# Investment Allocation and Performance in Venture Capital

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**Keywords:** Venture Capital, Investment Decision, Investment Performance
**JEL Codes:** *G20, G24, G30*

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# 1 Introduction

The performance of venture capital (VC) funds is highly persistent across successive funds managed by the same VC firm (see Kaplan and Sensoy (2015) for a review of evidence). Within this overall pattern of performance predictability, however, we show that there is a stark contrast between the performance of investments within and across the funds of the VC firm. First, there is no persistence in the performance of investments within the same fund. Early investments of a VC fund are more likely to exit successfully via IPOs or acquisitions than its later investments, but the success of the early investments does not predict the performance of a fund's later investments. Second, if a VC firm is successful in raising a new fund, the performance of investments in the VC firm's existing fund, over the same investment period, compares extremely poorly with those in the new fund. Because of the lack of persistence in investment performance within a VC fund, the documented persistence in performance across VC funds is driven almost entirely by their early investments.

What might explain these seemingly contradictory performance patterns? We propose that the sequential and overlapping manner in which funds are raised by VC firms affects their investment decisions. VC funds, organized as limited partnerships, usually have a life of ten years. VC firms that experience investment success, however, often return to investors to obtain capital commitments for follow-on funds well before their existing funds are dissolved. As a result, VC firms will often have overlapping funds and the choice of funds through which to finance and monitor a particular investment. Our contention is that the VC's ability to allocate investments between its new and older funds can account for the empirical patterns noted above. We argue that it may be optimal, in equilibrium, for VCs to direct their better investment opportunities to newly raised funds, despite adverse performance consequences for their older funds. Industry publications suggest that it is a familiar notion that VC funds may be treated differently during periods with overlapping investments. A legal newsletter to VC fund managers and investors, for instance, suggests the potential for conflicts of interest since in "funds with overlapping investment periods... a manager can be incentivized to favor one or more funds it manages over others... depending on how they have been performing or according

to their compensation structure."[1]

We develop our arguments in the context of an equilibrium model in which market participants learn about a VC's ability based on the success of its investments. Investment failure precludes the raising of new funds. Investment success, however, leads to a positive reassessment of VC ability and enables the VC to raise a new fund, along with its existing fund. As new investment opportunities arrive, the VC chooses between allocating more valuable investments to the newly raised fund or its older fund. Our analysis suggests two reasons for why it may be optimal for the VC to allocate higher quality investments to the newly raised fund. The first reason is based on a co-ordination argument regarding learning about VC ability. A VC will allocate higher quality investments and effort to the new fund if it expects to be primarily assessed on success of its new fund's investments. Sustaining the equilibrium, market participants will be especially attentive to the success of the new fund's investments, if these are the focus of the VC's effort and are informative about his ability. Second, the contractual terms (e.g., fund size and profit sharing) of the new fund will tend to be somewhat more favorable to the VC than those of its existing fund. The reason is that the new fund is raised after a successful investment outcome, when the VC is perceived as being of higher quality. These more favorable terms will induce the VC to allocate higher quality investments to its new fund.

We show that investment allocation to favor newly established VC funds has some distinct, testable implications for investment outcomes and fund performance. First, within a VC fund, its earlier investments will be expected to be more successful than its later investments. As VC firms direct their better opportunities to newly raised funds, the performance of later investments in their existing funds will be worse. Second, as a result of investment allocation by VC firms, investments undertaken by a newly raised fund will perform better than concurrent investments in its older funds. Finally, the persistence in performance between the early investments across successive funds of the same VC firm will be stronger than the performance persistence between the early and later investments within the same fund.

For our empirical analysis, we use a sample of VC investments in 17,154 portfolio companies by 4,578 funds that belong to 2,617 VC firms. We focus on investments of VC funds as lead VCs.

[1]See "Managing potential conflicts of interest in investment funds," Lavery CAPITAL, October 2017.

We first document that the early investments of a VC fund are more likely to be successful than its later investments. In particular, the first investment is more likely to exit through an IPO or an acquisition than subsequent investments. We find similar evidence on the investment outcome for a fund's first year investments compared to its later investments. For the full sample of VC investments, 37.1% of the first-year investments exit through IPOs or mergers and acquisitions (M&As), while 28.6% of the later investments exit through the same channels. The relation between the investment sequence of a VC fund and investment outcome cannot be explained by VC firm or fund characteristics, VC fund investment horizon in the portfolio company, or market conditions.

To examine whether and how VC investment allocation affects investment outcomes across funds, we study investment outcomes in a sample of "paired" VC funds: Consecutive funds with overlapping investment periods that are managed by the same VC firm. We focus on pairs of consecutive funds managed by the same VC firm such that the later investment period of the first (existing) fund corresponds to the early investment period of the second (new) fund. We find that, for investments made during the overlapping period, the investments of the second fund are significantly more likely to be successful than those of the first fund. During the overlapping periods, 36.1% of the investments in the new funds exit via IPOs or acquisitions, but only 13.7% of the investments in existing funds do so (9.1% vs. 3.5% in exits via IPOs).

The investment allocation effects are stronger if the early investments of the first fund are eventually successful. When the early investments of the first fund are successful, particularly via an IPO exit, there tends to be a substantial difference in the ensuing concurrent period investment performance between the first and the follow-on funds. By contrast, there is considerably less difference in the concurrent period investment outcomes when the early investments of the first fund are not successful. We also find that the investment allocation effects are more pronounced for experienced VC firms. These results provide additional support for the investment allocation hypothesis. VC firms that have access to high quality projects are more likely to allocate investments across funds.

The allocation of high quality projects across funds can contribute to performance persistence across the successive VC funds. We confirm, using investment outcome as a measure of

VC investment performance, that investment performance is highly persistent across VC funds. Our investigation reveals that such persistence, however, does not exist within a VC fund: early investment success in a VC fund is not correlated with the outcome of its later investments. Consistent with the model's prediction, we show that the early investment success of the preceding fund strongly predicts the early investment success of the subsequent fund and that performance persistence across successive funds is stronger for early investments. In fact, the outcomes of early investments in VC funds are responsible for virtually all of the performance persistence across successive funds.

VC firms typically seek to raise a new fund before the expiration of the existing fund's investment period, and well before the expiration of the existing fund (Gompers and Lerner, 2000). Hence, the outcome or the expected outcome of the early investments can play an important role in attracting investors to a follow-on fund. Not surprisingly, our analysis on VC fund raising shows that early investment outcomes in the current fund are positively correlated with the probability of successful fund raising. The result holds after we include the performance of the VC firm's past funds in the regression. These results suggest that VCs may be especially concerned about a fund's early investment success and regard it as being critical for future fundraising. The fact that information on the overall performance of the current VC fund is unavailable to the market at the time of fund raising also makes such a scenario likely. An emphasis on early success is consistent with the observed investment allocation across funds: VC firms would want to allocate their highest quality investments to the fund that was newly raised.

Overall, the empirical evidence is strongly supportive of the model's predictions. Early investments by a VC fund are more likely to exit successfully than its later investments and the difference in investment performance is at least partly driven by the strategic allocation of investments across successive VC funds. Because VC firms allocate high quality projects to their new funds after investment success in existing funds, the probability of successful exits is much higher for early investments in new funds than for concurrent investments in existing funds. This investment allocation strategy leads to poor performance of later investments of a VC fund, bolsters early investment success of the subsequent fund, and contributes to performance

persistence across funds of the same VC firm.

Our findings shed light into VC fund performance persistence. Existing studies generally attribute VC fund performance persistence to VC managerial skills (see, e.g., Kaplan and Schoar, 2005, Harris *et al.*, 2014, Ewens and Rhodes-Kropf (2015)) or the matching of VC skills with the quality of portfolio firms (Sørensen, 2007). Our findings suggest that VC fund performance persistence may be affected by factors other than just VC managerial skills. Strategic investment allocation across funds by VC firms has the effect of smoothing performance across funds and can contribute to observed fund performance persistence. Hochberg, Ljungqvist, and Vissing-Jørgensen (2014) argues that investors (limited partners) in existing VC funds may enjoy hold-up power over VC firms in fund raising and fee setting. While Hochberg, Ljungqvist, and Vissing-Jørgensen (2014) intends to explain why VC investor demand does not eliminate (after-fee) performance persistence, we show that VC investment allocation behavior directly contributes to (before-fee) performance persistence. Furthermore, our model and evidence suggest that VC firms, through investment allocation decisions, could constrain the hold-up power of the existing investors.

The findings in the paper are particularly important for the interpretation of the evidence on the performance persistence of overlapping funds. Phalippou (2010) and Korteweg and Sørensen (2017) argue that exposure to common macroeconomic and financial conditions could lead to spurious performance persistence in the partially overlapping funds. Korteweg and Sørensen (2017) estimates that the overlapping effect accounts for a substantial portion (44%) of the observed autocorrelation in VC fund returns. Our findings, based on the outcome of the individual investments made during the overlapping period, show that there is little correlation between the investment performance of the successive funds over the same period. The results suggest that the overlapping effect in VC performance persistence is not solely due to the exposure to common factors. The overlapping structure of successive funds can in fact help to create correlations in returns through investment allocation across these funds.

Our paper is related to recent studies that examine how fundraising incentives affect the actions of VC funds. Several papers suggest, for instance, that VC funds distort reported performance prior to fund raising. Jenkinson et al. (2013) show that reported VC interim

returns are inflated during fundraising, and Chakraborty and Ewens (2015) find that VC firms delay revealing negative information about fund performance until after a new fund is raised. Barber and Yasuda (2017) find that some VC firms manage reported fund investment valuation in order to raise new funds. These studies examine the effects of fundraising incentives on investment valuation or reported returns by the VC firms. Our results show that such incentives can affect VC investment decisions, both in the current fund and in the newly raised fund.

Our study on VC investment decisions expands the literature that examines agency problems in VCs' investment and exit decisions in relation to the finite life span of VC funds and the fundraising incentives of VC firms. For example, Gompers (1996) and Lee and Wahal (2004) document the effects on VC exit decisions, while Lerner (1995) and Tian (2012) provide evidence on syndicate decisions. Kandel, Leshchinskii, and Yuklea (2011) show that the finite life span of VC funds could lead to inefficient VC investment decisions, e.g., abandoning good projects when VC funds "age." We show that fund raising incentives have significant impacts on overall VC investment decisions, both within and across VC funds.

The sequential and overlapping manner in VC fund raising and VC investments have aroused concerns from investors and regulators. Recently, SEC's enforcement program has targeted "crossover" investments in the private equity industry.[2] In these "crossover" investments, a fund joins the follow-on financing rounds of investments made by another fund from its VC firm. The success of the investment can then be shared by both funds. Conflicts of interest issues can arise in "crossover" investments due to different investment horizons of the VC funds, difficulties in the valuation of the portfolio company, and the distribution of costs and fees among the funds. Compared with "crossover" investments by VC funds, investment allocation across funds may not trigger immediate concerns of conflicts of interest, but could have implications for both VC-investor relations and VC-entrepreneur matching.

[2]See, "Securities Enforcement Forum West 2016 Keynote Address: Private Equity Enforcement", https://www.sec.gov/news/speech/private-equity-enforcement.html

# 2 A Model of VC Investment Allocation

We sketch a stylized model to develop our intuition and empirical predictions about VC investment allocation within and across successive funds of a VC firm. VC firms allocate high quality projects to their newly raised funds in equilibrium. While investment quality is known only to VCs, investors rationally anticipate the allocation of investments in equilibrium.

## 2.1 Set-up

We consider a VC firm that, conditional on the success of its investments, engages in raising (and closing) funds over time. For simplicity, each fund is taken to have a fixed life of two periods (with three dates). The VC can undertake investments in both periods of a fund. The VC can also undertake concurrent investments in different funds, if more than one fund is being managed. All agents are taken to be risk-neutral and the discount rate is set to zero.

Figure 1 illustrates the sequence of funds operated by the VC firm, with two funds operating at a time. The two-fund assumption is made for tractability and can be justified (discussed below) on account of limited investment opportunities and cost of fund raising. As shown in the figure, the first investment round of a new fund (if successfully raised) is concurrent with the second investment round of the prior fund. For instance, at $T = 0$, Fund-1 makes its first investment while Fund-0 makes its second investment. This structure allows for concurrent investments and, thereby, allocation of investments across funds (indicated by dotted lines in Figure 1).

### 2.1.1 Fund Timing and Investments

We describe fund timing and investment in the context of a representative fund, say Fund-1 in Figure 1. Fund-1 is raised on date $T = 0$, while the prior fund, Fund-0, is in its second period. At $T = 0$, Fund-1 makes its initial investment, while Fund-0 makes its second (and final) investment. Investment outcomes become known one period after the investment is made. For Fund-1 the outcomes of investments made on dates $T = 0$ and $T = 1$ become known to the VC and Limited Partners (LPs) on dates $T = 1$ and $T = 2$, respectively. We assume that there is no shirking, diversion or other types of agency problem between the VC and LPs. To

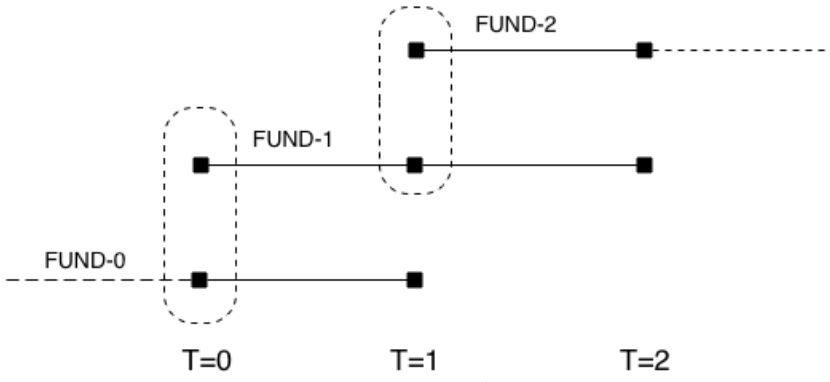


*Figure 1: Fund Sequence & Investment Allocation*

simplify the exposition, the capital required for each portfolio firm investment is normalized to \$1. To fix the size of each fund, we assume that in any period the first \$2 can be raised from LPs at a normalized cost of zero, with marginal costs increasing sharply thereafter, limiting the viable size for a VC fund to \$2. In addition, there is a fixed cost $K$ associated with creating a fund. We assume that the anticipated return to LPs can be normalized to 0.[3]

### 2.1.2 Investment Opportunities

Investment outcomes are affected by the VC's ability that can be either $g$ (good) or $b$ (bad). There are two types of investments: High-quality investments (type-$H$) and more "ordinary" or mundane investments (type-$O$). Both investment types deliver a payoff of $V$ if successful, and zero otherwise. The quality of the investment is observable to the VC, though not to LPs and other market participants. The type-$O$ investment is successful with probability $\eta > 0$ and, given the mundane nature of the investment, its likelihood of success is not affected by the VC's ability. However, VC's ability is critical for the success of type-$H$ investments (these require superior venture-related skills): a $g$-type VC ($b$-type VC) is successful with a type-$H$

[3]We abstract away from modeling bargaining between existing LPs and potential outside investors, as in Hochberg, Ljungqvist, and Vissing-Jørgensen (2014). By assuming that existing LPs have better information about VC ability and fund outcome, it is possible to introduce bargaining in our model. However, this would not provide any additional insight into investment allocation between funds, as long as it was not possible to contract on project quality.

investment with probability $\pi_g$ ($\pi_b$). We assume $\pi_g > \eta > \pi_b > 0$.

Market participants (including the VC) do not have precise knowledge of the VC's ability and update their beliefs based on investment outcomes over time. The likelihood of the VC being $g$-type at time $t$ is denoted by $\theta_t$, which can be interpreted as a measure of the VC's reputation. The VC firm receives a flow of two potential investment opportunities on each investment date, where one is of type-$H$, while the other is type-$O$. The NPV of the two types of investments can be described as follows:

At $T = 0$, the VC has a perceived ability of $\theta_0$, where $\theta_0$ is assumed to be sufficiently high to enable the VC to raise Fund-1. Investment by the VC in a type-$H$ investment at $T = 0$ is expected to generate a NPV of:

$$Q_H(\theta_0) = [\theta_0 \pi_g + (1 - \theta_0)\pi_b]V - 1 \qquad (M1)$$

We define $\theta^*$ such that $Q_H(\theta^*) = 0$. Given fixed costs for raising a new fund, a VC that is perceived as having ability $\theta \leq \theta^*$ will no longer be able to raise a new fund on the basis of type-$H$ investments.

The other type of investment, type-$O$, is assumed to have a marginally positive NPV, i.e., $Q_O = \eta V - 1 > 0$. The NPV of type-$O$ investments is taken to be small so that VCs of low ability ($\theta \leq \theta^*$), who might be expected to invest only in type-$O$ projects, are precluded from raising funds. Specifically, the fixed cost of raising a fund exceeds the NPV of two type-$O$ investments: $K > 2Q_O$. As a result, a VC that is believed to be of low quality will be unable to raise new funds.

### 2.1.3 Learning About VC ability

We next characterize learning about the VC's ability. At $T = 0$, the VC's perceived ability $\theta_0$ is assumed to be sufficiently high so that it is optimal for the VC to undertake the type-$H$ investment at $T = 0$ (i.e., $Q_H(\theta_0) > Q_O$.) We analyze the conditions for an equilibrium in which the VC always chooses to allocate the type-$H$ investment to its newly raised fund – and its ability is assessed on the basis of the outcomes of the investments in newly raised funds. While the VC knows the investment type, LPs and other market participants assume that the VC allocates the type-$H$ investments to the new fund in equilibrium and update their view on

his ability accordingly. On date $T = 1$, when the outcome (success or failure) of the initial Fund-1 investment becomes known, the VC and existing LPs update their beliefs regarding the manager's type using Bayes's rule (recall that only type-$H$ investments are informative of VC ability).

*If Fund-1's initial investment fails at T=1*

If the initial investment in Fund-1 fails, the posterior on the manager's type will be:

$$\theta_1^- = \frac{\theta_0(1-\pi_g)}{\theta_0(1-\pi_g)+(1-\theta_0)(1-\pi_b)} < \theta_0. \qquad (M2)$$

The updating is based on the expected equilibrium allocation by the VC. For simplicity, we assume that the posterior $\theta_1^- \leq \theta^*$, which results in the VC being unable to raise follow-on funds.[4] The VC chooses the type-$O$ investment in Fund-1 on date $T = 1$ (since the $Q_H(\theta^-) < 0$). At date $T = 2$, the fund is closed, assets are distributed and the sequence of fund raising/closing comes to an end.

*If Fund-1's initial investment is successful:*

On the other hand, if the first investment is successful, the posterior on VC ability $\theta_1^+$ is given by:

$$\theta_1^+ = \frac{\theta_0\pi_g}{\theta_0\pi_g+(1-\theta_0)\pi_b} > \theta_0. \qquad (M3)$$

In the above equation, the denominator represents the likelihood of a successful outcome, while the numerator represents the likelihood that the successful outcome was associated with a $g$-type VC.

If the initial Fund-1 investment is successful, the VC is expected to be able to raise the follow-on Fund-2 at $T = 1$.[5] As before, the VC firm is assumed to receive two potential investment projects (of types $H$ and $O$) at $T = 1$ . In the allocation equilibrium we propose below, the VC firm will allocate the type-$H$ investment to the new Fund-2 and allocate the type-$O$ investment to Fund-1.

[4]This will be the case if, for instance, $\frac{1-\pi_b}{1-\pi_g}$ is sufficiently large. With $\theta_1^- \leq \theta^*$ and the fixed cost of establishing a new fund, the existing LPs will be unwilling to reinvest in the new fund. Hence, in equilibrium new investors will also choose not to provide capital.

[5]This follows since $\theta^+ > \theta_0$ and the (starting) assumption is that Fund-1 was raised at $t = 0$ with VC ability perceived to be $\theta_0$.

## 2.2 VC Firm Investment Allocation in Equilibrium

We propose the existence of an equilibrium, in which the VC firm allocates investments across successive funds – and where its ability to raise a new fund is strongly affected by the success of early investments in its funds. For expositional ease, we list below the salient attributes of this allocation equilibrium. We follow the various stages of Fund-1 that is raised at date $T = 0$ (see Figure-1). In Appendix A, we discuss the attributes of the equilibrium more fully, along with necessary conditions for such an equilibrium to exist.

**Fund-1 Investment/Outcome Cycle (T=0,1 & 2)**

1. **On date $T = 0$:**
   - VC raises \$2 for new Fund-1.
   - VC firm allocates its type-$H$ and type-$O$ investments. Only VC knows investment type.
     - Allocates Type-$H$ investment to newly raised Fund-1.
     - Allocates Type-$O$ investment to the existing Fund-0 (its second and last investment).
2. **On date $T = 1$:**
   - Success or failure of Fund-1's initial investment (type-$H$) observed by VC and LPs.
     - *If Fund-1's initial investment is successful:*
       * LPs' posterior on VC ability is higher ($\theta_1 > \theta_0$) and new Fund-2 is raised.
       * Cycle of investment allocation repeats.
     - *If Fund-1's initial investment fails:*
       * LPs' posterior on VC ability: $\theta_1 < \theta^*$. (assumption on model parameters).
       * VC firm is unable to raise new Fund-2.
       * VC firm allocates remaining \$1 to type-$O$ investment in Fund-1.[6]
   - Fund-0 is closed & its assets distributed.
3. **On date $T = 2$:**
   - On date $T = 2$, Fund-1 is closed and assets distributed.

[6]Since $H$-type investment has a negative NPV when $\theta_1 < \theta^*$, the VC does not invest in any $H$-type investments.

The equilibrium is discussed in more detail in Appendix A. As we discuss, there are two related reasons for why it is incentive-compatible for VCs to allocate higher quality investments to newly raised funds. The first is that a VC has no reason to deviate from the equilibrium allocation if he expects to be primarily assessed by LPs on the basis of initial investments in the new fund. Second, the contractual terms of new funds, since they tend to be raised following successful outcomes in prior funds, will be somewhat more favorable to the VC than those on existing funds. These more favorable terms will induce the VC to allocate higher quality investments to its new fund.

### 2.3 Testable Predictions:

The above model delivers several predictions that we will test in our subsequent empirical analyses. The first two predictions follow directly from the proposed equilibrium in which the allocation results in the superior ($H$-type) investment being undertaken in the newly raised fund.

**Prediction-1:** *The success rate of the first project (or early projects) in a fund will be greater than the success rate of the second project (or later projects) in the same fund.*

**Prediction-2:** *Among concurrent projects, better quality projects will be allocated to the new fund, implying that the success rate of the new fund's initial investments will be greater than concurrent investments in the prior fund.*

For our next prediction, we note that the difference in probability of success across concurrent projects is expected to be greater when the VC's assessed ability is higher. The reason is that a larger $\theta$ is associated with a greater likelihood of success, while the type-$O$ investment is unaffected by $\theta$. Hence, a greater difference in success outcomes will be evident for funds with higher perceived VC ability. We state:

**Prediction-3:** *The allocation effect across funds will be more apparent when the VC has a greater assessed ability.*

Finally,

**Prediction-4:** *The persistence in performance between the first (or early) investments across successive funds of the same VC firm will be stronger than the performance persistence between the first (or early) and second (or later) investments in the same fund.*

This follows directly from the nature of investment allocations in the proposed equilibrium. The type-$H$ investments tend to be early investments in newly formed funds, while the type-$O$ investments are taken up at later stages in the fund's life. The correlation between the outcomes of the early ($H$) investments in consecutive funds of a VC firm will be greater than between its early ($H$) and later ($O$) same-fund investments.

# 3 Data

The data pertaining to the sample of VC-backed portfolio companies and their VC investors (both at the fund and firm level) come from the SDC VentureXpert database. Most of the VC funds are organized as limited partnerships with a 10-year horizon. Therefore, in order to fully track the performance of a VC fund's investment sequence over its 10-year life, we obtain the data of all U.S. based VC funds that started between 1975 and 2000.[7] For each VC fund, we obtain the sample of portfolio companies for which the VC fund is the lead investor. We focus on investments in which the VC fund serves as lead investor because of our interest in the investment selection and allocation decisions of VC funds. Following the literature, we identify the lead VC as the investor whose VC fund made the largest investment in the first financing round of the portfolio company. If multiple VC funds meet this criterion, the one that made the largest overall investments in the portfolio company in question is identified as the lead VC. The final sample contains 17,154 portfolio companies lead-invested by 4,578 funds that belong to 2,617 VC firms.

Table 1 provides the summary statistics of the characteristics of VC firms and their funds and portfolio companies in the full sample. On average, a VC fund serves as the lead investor of 3.75 portfolio companies throughout its life with a median of two portfolio companies. At the VC firm level, the average number of companies invested in as a lead investor by a VC firm

[7] We define a fund's starting year as the earlier of (1) the fund's vintage year obtained in the VentureXpert database, and (2) the year in which the fund makes its first investment.

amounts to 6.55 in the sample. In what follows, we describe in detail the variables we specify at the VC fund, VC firm, and portfolio company levels.

### 3.1 VC funds and VC firms

We first describe the variables that represent the characteristics of VC funds and VC firms. At the fund level, we obtain fund size and a seed or early stage fund dummy variable that is equal to 1 if the fund's investment focus is seed or early stage companies. These characteristics are correlated with VC investment strategy and performance. The literature finds, for instance, that the size of a VC fund is related to investment performance at the fund or portfolio company level (Kaplan and Schoar, 2005, Sørensen, 2007, Hochberg, Ljungqvist, and Lu, 2007). On the other hand, VC funds that focus on seed or early stage companies could perform worse because of the high failure rates of these types of investments (Hochberg, Ljungqvist, and Lu, 2007). Table 1 reports that the average fund size in the sample is 250.24 million dollars. Further, 30.97% are seed and early startup funds. At the firm level, the mean capital under management for the VC firms is 1,069.99 million dollars based on information at the end of the sample period.[8]

### 3.2 Portfolio companies

In order to understand whether a VC fund's earlier investments perform differently than its later investments, we first determine the chronological order of the portfolio companies in a VC fund's investment sequence, using dates of the first financing rounds of the portfolio companies.[9] We then identify the portfolio company that is the first lead investment in the VC fund's investment sequence.[10] We also categorize a VC fund's first-year lead investments, which are made by the VC fund during the one-year period beginning from the start date of the fund or the date of its first investment. As reported in Table 1, 17.70% of the 17,154 portfolio companies are first investments for VC funds, whereas 43.71% of these companies are first-year investments.[11]

[8] Throughout this paper, all the dollar amount figures are adjusted for inflation and expressed in 2016 dollars. Our main results remain unchanged without the inflation adjustment.

[9] For some portfolio companies, we find the date of their first financing rounds to be earlier than the first investment date of their lead VC fund. In these cases, we define the starting dates of these portfolio companies as their lead VC fund's first investment date.

[10] If there are multiple portfolio companies starting on the same date and are the first in the fund's investment sequence, then all these companies are categorized as first investments.

[11] In some cases, a VC fund invests in only one portfolio company. We exclude these investments as "first investments," "last investments," or "first-year investments." Excluding these "sole" investments does not materially

Table 1 reports that VC funds invest an average of $8.66 million in their portfolio companies (when such information is available from the data source). Among all the portfolio companies, slightly over sixty percent are seed or early stage companies.

### 3.3 Investment outcomes

We measure the performance of a VC fund based on the outcomes of its portfolio companies, specifically by whether there are successful exits through initial public offerings (IPOs) or mergers and acquisitions (M&As).[12] Following Hochberg, Ljungqvist, and Lu (2007), we determine the exit date of a portfolio company to be the earlier of (1) its exit date and (2) the end of the fund's 10-year life. If a portfolio company is not exited by the end of the fund's 10-year life, the company is assumed to be written off.

Table 2 describes the distribution of portfolio companies' exits in the full sample. In Panel A, for the overall sample of VC investments, 8.60% of the portfolio companies went public via IPOs, whereas 23.73% of them exit through mergers and acquisitions. The remaining 67.68% of portfolio companies are write-offs.

## 4 VC Investment Allocation and Investment Outcome

In this section, we present evidence on the patterns of VC fund investments and investment outcomes based on the predictions of our VC investment allocation model. We first document the relation between VC investment sequence and investment outcome within a VC fund. We then study investment allocations across funds of the same VC firm. In particular, we examine whether investments undertaken in new funds of a VC firm tend to be more successful than concurrent investments in existing funds. We provide additional evidence on the pattern of investments and investment performance conditional on the outcome of early fund investments and the reputation of VC firms.

change the main results.

[12] Smith *et al.* (2011) empirically examine the the contribution of IPO and M&A exits to overall VC fund performance. For literature that employs a portfolio company's successful exit as a measure of investment performance, see Sørensen (2007), Hochberg, Ljungqvist, and Lu (2007), Nahata (2008), Nanda, Samila, and Sorenson (2017), among others.

### 4.1 Full sample results

We study the relation between investment sequence and investment success within funds and test whether the first or early investments are more likely to be successful (Prediction-1). In Table 2, Panel A reports the distribution of investment outcomes for the full sample of 17,154 portfolio companies, while Panel B provides information on the investment outcomes of portfolio companies based on the sequence of VC fund investments.

As indicated in Table 1, in our sample, the mean number of companies a fund invests in as lead VC is 3.75, and the median is 2. Our analysis focuses on the investment decisions and outcomes of lead VC funds and we take their first investments as our main proxy for early investments. Panel B highlights some systematic differences between the outcome of the first and the later investments. On average, 9.58% of funds' first investments as lead VC exit successfully via IPOs. In comparison, 6.17% of VC funds' last investments exit successfully via IPOs. The IPO exit rate for the funds' first investments is significantly higher than the exit rates of their other investments (8.39%). We obtain similar results when we use a VC fund's first-year investments as an alternative measure for early investments. The results show that 9.68% of VC funds' first-year investments exit successfully via IPOs, compared with 7.76% IPO exit rates of investments after the first-year. These univariate findings are supportive of Prediction-1.

Results based on an alternative measure of successful exits using both IPO and M&A exit rates in Panel C are consistent with those measured solely by IPO exits in Panel B. For instance, 34.16% of VC funds' first investments exit through IPOs or M&As, while 26.31% of the last investments do so. Similarly, VC funds' investments in the first year have a successful exit rate of 37.14%, while the remaining investments have a 28.58% exit rate.

We next turn to a multivariate setting, in which we test whether an investment's success rate is related to its position in a fund's investment sequence. In Table 3, we report the results from Logit regressions of a portfolio company's exit outcome on its position in the VC fund's investment sequence, while controlling for a variety of fund and portfolio company characteristics as well as market conditions. In the first set of results (Models 1-4), the dependent variable

is equal to 1 if the portfolio company's exit is through an IPO, and zero otherwise. We define several binary variables to specify the sequence of the investments. "First Investment Dummy" is an indicator variable that is equal to 1 if the portfolio company is the first investment in the sequence. If there are multiple portfolio companies that start on the same date and are the first in the sequence, then all the companies are categorized as first investments. We also define a "First-year Investment Dummy" variable that equals 1 if the portfolio company is invested in within the first year after the start of the VC fund. Finally, to capture a VC fund's overall investment sequence and the associated outcome, we further specify an "Investment Sequence Number" using the portfolio company's position in the investment sequence, scaled by the total number of the VC fund's investments.

Panel A reveals that earlier investments are more likely to be successful as measured by exits through IPOs. Specifically, the results indicate that the sequence of fund investments is related to outcome success. Model 1 suggests that the first investment of a VC fund is significantly more likely to exit via an IPO than later investments, while Model 2 finds the same result after controlling for VC firm fixed effects. Including VC firm fixed effects allows us to control for the effect of time-invariant VC firm characteristics (e.g., VC "ability") that are not captured by the variables in the regression. Model 3 presents the results based on the alternative First-year Investment dummy, and the results show that a VC fund's investments in the first year are more likely to exit via an IPO than later investments. In Model 4, we include the Investment Sequence Number. The sequence number has a significantly negative coefficient, indicating that, based on the full investment sequence, later investments are less likely to be successful. Supportive of Prediction-1, the results confirm that a VC fund's early investments have a higher probability of a successful IPO exit.

The median number of VC fund investments is 2 and, not surprisingly, many funds as lead VCs have only a single portfolio company. In untabulated results, in addition to the first investment dummy, we include an indicator variable in the regression for cases in which the VC firm has a single investment. While a VC fund's only investment is also more likely to exit through an IPO, including the dummy variable does not affect outcome results for first or the first-year investments. Further, in unreported results we find that, when the Investment Se-

quence Number and the First (or First-year) Investment dummy are included in the regression, both of them remain significant. This finding suggests that the declining probability of success is not restricted to the beginning of the investment sequence.

In the regressions in Table 3, we include a "Fund Sequence" variable that is related to VC firm experience. "Fund Sequence" is the sequence number of a VC fund in the series of funds raised by the VC firm. "Fund Sequence" is significantly related to investment outcome: VC firms that have raised more funds in the past are more likely to exit their investment successfully. Not surprisingly, after controlling for VC firm fixed effects, this variable loses significance. For IPO exits, fund size is not related to investment outcome, but the dollar amount of investment in the portfolio company predicts investment outcome. However, because fund investment in a company reflects both the size of the initial investment and the later accumulated investments, the investment size effect correlates highly with project quality (Nahata, 2008). We obtain stronger results for early investments if we do not include the fund investment variable in the regression. Finally, at the market level, overall IPO activity also has considerable impacts on VC exits via IPOs (Gompers *et al.*, 2008).

Acquisitions by both public and private companies constitute a sizable portion of VC investment exits, as indicated in Table 2. Though generally viewed as a less satisfactory outcome than an IPO, particularly in the early periods of the venture capital industry (see Sahlman, 1990), exits through M&As appear to have replaced IPOs as the most important exit choice by VCs. While IPOs typically generate the highest returns for VC investments, highly priced acquisitions can also provide strong returns (Hall and Woodward, 2010). In Models 5 to 8 in Table 3, Panel A, we report results based on Logit regressions where the dependent variable is equal to 1 if the portfolio company's exit is through an IPO or through an acquisition. Results from this set of models are largely consistent with those based on IPO exits. The regression results show that investment sequence has significant impacts on investment outcome and that earlier investments are more likely to be successful through IPO or M&A exits. In the remainder of the paper, we use the term IPO/M&A to refer to portfolio company exit through IPOs or M&As.

In our model we argue that the lower probability of success for a fund's later investments

may result from VC firms allocating their better investments to new funds. However, there may be non-mutually exclusive alternative explanations for the lower success rate. One such alternative explanation is that earlier investments may be more likely to succeed as VC funds have a longer investment management period with the earlier investments. Because the earlier investments are less affected by the constraints of a 10-year horizon, the longer incubation periods may allow VC funds to better nurture and develop their investment projects. Hsu (2013) finds that, in a sample of VC-backed IPOs, investments with longer incubation periods have more innovations and are more likely to be successful post-IPO. To examine whether the investment sequence results in Panel A are materially affected by time horizon constraints, we include a "Time to Investment" variable in the regression to control for such effects.

"Time to Investment" is the number of years from the fund's starting year to the year of the initial investment in the portfolio company. It thus provides a measure of the time constraint the fund faces. Based on this measure, VC funds' earlier investments have a shorter time to investment and are less affected by the 10-year time horizon constraints. In all models in Table 3, Panel B, we include the "Time to Investment" variable along with the early investment variables in the Logit regression. In specifications based on IPO exit (Models 1-4), the early investment variables (i.e., First Investment, First-year Investments, and Investment Sequence) remain highly significant, while the "Time to Investment" variable is insignificant. However, in models based on IPO/M&A exit (Models 5-8), both the early investment variables and the "Time to Investment" variable are significantly related to investment outcome. The results, therefore, suggest that the relation between investment sequence and the investment outcome is not simply driven by the time constraints VC funds face in nurturing their investments. While such constraints could play a role in the investment outcome, investment sequence appears to be a much stronger predictor of investment outcome than time constraints.

### 4.2 "Paired" sample results

Our results so far indicate that the investment sequence within a VC fund predicts the investment outcome, i.e., earlier fund investments are more likely to exit successfully. Our hypothesis is that this pattern could be the result of VC firms steering the best investment opportunities

to their new funds (Prediction-2). However, a non-mutually exclusive explanation is that VCs follow a strategy of first investing in the best projects available to them, while deferring less attractive opportunities. The quality of available investments declines if, for instance, there is insufficient arrival of new high quality firms seeking capital. As a result, it is conceivable that VCs go down the ladder in terms of investment quality in their portfolio companies. This would imply that later investments tend to be less successful than the earlier ones, whether undertaken in the same fund or elsewhere in the VC firm. We refer to this as the "diminishing-quality" alternative explanation. While the two explanations are not mutually exclusive, they offer different predictions on the relation between fund investment and investment outcome across VC funds, the relation between early and later investment performance within a VC fund, and the source of performance persistence across VC funds.

The inter-fund allocation prediction of our model offers sharply testable predictions on the relation between investments and outcome success in concurrent periods across funds in a VC firm. Further, if VC firms strategically allocate investment projects across their funds, then any VC-skill-related performance persistence between early and later investments within a fund will be substantially weakened, as indicated by Prediction-4. On the other hand, if there is an overall decline in the quality of investments available to a VC family, as suggested by the declining-quality explanation, we would expect concurrent investments across funds to have similar success rates regardless of the fund sequence in the VC firm. In addition, if there is persistence in outcome success on account of VC skills, we would expect early investment outcomes of a fund to predict later investment outcomes. In this and the next subsection, we seek to test between these explanations by investigating investment outcomes of different funds of the same VC firm over the same time period.

To determine whether VC firms strategically allocate investments across funds, we study VC investment decisions and their investment outcomes in a matched sample of VC funds. From the full sample of VC funds, we form 1,942 "pairs" of sequential funds from the same VC firms. To construct the sample, we select VC funds from the same VC firm based on their funding date sequence, and form a "pair" of two VC funds if the start of the subsequent fund

falls within the investment period of its immediately preceding fund.[13] This subsample includes 1,942 pairs and contains 2,847 unique funds invested by 905 VC firms. For ease of discussion, we refer to the first fund in the pair (i.e., earlier in the VC firm's fund sequence) simply as the "first fund" and the second fund in the pair as the "second fund." Note also that a fund could be included in two pairs as it can be the second fund in one pair and the first fund in the subsequent pair.

From the paired VC funds, we identify VC investments over concurrent investment time periods. The concurrent period includes the two-year period following the start (or the first investment date) of the second fund. The concurrent investments are defined as investments made by both funds during this period. This subsample of funds with concurrent investments includes 2,360 funds invested by the same 905 VCs. In unreported analyses, we adopt the more conservative approach of including the investments of the first fund in the one year period prior to and the one year period following the start of the second fund. Results based on this alternative concurrent period definition are qualitatively similar.

Panel A of Table 4 provides some basic information about the paired sample of VC funds. Because the paired sample is from the VC firms that have successfully raised (at least) a second fund, VC funds in the paired sample are on average larger than the full sample of VC funds and have more investments. The VC firms in the paired sub-sample are also larger than those in the full sample and have more investments.

Panel B shows that the outcome of the investments of the "paired" funds and their investments made during the concurrent periods. Compared with the full sample results in Table 2, the IPO exit rate of 9.13% is slightly higher than the full sample rate of 8.60%, and the M&A rate of 25.01% is also slightly higher than the full sample rate of 23.73%. There is also some difference between the outcome of all investments of the paired funds, and the outcome of the concurrent investments by the paired funds. For concurrent investments, the IPO exit rate is 9.16% and the M&A rate is 26.70%.

[13] In the reported results, we do not explicitly define the investment period of the first fund as we examine the outcome of the investments made by both funds during the same period. In separate tests, we find similar results by restricting the investment period to be the first five years of the first fund. Additionally, this restriction has minimal impact on the sample.

Panel C compares the fund-level outcome of the concurrent investments between the first and second funds in the pair. The IPO exit rate for the concurrent investments of the first fund is 3.51%, while the rate is substantially higher at 9.11% for the second fund. Based on IPO/M&A exits, the exit rate is 13.71% for the first fund, and 36.06% for the second fund. These findings are consistent with Prediction-2 and counter to the declining quality alternative explanation. There is also a notable difference between the outcome of the first fund's pre-concurrent investments and its investments during concurrent period.

Even though VC firms tend to focus on a small number of industries and do not deviate from their key areas of competence (see, for example, Sorenson and Stuart, 2001), individual funds of the same VC firm may choose to invest in portfolio companies of different industries. If such industry switching strategy is actively pursued by the VC firms, it could constrain VC investment allocation and may also affect the results we documented above. We examine VC portfolio industry mix within and across successive VC funds based on the VentureXpert's first-level industry classification of the portfolio companies. For the "paired sample," if we define industry switching at the fund level, i.e., none of the second fund's investments are in any of the industries of the first fund's investments, then almost zero percent of the funds switch industries completely. If we define industry switching at the individual investment level, then close to one quarter of the investments of the second funds are different from any of the industries of the first fund's investments. While the main concern for our analysis is binding industry constraint at the fund level, we include a dummy for investment level industry switching in the regression analysis described below (Table 5). The unreported results show that including the industry switching dummy does not affect the investment allocation results. In fact, the second fund's investments that belong to the same industries of the first fund are more likely to exit successfully. The result is consistent with the evidence documented in Nanda, Samila, and Sorenson (2017) that industry focus is a main determinant of VC investment performance persistence.

Table 5 provides the regression results for the sample of concurrent investments of the paired VC fund sample. For all the concurrent investments in the sample, we specify a dummy variable based on the sequence of the two funds in the pair. If the investment is made by the second fund, the Second Fund Investment dummy variable equals 1 and zero otherwise. The remaining

control variables in Table 5 are the same as those in Table 3 for the full sample. Again, we control for VC firm fixed effects in all the regressions. In Models 1 and 3 in Table 5, the results based on both IPO exits and IPO/M&A exits confirm that investments of the second fund are more likely to exit successfully than the investments made by the first fund during the same period, consistent with Prediction-2. We obtain similar results by using the number of financing rounds as a measure of investment outcome in Model 5.

To ensure the robustness of the results, we re-estimate the models based on the sample of investments of the second fund after excluding its first investment. Note that first investments are more likely to be successful than other investments based on the full sample results. By excluding the first investment of the second fund, we intend to assess whether the results are due solely to the greater success of the first investment. Models 2, 4, and 6 of Table 5 report the results. As we would expect, results from these models are weaker than those in Models 1, 3, and 5. However, even after excluding the first investment of the second fund, the other investments of the second fund during the concurrent period are still more likely to be successful than the investments of the first fund over the same period.

It is possible that, given the shortened investment horizon, the first VC funds may choose to invest in "safer" projects that do not require a long incubation period. However, such an investment strategy can lead to lower returns from the investments, not lower probability of success as measured by the exit outcome. Because the "safer" investments could be more likely to enjoy moderate success (such as M&A exit) and are less likely to be total write-offs. As discussed earlier, using investment exit rather than fund return as a measure of investment performance allows us to examine the outcome of the individual investment decisions.

The results based on the paired VC fund sample confirm the results from the full sample that early investments by VC funds are more likely to be successful. More important, after controlling for the time of investment, evidence on the higher probability of success in the earlier investments of the second fund helps to test between the two explanations, as discussed above. Supportive of Prediction-2, the results show that the relation between investment sequence and investment outcome within a VC fund is not fully explained by a decline in investment quality. The greater success of early investments of the second fund during the same time period when

both funds have access to the projects supports the explanation that VC firms strategically allocate investment projects across VC funds.

### 4.3 Additional evidence

The results from the preceding subsections suggest that VC firms strategically allocate investment projects across funds. In this subsection, we study allocation decisions in the paired VC fund sample, conditional on early investment outcomes and VC firm reputation.

We first examine whether the outcome of the early investment of the first fund affects the VC firm's investment allocation decision across funds. We use the VC fund's first investment to measure the success or failure of VC fund's early investments because it is easy to quantify the outcome of a single investment. In robustness tests, we obtain similar results using the percentage of successful exits or a dummy variable for a successful exit in first-year VC investments.[14] The final outcome of the early investments may not be known to the market or even to the VC managers when the VCs decide to invest in new projects. However, it is likely that VC fund managers may have information on the likelihood of the eventual outcome of the early investment projects. Consequently, the proxy we use to define the success or failure of the project is the actual outcome of the investment.

We examine the outcome of the concurrent period investments by both the first and the second fund, conditional on the early investment outcome of the first fund. Table 6 contains estimates from regressions of the portfolio company's exit for the two sub-samples of "paired" VC funds. In the "Success" sample, the first investment of the first VC fund eventually exits through an IPO. The "Failure" sample contains VC fund pairs where the first investment of the first funds did not exit successfully via an IPO. Again, we include various company characteristics variables and market condition variables in addition to the fund characteristics variables in the regression.

Models 1 and 2 in Table 6 report the results for the "Success" sample. The results show a strong investment allocation effect. If the first investment of the first fund eventually exits successfully, the investments during the concurrent period by the second fund are significantly

[14]From Table 1, the mean number of companies VC funds invest in as lead VCs in is 3.75, and the median is 2. So the first investment also represents a substantial portion of the VC fund portfolio.

more likely to be successful than other investments by the first fund over the same time frame. The results hold for IPO exits and IPO/M&A exits. Note that, in the analysis, we are comparing the investment outcome of two funds that belong to the same VC firms, so the greater success of the second fund's early investments are not due to differences of VC managerial skills across firms. We further include VC firm fixed effects in the regression to control for unobservable time-invariant heterogeneity.

Models 3 to 4 in Table 6 report the results for the "Failure" sample. The results are considerably weaker than the "Success" sample results. When the first investment of the first fund does not eventually exit successfully, the investment during the concurrent period by the second fund is either not significantly different (using IPO exits) or more likely to be successful (using IPO/M&A) than the investments of the first fund over the same time frame. Overall, the investment allocation effects are not as strong in the "Failure" sample as in the "Success" sample. A possible explanation for these weaker results is that the VC firm may be reluctant (or unable) to allocate attractive investment opportunities to the second fund when good performance of the first fund is still not secured.

We next examine whether the fund raising incentives can lead to noticeable differences in investment allocation decisions between experienced and young VC firms. Our model predicts (Prediction-3) that the allocation between funds is likely to be more evident when the VC firm is more established and has stronger reputation. Young VC firms may be of lower ability than established VC firms and, hence, less capable of successful outcomes for investments of similar quality (see Nahata, 2008 and Krishnan *et al.*, 2011). In addition, less reputed VCs may have less access to high quality investment opportunities (see, for example, Hsu, 2004 and Sørensen, 2007). Hence, relative to younger and less reputable VC firms, we would expect the allocation of investments across funds to be more apparent for experienced, more reputable VC firms.

In this paper, we construct the VC reputation (or experience) measure by obtaining, for each portfolio company, the number of financing rounds the lead VC fund's firm has participated in. Such measure of VC reputation is widely used in the existing literature (see Sørensen, 2007, Hochberg, Ljungqvist, and Lu, 2007, among others). As Table 1 shows, the sample average number of financing rounds VC firms participate in is 141.26 with a median of 36. As our

sample period starts from 1975, fewer VC firms have substantial investment experience in the early part of the sample. Throughout the paper, high versus low VC experience is based on the median split.

Models 5 to 8 of Table 6 report the results for the sub-samples of VC firms with high versus low experiences. The results show that experienced VC firms exhibit a greater difference between the investment outcomes of the paired funds. For VC firms with an established history, the investment during the concurrent period by the second fund is significantly more likely to be successful than the investments by the first fund during the same time period. The results again hold for IPO exits and IPO/M&A exits. For young VC firms, the results are considerably weaker: There is no difference in the concurrent investment outcome of the first and second fund based on both IPO exits and IPO/M&A exits in Models 7 and 8.

# 5 Investment Allocation and Performance Persistence

Existing studies show that VC performance is highly persistent across funds of the same VC firms. The studies conclude that VCs possess specialized skills in project selection and/or investment management, and these skills lead to persistence in the performance of their funds over time. VC firms', or more specifically, VC managers' overall skills in attracting, selecting and managing investments can all lead to performance persistence (see Ewens and Rhodes-Kropf, 2015 and Bernstein, Giroud, and Townsend, 2016). Increasing competition among VC firms over time, however, could reduce performance persistence (see Braun, Jenkinson, and Stoff, 2017). In this section we examine whether and how VC firms' investment allocation across funds affects performance persistence and the fund raising activities by the VC firms.

## 5.1 Investment allocation and performance persistence

We first examine whether investment allocation across funds has any bearing on funds' observed performance persistence. If we start from the premise that performance persistence across the funds of a VC firm is primarily a reflection of VC skills, we should expect there to be persistence in the performance of investments undertaken within individual funds (if investment allocation across funds is absent). Hence, the success of early investments of a VC fund should

be informative about the likelihood of its later investments being successful. However, if VC firms actively allocate investments across funds, this could substantially weaken the potential positive correlation between early and later investment outcomes within the same fund. The prediction (Prediction-4) from our model is that persistence in performance between the early and later investments in the same fund will be weaker than those between the first (or early) investments across different funds of the same VC.[15]

Because we rely on investment exits as our measure of performance, we first establish evidence on performance persistence across funds of VC firms based on such exits. The first four models in Table 7 report the relation between the performance of sequential VC funds in our sample based on IPO and IPO/M&A exits. We use dummy variables for IPO and IPO/M&A exits as well as the number of these exits in our analysis. The models examine whether IPO or IPO/M&A investment exits in the first fund predict investment exits in the second fund, after controlling for both VC fund and investment characteristics. The results show that the investment outcomes of the first fund are predictive of the investment outcomes of the second fund, whether the investment outcomes are measured by IPO or IPO/M&A exits. These results on performance persistence based on portfolio company exits are consistent with existing evidence based on VC fund returns. One difference between our results and prior results on VC fund performance persistence is that, by using a VC fund's internal rate of return (IRR), prior studies measure fund performance net of management fee and carried interest, while our measure of fund performance is unaffected by VC compensation.

After establishing the evidence of performance persistence across sequential VC funds in the sample, we examine performance persistence within VC funds. Models 5 and 6 of Table 7 report the results on the relation between early and later investments of the first fund in the paired VC fund sample. We define "early investments" as the investments made by the first fund prior to the concurrent period (as defined earlier) with a follow-on fund, and "later investments" as those during or after the concurrent period. The results show that, based on both IPO

[15]Nanda, Samila, and Sorenson (2017) also examine performance persistence based on the outcome of individual investments but do not distinguish investments across different funds or VC investments as lead VCs or syndicate members. They show that early investment success can affect deal flow and helps to generate VC firm level performance persistence.

and IPO/M&A exits, the outcome of early investments is unrelated to the outcome of later investments. In unreported analyses, we find no relation between early and later investments based on the number of IPOs or IPO/M&As (similar to Models 3 and 4), as very few VC funds have multiple later investment successful exits. Overall, these findings are supportive of the prediction (Prediction-4) from our model.

The contrast between performance persistence within and across VC funds suggests that managerial skills alone do not fully account for the performance persistence across the sequential VC funds.We next examine how investment allocation decisions can directly affect performance persistence across VC funds. In the paired VC fund sample, we specify three investment periods for the two funds: the pre-concurrent, or the early investment period of the first fund (we term this as period A), the concurrent investment period of both the first and second fund, which represents the late investment period of the first fund and the early investment period of the second fund (we term this as period B), and the post-concurrent or late investment period of the second fund (we term this as period C). We examine performance persistence of the VC funds across the sub-periods.

Table 8 reports the results. In Models 1 and 2, we examine the relation between the performance of the first fund's early investments and that of the second fund's early investments. We again use the IPO or IPO/M&A dummies to measure the investment outcomes of the VC funds. The early investments of the first fund are investments made during the period prior to the concurrent period (period A) and the early investments of the second fund are investments made during the concurrent period (period B). The results show that the early investment outcomes of the first fund positively and significantly predict the early investment outcomes of the second fund. The results hold for both IPO and IPO/M&A exits. Comparing the results in these two models with those in Models 5 and 6 in Table 7, we find that even though the early investment success of the first fund does not predict the outcome of later investments by the same fund, it predicts the outcome of the early investments by the second fund of the same firm, made during the concurrent period.

Models 3 and 4 in Table 8 examine the relation between the performance of the first fund's early investments and the overall investment performance of the second fund. We find a signifi-

cant and positive relation between the early investment success of the first fund and the overall investment performance of the second fund for both definitions of success: exiting through IPO and IPO/M&A. The findings in Models 1 to 4 thus support Prediction-4 of our model.

We further examine the extent to which the overall performance persistence between the sequential funds is attributable to the predictive power of the early investment outcome of the first fund. To this end, we consider both the early investment outcome and the later investment outcome of the first fund in explaining the overall investment outcome of the second fund. We again define the early investments as the investments made by the first fund prior to the concurrent period (Period A) and the later investments as those made by the first fund during the concurrent period (Period B).[16] Models 5 and 6 report the results. Both the IPO exits and IPO/M&A exits in the early investments of the first fund significantly predict corresponding IPO exits and IPO/M&A exits in the second fund. In both models, the later investment outcome of the first fund does not have any predictive power on the investment outcome of the second fund when the early investment outcome of the first fund is included in the regression. In Models 7 and 8, we examine whether the later investment outcome of the first fund alone, in the absence of the early investment outcome, explains the overall investment outcome of the second fund. The results suggest otherwise: later investment outcome of the first fund has no predictive power for the overall performance of the second fund. We further examine for evidence of performance persistence in a sample of sequential funds where the second fund starts five years after the first fund starts and the two funds do not have overlapping investment period. In un-tabulated results, we find weak evidence of performance persistence based on the number of IPO/M&A exits and no evidence of performance persistence based on IPO exit or IPO/M&A exit dummies or the number of IPOs.

Phalippou (2010) and Korteweg and Sørensen (2017) argue that exposure to common macroeconomic and financial conditions can lead to spurious performance persistence in the partially overlapping funds. Korteweg and Sørensen (2017), using data on VC fund returns, estimate that the overlapping effect accounts for a substantial portion of the observed autocor-

[16] In a small number of cases, we observe that the first fund also invests in Period C. We did not consider these investments in the reported analysis. But including these investments does not change the results.

relation in VC funds. We examine performance persistence between successive funds based on the outcome of the individual investments during the overlapping period. The deal-level results reveal that there is little correlation between the investment outcome of the successive funds during the overlapping period. The findings in this paper suggest that investment allocation, rather than exposure to common factors, may account for the increased correlations in VC fund returns.[17]

In summary, the results from Tables 7 and 8 provide evidence that investment allocation contributes directly to VC fund performance persistence. Investment performance does not persist between the early and later investments of the same fund, but does persist between funds. The evidence reveals that the performance persistence between the funds of the same VC firm is largely driven by the performance of their early investments. Later investment performance of the current fund, either alone or in combination with early investment performance, is unrelated to the performance of subsequent funds.

### 5.2 Investment outcomes and fund raising activities

In the model, we hypothesize that fund raising incentives leads to allocation of investments across VC funds. In this section, we study the relation between investment outcomes and fund raising activities. Specifically, we examine the impact of early and later investment outcomes on fund raising activities as well as the impact of the most recent investment performance and past fund performance on fund raising. Such an analysis provides a direct link between investment decisions and fund raising incentives and offers further insights on the interaction between fund raising and VC investment decisions.

Efforts to raise new funds start soon after VC firms close the current funds. A VC firm that raises a new fund successfully will typically have done so within three to five years after the start of its previous fund. As a result, the performance of the early investments in the VC's current fund are likely to be particularly important for fund raising. In Panel A of Table 9, we report the effects of early investment success on subsequent fund raising activities for the full

[17]In this paper, we only examine the outcome of the VC investments as lead VCs. The performance of VC investments as members of VC syndicates in which VCs do not exert control in investment allocation could be more affected by common macroeconomic conditions in the overlapping period.

sample of VC funds and for sub-samples of high and low reputation VC funds.

Reputation can serve as an effective mechanism to mitigate the influence of fund raising on investment decisions (see Barber and Yasuda, 2017). Young VCs are particularly subject to effects of fund raising. For experienced VC firms, because they have a long track record and have already established themselves as successful managers, the effects of fund raising on investment decisions in the current fund are likely to be much weaker. Examining fund raising activities and how investment outcomes affect such activities can help us to understand how VC fund investors evaluate fund performance and make investment decisions based on the VC firm's current and past investment performance.

Panel A provides estimates from regressions of VC firms' fund raising based on the outcome of the fund's first or first-year investments. We measure a VC firm's fund raising activity in the five-year period starting from the initial year of its current funds. The dependent variable is equal to 1 if the VC raises the next fund in 5 years, and zero otherwise. Studies on VC fund raising show that VC firms typically start their subsequent funds within three to five year periods after the initiation of previous funds. We use two proxies for the success or failure of the early investments: whether the early investments eventually exit through IPOs or M&As. Table 9 reports results based on IPOs, though results based on IPO/M&As are qualitatively similar. For early investments, we consider both the first investment and first-year investments of the fund.

Panel A presents the main results on the relation between the early investment success of the current VC fund and the subsequent fund raising outcome of the VC firm. For the full sample of VC funds, early investment success in the current fund is positively associated with the probability of successful fund raising. The results hold for both the first investment and first-year investments. We find considerable differences in the relation between investment outcomes and fund raising activity between the sub-samples of experienced and young VCs. The outcome of the early investments has a far stronger effect on the fund raising outcome for the young VCs than for experienced VCs. In Model 2, when early investment success is defined as the IPO exit of first investment, the early investment outcome has a positive though insignificant relation with fund raising outcome for high experience VC firms.

We conduct several additional analyses to verify the robustness of the results. First, we measure fund raising outcomes during the three-year (instead of the five-year) period after the initiation of the previous fund. Results based on fund raising outcome over the three-year period are slightly more pronounced than those in Panel A, and the relation between early investment outcome and fund raising is significant for both high- and low-experience VCs. Second, we include both the early investment success (first and first-year investments) and late investment outcome in the regression. For the full sample of VC funds, the early investment success has positive impact on the probability of fund raising, while the later investment success is marginally significant. To conserve space, we do not tabulate the results.

In Panel B, we include the overall investment performance of the previous VC fund in the analysis to assess the joint effects of past investment performance and current investment performance on fund raising activities. For Table 9, the previous fund is defined as the fund immediately proceeding the current fund. All other variables are the same as in Panel A. Because we require performance information for at least two sequential funds for the analysis, the sample in Panel B is considerably smaller than the sample in Panel A. For the full sample (Models 1 and 2), the results show that both the early investment outcome of the current fund and the overall performance of the previous fund are positively associated with subsequent fund raising. For young VCs, early investment outcome of the current fund seems to have a stronger effect on fund raising. When combined with first-year investment outcome, the performance of the preceding fund does not have any impact on fund raising. For experienced VCs, the early investment outcome does not have significant impacts on fund raising, neither does the performance of the immediate preceding fund.

The results in Table 9 confirm that the investment outcome has a significant impact on fund raising activities. The impact differs for early and later investments and between young and experienced VCs. Such evidence is important for at least two reasons. First, because the outcome of the early investment appears to have a disproportionately large impact on fund raising, VCs could have the incentive to generate early investment success. This could increase the incentive to allocate high quality projects to second fund soon after its initiation. Second, because both the current investment success and the past investment success play an important

role in fund raising activities, VCs have a strong incentive to move high quality projects to the next fund after a successful investment in the current fund.

The fund raising results of experienced and young VCs differ from the results on investment allocation for the two groups of VCs. In the fund raising results, early investment success in the current fund is particularly important for young VCs in their fund raising activity. The results suggest that young VCs face greater pressure to generate a successful early investment outcome. They may thus have a stronger incentive to allocate high quality projects across funds than experienced VCs. Our results indicate that experienced VCs, rather than young VCs, appear to have a stronger tendency to allocate projects across funds. The two sets of results are not necessarily inconsistent with each other. The observed investment allocation decisions could indicate that experienced VCs are *able* to allocate high quality projects across funds because they have better access to quality projects and, in any case, are more likely to be successful for similar quality projects.

# 6 Discussion and Conclusion

This paper studies venture capital investment allocation decisions. We argue, by means of a stylized model, that VC firms have the incentive to engage in strategic allocation of investment projects across VC funds. In particular, following the success of early investments in a fund, VCs are likely to raise financing for a new fund and to allocate higher quality projects to the newly raised fund. As result of such allocation, the model's prediction – for which we find strong support – is that the first (or early) investment(s) of a fund will tend to be significantly more likely to succeed than later investments. Consistent with the allocation across funds, we find that the early investments of a newly formed follow-on fund are much more successful than concurrent investments in a VC's existing fund. Further, consistent with the predictions, these patterns are shown to be more evident for more reputed VC firms.

We show that investment allocation affects VC fund performance persistence. Investment performance does not persist between the early and later investments within the same fund, but does persist across funds. The evidence reveals that much of the performance persistence between the highly successful funds is driven by the success of their early investments and

investment allocation contributes to the persistence of overall VC fund performance.

Strategic investment allocations by VC firms could have implications for both VC-investor relationships and VC-entrepreneur matching. The allocation of investments across funds could be potentially problematic if investors regard this as a form of expropriation. This is less likely to be a concern as long as successful VC firms – the ones with the ability to form new funds – have a relatively stable investor base and the VC performance and fund flow relationship is largely driven by existing investors.

## References


Bernstein, S., X. Giroud, and R. Townsend, 2016, The impact of venture capital monitoring, *Journal of Finance* 71, 1591-1622.

Barber, B. and A. Yasuda, 2017, Interim fund performance and fundraising in private equity, *Journal of Financial Economics* 124, 172-194.

Braun, R., T. Jenkinson, and I. Stoff, 2017, How persistent is private equity performance? Evidence from deal-level data, *Journal of Financial Economics* 123, 273-291.

Chakraborty, I., and M. Ewens, 2016, Managing performance signals through delay: Evidence from venture capital, working paper, University of Miami.

Ewens, M., and M. Rhodes-Kropf, 2015, Is a VC partnership greater than the sum of its partners? *Journal of Finance* 70, 1081-1113

Gompers, P. A., 1996, Grandstanding in the venture capital industry, *Journal of Financial Economics* 42, 133-56.

Gompers, P. A., A. Kovner, J. Lerner, and D. Scharfstein, 2008, Venture capital investment cycles: the impact of public markets, *Journal of Financial Economics* 87, 1-23.

Gompers, P. A., and J. Lerner, 2000, Money chasing deals? The impact of fund inflows on private equity valuation, *Journal of Financial Economics* 55, 281-325.

Hall, R., and S. Woodward, 2010, The burden of the nondiversifiable risk of entrepreneurship, *American Economic Review* 100, 1163-94.

Harris, R., T. Jenkinson, and S. Kaplan, 2014, Private equity performance: What do we know? *The Journal of Finance* 69, 1851-1882.

Hochberg, Y., A. Ljungqvist,and Y. Lu, 2007, Whom you know matters: Venture capital networks and investment performance, *Journal of Finance* 62, 251-301.

Hochberg, Y., A. Ljungqvist, and A. Vissing-Jørgensen, 2014, Informational hold-up and performance persistence in venture capital, *Review of Financial Studies* 27, 102-152.

Hsu, D., 2004, What do entrepreneurs pay for venture capital affiliation? *Journal of Finance* 59, 1805-1844.

Hsu, S., 2013, Technology timing of IPOs and venture capital incubation, *Journal of Corporate Finance* 19, 36-55.

Jenkinson, T., M. Sousa, and R. Stucke, 2013, How fair are the valuations of private equity funds?, Working paper, University of Oxford.

Kandel, E., D. Leshchinskii, and H. Yuklea, 2011, VC funds: Aging brings myopia , *Journal of Financial and Quantitative Analysis* 46, 431-457.

Kaplan, S., and A. Schoar, 2005, Private equity performance: Returns, persistence, and capital flows, *Journal of Finance* 60, 1791-1823.

Kaplan, S., and, B. Sensoy, 2015, Private equity performance: A survey, *Annual Review of Financial Economics* 7, 597-614.

Krishnan, C.N.V., R. Masulis, V. Ivanov and A. Singh, 2011, Venture capital reputation, Post-IPO Performance and corporate governance, *Journal of Financial and Quantitative Analysis* 46, 1295-1333.

Korteweg, A., and M. Sørensen, 2017, Skill and luck in private equity performance, *Journal of Financial Economics* 124, 535-562.

Lee, P. M., and S. Wahal, 2004, Grandstanding, certification and the underpricing of venture capital backed IPOs, *Journal of Financial Economics* 73, 375-407.

Lerner, J., 1995, The syndication of venture capital investments, *Financial Management* 23, 16-27

Nahata, R., 2008, Venture capital reputation and investment performance, *Journal of Financial Economics* 90, 127-151.

Nanda, R., S. Samila, and O. Sorenson, 2017, The persistent effect of initial success: Evidence from venture capital, working paper, Harvard University.

Phalippou, L., 2010, Venture capital funds: flow-performance relationship and performance persistence. *Journal of Banking and Finance* 34, 568-577.

Sahlman, W.A., 1990, The structure and governance of venture capital organizations, *Journal of Financial Economics* 27, 473-521.

Smith, R., R. Pedace, and V. Sathe, 2011, VC fund financial performance: The relative importance of IPO and M&A Exits and exercise of abandonment options, *Financial Management*, 40, 1029-1065.

Sørensen, M., 2007, How smart is smart money? A two-sided matching model of venture capital, *Journal of Finance* 62, 2725-2762.

Sorenson, O., and T. Stuart, 2001, Syndication networks and the spatial distribution of venture capital investments, *American Journal of Sociology* 106, 1546-1588.

Tian, X., 2012, The role of venture capital syndication in value creation for entrepreneurial firms, *Review of Finance* 16, 245-283.

## Appendix A: Allocation Equilibrium

We obtain conditions for the existence of the allocation equilibrium described in Section 2.2.

First, we determine conditions under which investors (existing LPs and new investors) would be willing to invest in the VC's Fund-1 at date $T = 0$. In making their capital commitment, investors/LPs correctly anticipate that, in equilibrium, the VC will allocate the $H$-type investment to the new fund Fund-1 and the O-type investment to the prior fund Fund-0 at date $T = 0$. Given the assumption that type-$H$ investments are informative about the VC's ability while type-$O$ are not, the VC's ability will be reassessed on the basis of the outcome of the first investment in Fund-1. At $T = 1$, the cycle will repeat itself. If the VC raises a new fund Fund-2, he is expected to allocate the type-$H$ investment arriving at date $T = 1$ to next fund that is raised (Fund-2), while allocating the type-O investment to Fund-1. Recall that quality of the investment ($H$ or $O$) is privately observed by the VC and not known to investors or other market participants. Hence, investors beliefs regarding the allocation of projects will strongly affect the updating of VC ability by investors.

Second, given investors beliefs regarding the allocation of investment types in equilibrium, we argue that it will be optimal for the VC (i.e., incentive compatible) to allocate the H-type investment to Fund-1 on date $T = 0$ and to Fund-2 on date $T = 1$.

*Capital Provision by Investors:*

Under the assumption that investors correctly anticipate the investment allocation decisions by the VC (that occur after Fund-1 is raised), we obtain the necessary conditions under which capital will be provided.

At date $T = 0$, the overall NPV of Fund-1 can be expressed as:

$$W_0(\theta_0) = [\theta_0\pi_G + (1-\theta_0)\pi_B]V + \eta V - (2+K) > 0 \qquad (M4)$$

In the equation above, the first term on the right-hand-side is the expected payoff from investment in the type-$H$ project at date $T = 0$, with the VC's ability assessed at $\theta_0$. The second term ($\eta V$) represents the value from investment in a type-$O$ project on date $T = 1$. As we have seen, Fund-1 invests in a type-$O$ project at date $T = 1$, irrespective of whether the fund's initial investment succeeds or not. Existing LPs will be willing to provide a capital of \$2 if the VC offers them a contract in which they expect to recover their investment of \$2. For instance, LPs could be offered a fraction $\beta_1$ of the expected profits such that $\beta_1 W_0 = 2$. The VC will receive the rest of the expected value $(1 - \beta_1)W_0$.

As noted, if the initial project in Fund-1 fails, the assessment of VC's ability falls below $\theta^*$ (from Equation (M2)) and the expected (positive NPV) payoff from a type-$O$ project will be greater than that from a low ability VC investing in a type-$H$ project. If the initial investment in Fund-1 succeeds, the VC's ability will be perceived to be $\theta_1^+$ (from Equation (M3)) and he will be able to raise his next fund, Fund-2.

*VC's Allocation Decision:*

We now discuss why it is rational for the VC to allocate the higher quality investment to the new fund, Fund-1. There are two reasons that emerge from our analysis:

1. The first reason has to do with the updating of VC ability. While the VC is aware of the type of investment, LPs are not. In equilibrium, investors update their assessment about

managerial ability solely based on the outcomes that they believe are influenced by VC's ability. Since, in the proposed equilibrium, the VC is expected to allocate the type-$H$ investment to the new fund, Fund-1, the outcome of the investment in Fund-1 will be important for updating VC's perceived ability – while the outcome of the investment in Fund-0 will be assumed by investors to be of type-$O$ and will not affect their perception of VC ability.

The likelihood of investment success is characterized by $\pi_g > \eta > \pi_b > 0$. Further, Equation (M4) is satisfied in equilibrium. Note that the type-$O$ investment is only slightly positive NPV (not enough to overcome fixed costs $K$ if the only investment is type-$O$), while from Equation (M4) the type-$H$ investment is sufficiently positive NPV to overcome fixed costs. It follows that $[\theta_0\pi_G + (1-\theta_0)\pi_B]V > \eta V$, i.e., the likelihood of a successful outcome with a type-$H$ investment is greater than that with a type-$O$ investment: $[\theta_0\pi_G + (1-\theta_0)\pi_B] > \eta$. Therefore, the ability of the VC to raise a new fund, Fund-2, at $T = 1$ will be greater with a type-$H$ investment undertaken in Fund-1, than a type-$O$ investment. Hence, the VC has no incentive to deviate from the proposed allocation equilibrium, in which his ability is updated based on the outcome of the first investment in Fund-1 on date $T = 0$.

2. The second reason is that the terms on which the VC raises capital for Fund-1 will be somewhat more favorable than those of his prior fund, Fund-0. The reason is that in our set-up, new funds are raised only after a successful investment outcome. As a result, the VC's ability is assessed to be stronger after a successful outcome at $T = 0$, i.e., $\theta_0 > \theta_{-1}$, where $\theta_{-1}$ was the VC's perceived ability at the time Fund-0 was raised. It follows, from Equation (M4), that an increase in perceived VC ability increases the NPV of the project: $W_0(\theta_0) > W_{-1}(\theta_{-1})$ and the share of the NPV $(1-\beta_1)$ received by the VC is correspondingly higher. While we have expressed the contract in Fund-1 to be better than Fund-0 in terms of profit sharing, there are several other features of VC contracts (e.g., the LPs' rights in terms of the types of investment that can be undertaken) that may make the terms of a fund contract better for the VC. A VC that is perceived as higher quality will presumably be in a stronger position to offer contractual terms that favor him more.

## Appendix B: Data Filters

This appendix describes the VC fund samples and their investments used in the paper. The full sample of VC investments pertains to the universe of VC-backed portfolio companies and their VC investors (both at the fund and firm level) from the VentureXpert Database. In order to fully track the performance of a VC fund's investment sequence over its 10-year life, we obtain the data of all U.S. based VC funds that started from 1975 to 2000. For each VC fund, we obtain the sample of portfolio companies for which the VC fund is the lead investor. The final sample contains 17,154 portfolio companies invested by 4,578 funds that belong to 2,617 VC firms.

To further investigate the strategic investment allocation decisions by VC firms, we form 1,942 pairs of "sequential funds" from the full sample of VC funds. For each pair, the funds are managed by the same VC firms and the investment periods of the first and second fund overlap. This subsample contains 2,847 funds managed by 905 VC firms. Finally, we form, within the sample of "sequential funds," a sub-sample of concurrent investments by these funds. Concurrent investment period is defined as the two-year period following the start of the second fund. This subsample further trims down to 2,360 funds invested by the same 905 VCs. This sub-sample might introduce a selection bias, as a VC firm whose first fund is unsuccessful might not be able to raise a second fund. Therefore, first fund in this subsample is likely to have better performance than the unconditional average.

**Table 1: Summary Statistics**

Table 1 reports the characteristics of the full sample of 17,154 VC-backed portfolio companies, their lead VC funds, and VC firms. The sample period is from 1975 to 2010. For a given VC fund, we only consider portfolio companies for which the fund serves as the lead investor. No. of Investments Per Fund is the total number of portfolio companies for which the fund serves as the lead investor. Fund Size is the fund's amount of committed capital reported by VentureXpert. Seed or Early Stage Funds are funds whose focus is on seed or early stage investments. No. of Investments Per Firm is the total number of portfolio companies for which the VC firm's funds serve as lead investors. Firm Capital under Management is the amount of capital available to a management team for investments as reported by the VC firm. VC Experience is the cumulative number of financing rounds in which the VC firm has invested. Seed or Early Stage Company is a dummy variable equal to 1 if the company was in a seed or early investment stage at the initial VC investment. Throughout this paper, all dollar figures are adjusted for inflation and are expressed in 2016 dollars.

| | **N** | **Mean** | **Median** | **STD** |
|---|---|---|---|---|
| **VC Fund Characteristics** | | | | |
| No. of Lead Investments Per Fund | 4578 | 3.75 | 2 | 4.52 |
| Fund Size ($m) | 2913 | 250.24 | 83.44 | 592.53 |
| Seed or Early Stage Fund (fraction, %) | 4578 | 30.97% | | |
| **VC Firm Characteristics** | | | | |
| No. of Lead Investments Per Firm | 2617 | 6.55 | 2 | 13.38 |
| Firm Capital under Management ($m) | 1783 | 1069.99 | 123.32 | 4324.00 |
| VC Experience (No. of Lead Financing Rounds) | 16945 | 141.26 | 36 | 267.21 |
| **Portfolio Company Characteristics** | | | | |
| Is the VC Fund's First Investment | 17154 | 17.70% | | 0.38 |
| Is the VC Fund's First-Year Investment | 17154 | 43.71% | | 0.50 |
| VC Fund's Investment in the Company ($m) | 14197 | 8.66 | 3.23 | 32.72 |
| Seed or Early Stage Company (fraction,%) | 17154 | 60.70% | | |

**Table 2: VC Portfolio Company Exits**

Table 2 reports the univariate analyses of VC portfolio company exits. Panel A reports the distribution of portfolio company exits for the full sample of VC portfolio companies. Panels B and C report the comparison of IPO exit rates and IPO and M&A exit rates, respectively, between portfolio companies that are the VC fund's first, the last, and the first-year lead investments and the other companies. The portfolio company is categorized as a first-year (lead) investment if it is invested within the first year after the initiation of the VC fund. If a fund makes only one investment, it is excluded as the first, the last, and the first-year investment. t-statistics of the difference in success rates are reported. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

| **A: Portfolio Companies' Exits** | | |
|---|---|---|
| **Exit Type** | No. of Observations | % of Total Observations |
| IPO | 1475 | 8.60% |
| M&A | 4070 | 23.73% |
| Write-offs | 11609 | 67.68% |
| Total | 17154 | |

| **B: IPO Exit Rate Based on Investment Sequence** | | | |
|---|---|---|---|
| Investment Sequence | Yes | No | T-stat |
| Is the Fund's First Investment | 9.58% | 8.39% | 2.14** |
| Is the Fund's Last Investment | 6.17% | 9.09% | -5.13*** |
| Is the Fund's First-year Investment | 9.68% | 7.76% | 4.47** |

| **C: IPO and M&A Exit Based on Investment Sequence** | | | |
|---|---|---|---|
| Investment Sequence | Yes | No | T-stat |
| Is the Fund's First Investment | 34.16% | 31.93% | 2.38** |
| Is the Fund's Last Investment | 26.31% | 33.56% | -7.63*** |
| Is the Fund's First-year Investment | 37.14% | 28.58% | 11.94** |

**Table 3: Relation between VC Investment Sequence and Investment Outcome**

Table 3 contains estimates from Logit regressions of the portfolio company's successful exit on its order in the VC fund's investment sequence. In Models (1) to (4), the dependent variable is equal to 1 if the portfolio company exits through IPO, and zero otherwise. In Models (5) to (8), the dependent variable is equal to 1 if the portfolio company exit through IPO or M&As, and zero otherwise. First Investment Dummy is a binary variable equal to 1 if the portfolio company is the first investment in the VC fund's investment sequence. First-year Investments Dummy is a binary variable equal to 1 if the portfolio company is invested within one year after the initiation of the VC fund. Investment Sequence Number is the portfolio company's number that follows the chronological order in the VC fund's lead investment sequence, scaled by total number of lead investments made by the fund. Fund Sequence is the number of the VC fund in the VC firm's investment sequence. In Panel B, Time to Investment is the number of years from the VC fund's vintage year to the year of the investment of the company in question. z-statistics are reported in parentheses, after controlling for clustered standard errors at the VC firm level. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

| **A. Dependent Variable** | **=1 if IPO (Models (1) to (4))** | | | | **=1 if IPO or M&As (Models (5) to (8))** | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| First Investment Dummy | 0.229*** | 0.303*** | | | 0.236*** | 0.294*** | | |
| | (2.65) | (3.34) | | | (4.12) | (4.87) | | |
| First-year Investments Dummy | | | 0.237*** | | | | 0.270*** | |
| | | | (3.04) | | | | (4.84) | |
| Investment Sequence Number | | | | -0.615*** | | | | -0.581*** |
| | | | | (-4.96) | | | | (-7.16) |
| Fund Sequence | 0.073*** | -0.005 | -0.008 | 0.025 | 0.072*** | 0.039 | 0.037 | 0.047* |
| | (3.58) | (-0.10) | (-0.15) | (0.46) | (6.88) | (1.51) | (1.41) | (1.65) |
| Ln(Fund Size) | -0.039 | 0.052 | 0.045 | -0.091 | 0.212*** | 0.289** | 0.277** | 0.155 |
| | (-0.45) | (0.29) | (0.24) | (-0.36) | (3.39) | (2.16) | (1.98) | (0.94) |
| Ln(Fund Size) Squared | 0.002 | -0.030 | -0.030 | -0.026 | -0.014** | -0.036** | -0.035** | -0.026 |
| | (0.15) | (-1.59) | (-1.52) | (-1.02) | (-2.05) | (-2.47) | (-2.32) | (-1.56) |
| Seed or Early Stage Fund | -0.244*** | -0.286 | -0.290 | -0.245 | 0.005 | -0.361*** | -0.366*** | -0.372*** |
| | (-2.73) | (-1.52) | (-1.53) | (-1.20) | (0.08) | (-3.07) | (-3.06) | (-2.96) |
| No. of IPOs (in Thousands) | 0.934*** | 0.448*** | 0.411** | 0.389** | 0.321*** | 0.088 | 0.028 | -0.028 |
| prior to the Fund's Vintage Year | (6.55) | (2.67) | (2.47) | (2.27) | (3.28) | (0.77) | (0.24) | (-0.24) |
| Ln(Fund Investment) | 0.116*** | 0.140*** | 0.136** | 0.116** | 0.085*** | 0.067** | 0.062** | 0.028 |
| | (3.25) | (2.81) | (2.71) | (2.06) | (4.23) | (2.42) | (2.25) | (0.95) |
| Company's Industry M/B Ratio | -0.268*** | -0.091 | -0.095 | -0.081 | 0.060 | 0.151*** | 0.143*** | 0.187*** |
| | (-4.02) | (-1.12) | (-1.18) | (-0.95) | (1.47) | (3.15) | (2.95) | (3.71) |
| Seed or Early Stage Company | -0.046 | -0.077 | -0.089 | -0.071 | -0.033 | -0.055 | -0.067 | -0.076 |
| | (-0.70) | (-0.97) | (-1.11) | (-0.86) | (-0.69) | (-1.08) | (-1.31) | (-1.46) |
| Invested in 1995-2000 | -0.419*** | -0.103 | -0.127 | -0.110 | -0.120** | -0.004 | -0.032 | 0.009 |
| | (-4.63) | (-0.82) | (-1.00) | (-0.84) | (-2.16) | (-0.05) | (-0.46) | (0.13) |
| VC Firm Fixed-effects | No | Yes | Yes | Yes | No | Yes | Yes | Yes |
| $R^2$ | 0.024 | 0.014 | 0.018 | 0.014 | 0.021 | 0.007 | 0.010 | 0.008 |
| N | 11626 | 7617 | 7617 | 7327 | 11626 | 10110 | 10110 | 9703 |

**Table 3 - Continued**.

| **B. Dependent Variable** | **=1 if IPO (Models (1) to (4))** | | | | **=1 if IPO or M&As (Models (5) to (8))** | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| First Investment Dummy | 0.291*** | 0.358*** | | | 0.300*** | 0.377*** | | |
| | (2.99) | (3.48) | | | (3.29) | (5.49) | | |
| First-year Investments Dummy | | | 0.201** | | | | 0.342*** | |
| | | | (2.34) | | | | (4.88) | |
| Investment Sequence Number | | | | -0.480*** | | | | -0.155 |
| | | | | (-2.74) | | | | (-1.46) |
| Time to Investment | -0.067 | -0.066 | -0.036 | -0.052 | 0.131 | -0.101** | -0.111* | -0.121*** |
| | (-1.30) | (-1.01) | (-1.13) | (-0.56) | (1.50) | (-2.36) | (-1.77) | (-5.63) |
| Fund Sequence | 0.072*** | -0.005 | 0.069*** | 0.022 | -0.006 | 0.038 | 0.036 | 0.034 |
| | (3.51) | (-0.11) | (3.36) | (0.40) | (-0.12) | (1.48) | (1.39) | (1.13) |
| Ln(Fund Size) | -0.041 | 0.040 | -0.029 | -0.106 | 0.052 | 0.274** | 0.281** | 0.091 |
| | (-0.48) | (0.22) | (-0.34) | (-0.42) | (0.29) | (2.06) | (2.00) | (0.54) |
| Ln(Fund Size) Squared | 0.002 | -0.029 | 0.000 | -0.025 | -0.030 | -0.035** | -0.036*** | -0.020 |
| | (0.16) | (-1.56) | (0.02) | (-0.96) | (-1.57) | (-2.41) | (-2.33) | (-1.14) |
| Seed or Early Stage Fund | -0.248*** | -0.285 | -0.258*** | -0.247 | -0.286 | -0.361*** | -0.368*** | -0.385*** |
| | (-2.77) | (-1.52) | (-2.87) | (-1.20) | (-1.52) | (-3.07) | (-3.06) | (-2.98) |
| No. of IPOs (in Thousands) | 0.923*** | 0.434** | 0.891*** | 0.384** | 0.442*** | 0.073 | 0.019 | -0.064 |
| prior to the Fund's Vintage Year | (6.44) | (2.58) | (6.17) | (2.26) | (2.64) | (0.64) | (0.17) | (-0.54) |
| Ln(Fund Investment) | 0.114*** | 0.139*** | 0.114*** | 0.113** | 0.138*** | 0.065** | 0.062** | 0.016 |
| | (3.20) | (2.78) | (3.21) | (1.97) | (2.76) | (2.37) | (2.24) | (0.53) |
| Company's Industry M/B Ratio | -0.269*** | -0.089 | -0.273*** | -0.082 | -0.092 | 0.152*** | 0.145*** | 0.181*** |
| | (-4.02) | (-1.10) | (-4.12) | (-0.97) | (-1.14) | (3.17) | (2.99) | (3.60) |
| Seed or Early Stage Company | -0.049 | -0.077 | -0.057 | -0.076 | -0.078 | -0.055 | -0.067 | -0.092* |
| | (-0.73) | (-0.97) | (-0.86) | (-0.93) | (-0.97) | (-1.08) | (-1.31) | (-1.74) |
| Invested in 1995-2000 | -0.419*** | -0.103 | -0.429*** | -0.121 | -0.106 | -0.005 | -0.040 | -0.033 |
| | (-4.63) | (-0.82) | (-4.66) | (-0.91) | (-0.85) | (-0.07) | (-0.57) | (-0.48) |
| VC Firm Fixed-effects | No | Yes | Yes | Yes | No | Yes | Yes | Yes |
| $R^2$ | 0.025 | 0.014 | 0.024 | 0.018 | 0.014 | 0.008 | 0.008 | 0.013 |
| N | 11626 | 7617 | 11626 | 7327 | 7617 | 10110 | 10110 | 9703 |

**Table 4: "Paired" VC Funds and Portfolio Company Exits**

Table 4 reports the distribution of portfolio company exits and success rates for the sample of "paired" VC funds. Two sequential VC funds from the same VC firm that have overlapping investment period are classified as "paired" VC funds, and the concurrent investment period is defined as the two-year period following the start of the second fund. Panel A reports the VC fund and firm characteristics for the paired VC funds. Panel B reports the overall investment outcomes of the paired VC funds and the outcomes of the investments made during the concurrent period by these funds. Panel C compares the success rates (at fund level) among the first fund's pre-concurrent period, the first fund's concurrent period, and the second fund's concurrent period. t-statistics of the difference in success rates between the first fund's concurrent period and the second fund's concurrent period are reported. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

**A: The "Paired" Fund Sample**

| | **N** | **Mean** | **Median** | **STD** |
|---|---|---|---|---|
| **VC Fund Characteristics** | | | | |
| No. of Investments | 2847 | 4.59 | 3 | 4.98 |
| Fund Size ($m) | 1987 | 309.35 | 110.78 | 673.90 |
| **VC Firm Characteristics** | | | | |
| No. of Investments | 905 | 14.42 | 8 | 20.05 |
| Capital under Management ($m) | 704 | 1571.38 | 230.56 | 5849.08 |

**B: Portfolio Companies' Exits of the "Paired" Fund Sample**

| | All Investments | | Concurrent Investments | |
|---|---|---|---|---|
| **Exit Type** | No. of Obs | % of Obs | No. of Obs | % of Obs |
| IPO | 1192 | 9.13% | 816 | 9.16% |
| M&A | 3265 | 25.01% | 2379 | 26.70% |
| Write-offs | 8597 | 65.86% | 5716 | 64.14% |
| No. of Investments | 13054 | | 8911 | |

**C: Comparing Successful Exits at Fund Level**

| **Exit Type** | First Fund Pre-Concurrent Period (1) | First Fund Concurrent Period (2) | Second Fund Concurrent Period (3) | T-stat (2) - (3) |
|---|---|---|---|---|
| IPO | 10.11% | 3.51% | 9.11% | -9.17*** |
| IPO or M&A | 31.48% | 13.71% | 36.06% | -21.61*** |
| At Least One IPO | 28.06% | 6.59% | 23.69% | -15.91*** |

**Table 5: Investment Outcome of the "Paired" VC Funds**

Table 5 contains estimates from the Logit and OLS regressions of concurrent investments' successful exits and financing rounds for the sample of "paired" VC funds. Two sequential VC funds from the same VC firm that have overlapping investment period are classified as "paired" VC funds, and the concurrent investment period is defined as the two-year period following the start of the second fund. In Models (1) to (2), the dependent variable is equal to 1 if the portfolio company's exit is through an IPO, and zero otherwise. In Models (3) to (4), the dependent variable is equal to 1 if the portfolio company's exit is through an IPO or M&A, and zero otherwise. In Models (5) to (6), the dependent variable is the logarithm of the number of financing rounds experienced by the company. Second Fund Investment is a dummy variable equal to 1 if the portfolio company in the concurrent period is invested in by the second fund. In Models (2), (4), (6), the first investment of the second fund is excluded from the sample. z-statistics are reported in parentheses for Models (1) to (4) and t-statistics are reported in parentheses for Models (5) to (6). We control for clustered standard errors at the VC firm level. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

| **Dep. Var.** | IPO | | IPO/M&As | | Ln(Financing Rounds) | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Second Fund Investment | 0.265** | 0.230* | 0.349*** | 0.315*** | 0.162*** | 0.150*** |
| | (2.44) | (1.88) | (5.20) | (4.35) | (5.62) | (5.00) |
| Fund Sequence | -0.006 | 0.021 | 0.035 | 0.040 | -0.030*** | -0.023** |
| | (-0.15) | (0.34) | (1.48) | (1.41) | (-2.99) | (-2.01) |
| Ln(Fund Size) | -0.046 | -0.028 | 0.171 | 0.060 | 0.099 | 0.169* |
| | (-0.18) | (0.10) | (0.91) | (0.26) | (1.23) | (1.84) |
| Ln(Fund Size) Squared | -0.025 | -0.037 | -0.026 | -0.018 | -0.007 | -0.015* |
| | (-0.92) | (-1.19) | (-1.39) | (-0.86) | (-0.86) | (-1.74) |
| Seed or Early Stage Fund | -0.391* | -0.453* | -0.483*** | -0.528*** | 0.075 | 0.076 |
| | (-1.83) | (-1.85) | (-3.38) | (-3.27) | (1.54) | (1.30) |
| No. of IPOs (in Thousands) | 0.531** | 0.494* | 0.234 | 0.159 | 0.045 | 0.033 |
| prior to the Fund's Vintage Year | (2.16) | (1.73) | (1.37) | (0.84) | (0.78) | (0.49) |
| Ln(Fund Investment) | 0.138** | 0.156** | 0.036 | 0.014 | 0.009 | 0.008 |
| | (2.22) | (2.04) | (1.08) | (0.35) | (0.77) | (0.68) |
| Company's Industry M/B Ratio | -0.144 | -0.161 | 0.157*** | 0.169*** | 0.005 | 0.007 |
| | (-1.50) | (-1.64) | (2.74) | (2.68) | (0.23) | (0.31) |
| Seed or Early Stage Company | 0.017 | 0.009 | -0.029 | -0.055 | 0.252*** | 0.257*** |
| | (0.16) | (0.08) | (-0.45) | (-0.79) | (9.38) | (8.69) |
| Invested in 1995-2000 | 0.014 | 0.016 | 0.039 | 0.051 | -0.066** | -0.060* |
| | (0.09) | (0.10) | (0.49) | (0.58) | (-2.12) | (-1.73) |
| VC Firm Fixed-effects | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.017 | 0.020 | 0.009 | 0.009 | 0.177 | 0.180 |
| N | 4649 | 3751 | 6102 | 4914 | 6700 | 5471 |

**Table 6: Investment Outcome of the "Paired" VC Funds - Subsample analyses**

Table 6 reports estimates from the Logit regressions of concurrent investments' successful exits for the subsamples of the "paired" VC funds. Two sequential VC funds from the same VC firm that have overlapping investment period are classified as "paired" VC funds, and the concurrent investment period is defined as the two-year period following the start of the second fund. In Models (1) to (4), we split the sample of VC investments based on the investment outcome of the first fund's first investment. We define success if the investment exits via IPOs. In Models (5) to (8), we split the sample of VC investments based on the VC firm's experience. The high or low VC experience group is determined based on the median split of the number of previous financing rounds made by the VC prior to investing in the company in question. Second Fund Investment is a dummy variable equal to 1 if the portfolio company in the concurrent period is invested by the second fund. In Models (1), (3), (5), (7), the dependent variable is a dummy equal to 1 if the portfolio company's exit is through IPO, and zero otherwise. In Models (2), (4), (6), (8), the dependent variable is a dummy equal to 1 if the portfolio company's exit is through an IPO or M&A, and zero otherwise. z-statistics are reported in parentheses. We control for clustered standard errors at the VC firm level. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

| | First Investment Succeeds | | First Investment Fails | | High VC Experience | | Low VC Experience | |
|---|---|---|---|---|---|---|---|---|
| Dep Var | IPO | IPO/M&A | IPO | IPO/M&A | IPO | IPO/M&A | IPO | IPO/M&A |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Second Fund Investment | 1.054*** | 0.545*** | 0.058 | 0.302*** | 0.290** | 0.369*** | 0.073 | 0.274 |
| | (4.22) | (3.29) | (0.41) | (3.77) | (2.34) | (4.92) | (0.29) | (1.43) |
| Fund Sequence | 0.176*** | 0.152** | -0.143 | 0.000 | 0.032 | 0.030 | 0.051 | 0.058 |
| | (2.77) | (2.20) | (-1.63) | (0.00) | (0.70) | (1.05) | (0.32) | (0.50) |
| Ln(Fund Size) | 0.202 | -1.583 | -0.017 | 0.192 | -0.013 | 0.332 | -0.205 | 0.028 |
| | (0.17) | (-1.64) | (-0.04) | (0.84) | (-0.03) | (1.34) | (-0.48) | (0.10) |
| Ln(Fund Size) Squared | -0.095 | 0.082 | -0.001 | -0.019 | -0.037 | -0.043* | 0.016 | -0.006 |
| | (-1.08) | (1.08) | (-0.02) | (-0.83) | (-1.02) | (-1.86) | (0.36) | (-0.19) |
| Seed or Early Stage Fund | 0.134 | -0.561** | -0.150 | -0.480*** | -0.230 | -0.531*** | -1.087** | -0.568* |
| | (0.36) | (-2.05) | (-0.44) | (-3.36) | (-0.92) | (-2.80) | (-2.06) | (-1.90) |
| No. of IPOs (in Thousands) | 1.161* | 0.282 | 0.311 | 0.120 | 0.577* | 0.111 | 0.152 | 0.188 |
| prior to the Fund's Vintage Year | (1.85) | (0.61) | (0.99) | (0.66) | (1.70) | (0.50) | (0.32) | (0.62) |
| Ln(Fund Investment) | 0.081 | -0.055 | 0.136** | 0.050 | 0.107 | 0.018 | 0.050 | 0.026 |
| | (0.52) | (-0.46) | (2.35) | (1.37) | (1.35) | (0.43) | (0.50) | (0.41) |
| Company's Industry M/B Ratio | -0.116 | 0.193 | -0.140 | 0.165*** | -0.131 | 0.240*** | 0.006 | 0.036 |
| | (-0.49) | (0.86) | (-1.22) | (2.88) | (-1.09) | (3.50) | (0.03) | (0.33) |
| Seed or Early Stage Company | 0.176 | 0.263** | 0.000 | -0.050 | 0.064 | -0.045 | -0.073 | -0.010 |
| | (0.90) | (1.99) | (0.00) | (-0.68) | (0.51) | (-0.59) | (-0.43) | (-0.09) |
| Invested in 1995-2000 | -0.361 | 0.057 | 0.085 | 0.015 | 0.009 | 0.103 | -0.239 | -0.106 |
| | (-1.07) | (0.23) | (0.44) | (0.16) | (0.05) | (1.08) | (-0.62) | (-0.54) |
| VC Firm Fixed-effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.044 | 0.021 | 0.013 | 0.007 | 0.019 | 0.013 | 0.009 | 0.005 |
| N | 917 | 922 | 3430 | 5054 | 3085 | 3654 | 1146 | 2305 |

**Table 7: Performance Persistence within and across VC Funds**

Table 7 reports estimates from the Logit and negative binomial regressions of investment outcome in the paired fund sample. Models 1 to 4 examine the relation between the outcomes of the first fund investments and the second fund investments. Models 5 and 6 examine the relation between the early investment outcome of the first fund and its later investment outcome. First Fund Early Investments refer to investments made by the first fund prior to the concurrent period. In Models 1 and 5, the dependent variable is equal to 1 if the investment exits via IPO. In Models 2 and 6, the dependent variable is equal to 1 if the investment exits via an IPO or M&A. In Models 3 and 4, the dependent variable is the number of IPO or IPO/M&A exits, and we use negative binomial regressions framework. Ln(VC Inflows) is the logarithm of the aggregate amount of capital raised by other VC funds in the sample fund's vintage year. z-statistics are reported in parentheses, all controlling for clustered standard errors at the VC firm level. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

| | Second Fund Investments (Models (1) to (4)) | | | | First Fund Later Investments (Models (5) to (6) | |
|---|---|---|---|---|---|---|
| | IPO | IPO/M&A | #IPO | #IPO/M&A | IPO | IPO/M&A |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| IPO in First Fund Investments | 0.478*** | | 0.408*** | | | |
| | (3.32) | | (3.69) | | | |
| IPO/M&A in First Fund Investments | | 0.329*** | | 0.278*** | | |
| | | (2.62) | | (3.40) | | |
| IPO in First Fund Early Investments | | | | | 0.059 | |
| | | | | | (0.21) | |
| IPO/M&A in First Fund Early Investments | | | | | | -0.250 |
| | | | | | | (-1.54) |
| Ln(Fund Size) | 0.651** | 0.687*** | 0.682*** | 0.804*** | -0.033 | 0.123 |
| | (2.56) | (3.37) | (2.75) | (4.57) | (-0.08) | (0.53) |
| Ln(Fund Size) Squared | -0.022 | -0.025 | -0.024 | -0.037** | 0.030 | 0.011 |
| | (-0.92) | (-1.18) | (-0.99) | (-2.04) | (0.81) | (0.47) |
| Seed or Early Stage Fund | 0.110 | 0.432*** | 0.136 | 0.419*** | -0.808** | 0.006 |
| | (0.73) | (3.27) | (1.12) | (4.37) | (-2.40) | (0.03) |
| Ln(VC Inflows) | -0.671*** | -0.287*** | -0.666*** | -0.328*** | -0.134 | 0.107 |
| | (-11.01) | (-4.81) | (-10.98) | (-8.71) | (-1.36) | (1.49) |
| No. of IPOs (in Thousands) | 1.484*** | -0.024 | 1.095*** | 0.436*** | -0.299 | -0.229 |
| prior to the Fund's Vintage Year | (4.63) | (-0.08) | (4.63) | (2.76) | (-0.54) | (-0.60) |
| VC Firm Fixed-effects | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.119 | 0.076 | 0.082 | 0.057 | 0.041 | 0.024 |
| N | 1443 | 1443 | 1443 | 1443 | 1335 | 1335 |

**Table 8: Investment Allocation and Performance Persistence across VC Funds**

Table 8 reports estimates from Logit regressions of the investment outcome of the second fund on early and later investment outcomes of the first fund (FF) in the paired VC fund sample. In Models 1 to 2, the dependent variable IPO (IPO/M&A) is equal to 1 if there is at least one IPO (IPO/M&A) in the second fund's early investments, whereas early investments are those investments made during the concurrent period. In Models 3 to 8, the dependent variable IPO (IPO/M&A) is equal to 1 if there is at least one IPO (IPO/M&A) in the second fund's total investments, and zero otherwise. Ln(VC Inflows) is the logarithm of the aggregate amount of capital raised by other VC funds in the sample fund's vintage year. The IPO (IPO/M&A) dummies in the independent variables are defined correspondingly. z-statistics are reported in parentheses, all controlling for clustered standard errors at the VC firm level. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

| | Second Fund Early Investments (Models (1) to (2)) | | Second Fund Investments (Models (3) to (6)) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | IPO | IPO/M&A | IPO | IPO/M&A | IPO | IPO/M&A | IPO | IPO/M&A |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| IPO in FF Early Investments | 0.432*** | | 0.512*** | | 0.511*** | | | |
| | (2.81) | | (3.44) | | (3.45) | | | |
| IPO/M&A in FF Early Investments | | 0.246** | | 0.257** | | 0.257** | | |
| | | (2.08) | | (2.15) | | (2.14) | | |
| IPO in FF Later Investments | | | | | 0.062 | | 0.161 | |
| | | | | | (0.15) | | (0.39) | |
| IPO/M&A in FF Later Investments | | | | | | 0.321 | | 0.321 |
| | | | | | | (1.24) | | (1.27) |
| Ln(Fund Size) | 0.497** | 0.708*** | 0.636** | 0.688*** | 0.636** | 0.684*** | 0.690*** | 0.691*** |
| | (2.00) | (3.41) | (2.51) | (3.38) | (2.51) | (3.35) | (2.60) | (3.33) |
| Ln(Fund Size) Squared | -0.009 | -0.031 | -0.021 | -0.025 | -0.021 | -0.025 | -0.024 | -0.024 |
| | (-0.39) | (-1.42) | (-0.87) | (-1.18) | (-0.87) | (-1.16) | (-0.93) | (-1.09) |
| Seed or Early Stage Fund | 0.127 | 0.473*** | 0.108 | 0.433*** | 0.109 | 0.431*** | 0.110 | 0.434*** |
| | (0.82) | (3.63) | (0.72) | (3.27) | (0.73) | (3.26) | (0.26) | (3.25) |
| Ln(VC Inflows) | -0.605*** | -0.260*** | -0.674*** | -0.289*** | -0.674*** | -0.283*** | -0.702*** | -0.294*** |
| | (-9.98) | (-4.47) | (-11.08) | (-4.82) | (-11.09) | (-4.72) | (-11.31) | (-4.86) |
| No. of IPOs (in Thousands) | 1.168*** | -0.071 | 1.475*** | -0.022 | 1.475*** | -0.012 | 1.556*** | 0.023 |
| prior to the Fund's Vintage Year | (3.62) | (-0.23) | (4.59) | (-0.07) | (4.59) | (-0.04) | (4.84) | (0.07) |
| $R^2$ | 0.098 | 0.066 | 0.120 | 0.074 | 0.120 | 0.076 | 0.120 | 0.075 |
| N | 1443 | 1443 | 1443 | 1443 | 1443 | 1443 | 1443 | 1443 |

**Table 9: Performance of VC Investments and VC Fund Raising**

Table 9 reports estimates from regressions of the VC fund's subsequent fundraising on the performance of the VC fund's first and first-year investments. The dependent variable is equal to 1 if the VC raises the next fund within 5 years of the initiation of the current fund, and zero otherwise. First Investment Success is a dummy variable that equals one if the first investment of the fund exits through an IPO or M&A, and zero otherwise. First-year Investment Success is a dummy variable that equals one if at least one of the fund's first year investments exit through an IPO or M&A, and zero otherwise. High versus Low VC experience are based on a median split of cumulative financing rounds made by the VC firm before investing in the fund in question. In Panel B, Performance of the Previous Fund is a dummy variable equal to one if at least one of the previous fund's investments exits through an IPO or M&A, and zero otherwise. Ln(VC Inflows) is the logarithm of the aggregate amount of capital raised by other VC funds in the sample fund's vintage year. z-statistics are reported in parentheses, all controlling for clustered standard errors at the VC firm level. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

| A: Dependent Variables | =1 if the VC raises the next fund in 5 years | | | | | |
|---|---|---|---|---|---|---|
| | All VCs | | Hi-Exp VCs | | Lo-Exp VCs | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| First Investment Success | 0.272*** | | 0.243 | | 0.295*** | |
| | (3.16) | | (1.57) | | (2.74) | |
| First-year Investment Success | | 0.527*** | | 0.379** | | 0.574*** |
| | | (4.96) | | (2.05) | | (4.18) |
| Ln(Fund Size) | 0.643*** | 0.792*** | 0.103 | 0.237 | 0.744*** | 0.879*** |
| | (7.03) | (6.74) | (0.50) | (0.90) | (6.31) | (6.20) |
| Ln(Fund Size) Squared | -0.025** | -0.027* | 0.026 | 0.020 | -0.049*** | -0.047*** |
| | (-2.23) | (-1.92) | (1.11) | (0.68) | (-3.33) | (-2.59) |
| Seed or Early Stage Fund | 0.285*** | 0.279** | 0.229 | 0.311 | 0.248** | 0.205 |
| | (2.93) | (2.26) | (1.40) | (1.49) | (2.12) | (1.36) |
| Ln(VC Inflows) | -0.136*** | -0.257*** | -0.184** | -0.324*** | -0.111** | -0.215*** |
| | (-3.51) | (-4.93) | (-2.55) | (-3.43) | (-2.46) | (-3.47) |
| No. of IPOs (in Thousands) | 0.773*** | 0.650** | 0.122 | -0.035 | 1.044*** | 0.956*** |
| prior to the Fund's Vintage Year | (3.78) | (2.44) | (0.35) | (-0.08) | (4.06) | (2.88) |
| $R^2$ | 0.093 | 0.143 | 0.036 | 0.056 | 0.080 | 0.129 |
| N | 2884 | 1883 | 1166 | 801 | 1718 | 1082 |

**Table 9 - Continued**.

| B: Dependent Variables | =1 if the VC raises the next fund in 5 years | | | | | |
|---|---|---|---|---|---|---|
| | All VCs | | Hi-Exp VCs | | Lo-Exp VCs | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| First Investment Success | 0.373*** | | 0.270 | | 0.512*** | |
| | (2.76) | | (1.38) | | (2.71) | |
| First-year Investment Success | | 0.485*** | | 0.112 | | 0.681*** |
| | | (3.13) | | (0.47) | | (3.14) |
| Performance of the Previous Fund | 0.460*** | 0.366** | 0.309 | 0.330 | 0.374** | 0.192 |
| | (3.51) | (2.32) | (1.39) | (1.21) | (2.15) | (0.91) |
| Ln(Fund Size) | 0.074 | 0.141 | -0.386 | -0.293 | 0.337 | 0.395 |
| | (0.44) | (0.67) | (-1.28) | (-0.74) | (1.62) | (1.56) |
| Ln(Fund Size) Squared | 0.022 | 0.022 | 0.082** | 0.078* | -0.024 | -0.024 |
| | (1.14) | (0.94) | (2.35) | (1.83) | (-1.04) | (-0.87) |
| = 1 if Seed or Early Stage Fund | 0.155 | 0.293* | 0.259 | 0.515** | -0.036 | -0.030 |
| | (1.11) | (1.72) | (1.23) | (1.98) | (-0.19) | (-0.13) |
| Ln(VC Inflows) | -0.252*** | -0.359*** | -0.267*** | -0.285** | -0.235*** | -0.384*** |
| | (-3.87) | (-4.39) | (-2.70) | (-2.31) | (-2.74) | (-3.46) |
| No. of IPOs (in Thousands) | 0.333 | 0.249 | -0.290 | -0.306 | 1.071** | 0.861 |
| prior to the Fund's Vintage Year | (1.00) | (0.59) | (-0.64) | (-0.49) | (2.09) | (1.48) |
| $R^2$ | 0.048 | 0.070 | 0.049 | 0.056 | 0.039 | 0.066 |
| N | 1455 | 1056 | 817 | 596 | 638 | 460 |