An analysis of compensation in the U.S. venture capital partnership

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Abstract

Venture capital limited partnerships are an attractive arena to study cross-sectional and time-series variations in compensation schemes. We empirically examine 419 partnerships. The compensation of new and smaller funds displays considerably less sensitivity to performance and less variation than that of other funds. The fixed base component of compensation is higher for younger and smaller firms. We observe no relation between incentive compensation and performance. Our evidence is consistent with a learning model, in which the pay of new venture capitalists is less sensitive to performance because reputational concerns induce them to work hard. © 1999 Elsevier Science S.A. All rights reserved.

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1. Introduction

This paper explores the cross-sectional and time-series variation in the compensation specified in venture capital limited partnership agreements. These partnerships have several features which make them particularly attractive for empirical study. First, the partnership agreement signed at the fund’s inception clearly defines the compensation over the fund’s life, which is usually a decade or more. Typically, these agreements designate a percentage of the fund’s capital or assets as an annual management fee, and a percent of the profits to be paid out as investment returns are realized. Compensation is based on observable and verifiable returns from the venture fund’s investments. While compensation in the different funds raised by a venture organization may differ, the individual partnership agreements are rarely renegotiated, unlike executive employment contracts. Second, contractually specified compensation is particularly important in the venture capital setting. Investors in venture funds, the limited partners, cannot utilize many of the methods of disciplining managers found in corporations, such as dismissal, the active involvement of boards of directors, and the market for corporate control. In order to maintain their limited liability, investors must avoid direct involvement in the fund’s activities. Removing a venture capitalist, a general partner, is a difficult and costly procedure. Consequently, as Venture Economics (1989b) notes, compensation is ‘one of the most contentious issues between limited and general partners of venture funds’. Third, venture organizations are heterogeneous. The differences across venture groups and the evolution of these organizations over time allow us to empirically identify which factors affect compensation terms. Finally, compensation plans resembling those in venture partnerships are becoming increasingly common. Similar schemes are found in funds devoted to leveraged buyout, mezzanine, real estate, and oil-and-gas investments, as well as hedge funds. Estimates suggest that equity investments in such funds totaled between one-half and one trillion dollars at the beginning of 1995. Because these organizations often make leveraged investments, the funds controlled assets worth several times this amount. We are unaware of any prior research that has examined the factors that influence contractual terms in a panel of agreements similar to ours.

Our analysis examines compensation terms in 419 venture partnership agreements and offering memoranda for funds formed between 1978 and 1992. We examine the cross-sectional differences in compensation, comparing one venture capital organization to another, as well as the time-series variation, examining how contracts change as organizations become more seasoned. We find that compensation for older and larger venture capital organizations is more sensitive to performance than the compensation of other venture groups. For example, the oldest and largest venture groups command about a one percent greater share of the capital gains than their less-established counterparts. This
greater profit share matters little if the fund is not successful, but can represent a 4% or greater increase in the net present value of total compensation if the fund is successful. These differences are statistically significant whether we examine the percentage of profits accruing to the venture capitalists (although these analyses are very noisy) or the elasticity of compensation with respect to performance. The cross-sectional variation in compensation terms for younger, smaller venture organizations is considerably less than for older, larger organizations. The fixed component of compensation is higher for smaller, younger funds and funds focusing on high-technology or early-stage investments. Finally, we do not find any relationship between incentive compensation and performance.

We discuss two models that might explain the cross-sectional and time-series variation in compensation, a learning and a signaling model. The empirical results are consistent with the primary predictions of the learning model. In the learning model, neither the venture capitalist nor the investor knows the venture capitalist’s ability. In his early funds, the venture capitalist will work hard even without explicit pay-for-performance incentives because, if he can establish a good reputation for either selecting attractive investments or adding value to firms in his portfolio, he will gain additional compensation in later funds. These reputation concerns lead to lower pay-for-performance provisions for smaller and younger venture organizations. Once a reputation has been established, explicit incentive compensation is needed to induce the proper effort levels. The signaling model, in which the venture capitalist knows his ability but investors do not, predicts that new funds should have higher pay-for-performance sensitivities and lower base compensation, because high-ability venture capitalists try to reveal their type by accepting riskier pay.

The paper is organized as follows. A brief overview of the venture capital industry is presented in Section 2. Section 3 discusses the theoretical models of the determinants of compensation. Section 4 describes the sample of partnership agreements, which are analyzed in Section 5. Section 6 examines the relationship between incentive compensation and performance. Section 7 concludes the paper.

2. The venture capital industry

Venture capitalists invest in young, high-potential companies. Through a combination of careful due diligence, intensive monitoring, and direct assistance, the venture capitalist seeks to create companies that can eventually go public.

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2 This discussion is based upon Gompers and Lerner (1996).
Well-known firms like Compaq, Genentech, Intel, Microsoft, Netscape, Staples, and Starbucks all received venture capital financing. Nearly one-third of all companies going public in recent years have received venture capital backing (Barry et al., 1990).

The first modern venture capital firm, American Research and Development (ARD), was formed in 1946. Because institutional investors were reluctant to invest, ARD was structured as a publicly traded closed-end fund, marketed mostly to individuals (Liles, 1977). The few other venture organizations begun in the decade after ARD’s formation were also structured as closed-end funds. The venture capital industry, which annually raised no more than a few hundred million dollars in the 1960s and 1970s, grew explosively after 1978 due to two regulatory changes. These changes were the reduction of capital gains tax rates in 1978 and the U.S. Department of Labor’s reinterpretation of pension investment rules in 1979. Fueled by pension investments, annual commitments to venture funds increased by a factor of ten in less than a decade.

An associated change in the venture capital industry during this period was the rise of the limited partnership as the dominant organizational form. The first venture capital limited partnership was formed in 1958, but limited partnerships remained a relatively small fraction of the venture capital pool until the end of the 1970s. During the 1980s and 1990s, however, over 80% of the capital committed to venture funds went to limited partnerships. Venture partnerships have pre-determined, finite lifetimes, usually ten years, although extensions of between one and three years are often allowed. Most venture organizations raise funds by forming partnerships every two to five years. The typical venture fund makes one to two dozen investments over its life-span. In a venture capital limited partnership, the venture capitalists are general partners and control the fund’s activities. The typical fund has between two and ten general partners. The investors serve as limited partners. Investors can monitor the fund’s progress, but cannot become involved in the fund’s day-to-day management if they are to retain limited liability. Compensation is therefore the most important contractual mechanism for aligning the incentives of the venture capitalist and his investors.

The limited partnership agreement explicitly specifies the terms that govern the venture capitalists’ compensation over the entire ten-to-thirteen year life of the fund. It is extremely rare that these terms are renegotiated. The specified compensation has a simple form. The venture capitalist typically receives an annual fixed fee, plus variable compensation that is a specified fraction of the fund’s profits. The fixed portion of the specified compensation is usually between 1.5% and 3% of the committed capital or net asset value, and the variable portion is usually about 20% of fund profits. The simplicity and specificity of the contracts enable us to examine how the fixed and variable compensation differ across venture organizations and over time.
3. Determinants of venture capitalist compensation

This section explores how information about the venture capitalist’s ability should affect the time-series and cross-sectional variation of compensation for venture capitalists for both fixed and variable pay. We discuss two stylized models that generate predictions which frame the empirical analyses. In Section 3.1, we adapt the compensation model from Gibbons and Murphy (1992) to the venture capital setting and derive the equilibrium compensation to explore the learning model. We assume that initially there is symmetric uncertainty about the ability of the venture capitalist. In Section 3.2, we assume the venture capitalist, but not the investor, is initially informed about the venture capitalist’s ability in our discussion of the signaling model. Appendices A and B discuss the models in detail.

3.1. The learning model

An abstraction of the learning model is the assumption that venture capitalists raise two funds (partnerships) in two consecutive periods. The outcome of investments in the first fund, including any investment returns, are realized prior to the second fund being raised. No projects shift from the first fund to the second. The fund return is a function of the venture capitalists’ ability to both select high-quality projects and add value after the investment, their effort, and noise. While the venture capitalists’ ability either to select attractive projects or to add value after the investment is uncertain, both venture capitalists and investors know the distribution of abilities in advance. Investors cannot observe the effort level chosen in either fund, because this information is private. The venture capitalists’ compensation is assumed to be a linear function of fund returns.

Compensation contracts are written for each fund and are conditional on the information available from returns, if any exist. The compensation contract is set out before effort is chosen or investments are made. Investors in both funds can, but need not, be the same. Investors in the second fund, however, have verifiable information about the performance of the first fund.

The learning model has five implications for venture capitalist compensation:

- **Level of pay-for-performance sensitivity over time.** The sensitivity of compensation to performance is higher in the venture capitalists’ second fund. Venture capitalists have an incentive to work hard in their first fund because, if they increase effort, investors think they have higher ability. (This relation holds for fixed expectations about equilibrium effort choice.) Greater effort not only
increases current income, but also raises total compensation in the second period.\(^3\)

- **Level of fixed fees over time.** The learning model is ambiguous about the relative fixed fees in new and old venture firms. While the level of variable compensation unambiguously increases in established venture firms, fixed fees could rise, fall, or remain unchanged.

- **Level of fixed fees and effort level.** Because we assume a Nash bargaining solution, fixed fees incorporate the cost of effort such that the higher the cost of effort, the higher the fixed fees. All else being equal, higher investment and monitoring costs lead the venture capitalists to receive higher fixed fees.

- **Variance in pay-for-performance sensitivity over time.** This model also predicts that the cross-sectional variance should be lower for new and smaller venture organizations than for established organizations. Compensation schemes for small, young venture capital organizations should be clustered, because neither the venture capitalists nor the investors know the venture capitalists’ abilities. As venture capitalists’ abilities become known, compensation schemes can reflect the updated information about ability. If there is a distribution of abilities, then the cross-sectional variance of variable compensation should be higher for larger, older venture capital organizations.

- **Level of pay-for-performance sensitivity and performance.** Finally, the learning model predicts that pay-for-performance sensitivity across periods should be unrelated to the performance of the venture capital fund. In the first period, even though pay-for-performance is lower, the venture capitalist is driven to work hard by the desire to establish a reputation. In the second period, higher explicit incentives are required because the potential for higher compensation in the next period is not there. Put another way, incentive compensation is endogenous and elicits the optimal effort given the perceived ability of the venture capitalist. In a cross-section of venture capital funds, pay sensitivity should have no predictive power for performance.

\(^{3}\) The comparison of first and second fund compensation can be viewed as indicative of patterns among venture capitalists with and without established reputations. If a venture capital firm has established a good reputation, it needs explicit incentives in the form of high pay-for-performance sensitivity in order to induce effort. To empirically assess this claim, we will use venture organization age and size as proxies for reputation. Older and larger venture capital organizations are likely to have established reputations, and therefore need higher pay sensitivities to induce the desired effort level. New and smaller venture organizations work harder because they seek to establish a reputation that will allow them to command greater compensation in future funds. This implicit incentive means that less pay-for-performance sensitivity is necessary for small, young venture firms. An important issue that we do not model is whether reputation adheres to the venture organization or the individual venture capitalists. While we show in the empirical analysis below that established venture capital organizations tend to be comprised of more experienced venture capitalists, exploring the ways in which reputation resides in and transfers between financial institutions is a fertile topic for future research.
3.2. The signaling model

The principal-agent literature demonstrates that the nature of contracts changes dramatically once informational assumptions are altered. In the learning model, investors and venture capitalists both have the same initial information about venture capitalists’ abilities. Symmetric uncertainty leads to the central result. If venture capitalists have better information before entering into the contract, however, the possible contracts signed in equilibrium states change. Under certain assumptions, high-ability venture capitalists will attempt to signal their type through the contracts they offer to investors in the first period.4

In this simple signaling model, the second fund’s variable compensation is the same for high- and low-ability venture capitalists. This result follows from our assumption that marginal productivity after the first unit of effort and effort costs of both types of venture capitalists are identical. Because types are fully revealed in the first fund, second period compensation differs only in the base compensation. High-ability venture capitalists receive higher fixed fees in subsequent funds. Once the type of the high-ability venture capitalists has been revealed, they desire more insurance, and hence receive higher fixed compensation and less variable compensation.

Deriving optimal first period compensation schemes is more difficult. These classes of signaling models usually have a continuum of equilibria. Because low-ability venture capitalists set their compensation for their second fund under full information about ability, their optimal first fund contract will be identical to the optimal second fund contract. Low-ability venture capitalists act as if their type is completely known in their first fund.

High-ability venture capitalists offer a contract that maximizes their utility, subject to the constraint that low-ability venture capitalists are just indifferent between accepting this contract and their own. As shown in Appendix B, the variable compensation for the high-ability venture capitalists in the first fund is more sensitive to performance than it is in the second fund. Likewise, the fixed component of compensation is smaller in the first fund. The fixed component in a first fund contract might even be negative, in which case high-ability venture capitalists would pay for the opportunity to invest in start-up companies in their first fund. In order for high-ability venture capitalists to separate from low-ability types, they must be willing to accept more risk. Linking compensation more closely to uncertain future returns increases the risk that the high-ability venture capitalists bear. The higher expected level of pay compensates these venture capitalists for the greater risk. Pay-for-performance sensitivity in the

4 While we examine the Riley (1979) information equilibrium, it is likely that other separating, as well as pooling, equilibria exist.
first fund for high-ability venture capitalists increases as the difference in abilities increases. The difference in second period compensation is greater, and therefore low-ability venture capitalists have more to gain from imitating high-ability types.

The signal in this model is the level of risk that the venture capitalists bear. Variable compensation divides an uncertain payoff between venture capitalists and investors. Unlike signaling models in which the signal is explicitly non-productive, such as in education, the use of pay sensitivity as a signal has a second effect of inducing different effort choices in equilibrium.

Heinkel and Stoughton (1994) examine the case in which investors evaluate portfolio managers on both the contracts offered and past performance. Their optimal contracts are complex, but qualitatively resemble the learning model. This is because their paper has both learning and signaling components. Adding a noisy signal of ability, like performance, creates incentives to work harder. Heinkel and Stoughton show that under their assumptions, the learning effect is stronger. In the model in this section, however, investors do not have an opportunity to use past returns to update beliefs. Types are totally revealed to investors by the contracts offered in the first fund before the venture capitalists have any performance. In the learning model of Section 3.1, both the venture capitalists and investors infer the venture capitalists’ ability through realized returns. Our empirical analysis can be seen as a comparison of the power of these two effects, which are depicted in extreme form in our models. Our central empirical result – the greater pay-for-performance sensitivity of more established venture organizations – is consistent with the predictions presented in Heinkel and Stoughton (1994) and the learning model of Section 3.1.

In our signaling model, where venture capitalists know their ability to select and oversee entrepreneurs before raising a fund, the predicted empirical patterns differ from those derived in the learning model, where venture capitalists and investors have equally poor initial information about ability:

- **Level of pay-for-performance sensitivity over time.** The signaling model predicts that new and smaller venture organizations, who are confident that they have high ability, will increase their pay-for-performance sensitivity in early funds. Once the venture capitalists’ ability has been revealed through their contract choice, the desire for insurance on the part of the risk-averse venture capitalists causes incentive compensation in subsequent funds to decline. Older and larger venture capital organizations with established reputations should have less incentive compensation.

- **Level of fixed fees over time.** Fixed fees for older and larger venture capital firms should be higher, because these organizations will demand insurance.

- **Level of fixed fees and effort level.** As in the learning model, higher investment and monitoring costs should lead the venture capitalists to receive higher fixed fees.
• Variance in pay-for-performance sensitivity over time. We also expect that the cross-sectional variance in pay-for-performance sensitivities will be smaller in older, larger organizations. In the model where each type's marginal product is equal, there is no variance in the variable compensation for the later fund. Thus, both the level and the cross-sectional variance of pay-for-performance sensitivities should be higher for younger venture capital firms. Both of these predictions are the reverse of the predictions of the learning model.

• Level of pay-for-performance sensitivity and performance. Finally, the signaling model predicts that pay sensitivity should be positively related to performance. High-ability venture capitalists increase their pay-for-performance sensitivity to signal their quality. Young, high-ability venture capitalists will work hard because of the higher variable compensation and have higher returns.

4. The sample

4.1. Sample definition and construction

We restrict our analysis to U.S. venture capital partnerships, excluding several similar organizations. We include only independent private partnerships primarily engaged in venture capital investments. We define venture capital investments as investments in equity or equity-linked securities of private firms, with active participation by the fund managers in the management or oversight of the firms. We eliminate funds whose stated mandate is to invest more than 50% of their capital in other types of assets, such as the securities of firms undergoing leveraged buy-outs, ‘special situations’, or publicly traded securities. Many venture capital organizations in the sample raised leveraged buyout (LBO) funds during the 1980s. We do not include such funds, even if all the other funds associated with the organization are devoted to venture capital. Venture funds that invest more than 50% of their capital in other venture partnerships, known as ‘funds of funds’, are also excluded. Similarly, Small Business Investment Companies (SBICs), publicly traded venture funds, and funds with a single limited partner are eliminated. We exclude all of these organizations because their investment opportunities or regulatory environment are substantially different from venture capital funds, and their negotiated compensation terms may be expected to differ.

We use the partnership agreements collected by three organizations to construct the sample. The organizations are the Aeneas Group, Kemper Financial Services, and Venture Economics. Each of these organizations has been involved in venture investing for at least fifteen years. Nonetheless, there are substantial differences in the funds in which each invests. We describe these organizations in Appendix C. We determine whether a fund meets our selection criteria in two
ways. We review each private placement memorandum, which has a section that describes the partnership. We also consult a database of venture capital funds compiled by Venture Economics, described in more detail below, to ensure that we have not inadvertently included inappropriate cases. If we are unsure whether a fund corresponds to our criteria, we do not include it.

The Venture Economics database of funds contains summary information on 1159 funds raised between 1978 and 1992. It includes many funds whose partnership agreements or private placement memoranda were not found in the Venture Economics files. In all, documents on 221 funds were found in the Venture Economics files and documents on 198 additional funds were found in files of Aeneas or Kemper.

We also characterize the investment focus of the funds. Firms typically state in their private placement memoranda whether they intend to have an industry or stage focus. Because these are imperfectly recorded by Venture Economics, we check the original fund documents. One concern may be that funds need not make investments that are consistent with these stated objectives. The partnership agreements, which unlike the private placement memoranda are legal contracts, rarely state the funds’ objectives. At the same time, venture capitalists who deviate significantly from the stated goals of their partnership are likely to alienate institutional investors and the investment managers who advise them, and may find it difficult to raise a follow-on fund (e.g., the discussion in Goodman, 1990).

4.2. Completeness of the sample

We assess the completeness of our sample of 419 funds by comparing it with a database compiled by Venture Economics’ Investors Services Group. This database includes over two thousand venture capital funds, SBICs, and related organizations. The Investors Services Group database is used in preparation of directories, such as the Venture Economics annual volume Venture Capital Performance. The database is compiled from information provided by venture capitalists and institutional investors. Our sample accounts for 35% of the 1159 funds raised by independent venture capital organizations between 1978 and 1992 that are in the Venture Economics funds database. Weighting observations by fund size, using constant 1992 dollars, our measure of sample coverage is much better: funds in our sample account for $24.4 billion out of a total of $39.9 billion of invested capital, or 61%.

Venture capital limited partnerships will have one or more closings, where the limited and general partners sign legal documents stating the terms of the partnership, and initial cash payments are made. Having several closings enables venture funds to begin investing before fundraising is completed. Additional limited partners can be added to the partnership in the subsequent closings. We use the date of the first closing in the analyses in this paper.
Table 1
The characteristics of the research sample of venture capital funds

The first two columns compare characteristics of funds within the Venture Economics funds database whose first closing was between January 1978 and December 1992 which were included in our sample and those which were not. Our sample includes only those funds whose partnership agreements or private placement memoranda were found in the files of Aeneas, Kemper, and Venture Economics. We present both the mean and median (in brackets) of several measures. The third column presents the p-values of t-tests, Wilcoxon signed-rank tests (in brackets), and Pearson χ²-tests (in braces) of the null hypotheses that these distributions are identical. The final column presents corrected summary statistics for the entire sample.

<table>
<thead>
<tr>
<th>Funds in Venture Economics database</th>
<th>Included in our sample</th>
<th>Not included in our sample</th>
<th>p-Value, test of no difference</th>
<th>All funds included in our sample*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
<td>401</td>
<td>757</td>
<td>419</td>
<td></td>
</tr>
<tr>
<td>Size of fund (millions of 1992 dollars)</td>
<td>62.6 [40.1]</td>
<td>42.7 [29.4]</td>
<td>0.000 [0.000]</td>
<td>62.7 [40.1]</td>
</tr>
<tr>
<td>Size of venture organization (capital raised as % of total in past 10 yr)</td>
<td>0.42% [0.11%]</td>
<td>0.40% [0.00%]</td>
<td>0.821 [0.000]</td>
<td>0.43% [0.10%]</td>
</tr>
<tr>
<td>Age of venture organization (in years)</td>
<td>5.35 [3.50]</td>
<td>4.33 [1.83]</td>
<td>0.006 [0.002]</td>
<td>4.92* [3.09]*</td>
</tr>
<tr>
<td>Fund focuses on high technology?</td>
<td>20.4% [7.4%]</td>
<td>7.4% [1.83]</td>
<td>0.000 [0.002]</td>
<td>48.0%* [3.09]*</td>
</tr>
<tr>
<td>Fund focuses on early-stage investments?</td>
<td>29.2% [12.8%]</td>
<td>12.8% [6.4%]</td>
<td>0.000 [0.000]</td>
<td>41.8%* [3.09]*</td>
</tr>
</tbody>
</table>

* The data for the entire sample of 419 differ from the sub-sample of 401 for two reasons. In the final column, the sample size is larger and several aspects of the Venture Economics data have been corrected with information from fund documents. First, venture organization age is sometimes erroneously entered in the Venture Economics funds database. Second, the coding of investment focus is incomplete in the Venture Economics funds database. In order to allow a comparison with the 757 funds not included in our sample for which we only have the Venture Economics data, we report the age and focus of the 401 funds as coded by Venture Economics. The summary statistics about the 419 funds incorporates our corrections based on information in the private placement memoranda.

The first three columns of Table 1 compare those entries in the Venture Economics funds database for which we do and do not have compensation data. We compare the distributions of the included and missing funds using t-tests, Wilcoxon signed-rank tests, and Pearson χ²-tests. Larger and more recent funds, as well as funds raised by more established venture organizations, are significantly more likely to be included in our sample. Funds specializing in
high-technology and early-stage investments are disproportionately represent-
ed, perhaps reflecting their frequent sponsorship by established organizations.
The fourth column of Table 1 displays the characteristics of the funds in the final
sample, including the ones not in the Venture Economics database and hence
not included in the first column. The summary statistics in column four are also
different from column one because the data reported in the fourth column were
corrected using documents from the venture organizations.

While the sample is not entirely representative of the venture industry as
a whole, these differences should have a limited impact on the empirical results.
As a check of this claim, we repeat the analyses reported below using only the
221 observations where the partnership agreements or private placement mem-
oranda were found in the files of Venture Economics. These observations are
significantly more representative of the population of venture funds than the
Aeneas and Kemper samples. The results remain similar, though the significance
falls, reflecting the smaller sample size.

5. The form of compensation

We analyze the form of venture capitalist compensation in three ways. First,
we examine the most visible aspect of compensation, the percentage of profits
received by the venture capitalists. Second, we examine the net present value
(NPV) of the fixed management fees. Finally, we examine the elasticity of
venture partnerships' compensation, defined as the percentage change that will
occur in the NPV of total compensation in response to a 1% change in
performance. The elasticity is a function of both the percentage of profits
retained by general partners and the base compensation, and therefore is the
best measure of the sensitivity of compensation to performance.

5.1. The percentage of profits

Fig. 1 presents the distribution of the percentage of profits allocated to the
general partners after any provision for the return of invested capital, or of
invested capital plus a premium. The share in our sample varies from 0.7% to
45%, but 81% of the funds are between 20% and 21%, inclusive. This concen-
tration is broadly consistent with a learning model in which information is
revealed slowly. If investment ability is uncertain, venture capitalists negotiate
very similar compensation terms.

Panel A of Table 2 presents the mean level of variable compensation. We
divide the observations in several ways. As discussed above, we use two
measures of venture organization reputation. The first measure is the age of the
venture organization, or the time from the closing of the first partnership that
the venture organization raised to the closing of this fund. We use this measure
for age because investors should know more about the ability of older venture organizations. These older venture organizations may, however, also be of higher quality. Low-quality venture capitalists should eventually be unable to raise new funds. The average level of compensation should rise because we do not observe the low compensation of poor venture capitalists in later funds. We compute venture capital age using the funds database discussed in Section 4.2. When we use this database, we augment and correct the database using historical information reported in the private placement memoranda for each fund. If the Venture Economics database and the offering memorandum disagree, then we use the information in the offering memorandum, because we are more confident in the information coming directly from the venture organization.

Venture organization age will not, however, capture the fact that venture capitalists beginning a new organization may have had considerable experience at another venture group, or elsewhere. We consequently employ a second proxy for the experience of the venture capitalists, which is the size of the venture organization's previous funds. Venture organization size is a potentially useful measure of uncertainty concerning ability. Investors may provide larger sums to venture capitalists with proven track records, even if they have not raised any earlier funds. We total the capital invested in the organization's funds, using 1992 dollars, whose first closing was in the ten calendar years prior to the year that this fund closed. Because the size of the venture pool increased dramatically over these years, we employ a measure of relative size. We divide this sum by the total amount raised by venture organizations in these years, again using 1992 dollars.

Neither measure of experience is perfect. Ideally, we would have a measure of the cumulative experience of the venture capitalists associated with the fund.
Table 2
The share of profits received by venture capital organizations

The sample consists of 419 venture capital partnerships whose first closing was between January 1978 and December 1992. We present the mean share of capital gains received by the venture capital organizations (VCs) after any initial return of investment to the limited partners. We also present the number of observations. The size of the venture organization is the ratio of the capital invested in the organization’s funds, in 1992 dollars, whose first closing was in the ten calendar years prior to the year that this fund closed, to the total amount raised by all venture organizations in these years, again in 1992 dollars. Panel B tests the significance of these patterns.

<table>
<thead>
<tr>
<th>Panel A: Mean percentage of profits received by venture capitalists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of profits received by VCs</td>
</tr>
<tr>
<td>Age of venture organization</td>
</tr>
<tr>
<td>No earlier funds</td>
</tr>
<tr>
<td>Four years or less</td>
</tr>
<tr>
<td>Between four and eight years</td>
</tr>
<tr>
<td>More than eight years</td>
</tr>
<tr>
<td>Size of venture organization</td>
</tr>
<tr>
<td>No earlier funds</td>
</tr>
<tr>
<td>Between 0.0% and 0.2%</td>
</tr>
<tr>
<td>Between 0.2% and 0.7%</td>
</tr>
<tr>
<td>Greater than 0.7%</td>
</tr>
<tr>
<td>Objective of fund</td>
</tr>
<tr>
<td>Focus on high-technology firms</td>
</tr>
<tr>
<td>Other industry focus (or no focus)</td>
</tr>
<tr>
<td>Focus on early-stage investments</td>
</tr>
<tr>
<td>Other stage focus (or no focus)</td>
</tr>
<tr>
<td>Date of closing</td>
</tr>
<tr>
<td>January 1978–December 1984</td>
</tr>
<tr>
<td>January 1985–June 1986</td>
</tr>
<tr>
<td>June 1986–December 1988</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Panel B: Tests involving percentage of profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>Correlation, age of venture organization and % of profits</td>
</tr>
<tr>
<td>Correlation, size of venture organization and % of profits</td>
</tr>
<tr>
<td>Correlation, date of closing and % of profits</td>
</tr>
<tr>
<td>t-test, high-technology focus and % of profits</td>
</tr>
<tr>
<td>t-test, early-stage focus and % of profits</td>
</tr>
<tr>
<td>Variance test, organizations below and above 0.7% of pool</td>
</tr>
<tr>
<td>Variance test, organizations below and above 10 yr old</td>
</tr>
</tbody>
</table>

* This category also includes funds which raised a previous fund whose size cannot be determined.

p-value from a t-test comparing the percentage of profits received by funds with and without this investment focus.

p-value from an F-test comparing the variance of profits received by experienced and inexperienced venture organizations.
Unfortunately, constructing such a measure is problematic. Many venture capitalists have diverse backgrounds, including experience as founders of entrepreneurial firms, corporate managers, or university researchers. It is unclear how individual experience should be aggregated. Even if such an experience measure could be designed, only about half of the private placement memoranda provide detailed information on the backgrounds of the general partners. Obtaining biographical information on venture capitalists elsewhere is often very difficult. To address this concern, we examine whether the venture capitalists in older and larger venture organizations had more prior experience. We look at 267 venture funds established between 1978 and 1985, including some not in the sample, that had a board seat on at least one firm that went public in the seven years after the fund closed. To assess experience, we look at the boards on which the venture capitalists served prior to the closing of this fund. We total the inflation-adjusted market capitalization of all IPOs on whose boards these venture capitalists served. Older and larger venture organizations tend to have more experienced venture capitalists. The correlation coefficients, 0.29 and 0.25, respectively, are significant at the one percent confidence level.

The oldest and largest funds command about a 1% greater share of profits than less established funds. As the correlation analysis in Panel B of Table 2 demonstrates, these effects are significant at least at the 5% confidence level. Similarly, firms with a focus on high-technology or early-stage investments receive a significantly higher percent of profits. No significant time effect appears. Again, consistent with the learning model, larger and older venture capital organizations also have significantly greater variance in the share of profits that they receive.

Even if the differences between more and less established funds are statistically significant, they may not be economically meaningful. To address this concern, we examine a representative fund, using the assumptions outlined in Appendix D. A 1% difference in the share of profits matters very little if the venture fund does not perform well. For instance, if the fund’s investments grow only at an annual rate of 10%, a increase in the venture capitalists’ profit share from 20% to 21% boosts the NPV of total compensation by only 0.3%. The small magnitude of this change occurs because the compensation in this case is dominated by the fixed fee. If, however, the fund’s investments perform well, a very different picture emerges. For example, if the fund’s investments grow at an annual rate of 50%, an increase in the profit share for the venture capitalists from 20% to 21% raises the NPV of total compensation by 4.2%.

Table 3 reports the results from several regression analyses. The first is an ordinary least squares (OLS) analysis. The dependent variable is the venture capitalists’ share of profits. We express this variable as a number between 0 and 100, where 21.2 represents a profit share of 21.2%. Independent variables are the date of the closing, venture organization size and age, and dummy variables denoting whether the fund focuses on high-technology or early-stage firms. We
Table 3
Regression analyses of the share of profits received by venture capital organizations

The sample consists of 419 venture capital partnerships whose first closing was between January 1978 and December 1992. The first three regressions are ordinary least squares (OLS) analyses, with the capital gains received by the venture capital organizations after any initial return of investment to the limited partners as the dependent variable. The next two regressions are ordered logit analyses, with funds receiving below 20% coded as 0, those between 20% and 21% as 1, those between 21% and 25% as 2, those between 25% and 30% as 3, and those above 30% as 4. The sixth is a Tobit analysis of whether the percentage of profits is above 21%, and if so, by how much. The final two regressions are a maximum likelihood analysis of whether the fund receives between 20% and 21% of profits, and if not, what the level is, assuming a normal distribution for those observations not between 20% and 21%. Independent variables include the date of the closing, with January 1, 1978 coded as 1978.0, and so forth, the size of the venture capital organization, measured as the ratio of capital raised in the ten calendar years prior to the year in which the fund closed to the total amount raised by venture capital organizations in that time, the age of the venture organization at the time of the fund closing, in years, and dummy variables indicating whether the fund focused on high-technology or early-stage investments, with 1 denoting such a fund. Absolute t-statistics in brackets.

<table>
<thead>
<tr>
<th></th>
<th>OLS</th>
<th>OLS</th>
<th>OLS</th>
<th>Ordered logit</th>
<th>Ordered logit</th>
<th>Tobit</th>
<th>Maximum likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Profits in target range?</td>
</tr>
<tr>
<td>Date of closing</td>
<td>0.04</td>
<td>-0.02</td>
<td>0.01</td>
<td>-0.03</td>
<td>-0.21</td>
<td>0.05</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>[0.80]</td>
<td>[0.03]</td>
<td>[0.19]</td>
<td>[0.73]</td>
<td>[1.07]</td>
<td>[1.94]</td>
<td>[0.61]</td>
</tr>
<tr>
<td>Fund closed in 1978–1982?</td>
<td></td>
<td></td>
<td>-0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[0.02]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fund closed in 1983–1987?</td>
<td></td>
<td></td>
<td>-0.27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[0.80]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of venture organization</td>
<td>50.67</td>
<td>48.19</td>
<td>42.57</td>
<td>189.78</td>
<td>-17.90</td>
<td>117.58</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[2.54]</td>
<td>[2.40]</td>
<td>[2.86]</td>
<td>[2.60]</td>
<td>[2.05]</td>
<td>[1.86]</td>
<td></td>
</tr>
<tr>
<td>Age of venture organization</td>
<td>0.07</td>
<td></td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[2.47]</td>
<td></td>
<td>[2.11]</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>0.93</td>
<td>0.94</td>
<td>0.61</td>
<td>1.57</td>
<td>0.10</td>
<td>4.18</td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Fund focuses on high tech?</td>
<td>[3.08]</td>
<td>[3.13]</td>
<td>[2.41]</td>
<td>[2.27]</td>
<td>[0.72]</td>
<td>[3.19]</td>
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</tr>
<tr>
<td>Fund focuses on early stages?</td>
<td>0.75</td>
<td>[2.41]</td>
<td>0.35</td>
<td>[1.39]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>58.52</td>
<td>23.53</td>
<td>20.26</td>
<td>433.26</td>
<td>91.38</td>
<td>210.63</td>
<td></td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.03</td>
<td>0.02</td>
<td>0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td>5.07</td>
<td>3.49</td>
<td>3.83</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td></td>
<td></td>
<td></td>
<td>–306.07</td>
<td>–309.52</td>
<td>–328.16</td>
<td>–461.74</td>
</tr>
<tr>
<td>$\chi^2$-statistic</td>
<td></td>
<td></td>
<td></td>
<td>12.42</td>
<td>5.52</td>
<td>9.78</td>
<td>22.07</td>
</tr>
<tr>
<td>p-Value</td>
<td>0.002</td>
<td>0.016</td>
<td>0.005</td>
<td>0.006</td>
<td>0.137</td>
<td>0.020</td>
<td>0.001</td>
</tr>
<tr>
<td>Number of observations</td>
<td>416</td>
<td>416</td>
<td>416</td>
<td>416</td>
<td>416</td>
<td>416</td>
<td>416</td>
</tr>
</tbody>
</table>
include the dummy variables for fund focus to control for other factors that may influence base compensation and that may also be associated with fund reputation, in order to isolate the effect of the reputation measures. These dummy variables take on a value of 1 if the fund has such a focus.

We are unsure, however, whether OLS is the proper specification, so we also employ three alternatives. First, we classify funds into those where venture capitalists’ percentage of profits is in five ranges, and run an ordered logit regression. We code funds receiving below 20% as 0, those between 20% and 21% as 1, those between 21% and 25% as 2, those between 25% and 30% as 3, and those above 30% as 4. Second, we perform a Tobit regression, where we examine whether the venture organization received more than 21% of the profits, and if so, how much more. The use of this specification is motivated by the fact that the vast majority of contracts fall into the range between 20% and 21%, or else are greater than 21%. The final set of regressions employs a maximum likelihood approach. We estimate if the venture capitalists received between 20% and 21% of the profits, and if not, what percentage was received. We assume that the percentage received by the venture capitalists, if not in the 20–21% range, has a normal distribution. This allows us to use funds receiving less than 20% as well as those getting more than 21%. It also allows us to estimate separate coefficients for the decision to deviate from the standard range, and the extent of the deviation.

As reported in Table 3, the venture organization’s size and age are positive and significant in the first six regressions. While the regressions are noisy and the adjusted \( R^2 \)'s are quite low, the results are consistent with the learning model. In the final pair of maximum likelihood regressions, larger venture capitalists are more likely to deviate from the 20% to 21% range and to receive a larger share of profits (at the 10% confidence level).

5.2. Base compensation

We next examine fixed fees, also known as management fees. Because these fees are a significant fraction of venture capitalist’s compensation and are calculated in many different ways, omitting them may give a misleading impression. Fixed fees may be specified as a percent of the committed capital (that is, the amount of money investors have committed to provide over the life of the fund), the value of fund’s assets, or some combination or modification of these two measures. Both the base used to compute the fees and the percentage paid as fees may vary over the life of the fund. To examine management fees, we compute the NPV at the time of the partnership’s closing of the fixed fees that are specified in the contractual agreement. We express the value as a percent of the committed capital. We discount relatively certain compensation, such as fees based on committed capital, at 10%, while applying a 20% discount rate to more uncertain compensation, such as fees based on net asset value. The results
do not change significantly when we use other discount rates. When necessary, for example, in cases where fees are based on net asset value, we make a series of assumptions about fund performance, which are summarized in Appendix D.

Table 4 reports the mean NPV of the base compensation as a percentage of committed capital. Older and larger venture capital organizations receive lower

Table 4
Base compensation and sensitivity of compensation to performance for venture capital organizations

The sample consists of 419 venture capital partnerships whose first closing was between January 1978 and December 1992. We present base compensation as the mean net present value of the fixed fees as a percentage of committed capital, and sensitivity of compensation to performance as the mean percentage increase in the net present value of total compensation associated with an increase in the asset growth rate from 20% to 21%. We discount relatively certain compensation, such as fees based on committed capital, at 10%, and uncertain compensation, such as the venture capitalists’ share of the capital gains, at 20%. The size of the venture organization is the ratio of the capital, in 1992 dollars, invested in the organization’s funds whose first closing was in the ten calendar years prior to the year that this fund closed to the total amount, again in 1992 dollars, raised by all venture organizations in these years. Panels B and C test the significance of these patterns.

Panel A: Mean base compensation and sensitivity of compensation to performance

<table>
<thead>
<tr>
<th>Age of venture organization</th>
<th>Mean base compensation (in percent)</th>
<th>Mean sensitivity of compensation to performance (in percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No earlier funds</td>
<td>18.9%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Four years or less</td>
<td>18.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Between four and eight years</td>
<td>19.3</td>
<td>4.3</td>
</tr>
<tr>
<td>More than eight years</td>
<td>15.9</td>
<td>4.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size of venture organization</th>
<th>Mean base compensation (in percent)</th>
<th>Mean sensitivity of compensation to performance (in percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No earlier funds*</td>
<td>18.8</td>
<td>4.5</td>
</tr>
<tr>
<td>Between 0.0% and 0.2%</td>
<td>19.9</td>
<td>4.4</td>
</tr>
<tr>
<td>Between 0.2% and 0.7%</td>
<td>18.2</td>
<td>4.5</td>
</tr>
<tr>
<td>Greater than 0.7%</td>
<td>15.1</td>
<td>5.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective of fund</th>
<th>Mean base compensation (in percent)</th>
<th>Mean sensitivity of compensation to performance (in percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus on high-technology firms</td>
<td>18.8</td>
<td>4.6</td>
</tr>
<tr>
<td>Other industry focus (or no focus)</td>
<td>17.8</td>
<td>4.6</td>
</tr>
<tr>
<td>Focus on early-stage investments</td>
<td>19.2</td>
<td>4.6</td>
</tr>
<tr>
<td>Other stage focus (or no focus)</td>
<td>17.6</td>
<td>4.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date of closing</th>
<th>Mean base compensation (in percent)</th>
<th>Mean sensitivity of compensation to performance (in percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1978–December 1984</td>
<td>16.7</td>
<td>5.2</td>
</tr>
<tr>
<td>January 1985–June 1986</td>
<td>18.8</td>
<td>4.6</td>
</tr>
<tr>
<td>June 1986–December 1988</td>
<td>18.9</td>
<td>4.3</td>
</tr>
<tr>
<td>January 1989–December 1992</td>
<td>18.3</td>
<td>4.4</td>
</tr>
</tbody>
</table>
Table 4. Continued.

Panel B: Tests involving base compensation

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation, age of venture organization and base compensation</td>
<td>-0.238</td>
<td>0.000</td>
</tr>
<tr>
<td>Correlation, size of venture organization and base compensation</td>
<td>-0.330</td>
<td>0.000</td>
</tr>
<tr>
<td>Correlation, date of closing and base compensation</td>
<td>0.134</td>
<td>0.008</td>
</tr>
<tr>
<td>t-test, high-technology focus and base compensation</td>
<td>0.041&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>t-test, early-stage focus and base compensation</td>
<td>0.001&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Variance test, organizations below and above 0.7% of pool</td>
<td>0.417&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Variance test, organizations below and above 10 years old</td>
<td>0.227&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

Panel C: Tests involving sensitivity of compensation to performance

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation, age of venture organization and performance sensitivity</td>
<td>0.109</td>
<td>0.031</td>
</tr>
<tr>
<td>Correlation, size of venture organization and performance sensitivity</td>
<td>0.242</td>
<td>0.000</td>
</tr>
<tr>
<td>Correlation, date of closing and performance sensitivity</td>
<td>-0.274</td>
<td>0.000</td>
</tr>
<tr>
<td>t-test, high-technology focus and performance sensitivity</td>
<td>0.950&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>t-test, early-stage focus and performance sensitivity</td>
<td>0.459&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Variance test, organizations below and above 0.7% of pool</td>
<td>0.042&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Variance test, organizations below and above 10 years old</td>
<td>0.043&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> This category also includes funds which raised a previous fund whose size cannot be determined.

<sup>b</sup> p-value from a t-test comparing the performance sensitivity in funds with and without this investment focus.

<sup>c</sup> p-value from an F-test comparing the variance of performance sensitivity in funds of experienced and inexperienced venture organizations.

Base compensation than younger, smaller ones. Funds focusing on early-stage and high-technology investments have higher base compensation. The NPV of base compensation appears to have increased over time, rising by nearly 2% since 1984.

Regression results are presented in Table 5. The dependent variable is the NPV of base compensation as a percent of committed capital. Fees totaling 20% of committed capital would again be expressed as 20. Independent variables include the date of the fund’s closing, venture organization size and age, and dummy variables denoting whether the fund focuses on high-technology or early-stage investments, with 1 denoting such a fund. We find that larger and older venture organizations are associated with significantly lower fees, while funds specializing in early-stage or high-technology investments have significantly larger base compensation.
Table 5
Regression analyses of the net present value of base compensation of venture capital organizations

The sample consists of 419 venture capital partnerships whose first closing was between January 1978 and December 1992. The dependent variable is the net present value of the expected base compensation paid to venture capitalists as a percentage of committed capital. We assume an annual asset growth rate of 20% and discount relatively certain compensation, such as fees based on committed capital, at 10%, and uncertain compensation, such as fees based on net asset value, at 20%. Independent variables include the date of closing, measured as the ratio of capital raised in the ten calendar years prior to the year in which the fund closed to the total amount raised by venture capital organizations in that period, the age of the venture organization at the time of the closing of the fund, in years, and dummy variables indicating whether the fund focused on high-technology or early-stage investments, with 1 denoting such a fund. Absolute $t$-statistics in brackets.

<table>
<thead>
<tr>
<th>Dependent variable: Net present value of base compensation as a percent of committed capital</th>
<th>With dummy for high-tech focus</th>
<th>With dummy for early-stage focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of closing</td>
<td>0.22 [2.82]</td>
<td>0.35 [4.29]</td>
</tr>
<tr>
<td>Age of venture organization</td>
<td>$-0.25$ [5.88]</td>
<td>$-0.23$ [5.35]</td>
</tr>
<tr>
<td>Fund focuses on high technology?</td>
<td>0.86 [1.88]</td>
<td>1.02 [2.21]</td>
</tr>
<tr>
<td>Fund focuses on early stages?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.13</td>
<td>0.10</td>
</tr>
<tr>
<td>$F$-statistic</td>
<td>19.96</td>
<td>15.82</td>
</tr>
<tr>
<td>$p$-value</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Number of observations</td>
<td>393</td>
<td>393</td>
</tr>
</tbody>
</table>

The results are consistent with the predictions of the learning model. The model suggests that established firms will receive a greater share of their compensation in the form of variable payments. On the other hand, the signaling model predicts that base compensation should be higher for older and larger venture capital organizations. Once they have established reputations, venture capitalists should demand insurance through higher base compensation. This prediction is not borne out in the data.
5.3. The sensitivity of compensation to performance

An alternative measure of variable compensation is the elasticity of compensation with respect to fund performance. This allows us to get a more complete picture of the sensitivity of compensation to performance, as we can assess the impact of both the base and variable compensation. To determine the elasticity, we calculate the NPV of the total compensation under reasonable assumptions.

The specific procedure we employ is as follows. We discount the payments back to the date of the partnership’s formation. We undertake the calculation at two asset growth rates, 20% and 21%. By comparing these two values, we can examine the incremental value of a small amount of additional performance at a level of performance that is typical for this period. For example, Venture Economics (1989c) estimates that funds established prior to 1982 that were still active in 1989 had a mean return of 17.6%, with a standard deviation of 14.2%. We once again discount relatively certain compensation, such as that based on committed capital, at 10%, while applying a 20% discount rate to more uncertain compensation, such as expected profits. Additional assumptions are described in Appendix D. Fig. 2 displays the considerably greater dispersion in the sensitivity to performance than in the share of profits.

An alternative approach to measuring the elasticity of compensation to performance would be to view the venture capitalist’s compensation as consisting of two securities: a bond, the base compensation, and an option on the percentage of the assets of the partnership, which would be the variable compensation. We could then compute the value of the bond and the option. While

Fig. 2. The sensitivity of venture capitalist compensation to performance. The sample consists of 419 venture capital partnerships whose first closing was between January 1978 and December 1992. The figure indicates the percentage increase in compensation associated with an increase in the asset growth rate from 20% to 21%. We discount relatively certain compensation, such as fees based on committed capital, at 10%, and uncertain compensation, such as the venture capitalists’ share of the capital gains, at 20%.
Sahlman (1990) computes the value of such an option in a simple case, undertaking such a calculation for several hundred funds with different payout structures would be prohibitively difficult.

Table 4 reports the mean elasticity of compensation to performance. Older and larger venture organizations have significantly greater performance sensitivity. Funds specializing in high-technology and early-stage investments, which command both higher base and variable compensation, display no difference in the sensitivity of compensation to performance. The variance of the performance sensitivity is significantly higher for larger and older venture organizations.

Table 6 presents regression analyses of compensation sensitivity to performance. The dependent variable is the change in the NPV of total compensation associated with increasing the asset growth rate from 20% to 21%. Compensation for larger and older venture organizations displays a greater performance sensitivity, while compensation for funds specializing in early-stage and high-technology firms does not.

Two observations about the level and pattern of elasticity measures are in order. The first is the relatively large impact of an increase in performance on the pay of the venture capitalists. An increase in the asset growth rate from 20% to 21% leads to a 4% to 5% increase in compensation. This increase results from the highly leveraged position of the venture capitalists, who receive a share of the profits only after the return of investors’ committed capital. This sensitivity is magnified among the older and larger firms, due to the greater sensitivity of their compensation to performance.

Second, our analyses have a significant bias against finding the patterns in Tables 4–6. Several of the oldest and largest venture organizations do not charge a fixed annual fee based on committed capital or assets. Rather, they negotiate annual budgets with their limited partners. These organizations are reputed to have very low fee structures. This claim is corroborated through an examination of recent annual reports for eight such funds in the Aeneas files. The funds charged an average fee of 1.6% of committed capital, considerably below the standard 2.5%. These funds are not included in our analyses of base compensation or performance sensitivity, since their compensation is not fixed in advance. Were we able to include them, the level of base compensation would decline and the level and variance of the performance sensitivity would increase for the oldest and largest funds.

The elasticity results are consistent with the predictions of the learning model, but not the signaling one. As the abilities of venture capitalists become known with greater certainty, explicit incentives, typically in the form of variable performance compensation, replace implicit career concerns. The variance in compensation schemes rises over time as investors and venture capitalists learn about abilities. If early-stage and high-technology venture funds differ from other funds only in the level of effort necessary to monitor the portfolio, fixed fees should be higher, but performance sensitivity should not differ between the groups. This is what we find empirically.
Table 6
Regression analyses of the sensitivity of compensation to performance for venture capital organizations

The sample consists of 419 venture capital partnerships whose first closing was between January 1978 and December 1992. The dependent variable is the percentage increase in the net present value of total compensation associated with an increase in the asset growth rate from 20% to 21%. We discount relatively certain compensation, such as fees based on committed capital, at 10%, and uncertain compensation, such as the venture capitalists’ share of the capital gains, at 20%. Independent variables include the date of closing, with January 1, 1978 coded as 1978.0, and so forth, the size of the venture capital organization, measured as the ratio of capital raised in the ten calendar years prior to the year in which the fund closed to the total amount raised by venture capital organizations in that time, the age of the venture organization at the time of the closing of the fund, in years, and dummy variables indicating whether the fund focused on high-technology or early-stage investments, with 1 denoting such a fund. Absolute $t$-statistics in brackets.

<table>
<thead>
<tr>
<th>Dependent variable: Sensitivity of compensation to performance</th>
<th>With dummy for high-tech focus</th>
<th>With dummy for early-stage focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of closing</td>
<td>0.10</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>[5.73]</td>
<td>[6.53]</td>
</tr>
<tr>
<td>Size of venture organization</td>
<td>36.72</td>
<td>36.15</td>
</tr>
<tr>
<td></td>
<td>[5.05]</td>
<td>[4.93]</td>
</tr>
<tr>
<td>Age of venture organization</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>[3.87]</td>
<td>[3.73]</td>
</tr>
<tr>
<td>Fund focuses on high technology?</td>
<td>0.02</td>
<td>− 0.01</td>
</tr>
<tr>
<td></td>
<td>[0.18]</td>
<td>[0.09]</td>
</tr>
<tr>
<td>Fund focuses on early stages?</td>
<td>− 0.05</td>
<td>− 0.06</td>
</tr>
<tr>
<td></td>
<td>[0.44]</td>
<td>[0.53]</td>
</tr>
<tr>
<td>Constant</td>
<td>200.74</td>
<td>238.79</td>
</tr>
<tr>
<td></td>
<td>[5.86]</td>
<td>[6.66]</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.13</td>
<td>0.10</td>
</tr>
<tr>
<td>$F$-statistic</td>
<td>19.74</td>
<td>15.94</td>
</tr>
<tr>
<td>$p$-value</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Number of observations</td>
<td>393</td>
<td>393</td>
</tr>
</tbody>
</table>

6. Ex ante compensation and ex post performance

Our two models also differ in their predicted relationship between ex ante sensitivity of compensation to performance and ex post performance. In other
words, each model provides different predictions regarding whether performance-sensitive compensation negotiated at the time of the partnership agreement will be associated with higher returns. The learning model suggests that there will not necessarily be any relationship between pay sensitivity and performance. Reputational concerns lead young venture capitalists with little explicit incentive compensation to work hard and perform well. The signaling model, on the other hand, suggests a positive relationship between pay sensitivity and success. Higher-ability venture capitalists signal their ability by taking more risk and then work harder. In this section, we empirically examine this relationship. Consistent with the learning model, we do not find any evidence of a relationship between pay sensitivity and performance.

Several data constraints limit our analysis. First, we do not have access to the internal rate of return (IRR) information for the funds in our sample. While this information is compiled by several monitoring organizations, it is considered proprietary information. Second, our sample consists primarily of funds from the 1980s and 1990s. Few of these funds have yet been concluded. The ten-year contractual life for most venture funds is often extended by several years. Consequently, most of our funds have investments remaining in their portfolios. Because valuations of private firms are often very subjective, even if they were available, rates of return would be of limited value.

Thus, we employ an alternative measure of performance, which is the ratio of the market value of the fund's stakes in firms that went public to the total amount raised by the fund. This measure is highly correlated with the fund's final IRR. Venture capitalists generate the bulk of their profits from firms that go public. A Venture Economics study (1988) finds that a $1 investment in a firm that goes public provides an average cash return of $1.95 in excess of the initial investment, with an average holding period of 4.2 years. The next best alternative as estimated by Venture Economics (1988), an investment in an acquired firm, yields a cash return of only 40 cents over a 3.7 years average holding period.

We identify potential venture-backed initial public offerings (IPOs) using three sources. The first is the listings of venture-backed IPOs published in Venture Economics' Venture Capital Journal. This is the same source used by Barry et al. (1990), and Megginson and Weiss (1991). Venture Economics' listings, however, do not include approximately 15% of all venture-financed firms (Lerner, 1995). We consequently use listings of security distributions by venture funds. Venture capitalists typically divest their successful investments by distributing shares to their partners. We obtain lists of the distributions received by a major pension fund and three investment managers. Most of the successful investments by 135 venture funds can be identified from these lists. The final source is the private placement memoranda used to raise new venture funds. In these offering memoranda, venture organizations often list successful past
investments. We examine over 200 memoranda in the files of Venture Economics. We then examine the firms’ IPO prospectuses, and note each venture capital fund holding an equity stake of at least 5%. We identify 835 IPOs between 1972 and 1992 where one or more venture capitalists held such an equity stake. We then determine which venture capital funds in our sample of 419 partnerships held an investment in one of the IPO companies.

Venture capitalists typically do not sell their holdings at the time of the IPO, but hold them for approximately one and a half years thereafter (Gompers and Lerner, 1998). We do not know the precise date at which they liquidated these investments in most cases. We consequently value the venture capitalists’ stakes at the market price eighteen months after the IPO date, using the Securities Data Company Corporate New Issues and Center for Research into Securities Prices databases.

These analyses, reported in Table 7, employ all 234 funds begun before January 1987, which include those out of the sample of 419 with at least six years to take firms public. The dependent variable is the ratio of the dollar value of each fund’s stake in IPOs, summing the amount in 1992 dollars, to the fund’s total committed capital. Because older funds have had more time to harvest their portfolios, we normalize the ratio of the mean fund in each year to one. Independent variables include the date of the fund’s closing, venture organization size, and the percent of profits accruing to the general partners. One concern in choosing the sample of firms to review is that different venture organizations may take companies public at different times. Gompers (1996) shows that a new venture capital organization may take companies public earlier in order to impress potential investors in its second fund. Consequently, IPOs in the first years of a fund’s life may not provide a clear indicator of ultimate performance. We address this concern in unreported regressions by examining only the subset of funds begun before January 1983. For these funds, we can observe all IPOs over the first ten years of the fund’s life. Neither the magnitude nor the significance of the relationship between compensation and performance differs appreciably when this subset is used.

In the first regression, we use an OLS specification. Because the dependent variable is bounded by zero, this may produce biased coefficients. We thus employ a Tobit specification in the second regression. Finally, we employ a two-stage approach to control for factors that may explain the percentage of profits received by the venture capitalist. In each, the compensation measure has virtually no explanatory power. We explore several alternative approaches in unreported regressions. First, we use the measure of pay sensitivity defined in Section 5.3. We add additional independent variables, such as venture organization age. In none of these regressions is there a significant relationship between compensation and performance. This result is consistent with the predictions of the learning model.
Table 7
Regression analyses of the performance of venture capital funds

The sample consists of 234 venture capital partnerships whose first closing was between January 1978 and December 1986. The first regression is an ordinary least squares (OLS) analysis, with the ratio of the value of the fund’s stakes in firms which had gone public in an initial public offering (IPO) by December 1992 to the total amount raised by the fund as the dependent variable. The value of the firm is determined eighteen months after the IPO. To control for the different maturities of the portfolios, the ratio of the mean fund begun in each year is normalized as 1.0. The second regression employs a Tobit specification, the third, a two-stage least squares approach, for which only the second-stage regression is reported. Independent variables include the date of closing, with January 1, 1978 coded as 1978.0, and so forth, the size of the venture capital organization, measured as the ratio of capital raised in the ten calendar years prior to the year in which the fund closed to the total amount raised by venture capital organizations in that time, and the percentage of profits received by the venture organization. Absolute t-statistics in brackets.

<table>
<thead>
<tr>
<th></th>
<th>OLS analysis</th>
<th>Tobit analysis</th>
<th>Two-stage least squares analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of closing</td>
<td>0.004</td>
<td>-0.05</td>
<td>-0.12</td>
</tr>
<tr>
<td></td>
<td>[0.09]</td>
<td>[0.78]</td>
<td>[0.29]</td>
</tr>
<tr>
<td>Size of venture org.</td>
<td>11.79</td>
<td>23.77</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>[1.07]</td>
<td>[1.70]</td>
<td>[0.11]</td>
</tr>
<tr>
<td>Venture capitalists’</td>
<td>0.004</td>
<td>0.001</td>
<td>17.92</td>
</tr>
<tr>
<td>percentage of profits</td>
<td>[0.15]</td>
<td>[0.04]</td>
<td>[0.76]</td>
</tr>
<tr>
<td>Constant</td>
<td>-6.92</td>
<td>91.27</td>
<td>-6.86</td>
</tr>
<tr>
<td></td>
<td>[0.08]</td>
<td>[0.79]</td>
<td>[0.07]</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>-0.008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td>0.41</td>
<td></td>
<td>0.40</td>
</tr>
<tr>
<td>Log likelihood</td>
<td></td>
<td>-388.64</td>
<td></td>
</tr>
<tr>
<td>$\chi^2$-statistic</td>
<td></td>
<td>4.06</td>
<td></td>
</tr>
<tr>
<td>Root MSE</td>
<td>1.454</td>
<td></td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>0.744</td>
<td>0.255</td>
<td>0.757</td>
</tr>
<tr>
<td>Number of observations</td>
<td>234</td>
<td>234</td>
<td>234</td>
</tr>
</tbody>
</table>

An interesting unanswered question is whether the variance of returns of high- and low-ability venture capitalists differs. The models presented constrain the variance of these two group’s returns to be the same. It could be that experienced venture capitalists invest in less risky firms or reduce these risks by engaging in active management of these firms. This question has not been empirically explored to date by financial economists, but is a topic that we are currently examining in a research project.
7. Conclusion

The unique institutional features of the U.S. venture capital organization provide an attractive arena to examine compensation schemes. Because they have few alternatives, investors in limited partnerships must rely on incentive schemes to control managers. The small number of general partners, and the accuracy with which their success can be measured, ensure that compensation schemes can effectively motivate management actions. Finally, the terms of the compensation schemes are clearly defined in the initial partnership agreements and are rarely renegotiated.

Evidence from 419 U.S. venture partnerships formed between 1978 and 1992 is generally consistent with the view that reputation is an important motivation for young, unseasoned venture capitalists. Using two proxies for reputation, the age and size of the venture organization, we find that the compensation of established funds is significantly more sensitive to performance and more variable than that of other funds. Older and larger firms have lower base compensation as well. Performance and pay sensitivity do not appear to be related.

The results indicate that venture capital entrants may not have superior information about their investment abilities and may be concerned about establishing a reputation. This interpretation seems plausible. The venture capital industry may require skills that were not used in venture capitalists’ previous employment. Venture capitalists argue that it is difficult to predict success of new partners in advance. For instance, Robert Kunze (1990) of Hambrecht and Quist notes: ‘The life of the associate [at a venture capital firm] is akin to playing house. Since associates never make the actual investment decision… it’s impossible to tell whether or not they’ll be successful venture capitalists if and when they get the chance’. Meanwhile, investors are sophisticated institutions that closely track performance. It is reasonable to expect that neophyte venture capitalists do not know their own investment abilities any better than their investors do.

While we have only tested the learning model against the signaling model, other factors may help explain compensation patterns. A leading alternative is a human capital-based model. Leading venture capitalists may be able to extract higher pay than their less-seasoned counterparts because more investors want to invest in their next funds. This might lead to a similar pattern of older venture organizations, whose venture capitalists often have extensive investment experience, receiving higher compensation as a return on their superior human capital. It is difficult to build a human capital model, however, that has the higher pay occurring only in the variable compensation. If venture capitalists are risk averse, they should demand more insurance. Established venture capital firms should raise new funds with higher base and variable compensation, if the venture capitalists extract higher pay with both components, or with higher base compensation as well.
and lower variable compensation, if the demand for insurance predominates. Section 5 demonstrates that older and larger venture capital organizations receive higher variable and lower base compensation. This pattern is not what a human capital-based model would suggest, but it is consistent with our learning model.

These empirical patterns raise several unanswered questions. One unresolved issue is why there is so much uniformity in the most visible aspect of compensation, the distribution of carried interest. Clustering of the visible portion of compensation is very common. For instance, many lawyers work for a 33% contingent fee and most real estate brokers in an area charge the same sales commission. An interesting theoretical model would attempt to explain this lack of variation within professions and the factors that lead to these focal equilibria. A second puzzle is how compensation arrangements in limited partnerships interact with the many restrictions in these arrangements. Gompers and Lerner (1996) find that there is considerably more variability in the use of covenants and restrictions in venture capital limited partnership agreements. These variations in covenants might be thought of as prices as well. Why the price of restrictions is more variable than explicit compensation terms is a fertile area for future research.

Appendix A. Derivation of the learning model

We assume that there is symmetric uncertainty about the ability of the venture capitalist, \( \eta \). This can represent either the venture capitalist’s skill in selecting portfolio companies (either through screening or through pro-actively identifying transactions), or his ability to add value after the investment. Venture capitalists and investors believe that \( \eta \) is distributed normally, with mean \( m_\eta \) and variance \( \sigma^2_\eta \). Neither side has private information about the venture capitalist’s quality in advance of the project.

Venture capitalists raise two partnerships in two consecutive periods. The outcome of investments in the first fund and any investment returns are realized prior to the second fund being raised. No projects shift from the first fund to the second. The fund return in period \( t \), \( \pi_t \), is a function of ability, the venture capitalist’s effort (\( e_t \)), and noise (\( \varepsilon_t \)):

\[
\pi_t = \eta + e_t + \varepsilon_t.
\] (A.1)

We use the simple additive production function to simplify the derivation of the optimal contract. We have also derived results for a multiplicative production function (i.e., \( \eta e \)). Using this alternative production function, the feature of the learning model that distinguishes it from the signaling model presented below remains the same: early funds have lower pay-for-performance sensitivity. The multiplicative production function, however, leads to second-period
compensation schemes in which high-ability venture capitalists have lower pay-for-performance sensitivity than the others. In reality, certain activities of the venture capitalist appear to be additive, such as providing contacts and advice, while others, like reputational spillovers, seem to be multiplicative.

In Eq. (A.1), noise \((\varepsilon_t)\) is distributed independently and identically normal with mean 0 and variance \(\sigma^2_e\). The number of projects in a venture fund is typically small enough that residual uncertainty about returns exists. At the time a venture capitalist raises his next fund, considerable uncertainty about abilities is likely to remain. While venture capitalists and investors have the same beliefs about ability before the funds are formed, investors cannot observe the effort level chosen in either fund. Effort choice is private information.

The venture capitalist’s compensation, \(w_t\), is a linear function of fund returns. Holmstrom and Milgrom (1987) show that when effort choice and output are continuous, but monitoring by the principal is periodic, linear sharing rules are optimal. An added motivation for using a linear scheme in the model is the prevalence of such agreements in venture partnership agreements. The venture capitalist receives some fixed payment, \(f_t\), and variable compensation which represents a share, \(v_t\), of the return on the fund:

\[
w_t(\pi_t) = f_t + v_t\pi_t. \tag{A.2}
\]

\(C(e_t)\) is the direct disutility, in monetary terms, of effort. Both the venture capitalist and the investor know \(C(e_t)\). \(C(e_t)\) is convex, and \(C'(0) = 0\), \(C'(\infty) = \infty\), and \(C''' \geq 0\). \(C''' \geq 0\) ensures uniqueness of the equilibrium contract. The investor is risk neutral, but the venture capitalist is risk averse, with a coefficient of risk aversion, \(r\), and a constant per-period discount rate, \(\delta\). The venture capitalist’s utility function is given by Eq. (A.3):

\[
U(w_1, w_2; e_1, e_2) = -\exp\left(-r\sum_{i=1}^{2} \delta^{i-1}[w_i - C(e_i)]\right). \tag{A.3}
\]

As in Gibbons and Murphy (1992), this utility function is not additively separable. The utility function displays constant absolute risk aversion and makes the derivation of two-period incentive schemes easier. Because investors in venture funds are primarily large institutions, such as pension funds and insurance companies, investor risk neutrality is reasonable. Venture capitalist risk aversion may result from wealth constraints or lack of investment portfolio diversification (for survey evidence, see Tyebjee and Bruno, 1984).

Compensation contracts are written for each fund, conditional on the information available from returns, if any exist. The terms of the compensation contract are set out before effort is chosen or investments are made. Investors in both funds can, but need not be, the same investors as in the first fund. Investors in the second fund, however, have verifiable information about the performance
of the first fund. We assume that one investor and one venture capitalist negotiate over the terms of the compensation and that a Nash (1950) bargaining solution is relevant, that is, the compensation package evenly splits the expected gains from investment:

\[ f_1(v_1) + v_1E(p_1 | \hat{\epsilon}_1) - C(\hat{\epsilon}_1) = \frac{1}{2}[E(p_1 | \hat{\epsilon}_1) - C(\hat{\epsilon}_1)], \tag{A.4} \]

\[ f_2(v_2) + v_2E(p_2 | p_1, \hat{\epsilon}_1, \hat{\epsilon}_2) - C(\hat{\epsilon}_2) = \frac{1}{2}[E(p_2 | p_1, \hat{\epsilon}_1, \hat{\epsilon}_2) - C(\hat{\epsilon}_2)]. \tag{A.5} \]

A Nash bargaining solution, which assumes equal bargaining power, seems appropriate for venture capital settings where only a small number of potential players are involved in the negotiations. The number of investors and venture capitalists is not large. The model’s theoretical predictions are robust to other divisions of the surplus.

The venture capitalist maximizes his expected utility in both funds:

\[ \text{max} - E[\exp(-r[f_1 + v_1(\eta + e_1 + \epsilon_1) - C(e_1)])] \]

\[ - r\delta[f_2 + v_2(\eta + e_2 + \epsilon_2) - C(e_2))]. \tag{A.6} \]

The optimal schedule of incentives is derived by starting in the second period. Conditional on first fund returns of \( p_1 \), venture capitalists choose effort to maximize:

\[ \text{max} - E[\exp(-r[f_2 + v_2(\eta + e_2 + \epsilon_2) - C(e_2)]) | p_1]. \tag{A.7} \]

If the investor observes a return of \( p_1 \) and believes that the venture capitalist exerted \( \hat{\epsilon}_1 \) in the first fund, the investor’s posterior estimate of the venture capitalist’s ability will be

\[ m_1(p_1, \hat{\epsilon}_1) = \frac{\sigma^2_m + \sigma^2_0(p_1 - \hat{\epsilon}_1)}{\sigma^2 + \sigma^2_0}. \tag{A.8} \]

The intuition behind Eq. (A.8) is that the higher first period returns are, the larger the revision in beliefs about ability will be. The higher the variance of noise relative to the variance in abilities is, the smaller the revision in beliefs will be. If Eq. (A.7) is maximized with respect to \( e_2 \), we get the first order condition for the optimal second period effort:

\[ C'(e_2) = v_2. \tag{A.9} \]

Eq. (A.9) says that venture capitalists work until their marginal share of the expected increase in return equals their marginal effort cost. We substitute
Eq. (A.5) into Eq. (A.7), and take the expectation, to get

$$\max - \exp \left[ - \frac{r}{2} [m_1(r_1, \hat{e}) + e_2(v_2) - C(e_2(v_2)) - \frac{r}{2} v_2^2(\sigma^2_z + \sigma^2_0)] \right]. \quad (A.10)$$

Note that $\mathbb{E}\{\exp(-kx)\} = \exp(-k\mu + \frac{1}{2}k^2\sigma^2)$. Maximizing Eq. (A.10) gives the first order condition for $v^*_2$. Eq. (A.11) gives the expression derived from that solution:

$$v^*_2 = \frac{1}{1 + 2r(\sigma^2_z + \sigma^2_0)C''(e^*_2(v_2)).} \quad (A.11)$$

To get a value for $v_1$, Eqs. (A.5) and (A.4) are substituted into Eq. (A.6), to yield

$$\max - \mathbb{E}\left[ \exp \left( - r \left[ \frac{1}{2} (1 - 2v_1)(m_0 + \hat{e}_1(v_1)) + C(\hat{e}_1(v_1)) \right] ight) + v_1[\eta + e_1(v_1) + \epsilon_1] - C(e^*_1(v_1)) \right]$$

$$- r \delta \left[ \frac{1}{2} (1 - 2v_2) \left[ \frac{\sigma^2_z m_0 + \sigma^2_0 (\hat{e}_1(v_1) - \hat{e}_1(v_1)) + \hat{e}_2(v_2)}{\sigma^2_z + \sigma^2_0} + C(\hat{e}_2(v_2)) \right] + v_2[\eta + e_2(v_2) + \epsilon_2] - C(e_2(v_2))] \right]. \quad (A.12)$$

Taking the expectation of Eq. (A.12) yields:

$$\max - \exp \left\{ - r \left[ \frac{1}{2} (m_0 + \hat{e}_1(v_1)) - C(\hat{e}_1(v_1))] \right] - \frac{1}{2} r \delta [m_0 + e_2(v_2)$$

$$- C(e_2(v_2))] + \frac{1}{2} r^2 \delta^2 v_1^2 (\sigma^2_z + \sigma^2_0) + \frac{1}{8} r^2 \delta^2 (1 - 2v_2)^2 (\sigma^2_0)^2 (\sigma^2_z + \sigma^2_0)$$

$$+ \frac{1}{2} r^2 \delta^2 v_2 (\sigma^2_z + \sigma^2_0) + \frac{1}{2} r^2 \delta v_1 (1 - 2v_2)(\sigma^2_0)(\sigma^2_z + \sigma^2_0)$$

$$+ \frac{1}{2} r^2 \delta^2 v_2 (1 - 2v_2) \sigma^2_0 + r^2 \delta v_1 v_2 \sigma^2_0 \right\}. \quad (A.13)$$

The $v_1$ that satisfies the first-order condition for Eq. (A.13) will be the optimal variable compensation sensitivity. The first-order condition is

$$- \frac{1}{2} + \frac{1}{2} C'(e^*_1(v_1)) + rv_1(\sigma^2_z + \sigma^2_0)C''(e^*_1(v_1)) + \frac{1}{2} r \delta (1 - 2v_2) \sigma^2_0 C''(e^*_1(v_1)) = 0. \quad (A.14)$$
From Eq. (A.12), we know that the venture capitalist’s optimal effort level in period 1, \(e_1\), must be given by

\[
C'(e_1^*(v_1)) = v_1 + \delta(1 - 2v_2)\frac{\sigma_0^2}{\sigma_e^2 + \sigma_0^2}.
\]  
(A.15)

We substitute Eq. (A.15) into Eq. (A.14) and solve for the optimal variable compensation in period 1:

\[
v_1 = \frac{1}{1 + 2rC''[e_1^*(v_1)]} \left[ \frac{\delta(1 - 2v_2)\sigma_0^2}{\sigma_e^2 + \sigma_0^2} \right] - \frac{2r\delta v_2^*\sigma_0 C''[e_1^*(v_1)]}{1 + 2r(\sigma_e^2 + \sigma_0^2)C''[e_1^*(v_1)]}.
\]  
(A.16)

The level of fixed fees is determined by substituting Eq. (A.11) and Eq. (A.16) into Eq. (A.5) and Eq. (A.4), respectively, taking expectations, and solving, to yield \(f_1\) and \(f_2\):

\[
f_1(v_1^*) = \frac{1}{2}[(1 - 2v_1^*)[m_0 + e_1^*(v_1^*)] + C(e_1^*(v_1^*))],
\]  
(A.17)

\[
f_2(v_2^* | \pi_1) = \frac{1}{2}[(1 - 2v_2^*)\left[ \frac{\sigma_e^2m_0 + \sigma_0^2(\pi_1 - e_2^*(v_2^*))}{\sigma_e^2 + \sigma_0^2} + e_2^*(v_2^*) \right] + C(e_2^*(v_2^*))].
\]  
(A.18)

**Appendix B. Derivation of the signaling model**

We continue to employ the basic framework and notation of Appendix A, except that we assume venture capitalists initially know their ability type, but investors do not. For ease of exposition, we assume that venture capitalists can have two types, high-ability (H) or low-ability (L), with \(\eta^H > \eta^L\). Effort after the first unit is equally productive for both types because we have assumed an additive return function. In order to determine the optimal contract that will be offered by high-ability venture capitalists, we first need to assume that we are constructing a separating equilibrium. Not only will other separating equilibria exist, but pooling equilibria are also likely to exist for various parameter values. Because we are interested in the case in which high-ability types are able to distinguish themselves, we will only focus on the Riley (1979) separating equilibrium.

We again assume that venture capitalists and investors split the expected surplus from investments:

\[
f_2^H + v_2^H[\eta^H + \hat{e}(v_2^H)] - C(\hat{e}(v_2^H)) = \frac{1}{2}[E(\eta^H + \hat{e}(v_2^H)) - C(\hat{e}(v_2^H))],
\]  
(B.1)

\[
f_2^L + v_2^L[\eta^L + \hat{e}(v_2^L)] - C(\hat{e}(v_2^L)) = \frac{1}{2}[E(\eta^L + \hat{e}(v_2^L)) - C(\hat{e}(v_2^L))].
\]  
(B.2)
The single-period maximization problem then becomes a problem of maximizing expected utility in the second period, assuming full information. Because we are constructing separating equilibria, information about abilities is totally revealed in the first period. Contracts signed in the second period reflect this information. For high-ability venture capitalists, we solve

\[
\max - \mathbb{E}[\exp(-r[f_2^H + v_2^H(\eta^H + e_2 + \varepsilon_2) - C(e_2)])].
\]

The second fund’s variable compensation for both high- and low-ability venture capitalists is

\[
v_2^H = v_2^L = \frac{1}{1 + 2r\sigma_f^2C'[\sigma_f^2(v_2)]] = v_2. \quad \text{(B.4)}
\]

The result in Eq. (B.4) is not surprising, because we assume that marginal productivity and effort costs of high- and low-ability venture capitalists are the same. Because types are fully revealed in the first period, second period compensation differs only in the base component of compensation. This is true because the utility function we choose does not display any wealth effects. The level of expected income does not affect risk aversion. Fixed compensation for the two types is given by Eqs. (B.5) and (B.6):

\[
f_2^H(v_2^H) = \frac{1}{4}[1 - 2v_2^H][\eta^H + e_2^H(v_2^H)] + C(e_2^H(v_2^H)), \quad \text{(B.5)}
\]

\[
f_2^L(v_2^L) = \frac{1}{4}[1 - 2v_2^L][\eta^L + e_2^L(v_2^L)] + C(e_2^L(v_2^L)), \quad \text{(B.6)}
\]

The difference in second period fixed compensation is directly proportional to the difference between high- and low-ability venture capitalists:

\[
f_2^H - f_2^L = \frac{1}{4}(1 - 2v_2^H)[\eta^H - \eta^L]. \quad \text{(B.7)}
\]

The optimization program for the high-ability venture capitalist in period 1 is given by Eq. (B.8):

\[
\begin{align*}
\max & - \mathbb{E}[\exp\{- r[\frac{1}{4}((1 - 2v_1^H)[\eta^H + e_1(v_1^H) + C(e_1(v_1^H))] \\
& + v_1^H[\eta^H + e_1(v_1^H) + \varepsilon_1] - C(e_1(v_1^H))]]
\end{align*}
\]

s.t

\[
\begin{align*}
& - \mathbb{E}[\exp\{- r[\frac{1}{4}((1 - 2v_1^L)[\eta^L + e_1^L(v_1^L) + C(e_1^L(v_1^L))] \\
& + v_1^L[\eta^L + e_1^L(v_1^L) + \varepsilon_1] - C(e_1^L(v_1^L)) + \delta((1 - 2v_1^L)[\eta^L + e_2^L(v_1^L)]] \\
& + C(e_2^L(v_1^L)] + v_2^L[\eta^L + e_2^L(v_2^L) + \varepsilon_2] - C(e_2^L(v_2^L)))]\}]]
\end{align*}
\]

\[
\begin{align*}
& = - \mathbb{E}[\exp\{- r[\frac{1}{4}((1 - 2v_1^H)[\eta^H + e_1^H(v_1^H) + C(e_1^H(v_1^H))] \\
& + v_1^H[\eta^H + e_1^H(v_1^H) + \varepsilon_1] - C(e_1^H(v_1^H))] \\
& + \delta((1 - 2v_1^L)[\eta^L + e_2^L(v_1^L) + C(e_2^L(v_1^L))]] \\
& + v_2^L[\eta^L + e_2^L(v_2^L) + \varepsilon_2] - C(e_2^L(v_2^L)))]\}]].
\end{align*}
\]

\[
\text{(B.8)}
\]
The interpretation of Eq. (B.8) is straightforward. High-ability venture capitalists maximize their utility in the first period, subject to the constraint that low-ability venture capitalists are indifferent between offering their optimal contract which reveals their type in period 1 and offering the contract that high types offer. The choice of contract for high-ability venture capitalists in the first period will not influence the form of their second period contract, so their program for the first period is to maximize their first period utility, assuming that low-ability venture capitalists will not find it in their interest to mimic the high type’s offer. The high-ability venture capitalist is concerned only about first-period utility because we are ruling out two-period contracts.

Taking the expectation of Eq. (B.8), and remembering from Eq. (B.4) that \( v_2^H = v_1^L = v_2 \), yields the following:

\[
\begin{align*}
\text{max} & \quad - \exp \left\{ - r \left[ \frac{1}{2} [\eta^H + e_1^*(v_1^H) - C(e_1)] - \frac{r}{2} (v_1^H)^2 \sigma_e^2 \right] \right\} \\
\text{s.t.} & \quad - \exp \left\{ - r \left[ \frac{1}{2} [\eta^L + e_1^*(v_1^L) - C(e_1^L)] - \frac{r}{2} (v_1^L)^2 \sigma_e^2 \right] \\
& \quad + \delta \left\{ \frac{1}{2} [\eta^H + e_1^*(v_2) - C(e_1^L)] - \frac{r}{2} (v_2)^2 \sigma_e^2 \right\} \right\} \\
& \quad = - \exp \left\{ - r \left[ \frac{1}{2} [(1 - 2v_1^H)\eta^H + 2v_1^H\eta^L + e_1^*(v_1^H) - C(e_2(v_2))] - \frac{r}{2} (v_1^H)^2 \sigma_e^2 \right] \\
& \quad + \delta \left\{ \frac{1}{2} [(1 - 2v_2)\eta^H + 2v_2\eta^L + e_1^*(v_2^H) - C(e_2^L(v_2))] - \frac{r}{2} (v_2)^2 \sigma_e^2 \right\} \right\}. \\
\end{align*}
\]

(B.9)

Eq. (B.9) can be transformed into an equivalent optimization problem by removing the exponentials, to give the program in Eq. (B.10):

\[
\begin{align*}
\text{max} & \quad \frac{1}{2} [\eta^H + e_1^*(v_1^H) - C(e_1)] - \frac{r}{2} (v_1^H)^2 \sigma_e^2 \\
\text{s.t.} & \quad \frac{1}{2} [\eta^L + e_1^*(v_1^L) - C(e_1^L)] - \frac{r}{2} (v_1^L)^2 \sigma_e^2 + \delta \left\{ \frac{1}{2} [\eta^L + e_1^*(v_2)] \right\} \\
& \quad - C(e_2^L(v_2))] - \frac{r}{2} (v_2)^2 \sigma_e^2 \right\} \\
& \quad = \frac{1}{2} \{(1 - 2v_1^H)\eta^H + 2v_1^H\eta^L + e_1^*(v_1^H) - C(e_2(v_2))] - \frac{r}{2} (v_1^H)^2 \sigma_e^2 \\
& \quad + \delta \left\{ \frac{1}{2} [(1 - 2v_2)\eta^H + 2v_2\eta^L + e_1^*(v_2^H) - C(e_2^L(v_2))] - \frac{r}{2} (v_2)^2 \sigma_e^2 \right\}. \\
\end{align*}
\]

(B.10)
Eq. (B.10) can be solved by forming the Lagrangian Eq. (B.11), and taking the first-order conditions for $v_1^H$:

$$
L = \left[ \eta^H + e_1^*(v_1^H) - C(e_1^*) \right] - r(v_1^H)^2 \sigma_z^2 - \lambda \left\{ (1 - 2v_1^H)\eta^H + 2v_1^H\eta^L + e_1^*(v_1^H) \right. \\
+ \left. e_1^*(v_1^H) - C(e_2^*(v_2)) - r(v_1^H)^2 \sigma_z^2 + \delta \left\{ [(1 - 2v_2)\eta^H + 2v_2^H\eta^L + e_2^*(v_2) \\
- C(e_2^*(v_1^H))] - r(v_2)^2 \sigma_z^2 \right\} - \delta \left\{ [\eta^L + e_1^*(v_1^H) - C(e_1^*(v_1^H))] \\
- r(v_1^H)^2 \sigma_z^2 + \delta \left\{ [\eta^L + e_2^*(v_2) - C(e_2^*(v_2)) - r(v_2)^2 \sigma_z^2 B] \right\} \right\}. \quad (B.11)
$$

The solution to these first-order conditions is shown in Eq. (B.12) and (B.13):

$$
v_1^H = \frac{1 + 2 \left( \frac{\lambda}{1 - \lambda} \right)(\eta^H - \eta^L)C''[e_1^*(v_1^H)]}{1 + 2r\sigma_z^2 C''[e_1^*(v_1^H)]}, \quad (B.12)
$$

$$
\lambda = \frac{e_1' - C'(e_1)e_1' - 2rv_1^H\sigma_z^2}{e_1' - C'(e_1)e_1' - 2rv_1^H\sigma_z^2 + 2(\eta^L - \eta^H)}. \quad (B.13)
$$

Because the optimal $v_1^H$ is above the unconstrained optimal $v$, both the numerator and the denominator in Eq. (B.13) are less than 0. The absolute value of the denominator is greater than the absolute value of the numerator, and the Lagrangian multiplier is therefore between 0 and 1:

$$
0 < \lambda < 1. \quad (B.14)
$$

Appendix C. Data sources

The Aeneas Group (now known as Harvard Private Capital Group) is the affiliate of Harvard Management Company that handles the private-market investments for the Harvard University endowment. The Group’s files on venture investments date back to the late 1970s. Aeneas’ venture investment strategy was shaped by the philosophy of Walter Cabot, who ran Harvard Management between 1974 and 1990. While investing in risky asset classes, such as venture capital and oil and gas, he emphasized the importance of conducting business with established and reputable financial intermediaries (Grassmuck, 1990).

Kemper Financial Services is an investment manager, also known as a gatekeeper, which has invested in venture capital on a regular basis since 1978.
Institutional investors, such as pension funds, frequently seek to diversify their portfolios to include privately held assets. They may not have the resources to evaluate potential investments or may not wish to grapple with the complications posed by these investments. For instance, venture capitalists frequently liquidate investments in firms by distributing thinly traded shares to investors. Investment managers will select and manage private investments for institutions, typically for a fee of one percent of the funds invested (Venture Economics, 1989a). Gatekeepers will usually invest in a variety of funds, but the very oldest and youngest funds are likely to be under-represented. Very established venture capital organizations typically have close relationships with their limited partners who have invested in several of their funds. They are unlikely to turn to gatekeepers for funding. Meanwhile, gatekeepers may be reluctant to invest in new funds of unproven venture capitalists (Goodman, 1990).

Venture Economics is a unit of Securities Data Company that tracks the venture capital industry. The organization was known as Capital Publishing when it was established in 1961 to prepare a newsletter on Small Business Investment Companies. Since its acquisition by Stanley Pratt in 1977, the company has maintained a file on venture partnerships. Venture Economics collects this information for its Fund Raiser Advisory Service, which provides consulting assistance to venture capital organizations that are drafting partnership agreements or seeking investors. The funds whose documents are in their files appear to represent a random sample of the industry.

All three organizations began collecting information on a regular basis in the late 1970s. The occasional earlier documents in these files do not appear to have been gathered systematically. We consequently restrict our analysis to funds that closed in the period from 1978 through 1992. We find two types of documents in these files. The first are private placement memoranda, the marketing documents that are circulated to potential investors. The second are limited partnership agreements. These are the contracts that govern the workings of the funds. The files at Aeneas and Kemper generally contain both types of documents. The files at Venture Economics frequently only contain the former documents. We use the limited partnership agreements in this analysis when available. Not only are these documents more comprehensive, but they contain the final version of the contractual terms. We undertake our analyses using the entire sample, then repeat the analyses using just the limited partnership agreements. This provides a check that our use of two data sources does not introduce biases.

The search of these three files identifies a total of 543 venture capital funds which apparently meet our criteria. We are reluctant to use some of the 142 funds with compensation information that are not included in the database of funds compiled by the Venture Economics’ Investors Services Group. This subset of the sample is described in Section 4.2. Our primary concern relates to
those funds whose only documentation is the private placement memorandum in the Venture Economics collection. We are often unsure whether the fund ever closed. In some cases, the general partners may have been unable to raise the stipulated minimum amount of funds. Several files at Venture Economics contain a notation indicating that the fund never closed. In other cases, we know independently that the fundraising was unsuccessful, but there is no such notation in the Venture Economics files. Since many of the offering documents in Venture Economics files are for young venture capital organizations, there is a danger of including funds that were never raised.

Consequently, we do not include all 543 funds in this analysis. Instead, we include funds that satisfy one of two conditions. Either the fund is included in the Venture Economics funds database and is coded as a partnership sponsored by an independent venture capital organization, or the fund itself is not included in the database but the documentation indicates that it is a partnership sponsored by an independent venture capital organization, and independent corroboration of this fund’s successful closing can be found. This corroboration can include its listing as a previous fund in a subsequent marketing document, the presence of a signed contract in one of the files, or a listing by Asset Alternatives (another consulting firm). From our review, we find partnership agreements or private placement memoranda in the files of Aeneas, Kemper, and Venture Economics for 401 funds that satisfied the first set of criteria. 18 funds met the second requirement.

### Appendix D. Assumptions used in the calculation of variable and base compensation

The fixed fee in venture capital fund contracts, also known as the management fee, changes in many funds over time. For instance, the management fees will often be reduced in later years, reflecting the expectation that the partnership’s costs will decline in the last years of a venture capital fund’s life. The fees may contain provisions for inflation adjustments. The base used to calculate the fee also often varies. While most agreements compute the annual fee as a percentage of invested capital, in some cases the partnership’s net asset value is used as the base. Funds will also often limit the maximum or the minimum fee, or both. A number of funds do not charge a stated fee, but rather negotiate fees based on actual expenses. While in most cases the contract will indicate a range in which fees are expected to fall, in other cases a budget is negotiated annually. Finally, a number of firms charge fees not only on the funds raised by the partnership, but also on the indebtedness of the companies in which they invest. This fee structure was commonplace in the 1960s when Small Business Investment Companies, many of which were commercial bank affiliates, made equity investments in firms and arranged for their credit lines.
In order to address the problems that arise from the disparities in venture capital partnership agreements, we make several assumptions, as follows:

- We do not include in the analysis cases where a budget is negotiated each year, or where fees are charged on the indebtedness of companies in which they invest. These cases represent only 6% of the observations.
- We assume that all funds last for 11 years. Most funds have a contractual life of ten years (a few have shorter lives). Most have provisions, however, for one or two extensions, each of which can extend the life of the contract for one or two more years, which venture capitalists frequently exercise. We repeat the analysis assuming that the partnerships have a 13 years life. Because most funds have fees in their final years that are considerably below the fees charged in earlier years and the assets remaining in the funds at this point are typically quite small, we find that this change makes little difference.
- In some cases, the fixed fees stipulated in the private placement memoranda are conditional on the ultimate amount raised. For example, fees could be set at 2.5% of committed capital up to $20 million and 2% of all committed capital above that amount. In these cases, we employ the ultimate amount raised by the partnership to compute the annual fee. If we do not know the ultimate amount raised, we use the mid-point between the minimum and maximum amount being sought. We know the actual amount raised for 94% of the funds.
- We assume that the venture fund’s assets, before any deductions for fees, grow at one of three rates: 5%, 20%, or 35%. These values roughly correspond to the average returns and a one standard deviation range for funds active over the sample period. As noted above, Venture Economics (1989c) estimates that funds established prior to 1982 that were still active in 1989 had a mean return of 17.6% with a standard deviation of 14.2%.
- We assume that the venture capitalist draws down funds from the limited partners in even amounts at the beginning of the year. Venture partnership agreements typically call for funds to be disbursed in a series of capital infusions. This structure reflects the staged nature of the venture investment process, wherein the bulk of the funds are not immediately needed (Sahlman, 1990). For example, if the contract calls for 40% of the funds to be disbursed at the close of the investment and 30% to be disbursed at the first and second anniversaries, we treat these as three equal installments. If the contract only indicates a minimum and maximum time until the last investment will be required, we use the anniversary nearest the mid-point of this range. If no schedule of capital infusions is provided, we assume that the funds are drawn down in three equal amounts, at the closing and first and second anniversaries. For those funds in our sample with complete data, the mean time from the closing to the last draw-down is 2.4 years; the median, 2.0 years.
We assume that distributions follow an identical pattern for all funds included in the sample. A major institutional investor has provided us with monthly valuation and distribution data through December 1992 for 140 domestic and foreign venture funds. For the 116 funds which we can confirm as independent U.S.-based venture partnerships, we compute the ratio of the distributions in each year of the fund’s life to its valuation on the previous anniversary. We assume that each fund follows this average pattern in undertaking its distributions. In other words, since the average fund distributes 10% of the value of its assets between its fourth and fifth anniversary, each fund in our calculations does the same. If all distributions go to the limited partners prior to the return of committed capital, we replicate this pattern in our calculations, and if the fund specifies a hurdle based on net asset value, we employ such a test. We assume that the portfolios are completely liquidated on their eleventh anniversary. We explore the robustness of the results to other assumptions by repeating the calculations using two other rules. We alternatively assume that (i) distributions, as a percentage of asset value, are twice as high as in the institutional investor’s sample, and (ii) that no fund undertakes any distributions until the end of the eleventh year. The results in Tables 4–6 are robust to these assumptions.

For those funds that compute fees on the basis of capital under management, less the cost basis of distributions and write-offs, we assume that the cost basis of distributions follows a pattern proportional to the distributions, such that if 10% of all distributions over the life of the partnership occur in one year, then 10% of the reduction in the cost basis occurs in that year. When we vary the pattern of distributions as described above, we vary the change in the cost basis accordingly.

We assume that each year’s fixed fees are paid in advance on each anniversary. These payments are almost always paid in advance on a quarterly basis, but this assumption simplifies the calculations considerably.

If the fees are reduced after the fund is fully invested, we assume that this reduction occurs two years after the date of the last capital draw-down. If the fees are reduced after the fund is 75% invested, we assume that this reduction occurs one year after the date of the last capital infusion. We also assume that these events occur four and two years, respectively, after the last capital draw-down, and find that the changes have little impact.

If the fees are reduced after the organization raises a new fund, we assume that this event occurs on the fund’s sixth anniversary. We use this anniversary year because of historical patterns. Examining the venture funds raised before 1985, we find that the median organization raised its next fund four years and one month after the last closing. Because fund-raising has become more difficult in recent years, we use a slightly longer interval for our calculations. We also assume that the next fund is raised four years after this fund’s closing.
We find that the change has little impact. If fees are indexed for inflation, we assume that they rise at a 4% annual rate.

- In our calculations, we do not consider whether the fixed fee covers the legal, accounting, brokerage, and consulting fees, or whether these additional costs are borne in whole or in part by the limited partners. These charges are generally modest. An analysis of recent annual reports in the files of Aeneas, which include a total of 141 reporting years covering 44 funds, suggest that these fees average less than 0.1% of net asset value. Our reluctance to include these fees stems from the disparate information contained in the partnership agreements and private placement memoranda. While the treatment of these fees is always addressed in the partnership agreements, such relatively minor considerations are often ignored in placement memoranda. Rather than introduce biases due to incomplete reporting, we ignore this factor entirely. This choice will lead to a slight understating of fees. Similarly, we ignore any reductions in fees due to the payment of board membership fees by portfolio companies to the general partners. This omission will lead to a slight overstatement of fees.

- We alternately discount the venture capitalists’ compensation at 10%, 15%, or 20%. We also discount fees that can be expected to be paid with relative certainty, including those based on committed capital, committed capital less the cost basis of distributions, or the minimum of committed capital and net asset value, at 10%, while applying a 20% discount rate to the more uncertain fees, based on net asset value or the maximum of asset value and capital under management. Distributions of capital gains are discounted in this case at 20%.

References


