 92 |
| Death in CA | 0.27 | 0.45 | 0.00 | 0.00 | 1.00 | 92 |
| Retired | 0.10 | 0.30 | 0.00 | 0.00 | 1.00 | 92 |
| Found in Lexis Nexus | 0.95 | 0.23 | 0.00 | 1.00 | 1.00 | 92 |
| Has SSN | 0.95 | 0.23 | 0.00 | 1.00 | 1.00 | 92 |
| Has patent | 0.16 | 0.37 | 0.00 | 0.00 | 1.00 | 92 |
| Average capital stock at death | 79.72 | 76.33 | 0.63 | 63.96 | 427.89 | 91 |
| Years on affected startup board | 9.08 | 5.42 | 1.00 | 8.00 | 29.00 | 92 |
| Number years of board experience | 16.09 | 7.81 | 1.00 | 15.00 | 32.00 | 92 |
| Avg. board size (investors) at death | 3.44 | 1.75 | 1.00 | 3.20 | 9.00 | 92 |
| Active boards at death | 2.43 | 2.60 | 1.00 | 1.00 | 14.00 | 92 |
| Year of first board seat | 1998.79 | 6.98 | 1990.00 | 1999.00 | 2018.00 | 92 |

Panel B: Causes of death

| | % deaths |
|---|---|
| Cancer | 40.98% |
| Cardiovascular / Heart disease | 19.67% |
| Brain disease | 8.20% |
| Accident / Natural disaster | 4.92% |
| Other causes | 6.56% |
| Suicide | 9.84% |
| Lung disease | 3.28% |
| Liver/Kidney/Organ disease | 4.92% |
| Stroke | 1.64% |
| # with known cause of death | 61 |

Table 2: Comparing deceased and non-deceased investor directors

Notes: The table compares the set of deceased directors with all other VC board members as of the end of the sample. "Diff" reports the differences (Alive minus deceased) in means and the stars represent significance from a two-sided t-test.

| | Alive | Deceased | Diff. | s.e. | obs. |
|---|---|---|---|---|---|
| Startup first capital raised (m) | 6.70 | 6.26 | 0.44 | (1.26) | 11051 |
| Startup first syndicate size | 2.46 | 2.58 | -0.12 | (0.16) | 10998 |
| Startup's first financing Series A? | 0.50 | 0.61 | -0.10** | (0.04) | 11599 |
| Startup in information technology | 0.41 | 0.40 | 0.01 | (0.04) | 11599 |
| Startup in healthcare | 0.26 | 0.42 | -0.16*** | (0.04) | 11599 |
| Startup in business/consumer | 0.17 | 0.10 | 0.07** | (0.03) | 11599 |
| Startup in MA | 0.39 | 0.43 | -0.04 | (0.04) | 11599 |
| Total seats (2023Q1) | 4.99 | 10.03 | -5.04*** | (0.69) | 11599 |
| Year of first board seat | 2007.78 | 1997.87 | 9.91*** | (1.03) | 11599 |
| Year of last board seat | 2011.98 | 2006.58 | 5.40*** | (0.88) | 11599 |
| % startups with patent | 0.36 | 0.61 | -0.25*** | (0.04) | 11592 |
| % IPOs | 0.07 | 0.18 | -0.11*** | (0.02) | 11599 |
| % acquisitions | 0.31 | 0.38 | -0.07* | (0.04) | 11599 |
| % failed | 0.29 | 0.36 | -0.07* | (0.04) | 11599 |
| | 11,507 | 92 | | | |

Table 3: Comparing startups with and without deaths

Notes: The table compares the set of startups with and without at least one VC director death, first financed prior to 2019, and with at least two financing rounds (i.e., the sample in the cross-sectional analysis in Table 5. "Diff" reports the differences ("No death" minus "Had death") in means and the stars represent significance from a two-sided t-test.

| | No death | Had death | Diff. | s.e. | obs. |
|---|---|---|---|---|---|
| Year of founding | 2003.88 | 2000.78 | 3.10*** | (0.61) | 18535 |
| Year of first VC | 2005.55 | 2002.23 | 3.31*** | (0.59) | 18535 |
| First capital raised (m) | 5.97 | 6.10 | -0.13 | (0.98) | 17298 |
| Size of first syndicate | 2.36 | 2.51 | -0.14 | (0.12) | 18506 |
| First round Series A | 0.56 | 0.62 | -0.06* | (0.03) | 18535 |
| Information technology | 0.41 | 0.38 | 0.03 | (0.03) | 18535 |
| Healthcare | 0.23 | 0.42 | -0.19*** | (0.03) | 18535 |
| Business and Financial Services | 0.18 | 0.13 | 0.05** | (0.03) | 18535 |
| California | 0.45 | 0.45 | -0.00 | (0.03) | 18535 |
| Massachusetts | 0.11 | 0.14 | -0.03 | (0.02) | 18535 |
| Number financings | 4.61 | 6.49 | -1.88*** | (0.17) | 18429 |
| Startup has patent | 0.41 | 0.70 | -0.28*** | (0.03) | 18429 |
| Number VC directors | 2.79 | 4.33 | -1.54*** | (0.12) | 18535 |
| Total capital raised (m) | 72.85 | 98.59 | -25.74 | (21.43) | 18491 |
| Went public | 0.10 | 0.16 | -0.06*** | (0.02) | 18535 |
| Acquired | 0.38 | 0.36 | 0.02 | (0.03) | 18535 |
| Failed | 0.33 | 0.33 | -0.00 | (0.03) | 18535 |
| | 18,356 | 212 | | | |

Table 4: Sample summary statistics

Notes: The table reports summary statistics for the startups in our sample both at the cross-section (Panel A) and at the director-startup-year unit (Panel B). Variable definitions are found in Appendix Table A1.

| | Panel A: Startups | | | | | |
|---|---|---|---|---|---|---|
| | Mean | SD | Min | Med. | Max | N |
| Year of founding | 2003.85 | 8.80 | 1919.00 | 2004.00 | 2019.00 | 18,535 |
| Year of first VC | 2005.51 | 8.54 | 1973.00 | 2006.00 | 2019.00 | 18,535 |
| First round Series A | 0.56 | 0.50 | 0.00 | 1.00 | 1.00 | 18,535 |
| First capital raised (m) | 5.97 | 13.90 | 0.01 | 2.91 | 923.22 | 17,298 |
| Size of first syndicate | 2.36 | 1.77 | 1.00 | 2.00 | 32.00 | 18,506 |
| Post-money (first round) | 19.68 | 41.09 | 0.26 | 11.42 | 1661.79 | 9,302 |
| Information technology | 0.41 | 0.49 | 0.00 | 0.00 | 1.00 | 18,535 |
| Healthcare | 0.23 | 0.42 | 0.00 | 0.00 | 1.00 | 18,535 |
| Business and Financial Services | 0.18 | 0.39 | 0.00 | 0.00 | 1.00 | 18,535 |
| California | 0.45 | 0.50 | 0.00 | 0.00 | 1.00 | 18,535 |
| Massachusetts | 0.11 | 0.31 | 0.00 | 0.00 | 1.00 | 18,535 |
| Startup has patent | 0.42 | 0.49 | 0.00 | 0.00 | 1.00 | 18,429 |
| No product at first VC | 0.80 | 0.40 | 0.00 | 1.00 | 1.00 | 18,429 |
| Had exit | 0.81 | 0.39 | 0.00 | 1.00 | 1.00 | 18,535 |
| Failed | 0.33 | 0.47 | 0.00 | 0.00 | 1.00 | 18,535 |
| IPO or Acq. | 0.48 | 0.50 | 0.00 | 0.00 | 1.00 | 18,535 |
| Age at exit (years) | 7.50 | 3.88 | 1.00 | 7.00 | 32.00 | 14,962 |
| Exit value to capital | 3.48 | 17.08 | 0.00 | 0.00 | 1212.88 | 11,437 |
| | Panel B: Director-startup-year | | | | | |
| | Mean | SD | Min | Median | Max | N |
| Year of founding | 2003.05 | 8.20 | 1919.00 | 2002.00 | 2022.00 | 279415 |
| Year of first VC | 2004.69 | 7.98 | 1973.00 | 2004.00 | 2022.00 | 279415 |
| First round Series A | 0.60 | 0.49 | 0.00 | 1.00 | 1.00 | 279415 |
| First capital raised (m) | 6.61 | 13.81 | 0.01 | 3.39 | 1167.22 | 264820 |
| Size of first syndicate | 2.45 | 1.70 | 1.00 | 2.00 | 43.00 | 274244 |
| Post-money (first round) | 20.76 | 75.82 | 0.13 | 11.99 | 17906.41 | 155841 |
| Information technology | 0.42 | 0.49 | 0.00 | 0.00 | 1.00 | 279415 |
| Healthcare | 0.27 | 0.44 | 0.00 | 0.00 | 1.00 | 279415 |
| Business and Financial Services | 0.17 | 0.38 | 0.00 | 0.00 | 1.00 | 279415 |
| California | 0.45 | 0.50 | 0.00 | 0.00 | 1.00 | 279415 |
| Massachusetts | 0.12 | 0.32 | 0.00 | 0.00 | 1.00 | 279415 |
| Startup has patent | 0.51 | 0.50 | 0.00 | 1.00 | 1.00 | 279078 |
| No product at first VC | 0.79 | 0.41 | 0.00 | 1.00 | 1.00 | 279078 |
| Had exit | 0.81 | 0.39 | 0.00 | 1.00 | 1.00 | 279415 |
| Failed | 0.31 | 0.46 | 0.00 | 0.00 | 1.00 | 279415 |
| IPO or Acq. | 0.50 | 0.50 | 0.00 | 1.00 | 1.00 | 279415 |
| Age at exit (years) | 9.74 | 4.73 | 1.00 | 9.00 | 32.00 | 227183 |
| Exit value to capital | 2.92 | 12.74 | 0.00 | 0.00 | 1212.88 | 172317 |

Table 5: Startup outcomes: with and without VC director death

Notes: The table reports startup-level outcomes. The unit of observation is a startup-investor pair and the main independent variable of interest "Board experienced death" is equal to 1 if the startup experienced at least one VC director death from its first VC financing to exit. Startups first financed before 2019 and with at least two financings are included (so there is time for exits and the board has enough activity to have the risk of a death event). "Failed" is equal to one if the startup failed, "IPO / Acq." is a dummy variable for an initial public offering or acquisition. "$> 2X$ if exit" is one if the startup had an exit with a reported exit valuation two times or greater than equity invested (excluding failures). "Yrs. to exit" is the log of the number of years from first VC financing to exit (missing if no exit event). "Log exit value" is the log of exit valuation for non-failed startups. "VC FE" are VC firm fixed effects, "First fin. year" are fixed effects for the startup's first VC financing year, "Industry FE" are eight industry fixed effects and 'State FE" are fixed effects for the startup's state headquarters. Standard errors are clustered at the startup level.

| | Failed<br>(1) | IPO / Acq.<br>(2) | IPO / Acq. if exit<br>(3) | >2X<br>(4) | Yrs. to exit<br>(5) | Log exit value (> 0)<br>(6) |
|---|---|---|---|---|---|---|
| Board experienced death | 0.067* | -0.10** | -0.096** | -0.028 | 0.26*** | 0.022 |
| | (0.038) | (0.041) | (0.043) | (0.064) | (0.034) | (0.13) |
| Log capital raised | -0.065*** | 0.0052 | 0.055*** | | 0.20*** | 0.75*** |
| | (0.0033) | (0.0037) | (0.0042) | | (0.0039) | (0.016) |
| Observations | 33657 | 33657 | 27800 | 10949 | 27923 | 10944 |
| Mean dep. var. | 0.31 | 0.52 | 0.63 | 0.66 | 1.96 | 4.84 |
| # startups | 17944 | 17944 | 14490 | 5226 | 14554 | 5221 |
| # startups w/ death | 212 | 212 | 181 | 77 | 181 | 77 |
| $R^2$ | 0.17 | 0.19 | 0.13 | 0.17 | 0.34 | 0.52 |
| VC FE | Y | Y | Y | Y | Y | Y |
| First fin. year FE | Y | Y | Y | Y | Y | Y |
| Founding year FE | Y | Y | Y | Y | Y | Y |
| Industry FE | Y | Y | Y | Y | Y | Y |
| State FE | Y | Y | Y | Y | Y | Y |

Table 6: Capital raising around death events

Notes: The table reports OLS regressions of startup-year or startup-director-year outcomes on the main independent variable "Post-death", which is one if the startup experienced a death in the past. The unit of observation is either the startup-year (columns 1 and 3) or startup-investor(director)-year (columns 2 and 8). The VC investor associated with the deceased director is assumed to keep the board seat unless we have data indicating otherwise. Treatment with "Post-death" impacts all investors (or years) with board seats after the death event. The variable "Board experienced death" is one if the startup ever experienced a death. The outcome variable in the first four columns is a dummy variable that is equal to one if the startup raised a new round of financing in that year. In the last four columns, the dependent variable is the log of the capital raised in a completed financing scaled by the previous capital raised amount (the "capital ramp"). The control "Log total capital raised" is the log of cumulative capital prior to the current year. "VC FE" are fixed effect for the VC investor with the board seat. "Round # FE" are fixed effects for the financing round number, "Fin. year FE" are financing year fixed effect, "First fin. year FE" is a dummy for the year the startup first raised VC financing, "Founding year FE" is a dummy for the year the startup was founded, "Industry FE" are dummies for the eight startup industries, and "State FE" are fixed effects for the startup's state headquarters and . Robust standard errors in columns 1 and 3. Standard errors clustered at the startup level in columns 2 and 4.

| | Raised new financing? | | Log $K_t/K_{t-1}$ | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Post-death | -0.076*** | -0.047** | -0.23** | -0.26*** |
| | (0.023) | (0.022) | (0.091) | (0.074) |
| Board experienced death | 0.044** | 0.079*** | 0.11** | 0.15*** |
| | (0.018) | (0.014) | (0.047) | (0.035) |
| Log capital stock (t-1) | -0.11*** | -0.15*** | | |
| | (0.0035) | (0.0018) | | |
| Observations | 117981 | 209386 | 47425 | 89282 |
| # startups | 22653 | 22482 | 18541 | 18204 |
| # w/ death | 222 | 222 | 130 | 130 |
| Mean dep. var. | 0.43 | 0.46 | 0.35 | 0.31 |
| $R^2$ | 0.25 | 0.32 | 0.11 | 0.14 |
| Unit | Startup-$t$ | Director- -startup-$t$ | Startup-$t$ | Director- -startup-$t$ |
| VC FE | N | Y | N | Y |
| Round # FE | Y | Y | Y | Y |
| Fin. year FE | Y | Y | Y | Y |
| First fin. year FE | Y | Y | Y | Y |
| Founding year FE | Y | Y | Y | Y |
| Industry FE | Y | Y | Y | Y |
| State FE | Y | Y | Y | Y |

Table 7: Capital raising around death events: time to closing and valuations

Notes: The table reports OLS regressions of startup-year or startup-director-year outcomes on the main independent variable "Post-death", which is one if the startup experienced a death in the past. The unit of observation is either the startup-year (columns 1 and 3) or startup-investor(director)-year (columns 2 and 4). The VC investor associated with the deceased director is assumed to keep the board seat unless we have data indicating otherwise. Treatment with "Post-death" impacts all investors (or years) with board seats after the death event. The outcome variable in the first two columns is log number of years to close the current financings. In the last two columns, the dependent variable is the log of post-money valuation (if reported). All controls and fixed effects are as defined in Table 6. Robust standard errors in columns 1 and 3. Standard errors clustered at the startup level in columns 2 and 4.

| | Log # yrs. since last fin. | | Log post-money valuation | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Post-death | 0.11*** | 0.099*** | -0.098 | -0.0023 |
| | (0.039) | (0.033) | (0.11) | (0.11) |
| Board experienced death | 0.00057 | -0.0032 | 0.042 | 0.042 |
| | (0.019) | (0.018) | (0.056) | (0.062) |
| Log capital stock (t-1) | -0.0018 | -0.010*** | 0.67*** | 0.60*** |
| | (0.0081) | (0.0029) | (0.0078) | (0.0088) |
| Observations | 51308 | 95966 | 26564 | 50722 |
| # startups | 19163 | 18829 | 13484 | 13152 |
| # w/ death | 142 | 142 | 85 | 84 |
| Mean dep. var. | 0.32 | 0.32 | 4.07 | 4.21 |
| $R^2$ | 0.15 | 0.18 | 0.59 | 0.67 |
| Unit | Startup-$t$ | Director-<br>-startup-$t$ | Startup-$t$ | Director-<br>-startup-$t$ |
| VC FE | N | Y | N | Y |
| Fin. year FE | Y | Y | Y | Y |
| Round # FE | Y | Y | Y | Y |
| First fin. year FE | N | N | Y | Y |
| Founding year FE | Y | Y | Y | Y |
| Industry FE | Y | Y | Y | Y |
| State FE | Y | Y | Y | Y |

Table 8: Investor participation and financing type

Notes: The table reports OLS regressions of startup-year or startup-director-year outcomes on the main independent variable "Post-death", which is one if the startup experienced a death in the past. The unit of observation is either the startup-year (columns 1 and 3) or startup-investor(director)-year (columns 2 and 4). The VC investor associated with the deceased director is assumed to keep the board seat unless we have data indicating otherwise. Treatment with "Post-death" impacts all investors (or years) with board seats after the death event. The outcome variable in the first two columns is a dummy variable that is one if there is at least one new investor in a follow-on financing. In the last two columns, the dependent variable is a dummy variable for whether the financing is a debt, bridge, or corporate round. All controls and fixed effects are as defined in Table 6. Robust standard errors in columns 1 and 3. Standard errors clustered at the startup level in columns 2 and 4.

| | New investor? | | Non-traditional round? | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Post-death | -0.10*** | -0.11*** | 0.085*** | 0.096** |
| | (0.037) | (0.036) | (0.029) | (0.037) |
| Board experienced death | 0.070*** | 0.063*** | -0.020 | -0.044** |
| | (0.023) | (0.021) | (0.019) | (0.020) |
| Log capital stock (t-1) | -0.0045** | -0.019*** | 0.033*** | -0.011*** |
| | (0.0020) | (0.0021) | (0.0046) | (0.0020) |
| Observations | 48340 | 91039 | 51314 | 95966 |
| # startups | 18800 | 18457 | 19166 | 18829 |
| # w/ death | 133 | 133 | 142 | 142 |
| Mean dep. var. | 0.73 | 0.73 | 0.22 | 0.22 |
| $R^2$ | 0.10 | 0.15 | 0.097 | 0.19 |
| Unit | Startup-$t$ | Director--startup-$t$ | Startup-$t$ | Director--startup-$t$ |
| VC FE | N | Y | N | Y |
| Fin. year FE | Y | Y | Y | Y |
| Round # FE | Y | Y | Y | Y |
| First fin. year FE | N | N | Y | Y |
| Founding year FE | Y | Y | Y | Y |
| Industry FE | Y | Y | Y | Y |
| State FE | Y | Y | Y | Y |

Table 9: CEO replacement, employee headcount, and product development

Notes: The table reports OLS regressions of startup-year or startup-director-year outcomes on the main independent variable "Post-death", which is one if the startup experienced a death in the past. The unit of observation is either the startup-year (odd columns) or startup-investor(director)-year (even columns). The VC investor associated with the deceased director is assumed to keep the board seat unless we have data indicating otherwise. Treatment with "Post-death" impacts all investors (or years) with board seats after the death event. The outcome variable in Panel A is log number of years to close the current financings. In Panel B, the dependent variable is the log of post-money valuation (if reported). The control "Log total capital raised" is the log of cumulative capital prior to the current year. "VC FE" are fixed effect for the VC investor with the board seat. "Fin. year FE" are financing year fixed effect, "Industry FE" are dummies for the eight startup industries, "State FE" are fixed effects for the startup's state headquarters and "Round # FE" are fixed effects for the financing round number. Robust standard errors in odd columns. Standard errors clustered at the startup level in even columns.

| | CEO replaced? | | Log # emp. | | Released product? | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Post-death | 0.029$^{**}$ | 0.024 | -0.043 | -0.015 | 0.0091 | 0.022 |
| | (0.014) | (0.020) | (0.047) | (0.10) | (0.014) | (0.036) |
| Board experienced death | -0.028$^{**}$ | -0.029$^{***}$ | 0.032 | 0.0094 | -0.071$^{***}$ | -0.083$^{***}$ |
| | (0.0099) | (0.011) | (0.035) | (0.090) | (0.012) | (0.030) |
| Log capital stock (t-1) | 0.0068$^{***}$ | 0.0073$^{***}$ | 0.30$^{***}$ | 0.32$^{***}$ | 0.016$^{***}$ | 0.023$^{***}$ |
| | (0.0016) | (0.00089) | (0.024) | (0.0075) | (0.0024) | (0.0021) |
| Observations | 59470 | 103725 | 105182 | 193619 | 88980 | 162619 |
| # startups | 13438 | 13256 | 19942 | 19973 | 16024 | 15888 |
| # w/ death | 97 | 97 | 213 | 213 | 154 | 154 |
| Mean dep. var. | 0.047 | 0.051 | 3.63 | 3.74 | 0.83 | 0.83 |
| $R^2$ | 0.033 | 0.055 | 0.35 | 0.33 | 0.20 | 0.26 |
| Unit | Startup-$t$ | Director--startup-$t$ | Startup-$t$ | Director--startup-$t$ | Startup-$t$ | Director--startup-$t$ |
| VC FE | N | Y | N | Y | N | Y |
| Fin. year FE | Y | Y | Y | Y | Y | Y |
| Round # FE | Y | Y | Y | Y | Y | Y |
| First fin. year FE | Y | Y | Y | Y | Y | Y |
| Founding year FE | Y | Y | Y | Y | Y | Y |
| Industry FE | Y | Y | Y | Y | Y | Y |
| State FE | Y | Y | Y | Y | Y | Y |

Table 10: Patenting activity

Notes: The table reports Poisson (columns 1 and 2) and OLS (columns 3 and 4) regressions of startup-year or startup-director-year outcomes on the main independent variable "Post-death", which is one if the startup experienced a death in the past. The unit of observation is either the startup-year (columns 1 and 3) or startup-investor(director)-year (columns 2 and 4). The VC investor associated with the deceased director is assumed to keep the board seat unless we have data indicating otherwise. Treatment with "Post-death" impacts all investors (or years) with board seats after the death event. The outcome variable in the first two columns is number of patents applied for in a year (Poisson model, including zeros). In the last two columns, the dependent variable is a dummy variable for whether the startup applied for a (eventually granted) patent in that year. All controls and fixed effects are as defined in Table 6. Robust standard errors in columns 1 and 3. Standard errors clustered at the startup level in columns 2 and 4.

| | # of patent applications | | Has patent? | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Post-death | -0.33*** | -0.093 | -0.056*** | -0.047 |
| | (0.13) | (0.19) | (0.018) | (0.036) |
| Board experienced death | 0.15** | -0.013 | 0.10*** | 0.083*** |
| | (0.067) | (0.12) | (0.013) | (0.029) |
| Log capital stock (t-1) | 0.61*** | 0.57*** | 0.046*** | 0.049*** |
| | (0.031) | (0.031) | (0.0053) | (0.0022) |
| Observations | 116577 | 196172 | 117981 | 209386 |
| # startups | 21516 | 19916 | 22653 | 22482 |
| # w/ death | 221 | 217 | 222 | 222 |
| Mean dep. var. | 0.79 | 0.98 | 0.21 | 0.24 |
| $R^2$ | | | 0.12 | 0.18 |
| Unit | Startup-*t* | Director-<br>-startup-*t* | Startup-*t* | Director-<br>-startup-*t* |
| VC FE | N | Y | N | Y |
| Fin. year FE | Y | Y | Y | Y |
| Round # FE | Y | Y | Y | Y |
| First fin. year FE | N | N | Y | Y |
| Founding year FE | Y | Y | Y | Y |
| Industry FE | Y | Y | Y | Y |
| State FE | Y | Y | Y | Y |

Table 11: Changes by startup stage at time of death: capital raising

Notes: The table reports OLS regressions of startup-director-year outcomes on the main independent variable "Post-death", which is one if the startup experienced a death in the past. The unit of observation is startup-investor(director)-year. The VC investor associated with the deceased director is assumed to keep the board seat unless we have data indicating otherwise. Treatment with "Post-death" impacts all investors (or years) with board seats after the death event. The variable "Board experienced death" is one if the startup ever experienced a death. The outcome variables are the same as those found in previous tables, now split by the age of the startup measured by the number of financing rounds. The "Early" columns consider the sub-sample of the first four financings of the startup and the "Late" considers all rounds after (so the same startup can be in both sub-samples). The control "Log total capital raised" is the log of cumulative capital prior to the current year. "VC FE" are fixed effect for the VC investor with the board seat. "Round # FE" are fixed effects for the financing round number, "Fin. year FE" are financing year fixed effect, "First fin. year FE" is a dummy for the year the startup first raised VC financing, "Founding year FE" is a dummy for the year the startup was founded, "Industry FE" are dummies for the eight startup industries, and "State FE" are fixed effects for the startup's state headquarters and . Standard errors clustered at the startup level.

| | Raised new financing? | | Log $K_t/K_{t-1}$ | | Years since | | Log post$ | |
|---|---|---|---|---|---|---|---|---|
| | Early | Late | Early | Late | Early | Late | Early | Late |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Post-death | 0.025 | -0.081*** | -0.36*** | -0.20* | 0.098* | 0.11*** | -0.14 | 0.084 |
| | (0.040) | (0.026) | (0.13) | (0.10) | (0.055) | (0.041) | (0.11) | (0.15) |
| Board experienced death | 0.042** | 0.10*** | 0.13** | 0.15*** | 0.0072 | -0.0089 | 0.090 | -0.042 |
| | (0.017) | (0.019) | (0.058) | (0.053) | (0.023) | (0.028) | (0.054) | (0.11) |
| Log capital stock (t-1) | -0.17*** | -0.13*** | | | 0.00036 | -0.045*** | 0.50*** | 0.86*** |
| | (0.0022) | (0.0029) | | | (0.0034) | (0.0055) | (0.0090) | (0.020) |
| Observations | 97832 | 111238 | 53115 | 35604 | 55870 | 39518 | 33422 | 16726 |
| # startups | 20271 | 11305 | 17275 | 7102 | 17928 | 7651 | 11832 | 4434 |
| # w/ death | 89 | 173 | 66 | 97 | 69 | 109 | 45 | 55 |
| Mean dep. var. | 0.40 | 0.52 | 0.45 | 0.097 | 0.32 | 0.31 | 3.92 | 4.80 |
| $R^2$ | 0.44 | 0.22 | 0.17 | 0.096 | 0.23 | 0.17 | 0.63 | 0.70 |
| Unit | Director-startup-$t$ | | | | | | | |
| VC FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Round # FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Fin. year FE | Y | Y | Y | Y | N | N | Y | Y |
| First fin. year FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Founding year FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Industry FE | Y | Y | Y | Y | Y | Y | Y | Y |
| State FE | Y | Y | Y | Y | Y | Y | Y | Y |

Table 12: Changes by startup stage at time of death: investors and patenting

Notes: The table reports regressions of startup-director-year outcomes on the main independent variable "Post-death", which is one if the startup experienced a death in the past. The unit of observation is startup-investor(director)-year. The VC investor associated with the deceased director is assumed to keep the board seat unless we have data indicating otherwise. Treatment with "Post-death" impacts all investors (or years) with board seats after the death event. The variable "Board experienced death" is one if the startup ever experienced a death. The outcome variables are the same as those found in previous tables, now split by the age of the startup measured by the number of financing rounds. The "Early" columns consider the sub-sample of the first four financings of the startup and the "Late" considers all rounds after (so the same startup can be in both sub-samples). The control "Log total capital raised" is the log of cumulative capital prior to the current year. "VC FE" are fixed effect for the VC investor with the board seat. "Round # FE" are fixed effects for the financing round number, "Fin. year FE" are financing year fixed effect, "First fin. year FE" is a dummy for the year the startup first raised VC financing, "Founding year FE" is a dummy for the year the startup was founded, "Industry FE" are dummies for the eight startup industries, and "State FE" are fixed effects for the startup's state headquarters and . Standard errors clustered at the startup level.

| | New inv.? | | Non-trad.? | | # patents | | Patented? | |
|---|---|---|---|---|---|---|---|---|
| | Early | Late | Early | Late | Early | Late | Early | Late |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Post-death | -0.12** | -0.098** | 0.046 | 0.11** | 0.13 | -0.19 | 0.014 | -0.097** |
| | (0.054) | (0.047) | (0.045) | (0.053) | (0.24) | (0.21) | (0.044) | (0.048) |
| Board experienced death | 0.071** | 0.048 | -0.021 | -0.058* | 0.040 | 0.017 | 0.064** | 0.10** |
| | (0.028) | (0.029) | (0.021) | (0.032) | (0.14) | (0.16) | (0.027) | (0.044) |
| Log capital stock (t-1) | -0.032*** | 0.011*** | -0.0030 | -0.030*** | 0.38*** | 0.80*** | 0.038*** | 0.079*** |
| | (0.0023) | (0.0041) | (0.0021) | (0.0044) | (0.024) | (0.049) | (0.0022) | (0.0047) |
| Observations | 53647 | 36797 | 55870 | 39518 | 121588 | 70012 | 132584 | 76554 |
| # startups | 17519 | 7364 | 17928 | 7651 | 19027 | 7074 | 21658 | 7787 |
| # w/ death | 63 | 103 | 69 | 109 | 124 | 139 | 127 | 142 |
| Mean dep. var. | 0.77 | 0.68 | 0.15 | 0.32 | 0.79 | 1.37 | 0.21 | 0.29 |
| $R^2$ | 0.15 | 0.18 | 0.14 | 0.21 | | | 0.17 | 0.23 |
| Unit | Director-startup-$t$ | | | | | | | |
| VC FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Round # FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Fin. year FE | Y | Y | Y | Y | Y | Y | Y | Y |
| First fin. year FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Founding year FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Industry FE | Y | Y | Y | Y | Y | Y | Y | Y |
| State FE | Y | Y | Y | Y | Y | Y | Y | Y |

## Table 13: Stacked regression difference-in-difference

Notes: The table reports stacked difference-in-difference regressions of startup-year. For each deceased partner, a control sample is created using all other startups that are alive at the time of the death event. The death year for this deceased director is used as the sub-experiment's event time. The sample is restricted to five years before and after the death year (the results are robust to using 3 - 10 years). Treated started are those where the deceased director had a board seat at the time of death and at least one year of activity pre-death year. Control startups are those that were alive and had activity at least one year prior to the matched death year. This process is repeated for all deceased director deaths. The outcome variables are as defined in the tables above. All controls and fixed effects are as defined in Table 6. "Sub-exp. startup FE" are fixed effects for the startup-sub-experiment and "Sub-exp. time FE" are fixed effects for the year-sub-experiment time (thus "Post" is not identified). "Round # FE" are fixed effects for the financing round of the startup (or the last financing round number if a year without a financing). Standard errors are clustered at the startup-level (results are similar if clustered at the sub-experiment-startup level).

| | Raised VC? | Log $K_t/K_{t-1}$ | Time since | New inv.? | Non-trad | # Patents |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Post X Experienced death | -0.15*** | -0.21* | 0.11** | -0.033 | 0.018 | -0.089 |
| | (0.025) | (0.11) | (0.050) | (0.043) | (0.036) | (0.16) |
| # startups | 19818 | 16295 | 12850 | 13239 | 17102 | 6898 |
| # w/ death | 215 | 121 | 122 | 119 | 128 | 133 |
| Mean dep. var. | 0.42 | 2.18 | 0.36 | 0.72 | 0.22 | 1.93 |
| $R^2$ | 0.47 | 0.65 | 0.33 | 0.41 | 0.41 | |
| Unit | Startup-$t$ | Startup-$t$ | Startup-$t$ | Startup-$t$ | Startup-$t$ | Startup-$t$ |
| Sub-exp. startup FE | Y | Y | Y | Y | Y | Y |
| Sub-exp. time FE | Y | Y | Y | Y | Y | Y |
| Round # FE | Y | Y | Y | Y | Y | Y |

Table 14: Venture capital firm outcomes: fund outcomes

Notes: The table reports OLS and Poisson regressions of VC firm and fund outcomes. The main independent variable "Post-death" is equal to one if the VC firm (and its funds) experienced a death in the current or past years. "Raised fund?" is equal to one if the VC firm raised a new fund in the year. "Fund size" is the log of a new fund raised in the year (missing if no fund raised). The remaining columns consider the investment activity and outcomes of the VC firms' investments / funds in each year. "Exit value" is the average of exit valuations (when reported) for portfolio firm exits in that year. For this and the following three columns, we use the Poisson pseudo-likelihood regression with multiple levels of fixed effects ("ppmlhdfe" in Stata) to allow for zeros. "# acq." is the number of acquisition exits, "# IPO" is the number of IPOs and "# new inv." are the number of new investments in startups across the VC firm's funds. The last column reports the log of total capital invested by the firm's funds in that year ("Log $ inv."). The control "Log dollars invested t-1" is the lag of total dollars invested, "Log # investments t-1" is the log (plus 1) of the total investments made by the VC firm in the previous year. "Fund seq. FE" are fixed effects for the number of funds raised as of year $t$. Standard errors clustered at the VC firm.

| | Panel A: All death events | | | | | | |
|---|---|---|---|---|---|---|---|
| | Fundraising | | Fund investing | | | | |
| | Raised fund? | Fund size | Exit value | # acq. | # IPO | # new inv. | Log $ inv. |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Post-death | -0.028*** | 0.040 | -67.7* | -0.11* | -0.071 | 0.084 | -0.044 |
| | (0.0090) | (0.12) | (40.5) | (0.060) | (0.083) | (0.052) | (0.064) |
| Log dollars invested t-1 | 0.026*** | 0.062** | 23.3 | 0.27*** | 0.45*** | 0.030** | |
| | (0.0027) | (0.026) | (15.5) | (0.016) | (0.026) | (0.014) | |
| Log # investments t-1 | 0.056*** | 0.069** | -32.0** | 0.043* | -0.054* | 0.42*** | 0.53*** |
| | (0.0048) | (0.034) | (14.5) | (0.024) | (0.032) | (0.025) | (0.017) |
| Observations | 28298 | 2700 | 11719 | 24013 | 16975 | 24752 | 28183 |
| $R^2$ | 0.11 | 0.82 | 0.28 | | | | 0.78 |
| Mean dep. var. | 0.12 | 4.62 | 191.2 | 0.50 | 0.41 | 2.47 | 1.34 |

| | Panel B: Deaths of partners and managing directors | | | | | | |
|---|---|---|---|---|---|---|---|
| | Fundraising | | Fund investing | | | | |
| | Raised fund? | Fund size | Exit value | # acq. | # IPO | # new inv. | Log $ inv. |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Post-death | -0.034*** | 0.20 | -63.9 | 0.011 | 0.031 | 0.11 | -0.10 |
| | (0.011) | (0.17) | (49.9) | (0.070) | (0.11) | (0.067) | (0.091) |
| Log dollars invested t-1 | 0.026*** | 0.062** | 23.3 | 0.27*** | 0.45*** | 0.030** | |
| | (0.0027) | (0.026) | (15.5) | (0.016) | (0.026) | (0.014) | |
| Log # investments t-1 | 0.056*** | 0.068** | -31.8** | 0.044* | -0.053* | 0.42*** | 0.53*** |
| | (0.0048) | (0.034) | (14.5) | (0.024) | (0.032) | (0.025) | (0.017) |
| Observations | 28298 | 2700 | 11719 | 24013 | 16975 | 24752 | 28183 |
| $R^2$ | 0.11 | 0.82 | 0.28 | | | | 0.78 |
| Model | OLS | OLS | OLS | Poisson | Poisson | Poisson | OLS |
| VC firm FE | Y | Y | Y | Y | Y | Y | Y |
| Fund seq. FE | Y | Y | Y | Y | Y | Y | Y |
| Year FE | Y | Y | Y | Y | Y | Y | Y |

# Internet Appendix

Figure A1: Patenting over the startup lifecycle (firms with at least one patent)

Notes: The figure reports the average and median number of patents applied for (and eventually granted) by firm age. The sample includes startups with at least one patent over their pre-exit life.

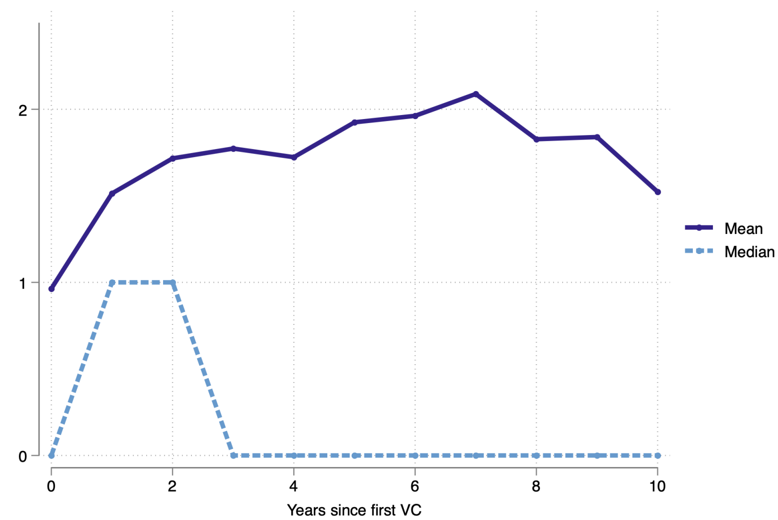


Table A1: Variable definitions

| Variable | Definition |
|---|---|
| Year founded | Year the startup was founded. |
| Year first VC | Year first raised venture capital. |
| First round Series A | Dummy variable for whether the first round raised was a Series A (alternatives are Seed, Angel, Bridge, etc.) |
| First capital raised (m) | The total capital raised in the first financing round. |
| Size of first syndicate | Number of investors in the startup's first financing round. |
| Post-money (first round) | Valuation (m) of the first financing round. |
| Information technology | Dummy variable for whether the startup is in the information technology industry. |
| Business and Financial Services | Dummy variable for whether the startup is in the Business and Financial Services industry. |
| California | Dummy variable for whether the startup is headquartered in California. |
| Massachusetts | Dummy variable for whether the startup is headquartered in Massachusetts. |
| No product at first VC | Dummy variable for whether the startup reports a completed product at the time of first VC financing. |
| Failed | Dummy variable for whether the startup failed as of 2023Q1. If the startup had not raised capital 3 years since its last financing, then we set the firm to failure and use the beta distribution to assign a failure date between 2 and 5 years after the last financing event. |
| Exit value > 2X capital raised | Dummy variable for whether the startup exited at a valuation at least two times capital raised. |
| IPO | Dummy variable for whether the startup had an initial public offering as of the end of the sample (2023Q1). |
| Experienced death | Startup had at least one director death during its life (prior to any exit). |
| Log capital stock $(t-1)$ | The log of the sum of capital raised through the previous year. |

Table A2: Startup outcomes: with and without VC director death that is followed by a new financing

Notes: The table reports startup-level outcomes for the set of firms with at least two financing and restricted to deaths that were followed by a new financing round. The unit of observation is a startup-investor pair and the main independent variable of interest "Board experienced death" is equal to 1 if the startup experienced at least one VC director death from its first VC financing to exit. Startups first financed before 2019 and with at least two financings are included (so there is time for exits and the board has enough activity to have the risk of a death event). "Failed" is equal to one if the startup failed, "IPO / Acq." is a dummy variable for an initial public offering or acquisition. "$> 2X$ if exit" is one if the startup had an exit with a reported exit valuation two times or greater than equity invested (excluding failures). "Yrs. to exit" is the log of the number of years from first VC financing to exit (missing if no exit event). "Log exit value" is the log of exit valuation for non-failed startups. "VC FE" are VC firm fixed effects, "First fin. year" are fixed effects for the startup's first VC financing year, "Industry FE" are eight industry fixed effects and 'State FE" are fixed effects for the startup's state headquarters. Standard errors are clustered at the startup level.

| | Failed<br>(1) | IPO / Acq.<br>(2) | IPO / Acq. if exit<br>(3) | >2X<br>(4) | Yrs. to exit<br>(5) | Log exit value (> 0)<br>(6) |
|---|---|---|---|---|---|---|
| Board experienced death | 0.064 | -0.12** | -0.10* | -0.088 | 0.24*** | -0.15 |
| | (0.046) | (0.048) | (0.053) | (0.084) | (0.041) | (0.16) |
| Log capital raised | -0.065*** | 0.0054 | 0.055*** | | 0.20*** | 0.75*** |
| | (0.0033) | (0.0037) | (0.0042) | | (0.0040) | (0.016) |
| Observations | 33469 | 33469 | 27622 | 10875 | 27744 | 10870 |
| Mean dep. var. | 0.31 | 0.52 | 0.63 | 0.65 | 1.96 | 4.84 |
| # startups | 17870 | 17870 | 14418 | 5196 | 14482 | 5191 |
| # startups w/ death | 141 | 141 | 113 | 48 | 113 | 48 |
| $R^2$ | 0.17 | 0.19 | 0.13 | 0.17 | 0.34 | 0.52 |
| VC FE | Y | Y | Y | Y | Y | Y |
| First fin. year FE | Y | Y | Y | Y | Y | Y |
| Founding year FE | Y | Y | Y | Y | Y | Y |
| Industry FE | Y | Y | Y | Y | Y | Y |
| State FE | Y | Y | Y | Y | Y | Y |