A Methodology for Analyzing the Performance of Private Equity by Sector and Industry

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Abstract

The performance of private investments has historically been undertaken at the fund level. Recent advances in data collection and access have made it possible instead to analyze the performance of private investment deals. One benefit of analyzing deal-level data is it allows for a more granular look at specific sector and industry performance, since most funds are composed of a mixture of industries that precludes the possibility. Another benefit is that it allows a clearer analysis of value accretion since deal-level cash flows are typically gross of fees, whereas fund-level cash flows include fees that a limited partner would experience. Finally, it also allows one to analyze how much the performance of funds depends on finding long tail ”home run” deals. I propose ways of reaping these benefits using a novel data set of private equity deals in U.S. companies from StepStone, focusing on the information technology sector to illustrate. I find that private equity investment in North American information technology companies generally provides excess risk-adjusted returns over the general public market and the information technology public market, although the presence of risk-adjusted returns is disputable for some information technology industries and venture capital.

Keywords: private equity, venture capital, finance, information technology

JEL Classification: G24, G11, L86

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1 Introduction

Private equity investments have historically been analyzed at the fund level due to the accessibility of fund-level data. The nature of private equity funds, however, precludes a clean and comprehensive analysis of private equity investment at the sector or industry level because a typical private equity fund consists of portfolio companies in multiple sectors or industries.

Most recently, a small number of studies have leveraged deal-level data. For example, Braun et al. (2017) analyze 13,523 buyout deals sourced from three large fund-of-fund managers to estimate persistence of private equity performance.[1] Binfarè et al. (2022) use deal-level data from StepStone to decompose value creation in private equity deals into a ”value bridge” that isolates manager effects versus wider industry effects. Brown et al. (2023) use deal-level analysis with MSCI-Burgiss data to study the importance of deals per fund in portfolio management. Ercan et al. (2025) use deal-level data from StepStone to demonstrate that investors can improve their assessment of final outcomes by analyzing the performance of individual portfolio companies.

This paper highlights two benefits of deal-level analysis. First, it highlights the role deal-level analysis has in understanding sector- and industry-specific performance. Most funds have a mixture of sectors or industries that precludes a clean sector- or industry-specific analysis at the fund level. Second, deal-level data is typically gross of fees, that is, it reflects value accretion rather than investor returns. For anyone interested in the value-added of private equity activity at the company level, gross returns are of keen interest.

This paper also proposes two methodological advances in deal-level analysis. First, it proposes a measure of ”home run” deals, that is, long-tail high-return deals that venture capital funds rely on; and then analyses how the incidence of home-run deals affects fund-level performance based on the number of investments in a fund. Second, it uses the difference between fund-level returns (which are net of fees) and deal-level returns (which are gross of fees) to estimate the limited partner share in private equity investments. This relationship can then be used to estimate sector- and industry-specific performance net of fees, in effect simulating sector- and industry-specific funds.

[1] The authors also document several other issues inherent in fund-level analysis that are not otherwise discussed here, for example mismatches between the reported vintage of a fund and the actual dates of specific deals which often occur over a 5-year period.

I briefly report the main findings. In terms of value accretion, private North American IT equity deals deliver a pooled investment multiple on invested capital (MOIC) of 2.9x with 2.8x in buyout IT and 3.3x in venture IT. The highest multiples are seen in software at 3.1x and hardware at 3.4x, and the lowest are seen in semiconductors at 1.6x and communications equipment at 1.7x. Using the difference between fund-level and deal-level cash flows to estimate the impact of fees and carry, the IT sector has a net multiple of 2.1x with 2.08x in buyout IT and 2.5x in venture capital IT.

Adjusting relative to the value-weighted public equities market, the private IT sector equity net public market-adjusted multiple, or public market equivalent (PME), is about 1.3x for both buyout IT and venture capital IT. All IT industries have positive and statistically significant excess returns except for communications equipment and semiconductors, which are essentially at parity with the public market. Using public IT sector equities instead as a public benchmark, private IT equity has a net PME of 1.16x and buyout IT of 1.18x, both of which are statistically significant in excess performance; the venture IT PME is 1.12 and only marginally statistically significant. Communications equipment and semiconductors are essentially at parity with the public IT benchmark, and electronic equipment is only marginally significant with a net PME of 1.17; the other IT industries still have statistically significant excess returns. Using IT industry-specific benchmarks actually increases the communications equipment PME to 1.17, although it is still statistically insignificant along with semiconductors. Software and hardware have respective PMEs of 1.14 and 1.83, but only exhibit marginal statistical significance. Electronic equipment and IT services still have statistically significant excess performance with PMEs of 1.34x and 1.40x, respectively.

Solving for break-even betas that equate private IT performance to public IT sector performance by solving for unity PME shows that electronic equipment and IT services have clear positive risk-adjusted returns: a level of exposure equivalent to a market beta in excess of 3 would be required to create public market parity. Buyout IT also has a high break-even beta of 2.7. The IT sector as a whole has a break-even beta of 2.04, which is more difficult to put into context, and the venture capital IT break-even beta of 1.32 is lower than many estimates of venture capital beta, suggesting that IT venture capital might not provide excess risk-adjusted returns. Break-even betas for other IT industries depend heavily upon the benchmark used, with some ranging from a break-even beta above 3 when using the general public market, to a break-even beta of only 1.24

when using the industry-specific benchmark.

Compared to general venture capital, the incidence of home run IT deals is roughly equivalent at about 8% of deals. The largest incidence of home run deals come within the hardware industry with 12% of deals and software with 9% of deals. On the other hand, only 3.8% of IT services deals have been home runs, 4.2% of communications equipment deals, and 4.6% of semiconductors deals. Despite the high volatility of IT deals, with mean performance typically exceeding median performance by a substantial margin on account of the presence of extreme home run deals and a plethora of failed deals, even portfolios ("funds") with a relatively small number of IT deals exhibit strong benefits in terms of median outcomes. For example, the median portfolio with only 10 IT deals has a net PME of 1.23, compared to the median *gross* deal-level PME of 0.90.

I conclude that excess risk-adjusted returns have been present for investors in private IT equity, but not for every IT industry and asset class. Some industries, namely electronic equipment and IT services, have particularly high bars that likely hold up against any reasonable risk and market adjustments. But other industries have shown ambiguous or weak performance relative to analogous public markets, especially semiconductors.

2 Data and Summary Statistics

2.1 Data, Metrics, and Categorization

The relatively novel deal-level data in this paper comes from StepStone Group. StepStone is a global private markets investment firm that builds private market portfolios with its clients. They manage around 190 billion USD and have a total capital responsibility of 700 billion USD as of writing. Their business model involves the collection and analysis of private market data, which is gathered into their intelligence platform called SPI. This information comes from their own investments, from client investments, and from fundraising. StepStone data is quite new in academic analysis; Ercan et al. (2025) provide an overview compared to MSCI-Burgiss data, which is typically considered the best source of private equity data (Harris et al., 2016), and find the quality of StepStone data to be generally good.

The StepStone data has two essential advantages over some alternative sources. First, it has cash flows for deal investments, which makes it possible to discount the cash flows relative to a benchmark of public returns. Second, deals are categorized according to the Global Industry Classification Standard (GICS) developed by MSCI and S&P Dow Jones Indices.[2] At the highest level, GICS has 11 sectors; at its most granular level, it has 163 sub-industries. For this paper, I will focus on the Information Technology sector (IT) and its 6 industries: IT services; Software; Communications Equipment; Technology Hardware, Storage & Peripherals; Electronic Equipment, Instruments & Components; Semiconductors & Semiconductor Equipment.[3] For elegance I will refer to "Communications Equipment" as "Comm Equipment", to "Technology Hardware, Storage & Peripherals" as "Hardware", to "Electronic Equipment, Instruments & Components" as "Electronic Equipment", and to "Semiconductors & Semiconductor Equipment" as "Semiconductors". The analysis within this paper can of course be used for any sector or sub-industry, but IT was chosen for expositional focus.

The majority of this paper will revolve around performance analysis. I use two multiple-based metrics: multiple on invested capital (MOIC) and the public market equivalent (PME) of Kaplan and Schoar (2005). The simplest metric is MOIC, defined to be the inflows plus residual value (i.e. funds received from selling shares of the company plus the value of remaining shares) divided by outflows (total capital invested into the company). MOIC above (below) one indicates an increase (decrease) in value. For example, an investment of $1 that returns $3 has a MOIC of 3x. PME is essentially a public market-adjusted MOIC; inflows and outflows are discounted by public market returns into present value terms, and the ratio of those present values is taken. In other words, PME relatives to a counterfactual investment and measures how much better or worse the private market investment did relative to the public market investment that had the same outflows and the same inflow pattern. Public markets tend to grow over time, so a PME is usually lower than a MOIC. A PME above (below) one indicates that the private investment has outperformed (underperformed) the public benchmark.

I also use two rate-based metrics. Most well known is the internal rate of return (IRR), which equates discounted inflows to discounted outflows, the satisfying discount rate being the IRR. The direct alpha (DA) of Gredil et al. (2023) is to IRR and PME is to MOIC; that is, direct alpha calculates the IRR using cash flows discounted by the public benchmark in the same way as in

[2] More information on the GICS standard can be found at https://www.msci.com/indexes/index-resources/gics

[3] See `https://www.msci.com/indexes/documents/methodology/1_MSCI_Global_Industry_Classification_Standard_GICS_Methodology_20240801.pdf` for a detailed description of these categories.

PME. Like with PME, one would usually expect direct alpha to be lower than IRR since public markets tend to grow over time.

I also construct a novel ”home run deal” measurement that calculates a deal's MOIC as though the deal has been active for 5 years. (The mean deal length of venture capital deals is 5.1 years and the median is 4.6 years; 5 years is used as a convenient middle-ground.) For example, a 2-year old deal with a MOIC of 1.5x had an annual accretion rate of $1.5^{1/2} - 1 \approx 22.5\%$. Compounding this accretion rate through 5 years gives the 5-year MOIC $(1 + 0.225)^5 \approx 2.8$x, which would not be considered a home run deal because it is lower than 10x. On the other hand, a 2-year old deal with a 3x MOIC has a 5-year analogue of $3.0^{5/2} \approx 15.6$x, which would be considered a home run deal. The incidence of home run deals is important because it helps determine how many deals one might want in a venture capital fund to have a sufficiently high probability of actually landing a home run deal.

Unless stated otherwise, deals in consideration will be deals from Unites States buyout and venture capital funds made in any year 2000 through 2019. In total there are 9,985 deals with total invested capital of 315 billion USD. Figure 1 shows deal number and deal size over time, and Table 1 shows the breakdown by industry. The huge majority of IT deals are in the software industry, accounting for 7,339 deals and 217 billion USD of invested capital. All other industries have under 1,000 deals and under 40 billion USD capital invested. The industry categorization is nearly complete, with only 27 IT deals worth 1.7 billion USD capital invested of unknown IT industry. The majority of IT deals are venture capital with 7,626 compared to 2,359 buyout deals; whereas the majority of capital invested is in buyout deals with 247.4 billion USD compared to 68.0 billion USD in venture capital deals.

2.2 Funds and Sector Distributions

I now illustrate the problem with using fund-level data to analyze sector and industry performance by focusing on the information technology sector. In order to compare funds and deals cleanly, I only look at deals and funds for which both are present in the data; funds without deals data are omitted, and deals without funds data are omitted. This leaves 1392 deals over 316 funds.

Figure 2 shows the distribution of invested capital into IT companies for funds that have at

INFORMATION TECHNOLOGY DEALS BY NUMBER AND SIZE, YEARS 2000 THROUGH 2019

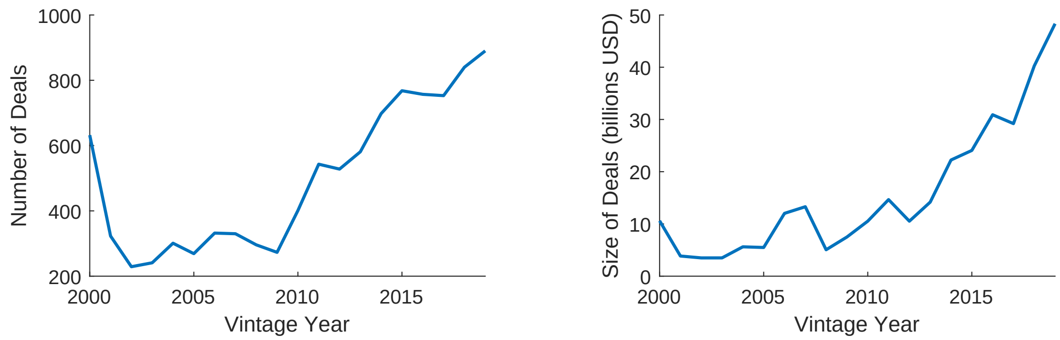

Figure 1: This figure shows the number of IT deals (left) and the cumulative invested capital of those deals (right) from years 2000 through 2019.

Table 1: Sector/Industry Deal Counts and Capital Invested (bn USD)

Sector/Industry	Number of Deals	Capital Invested
Information Technology	9985	315.4
Comm Equipment	630	23.8
Electronics Equipment	584	16.9
IT Services	783	35.4
Semiconductors	380	11.1
Software	7339	216.6
Hardware	242	9.8
Buyout IT	2359	247.4
Venture Capital IT	7626	68.0

least one IT company. As can be seen by the left skew, the majority of funds with an IT investment are not primarily IT funds. Of the 316 funds shown, only 6 of those funds consist of only IT investments. Supposing that a fund is characterized as an IT fund when 50% or more of its invested capital is in IT (a common threshold seen for example in MSCI-Burgiss data), IT funds account for 828 tech deals compared to 564 in non-IT funds. Likewise, IT funds account for 19.4 billion USD in IT investment compared to 24.1 billion USD in IT investment for non-tech funds; and IT funds have 7.3 billion USD in non-tech investments.

To put it differently: a performance evaluation on IT funds misses 55% of IT investment and includes 37% non-IT investment. The takeaway is clear: a fund-level analysis on the IT sector can be neither clean nor comprehensive, and this implication holds for any sector. Indeed, this can be reinforced by looking at all sectors with 6,042 deals over 552 funds. For funds with a sector share in excess of 50% (and therefore would often be given a discrete sector classification), a mean and median 75% share is in the largest sector, and therefore an average of 25% of fund size is in another sector entirely.

Because cleanly classifying funds by sector is difficult enough, classifying them more granularly by industry is even rarer. On the other hand, classifying deals by industry is relatively clean, and one can then focus only on deals within an industry for a very clean analysis. This problem also likely affects geographical fund classifications as well, although I do not explore that issue here.

2.3 Summary Statistics

Unless noted otherwise, performance will only be measured on deals that are at least 3 years old or are otherwise fully exited. IRR and direct alpha are very prone to extreme outliers when using deal-level data, so like Braun et al. (2017) I omit them from basic summary stats. However, I do calculate IRR and direct alpha using pooled cash flows. I use U.S. market returns as provided by the Kenneth R. French data library and as described in Fama and French (2023) as the primary public benchmark, although I use more targeted public benchmarks later. I also winsorize PME and MOIC at the 99.5th quantile of all buyout and venture capital deals.

The distribution of gross MOIC and PME are shown in Figure 3. Note that a large number of deals have multiples well beneath unity, illustrating how commonplace failed deals are (which in turn justifies the outsized attention places on finding ”home run” outlier deals).

Distribution of Invested Capital into Information Technology Companies for Funds With at least One Information Technology Company

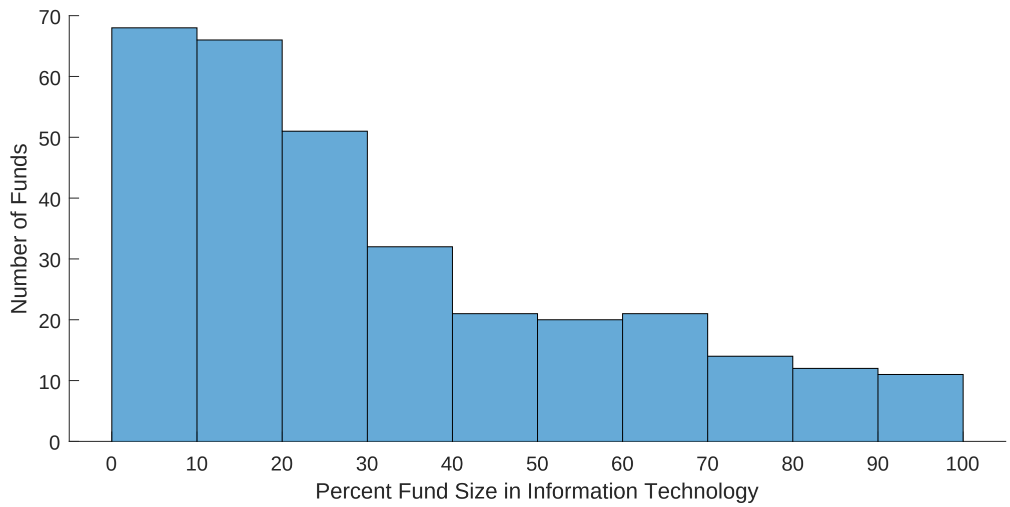

Figure 2: This figure shows the distribution of the percent of invested capital into information technology companies for any funds that have at least one information technology deal. As seen from the left skew, most funds that contain technology deals do not contain primarily technology deals.

Gross MOIC and PME of Information Technology Deals, Years 2000 through 2019

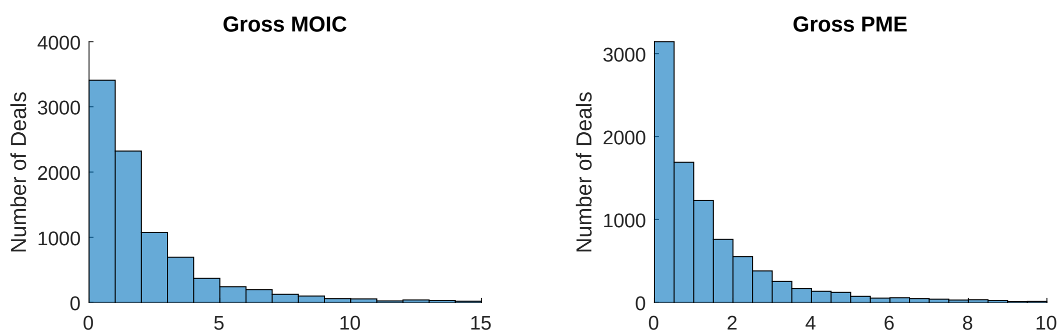

Figure 3: This figure shows the distribution of deal gross MOICs (left) and PMEs (right) for information technology deals from years 2000 through 2019.

Basic summary statistics are shown in Table 2. Note again that because these are deal-level metrics, they are gross of fees. The first thing to notice is that mean MOIC and PME are all above unity for all categories, indicating that on average, private IT investment not only accrues positive value but also accrues value in excess of the public market.

The MOIC and PME for the information technology sector are 2.9 and 1.8, respectively, with

Table 2: Sector/Industry Gross Performance Metrics and Size Distributions

Sector/Industry	Metric	Obs	Mean	StDev	Q10	Q25	Q50	Q75	Q90
Information Technology	MOIC	8824	2.92	5.92	0.00	0.24	1.34	3.09	6.18
	PME	8824	1.76	3.21	0.00	0.16	0.90	2.03	3.88
	Deal Size	8824	33.08	103.45	0.36	2.17	8.15	20.02	61.17
Comm Equipment	MOIC	606	1.55	3.40	0.00	0.01	0.50	1.95	3.77
	PME	606	1.09	2.16	0.00	0.01	0.38	1.46	2.68
	Deal Size	606	37.74	103.96	2.43	6.08	11.22	26.00	64.18
Electronic Equipment	MOIC	519	2.37	4.76	0.00	0.11	1.30	2.72	5.08
	PME	519	1.50	2.49	0.00	0.08	0.91	1.84	3.34
	Deal Size	519	29.57	73.46	0.70	3.49	10.94	24.12	68.01
IT Services	MOIC	689	2.83	5.07	0.00	0.30	1.67	3.22	5.74
	PME	689	1.74	2.78	0.00	0.24	1.11	2.12	3.67
	Deal Size	689	47.83	115.25	0.62	3.79	12.28	35.76	119.72
Semiconductors	MOIC	359	1.69	4.51	0.00	0.03	0.80	1.78	3.50
	PME	359	1.14	2.53	0.00	0.02	0.60	1.30	2.39
	Deal Size	359	30.45	104.91	1.76	5.73	11.22	19.36	52.47
Software	MOIC	6406	3.17	6.33	0.00	0.37	1.46	3.30	6.62
	PME	6406	1.88	3.42	0.00	0.23	0.95	2.15	4.09
	Deal Size	6406	31.11	101.82	0.25	1.70	7.07	18.17	54.78
Hardware	MOIC	225	2.85	5.52	0.00	0.00	1.05	3.14	7.96
	PME	225	1.79	3.06	0.00	0.00	0.63	2.02	4.81
	Deal Size	225	39.28	123.76	0.65	2.68	10.80	23.13	57.16
Buyout IT	MOIC	2156	3.12	4.88	0.05	1.05	2.25	3.74	6.06
	PME	2156	1.98	2.78	0.04	0.69	1.46	2.41	3.84
	Deal Size	2156	107.30	189.90	5.67	15.92	39.40	112.06	291.88
Venture Capital IT	MOIC	6668	2.85	6.22	0.00	0.11	1.08	2.76	6.27
	PME	6668	1.69	3.34	0.00	0.07	0.72	1.82	3.91
	Deal Size	6668	9.08	12.15	0.25	1.32	5.62	11.98	21.25

PME calculated using Fama-French U.S. public market returns.

a respective 3.1/2.0 for buyout and 2.9/1.7 for venture capital. The IT industry with the highest MOIC and PME is software with 3.2/1.9, and hardware also has a PME of 1.8; and the lowest is communications equipment with 1.6/1.1. While the means are all in excess of unity, medians are less flattering. Overall IT has a median MOIC of 1.3 and median PME if 0.9, indicating that over 50% of IT deals fail to match public market returns. That said, buyout IT has a median MOIC of 2.3 and PME of 1.5, indicating majority outperformance of public markets. Venture capital has a median MOIC of essentially 1.1, indicating that a little over 50% of deals accrue negative value, and the PME of 0.72 indicates that more than 50% of venture IT deals underperform the public market by at least 28%. The industry with the highest median MOIC and PME is IT services with 1.67/1.1, and the lowest is again communications equipment with 0.50/0.38. The consistently higher means than medians illustrate the reliance information technology funds have on finding high-performing outlier deals, especially for venture capital.

Pooled statistics are shown in Table 3. For MOIC and PME, one can think of pooled MOIC and PME as being size-weighted averages, since all cash flows are pooled together without normalizing their values. (The same cannot be said of IRR and DA since IRR is a non-linear function.) Since pooled metrics are considered the primary metrics by which private investments are measured, I also use the bias-corrected and accelerated (BCa) bootstrap of Efron (1987), which accounts for skewness and estimation bias, to calculate p-values for multiples above unity and rates above zero.

First, note that all pooled MOICs and PMEs are above unity. Pooled MOIC and PME the for information technology sector are 2.9/1.7. Unlike with mean metrics, venture capital has a higher MOIC than does buyout with 3.3 versus 2.8. PME on the other hand still marginally favors buyout at 1.7 versus 1.6. Whereas mean performance was dominated by the software industry, pooled performance is highest in the hardware industry with a MOIC of 3.4 and a PME of 2.5 compared to software with 3.1/1.8. The lowest MOIC and PME are in semiconductors with 1.6/1.2. That said, hardware also has the lowest sample size with 226 deals. The IRR for IT is 20.6% with 22.8% in buyout and 16.7% in venture capital. The highest IRR again comes from hardware at 51.2%, with software following at 22.5%, and communications equipment the lowest at 11.0%. Direct alpha is 11.8% for information technology with 14.8% in buyout and 7.5% in venture capital, the highest industry being hardware at 56.0% followed by software at 12.2% and with communications equip-

Table 3: Sector/Industry Gross Pooled Performance Metrics

Sector/Industry	MOIC	PME	IRR (%)	DA (%)
Information Technology	2.87***	1.68***	20.6***	11.8***
Comm Equipment	1.70***	1.17	11.0***	3.9*
Electronic Equipment	2.55***	1.57***	19.2***	10.7***
IT Services	2.66***	1.67***	17.8***	10.9***
Semiconductors	1.60**	1.18	13.6***	6.6
Software	3.12***	1.78***	22.5***	12.2***
Hardware†	3.37***	2.54***	51.2***	56.0***
Buyout IT	2.77***	1.69***	22.8***	14.6***
Venture Capital IT	3.26***	1.64***	16.7***	7.5***

PME calculated using Fama–French U.S. public market returns.
p-values are for excess performance and are calculated using BCa bootstraps with 10,000 iterations.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$
†Two very large hardware investments in 2000 dominate; excluding 2000 gives MOIC 3.13, PME 1.90, IRR 30.7%, DA 20.1%.

ment the lowest at 3.9%. Both pooled IRR and pooled direct alpha are positive, indicating positive value accrual and overall outperformance of the public market.

The IRR and direct alpha of hardware might raise eyebrows. The source of these high numbers can be isolated to vintage year 2000, which has two large and extraordinarily successful investments that occurred during an IT market downswing. Removing year 2000 from the estimate instead gives a MOIC of 3.13, a PME of 1.90, and IRR of 30.7%, and a DA of 20.1%. This does highlight a drawback of using deal-level data when a relatively small number of deals are present; hardware has the fewest deals of any IT industry with 226.

2.4 Home Run Deals

Home run deals are again to be defined as any deal such that its MOIC, re-adjusted as though it were a 5-year investment, exceeds 10x. I will also consider the incidence of 25x and 50x deals. I only include full-exited deals of at least 6 months in length. In addition to the full sample ranging 2000 to 2019, I also look at 5 year increments to see how home run incidence might have changed over time.

The results are shown in Table 4. Over the full time span, the rate of IT home runs is 7.9% of

Table 4: Sector/Industry Venture Capital Home Run Rates

Sector/Industry	**Rate**	**2000–2019**	**2000–2004**	**2005–2009**	**2010–2014**	**2015–2019**
Information Technology	10× HR Rate	7.9%	2.6%	7.6%	9.6%	13.6%
	25× HR Rate	4.3%	1.0%	3.6%	5.7%	7.6%
	50× HR Rate	2.8%	0.7%	2.1%	3.8%	4.9%
	Observations	3857	1073	757	1270	757
Comm Equipment	10× HR Rate	4.2%	3.4%	5.4%	7.1%	7.7%
	25× HR Rate	1.5%	0.9%	3.6%	0.0%	7.7%
	50× HR Rate	0.9%	0.9%	1.8%	0.0%	0.0%
	Observations	349	250	56	30	13
Electronic Equipment	10× HR Rate	6.9%	1.7%	3.0%	18.4%	6.7%
	25× HR Rate	5.0%	0.0%	3.0%	13.2%	6.7%
	50× HR Rate	3.8%	0.0%	3.0%	10.5%	3.3%
	Observations	170	61	36	39	34
IT Services	10× HR Rate	3.8%	0.0%	5.0%	6.5%	5.4%
	25× HR Rate	1.4%	0.0%	2.5%	1.6%	2.7%
	50× HR Rate	0.5%	0.0%	0.0%	0.0%	2.7%
	Observations	229	74	42	72	41
Semiconductors	10× HR Rate	4.6%	2.3%	0.0%	23.1%	33.3%
	25× HR Rate	2.6%	1.1%	0.0%	15.4%	0.0%
	50× HR Rate	1.5%	0.0%	0.0%	11.5%	0.0%
	Observations	206	90	84	29	3
Software	10× HR Rate	8.9%	2.8%	9.1%	8.9%	14.7%
	25× HR Rate	4.7%	1.1%	4.0%	5.2%	8.0%
	50× HR Rate	3.1%	0.9%	2.2%	3.5%	5.2%
	Observations	2779	557	516	1064	642
Hardware	10× HR Rate	12.0%	3.1%	18.2%	18.8%	9.1%
	25× HR Rate	10.2%	3.1%	9.1%	18.8%	9.1%
	50× HR Rate	7.4%	0.0%	9.1%	12.5%	9.1%
	Observations	112	34	22	33	23
All Venture Capital	10× HR Rate	8.1%	3.3%	6.7%	10.3%	12.4%
	25× HR Rate	4.4%	1.5%	3.8%	5.8%	6.6%
	50× HR Rate	2.9%	1.1%	2.5%	3.9%	4.3%
	Observations	8570	2051	2064	2744	1711

deals. This is practically the same as that of all venture capital deals with 8.1%. The incidence of home runs appears to increase over time for both IT and all venture capital, hovering around 3% from 2000-2004 and increasing monotonically to around 12% or 13% for 2015-2019.

There is considerable variation in IT industry, however. The highest incidents of home runs come from hardware deals at 12.0%. Granted, hardware home runs deals also have the lowest number of observations with 112. Second highest is software at 8.9%. The lowest home run rate is in IT services at 3.8%. While IT and all venture capital have their highest home run rates in

2015-2019, that is not true of all IT industries. Electronic equipment has an 18.4% home run rate in 2010-2014, but only 6.7% in 2015-2019; and hardware has a home run rate of 18.8% in 2010-2014, but only 9.1% in 2015-2019. The most apparent drought of home runs deals can be seen in semiconductors from 2005-2009, where not a single home run deal was observed out of its 84 deals.

Another way of interpreting these results is to re-frame and ask: how many deals are needed in a fund, on average, to land a home run deal? This is answered simply by taking the reciprocal of the percentages shown in Table 4. Rounding and looking at the entire time period, an IT fund would need on average a fund of 13 deals in order to land a 10x home run deal, a fund of 23 deals to land a 25x deal, and a fund of 37 deals in order to land a 50x deal. In contrast, a software fund would respectively need 11 deals, 21 deals, and 33 deal; and an IT services fund would respectively need 26 deals, 71 deals, and 200 deals.

3 Estimated Fees and Funds

The previous section analyzed gross performance metrics, which are useful for judging the value accretion properties companies with private equity investment. But from the perspective of limited partners, who provide the majority of capital for private equity investments, it is more important to consider their financial returns which must net out fees a limited partner pays to the general partner. These fees typically come in two forms: a management fee, roughly 2% of fund size over the first five years of the fund which then typically falls proportionate to the amount of capital concurrently invested; and carried interest, which is typically 20% of profit provided that the fund's performance is sufficient (often judged by whether the fund's IRR is in excess of its hurdle rate of 8%).

Because these fees are typically charged at the fund level, the deal-level cash flows do not contain these fees. Therefore when considering a hypothetical fund of only IT deals, one must estimate net performance from gross performance. I estimate the relationship between gross performance and net performance in the following way. As in subsection 2.2, I focus on the intersection of funds for which deals data are present, and deals for which funds data are present. For each quarter of years 2000 through 2019, all fund cash flows of a vintage-quarter (i.e. funds with a first cash flow in that quarter) are pooled and all deal cash flows are pooled. With these, net metrics and gross metrics are respectively calculated. This gives 80 observations from which to ascertain the relationship between the two. Appealing to Table 3, the highest observed gross MOIC is 3.37, so I drop any pair with a gross MOIC in excess of 4. Likewise, I drop any pair with a gross PME in excess of 3, a gross IRR in excess of 60%, and a gross DA in excess of 60%. This ensures that any estimated relationship between gross and net performance is based on a range commensurate with the gross performance metrics of interest. I do this for buyout and venture combined and also separately, since buyout and venture could have systematically different fee structures.[4]

3.1 Regression Analysis

Results for a robust regression of net performance on gross performance are shown in Table 5, with scatterplots shown in Tables A1 and A2. The lowest R-squared is with MOIC at around 0.87 for both buyout and venture capital; the highest is for direct alpha at around 0.95 for buyout and 0.93 for venture capital. All coefficients are statistically significant at 99.9 confidence except for the intercept on venture capital PME, which has a p-value of 0.47. Also shown are the root mean square error (RMSE) of each regression, which gives the standard error of predicted net performance.

The tight fit of the observed relationship between gross and net suggests that estimating net from gross is a highly reliable estimate for all four metrics. Therefore these equations will be used to estimate the net performance of IT sector and industry returns by simply applying them to the results shown in Table 3. Before doing so, I briefly apply these regression equations to all 15,284 buyout deals and 18,829 venture capital deals regardless of sector/industry and compare them to the equivalents in MSCI-Burgiss. For buyout, the estimation in this paper gives a net MOIC of 1.74 compared to the MSCI-Burgiss buyout gross MOIC with end date of 12/31/2023 of 1.80, and a net IRR of 14.8% compared to the MSCI-Burgiss value of 14.0%. For venture capital, net MOIC is estimated to be 2.20 compared to the MSCI-Burgiss value of 2.18, and a net IRR of 13.1% compared to the MSCI-Burgiss value of 11.1%. I do not compare PME or DA since the same public benchmark is not available on the MSCI Private Capital Universe. For further comparison,

[4] For example, many venture capital funds have a hurdle rate of essentially zero, and some venture capital deals are based on a deal-level waterfall instead of a fund-level waterfall as in buyout.

Table 5: Robust Regression of Net Performance on Gross Performance

Variable	Equity	Buyout	Venture Capital
Net MOIC	0.626	0.630	0.738
Intercept	0.347	0.335	0.149
N	81	81	60
R-Squared	0.875	0.877	0.885
RMSE	0.11	0.11	0.21
Net PME	0.657	0.670	0.772
Intercept	0.202	0.188	0.030
N	84	82	70
R-Squared	0.916	0.915	0.884
RMSE	0.07	0.07	0.12
Net IRR	0.837	0.822	0.827
Intercept	-0.033	-0.027	-0.035
N	82	80	59
R-Squared	0.916	0.927	0.937
RMSE	2.2%	2.0%	3.2%
Net DA	0.817	0.837	0.811
Intercept	-0.044	-0.045	-0.045
N	84	84	72
R-Squared	0.932	0.940	0.924
RMSE	2.0%	1.9%	3.3%

Robust regressions calculated using iteratively reweighted least-squares. All coefficients except the intercept of venture capital PME are statistically significant at 99.9 confidence level.

the Preqin MOIC and IRR for buyout are 1.77 and 15.4%, and for venture capital are 1.68 and 8.4%. I conclude that the estimates for net MOIC proposed in this paper are very reliable, with IRR less so but still better than some alternatives.

One could do more involved regressions or data generation, for example combining separately calculated buyout and venture capital pairs and including a dummy variable for asset class; calculating gross and net pairs using month-year vintages instead of quarter-year vintages; comparing gross to net performance on a fund-to-fund basis; or randomly pooling funds and their respective deals, calculating gross and net performance thereof, and repeating. I chose separate quarter-year regressions due to simplicity, having an adequate number of pairs, and a good observed fit.[5]

I note briefly that these results can be used to estimate the share of profit that goes to LPs and to GPs. For example, the gross MOIC for buyout is 2.78, which implies 1.78 total return per dollar

[5]One difficulty with estimating fees on a fund-to-fund basis is accounting for the heterogeneity of fee structures across funds. Using pooled cash flows of many funds essentially aggregates fee structures before estimation, leading to much cleaner aggregate estimation.

of capital called. The net MOIC for buyout is estimated to be 2.09, implying a total return of 1.09 per dollar of capital called for LPs, a share of $1.09/1.78 \approx 61\%$. The remaining 39% share goes to the GP, although some of that will go to other GP expenses so the actual GP share is somewhat lower. For venture capital, the LP share is estimated to be 66%.

3.2 Estimated Net Performance

Estimated net performance is shown in Table 6. The bootstrap procedure for calculating net performance includes both uncertainty from the construction of bootstrap samples as well as by incorporating random error terms commensurate with the root mean squared error of each regression in Table 5. The estimated net MOIC for IT is 2.14 with 2.08 for buyout IT and 2.49 for venture capital IT. The highest MOIC in IT industries are hardware at 2.45 and software at 2.30. All MOICs are above unity with the lowest in communications equipment with 1.41 and semiconductors with 1.35. Estimated net PME for all IT is 1.31 with 1.32 in buyout and 1.20 in venture capital. The highest net PMEs are in hardware with 1.87 and software with 1.37. Communications equipment and semiconductors have PMEs marginally less than unity.

Estimated net IRR for all IT is 13.9% with 16.1% in buyout IT and 10.5% in venture capital IT. The highest net IRRs are in hardware with 39.6% and software with 15.5%, and the lowest in communications equipment with 5.9% and semiconductors with 8.1%. Estimated net DA for all IT is 5.3% with 7.7% in buyout IT and 1.6% in venture capital IT. The highest DA are in hardware at 41.4% and software with 5.6%, and the lowest in communications equipment with -1.2% and semiconductors with 1.0%. Again I note the outsized impact of two large and extremely successful deals in year 2000 on the hardware industry; removing year 2000 from the estimate instead gives a MOIC of 2.21, a PME of 1.45, an IRR of 22.4%, and a DA of 12.0%.

Note that the estimations are subject to some uncertainty and noise, which is why semiconductors can have a PME less than unity, implying underperformance relative to the market; but positive DA, implying outperformance of the public market. Both are quite close to equal performance with the public market, however, so the discrepancy is easily resolved by treating it as such.

Table 6: Sector/Industry Estimated Net Pooled Performance Metrics

Sector/Industry	**MOIC**	**PME**	**IRR**	**DA**
Information Technology	2.14***	1.31***	13.9***	5.3**
Comm Equipment	1.41***	0.97	5.9**	−1.2
Electronic Equipment	1.95***	1.23**	12.8***	4.3
IT Services	2.02***	1.30***	11.6***	4.5*
Semiconductors	1.35**	0.98	8.1	1.0
Software	2.30***	1.37***	15.5***	5.6**
Hardware†	2.45***	1.87***	39.6***	41.4***
Buyout IT	2.08***	1.32***	16.1***	7.7***
Venture Capital IT	2.49***	1.30**	10.5***	1.6

PME calculated using Fama–French U.S. public market returns.
p-values are for excess performance and are calculated using BCa bootstraps with 10,000 iterations.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$
†Two very large and successful hardware investments in year 2000 dominate hardware; removing year 2000 from the estimate instead gives a MOIC of 2.21, a PME of 1.45, an IRR of 22.4%, and a DA of 12.0%.

3.3 Simulated Funds

As mentioned previously in this paper, the incidence of home run deals is critical in deciding the size of a private equity fund, especially for venture capital. I estimate the influence of these home runs deals by simulating funds with 10, 25, and 50 randomly chosen deals to see how the number of portfolio companies affects fund performance. 10,000 funds are simulated for each category, and the metrics for these funds are winsorized at the same values at which deals are winsorized for Table 2.

The results for 10,000 simulated funds are shown in Tables A1 for funds with 10 deals, A2 for funds with 25 deals, and A3 for funds with 50 deals. The first thing to notice is that when a funds have more deals, the standard deviation of returns falls and the median increases. This is because small funds that land a home run deal will have extremely high performance, and small funds that do not land a home run deal will have extremely low performance. Larger funds that land a home run deal aren't going to be a disproportionately affected by those home runs deals since there are likely more non-home run deals offsetting that outside impact. This can also be seen by looking at how the 5th and 95th quantiles shrink towards the median as the number of deals increases.

For example, information technology funds with 10 deals have a net MOIC standard deviation 1.57, which drops to 0.94 with 25 and to 0.64 with 50 deals. The 5th-95th range shrinks from 0.96-4.46 to 1.23-3.76 to 1.46-3.43, and the medians increase marginally from 1.98 to 2.07 to 2.09. Likewise the means decrease marginally from 2.29 to 2.24 to 2.20. The skew of fund distributions also shrinks as the number of deals increases. In venture capital IT, for example, the mean-to-median MOIC spread is 0.58 with 10 deals, 0.32 with 25 deals, and 0.30 with 50 deals. Likewise for PME, the spread goes from 0.28 to 0.19 to 0.12.

I note that every category has mean MOIC well above unity for every number of deals per fund. The lowest observed is in semiconductors at 1.36 with 50 funds, and the highest observed is in software at 2.41 with 10 deals per fund. The same cannot be said of PME: semiconductors funds with 50 deals have a PME of 0.98 and communications equipment is also essentially unity at 1.01. The highest PME comes from hardware funds with 50 deals at 1.64.

It is interesting to compare the fund medians to the deal medians of 2. The median IT fund with only 10 deals has a MOIC of 1.98 compared to the median IT deal with 1.24. The effect is pronounced looking at venture capital IT, where the deal-level median is 1.01 but the fund-level median is 1.76. On the other hand, the deal-level MOIC is 2.68 compared to the fund-level MOIC of 2.37. For PME, the fund-level median is 1.04 compared to the deal-level median of 0.76; and the fund-level mean is 1.32 compared to the deal-level mean of 1.61. Again, we see the moderating effect that even a modest portfolio can provide.

That said, not all portfolios lead to vastly improved median outcomes. The deal-level median PME for semiconductor funds is 0.63 compared to 0.78 for funds with 50 deals. Most IT industries have fund-level median PMEs above unity with only 10 funds, however, the exceptions being communications equipment at 0.94 and semiconductors at 0.71. In contrast, the only deal-level PME above unity is in IT services at 1.05.

The choice of fund size is therefore ultimately a choice of risk with little effect on average or typical fund performance. Given that average/expected performance is roughly the same for fund sizes, and given that most investors are risk-averse, it follows that most investors would prefer larger IT funds, all else equal. This same basic pattern follows for all categories analyzed.

I conclude this section by noting that private equity IT investments accrue both value and returns in excess of the public market for limited partners. The performance of these IT investments are driven by most IT industries, the exceptions being communications equipment and semiconductors which are essentially a wash compared to the public market. The moderating effects of a portfolio are clear even with a modestly sized portfolio.

I discuss additional ways of thinking about risk in the next section.

4 Alternative Public Benchmarks

The preceding analysis used the market-wide public index as the benchmark. Using IT sector- and industry-specific benchmarks may be more appropriate depending on the context of analysis. Overall, the public IT sector tends to produce returns in excess of other public market sectors, and therefore will usually provide a more conservative estimate of market-adjusted private equity performance. That said, even the public IT sector might not be an ideal benchmark since public and private investment can be quite different even within the same sector.[6] Using finer IT industry benchmarks can therefore provide a more closely matched comparable, and furthermore likely yields an even more conservative estimate for high-return industries without over-discounting low-return industries.

Accordingly, I use public market returns from CRSP combined with GICS identifiers from Compustat to create an IT sector benchmark and wall as IT industry benchmarks for each industry. Series are constructed using ordinary common shares with the New York Stock Exchange, the American Stock Exchange, and NASDAQ. Each stock is value-weighted based on the previous day's values, giving results that are indistinguishable from Fama-French methodology.

4.1 Alternative Public Market Statistics

The benchmarks are plotted in Figure 4 and verify that IT sector returns are typically much higher than those of the market as a whole, and the same can be said for most IT industries as well. In fact, all IT industries have more than double the cumulative whole market return from 2000 until 2019, the only exceptions being communications equipment and electronic equipment; communications equipment is marginally lower than the general market.

Summary stats for each sector and industry are shown in Table 7. The highest mean returns

[6] See for example Brown et al. (2024) for an illustration of how private and public real assets differ in composition

IT SECTOR AND INDUSTRY VALUE-WEIGHTED U.S. PUBLIC MARKET INDICES

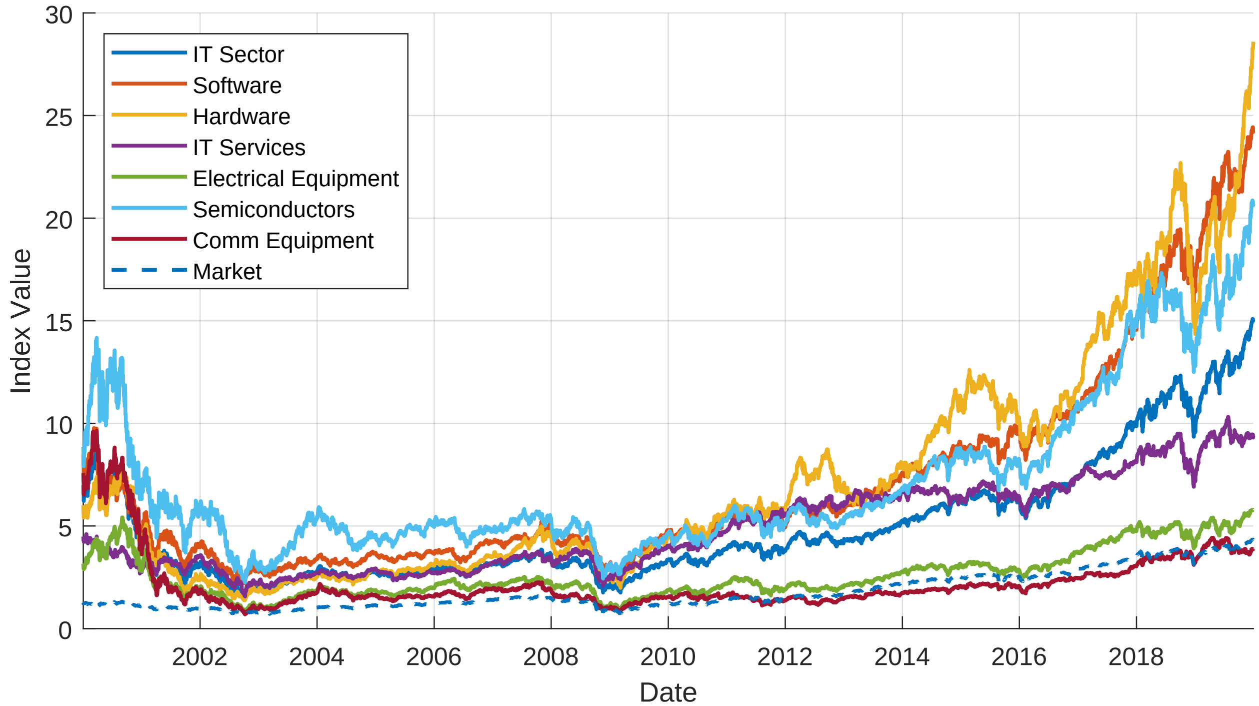

Figure 4: This figure shows time series for the public IT sector, each IT industry, and the public market as a whole.

come from hardware at 13.1% annualized and semiconductors at 10.6%, and the lowest with communications equipment with 2.3%. Note that IT has a lower mean of 7.9% than that of the market with 8.4%, but the IT sector has a higher standard deviation and a sizable positive skewness compared to the small negative skewness of the market at large, which ultimately drives the larger cumulative return exhibited in IT. While comparing Sharpe ratios of sectors and industries to the general market is a little unfair on account of sectors and industries possessing greater idiosyncratic risk, the highest Sharpe ratio is in hardware at 0.297, similar to that of the general market at 0.282; the lowest Sharpe ratio is with communications equipment at 0.057.

Fama and French (2023) 5-factor regressions of are shown in Table 8. All returns are measured above the risk-free rate. Market is the value-weighted CRSP market return, SMB (small minus big) refers to size related correlates, HML (high minus low) refers to book-to-market correlates, RMW (robust minus weak) refers to operating profitability correlates, and CMA (conservative minus aggressive) refers to investment intensity correlates. The table also includes the annualized alpha (the constant), adjusted R-squared, and the Sharpe ratio for each.

Table 7: Summary Statistics for U.S. Public Information Technology, 2000-2019

Sector/Industry	Mean	SD	Skewness	Kurtosis	Sharpe Ratio
Information Technology	7.9%	1.4%	0.47	14.10	0.182
Software	9.6%	1.5%	0.32	14.33	0.225
Hardware	13.1%	1.6%	0.52	14.60	0.297
IT Services	6.3%	1.2%	0.09	12.61	0.171
Electronic Equipment	7.7%	1.6%	0.20	11.40	0.163
Semiconductors	10.6%	1.8%	0.41	11.05	0.207
Comm Equipment	2.3%	1.8%	0.42	16.58	0.057
Public Market	8.4%	1.0%	-0.07	15.41	0.282

Mean and standard deviations are annualized.

IT and all of its industries have market betas near unity, with the lowest at 0.937 for IT services and the highest being 1.235 for semiconductors; all are highly statistically significant. In fact, almost all factors are highly statistically significant for all IT industries, typically negative for all factors except the market rate. The IT sector has a positive and statistically significant alpha of 5.8%, driven by software with 7.3% and hardware at 11.4%, and to a lesser extent semiconductors at 8.3%.

4.2 Alternative Public Market Equivalents and Direct Alphas

I calculate direct alphas and PMEs using both the IT sector benchmark as well as the industry-specific benchmarks. Calculations for pooled gross PME and DA using the IT sector benchmark, as well as net PME and DA estimated using the regressions in Table 5, are shown in Table 9. Compared to the general market benchmark, the overall IT net PME falls from 1.31 to 1.16 and the net direct alpha falls marginally from 5.3% to 5.2%. The overall decline is driven by primarily by software which has a net PME of 1.17 and direct alpha of 4.1% compared to the 1.37 and 5.6% it had when using the general market index. Electronic services, IT services, and hardware also fall a small amount as well; communications equipment and semiconductors are basically unchanged and statistically insignificant anyway. Buyout and venture IT both fall from about 1.30 with the general market index 1.18 and 1.12 with the IT index, respectively.

Using the IT sector benchmark, IT overall maintains its statistically significant excess return

Table 8: 5-FACTOR REGRESSION OF U.S. PUBLIC INFORMATION TECHNOLOGY, 2000-2019

	IT	Software	Hardware	Services	Elec	Semi	Comm
Market	1.102***	1.084***	1.064***	0.937***	1.130***	1.235***	1.137***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SMB	−0.049**	−0.076***	−0.146***	−0.056**	0.388***	−0.038	−0.091**
	(0.022)	(0.004)	(0.000)	(0.040)	(0.000)	(0.360)	(0.012)
HML	−0.493***	−0.518***	−0.424***	−0.299***	−0.298***	−0.590***	−0.489***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RMW	−0.706***	−0.578***	−0.521***	−0.168***	−0.829***	−0.907***	−1.141***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CMA	−0.438***	−0.499***	−0.742***	0.079	−0.259***	−0.241***	−0.425***
	(0.000)	(0.000)	(0.000)	(0.137)	(0.000)	(0.004)	(0.000)
Constant	5.830**	7.296**	11.437***	0.227	3.437	8.257*	2.509
	(0.013)	(0.013)	(0.006)	(0.935)	(0.238)	(0.061)	(0.550)
Adj R-sq	0.867	0.792	0.667	0.684	0.815	0.698	0.706

Calculated using HC3-robust standard errors.
N = 7302 daily returns. Returns are above the risk-free rate and alpha is annualized.

in net PME and direct alpha, as does IT services, hardware, and buyout IT. Electronic equipment, software, and venture capital are borderline.

I show industry-specific results in Table 10. Compared to the general market, several IT industries show higher metrics due to their public equivalents having relatively low returns. Electronic equipment sees an increase in net PME from 1.23 to 1.34, IT services from 1.30 to 1.40, and communications equipment from 0.97 to 1.17, although communications equipment remains statistically insignificant. The largest negative change comes from software which falls from a net PME of 1.37 to 1.14, which is even lower than with the IT sector benchmark. Similar patterns follow for direct alphas. In fact, the estimate for PME becomes only statistically significant at 10% level and its direct alpha not at all. Using the industry-specific benchmarks, electronic equipment and IT services maintain statistically significant net excess returns, whereas software and hardware become even more borderline.

The choice of benchmark therefore often has a meaningful impact not only on estimated excess returns, but also on the confidence with which those excess returns can be ascertained. Depending on the application, it can make sense to use either the market-wide, sector-specific, or industry-

Table 9: IT Sector And Industry PME and DA with IT Sector-Specific Benchmarks

Sector/Industry	Gross PME	Net PME	Gross DA	Net DA
Information Technology	1.46***	1.16**	11.8***	5.2**
Comm Equipment	1.21*	0.99	5.8*	0.3
Electronic Equipment	1.47***	1.17*	11.0***	4.6
IT Services	1.56***	1.23**	13.3***	6.5**
Semiconductors	1.16	0.96	6.7	1.1
Software	1.47***	1.17**	10.4***	4.1*
Hardware†	2.43***	1.80***	79.7***	60.7***
Buyout IT	1.48***	1.18**	15.8***	8.8***
Venture Capital IT	1.41***	1.12*	6.4***	0.7

Benchmarks are IT sector public market returns from CRSP.
p-values are for excess performance and are calculated using BCa bootstraps with 10,000 iterations.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$
†Two very large and successful hardware investments in year 2000 dominate hardware; removing year 2000 from the estimate instead gives a gross and net PME of 1.53 and 1.21, respectively, and 17.2 and 9.6 for DA.

Table 10: IT Industry PME and DA with Industry-Specific Benchmarks

Sector/Industry	Gross PME	Net PME	Gross DA	Net DA
Comm Equipment	1.47***	1.17	11.7***	5.2
Electronic Equipment	1.73***	1.34***	14.3***	7.3**
IT Services	1.82***	1.40***	11.7***	5.1**
Semiconductors	1.18	0.97	6.9	1.2
Software	1.42***	1.14*	9.4***	3.2
Hardware†	2.48***	1.83*	80.1***	61.0**

Benchmarks are industry-matched public market returns from CRSP.
p-values are for excess performance and are calculated using BCa bootstraps with 10,000 iterations.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$
†Two very large and successful hardware investments in year 2000 dominate hardware; removing year 2000 from the estimate instead gives a gross and net PME of 1.32 and 1.07, respectively, and 11.3 and 4.8 for DA.

specific benchmark, but the different implications of each benchmark make clear the care that must be taken when choosing a benchmark.

Finally, I show MOIC and PME by IT sector/industry and by vintage in Figure 5, using the IT sector benchmark for all IT sectors and industries. In terms of PME, IT venture capital appears to trend upwards from year 2000, whereas IT buyout appears to be flat or possibly trending downward. The semiconductor and hardware industries exhibit the most variation over time, fluctuating from values distinctly below unity to values exceeding a 3x net PME multiple. Software appears to exhibit the least fluctuation by vintage, although its net PME appears to decline over time.

4.3 Break-even Betas

An implicit assumption in the calculation of PME and direct alpha is a unit market beta, which is to say, the discount factor used in calculating PME and direct alphas by default grows at a rate identical to that of benchmark returns. Accordingly, one might argue that the typical PME and direct alpha calculations will present overly charitable performance for investments that actually have betas in excess of unity, and overly pessimistic performance for investments with betas below unity.

That said, determining the appropriate beta with which to adjust discount factors for PME and direct alpha is not straightforward. Fund-level cash flows typically come with regular valuations that allow one to construct an index and use the index to calculate market betas, sometimes with lags to account for valuations staleness. For example, Brown et al. (2025) use the method of Dimson (1979) to accumulate lagged betas and use the resulting "Dimson beta" to amplify or attenuate benchmark returns in discount factors accordingly.

The basic methodology is to use estimated betas to lever benchmark returns such that

$$\text{levered return}_t = \text{risk-free return}_t + \beta \times (\text{benchmark return}_t - \text{risk-free return}_t), \qquad (1)$$

and use this levered benchmark return series in the calculation of PME. This is very similar to what is seen in Harris et al. (2016) and Brown et al. (2025), who choose plausible ranges of beta to see how market-adjusted metrics change over beta, potentially even changing signs when comparing

MOIC AND PME OF U.S. INFORMATION TECHNOLOGY DEALS, VINTAGES 2000 THROUGH 2019

Figure 5: This figure shows net and gross MOIC and PME using the IT sector benchmark from vintages 2000 through 2019.

smaller to larger betas. Because calculating a range of plausible betas is not possible in this paper given limitations of the data (namely a lack of interim valuations), and because data-driven sector- and industry-specific priors for beta are uncharted at such a granular level, I instead consider the break-even beta, denoted β^*, that satisfies $\text{PME}(\beta^*) = 1$. In other words, β^* illustrates how high beta can be before the private investment's risk-adjusted return is at parity with the benchmark.[7]

For example, if $\beta^* = 2$, then the private investment outperforms the benchmark on a risk-adjusted basis as long as the true beta is less than 2. A higher β^* therefore implies that an investment can maintain positive risk-adjusted performance even when exhibiting a higher degree of market correlation with larger swings, all else equal. This of course still leaves open the question of what the true beta actually is, but it can provide guidance relative to one's beliefs about what true beta is, especially if a break-even beta is particularly low or high.

A break-even beta can have other interesting implications as well. For example, using the difference between gross MOIC and net MOIC to estimate GP profit, we can examine the relationship between GP profit in a sector/industry and public market returns in that sector/industry. This relationship is shown in Figure 6. With the exception of the semiconductors industry, there is a clear positive relationship between how much a GP profits from private equity investment and the performance of analogous public equities. It is therefore natural to ask whether GPs are really adding value to an LP's portfolio through skillful deal selection and management, or whether GPs are merely providing something akin to a levered public market investment and taking a sizable cut in the process. In the latter scenario, the LP is "buying beta" that it could otherwise provide itself by levering itself into the public market. A very large break-even beta suggests that a levered public equities strategy would struggle to mimic the performance of private equity, thereby illustrating GP skill in selecting and managing its portfolio companies. A low break-even beta on the other hand suggests the opposite.

In most cases, I numerically solve for $\text{PME}(\beta) = 1$ and report the solution. However, any $\text{PME}(\beta)$ functions for which $\text{PME}(\beta) = 1$ is not satisfied for any $\beta < 3$ are simply reported at "3+" since actual betas above 3 strain credulity, empirical precedent, and contextualization, and can be interpreted as a blunt statement about the confidence of the presence of excess risk-adjusted

[7] The same idea could be used by solving for direct alpha equal to zero, but the PME calculation is computationally much simpler.

GP PROFIT VERSUS PUBLIC EQUITIES RETURN BY SECTOR/INDUSTRY

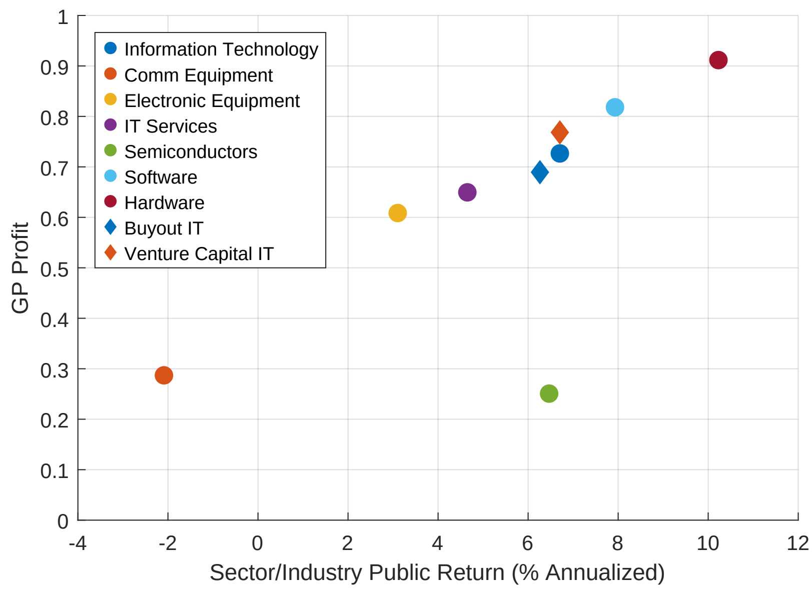

Figure 6: This figure shows the relationship between GP profit in a sector/industry and the annualized public return in that same sector/industry over the same investment period as the private investment window.

returns.

The results using the market benchmark, the IT sector benchmark, and each individual IT industry benchmark, are shown in Table 11. Against the public market benchmark, private IT would require a beta in excess of 3 to reach risk-adjusted parity, driven primarily by buyout IT; venture capital IT would require a beta of 1.9 to reach risk-adjusted parity, which is not an unreasonable belief given estimates of general venture capital in the literature that can sometimes exceed 2.0. Electronic equipment, IT services, software, and hardware also exhibit such high break-even betas that the presence of excess risk-adjusted are quite likely. Communication equipment and semiconductors, both of which have net PMEs below unity, would have to exhibit betas of about 0.80 for risk-adjusted parity with the public market.

When using the IT sector, break-even betas are typically much lower. The IT sector break-even beta is 2.04 with 2.73 in buyout, which still likely indicates excess risk-adjusted returns, and 1.32 in venture capital which could very well indicate negative risk-adjusted returns. Electronic equipment and IT services still exhibit clear excess risk-adjusted returns, as likely does hardware with a break-beta of 2.6. The break-even beta of software falls to 1.6, an intermediate value that is difficult to judge. Communication equipment needs a beta slightly less than unity to achieve risk-adjusted parity with the IT sector, and semiconductors needs a low beta of 0.7.

The IT industry-specific break-even betas are interesting because some public benchmarks have quite low returns. The communications equipment public benchmark has an average annual return of only 2.3% and accordingly can exhibit a beta of 1.84 while maintaining parity with its public market analogue. Electronic equipment and IT services still exhibit clear excess risk-adjusted returns. The software break-even beta falls further to 1.43 and hardware all the way down to 1.21; the presence of excess risk-adjusted returns in software is therefore even more questionable, and is questionable for hardware as well. The break-even beta for semiconductors is not much changed at 0.72.

Table 11: IT Sector and Industry Break-even Betas

Sector/Industry	**Public Market**	**IT Sector**	**IT Industry**
Information Technology	3+	2.04	-
Comm Equipment	0.82	0.93	1.84
Electronic Equipment	3+	3+	3+
IT Services	3+	3+	3+
Semiconductors	0.81	0.69	0.72
Software	3+	1.58	1.43
Hardware	3+	2.64	1.24
Buyout IT	3+	2.73	-
Venture Capital IT	1.88	1.32	-

Calculated with respect to estimated net PME. The public market benchmark is based on CRSP value-weighted returns, the IT sector benchmark based on CRSP value-weighted Information Technology sector returns, and the IT Industry benchmarks based on CRSP value-weighted Information Technology industry returns for each specific IT industry. Two very large and successful hardware investments in year 2000 that dominated hardware are removed from the hardware industry calculation, which otherwise would be 3+.

I conclude this section by again emphasizing that using a sector- or industry-matched index can make a large difference in either direction, depending not just on the overall performance of the public benchmark but also on the timing of its upswings and downswings relative to private investment upswings and downswings. Overall using IT sector-specific benchmarks tends to reduce market-adjusted performance of private IT investment, but not as an iron-clad law. Using IT industry-specific benchmarks can go either way, since some must have returns below the IT sector benchmark and some must have returns above the IT sector benchmark. This again emphasizes the importance of choosing the right level at which to benchmark.

5 Conclusion

In this paper I detail ways of analyzing the performance of private equity investments at the sector and industry level. Fund-level data is insufficient in both isolating sectors/industry and thoroughly accounting for sectors/industries. Using deal-level data, one can estimate gross metrics on specific sectors and industries; and by empirically estimating the relationship between gross and net performance, one can confidently estimate net performance of deal-level cash flows—and therefore sector/industry cash flows—as well. Using deal-level data in this way allows one to consider the incidence of home run deals, the effects of portfolio size, and tightly-matched sector and industry public benchmarks. Using the information technology sector to illustrate, I find that even against sector- and industry-matched benchmarks, private IT investment in the U.S. tends to outperform public IT investment in terms of value accretion and LP returns, likely on a risk-adjusted basis; and even modestly sized IT portfolios largely mitigate the idiosyncratic risk inherent in portfolio companies.

The analysis in this paper could in principle be extended to other sectors, industries, and regions. Doing so however will require both a sufficient number of deals and appropriate benchmarks. As demonstrated by Brown et al. (2025), public market indices for regions outside of the U.S. are not as well-suited for benchmarking private investments, often leading to questionable conclusions such as dubiously low betas and correspondingly high risk-adjusted returns. In the future, deal-level data might include interim valuations which in turn would allow for traditional estimates of beta as well as other methodologies for risk-adjusted returns, such as the generalized public market equivalent of Korteweg and Nagel (2024). In the mean time, interested parties will have to use their own judgment to determine where true betas lie in relation to break-even betas as reported in this paper.

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A Appendix

A.1 Gross and Net Performance Scatterplots

Scatterplot of Gross and Net Performance for Buyout Funds

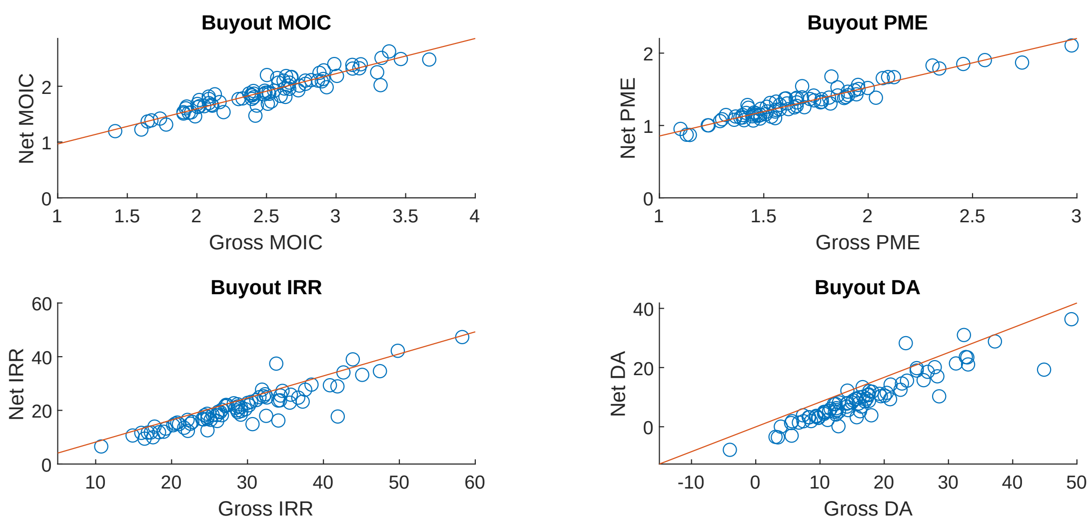

Figure A1: This figure plots gross and net performance metrics against each other for buyout. Each data point is calculated on the pool of cash flows found in each year-quarter from 2000 through 2019. The line is the robust regression line of net performance on gross performance.

Scatterplot of Gross and Net Performance for Venture Capital Funds

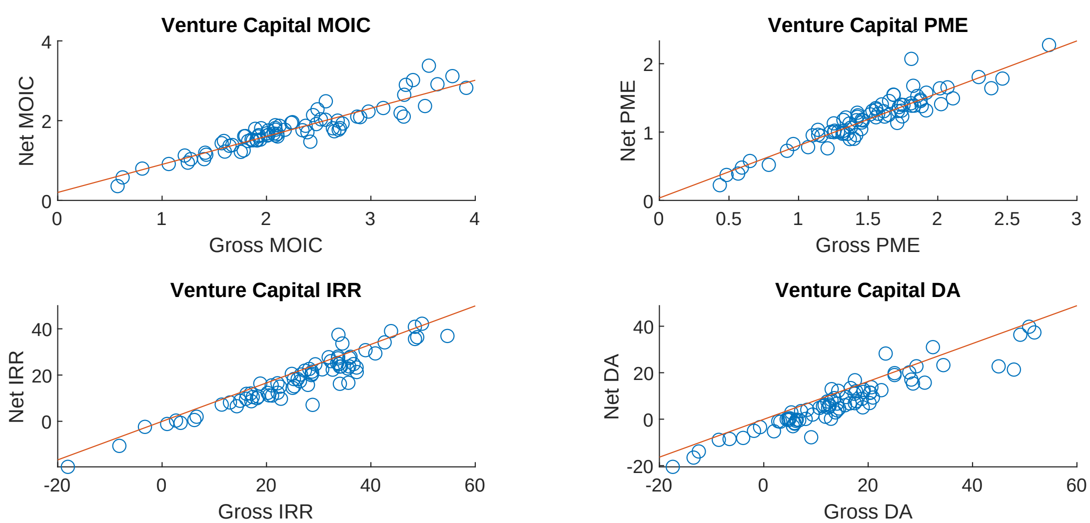

Figure A2: This figure plots gross and net performance metrics against each other for venture capital. Each data point is calculated on the pool of cash flows found in each year-quarter from 2000 through 2019. The line is the robust regression line of net performance on gross performance.

A.2 Fund Simulations

Table A1: Simulated IT Funds with 10 Deals Per Fund

	Information Technology					IT Buyout					IT Venture Capital				
Variable	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**
Net MOIC	2.29	1.57	0.96	1.98	4.46	2.15	0.80	1.27	2.02	3.36	2.37	2.18	0.80	1.76	5.90
Net PME	1.38	0.90	0.56	1.23	2.63	1.37	0.53	0.78	1.29	2.16	1.32	1.04	0.45	1.04	3.15
Net IRR	19.9%	41.9%	-3.5%	13.7%	55.1%	24.6%	40.6%	3.1%	17.3%	64.1%	14.5%	41.1%	-8.0%	8.8%	43.6%
Net DA	8.7%	34.0%	-12.8%	3.4%	42.2%	13.6%	37.1%	-6.2%	6.6%	53.8%	3.7%	32.3%	-17.0%	-0.8%	31.6%

	Communications Equipment					Electronics Equipment					IT Services				
Variable	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**
Net MOIC	1.51	0.72	0.58	1.38	2.75	2.02	0.88	1.08	1.86	3.24	2.17	0.78	1.14	2.06	3.47
Net PME	1.02	0.49	0.39	0.94	1.88	1.29	0.54	0.65	1.19	2.19	1.37	0.53	0.67	1.30	2.37
Net IRR	9.0%	50.3%	-28.2%	6.5%	43.2%	24.2%	43.9%	-0.6%	13.2%	76.5%	18.8%	19.1%	0.4%	15.1%	51.1%
Net DA	1.1%	46.5%	-35.0%	-1.7%	37.1%	13.1%	36.6%	-9.5%	3.4%	67.9%	8.4%	16.9%	-9.0%	5.1%	39.6%

	Semiconductors					Software					Hardware				
Variable	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**
Net MOIC	1.48	1.91	0.61	1.10	2.39	2.41	1.75	1.00	2.04	4.78	2.32	1.10	0.98	2.06	4.71
Net PME	1.09	1.97	0.39	0.71	1.69	1.44	0.90	0.59	1.26	2.72	1.57	0.90	0.59	1.32	3.65
Net IRR	22.7%	112.7%	-22.1%	0.0%	70.2%	20.6%	37.9%	-2.4%	15.4%	50.7%	23.4%	27.5%	-3.1%	15.8%	74.5%
Net DA	12.4%	103.5%	-32.0%	-8.1%	48.1%	9.1%	32.0%	-11.9%	4.5%	38.0%	12.8%	25.1%	-12.3%	5.8%	64.9%

Each simulation consists of 10,000 funds constructed with 10 random deals.

Table A2: Simulated IT Funds with 25 Deals Per Fund

	Information Technology					IT Buyout					IT Venture Capital				
Variable	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**
Net MOIC	2.24	0.94	1.25	2.07	3.76	2.12	0.48	1.52	2.05	2.99	2.40	1.50	1.12	1.99	5.30
Net PME	1.35	0.52	0.75	1.27	2.22	1.34	0.31	0.92	1.30	1.89	1.32	0.70	0.64	1.13	2.71
Net IRR	18.6%	31.5%	2.6%	14.5%	41.7%	22.8%	39.5%	6.8%	16.8%	48.6%	13.6%	27.6%	-0.4%	10.2%	31.2%
Net DA	8.3%	27.3%	-6.9%	4.4%	30.6%	12.5%	37.2%	-3.0%	6.5%	36.9%	3.3%	19.0%	-9.7%	0.6%	20.9%

	Communications Equipment					Electronics Equipment					IT Services				
Variable	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**
Net MOIC	1.50	0.50	0.76	1.45	2.36	2.00	0.49	1.42	1.92	2.86	2.11	0.46	1.43	2.08	2.91
Net PME	1.02	0.33	0.53	0.99	1.58	1.27	0.31	0.88	1.22	1.85	1.34	0.34	0.86	1.30	1.97
Net IRR	7.0%	13.9%	-12.8%	7.6%	26.5%	19.3%	18.4%	5.3%	14.0%	51.1%	17.9%	14.5%	5.1%	14.7%	41.6%
Net DA	-1.0%	14.0%	-20.5%	-0.6%	19.1%	9.6%	16.3%	-4.0%	4.6%	40.8%	8.2%	12.3%	-4.4%	5.2%	31.9%

	Semiconductors					Software					Hardware				
Variable	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**
Net MOIC	1.39	0.88	0.82	1.15	3.38	2.38	1.07	1.35	2.16	4.08	2.36	0.76	1.43	2.16	4.01
Net PME	1.01	0.95	0.52	0.75	3.23	1.43	0.54	0.81	1.33	2.33	1.62	0.63	0.92	1.45	3.00
Net IRR	22.2%	89.1%	-9.0%	0.5%	149.3%	19.1%	25.0%	4.8%	16.3%	36.4%	26.3%	18.1%	6.3%	19.5%	58.5%
Net DA	14.2%	86.4%	-17.3%	-7.4%	147.2%	8.0%	18.1%	-5.5%	5.6%	25.4%	17.5%	20.3%	-2.9%	9.9%	62.7%

Each simulation consists of 10,000 funds constructed with 25 random deals.

Table A3: Simulated IT Funds with 50 Deals Per Fund

	Information Technology					IT Buyout					IT Venture Capital				
Variable	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**
Net MOIC	2.20	0.64	1.46	2.09	3.34	2.10	0.34	1.67	2.05	2.72	2.42	1.12	1.34	2.12	4.59
Net PME	1.34	0.37	0.87	1.29	1.96	1.32	0.22	1.02	1.29	1.71	1.32	0.51	0.76	1.20	2.35
Net IRR	17.5%	22.0%	5.4%	14.7%	33.6%	20.5%	26.9%	8.9%	16.4%	42.1%	12.8%	15.2%	3.0%	11.0%	24.7%
Net DA	7.7%	22.2%	-4.2%	4.7%	23.5%	11.1%	27.0%	-0.9%	6.3%	38.2%	3.1%	11.8%	-6.5%	1.4%	15.0%

	Communications Equipment					Electronics Equipment					IT Services				
Variable	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**
Net MOIC	1.48	0.37	0.92	1.45	2.11	1.99	0.32	1.57	1.94	2.61	2.08	0.32	1.59	2.07	2.63
Net PME	1.01	0.24	0.64	1.00	1.41	1.26	0.20	0.98	1.23	1.64	1.33	0.24	0.97	1.31	1.75
Net IRR	7.8%	7.9%	-5.0%	8.0%	20.3%	16.5%	9.8%	7.1%	13.8%	36.0%	16.3%	9.4%	7.4%	14.4%	30.6%
Net DA	-0.3%	8.0%	-13.1%	-0.2%	12.6%	7.2%	9.3%	-1.8%	4.5%	25.6%	7.4%	8.6%	-2.0%	5.3%	23.5%

	Semiconductors					Software					Hardware				
Variable	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**	**Mean**	**StDev**	**Q05**	**Q50**	**Q95**
Net MOIC	1.36	0.52	0.93	1.18	2.72	2.35	0.73	1.55	2.20	3.65	2.37	0.56	1.65	2.24	3.46
Net PME	0.98	0.56	0.58	0.78	2.47	1.41	0.37	0.93	1.35	2.06	1.64	0.44	1.09	1.52	2.51
Net IRR	22.3%	60.4%	-4.2%	1.1%	142.7%	17.7%	9.2%	7.9%	16.7%	29.7%	28.8%	16.0%	10.6%	22.6%	55.7%
Net DA	15.3%	61.6%	-11.7%	-6.7%	141.9%	7.0%	8.8%	-2.7%	5.9%	18.6%	22.3%	21.2%	1.1%	13.2%	60.2%

Each simulation consists of 10,000 funds constructed with 50 random deals.