Management Science

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

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To cite this article:
Niklas Hüther, David T. Robinson, Sönke Sievers, Thomas Hartmann-Wendels (2019) Paying for Performance in Private Equity: Evidence from Venture Capital Partnerships. Management Science

Published online in Articles in Advance 21 Nov 2019

. https://doi.org/10.1287/mnsc.2018.3274

http://pubsonline.informs.org/journal/mnsc

MANAGEMENT SCIENCE
Articles in Advance, pp. 1–27
ISSN 0025-1909 (print), ISSN 1526-5501 (online)

Paying for Performance in Private Equity: Evidence from Venture Capital Partnerships

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Received: February 7, 2018
Revised: September 20, 2018
Accepted: November 20, 2018
Published Online in Articles in Advance: November 21, 2019

https://doi.org/10.1287/mnsc.2018.3274

Abstract. We offer the first empirical analysis connecting the timing of general partner (GP) compensation to private equity fund performance. Using detailed information on limited partnership agreements between private equity limited and general partners, we find that "GP-friendly" contracts—agreements that pay general partners on a deal-by-deal basis instead of withholding carried interest until a benchmark return has been earned—are associated with higher returns, both gross and net of fees. This is robust to measures of performance persistence, time period effects, and other contract terms and is related to exit-timing incentives. Timing practices balance GP incentives against limited partner downside protection.

History: Accepted by Gustavo Manso, finance.
Supplemental Material: The online appendix is available at https://doi.org/10.1287/mnsc.2018.3274.

Keywords: venture capital • compensation • private equity • VC partnership • pay-performance relation

1. Introduction

Limited partner agreements (LPAs), the contractual arrangements between general partners and their investors, are the central mechanisms that define the terms of general partner (GP) compensation in venture capital. These contracts specify management fees, the carried interest earned when venture capital investments are exited, as well as the precise timing conventions that govern *when* GPs get paid.[1] Litvak (2009) shows that these timing conventions are a major determinant of the present value of compensation that GPs receive. Her calculations indicate that standard shifts in timing induce changes in the net present value of compensation for medium-performing funds that are at least as large as observed shifts in management fees and carried interest percentages.[2] Despite the economic importance of the timing of the distribution waterfall, there is no empirical evidence connecting variation in carry timing conventions to the actual cash flows that limited partners receive. As a result, the investment and exit behavior as well as actual fund performance across these compensation practice remain shrouded in mystery.

The aim of this paper is to shed first light on this important aspect of venture capital compensation. We use a hand-collected, proprietary data set of management contracts to detail compensation practices in venture capital and connect these practices to investment behavior and fund performance. Our analysis centers around four questions. First, we ask whether there are differences in performance associated with different types of timing conventions. As we explain below, there are striking differences in performance. Connecting to a broader literature linking executive compensation and agency, this finding prompts three additional questions: (1) Are carry timing conventions related to performance through GP's quality/bargaining power? (2) Can incentives explain differences in performance? (3) Why do different timing conventions coexist given that one type is associated with stronger performance than another? Simply put, can timing conventions help alleviate agency problems in venture capital or are the timing conventions themselves a manifestation of this agency problem?

Historically, the timing of paying carried interest to general partners has followed one of two approaches. Deal-by-deal (DD) or "American" carry provisions allow the general partners to earn carried interest on each deal as it is exited, even if the fund as a whole has not returned sufficient capital to LPs for them to break even. Whole-fund (WF) or "European" carry provisions typically require that invested capital and fees are returned to LPs before the GP is entitled to earn any carried interest.[3]

To illustrate the difference, consider a fund that has exited two investments, the first at a gain and the second at a loss, so that the combined raw return is zero. A GP facing "fund-as-a-whole" carried interest provisions would not yet be eligible to receive carried interest on the strong initial exit because the fund as a whole had not yet earned a positive return on total invested capital. In contrast, a deal-by-deal contract would allow the GP to earn carried interest on the initial strong exit even though the combined return on the two investments was zero. To guard against overcompensation, deal-by-deal contracts often contain clawback provisions that require the return of carried interest to the LP if, at the end of the fund's life, the fund has not returned sufficient capital. However, because these clawback provisions are triggered at fund liquidation and because most contracts only require half the after-tax carry to be held in escrow, there is a natural concern that standard clawbacks provisions underinsure against poor performance (Schell 2016). This underinsurance does not stem from clawbacks not clawing anything back for amounts that are not held in escrow but rather from clawbacks that only require less than 100% of LP's capital to be returned before the GP receives compensation (if not 100% typically 80% or 50%).[4] Moreover, because clawback provisions typically do not require the return of interest, the GP essentially receives an interest-free loan over that time period even if he has to return part or all of the capital he has received.

Thus, fund-as-a-whole carried interest provisions would appear to safeguard limited partners by ensuring that they receive a certain hurdle rate before general partners receive any compensation. Indeed, the industry convention is that European, whole-fund contracts are regarded as LP-friendly, while American, deal-by-deal contracts are typically regarded as GP-friendly. As compensation practices have come under increasing scrutiny, many industry observers have argued that limited partners in private equity should insist on LP-first compensation structures (see, e.g., Institutional Limited Partner Association's Private Equity Principles (ILPA 2011)). In light of these concerns, the simplest way to frame our analysis is through the question, "Do limited partners earn higher returns with LP-friendly contracts?"

Our first set of results speaks directly to this question. We find strong evidence that so-called GP-friendly contracts are associated with better performance on both a gross and net-of-fee basis. The public market equivalent (PME) is around 0.89 for fund-as-a-whole (LP-friendly) contracts but is over 1.39 for deal-by-deal (GP-friendly) contracts. This means that whole-fund contracts are associated with net present value losses of nearly 11 cents per dollar of invested capital, whereas in deal-by-deal funds the present value of distributions exceeds that of contributed capital by about 39%.[5] In the same vein, the gross internal rate of return is approximately 14% points higher among the set of deal-by-deal contracts. These differences in gross performance are not fully absorbed by variation in other contract terms. While fees and carried interest percentages are typically higher for deal-by-deal funds, limited partners earn higher net returns in deal-by-deal funds than in funds with whole-fund carry provisions. Limited partners do not, on average, experience better performance with LP-friendly contracts.

Are timing conventions related to performance through GP's quality? The idea here is that better GPs, all else equal, are presumably better able to extract more favorable deal terms and thus would be more likely to have GP-friendly contract terms in place. If, whether by informational holdup or simply by industry convention, GPs have limited ability to vary the amount of fees and carry in LPAs, then GPs may not be able to fully capture the rents associated with their better performance.

To explore this channel, we model contract assignment as a function of observable performance characteristics. The richness of our data allow us to include many measures that are typically unavailable in this empirical setting. For example, we have detailed track records of managers, which allows us to measure past performance, even for managers operating first-time funds (by looking at the performance of the funds with which they were previously affiliated). We have financial performance measures that are dated as of the time of fundraising, so that we know the performance that would have been observable to the LP at the time the commitment to the fund occurred. We also consider fund size and the industry experience of the GP, which we are able to observe in our data. Indeed, we find clear evidence of this GP quality effect in our sample: funds with longer track records, stronger past performance, and GPs with more industry experience are more likely to command deal-by-deal contracts. The term quality is merely a simplification as it can only be approximated and should not be understood as being "equal to" past performance or industry experience. The finding that GPs with higher bargaining power use less salient fees is also in line with Morris and Phalippou (2012), who argue that fund managers are expected to increase the complexity of contracts to charge more when facing increased demand. Phalippou (2009) makes similar arguments related to the complexity of contracts in private equity.

To explore whether this is the whole story, in the second part of the paper we develop a propensity scoring strategy to compare observationally similar funds, one that receives a GP-friendly contract, one

that does not. Deal-by-deal contracts are still associated with higher performance; indeed, conditioning on observables removes around one third of the overall difference in performance. This indicates either that unobservable differences in quality simultaneously drive contract assignment and performance or that contracts change behavior by affecting incentives.

The fact that a large amount of the overall difference in performance cannot be explained by factors that would be observable to the LP at the time of the commitment lead us to the third part of our analysis, which provides direct evidence of differences in behavior across contract types. Among whole-fund contracts, successful exits cluster early in the fund's life, approximately around the time a firm begins fundraising for its next fund. This is consistent with the grandstanding effect first documented by Gompers (1996) and is in line with a recent study on exits in venture capital by Chakraborty and Ewens (2017). The evidence indicates that they "pull" successful investments forward in time. Although it is difficult to establish a counterfactual, a natural question is whether these exits would have been stronger still were it not for this grandstanding. In comparison, GP-friendly exit times more closely match the expected evolution of the underlying asset valuations of the portfolio companies in question. Similarly, GPs in LP-friendly contracts undertake less risky investments than those in GP-friendly contracts. The idea here is that whole-fund carry provisions essentially compensate the GP with an option on a portfolio of investments, whereas deal-by-deal compensation is akin to a portfolio of options. In line with theory, risk shifting should take place if the GP's carried interest is out of the money that is on average more likely under whole-fund distribution. Indeed, we find that whole-fund contracts are primarily associated with less risk-taking at the beginning of the investment period but the GP increases risk-taking as fund life grows. This points to the view that overall whole-fund contracts induce the tendency to play it safer compared with deal-by-deal contracts and "put some points on the board." Finally, for funds that have not returned capital to LPs, whole-fund contracts have longer waiting times to exit than deal-by-deal funds, consistent with the idea that the incentives to delay exits given whole-fund contracts are strongest in situations when the bulk of the realized return would be forfeited by the GP. This idea of opportunistic behavior is supported by Chakraborty and Ewens (2017), who analyze delay strategies in regard to fundraising incentives.

If, empirically, one contract form appears to dominate the other, then why are both types of contracts observed simultaneously in the market? One way to understand the GP quality channel is that variation in expected GP quality creates variation in the costs and benefits of alternative contract provisions. In other words, providing incentives for strong GP effort may come at the expense of insuring against poor GP performance. A closer examination of the incentive properties of these contracts supports this interpretation. Deal-by-deal provisions offer sharper incentives when investment-specific effort can have a large influence on the value of an individual exit, but their reliance on ex post settling up through clawbacks leaves the LP exposed to underperformance. This is the case for partial clawbacks (ones that require less than 100% to be clawed back) and a scenario in which the GP is financially unable to repay the required amount. Alternatively, whole-fund contracts protect LPs against underperformance but potentially blunt the incentives of GPs by allowing past exits to create a "debt overhang problem" that may undermine the effort incentives in an ongoing investment in line with predictions of a theoretical model by Manso (2011). Consistent with the idea that concerns around would-be clawback provisions drive LPs to favor whole-fund contracts, we find that investments in whole-fund contracts are more likely to be underwater; in other words, they are more likely to have triggered clawback provisions had they been structured as deal-by-deal contracts.

Taken together, these results demonstrate the different cost-benefit trade-offs of the alternative contract forms. When concerns surrounding clawing back overcompensation are the greatest, the added security of the whole-fund structure outweighs the effect such a structure has on incentives. When providing incentives for risk-taking is the more salient consideration, the deal-by-deal structure dominates. This helps explain why we observe both types of contracts simultaneously in the market when, at first blush, one contract form appears to dominate the other.

Although our focus is on compensation in venture capital, there are parallels to broader compensation practices in more traditional corporate settings. Carried interest in venture capital is similar to stock-based variable compensation in traditional firms. In that sense, our setting provides a natural testing ground for the implications of agency theory and use of pay-for-performance sensitivity to alleviate agency problems (see, e.g., Holmström 1979 or Prendergast 1999). Various studies find support of the optimality of fixed and variable compensation in venture capital (see, e.g., Kaplan and Strömberg 2003 or Robinson and Sensoy 2013). Focusing on discretionary portfolio company fees, Phalippou et al. (2018) argue that learning occurs in the market and that the optimal fee provisions evolve over time. Whereas fees and carried interest have been subject of much scholarship in this market, there has been no strong evidence that

changes in the carried interest percentage are economically important for payoffs in venture capital (see, e.g., Robinson and Sensoy 2013). One reason is the limited variation in this type of incentive compensation. The second is that these variations do not induce large changes in the net present value of GP compensation and are not a strong incentive device for a low- and medium-performing fund.

Relative to prior work, the novel feature of our analysis is its focus on carry-timing rules and the use of the data that allows new empirical analyses. We build on a number of recent papers. The closest is probably Litvak (2009), who establishes the importance of carry timing in a sample of contracts with no connected cash flow data. Gompers and Lerner (1999) and Metrick and Yasuda (2010) also analyze contracts but do not have direct access to detailed cash flows. Choi et al. (2012) model a variant of deal-by-deal contracts using simulations, but they do not employ actual fund contract and performance data. Robinson and Sensoy (2013) use larger, but coarser data and perform similar analysis with regards to the GP friendliness of carry contract and fund performance, but they do not analyze carry timing rules; instead, they analyze carry-percentage level and exit behavior around carried interest hurdles.

Our work is also connected to Axelson et al. (2009), who argue for the optimality of whole-fund compensation structures in private equity. At first blush, our results would seem to contradict their predictions: We show that deal-by-deal contracts outperform whole-fund contracts, whereas their model produces a whole-fund structure with deal-by-deal leverage as the optimal contract. Importantly, they only consider buyout funds, whereas we focus exclusively on venture capital funds; the inability to access deal-specific leverage in venture capital and the heavy right-skewness of venture returns are important differences between their setting and ours. Recent work by Hüther (2016) shows that in a model with no leverage considerations, whole-fund contracts are optimal when the skewness of returns is low, whereas deal-by-deal contracts are optimal when skewness is higher. At closer look, this idea squares with the mechanism by Axelson et al. (2009). If failures are very likely, deal-by-deal contracts discipline GPs to make good investment choices because of a higher expected compensation compared with whole-fund contracts. In the model by Axelson et al. (2009) it is the market that disciplines GPs by cutting off access to debt financing for deals that are likely to be unsuccessful.

The remainder of the paper is organized as follows. Section 2 discusses the data. Section 3 presents the main performance findings. Section 4 explores how contract types are determined in the market based on GP background and experience, and Section 5 provides evidence on the specific types of behavioral differences associated with the contracts. Section 6 contains limitations and caveats and Section 7 concludes.

2. Data Description

The data in our study were provided to us by one of the largest international limited partners in the world on an anonymous and confidential basis. Although they are a large, global investor, we restrict attention to U.S. venture capital partnerships to narrow the scope of the investment strategy to startups. For 85 venture capital funds raised between 1992 and 2005 we have detailed contract data obtained from the limited partnership agreements along with information on all 3,552 portfolio companies in which the venture capital funds (GPs) invested. Common examples of such portfolio companies are Google and Facebook.

Our data allow us to measure precisely the timing and size of all cash flows exchanged between each of the 85 funds and the 3,552 portfolio companies.[6] Importantly, our data provider undertakes special efforts to gather gross cash flow data because normally the GPs transmit any gains on their capital net of fees (see, e.g., Metrick and Yasuda 2010 and Robinson and Sensoy 2013). In addition, we have access to other internal information collected by our data provider in the due diligence process. This includes industry and fund management experience, age of the venture capital company, number of previous funds, investment focus, and objective of the fund.

2.1. Sample Representativeness and Basic Summary Statistics

In this section we compare our sample to publicly available data collected by Thompson One and the other above-mentioned studies to analyze the representativeness of our sample. In addition, we also briefly describe the three VC compensation elements established by Litvak (2009).

Panel A of Table 1 reports characteristics of the fund and its general partners. The average first closing date in our data are December 2000, which is close to the comparable funds from the Thompson One database. However, we find that our sample consists of statistically and economically larger funds than the average from Thompson One. Partly, this is attributable to the fact that the large size of the investor in question precluded them from investing in small funds. However, if compared with other recent studies with contract data, (e.g., Litvak 2009 or Metrick and Yasuda 2010), we find that the size of our analyzed funds is similar (556 million USD versus 401.7 million USD as in Litvak (2009) or 322 million USD as reported by Metrick and

Table 1. Sample Representativeness and GP Compensation Terms

Panel A: Fund and company data			
	Our sample: Cash-flow data with LPAs	Mean in Thompson One excluding our sample	*p*-values testing for difference between our sample and Thompson One
First closing	December 2000	September 2000	0.006
Size (m USD)	556.004	85.404	0.000
Early stage focus	56%	45%	0.042
VC company size (% of industry $)	0.589%	0.144%	0.000
VC company age (in years)	10.29	9.01	0.106
No. of past funds	2.81	1.71	0.001
Years relevant work experience	11.55	—	—
Panel B: Contract characteristics			
Carry timing			
No. of funds with deal-by-deal carried interest	60		
No. of funds with whole-fund carried interest	25		
Carried interest			
No. of funds with carry percentage > 25%	4		
No. of funds with 20% < carry percentage ≤ 25%	40		
No. of funds with carry percentage = 20%	40		
No. of funds with carry percentage < 20%	1		
Management fees			
No. of funds with initial fee level equal to 2.5%	46		
No. of funds with initial fee level equal to 2%	24		
No. of funds with initial fee level less than 2%	15		
Fee timing			
Percent of funds changing fee basis after investment period	28.2%		
Percent of funds changing fee level after investment period	67.1%		
Percent of funds changing both basis and level	8.2%		

Notes. Panel A reports comparisons between average characteristics of our data and that of Thompson One data, excluding our funds. We use Thomson One's Fund Statistics Report with the report date of March 31, 2012. Panel A shows fund data as follows: *First closing* denotes the mean first date of closing, while *Size* denotes the fund's committed capital in million USD; *Early stage focus* is an indicator variable which takes the value of one, if fund stage is classified as seed or early and zero for balanced and later. *VC company size* expresses the size of the company in questions (across all it's previous funds) as a fraction of the total capital it raised relative to the total amount raised by all venture organizations (i.e., investors' commitments) over the 10 years preceding each fund. *VC company age* shows the age of venture capital company, i.e., the time of the closing of the first partnership that the venture capital organization raised to the closing of this fund. The variable *No. of past funds* gives the number of past funds of the VCC, and *Years relevant work experience* denotes the average number of years the principal fund managers have spent in positions in venture, private equity management, and finance as measured by the investor. The third column in panel A presents the *p*-values associated with the null hypothesis that the moments of these distributions are identical. (Unreported median results are qualitatively the same.) Panel B tabulates contract terms. *Carry timing* shows the number of deal-by-deal versus whole-fund contracts in our sample. *Carried interest* splits the sample according to the level of carried interest as the percentage of the fund's profit. *Management fees* provides a breakdown regarding the level of annual management fees as the percentage of the fund's committed capital at the beginning of the fund's life. *Fee timing* includes the following three categories: *Percent of funds changing fee basis after investment period* is the proportion of funds that changes its fee basis from committed capital to net invested capital after the completion of the investment period (which is typically 5 years for a 10-year fund). *Percent of funds changing fee level after investment period* is the proportion of funds that changes its fee level from its initial fee level after the completion of the investment period. *Percent of funds changing both basis and level* is the proportion of funds that changes both its fee basis and fee level after the investment period.

Yasuda (2010)). The percentage of early stage focused funds with 56% is similar to the overall statistics in the Thompson One database (45%), but overall the sample tilts toward larger, more early stage funds than many industry data sets.

Whereas the age of the venture capital firm included in our sample is comparable to the overall investment universe approximated by Thompson One, our GPs are on average larger in terms of their previous investment activity. To capture this, we compute the size of previous funds operated by the same general partners as a fraction of the total investment activity in the sector over the previous 10 years. The GPs in our sample have committed about 4× as much capital as the average in Thompson One. They are more experienced by a number of other measures as well. They have raised 2.8 funds on average, in contrast to 1.7 funds in the Thompson One data.

Although researchers and especially practitioners highlight the tremendous importance of investment experience in the industry, to the best of our knowledge no study has direct access to all curriculum vitae and other detailed information of the investment team. In addition to the standard measures of GP

experience, our detailed access to due diligence materials allows us to measure the average experience of all investment professionals in the fund at the time the diligence materials are circulating. This is important because a first-time *fund* may comprise GPs with a wealth of experience at previous *firms*; their experience is typically unobservable to the econometrician but would surely be observable to a limited partner potentially considering a capital commitment. This allows us to control for previously unobservable variation in experience in our regressions later. The average team has 11.5 years of previous work experience in the industry.

Panel B of Table 1 summarizes contract characteristics, and, in particular, provides a first glimpse at the key variables of interest in our study, namely, the rules surrounding the timing of carried interest payments. Our sample includes 60 deal-by-deal agreements and 25 fund-as-a-whole agreements. Our contracts largely mirror conventional wisdom with regard to management fees and carried interest percentages. Our 20% carry percentage is in line with previous studies (Gompers and Lerner 1999, Metrick and Yasuda 2010, Robinson and Sensoy 2013), where virtually all funds employ a carry of 20%.

In terms of management fees, our data are similar to many previous studies. The majority (46 cases) uses a 2.5% fee. Furthermore, for 28% of our observations we observe some variation regarding changes in fee basis from committed capital to either managed capital or net asset value. Although the change in fee basis is only moderate, a change in fee level is far more pronounced. In roughly two thirds of all cases the fee declines to a mean value of 2% (see also Robinson and Sensoy 2013).

2.2. Definitions and Detailed Summary Statistics

Turning to our key variables of interest we distinguish between two distributions rules, that is, GP-friendly deal-by-deal compensation with clawback and LP-friendly fund-as-a-whole compensation with clawback. From Table 1, 71% (60 of 85 total funds) are deal-by-deal.

Panel A of Table 2 classifies our 85 venture capital funds by age and size of the VC firms, whereas panel B shows the breakdown of distribution rules based on fund characteristics. Although the distribution of compensation rules is relatively evenly distributed regarding the age of the venture capital funds, larger VC firms, and large funds (panel B), which are likely to have a successful track record, are capable of negotiating the GP-friendly compensation rule. In contrast, the stage of focus (i.e., early versus later stage) does not seem to play a main role. These findings confirm basic economic intuition.

Table 2. General Partner, Fund Characteristics, and Fund Performance

Panel A: GP characteristics by distribution method	Deal-by-deal	Whole-fund
Age of venture capital organization		
5 years or less	28	10
Between 5 and 15 years	13	9
More than 15 years	19	6
Size of venture capital organization		
No earlier funds	11	5
Between 0% and 0.5%	29	15
Greater than 0.5%	20	5
Panel B: Fund characteristics by distribution method		
Stage focus		
Early stage focus	26	13
Other stage focus	34	12
Fund size		
$100m or less	8	6
Between $100m and $500m	29	14
Greater than $500m	23	5

Notes. This table presents (panel A) the number of all distribution rules of the 85 sample limited partnership agreements for several GPs and (panel B) fund characteristics. *Age of venture capital organization* refers to the time of the closing of the first partnership that the venture capital organization raised to the closing of this fund. *Size of venture capital organization* is the ratio of the capital invested in the organizations funds, in USD, whose first closing was in the 10 calendar years prior to the year that this fund closed, to the total amount raised by all venture organizations (i.e., investors' commitments) in these years, again in USD. *Stage focus* splits the sample into early stage funds and other stage funds. Being precise, *Early stage focus* is a dummy variable which takes the value of one, if fund stage is classified as seed or early, and zero for balanced and later. *Fund size* is the total capital committed to the venture fund, specified in the partnership agreement.

3. Carry Provisions and Average Performance

3.1. Average Performance by Contract Type

The summary statics reported in Table 3 lay the foundation for our multivariate analysis by relating the distribution rules, years of relevant work experience, and the vintage year of the VC fund to fund performance. We follow Kaplan and Schoar (2005) and calculate the PME by dividing the present value of actual cash outflows by the present value of actual cash inflows, using the observed returns on the publicly tradable index over the same time period as the discount factor. In the spirit of the "tailored PMEs" of Robinson and Sensoy (2016), we calculate ours using the NASDAQ composite index; however, none of our results are dependent on the particular index used to calculate the PME.[7]

Table 3 shows that PMEs for funds with a fund-as-a-whole compensation are significantly below deal-by-deal funds. In gross-of-fee terms (panel A), whole-fund contracts averaged a PME of 0.891 versus 1.394 for deal-by-deal; net-of-fee the PMEs (panel B) were 1.017 for deal-by-deal versus 0.682. These differences

Table 3. Venture Capital Fund Performance and Distribution Rules: Raw Results

Panel A: Fund gross PME	Mean	SD	Min	p25	p50	p75	Max
Distribution rule							
Deal-by-deal	1.394	0.743	0.439	0.891	1.181	1.768	3.564
Whole-fund	0.891	0.623	0.182	0.470	0.670	1.174	2.736
Years relevant work experience							
6 years or less	0.875	0.579	0.262	0.530	0.750	0.823	2.302
Between 6 and 10 years	1.106	0.583	0.182	0.674	1.125	1.300	2.819
Greater than 10 years	1.409	0.821	0.298	0.860	1.118	1.980	3.564
Vintage year/first closing							
Jan. 1992 to Dec. 1997	1.499	0.829	0.439	1.158	1.386	1.473	2.828
Jan. 1998 to Dec. 1999	1.226	0.904	0.181	0.542	0.954	1.855	3.283
Jan. 2000 to Dec. 2001	1.262	0.783	0.298	0.639	1.114	1.621	3.563
Jan. 2002 to Dec. 2005	1.114	0.373	0.643	0.880	0.975	1.291	2.030
Panel B: Fund net PME							
Distribution rule							
Deal-by-deal	1.017	0.495	0.369	0.694	0.884	1.208	2.485
Whole-fund	0.682	0.482	0.065	0.282	0.547	0.979	1.802
Years relevant work experience							
6 years or less	0.604	0.229	0.152	0.424	0.656	0.770	0.875
Between 6 and 10 years	0.871	0.471	0.108	0.505	0.866	1.072	2.035
Greater than 10 years	1.013	0.554	0.065	0.662	0.896	1.331	2.485
Vintage year/first closing							
Jan. 1992 to Dec. 1997	1.191	0.622	0.378	0.868	1.057	1.364	2.285
Jan. 1998 to Dec. 1999	0.955	0.675	0.108	0.409	0.783	1.423	2.484
Jan. 2000 to Dec. 2001	0.853	0.481	0.065	0.481	0.848	1.079	2.420
Jan. 2002 to Dec. 2005	0.883	0.270	0.517	0.662	0.774	1.073	1.438

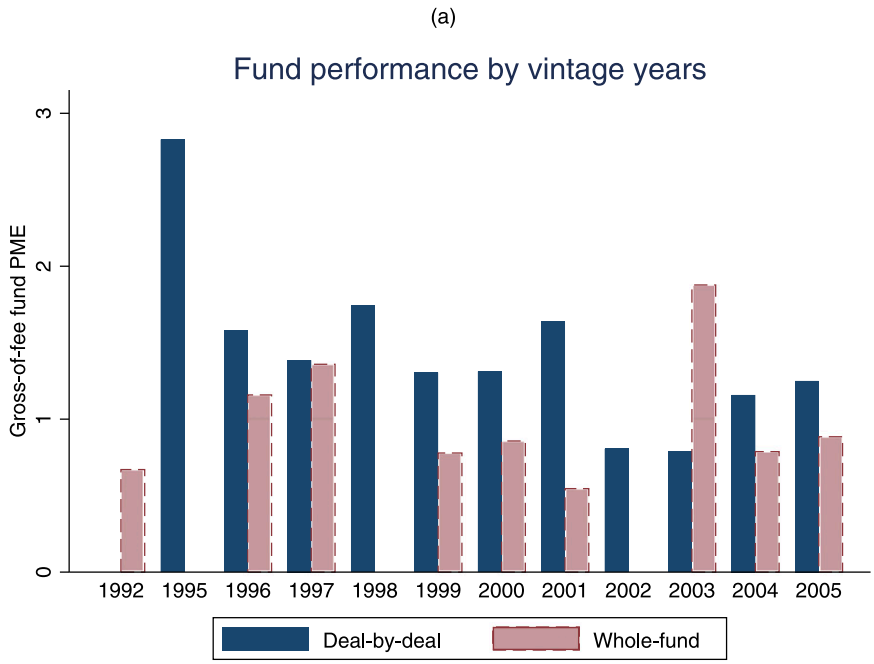
Panel C: Finer contractual details	Gross PME	*p*-value *t*-test	Net PME	*p*-value *t*-test
Strict deal-by-deal (GP-friendly: 1)	1.483		1.062	
Otherwise (GP-friendly: 2–4)	1.110	0.025	0.836	0.050
Deal-by-deal realized loss (GP-friendly: 2)	1.299		0.969	
Otherwise (GP-friendly: 3, 4)	0.891	0.016	0.682	0.019
Basic fund-as-a-whole (GP-friendly: 3)	0.966		0.714	
Otherwise (GP-friendly: 1, 2)	1.394	0.032	1.017	0.026
Full fund back (GP-friendly: 4)	0.698		0.600	
Otherwise (GP-friendly: 1–3)	1.296	0.041	0.947	0.086

Notes. This table reports details about the distribution of public market equivalents (PMEs) for the main variables of interest. The PME is calculated by discounting the actual cash outflows and cash inflows of the fund with the returns on the NASDAQ over the same time period and forming the ratio of the discounted cash inflows over the discounted outflows. Panel A reports descriptive statistics on gross-of-fee PMEs, and panel B looks at net-of-fee fund performance. *Years relevant work experience* denotes the average number of years the principal fund managers have spent in positions in venture, private equity management and finance as measured by the Investor. *Vintage year/first closing* denotes date of fund's first closing. Panel C presents raw (mean) fund PMEs broken out by closer refinements of the distribution rule. *Strict deal-by-deal* dummy takes the value of one if the GP is paid on a single deal basis getting paid after each single positive exit, and zero if the GP is paid on a "whole-fund" basis or on a "deal-by-deal realized loss" basis; *deal-by-deal realized loss* dummy takes the value of one if the GP is paid on a single deal basis but has to reimburse previous realized losses, and zero if the GP is paid on a "whole-fund" basis; *basic fund-as-a-whole* dummy takes the value of one if the GP receives no carry until LPs get distributions equal to contributed or invested capital, plus where applicable a preferred return, and zero if the GP is paid on a "deal-by-deal basis". *Full fund back* equals the value of one if the GP receives no carry until LPs get distributions equal to committed capital, plus where applicable a preferred return, and zero otherwise.

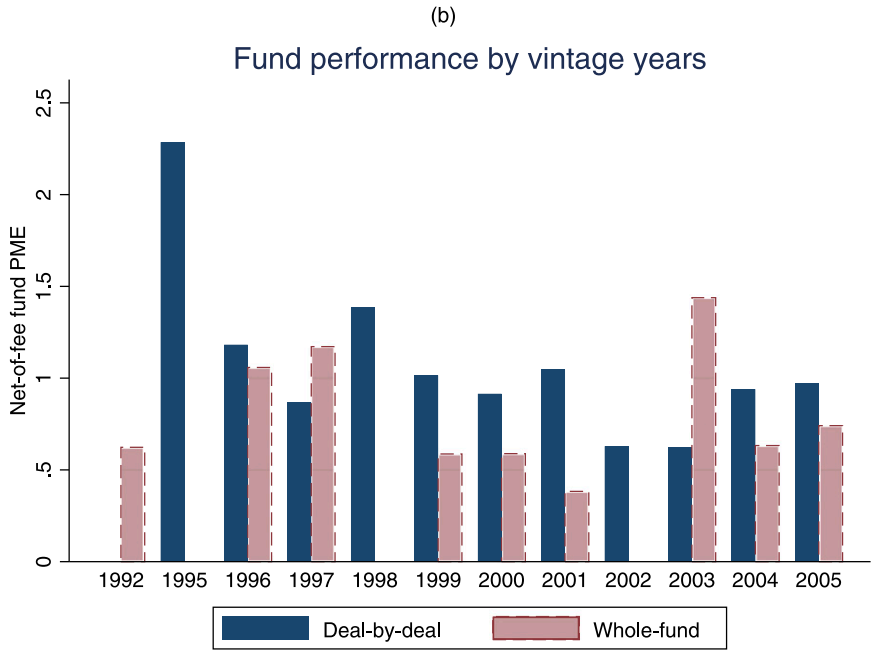
are also highly statistically significant. Performance is highly correlated with years of work experience and is significantly stronger in the 1992–1997 period.

For a clearer picture of the time distribution of PME, Figure 1 shows average gross-of-fee PMEs (panel (a)) and average net-of-fee PMEs (panel (b)) per vintage

Figure 1. (Panel (a)) Deal-by-Deal (DD) and Whole-Fund (WF) Gross-of-Fee and (Panel (b)) Net-of-Fee Performance Across Vintage Years



Gross-of-fee fund performance



Net-of-fee fund performance

year for deal-by-deal contracts versus whole-fund. In line with Table 3 we observe higher average performance until 1997. The figure also shows that there are years in which GP-friendly or LP-friendly contracts are prevalent. With only a few exceptions, the distribution of contracts over the sample period is similar between deal-by-deal and whole-fund contracts. Reflecting the overall venture capital market, the majority of

contracts—both for deal-by-deal and whole-fund—can be found between 1999 and 2001 (see Figure A15 in Section D of the online appendix).

Our data are rich enough to explore finer gradations in contract terms. In particular, we can distinguish between "strict deal-by-deal," in which the GP is paid on a single deal basis getting paid after each single positive exit, and "deal-by-deal realized loss," which occurs when the GP is paid on a single deal basis but has to reimburse previous realized losses before earning carried interest. In addition, "basic fund-as-a-whole" occurs when the GP receives no carry until LPs get distributions equal to contributed or invested capital, plus where applicable a preferred return. In contrast, "full fund back" implies that the GP receives no carry until LPs get distributions equal to committed capital, plus where applicable a preferred return.

Panel C of Table 3 explores these finer gradations. It shows that there is a monotonic relationship between fund performance and the GP friendliness of the contract terms. Strict deal-by-deal contracts are associated with the best average performance; these contracts offer the friendliest terms for general partners because they allow the GP to earn carry regardless of what has happened in prior deals. The differences between the different type of deal-by-deal contracts are less pronounced than the difference between either deal-by-deal contract and the average whole-fund contract.

3.2. Risk-Adjusted Performance

When comparing performance across funds in private equity one concern is whether returns are appropriately risk-adjusted. Whereas the PME of Kaplan and Schoar (2005) makes adjustments for the public equity market risk, it does not account for an asset's beta exposure to the market factor. The main concern is that high-beta funds mechanically outperform a public market index in times of rising public equity markets if their beta exposure is not controlled for. To account for a beta different from one, we lever the NASDAQ benchmark return and calculate "levered PMEs" along the lines of Robinson and Sensoy (2016). Differences in the distribution of returns between deal-by-deal and whole-fund remain qualitatively similar for betas of two and three (see Table A2 and A3 in Section C of the online appendix). Moving beta, for example, from one to two moves average leverage net-of-fee PME for deal-by-deal funds from 1.017 to 1.247 (for whole-fund from 0.682 to 0.906). In this case, the difference in average PMEs between distribution rules only changes by less than 0.01. For an additional robustness test, we adjust the PME by using the generalized PME (GPME) developed by Korteweg and Nagel (2016) (see Table A5 of Section C in the online appendix). GPME also accounts better for risk if portfolio assets have betas above one and public equity markets are rising. Results are qualitatively similar compared with the ones based on "levered PMEs" as well as the results based on the Kaplan and Schoar (2005) PME (see Tables A2, A3 and A5 in Section C of the online appendix).

Despite this evidence there may exist other priced risk factors. Given the difficulty to adjust for risk in private equity returns, we compute the spread in beta that is needed to bring the performance difference of deal-by-deal and whole-fund contracts to zero after a beta adjustment. This difference may help to get more traction on the concern whether higher observed performance for GP-friendly contracts is simply compensation for the higher risk involved in their investments.

Figure 2 displays cross-sectional average "levered PME" as a function of beta based on Robinson and Sensoy (2016). Reaffirming their finding, the figure shows that the levered PME-beta relation is convex. For a beta above one the average PME begins to increase again as early calls of funds get increasingly discounted. Robinson and Sensoy (2016) provide details on this convexity. Assuming a beta of 2.2 for venture capital funds under whole-fund, matching the average of beta estimates of venture capital funds in the most recent studies, the figure shows that a 2.1 (2.0) adjustment in beta is required to bring the gross(net)-of-fee performance difference to zero.[8] Because it is unlikely that deal-by-deal funds are associated with a two times smaller systematic risk exposure, it should be less of a concern that the higher deal-by-deal performance vanishes after a full risk adjustment.

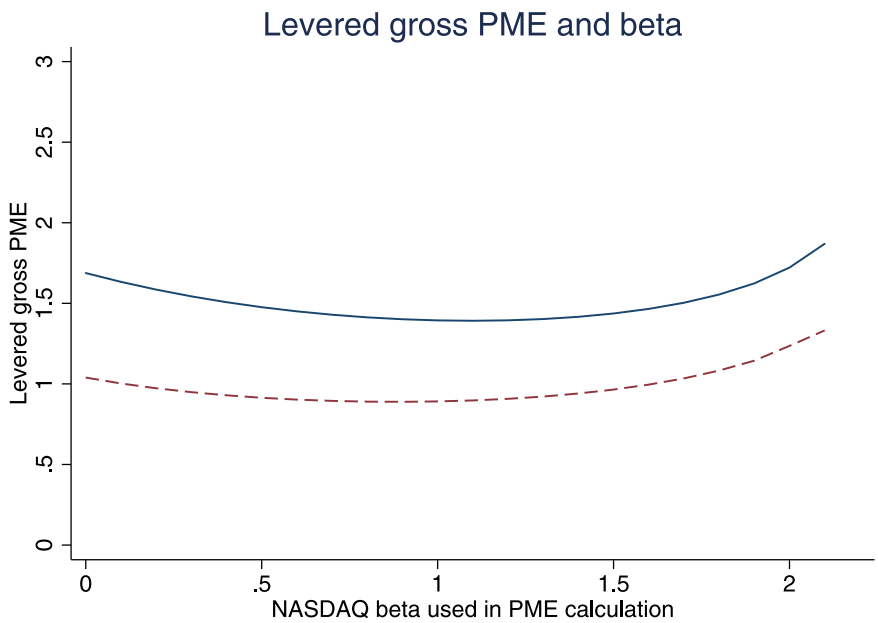
3.3. Understanding Variation in Fund Performance

Before we turn to the main results in the next section, Table 4 focuses on performance only explained by market cycles, GP, and fund characteristics.

The adjusted R^2 value in Model (1) indicates that vintage year fixed effects explain 3% of the total variation in PMEs. The adjusted R^2 value increases to 19% considering GPMEs and 33% for PMEs with beta equal to 3 (see Tables A11 and A7 in Section C of the online appendix). Models (2) and (3) connect performance of the fund in question to the observed cash multiple of previous funds at the time of the fundraising. (For first-time funds this is the average multiple of the last fund associated with each investment professional.) This closely follows the analysis of Phalippou (2010), who argues that the persistence results reported by Kaplan and Schoar (2005) are not achievable in real-time by actual private equity limited partners because the partner is required to commit to the follow-on fund before the performance of the extant fund is fully known. In Model (2) without vintage year fixed effects, we find no relation, consistent with Phalippou (2010). However, in Model (3) we add vintage year fixed

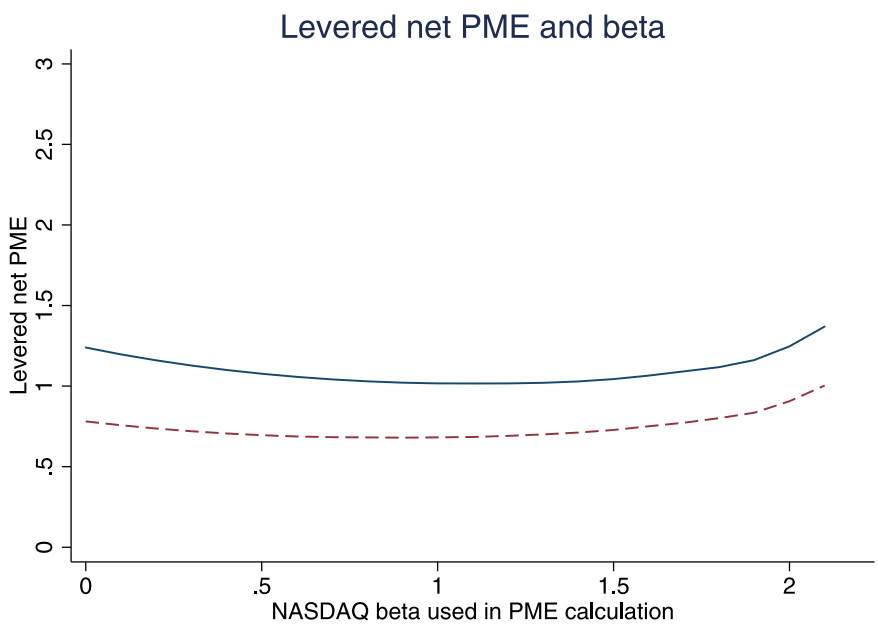
Figure 2. Levered PME-β Sensitivity Conditional on Deal-by-Deal and Whole-Fund

(a)



Levered gross-of-fee PME-β sensitivity

(b)



Levered net-of-fee PME-β sensitivity

Note. PMEs are calculated gross-of-fee (panel (a)) and net-of-fee (panel (b)). The blue line relates to deal-by-deal, while the red line shows whole-fund.

effects to the past performance regression, and the adjusted R^2 value rises to 5% and the loading on past performance becomes statistically significant at the 10% level.

Models (4) and (5) introduce our new measure, the years of relevant prior work experience. This variable measures a feature of the private placement memorandum that would be easily observable to the limited

Table 4. Explaining Gross Fund Returns

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Years relevant work experience				0.042**	0.047**	0.056**	0.053**	0.051**
				(0.017)	(0.022)	(0.022)	(0.022)	(0.021)
Observed prior multiple		0.071	0.114*			0.168***	0.168**	0.178**
		(0.059)	(0.062)			(0.062)	(0.067)	(0.069)
log(*fund size*)							0.052	1.401
							(3.476)	(3.389)
log(*fund size*)^2							0.024	–0.066
							(0.210)	(0.206)
No. past funds								0.043
								(0.034)
Vintage year FE?	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Observations	85	85	85	85	85	85	85	85
Adjusted R^2	0.028	0.023	0.051	0.080	0.131	0.196	0.244	0.238

Notes. This table presents ordinary least squares (OLS) regression estimates of the determinants of VC fund performance gross of carried interest and fees in 85 U.S. venture capital partnerships. The dependent variable is the Public Market Equivalent (PME), calculated by discounting the actual cash outflows and cash inflows that the fund received with the returns on the NASDAQ over the same time period and forming the ratio of the discounted cash inflows over the discounted outflows. *Years relevant work experience* denotes the average number of years the principal fund managers have spent in positions in venture, private equity management, and finance as measured by the Investor. *Observed prior multiple* denotes the previous fund's gross multiple, before carried interest and fee payments, at the time of the fund commitment. *Fund size* denotes the fund's committed capital in million USD. The variable *No. past funds* is the number of previously raised funds. Heteroscedasticity robust standard errors are reported in parentheses below point estimates.

*10%, **5%, ***1% two-tailed significance level.

partner in question but is not typically observable to the empiricist observing the data ex post. The measure is statistically significant but small in comparison with the average difference in contract terms. The magnitude of the point estimate indicates that it would take more than 10 years of work experience to erase the difference in the average performance between deal-by-deal and whole-fund contracts.

Model (6) introduces both measures simultaneously. Here we see that the explanatory power of the observed multiple jumps dramatically when we hold constant the work experience of the investment team. That is, persistence is strong if it is possible to condition on the past work experience of the investment professionals when comparing two first-time, second-time, third-time, etc. funds. This result is the opposite of what Phalippou (2010) argues and indicates that controlling for information that would be available to limited partners but unobservable to the econometrician is critical for understanding persistence (see also Korteweg and Sorensen 2017).

Models (7) and (8) include additional controls. Controlling for fund size and the number of past funds adds little to the analysis.

In the remainder of the analysis, we use the variables in Model (7) as baseline controls, as this specification has the highest adjusted R^2 of any of the models in Table 4. Model (7) shows that the performance persistence result first documented by Kaplan and Schoar (2005) holds in our sample even when it is based on performance data available at the time the commitment is made.

All models are also estimated using the generalized PME (GPME) developed by Korteweg and Nagel (2016) (see Table A11 in Section C of the online appendix), as well as "levered PMEs" according to Robinson and Sensoy (2016) using a beta of 2 and 3 (see Tables A6 and A7 in Section C of the online appendix). In addition, we present results by using the modified IRR (MIRR) (see Table A13 in Section C of the online appendix). Following Phalippou (2008) the MIRR is computed as the multiple of the investment raised to the power of one over the duration of the investment minus one, assuming cash flows are reinvested at 8% until the end of the fund life. The advantage of using the modified IRR instead of the IRR is that the MIRR does not lead to mechanically large differences in performance if deal-by-deal funds are incentivized to exit winner first (see Section 5.1). To control for potentially inaccurate final net asset value (NAV) of unrealized investments that are not reflecting market value we also estimated all models only based on realized investments (see Tables A8–A10 in Section C of the online appendix). All these additional specifications show qualitatively similar results.

3.4. Carry Distribution Rules and Average Performance

We begin in panel A of Table 5 by exploring the relation between carry distribution rules and gross-of-fee

Table 5. Distribution Rules and Fund Performance

Panel A: Gross-of-fee performance	(1)	(2)	(3)	(4)	(5)	(6)
Deal-by-deal	0.469***	0.426***			0.459***	0.381***
	(0.158)	(0.149)			(0.146)	(0.143)
PV mgmt. fee			0.058**		0.052*	0.052*
			(0.028)		(0.028)	(0.030)
Carried interest				1.058	–3.865	–1.503
				(3.187)	(2.799)	(3.002)
Years relevant work experience	0.048***	0.059***	0.048**	0.053**	0.046***	0.054**
	(0.016)	(0.021)	(0.021)	(0.023)	(0.015)	(0.021)
Observed prior multiple	0.127**	0.138**	0.168**	0.162**	0.139***	0.148**
	(0.050)	(0.060)	(0.064)	(0.063)	(0.052)	(0.063)
log(*fund size*)	–1.244	1.263	–0.530	0.623	–3.138	–0.069
	(3.821)	(3.143)	(3.705)	(3.556)	(4.409)	(3.408)
log(*fund size*)^2	0.076	–0.054	0.059	–0.011	0.195	0.027
	(0.229)	(0.190)	(0.222)	(0.216)	(0.264)	(0.207)
Vintage year FE?	no	yes	yes	yes	no	yes
Adjusted R^2	0.203	0.280	0.263	0.216	0.222	0.294
Panel B: Net-of-fee performance						
Deal-by-deal	0.325***	0.278***			0.326***	0.251**
	(0.120)	(0.098)			(0.113)	(0.099)
PV mgmt. fee			0.033		0.031	0.027
			(0.020)		(0.021)	(0.021)
Carried interest				1.014	–3.110	–0.439
				(2.044)	(1.917)	(1.848)
Years relevant work experience	0.032***	0.039***	0.032**	0.035**	0.032***	0.037***
	(0.010)	(0.013)	(0.013)	(0.014)	(0.010)	(0.013)
Observed prior multiple	0.064**	0.074***	0.093***	0.089***	0.073**	0.079**
	(0.032)	(0.027)	(0.033)	(0.032)	(0.032)	(0.030)
log(*fund size*)	–0.439	1.343	0.246	1.041	–1.815	0.765
	(2.598)	(1.916)	(2.274)	(2.196)	(2.966)	(2.052)
log(*fund size*)^2	0.027	–0.061	0.008	–0.040	0.114	–0.026
	(0.155)	(0.116)	(0.137)	(0.134)	(0.177)	(0.125)
Vintage year FE?	no	yes	yes	yes	no	yes
Adjusted R^2	0.173	0.337	0.311	0.281	0.189	0.337

Notes. This table presents OLS regression estimates of VC gross-of-fee and net-of-fee fund performance. The dependent variable is the NASDAQ PME. *Deal-by-deal* is a dummy that takes the value of one if a deal-by-deal structure is agreed, and zero otherwise. The variable *PV mgmt. fee* is calculated ex post based on actual fee payments, discounted at 5%. *Carried interest* is the level of carried interest as the percentage of the fund's profit. *Years relevant work experience* denotes the average number of years the principal fund managers have spent in positions in venture, private equity management, and finance as measured by the Investor. *Observed prior multiple* denotes the previous fund's gross multiple, before carried interest and fee payments, at the time of the fund commitment. *Fund size* is fund committed capital in millions of USD. Heteroscedasticity robust standard errors are reported in parentheses below point estimates. Eighty-five observations, one per VC fund.

*10%, **5%, ***1% two-tailed significance level.

performance. Overall, the results indicate that GP-friendly, that is, deal-by-deal, compensation is associated with higher performance. The economic effects are also large, slightly below the magnitude of the difference in unconditional means reported in Table 3.

Column (1) omits vintage year fixed effects but includes the controls from Table 4, Model (7). In this specification the average performance difference in gross performance is 0.469, which is slightly smaller than the raw performance difference reported in Table 3. In column (2) we introduce vintage year fixed effects and the magnitude of the distribution rule dummy drops to 0.426.

Columns (3) and (4) introduce management fees and carried interest. We find that higher fee funds deliver higher gross-of-fee performance, which is consistent with the net-of-fee evidence of Robinson and Sensoy (2013). Column (5) adds contract terms to the

specification but omits vintage year fixed effects; this specification is comparable to Model (1), and, indeed, the point estimate of 0.459 illustrates that controlling for deal terms in the absence of vintage year fixed effects does little to erase the main result. Although the limited amount of variation in the data gives us low power to identify the effect, the loading on carried interest in Model (5) says that VC funds that were able to command more than 20% carried interest underperformed after we control for other contract terms.

When we include vintage year fixed effects in Model (6), however, we see that the inclusion of fees and carry lowers the point estimate on the deal-by-deal dummy from 0.426 in column (2) to 0.381. The fact that controlling for fees and carry has a larger impact on the deal-by-deal point estimate in the presence of vintage year fixed effects is a reflection of the fact that there is a great deal of time series clustering of carry and fees, as illustrated by Robinson and Sensoy (2013). All told, the combined effect of vintage year fixed effects, observable GP characteristics and other contract terms erases around one quarter of the overall performance difference associated with deal-by-deal carry provisions.

The results in panel A of Table 5 do not allow us to know whether LPs benefit from a higher performance with GP-friendly provisions. They only indicate that GPs are better off with GP-friendly contracts. Panel B of Table 5 turns to the question of net-of-fee performance. This allows us to ask whether LPs are better off in funds with GP-friendly provisions.

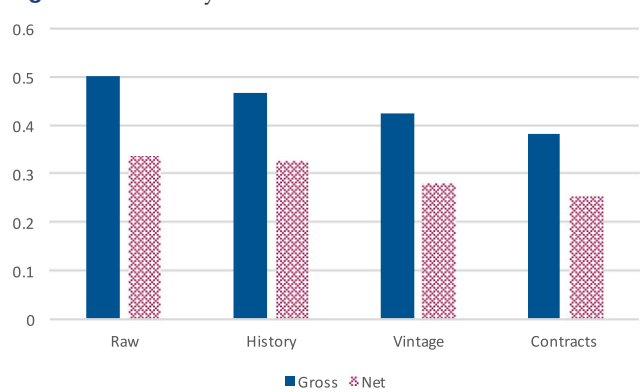
We relate contract terms to net-of-fee performance using regression specifications that mirror those reported in panel A of Table 5. The results are qualitatively similar. In particular, we find that net-of-fee returns are in between 25% to 33% points higher for deal-by-deal distribution rules than fund-as-a-whole rules. In panel A the analogous coefficients are 38 to 47. If the increased performance were purely captured by the GP, we would expect that there would be no difference in net-of-fee performance based on the distribution rule. In fact, pushing to the extreme, based on the evidence in the mutual fund industry, one might even expect deal-by-deal agreements to return *lower* net-of-fee performance if GPs were essentially able to overcharge for their quality.

In contrast, if the difference in performance owed strictly to induced incentives, and LPs were able to pin GPs down to their participation constraint, then we would expect the coefficients on net-of-fee performance to exactly equal those obtained for gross-of-fee performance. Instead, we see a result in the middle, indicating that the gains are shared between the two parties, with the bulk of the extra returns flowing directly to limited partners in the form of higher net-of-fee returns. Turning to management fees, panel B of Table 5 shows that performance is no longer significantly positively related to management fees, in contrast to the finding in panel A. This result supports the finding that differences in bargaining power drive the relation between management fees and performance. It also squares with Robinson and Sensoy (2013), who show that there is no evidence that funds with higher management fees have worse net-of-fee performance, contrary to the concern that contracts in venture capital may be inefficient.

The comparison of gross and net of fee returns is important for several reasons. First, it helps us to shed light on rent extraction and GP's bargaining power. One could argue if it were the case that GP-friendly provisions were purely a form of rent extraction, and that better quality GPs (or higher status GPs) were better able to bargain on their own behalf, then we would expect to see no results on net-of-fee returns. Instead, the results suggests that better quality GPs do not extract the entire performance differential between LP- and GP-friendly fund types.

Figure 3 summarizes the results of this section. Blue columns on the left are gross-of-fee performance, and red columns on the right are net-of-fee. The columns marked "Raw" reflect the uncorrected differences from Table 3. "History" summarizes column (1) of Table 5. The columns labeled "Vintage" adds vintage year fixed effects to the historical performance controls. This corresponds to column (2) of Table 5. Finally, "Contracts" adds contract terms; this is column (6) from Table 5. The table shows that there are pronounced differences between deal-by-deal and whole-fund contracts that persist even after controlling for vintage years, for contract terms, and for observable past performance. Moreover, much of this

Figure 3. Summary of Performance Results



Notes. This figure summarizes the performance difference between deal-by-deal and whole-fund carry timing. Blue columns are gross-of-fee performance, and red are net-of-fee. The columns marked "Raw" reflect the uncorrected differences from Table 3. "History" summarizes column (1) of Table 5. The columns labeled "Vintage" adds vintage year fixed effects to the historical performance controls. This corresponds to column (2) of Table 5. Finally, "Contracts" adds contract terms; this is column (6) from Table 5.

Table 6. Determinants of Distribution rule Provisions

Panel A: Simple slopes of investment history and work experience						
	(1)	(2)	(3)	(4)	(5)	(6)
No first-time fund		0.813**	0.733**	0.801**	0.711*	0.505
		(0.342)	(0.354)	(0.363)	(0.370)	(0.403)
Years relevant work experience			0.060		0.078*	0.085*
			(0.042)		(0.043)	(0.044)
Observed prior multiple				0.252**	0.290**	0.283**
				(0.109)	(0.114)	(0.119)
log(*fund size*)						0.511
						(7.339)
log(*fund size*)^2						0.013
						(0.441)
All specifications include vintage year fixed effects						
Observations	85	85	85	85	85	85
Pseudo R^2	0.067	0.116	0.130	0.141	0.166	0.184
Panel B: Work experience by investment history interaction						
No first-time fund	0.291	0.138	0.248	0.387	0.215	0.213
	(0.828)	(0.870)	(0.898)	(0.834)	(0.887)	(0.907)
Years relevant work experience	0.098*	0.107*	0.109*	0.099*	0.109**	0.112**
	(0.055)	(0.055)	(0.056)	(0.055)	(0.055)	(0.056)
Years relevant work experience ×	−0.108	−0.089	−0.084	−0.120	−0.099	−0.079
No first-time fund	(0.083)	(0.086)	(0.091)	(0.080)	(0.082)	(0.088)
Observed prior multiple		0.242**	0.230**		0.275**	0.268**
		(0.108)	(0.116)		(0.115)	(0.121)
log(*fund size*)			2.409			1.306
			(7.974)			(7.567)
log(*fund size*)^2			−0.118			−0.038
			(0.477)			(0.455)
Vintage year FE?	No	No	No	Yes	Yes	Yes
Observations	85	85	85	85	85	85
Pseudo R^2	0.110	0.146	0.164	0.152	0.180	0.184

Notes. This table presents estimated coefficients from probit models with the dependent variable equal to one if the fund's distribution rule provision is deal-by-deal, and zero otherwise. *No first-time fund* takes the value of one, if the GP has raised a fund before, and zero otherwise. *Years relevant work experience* denotes the average number of years the senior professionals have spent in positions in venture, private equity management and finance as measured by the Investor. *Observed prior multiple* denotes the previous fund's gross multiple, before carried interest and fee payments, at the time of the fund commitment. *Fund size* denotes the fund's committed capital in million USD. Heteroscedasticity robust standard errors are reported in parentheses below point estimates. Eighty-five observations, one per VC fund. Panel A reports simple slopes of investment history and work experience without interaction, whereas panel B reports estimated coefficients of partners' work experience on the choice of a deal-by-deal provision depending on the GP's investment history.

*10%, **5%, ***1% two-tailed significance level.

performance accrues to limited partners, it is not simply captured by general partners.

4. Understanding Contract Assignment

The results thus far demonstrate a correlation between the timing of carried interest and fund performance. One obvious explanation for this result is that better quality GPs are more likely to sort into GP-friendly contracts. In this section we explore this channel by exploring how GP characteristics are correlated with the observed distribution rules. First, we model the probability that a GP receives a GP-friendly contract as a function of observable characteristics. Then, we decompose the observed performance differential using a propensity score analysis to assess whether assignment based on observable characteristics captures the bulk of the difference in performance between GP- and LP-friendly contracts.

4.1. Probit Analysis

Table 6 displays estimates of probit models where the dependent variable equals 1 if we observe a fund with a deal-by-deal structure and zero otherwise. For the explanatory variables we consider GPs' investment histories and industry experience. The results in panel A of Table 6 show that not being a first-time fund is significantly related to the probability of a deal-by-deal compensation. Establishing a relationship with a GP and being able to invest in follow-on funds is often seen as an important reason for investing in a

first-time fund. On the basis of careful reading of due diligence reports and conversations with investors, a first-time fund is generally viewed as a high risk investment.

The increments in pseudo R^2 from column (1) to column (6) in panel A tell us that most of the variation in the distribution rule is related to market conditions and the *No first-time fund* dummy. In columns (3) and (4) we introduce the average venture capital experience of the managing partners (in years) and the previous fund's gross return multiple. In contrast to the return multiple, the positive loading on work experience is only significant when controlling for previous fund performance (column 5). Investors seem to discount work experience in their investment decision if managing partners do not have any track record in previous venture capital firms.[9] Controlling for fund size (column 6) slightly increases the explanatory power of variables in model (5).[10]

Panel B of Table 6 introduces interaction terms between *No first-time fund* and *Years of relevant work experience* to explore whether less noisy performance signals increase the probability of a deal-by-deal contract. Across all models we find a significant positive loading on work experience, that is, that the probability of a deal-by-deal provision increases with partners' previous work experience in a first-time fund. The results hold whether we exclude vintage year fixed effects (columns 1–3) or include them (columns 4–6). The structure of the regression equation essentially splits the overall effect of work experience into two components, a part that obtains among the sample of first-time funds, and a part that obtains among the sample of second-or-higher funds. The loadings imply that the years of relevant work experience is a significant predictor of receiving GP-friendly contracts only among first-time funds—those funds for which track records are the most noisy.

Overall, these results are consistent with the idea that GPs with higher bargaining power are able to obtain GP-friendly provisions in the limited partner agreements they strike with investors.

4.2. Propensity Score Matching

The results thus far show that the timing of carried interest affects fund performance, and they suggest that at least some portion of this is because of the fact that higher-talent GPs receive better contracts. The question is whether this is the whole story. Toward this end, in this section we implement a propensity score matching analysis first proposed by Rosenbaum and Rubin (1983), which allows us to match treated (i.e., GPs with deal-by-deal contracts) to nontreated (whole-fund contracts) funds based on a high-dimensional set of matching characteristics.[11] This allows us to compare the performance of a fund that received a deal-by-deal contract to an observationally similar fund that did not. Under the assumption that there is no selection on unobservables, the difference between the treated and observationally similar untreated funds is then a causal estimate of the treatment effect of contract assignment. We discuss the importance of this assumption in greater detail below.

Table 7 presents the analysis. In panel A, we report the probit model that generates the propensity score used to match deal-by-deal and observationally similar whole-fund contracts. Because we have an unbalanced sample of 60 funds with deal-by-deal contracts and 25 funds underlying whole-fund, we apply our matching methods with replacement. In general, matching with replacement performances better when the number of available matches is small because each treated fund is matched to the closest untreated one and thus matching produces larger bias reduction than matching without replacement (Rosenbaum 1989).

We include all relevant observable characteristics that help to explain the distribution of the carry distribution rule. Our matching variables stem from the probit models in Table 6. Most of the observable characteristics that are related to the probability of a deal-by-deal distribution reflect the GP's experience/track record. In addition, the vintage year of the fund appears to be important. For a more detailed discussion, see Section 4.1. The point estimates reported in panel A closely match those in panel A, column (6) of Table 6. The key difference is that instead of introducing vintage-year fixed effects, we include two "vintage-year period" effects, one for the 1992–1998 period, another for the 2002–2005 period. This broadens the scope for matching, allowing a 1993 vintage fund that received a deal-by-deal contract to be matched against a 1995 firm that was similar along observable dimensions but instead received a whole-fund contract. Using annual fixed effects instead would restrict matches to being in the same vintage year; this would result in many more treated observations falling outside a common support and therefore being dropped from the sample forming the comparison reported in panel B.

Propensity score matching hinges on the observable covariates that predict the distribution rule assignment and requires that there is substantial overlap between the propensity scores of treated funds (those with deal-by-deal contract) and untreated funds. We find limited overlap in terms of the deal-by-deal characteristics for nine funds; for example, these comparison funds have estimated propensity scores that are greater than the minimum—or less than the

Table 7. Propensity Score Matching on GP Quality (PME Based on NASDAQ)

Panel A: Probit model estimation for the propensity score

$$\Pr(\mathrm{DR}_i = 1|X_i) = F\big(12.497 + 0.558 \cdot \textit{No\_first\_time\_fund}_i + 0.092^{*} \cdot \textit{Yrs\_rel\_work\_exp}_i + 0.225^{*} \cdot \textit{Observed\_prior\_multiple}_i + 1.339 \cdot \log(\textit{fund\_size}_i) + 0.261 \cdot \log(\textit{fund\_size}_i)^2 + 0.750 \cdot \textit{Vintage\_year\_92\_98}_i + 0.591^{*} \cdot \textit{Vintage\_year\_02\_05}_i\big)$$

Diagnostics
LR test: all coefficients = 0, χ^2-stat.: 17.43** Pseudo-R^2: 0.169 N: 85

Panel B: Propensity score matching on distribution rule

	Sample (1)	DD (2)	Radius matching Diff. mean (3)	3-NN matching Diff. mean (4)
Beta = 1				
Gross PME	Unmatched	1.394	0.503***	0.503***
	Matched	1.398	0.453**	0.450**
Net PME	Unmatched	1.017	0.335***	0.335***
	Matched	1.025	0.288**	0.262*
Beta = 2				
Gross PME	Unmatched	1.722	0.486*	0.486*
	Matched	1.735	0.438*	0.426*
Net PME	Unmatched	1.247	0.340*	0.340*
	Matched	1.285	0.273	0.266
Beta = 3				
Gross PME	Unmatched	2.113	0.823*	0.823*
	Matched	2.202	0.783***	0.759**
Net PME	Unmatched	1.371	0.316	0.316
	Matched	1.419	0.301	0.303

Panel C: Covariate balance

X_i	Sample	Average treated	Differences in X_i between treatment and control:	
No first-time fund	Unmatched	0.833	0.273***	0.273***
	Matched	0.804	0.079	0.059
Years relevant work experience	Unmatched	11.265	−0.843	−0.843
	Matched	11.351	1.103	1.676
Observed prior multiple	Unmatched	1.751	0.5179*	0.5179*
	Matched	1.660	0.219	0.282
log(*fund size*)	Unmatched	8.582	0.2728**	0.2728**
	Matched	8.504	0.083	0.066
log(*fund size*)^2	Unmatched	73.849	4.548**	4.548**
	Matched	72.503	1.407	1.127
Vintage year 1992–1998	Unmatched	0.167	0.007	0.007
	Matched	0.176	−0.068	−0.072
Vintage year 2002–2005	Unmatched	0.417	0.177	0.177
	Matched	0.373	−0.030	−0.046

Notes. This table presents raw (mean) fund returns and raw covariates of propensity score matching on precontract differences in GP quality (distribution rule relevant fund characteristics). PMEs are calculated based on NASDAQ. First, propensity score matching involves an estimate of a probit model to select deal-by-deal on observable pretreatment covariates (panel A). Column (2) of panel B reports the average performance under treatment with deal-by-deal (unmatched sample (column 1) and the prediction of such conditional on observable pretreatment covariates as described in panel A (matched sample (column (1))). The average treatment effect on treated LPAs with deal-by-deal is reported in columns (3) and (4). These last two columns differ in propensity score matching algorithms: radius matching with caliper(0.1) (column 3) and 3-NN matching with replacement and caliper(0.1). In all our matching algorithms we impose a common support. Nine LPAs with deal-by-deal are out of the common support and are discarded with a total of 76 LPAs remaining. In panel C we test for the balancing of the treated. Column (2) reports the mean in the treated with difference to nontreated LPAs displayed in columns (3) and (4) both before and after matching, in reference to the matching algorithm described above. For a good balance, differences in means should not be significant after matching. All variables are as defined in previous tables.

maximum—propensity score for the untreated funds. To avoid selection biases, we restrict the analysis to funds in the region of the common support (as in, e.g., Dehejia and Wahba 1999) and lose these nine funds.

Panel B reports two forms of propensity score matching, radius-matching and three-nearest neighbor matching. Column (2) of panel B reports the average performance under treatment with deal-by-deal,

both for the unmatched sample (the upper row) and the matched sample (the lower row). Columns (3) and (4) report the average treatment effects on the treated for both types of matching algorithms. That is, columns (3) and (4) report the difference between the observed performance of the deal-by-deal sample and the hypothesized performance of that same sample if they had instead received whole-fund contracts, making use of the matched neighbors to compute this hypothesized counterfactual quantity. Thus, the matching algorithm indicates that about 90% of the observed average difference in gross PME remains after controlling for the endogenous sorting of high-quality GPs to GP-friendly contracts based on observable characteristics. The remainder could be associated with unobservable characteristics (unobservable to the econometrician, i.e., not found in due diligence documents) or the contract itself induces the GP to behave differently than they might otherwise facing different contract conditions.

Propensity score matching indicates that a larger fraction of the difference in net PME is attributable to contract assignment. One reason for this is the fact that contract terms are correlated: Deal-by-deal contracts also are more likely to have higher carried interest provisions and higher fees, which, in turn, means that the value flowing back to the LP is commensurately lower.

The quality of the matching exercise can be assessed from panel C. Column (2) reports the average value of the relevant independent variable among the set of deal-by-deal contracts that are matched as well as those that are unmatched. Columns (3) and (4) report differences in means between the treated and control group, both before and after matching. The goal is to obtain estimates of the propensity score that statistically balance the covariates between treated and control group. Thus, the fact that the differences are insignificant after matching indicates a good balancing.

The critical identifying assumption required to attach a causal interpretation to the differences we have reported above is that each fund has the same probability of receiving a deal-by-deal contract conditional on the observed propensity score (see Rosenbaum and Rubin 1983 or Dehejia and Wahba 1999). We cannot rule out that there is no selection on unobservables, which would violate the conditional independence assumption. This assumption is "equivalent to statistical independence of d and u conditional on $(x_1, \ldots, x_k)$" (Roberts and Whited 2012, p. 550), where d is the treatment assignment and u is the error term in the regression, and $x_1, \ldots, x_k$ are the observable covariates. We cannot claim that the selection bias is necessarily smaller if there is selection on unobservables, but prior analysis showed that propensity score matching may reduce that bias (see, e.g., Dehejia and Wahba 1999). Additionally, we have access to the same performance and due diligence information that is also available to the investor. Thus, these unobservable differences would also have to be unobserved by the investor or else observable but only in a manner that is not somehow captured in the recorded due diligence materials. Admittedly, fundraising involves soft information that is available to the LPs but unobservable in the data. That being said, soft information should be mostly relevant for funds where hard performance measures do not lead to a clear decision. If this was the case, we would expect to find less explanatory power from the observable variables in the probit model.

Given the likely positive correlation between selection and treatment, the possibility of violating the conditional independence assumption would lead our propensity score analysis to understate the true impact of selection. It is important to bear this consideration in mind when interpreting the results from this section; however, it is equally important to bear in mind that our goal is simply to ask whether selection is likely to account for the entire difference in observed performance between the two types of contracts.

5. Direct Evidence of Behavioral Differences

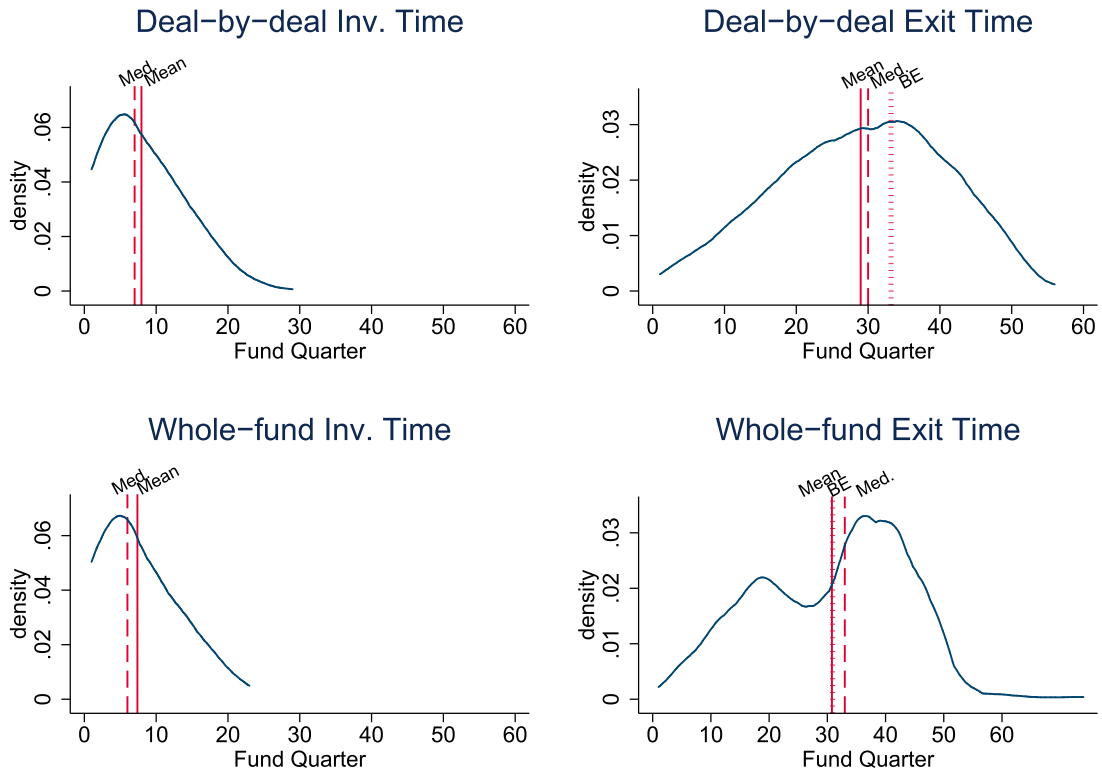
The previous sections demonstrate that GP-friendly contracts are associated with higher returns, both on a gross and net of fee basis, and that these return differences are not entirely due to observable differences in inherent GP quality. In this section we provide direct evidence that contracts are associated with different types of investment. To do so, we proceed in three steps. First, we examine how the timing of exits varies across contract types; second, we analyze effort incentives; and then we examine differences in risk-taking and contract timing.

5.1. Exit Timing

Figure 4 illustrates the timing of investment and exit decisions according to whether the fund follows a whole-fund or deal-by-deal carry scheme. The left column of Figure 4 depicts the distribution of investment times for the two types of contracts as a function of fund age. This is generated by pooling all initial investments by fund age for each contract type and then plotting the distribution of investments. There is very little difference in the distribution of investment times: for both contract types the median investment occurs in about the 7th or 8th quarter of the funds' existence (dashed line; solid line equals the mean), meaning that funds have made about half of their initial investments by the beginning of their third year of existence.

Unlike with investment times, there are substantial differences in the distribution of exit times by contract

Figure 4. Portfolio Companies Investment and Exit Times by Fund Quarter



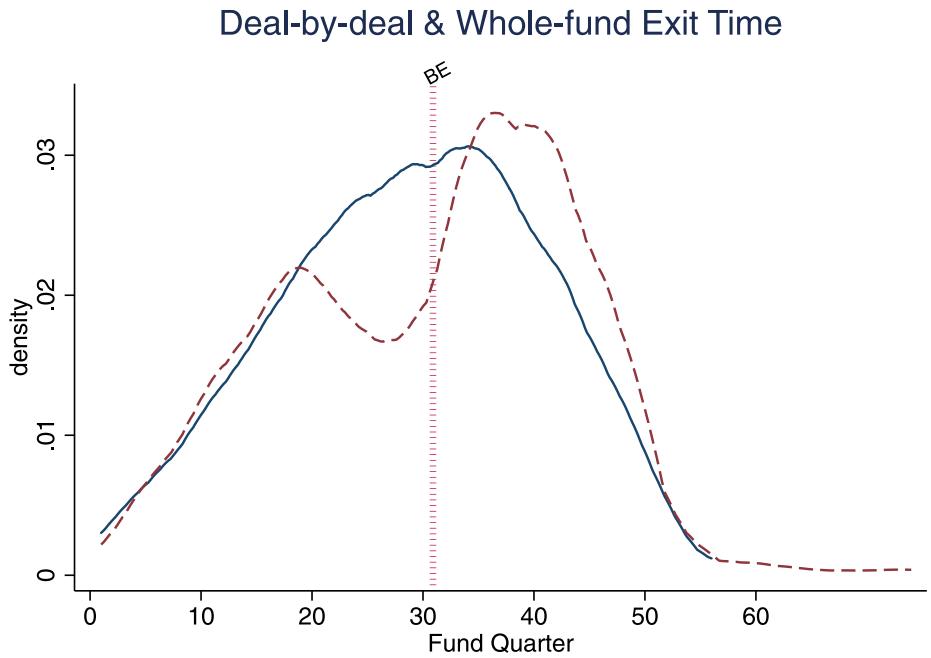
Notes. The left column of this graph depicts the distribution of investment times, denoted "Inv. Time," for the two types of contracts, i.e., deal-by-deal and whole-fund contracts, as a function of fund age. This is generated by pooling all initial investments by fund age for each contract type and then plotting the distribution of investments. The right column depicts the distribution of exit times by contract type. In addition, the plots contain the mean, median (Med.) and break-even (BE) point time marked by the different red lines.

type, as can be seen by the two graphs in the right column of Figure 4. For deal-by-deal funds, the mean exit occurs in around the 29th quarter, while for whole-fund the mean occurs in about the 33rd quarter. These differences in means and medians mask substantial variation in the overall distribution, however. Deal-by-deal distribution times follow the evolution of net asset values that one would obtain by using the parameters of Metrick and Yasuda (2010) and forecasting the evolution of NAVs.[12] This is consistent with the idea that managers under deal-by-deal contracts are acting under an incentive to maximize the value of each exit irrespective of how it is connected to the broader portfolio they manage. The incentive to exit big in each deal should be stronger than fundraising concerns for deal-by-deal funds, as these fund managers are already perceived as having a higher quality compared with whole-fund managers and rely less on a signal to build a reputation. We actually show in Table 6 that GP experience increases the probability of a deal-by-deal.

In contrast, whole-fund contracts are associated with a first spike in distributions between the 16th and 18th quarter of the fund's life, and a later spike around the 40th quarter of age. The first spike coincides with the time of raising a follow-on fund. On average, funds following a whole-fund carry scheme in our sample raise a new fund after 4.7 years of the current fund's life. The time to raise a next fund is slightly higher than the 3–4 years reported by Chakraborty and Ewens (2017) and Barber and Yasuda (2017), which can be attributed to lower GP quality and the longer fundraising times after the dot-com crash. The evidence of a spike in portfolio exits prefundraising is related to findings in a series of papers (Jenkinson et al. 2013, Barber and Yasuda 2017, Chakraborty and Ewens 2017, Brown et al. 2019) connecting the timing of fundraising decisions to revisions in the stated net asset values of the underlying assets under management of the GP: It suggests that whole-fund contracts operate under an increased incentive to grandstand, posting early returns to investors in order to send a signal of the fund's underlying quality.

In line with the findings by Robinson and Sensoy (2013), GPs also tend to cluster exits just after GPs' start earning money (breakeven (BE) fund quarter (dotted line)), in case they underlie a whole-fund carry distribution. By displaying the densities of exit times for whole-fund and deal-by-deal distributions in one graph (see Figure 5), one can see that GPs with a whole-fund compensation delay exits compared with funds

Figure 5. Combined Right-Hand Side Graphs from Figure 4



Note. This figure shows deal-by-deal (blue line) and whole-fund (red line) exit times by fund quarter with whole-fund breakeven (BE) point indicated by the red line.

with a deal-by-deal distribution. We cannot observe the counterfactual of what would happen to performance if GPs held investments for shorter or longer than they actually do. However, in unreported results, we find that the average investment PMEs of these exits are, in fact, lower compared with early exits for funds with a whole-fund carry provision. It seems that these GPs hope for better exits as long as the fund's expenses are not recouped.

Table 8 examines this in greater detail with hazard rate models that model the hazard of exiting a portfolio company investment as a function of the carry provisions. Columns (1)–(3) report multiple observations per failure specifications using the entire data set, where we have more than 500 deal-quarter observations per fund. Hazard impact factors are reported. The coefficients on deal-by-deal carry provisions indicate that relative to whole-fund carry provisions, deal-by-deal contracts have a higher exit probability. The finding that the better performing deal-by-deal funds exit their investment quickly is in line with Lopez-de Silanes et al. (2015), who show that good performing investments are exited faster than those that do poorly. Column (2) controls for the experience and prior performance of the GP as well as time-varying public equity and credit market conditions. Column (3) introduces dummy variables for the level of carried interest earned by the GP in question. LPAs with higher GP carried interest percentages are associated with longer holding times, but this is imprecisely estimated. Funds with higher observed prior multiples exit more slowly, as do larger investments. Funds with more experienced management teams are more likely to exit.

In column (4) we introduce an interaction term between the strict deal-by-deal indicator and a dummy for whether the fund is likely in fundraising—specifically, a dummy variable that is equal to one during fund quarters 12 through 22. The main effect of the fundraising period accelerates exit, but this effect is modest in the full sample. The interaction term indicates that investments undertaken in funds with deal-by-deal contracts are associated with a markedly lower hazard of exit during the fundraising period, confirming the intuition provided by Figure 5. This effect is highly statistically significant.

Columns (5) and (6) split the sample according to whether the investments in question were above or below their initial investment cost and repeats the analysis of column (4). Comparing the point estimates on the interaction term across the specifications illustrates that funds with whole-fund contracts are exiting strong investments early, presumably to "put points on the board," in a manner consistent with the findings of Brown et al. (2019), Barber and Yasuda (2017), and Chakraborty and Ewens (2017). In the subsample of in-the-money investments, the main effect of the fundraising time period dummy dramatically increases the hazard of exit and is highly significant. The combined interpretation is that having profitable investments to

Table 8. Fund Investment Exit Times for Strict Deal-by-Deal (GP-Friendly: 1) vs. Whole-Fund (GP-Friendly: 3, 4) Contracts

	Time-varying?	(1)	(2)	(3)	(4)	(5) multiple ≥ 1	(6) multiple < 1
Strict deal-by-deal (sDbD) vs. whole-fund	No	1.251*	1.353**	1.402**	1.511***	1.571**	1.524***
		(0.154)	(0.166)	(0.176)	(0.199)	(0.292)	(0.215)
Fundraising Quarters (FR Qtrs)	Yes				1.064	1.424*	0.915
					(0.152)	(0.275)	(0.158)
sDbD × FR Qtrs	Yes				0.701**	0.580**	0.789
					(0.122)	(0.160)	(0.161)
PV mgmt. fee	No			1.015	1.015	1.013	1.018
				(0.030)	(0.030)	(0.040)	(0.034)
Carried interest (20%)	No			0.986	0.997	0.426*	1.528
				(0.353)	(0.357)	(0.208)	(0.519)
Carried interest (22.5%)	No			0.581	0.590	0.255***	0.884
				(0.225)	(0.228)	(0.133)	(0.348)
Carried interest (25%)	No			0.750	0.757	0.268***	1.337
				(0.250)	(0.252)	(0.131)	(0.432)
Carried interest (30%)	No			0.840	0.842	0.336***	1.272
				(0.193)	(0.192)	(0.090)	(0.321)
Years relevant work experience	No		1.009	1.011**	1.001**	1.020**	1.008
			(0.006)	(0.005)	(0.005)	(0.009)	(0.007)
Observed prior multiple	No		0.857**	0.864**	0.858**	0.850	0.866**
			(0.066)	(0.063)	(0.064)	(0.093)	(0.062)
log(*Investment cost*)	No		0.588***	0.600***	0.600***	0.680***	0.517***
			(0.033)	(0.034)	(0.035)	(0.084)	(0.042)
1999Q1 to 2000Q1	Yes		1.253	1.136	1.160	1.720	0.984
			(0.393)	(0.360)	(0.367)	(0.888)	(0.249)
Quarterly return on Russell 2000 (%)	Yes		0.998	0.998	0.998	0.995	1.000
			(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
BAA cor. bond yield (in %)	Yes		6.098	6.411	6.378	9.421	5.050
			(6.836)	(7.260)	(7.291)	(13.520)	(6.599)
No. of fund-deal-quarters		46,364	46,364	46,364	46,364	22,078	24,286

Notes. This table presents hazard ratios associated with the GP's decision to sell/hold portfolio investments disregarding outcome and at loss/gain. We estimate Cox proportional hazards models. Hazard ratios can easily be converted into coefficients. The failure event is the exit so that each portfolio company is at risk during the holding period. If the fund exits the investment in several stages, we use the last transaction date in order to observe the return multiple and differentiate between exits over and under costs. Investments that are not exited by the end of our sample period are treated as right-censored with corrected estimators. *Strict deal-by-deal (sDbD)* dummy takes the value of one if the GP is paid on a single deal basis getting paid after each single positive exit, and zero if the GP is paid on whole-fund basis. *Fundraising quarters (FR Qtrs)* dummy takes the value of one between quarters 12 and 22 of the fund's life, which typically represents the period of a new fundraising, and zero otherwise. *Carried interest* dummy of 15% is omitted from the models. log(*Investment cost*) describes the log of investments cost of capital. *1999Q1 to 2000Q1* dummy is a time-varying covariate: over the fund's life, it equals one only in 1999Q1–2000Q2. *Quarterly return on Russell 2000* is the quarterly return on the Russell 2000 index. Another time-varying covariate is *BAA cor. bond yield* measuring the yield on corporate bonds (using Moody's BAA bond index estimated quarterly in March, June, September, and December). Additional covariates are estimated as defined in Table 4. All models include time fixed effects. Standard errors, shown in brackets, are adjusted for clustering on fund (that is, investments undertaken by the same fund are not assumed to be independent).

*10%, **5%, ***1% two-tailed significance level.

exit during the natural fundraising time period is highly correlated with exit for whole-fund contracts, but not for deal-by-deal contracts.

One concern is that deal-by-deal funds invest in younger startups or different industries, which could impact exit timing. To account for potentially unobserved heterogeneity due to omitted variables, we estimate frailty models. A frailty model is a random effects model for time variables, where the random effect (frailty) has a multiplicative effect on the hazard. When we control for this unobserved heterogeneity, we do not find a notable change, neither economically nor statistically, in the impact of the distribution rule on exit timing (see Table A30 in Section C of the online appendix).

5.2. Effort

The findings presented above call into question whether effort incentives might be distorted for these later exits. Manso (2011) shows that the tolerance for early failures and the prospect of pay for performance later on motivates more innovative business strategies. His findings in the broad area of managerial compensation map nicely into the deal-by-deal and whole-fund context. Basically, early failures lower the overall probability that the fund outcome reaches the GP's whole-fund compensation threshold. Therefore, the GP might be inclined to exert less effort for follow-on exits compared with deal-by-deal because he faces the risk of not being compensated for their success.

Figures 6 and 7 present cumulative distribution functions of realized investment PMEs conditional on the performance of early exits. Exits are considered early if they fall below the median time to exit in the same year cohort of the startup; otherwise, exits are defined as late. Early fund exits are labeled as strong if the ratio of top quartile (based on early exits of all funds) to total exits exceeds the ratio of bottom quartile to total exits by at least 50%.[13]

In line with our fund level results, Figure 6 shows that conditional late realized investment PMEs are more likely to be lower for a whole-fund compared with a deal-by-deal compensation. This difference increases conditional on weak early exits, as shown in Figure 7. Higher PMEs of late exits for deal-by-deal funds can be realized especially in the midrange performance. This finding illustrates the important effort incentive effects in correspondence to the compensation effect in terms of present value differences between distribution rules for mediocre funds, pointed out by Litvak (2009) and confirmed for our sample in Section A of the the online appendix. The result is also in line with the industry conjecture that little time is required for real winners (or worst performers) and that allocating the bulk amount of time to those middle portfolio companies is most efficient.

5.3. Market Timing and Risk-Taking

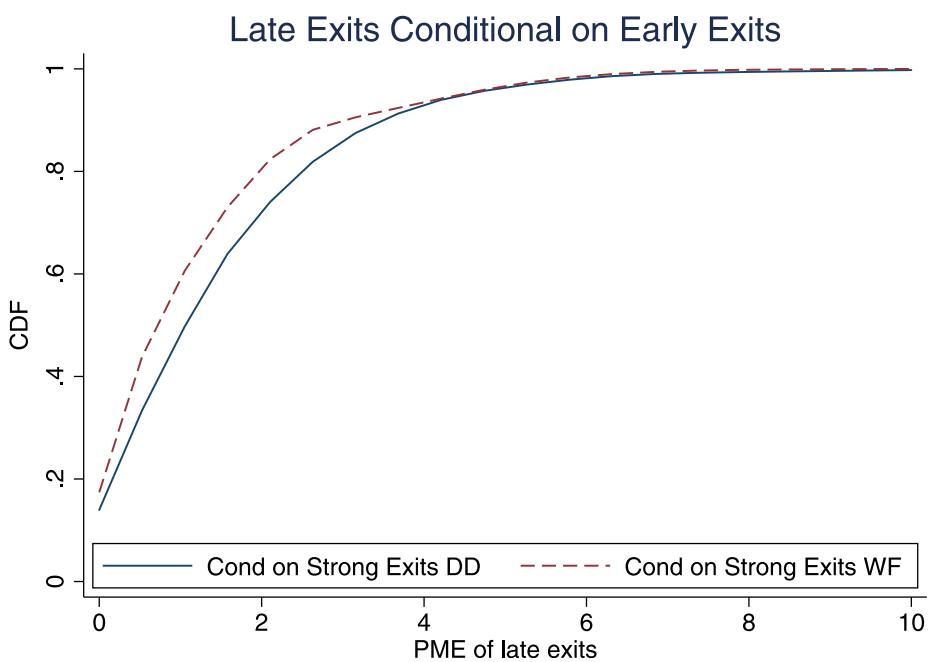
The evidence in Figure 4 suggests that general partners facing deal-by-deal contracts have a reduced incentive to exit early to signal their quality to investors. To explore exit timing in more detail, Figure 8 examines how the exit times line up with broader market conditions.

In the left column of Figure 8 we sort fund quarters not chronologically but instead by contemporaneous market returns over that quarter. Toward the left are quarters associated with low market returns; toward the right, market returns improve. Then, we plot the distribution of deal-level exit performance as a function of these underlying market conditions along the vertical axes. This allows us to plot the gross PME realized on each exit as a function of the market conditions when the exit occurred. To control for outliers, we winsorized the deal-level PME at the 5th and 95th percentile.

The blue line in the top portion of the left column shows PMEs for deal-by-deal funds; the fact that it is almost always above the red line (for whole-fund) indicates that in most market conditions deal-by-deal funds outperform whole-funds by a small margin. However, this margin grows substantially in the quarters with the very strongest market returns. This indicates that deal-by-deal funds are able to generate large exits in strong market conditions.

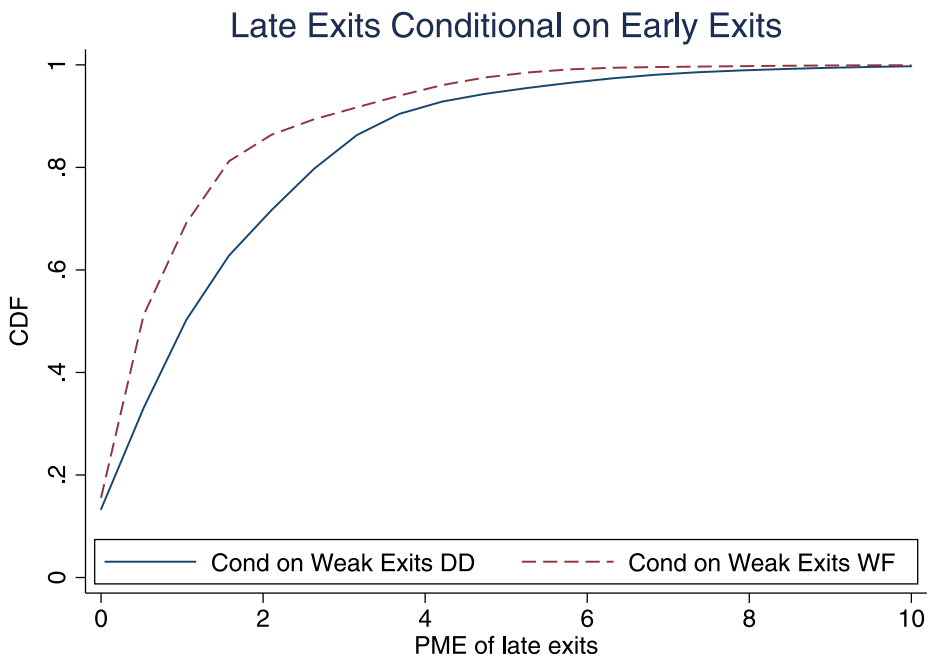
Another way to test whether deal-by-deal fund managers are better in timing of exits is to test whether their outperformance increases when using cash multiples/PMEs with a beta of 1 compared with PMEs with a beta above 1. It can formally be shown that the discount

Figure 6. Cumulative Distribution Function of Deal-by-Deal (DD) and Whole-Fund (WF) Investment PMEs Conditional on Early Strong Exits



Notes. "Early" is defined as one that exits below the median time to exit in the same year cohort of the startup. Early fund exits are labeled as strong if the ratio of top quartile (based on early exits of all funds) to total exits exceeds the ratio of bottom quartile to total exits by at least 50%.

Figure 7. Cumulative Distribution Function of Deal-by-Deal (DD) and Whole-Fund (WF) Investment PMEs Conditional on Early Weak Exits



Notes. "Early" is defined as one that exits below the median time to exit in the same year cohort of the startup. Early fund exits are labeled as strong if the ratio of top quartile (based on early exits of all funds) to total exits exceeds the ratio of bottom quartile to total exits by at least 50%.

factor decreases in beta and this incremental decrease is stronger for higher market returns as long as beta is small (see Section B of the online appendix for calculations): That means, if beta is increasing, a higher market return results in a lower discounted distribution. Thus, the extra PME for $\beta = 0$ under deal-by-deal contracts as shown in Figure 2 is due to better timing of exits. This is not to say that deal-by-deal managers possess market-timing skill in the traditional sense of the word, just that they are relatively better at exiting in strong market conditions than whole-fund managers are.

The final piece of behavioral evidence appears in the right column of Figure 8. Here we use the method described by Ljungqvist et al. (2017) to compute the volatility of venture capital investments at the portfolio company level. This allows us to plot the evolution of risk-taking over the fund's life as a function of whether it is associated with whole-fund or deal-by-deal carry. The difference in fund structures is striking. Whole-fund contracts are associated with less risk-taking upfront, but their risk-taking spikes as the fund's age grows. In contrast, deal-by-deal contracts are more uniformly concentrated in higher-risk investments throughout the fund's life.

Another way to test whether GP-friendly contracts induce different risk-taking behavior is to calculate value-at-risk measures along the lines of Lopez-de Silanes et al. (2015). Consistent with evidence in Figure 8, Figure 9 shows that deal-by-deal funds have a significantly higher ratio of complete write-offs as well as homeruns (exits with a modified IRR above 50%) compared with whole-fund. Overall losses (defined by a modified IRR below 0%) are more common for whole-fund contracts.

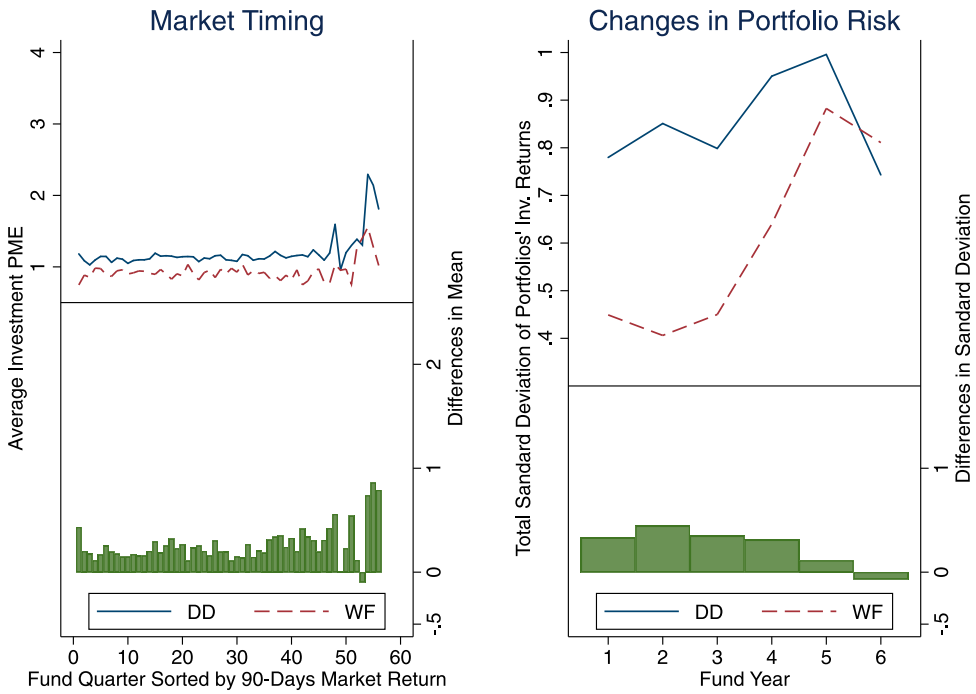
This indicates that deal-by-deal carry is associated with overall higher-risk investments, and these extreme returns on the deal-level culminate in return distributions on the fund level that look quite different for whole-fund and deal-by-deal contracts. Figure 10 plots returns for deal-by-deal and whole-fund contracts in terms of multiples on invested capital.

The distribution of returns is significantly more right-skewed for deal-by-deal contracts than for whole-fund contracts. Among the set of whole-fund contracts, the maximum multiple on invested capital is around 2.5, whereas for deal-by-deal contracts exceed 3.5× invested capital in some instances. Although our results cannot dispel that the difference in average returns, whether measured by PME or any other measure, stemming from selection on unobservables, we find that exit-timing, market-timing, and risk-taking in deal-by-deal contracts rather square with extreme returns that drive performance in venture capital.

6. Limitations and Caveats

We acknowledge that there are limitations of our study. We consider a sample with 85 observations that raises the concern of a small sample bias. In that case, coefficient estimates may be biased. To rule out that outliers may be a concern here, we run specifications

Figure 8. Market Timing and Changes in Portfolio Risk



Notes. The left column shows fund quarters sorted by contemporaneous market returns. Toward the left are quarters associated with low market returns; toward the right market returns improve. The plotted lines shows the distribution of exits measured by their PMEs as a function of these underlying market conditions along the vertical axes. To control for outliers, we winsorized the deal-level PME at the 5th and 95th percentile. The blue line in the top portion of the left column shows PMEs for deal-by-deal funds (DD); the fact that it is almost always above the red line (whole-fund; WF) indicates that in most market conditions deal-by-deal funds outperform whole-funds by a small margin. This margin grows substantially in the quarters with the very strongest market returns. The right column of this figure shows the volatility (calculated according to Ljungqvist et al. 2017) of venture capital investments at the portfolio company level. Thus, the evolution of risk-taking over the fund's life is displayed as a function of whether it is associated with whole-fund (red line; WF) or deal-by-deal carry (blue line; DD). Whole-fund contracts are associated with less risk-taking upfront, but their risk-taking spikes as the fund's age grows. In contrast, deal-by-deal contracts are more uniformly concentrated in higher-risk investments throughout the fund's life.

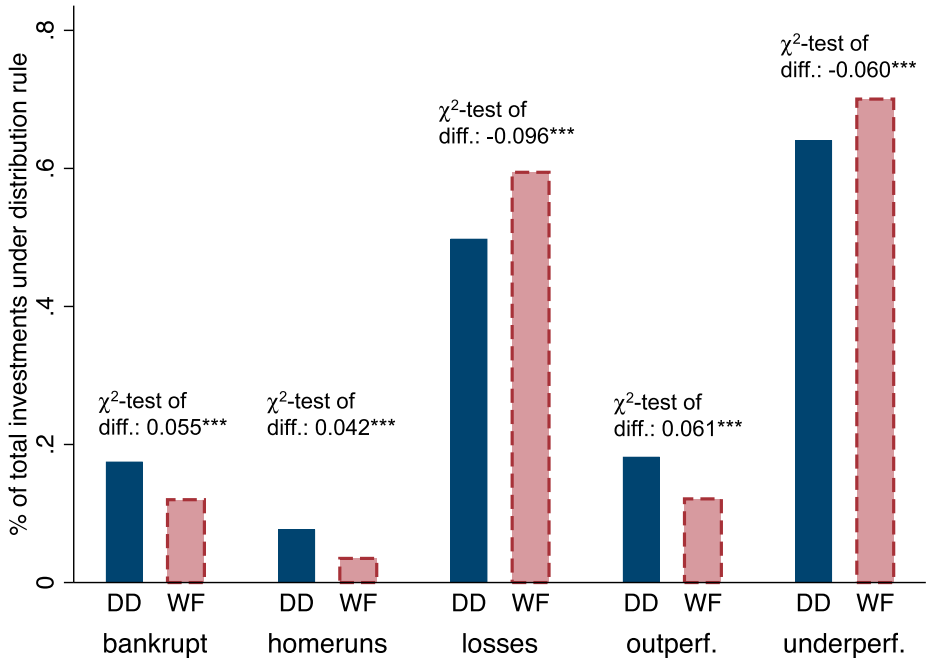
where we winsorize the performance measures at the 5th and 95th percentile (see Tables A16, A17, A24, and A25 in Section C of the online appendix). In addition, asymptotic standard errors may be biased. The higher confidence thresholds for t−statistics in a small sample size make it harder to reject $\beta = 0$, which biases larger standard errors in our favor. In general, with $n > 30$ this effect should not be large enough to affect inference.

To address the concern of the small degrees of freedom as well as the concern of imprecise fixed effects estimates due to limited number of observations, we run regressions in Table 5 without year fixed effects and include vintage year period dummies instead.[14] In this case, the number of parameters drop from 18 to 9. We estimate these regressions using the MIRR, the GPME developed by Korteweg and Nagel (2016) (see Table A22 in Section C of the online appendix) as well as "levered PMEs" for various β (see Tables A14–A16 and A18–A20 in Section C of the online appendix). We also winsorize the PME at the 5th and 95th percentile to control for outliers and reestimate models in Table 5 (see Table A16 in Section C of the online appendix). In addition, we estimate these models with clustered standard errors (see Tables A17 and A25 in Section C of the online appendix). For all these robustness tests, results remain qualitatively similar. By clustering on the GP level we obtain 52 clusters. Clustered standard errors are biased in a small sample, and it is not clear when cluster counts are too low to draw reliable inference. Angrist and Pischke (2009) suggest that 42 clusters are sufficient for standard cluster adjustment to be reliable, although this number is not a literal guide.

Although our results support the idea that the tradeoff between clawback risk and incentives warrants both types of contracts simultaneously in the market, more deal-level data would have been ideal to highlight how additional controls relate to clawback risk.

We also emphasize the caveat of observing only 25 whole-fund contracts and admit that the inclusion of buyout funds would have provided more insights on mechanisms across investment strategies. Unfortunately, access constraints made it impossible to retrieve any information on distribution rules and clawback provisions from such LPAs. Thus, we urge caution not to simply extrapolate our results to any kind of private equity fund.

Figure 9. Value-at-Risk Measures by Distribution Rule



Notes. Ratios are displayed in percent based on all investments under a given distribution rule. Investments are referred to as "homeruns" if they achieved a modified IRR above 50%, "losses" are characterized by a modified IRR below 0%, "outperformers" have a PME (based on NASDAQ) above 2, and "underperformers" have a PME below 1. Results for χ^2-tests of differences in proportions are displayed.

Although we did not find that outperformance is associated with other performance sensitive contract terms, we acknowledge that there are various aspects of the LPA where an additional contractual less salient provision or covenant may be correlated to the distribution rule and thus could be relevant.

7. Conclusion

Private equity compensation practices have come under increasing scrutiny in recent years. Many practitioners, academics, and industry observers have called for broad changes in the way that general partners are compensated, placing special emphasis on the timing of when LPs and GPs receive their carried interest compensation. Indeed, the Institutional Limited Partners Association (ILPA) argues that "a standard all-contributions-plus-preferred-return-back-first model must be recognized as a best practice" ILPA (2011, p. 4).

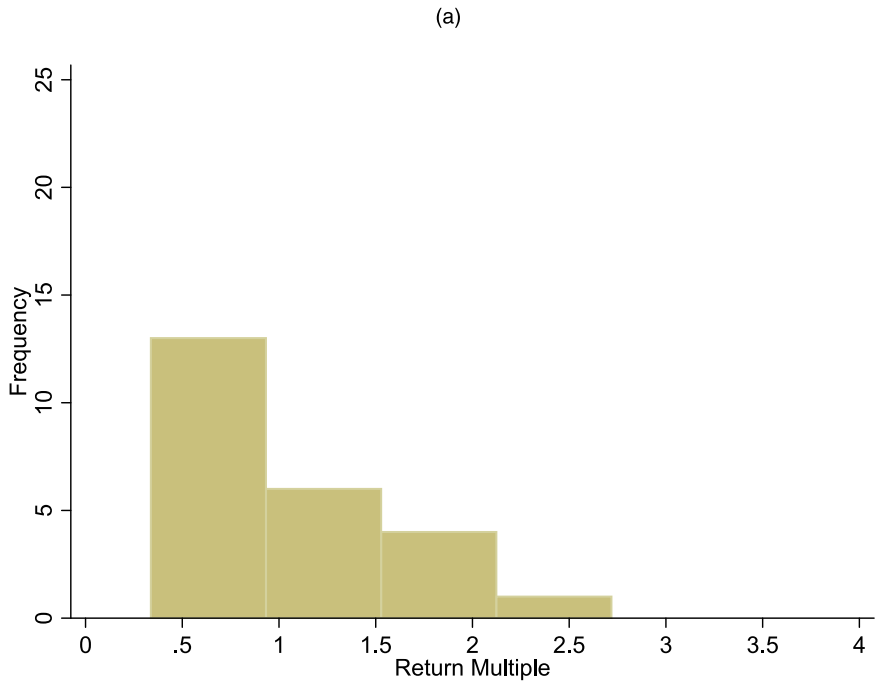
Suggestions such as this are, of course, predicated on the implicit assumption that these LP-friendly terms and conditions are, in fact, good for limited partners. This ignores two possible roles that contracts may play. One is that contracts effect incentives, i.e., that altering the compensation structure that GPs face will, in turn, alter their behavior. The second is that contracts signal quality, that is, that GPs and LPs can use the heterogeneity in the friendliness of compensation provisions as a way of allowing GPs of imperfectly observed quality to signal their ability.

This paper uses hand-collected, proprietary data connecting the terms of private equity management contracts to investment outcomes to show that GP-friendly contracts are associated with higher performance, both for the general partners as well as the limited partners. In other words, we find better investment performance for limited partners among the set of deals supported by GP-friendly contracts than among the set of deals supported by LP-friendly contracts. This finding does not support the oft-stated view that overly friendly management contracts destroy value for limited partners.

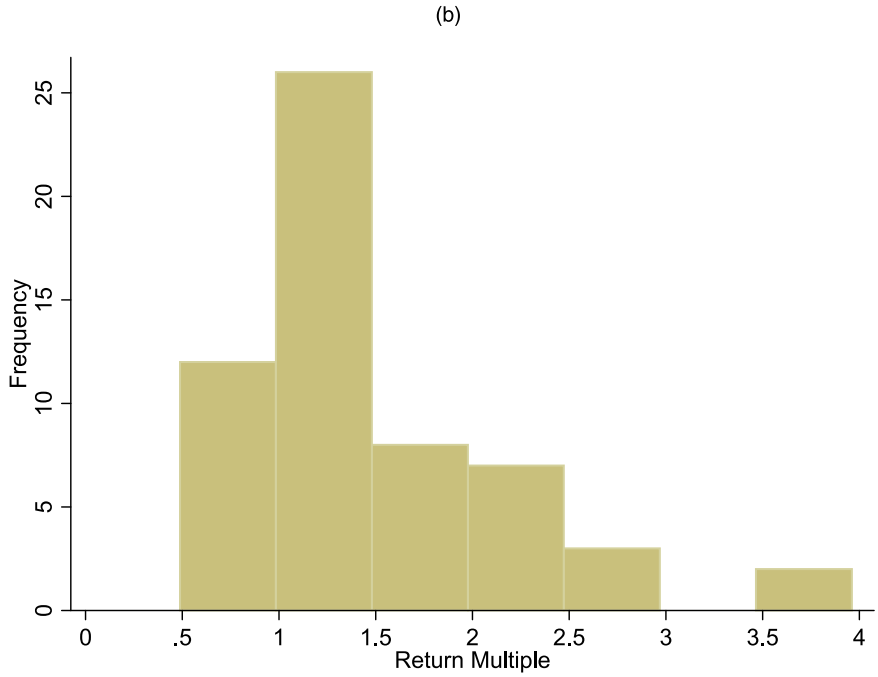
We, of course, urge caution in making causal claims. One reason for these findings is surely that the presence of GP-friendly terms is endogenous to the characteristics and past experience of the general partner. Better general partners command better compensation on average.

Our analysis suggests that there is more to the story than this. Indeed, the assignment of deal-by-deal contracts to better general partners is itself a reflection of the fact that the two contracts offer different trade-offs between incentives for effort and downside protection for LPs. Moreover, the terms of the contract appear to cause general partners to behave differently than they would have otherwise. GPs operating funds under LP-friendly contracts appear to begin by generating early exits in relatively less risky deals. This suggests they have a motive to "put points on the board," consistent with the classic "grandstanding" results of Gompers (1996).

Figure 10. Frequency Distribution of the Sample Funds' Return Multiples for (Panel (a)) Funds with a Whole-Fund Compensation and (Panel (b)) Funds with a Deal-by-Deal Compensation



Funds with whole-fund compensation



Funds with deal-by-deal compensation

There are a number of potentially competing mechanisms behind this finding. One is that the whole-fund provisions induce general partners to exit investments early so that they can begin earning carried interest. A second potential mechanism is more subtle and is based on a signaling argument. The idea here is that if market participants know that the pool of whole-fund contracts contains low-quality GPs as well as high-quality, but as-yet unproven, GPs, then general partners may use early exits as an attempt to signal their

quality. (This is closer in line with the spirit of the classic grandstanding result of Gompers (1996).) If this is the primary mechanism behind the early exit, then abolishing deal-by-deal carried interest, as suggested by ILPA and other industry observers, would cause known high-quality GPs to pool with everyone else, and the lack of an alternative available contract would presumably undermine the incentive to exit early. It is not possible to differentiate between these potential mechanisms, and it is important to recognize that they have potentially different welfare implications for limited partners. Thus, if anything, this paper shows that policy makers should proceed with care when prescribing changes to the contractual environment of private equity investment. Policy stances that would seem superficially to be desirable for limited partners are not obviously better. Indeed, our results suggest that venture investors get what they pay for, at least on average.

Acknowledgments

The authors are especially grateful to the editor, Gustavo Manso, an anonymous associate editor, and two anonymous referees for valuable comments and detailed suggestions; to Ulf Axelson, Ashwini Agrawal, Antoinette Schoar, Steve Kaplan, Barry Griffiths, Nicholas Crain, and Jefferson Davis; and to seminar participants at the 2013 American Finance Association Meetings, the 2015 European Finance Association Meetings, Indiana, LSE, MIT, Duke, UNC, Maryland, Amsterdam, the Stockholm School of Economics, and BI Oslo. Any errors are the authors'.

Endnotes

[1] Standard fee arrangements in venture capital typically require 2%–2.5% of committed capital as a management fee (often with reductions or step-downs to invested capital after conclusion of the investment period) and 20%–25% of the net return of an exited investment as carried interest. Transaction and monitoring fees together represent about 1.75% of total enterprise value (see Phalippou et al. 2018). These fees are typically specific to buyout funds.

[2] According to her calculations, an increase in management fee from 2% to 2.5% increases compensation from 15 million USD to 18.75 million USD, a carry increase from 20% to 25% yields 5.07 million USD more, while most importantly the effect of changing the distribution rule from LP-friendly to GP-friendly increases the GP's income ceteris paribus by 6.64 million USD (see Litvak 2009, p. 205). Replicating her findings with our data shows similar results: A shift in the distribution rule increases the GP's income by 6.94 million USD. Section A of the online appendix provides detailed calculations and a short explanation on distribution rules.

[3] Some contracts, especially in buyout funds, even stipulate that the LPs earn a preferred return on their investment. In such cases, these contracts typically include a "catchup provision" in which the GP earns accelerated carry after the hurdle is reached to compensate them for the carry they forfeited on early exits in order to satisfy the hurdle.

[4] For funds where LPs are not made whole, we observe a positive distribution in the final quarter that cannot be linked to a cash flow from a portfolio company exit and are most likely attributed to GP compensation that is clawed back.

[5] We use a Kaplan and Schoar (2005) public market equivalent, or PME, which expresses the return to a private equity investment in terms of its excess over a publicly investable benchmark, so that a PME of 1.1 implies that the PE fund outperformed its benchmark by 10% over the life of the fund (typically around 10 years). See Kaplan and Schoar (2005) or Robinson and Sensoy (2013) for more details. In additional robustness tests, we adjust the PME by using the generalized PME developed by Korteweg and Nagel (2016) as well as use "levered PMEs" along the lines of Robinson and Sensoy (2016).

[6] Our sample size is comparable to that of a number of other studies of detailed contract characteristics with hand-collected data sets. For example, Litvak (2009) uses a hand-collected sample of 68 funds, and Metrick and Yasuda (2010) have access to 94 funds provided by a single investor.

[7] In practice, the choice of benchmark in the PME calculation has little impact on the inferences one draws, especially in a setting like ours where most of the comparison is implicitly cross-sectional in nature (Jenkinson et al. 2016, Robinson and Sensoy 2016). Kaplan and Schoar (2005) use the S&P 500 index as a benchmark. Robinson and Sensoy (2016) also use the S&P 500 but extend their measure with "tailored" PMEs based on different indices being more in line with high-growth, high-risk characteristics of venture capital investments. In our analysis, we also use the Russell 2000 index as a benchmark, calculate "levered PMEs" along the lines of Robinson and Sensoy (2016), generalized PMEs according to Korteweg and Nagel (2016), and also calculate the modified internal rate of return as an additional performance measure.

[8] Estimates of beta for venture capital in the literature are above one and vary across studies. Driessen et al. (2012) find 2.7 for the beta estimate, Ewens et al. (2013) find 1.2, and Korteweg and Nagel (2016) find 2.6. Using different betas up to 3 does not notably reduce the required spread in beta to bring the PME difference to zero after a beta adjustment.

[9] We find a significant positive loading on work experience in Column (3) of panel A if we exclude observation of funds without track record of their managing partners.

[10] In nontabulated results, we estimated all models without vintage year fixed effects and find that previous work experience and past performance (if winsorized) no longer have a significant loading. Evidently, the choice of the distribution rule is less affected by measures of performance in good market conditions.

[11] See Li and Prabhala (2005) or Roberts and Whited (2012) for detailed discussions of finance-related applications in which propensity score models are used to address endogeneity concerns in corporate finance.

[12] Calculations based on simulations are available from the authors on request.

[13] Our results hold for various percentage differences between top and bottom quartile ratios. No whole-fund in our sample has reached the profit zone within the investment period.

[14] Fixed effects can still be estimated even for observations on singleton units—vintage years with just one observation—as these years have one value of 1 and 85 − 1 (85 = N in our sample) values of 0 in the year dummy. That dummy still has variance over 85 observations, so that its effect can be estimated and the year dummy is not dropped from the regression. The fixed effects estimator allows each vintage year to have its own constant term, and if there is only one observation in a year, that means that the value of the year's coefficient will be chosen to set the observation's residual precisely to 0. Therefore, these observations are just not contributing to the explanatory power of the model. That being said, it is a legitimate concern that fixed effects for a small number of observations are not estimated precisely and that statistical significance could be overstated and might lead to incorrect inference.

References

Angrist JD, Pischke J-S (2009) *Mostly Harmless Econometrics: An Empiricist's Companion* (Princeton University Press, Princeton, NJ).

Axelson U, Strömberg P, Weisbach MS (2009) Why are buyouts levered? The financial structure of private equity funds. *J. Finance* 64(4):1549–1582.

Barber BM, Yasuda A (2017) Interim fund performance and fundraising in private equity. *J. Financial Econom.* 124(1):172–194.

Brown GW, Gredil OR, Kaplan SN (2019) Do private equity funds manipulate reported returns? *J. Financial Econom.* 132(2):267–297.

Chakraborty I, Ewens M (2017) Managing performance signals through delay: Evidence from venture capital. *Management Sci.* 64(6):2875–2900.

Choi WW, Metrick A, Yasuda A (2012) A model of private equity fund compensation. Allen F, Aoki M, Fitoussi J-P, Kiyotaki N, Gordon R, Stiglitz J, eds. *The Global Macro Economy and Finance*, vol. 3 (Palgrave MacMillan, New York), 271–286.

Dehejia RH, Wahba S (1999) Causal effects in nonexperimental studies: Reevaluating the evaluation of training programs. *J. Amer. Statist. Assoc.* 94(448):1053–1062.

Driessen J, Lin T-C, Phalippou L (2012) A new method to estimate risk and return of nontraded assets from cash flows: The case of private equity funds. *J. Financial Quant. Anal.* 47(3):511–535.

Ewens M, Jones CM, Rhodes-Kropf M (2013) The price of diversifiable risk in venture capital and private equity. *Rev. Financial Stud.* 26(8):1854–1889.

Gompers P, Lerner J (1999) An analysis of compensation in the US venture capital partnership. *J. Financial Econom.* 51(1):3–44.

Gompers PA (1996) Grandstanding in the venture capital industry. *J. Financial Econom.* 42(1):133–156.

Holmström B (1979) Moral hazard and observability. *Bell J. Econom.* 10(1):74–91.

Hüther N (2016) Is the whole greater than the sum of its parts? Behavioral effects of management compensation. Working paper, Indiana University, Bloomington.

ILPA (2011) *Private Equity Principles* (Institutional Limited Partners Association, Washington, DC).

Jenkinson T, Harris R, Kaplan S (2016) How do private equity investments perform compared to public equity? *J. Investment Management* 14(3):1–24.

Jenkinson T, Sousa M, Stucke R (2013) How fair are the valuations of private equity funds? Working paper, Saïd Business School, University of Oxford, Oxford, UK.

Kaplan SN, Schoar A (2005) Private equity performance: Returns, persistence, and capital flows. *J. Finance* 60(4):1791–1823.

Kaplan SN, Strömberg P (2003) Financial contracting theory meets the real world: An empirical analysis of venture capital contracts. *Rev. Econom. Stud.* 70(2):281–315.

Korteweg A, Nagel S (2016) Risk-adjusting the returns to venture capital. *J. Finance* 71(3):1437–1470.

Korteweg A, Sorensen M (2017) Skill and luck in private equity performance. *J. Financial Econom.* 124(3):535–562.

Li K, Prabhala N (2005) Self-selection models in corporate finance. Eckbo E, ed. *Handbook of the Economics of Finance*, vol. 1 (Elsevier, New York), 37–86.

Litvak K (2009) Venture capital limited partnership agreements: Understanding compensation arrangements. *Univ. Chicago Law Rev.* 76(1):161–218.

Ljungqvist A, Richardson MP, Wolfenzon D (2017) The investment behavior of buyout funds: Theory and evidence. Working paper, Stern School of Business, New York University, New York.

Lopez-de Silanes F, Phalippou L, Gottschalg O (2015) Giants at the gate: Investment returns and diseconomies of scale in private equity. *J. Financial Quant. Anal.* 50(3):377–411.

Manso G (2011) Motivating innovation. *J. Finance* 66(5):1823–1860.

Metrick A, Yasuda A (2010) The economics of private equity funds. *Rev. Financial Stud.* 23(6):2303–2341.

Morris P, Phalippou L (2012) A new approach to regulating private equity. *J. Corporate Law Stud.* 12(1):59–84.

Phalippou L (2008) The hazards of using IRR to measure performance: The case of private equity. *J. Performance Measurement* 12(4):55–67.

Phalippou L (2009) Beware of venturing into private equity. *J. Econom. Perspect.* 23(1):147–166.

Phalippou L (2010) Venture capital funds: Flow-performance relationship and performance persistence. *J. Banking Finance* 34(3): 568–577.

Phalippou L, Rauch C, Umber M (2018) Private equity portfolio company fees. *J. Financial Econom.* 129(3):559–585.

Prendergast C (1999) The provision of incentives in firms. *J. Econom. Literature* 37(1):7–63.

Roberts MR, Whited TM (2012) Endogeneity in empirical corporate finance. Constantinides G, Harris M, Stulz R, eds. *Handbook of the Economics of Finance*, vol. 2 (Elsevier, New York), 271–286.

Robinson DT, Sensoy BA (2013) Do private equity fund managers earn their fees? Compensation, ownership, and cash flow performance. *Rev. Financial Stud.* 26(11):2760–2797.

Robinson DT, Sensoy BA (2016) Cyclicality, performance measurement, and cash flow liquidity in private equity. *J. Financial Econom.* 122(3):521–543.

Rosenbaum PR (1989) Optimal matching for observational studies. *J. Amer. Statist. Assoc.* 84(408):1024–1032.

Rosenbaum PR, Rubin DB (1983) The central role of the propensity score in observational studies for causal effects. *Biometrika* 70(1): 41–55.

Schell JM (2016) *Private Equity Funds: Business Structure and Operations*, 12th ed. (Law Journal Press, New York).