Alternative Investment Vehicles: Issues in Private Equity Management

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EUROPEAN
INVESTMENT BANK,
Luxembourg,
January 30, 2014

Agenda

1. Modeling the Cash Flow Dynamics of Private Equity Funds
2. The Value of Private Equity Fund Fees and Managerial Incentives
3. The Abnormal Performance and Systematic Risk of Private Equity

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1. Modeling the Cash Flow Dynamics of Private Equity Funds
   - Motivation
   - Model
   - Empirical Evidence
   - Risk Management Application
2. The Value of Private Equity Fund Fees and Managerial Incentives
3. The Abnormal Performance and Systematic Risk of Private Equity

Motivation

- The uncertain timing of capital drawdowns and proceeds poses a challenge to the management of future investment cash flows.
- We proposes a novel stochastic model on the typical cash flow dynamics of private equity funds.
- The model is easy to implement and it can be used in various directions:
    - Liquidity planning
    - Risk management

Institutional Framework and Notation

- The modeled fund is organized as a limited partnership with private equity firms being general partners (GPs) and investors being limited partners (LPs).
- The fund has a total (legal) maturity T_l and a commitment period T_c, where $T_l \geq T_c$ must hold.
- The fund has a total (initial) commitments denoted by C.
- Cumulated capital drawdowns up to t are denoted D_t, undrawn committed amounts up to time t are U_t, i.e., $D_t = C - U_t$.
- Cumulated capital distributions up to t are denoted P_t and $p_t = dP_t/dt$ denotes the instantaneous capital distributions.

- **Capital Drawdowns:** The dynamics of the cumulated capital drawdowns D_t can be described by:

$$dD_t = \delta_t U_t 1_{\{0 \leq t \leq T_c\}} dt$$

- **Drawdown Rate:** The drawdown rate δ_t is modeled by a CIR process:

$$d\delta_t = \kappa(\theta - \delta_t)dt + \sigma_\delta \sqrt{\delta_t} dB_{\delta,t}$$

  where $\theta > 0$ is the long-run mean, $\kappa > 0$ is the mean-reversion speed, and $\sigma_\delta > 0$ is the volatility. $B_{\delta,t}$ is a Brownian motion.

- **Capital Distributions:** Instantaneous capital distributions p_t are assumed to be log-normally distributed according to:

$$d \ln p_t = \mu_t dt + \sigma_P dB_{P,t}$$

- **Drift:** The funds expected multiple $E[M_t]$ is assumed to follow the ordinary differential equation:

$$E_s[dM_t] = \alpha t(m - E_s[M_t])dt, \ 0 \leq s \leq t,$$

where m is the multiple's long-run mean and α is the constant speed of reversion to this mean.

- The stochastic process for the instantaneous capital distributions at some time $t \geq s$ is given by:

$$p_t = \alpha t(mC - P_s) \exp\left\{-\frac{1}{2}[\alpha(t^2 - s^2) + \sigma_P^2(t-s)] + \sigma_P \epsilon_t \sqrt{t-s}\right\}$$

with $\epsilon_t \sim N(0,1)$.

Data

- Use a dataset of European private equity funds that has been provided by Thomson Venture Economics (TVE).
- The dataset contains a total of 777 funds over the period from 01/1980 through 06/2003.
- 95 of these funds are fully liquidated. Increase data universe by adding funds that have small net asset values compared to their realized cash flows at the end of the observation period.
- This gives an extended sample of mature funds that consists of a total of 203 funds and comprises 102 venture capital funds and 101 buyout funds.
- Calibrate the model to the sample cash flows by using the method of conditional least squares (CLS)

Goodness-of-Fit I

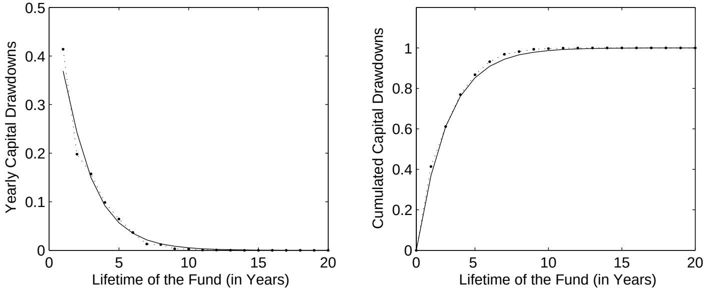

Figure: Annual Capital Drawdowns (Left) and Cumulated Capital Drawdowns (Right); Solid Lines represent Model Expectations; Dotted Lines represent Historical Data.

Goodness-of-Fit II

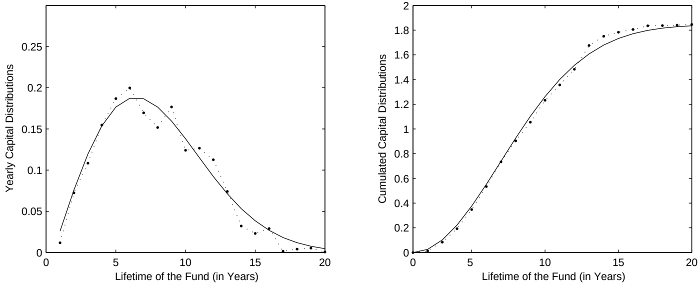

Figure: Annual Capital Distributions (Left) and Cumulated Capital Distributions (Right); Solid Lines represent Model Expectations; Dotted Lines represent Historical Data.

Goodness-of-Fit III

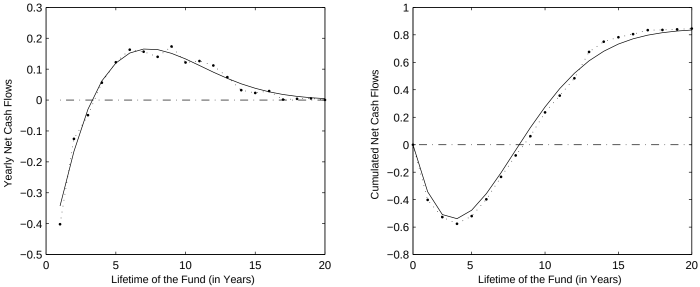

Figure: Annual Net Fund Cash Flows (Left) and Cumulated Net Fund Cash Flows (Right); Solid Lines represent Model Expectations; Dotted Lines represent Historical Data.

Table: Sensitivity Analysis for the Risk Profile of a Private Equity Fund

This table illustrates the risk profile of the private equity fund and provides a sensitivity analysis. The base case in column 1 is constructed by using the estimated model parameters for the sample liquidated funds. Columns 2-5 show how the results change by altering the long-run multiple m and the long-run drawdown rate θ. High Dist. (Low Dist.) corresponds to the case when m is equal to the base case parameter plus (minus) two times the standard error of the estimator. Similarly, Fast Draw. (Slow Draw.) corresponds to the case when θ is equal to the base case parameter plus (minus) two times the standard error of the estimator. All calculations are based on quarterly simulated fund cash flows.

	Internal Rate of Return (in % p.a.)				
	Base Case	High Dist.	Low Dist.	Fast Draw.	Slow Draw.
Mean	8.94%	13.04%	4.72%	8.67%	9.42%
Median	6.66%	10.12%	2.81%	6.53%	6.82%
Std.	13.84%	20.06%	12.09%	13.01%	16.34%
Lower 99th Quantile	-4.52%	-2.01%	-7.16%	-4.47%	-4.66%
Lower 95th Quantile	-1.88%	0.68%	-4.89%	-1.87%	-2.05%
Probability of a Loss (Prob(IRR<0%))	11.65%	3.55%	30.43%	11.65%	11.78%
Average IRR given a Loss	-2.00%	-1.54%	-2.81%	-1.97%	-2.09%

Agenda

Motivation

- The goal is to introduce a risk-neutral option-pricing approach to the valuation of private equity fund fees.
- We model cash flow dynamics in the spirit of part 1 (drawdowns and distribbutions) to derive the value of private equity funds fees in an equilibrium framework.
- Approach allows us to study determinants of private equity fund fee value and to analyze incentives generated by the standard compensation schemes.
- Related literature includes Sahlman (1990), Fenn et al. (1997), Gompers and Lerner (1999), and Metrick and Yasuda (2010).

Private Equity Fund Fee Components

- Following the typical structure of private equity funds GPs receive two types of compensation for managing the investments:
  - a fixed component called “management fee”
  - and a performance related component called “carried interest” or simply “carry”.

- Let MF_t denote cumulated management fees up to some time $t \in [0, T_l]$.
- **Management Fees:** If management fees are defined as a percentage c_{mf} of the committed capital C and are paid continuously, the dynamics are given by:

$$dMF_t = c_{mf} C dt$$

Carried Interest Example

Table: Carried Interest Calculation

This table illustrates the carried interest calculation for a $100M fund with a carried interest level of 20 percent, a hurdle rate of 8 percent, and a lifetime of ten years. The calculation is shown for a fund with no catch-up clause and fund with a catch-up clause of 100 percent.

Year	1	2	3	4	5	6	7	8	9	10	Total
Cash Flows	-50	-30	-10	-10	30	50	60	50	40	20	150
Cumulated Cash Flows	-50	-80	-90	-100	-70	-20	40	90	130	150	-
IRR (in % p.a.)	-100	-100	-100	-100	-33	-6	8	14	17	18	18
Carried Interest (No Catch-Up)	0	0	0	0	0	0	0	10	8	4	22
Carried Interest (With Catch-Up)	0	0	0	0	0	0	0	18	8	4	30

Carried Interest

- Let CI_t denotes the cumulated carried interest up to some time $t \in [0, T_l]$.
- **Carried Interest <u>without</u> Catch-up:** If the carried interest level is given by c_{ci} and h denotes the hurdle rate, carried interest dynamics are given by:

$$dCI_t = c_{ci} \max\{dP_t - dD_t - dMF_t, 0\} 1_{\{IRR_t > h\}}$$

  where $1_{\{IRR_t > h\}}$ indicates that carried interest is only payable at time t if the internal rate of return of the fund at that time, IRR_t, exceeds the hurdle rate h.
- Also define **Carried Interest <u>with</u> Catch-up** in the paper.

- **Theorem Fee Value:** Applying a risk-neutral valuation approach, the arbitrage-free value of the fund fees V_t^{GP} at time $t \in [0, T_l]$ is given by:

$$V_t^{GP} = \underbrace{E_t^{\mathbb{Q}}\left[\int_t^{T_l} e^{-r_f(u-t)} dMF_u\right]}_{\equiv V_t^{MF}} + \underbrace{E_t^{\mathbb{Q}}\left[\int_t^{T_l} e^{-r_f(u-t)} dCI_u\right]}_{\equiv V_t^{CI}}$$

where V_t^{MF} is the value of the outstanding management fees and V_t^{CI} is the value of the outstanding carried interest payments.

- **Management Fees:** The value of the outstanding management fees V_t^{MF} turns out to be:

$$V_t^{MF} = c_{mf} C \left[\int_t^{T_l} e^{-r_f (u-t)} du \right] = c_{mf} C \frac{1 - e^{-r_f (T_l - t)}}{r_f}$$

- **Carried Interest:** The value of the outstanding carried interest (with no catch-up) can be evaluated by solving

$$V_t^{CI} = E_t^{\mathbb{Q}}\left[\int_t^{T_l} e^{-r_f(u-t)} c_{ci} \max\{dP_u - dD_u - dMF_u, 0\} 1_{\{IRR_u > h\}}\right]$$

  with a numerical Monte-Carlo simulation.
- This is done under the equilibrium condition:

$$E^{\mathbb{Q}}\left[\int_0^{T_l} e^{-r_f u}(dP_u - dD_u - dMF_u - dCI_u)\right] = 0$$

- Investors' expected excess returns (net of fees) equal zero in equilibrium, such that GPs capture all rents (similar to Berk and Green (2004) for mutual funds).

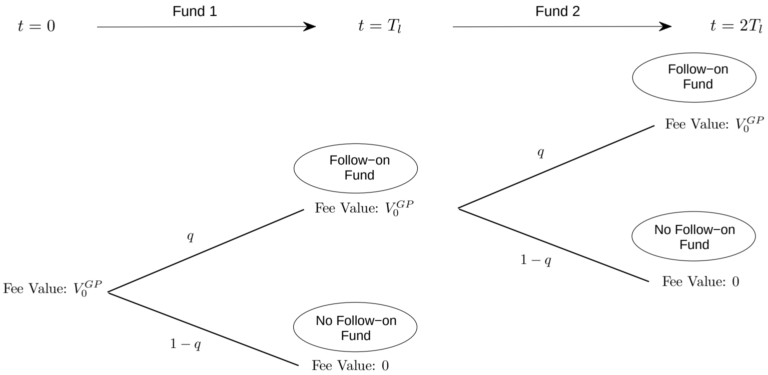

Figure: Model Setting with Multiple Funds in Sequence

- **Probability of Raising a Follow-on Fund:** We assume that GPs can only raise follow-on funds if the final performance of their current fund exceeds some threshold b:

$$q = Prob(IRR_{T_l} \geq b)$$

- **Value of Lifetime Fee Income:** For GPs who aim to raise m ($m \to +\infty$) funds, net present value of fee income is given by:

$$NPV_0^{GP} = V_0^{GP} \frac{1}{1 - \frac{q}{(1+r_f)^{T_l}}}$$

Table: Calibrated Model Parameters

This table summarizes the calibrated model parameters for the buyout segment. Sources used to calibrate model parameters are data from the Center of Private Equity Research (CEPRES) and results from Sahlman (1990), Gompers and Lerner (1999a), Campbell et al. (2001), Malherbe (2004), Jegadeesh et al. (2009), and Metrick and Yasuda (2010). All model parameters are stated annualized.

Parameter	Symbol	Value
Fund lifetime	T_l	10
Management fee level	c_{mf}	0.02
Carried interest level	c_{ci}	0.2
Hurdle rate	h	0.08
Asset volatility	σ_V	0.31
Return correlation	$Corr_{VM}$	0.39
Speed of adjustment drawdown rate	κ_δ	8.74
Long-term drawdown rate	θ_δ	0.32
Volatility drawdown rate	σ_δ	1.46
Speed of adjustment distribution rate	κ_ρ	17.47
Long-term distribution rate	θ_ρ	0.20
Volatility distribution rate	σ_ρ	1.93
Market price of risk	λ_V	0.05
Riskless rate	r_f	0.05

Table: Estimated Fee Values and Abnormal Returns

This table summarizes the outputs of the fee valuation. Fee values are expressed in dollars per $100 of committed capital. The fee terms employed for the calculations are a 2 percent management fee, a carried interest level of 20 percent, and a hurdle rate of 8 percent. The table also shows (gross of fees) abnormal fund returns necessary to compensate LPs for the fees taken. These abnormal returns are given in percent p.a. Calculations are shown for a fund with no catch-up clause and fund with a catch-up clause of 100 percent.

	Management Fee Value	Carried Interest Value	Total Fee Value	Abnormal Return
No Catch-up	15.86	3.45	19.31	6.30%
With Catch-up	15.86	3.88	19.74	6.55%

Risk-taking Incentives – Single Fund

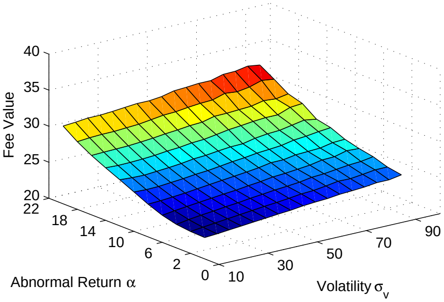

Figure: Fee Value of a Single Fund as a Function of Abnormal Return α (in % p.a.) and Volatility σ_V (in % p.a.)

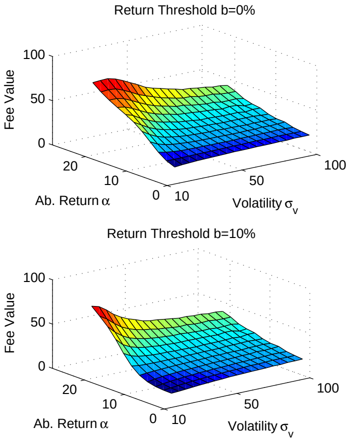

Figure: Fee Value of Multiple Funds in Sequence as a Function of Abnormal Return α (in % p.a.) and Volatility σ_V (in % p.a.)

- First, our results imply that low skilled GPs have a high incentive for excessive risk taking. This is consistent with Ljungqvist et al. (2008) who show that younger funds invest in riskier deals and reduce risk taking as they grow more experienced.
- Second, the model implies that risk taking also depends on the state of the private equity market through the return threshold b. Predicts a countercyclical investment performance of private equity funds that is consistent with findings of Kaplan and Stein (1993) and Gompers and Lerner (2000).

Agenda

- Statistical problems:
  - For private equity investments one can typically only observe a stream of multiple cash flows but no intermediate market valuations.
  - Cannot estimate risk loadings and abnormal performance of the asset class with standard regression techniques.
- Data problems:
  - Challenge of obtaining large scale and unbiased sample data on private equity investments.

Estimation Methodology

- Novel econometric approach to estimate the systematic risk and abnormal returns of illiquid assets based only on their observable cash flows.
- Assumes that the returns of a private equity investment are generated by the standard market model, and that the dividends from the investment occur at a stochastic, yet increasing rate from its unobservable interim values until the investment finally liquidates.
- Using a non-linear least-squares optimization, the methodology then estimates the systematic risk and abnormal returns of private equity by minimizing the distance between the model expected dividends and the cross-section of observed dividends over time.

Estimation Function

Non-Linear Least-Squares Optimization

Given a sample of N investments and a total observation period of length K, model parameters α, β and δ can be estimated by

$$\min_{\alpha,\beta,\delta} \sum_{k=1}^{K} \left(\Delta D_k - E[\Delta D_k]\right)^2 ,$$

where ΔD_k are the average dividends of the N sample investments in period-k, i.e.,

$$\Delta D_k = \frac{1}{N} \sum_{i=1}^{N} \Delta D_{i,k},$$

and $E[\Delta D_k]$ are the expected dividends in period-k, given by

$$E[\Delta D_k] = \frac{1}{N} \sum_{i=1}^{N} \sum_{j=1}^{k-1} \bar{\delta}_{i,k} \Delta T_{i,j} \prod_{s=j+1}^{k-1} [1 + r_{f,s} + \alpha + \beta(R_{M,s} - r_{f,s}) - \bar{\delta}_{i,s}],$$

for the expected dividend rate $\bar{\delta}_{i,k} = \frac{\tau}{\tau_i} \delta k$.

Table: Monte Carlo Simulation

This table presents the estimation results from the Monte Carlo simulation experiment. Investment returns are modeled by a single-factor market model, for which market returns and error terms are assumed to follow a shifted log-normal distribution. In the base case idiosyncratic volatility is set to 40% per month. Idiosyncratic volatility is set to 20% per month and 60% per month in the lower and higher volatility case, respectively. All simulations are repeated 1,000 times.

	True Model	Idiosyncratic Volatility			Sample Size	
	Parameters	Base Case	Low	High	1,000	10,000
Alpha						
mean	0.00%	-0.01%	0.00%	-0.02%	-0.02%	0.00%
median		-0.07%	0.00%	-0.28%	-0.19%	0.00%
std.		0.52%	0.08%	1.49%	1.04%	0.19%
Beta						
mean	2.50	2.51	2.50	2.56	2.52	2.50
median		2.52	2.50	2.51	2.51	2.50
std.		0.65	0.11	1.98	1.33	0.12
Delta						
mean	0.18	0.18	0.18	0.19	0.18	0.18
median		0.18	0.18	0.19	0.18	0.18
std.		0.01	0.00	0.03	0.02	0.00

Objective Function Space

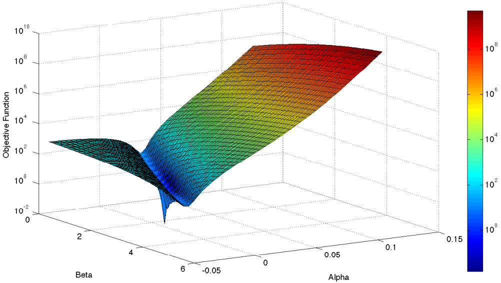

Figure: Objective Function Space of Parameters Alpha and Beta for the Optimal Delta

Data

- Use of a unique dataset from the Center of Private Equity Research (CEPRES)
  - Contains monthly cash flows for PE investments (unique feature)
  - Obtains data from private equity firms in exchange of access to services
  - Comprehensive and rich dataset (over 25 yrs of data, 45 countries, 10,798 liquidated PE investments)
  - Earlier version of this database is used by Cumming and Walz (2004), Cumming, Schmidt and Walz (2009), and Franzoni, Nowak and Phalippou (2012)

Data Descriptives

Table: Descriptive Statistics

This table shows descriptives for the investment data provided by CEPRES. The overall dataset includes 10,798 liquidated private equity investments that were started between 1980 and 2009. The follwing stage definitions are used: Venture capital (VC) represent the universe of all early- and later-stage venture investing. Buyout (BO) represent the universe of all growth and leveraged buyout investing.

	All Deals	VC Deals	BO Deals
Number of Observations			
absolute	10,798	6,380	4,418
relative	100.00%	59.09%	40.91%
Investment Size (in USD Mio.)			
mean	12.01	7.25	18.89
median	4.52	3.14	7.44
std.	74.85	90.49	42.33
Region			
US	57.09%	72.51%	34.83%
UK	14.05%	3.64%	29.09%
Europe (ex. UK)	19.86%	16.10%	25.31%
Rest of World	8.99%	7.75%	10.77%
Industry			
Industrials	15.43%	7.57%	26.78%
Consumer Goods and Services	23.65%	11.90%	40.63%
Information Technology	45.24%	63.71%	18.56%
Biotechnology	11.99%	14.86%	7.85%
Other/Unspecified	3.69%	1.96%	6.18%
Exit Type			
IPO	12.55%	13.53%	11.14%
Sale/Merger	33.55%	29.51%	39.38%
Write-Off	21.06%	28.51%	10.30%
Unspecified	32.84%	28.45%	39.18%

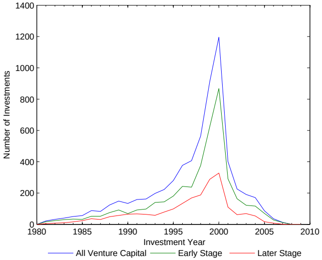

Figure: Sample Distribution by Stages: Venture Capital (Left) and Buyout (Right)

Sample Distribution Over Time – Industries

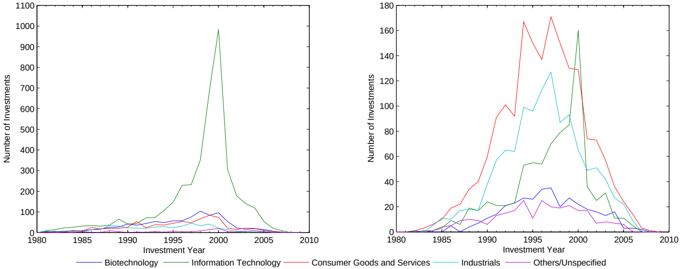

Figure: Sample Distribution by Industries: Venture Capital (Left) and Buyout (Right)

Table: Market Model Estimation Results

This table reports the estimated abnormal performance (Alpha p.a.), market risk (Beta Market), and dividend rate (Delta p.a.) using the one-factor market model. The S&P 500 total return index is used as proxy for market returns and the one-month US Treasury Bill rate is employed as the risk-free rate. Standard errors of the estimated coefficients are given in parentheses. ***, ** and * denotes statistical significance at the 1%, 5% and 10% level, respectively. Below each estimation, the root mean squared error (RMSE) and the coefficient of determination (R^2) are reported to indicate the goodness-of-fit of the estimation.

	Venture Capital	Buyout
Alpha (p.a.)	0.089***	0.070***
	(0.018)	(0.014)
Beta Market	2.567***	2.248***
	(0.204)	(0.127)
Delta (p.a.)	0.183***	0.173***
	(0.001)	(0.002)
No. Obs.	6,380	4,418
RMSE	0.0054	0.0053
R^2	75.10%	83.73%

Table: Estimation Results Across Quartiles

This table reports estimation results for different quartiles using the one-factor market model. To construct the quartiles, corresponding investments are ranked by their money-multiples. The S&P 500 total return index is used as proxy for market returns and the one-month US Treasury Bill rate is employed as the risk-free rate. Standard errors of the estimated coefficients are given in parentheses. ***, ** and * denotes statistical significance at the 1%, 5% and 10% level, respectively.

	Alpha (p.a.)	Beta Market	Delta (p.a.)	R^2	No. Obs.
Panel A: Venture Capital					
4th quartile	0.790***	0.928	0.460***	77.68%	1,595
	(0.071)	(0.720)	(0.001)		
3rd quartile	-0.043***	0.955***	0.068***	91.31%	1,595
	(0.010)	(0.143)	(0.001)		
2nd, 3rd, and 4th quartile	0.277***	1.514	0.226***	82.05%	4,785
	(0.067)	(0.949)	(0.005)		
All quartiles	0.089***	2.567***	0.183***	75.10%	6.380
	(0.018)	(0.204)	(0.001)		
Panel B: Buyout					
4th quartile	0.495***	1.548***	0.330***	76.96%	1,105
	(0.020)	(0.168)	(0.003)		
3rd quartile	0.173***	1.464***	0.200***	87.59%	1,105
	(0.009)	(0.091)	(0.001)		
2nd, 3rd, and 4th quartile	0.272***	1.289***	0.225***	84.55%	3,314
	(0.015)	(0.138)	(0.001)		
All quartiles	0.070***	2.248***	0.173***	83.73%	4.418
	(0.014)	(0.127)	(0.002)		

Table: Estimation Results Across Stages

This table reports estimation results for different stage specifications using the one-factor market model. The S&P 500 total return index is used as proxy for market returns and the one-month US Treasury Bill rate is employed as the risk-free rate. Standard errors of the estimated coefficients are given in parentheses and are derived from the Hessian matrix of the estimates. ***, ** and * denotes statistical significance at the 1%, 5% and 10% level, respectively.

	Venture Capital			Buyout		
	All	Early Stage	Later Stage	All	Leveraged Buyout	Growth
Alpha (p.a.)	0.089***	-0.022*	0.169***	0.070***	0.058***	0.119***
	(0.018)	(0.012)	(0.053)	(0.014)	(0.014)	(0.017)
Beta Market	2.567***	3.663***	1.871***	2.248***	2.357***	1.748***
	(0.204)	(0.128)	(0.666)	(0.127)	(0.125)	(0.199)
Delta (p.a.)	0.183***	0.166***	0.210***	0.173***	0.177***	0.155***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
No. Obs.	6,380	4,284	2,096	4,418	3,613	805
RMSE	0.0054	0.0056	0.0062	0.0053	0.0053	0.0068
R^2	75.10%	70.93%	75.26%	83.73%	84.64%	69.15%

Table: Estimation Results Across Exit Routes

This table reports estimation results for different exit routes using the following one-factor market model specification: $R_{i,t} = r_{f,t} + (\alpha + \alpha_{Dummy} \times Dummy_i) + \beta_M(R_{M,t} - r_{f,t}) + \epsilon_{i,t}$, where $Dummy_i$ is an investment specific dummy variable that equals one if the deal is exited during the bubble (January 1998 to March 2000), and zero otherwise. The S&P 500 total return index is used as proxy for market returns and the one-month US Treasury Bill rate is employed as the risk-free rate. Standard errors of the estimated coefficients are given in parentheses. ***, ** and * denotes statistical significance at the 1%, 5% and 10% level, respectively.

	Venture Capital				Buyout			
	IPO	IPO	Sale/ Merger	Sale/ Merger	IPO	IPO	Sale/ Merger	Sale/ Merger
Alpha (p.a.)	0.626***	0.412*	0.291*	-0.089***	0.526***	0.528***	0.090***	-0.018
	(0.095)	(0.241)	(0.150)	(0.021)	(0.037)	(0.090)	(0.010)	(0.033)
Alpha Dummy		0.372**		0.915***		-0.004		0.231***
		(0.189)		(0.031)		(0.568)		(0.037)
Beta Market	0.829	1.850	1.517	1.694***	0.527	0.517	2.319***	2.566***
	(0.972)	(1.391)	(2.006)	(0.112)	(0.328)	(1.943)	(0.085)	(0.154)
Delta (p.a.)	0.352***	0.406***	0.240***	0.466***	0.346***	0.347***	0.190***	0.198***
	(0.008)	(0.025)	(0.004)	(0.009)	(0.004)	(0.004)	(0.001)	(0.003)
No. Obs.	863	863	1,883	1,883	492	492	1,740	1,740
RMSE	0.0173	0.0173	0.0071	0.0067	0.0140	0.0140	0.0058	0.0059
R^2	72.25%	72.14%	75.17%	77.72%	73.42%	73.41%	84.14%	83.80%

Table: Estimation Results Across Regions

This table reports estimation results for different regions using the one-factor market model. In Panel A, the S&P 500 total return index is used as proxy for market returns and the one-month US Treasury Bill rate is employed as the risk-free rate. In Panel B, different total return indices are used for different regions. Standard errors of the estimated coefficients are given in parentheses. ***, ** and * denotes statistical significance at the 1%, 5% and 10% level, respectively.

	Venture Capital			Buyout			
	US	Europe ex UK	Rest of World	US	Europe ex UK	UK	Rest of World
Panel A: Benchmark Index S&P 500							
Alpha (p.a.)	0.116***	0.096***	0.153***	0.067***	0.041**	0.119***	-0.025
	(0.026)	(0.024)	(0.010)	(0.015)	(0.016)	(0.014)	(0.018)
Beta Market	2.493***	1.423***	2.270***	2.515***	2.800***	1.438***	2.934***
	(0.306)	(0.348)	(0.135)	(0.136)	(0.145)	(0.122)	(0.174)
Delta (p.a.)	0.198***	0.117***	0.178***	0.174***	0.170***	0.187***	0.175***
	(0.001)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
No. Obs.	4,626	1,027	495	1,539	1,118	1,285	476
RMSE	0.0060	0.0056	0.0110	0.0078	0.0063	0.0052	0.0063
R^2	73.04%	64.81%	42.27%	72.46%	80.58%	84.07%	66.53%

Table: Estimation Results Across Regions (continued)

	Venture Capital			Buyout			
	US	Europe ex UK	Rest of World	US	Europe ex UK	UK	Rest of World
Panel B: Different Benchmarks Indices							
Alpha (p.a.)	0.116***	0.099***	0.156***	0.067***	0.089***	0.091***	-0.037***
	(0.026)	(0.017)	(0.009)	(0.015)	(0.006)	(0.010)	(0.013)
Beta Market	2.493***	1.427***	2.230***	2.515***	2.865***	2.687***	3.280***
	(0.306)	(0.313)	(0.128)	(0.136)	(0.086)	(0.158)	(0.160)
Delta (p.a.)	0.198***	0.116***	0.177***	0.174***	0.147***	0.172***	0.173***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)
No. Obs.	4,626	1,027	495	1,539	1,118	1,285	476
RMSE	0.0060	0.0057	0.0111	0.0078	0.0063	0.0051	0.0063
R^2	73.04%	64.25%	41.71%	72.46%	80.38%	84.41%	66.66%

Table: Estimation Results Over Time

This table reports estimation results for different periods using the one-factor market model. The S&P 500 total return index is used as proxy for market returns and the one-month US Treasury Bill rate is employed as the risk-free rate. Standard errors of the estimated coefficients are given in parentheses and are derived from the Hessian matrix of the estimates. ***, ** and * denotes statistical significance at the 1%, 5% and 10% level, respectively.

Investment Years	Alpha (p.a.)	Beta Market	Delta (p.a.)	R^2	No. Obs.
Panel A: Venture Capital					
1980-1995	-0.064***	3.494***	0.102***	65.10%	1,800
	(0.013)	(0.102)	(0.002)		
1996-2000	0.263***	2.559***	0.232***	70.05%	3,455
	(0.004)	(0.107)	(0.004)		
2001-2005	-0.065***	4.594***	0.113***	61.30%	1,077
	(0.022)	(0.479)	(0.003)		
Panel B: Buyout					
1980-1989	0.043***	2.010***	0.150***	57.67%	325
	(0.006)	(0.111)	(0.002)		
1990-1999	0.050***	1.350***	0.127***	83.23%	2,983
	(0.009)	(0.076)	(0.002)		
2000-2005	0.168***	3.301***	0.177***	81.11%	1,073
	(0.006)	(0.163)	(0.002)		

Table: Estimation Results Across Industries

This table reports estimation results for different industries using the one-factor market model. The S&P 500 total return index is used as proxy for market returns and the one-month US Treasury Bill rate is employed as the risk-free rate. Standard errors of the estimated coefficients are given in parentheses. ***, ** and * denotes statistical significance at the 1%, 5% and 10% level, respectively.

	All	Information Technology	Biotech	Consumer Industry	Industrials	Other/ Unspecified
Panel A: Venture Capital						
Alpha (p.a.)	0.089***	0.102***	0.204**	-0.088***	-0.076	-0.124***
	(0.018)	(0.015)	(0.096)	(0.022)	(0.050)	(0.036)
Beta Market	2.567***	3.251***	0.810	3.507***	4.482***	3.893***
	(0.204)	(0.184)	(1.226)	(0.207)	(0.461)	(0.414)
Delta (p.a.)	0.183***	0.235***	0.135***	0.121***	0.159***	0.112***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.007)	(0.002)
No. Obs.	6,380	4,065	948	759	483	125
RMSE	0.0054	0.0063	0.0070	0.0073	0.0125	0.0137
R^2	75.10%	69.05%	70.31%	61.45%	36.51%	28.37%
Panel B: Buyout						
Alpha (p.a.)	0.070***	-0.063***	0.208***	0.004	0.193***	-0.250***
	(0.014)	(0.014)	(0.016)	(0.011)	(0.033)	(0.015)
Beta Market	2.248***	4.100***	1.523***	2.671***	0.812**	4.843***
	(0.127)	(0.121)	(0.154)	(0.097)	(0.329)	(0.127)
Delta (p.a.)	0.173***	0.207***	0.191***	0.153***	0.173***	0.155***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.004)	(0.002)
No. Obs.	4,418	820	347	1,795	1,183	273
RMSE	0.0053	0.0082	0.0111	0.0052	0.0054	0.0107
R^2	83.73%	70.79%	64.42%	83.59%	80.83%	53.23%

Summary: What are the Drivers of Alpha?

Table: Alpha Drivers

	Driver	Question posed	Influence on Alpha	
			VC	BO
1	Stage Sub-Classes	Are there differences between stage sub-classes?	Yes	Yes
2	Exit Routes	Are there differences between IPO exits and exits by sale/merger?	Yes	Yes
3	Region	Are there differences between the regions US and Europe?	No	No
4	Investment Year	Is the investment year decisive for alpha?	Yes	Yes
5	Industry	Does it make a difference in which industry investments are made?	Yes	Yes

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