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Private Equity Goes Public

Examining the Risk and Return Characteristics of Buyout Funds

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Private Equity Goes Public

Examining the Risk and Return Characteristics of Buyout Funds

Joachim Rosengaard and Oliver Quorning Langhoff*

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This paper analyzes the risk and return characteristics of buyout funds from two different perspectives and extends on previous studies by Harris and colleagues (2014) and Stafford (2017). Traditional performance metrics show a clear outperformance of buyout funds relative to public markets, however, these disregard much of the risk in buyout funds. Using a sample of 755 U.S. public-to-private LBOs, we show that buyout investors tilt toward small companies with low EBITDA multiples and modest profitability. These preferences suggest that the risk inherent in buyout funds is more akin to a portfolio of small value stocks. We construct a portfolio that mimics the following passive components of the private equity investment process; (1) asset selection criteria, (2) long holdings periods, (3) infrequent and conservative estimates of net asset values, and (4) use of leverage. This private equity mimicking portfolio generates an absolute return that is similar to the one of the Cambridge Associates U.S. Buyout Fund Index, before fees, implying a considerable outperformance, net-of-fees. With a CAPM beta of 2.07, the systematic risk exposure of the PE-mimicking portfolio seems more reasonable compared to the beta estimates ranging from 0.29 to 0.77 for the aggregate buyout index. A comparison of portfolio performance, using both mark-to-market and hold-to-maturity accounting, shows that the difference in measured risk between the aggregate buyout index and the private equity mimicking portfolio can be attributed to artificial return-smoothing resulting from infrequent and conservative estimates of portfolio net asset values. The findings bring into question the value added by active fund management, the existence of a liquidity premium, and the justification of the annual fees paid by LPs, estimated at more than 5%.

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*Thank you to our supervisor, Kasper Meisner Nielsen, for contributing with valuable insights and discussions. Throughout the writing process, Kasper has challenged our work and helped us better understand the topic area.

Table of Contents

Glossary

AUM	-	Assets Under Management
BAB	-	Frazzini/Pedersen Betting Against Beta Factor
BVCA	-	British Private Equity & Venture Capital Association
CA	-	Cambridge Associates
CAPM	-	Capital Asset Pricing Model
CMA	-	Fama/French Conservative Minus Aggressive Factor
CRSP	-	Center for Research in Security Prices
EBITDA	-	Earnings Before Interest and Taxes
EV	-	Enterprise Value
FF	-	Fama-French
FOIA	-	Freedom of Information Act
GP	-	General Partner
HML	-	Fama/French High Minus Low Factor
HWM	-	High Water Mark
IPO	-	Initial Public Offering
IRR	-	Internal Rate of Return
LBO	-	Leveraged Buyout
LIQ	-	Pástor/Stambaugh Traded Liquidity Factor
LP	-	Limited Partner
NAV	-	Net Asset Value
OLS	-	Ordinary Least Squares
PE	-	Private Equity
PME	-	Public Market Equivalent
PTP	-	Public-to-Private
RMW	-	Fama/French Robust Minus Weak Factor
RVPI	-	Residual Value to Paid-In
SMB	-	Fama/French Small Minus Big Factor
TVPI	-	Total Value over Paid-in
VC	-	Venture Capital

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1. Introduction

Private equity (PE) investments are generally believed to have unique benefits over investing in the public market. Kaplan and Strömberg (2009) sum up the key advantages of the PE model as three different kinds of engineering that they call "the levers of value creation," namely, governance-, financial-, and operational engineering. In case these levers of value creation are material advantages of PE over public market investing, we would expect the performance of PE funds before fees to be superior to the performance of a portfolio mimicking the passive components of the PE investment process in the public market.

This paper seeks to uncover the risk and return characteristics of private equity, by identifying risks that are specific to investing in buyout funds and examining loadings on well-documented risk factors. First, historical performance, as well as PE-specific performance predictors, such as aggregate fund dry powder, valuation levels, and fund size, are evaluated in a traditional PE framework. Second, we simulate the returns of the aggregate buyout index using a portfolio of stocks that mimics the passive components of the buyout investment process, which allows for an accurate analysis of performance and risk factor loadings. The former part is inspired by Harris, Jenkinson, and Kaplan (2014), while the latter leans on the methodology of Stafford (2017). We define the passive components of PE as (1) asset selection, (2) long holding periods, (3) conservative estimates of portfolio net asset values (NAVs), and (4) leverage.

Figure 1.1 plots the cumulative value of $1 invested in the Cambridge Associates (CA) U.S. Buyout Fund Index and the 2 times levered value-weighted CRSP index (the market) between July 1986 and June 2018.[1] The CA U.S. Buyout Fund Index is the most widely used index to estimate the returns of a diversified private equity allocation, after fees, and is computed by Cambridge Associates, aggregating cash flows and end-of-period self-reported NAVs for funds in its database quarterly. The figure shows that, between July 1986 and June 2018, the cumulative returns of the net-of-fees buyout index and the 2-times levered public market are broadly in line. This implies that the buyout index, before fees, has outperformed the levered public market substantially and highlights how successful the buyout industry has been at creating wealth since the 1980s. The figure also shows a remarkable difference in measured drawdown levels. Despite the substantial risk associated with leveraged buyouts, the buyout index barely registered any drawdown in equity capital during the financial crisis in 2008 – something that cannot be said of the levered market index.

[1] The 2 times leverage is consistent with the level of leverage deployed by buyout funds post-transaction (Axelson, Jenkinson, Strömberg, and Weisbach, 2013).

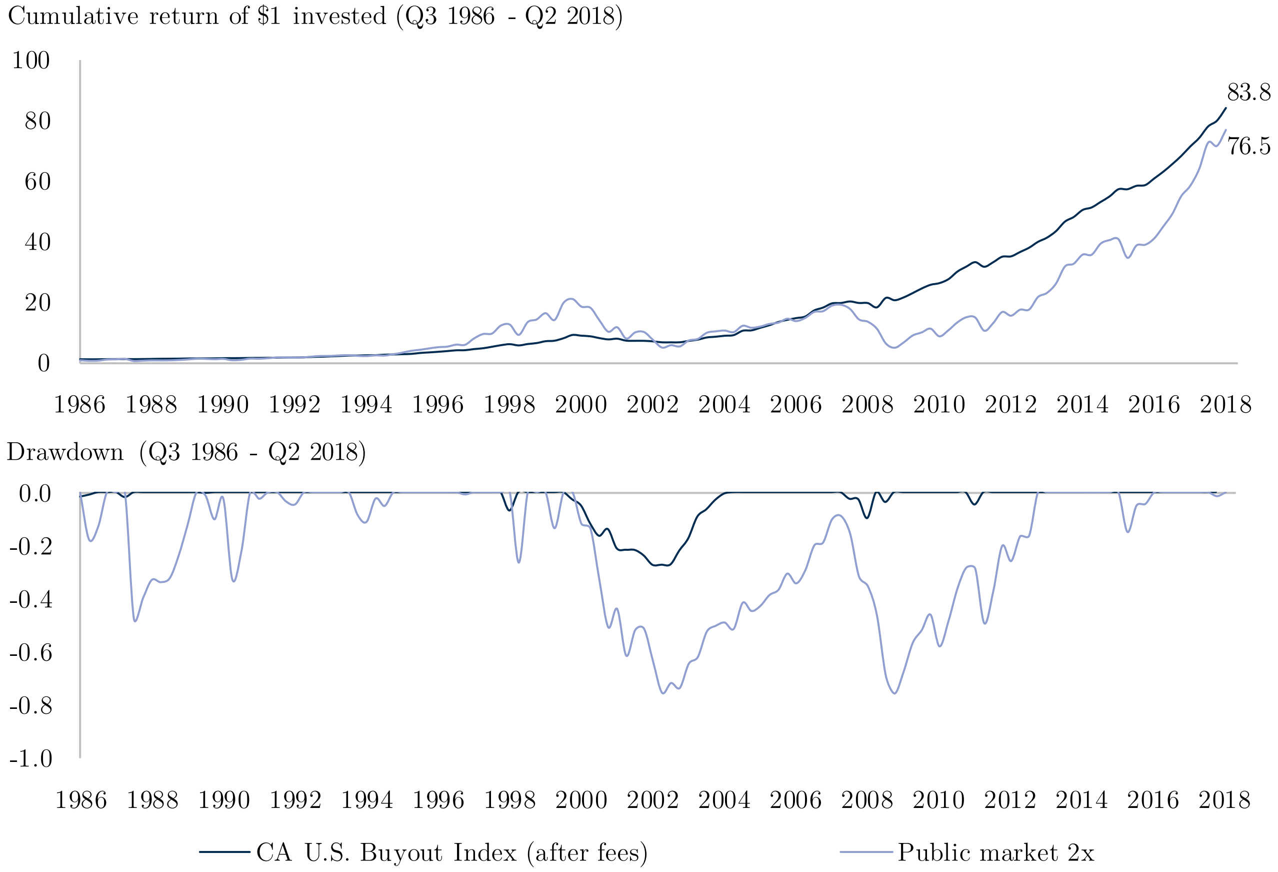

Figure 1.1: Comparison of aggregate buyout index and levered stock market (Q3 1986 - Q2 2018)
The top panel plots the cumulative value of $1 invested in the CA U.S. Buyout Fund Index and a portfolio that levers the value-weighted CRSP index by 2x. The CA U.S. Buyout Fund Index is a net-of-fees time series. The public market 2x index pays the monthly one-month U.S. Treasury yield in borrowing costs and a monthly index fee of 10bps. The bottom panel plots the corresponding drawdown series, calculated using the formula $(\mathrm{HWM}_t - \mathrm{P}_t)/\mathrm{HWM}_t$.

Due to the lack of co-movement between buyout fund returns and public market returns, the risk and return characteristics of PE has for many years been somewhat of a “black box” for investors. A significant contributor to the lack of co-movement between private and public equities is the infrequent and conservative marking of net-asset-values (NAVs) in PE. Public market assets are valued by investors daily, following a mark-to-market scheme. The differences in reporting, results in spurious diversifying characteristics when comparing PE to the broader public market, potentially leading to misconceptions around the risk and return characteristics of investing in PE funds.

All else equal, one would expect the risk of levered investments in public and private equities to be quite similar. However, as shown in Figure 1.1, the aggregate buyout index recorded only modest drawdown levels over the previous 33 years. Despite the well-known risk-distorting elements of PE, the British Private Equity & Venture Capital Association (BVCA) argues that "*… with NAVs as substitutes [of real continuous market prices], it is possible to calculate typical public market measures such as periodic returns, their volatilities and correlations with returns from other asset classes*" (BVCA, p. 9, 2015b). PE firms also advertise diversification as a core benefit to investors. The global PE firm Blackstone states in their marketing materials that "*… returns tend to be less correlated to the beta of traditional market investments and are more dependent on the individual manager's skill*" (Blackstone, p. 9, 2016).

Existing research on the risk and return characteristics of PE have generally focused on whether buyout funds have generated substantial risk-adjusted returns, after fees. Current research mainly relies on the Kaplan and Schoar (2005) public market equivalent (PME) metric, which is used to compare the performance of PE with the broader public market. Harris and colleagues (2014) analyze PE performance since the 1980s, using the PME metric and conclude, in line with previous studies, that PE funds have consistently outperformed public markets. However, the PME is not a return metric and does not attempt to adjust for the risk differential between buyout fund cash flows and the public market index used for estimation. Stafford (2017) suggests that a more accurate comparison of PE fund performance would be to construct replicating portfolios, consisting of publicly traded equities that mimic the passive components of the PE investment process. Doing so, Stafford (2017) concludes that a "*… passive portfolio of small, low EBITDA multiple stocks with modest leverage and hold-to-maturity accounting produces an unconditional return distribution that is highly consistent with that of the pre-fee aggregate private equity index*" (Stafford, p. 1, 2017). This paper builds on both the methodology from Harris and colleagues (2014) and Stafford (2017) to provide a comprehensive analysis of the risk and return characteristics of buyout funds.

The study is highly relevant in light of the record-amount of capital that has been flowing into the global buyout industry in recent years. With interest rates having been at historic lows since the great financial crisis, investors on the hunt for yield, have fallen in love with private equity. Over the past five years, buyout funds have attracted more capital than in any other five-year period, including the boom period leading up to the financial crisis in 2008 (Bain & Company, 2019). In 2018, buyout funds raised an all-time high of $320 billion globally, with an average fund size of $1.6 billion. The favorable fundraising environment has left buyout funds with a record amount of undeployed capital, also known as dry powder. By the end of 2018, dry powder for buyout funds globally was at a record-high $695 billion, representing a 15% increase since the end of 2017. While historically high fundraising levels is a signal of positive sentiment toward the buyouts asset class, the record-amount of dry powder indicates that increasing competition for high-quality assets and the increasing valuation levels are making it difficult for PE managers to put their capital to work.

1.1. Problem statement

The aim of this paper is to provide a better understanding of the risks and returns of investments in buyout funds. We first evaluate buyout fund performance using traditional measures such as the IRR, TVPI, and PME. This is followed by an examination of possible PE specific performance predictors. Prior studies and industry practitioners have documented numerous shortcomings of the IRR, TVPI, and PME, including that they are easily manipulated by fund managers. The PME is believed to be the most robust of these return measures but is entirely dependent on the chosen benchmark, which is usually the S&P 500. An examination of the characteristics of buyout targets could show if these are different from those of the average public company. Knowledge about such characteristics could be used to construct a portfolio that mimics the investment selection criteria of buyout funds. A portfolio that successfully simulates the return distribution of a diversified buyout portfolio will ensure more complete return data that can give new insights into the true risk-return trade-off of investing in buyout funds. Hence, the central research question of the paper has been formulated as below,

> "What does well-known performance measures tell us about the performance of the buyout industry, and can a portfolio that mimics the passive components of the private equity investment process provide additional insights about the risk and return characteristics of buyout fund investments?"

This question opens for a broad scope of analysis, and the results will contribute to the growing branch of private equity literature and the current discussion on industry risk-adjusted performance and of current fee levels.

1.2. Structure of the paper

At first, we set the foundation for the rest of the paper by providing an introduction to the world of private equity, as well as covering literature on private equity performance extensively. In Section 2, we start by presenting recent trends in private equity and outlining how buyouts and buyout funds are structured. Section 3 is a review of the central literature on the risk and return characteristics of private equity. In Section 4 we discuss data sources and describe the data used for analyzing the characteristics of companies acquired by private equity funds.

The second part of the paper builds on the foundation laid out in the first part. In Section 5, we use data obtained from the Preqin database to analyze U.S. buyout performance, with a focus on the traditional performance measures; the IRR, TVPI, and PME. Additionally, possible PE-specific performance predictors, such as industry dry powder, valuation levels, and fund size, are analyzed. This analysis builds on Harris and colleagues (2014) but with a larger sample of buyout fund data. We also test additional performance predictors, such as absolute and relative valuation levels, which will help give a better understanding of industry-level predictors of fund performance.

Inspired by Stafford (2017), in Section 6 we construct a portfolio that simulates the return distribution of the CA U.S. Buyout Fund Index. The portfolio is constructed based on a regression analysis of the characteristics of buyout targets. The analysis of firm characteristics is based on the sub-sample of buyout transactions where publicly listed firms are taken private by buyout funds. In addition to targeting firms with specific characteristics, the portfolio incorporates several elements of the PE model, such as the use of leverage, long holding periods and conservative estimates of portfolio NAVs. To better understand the risk and return characteristics of buyout fund investments, we analyze the PE-mimicking portfolio and compare it to the CA U.S. Buyout Fund Index, before- and after fees. We also run regressions of the portfolio against well-known risk factors to investigate the risk factor exposure of the buyout funds.

In Section 7, we discuss our findings and relate these to the existing literature on the subject with the hope of providing new perspectives on the subject matter. We also discuss various limitations with regards to our results. Lastly, our findings will be concluded in Section 8.

Hence, the paper consists of a total of 8 sections, structured as follows,

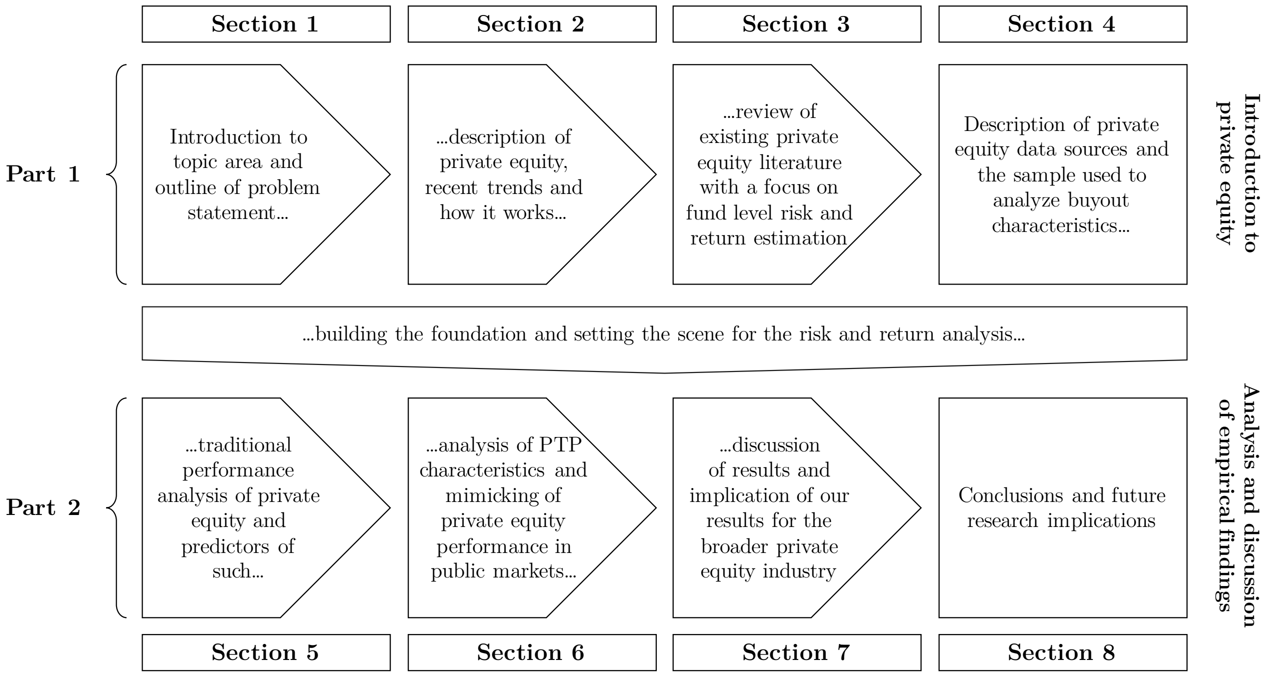

Figure 1.2: A sectioned overview of the paper

The framework laid out above is designed to help us address our problem statement from various angles and to provide the most accurate analysis of risk and return characteristics of buyout funds.

1.3. Thesis limitations

This paper studies the risk and return characteristics of investments in buyout funds by constructing portfolios of publicly traded equities that mimic the passive components of the buyout investment process. It is acknowledged that the component of active management and the operational engineering following PE ownership are not captured using this approach. Nonetheless, it still provides valuable insights into a central element of the buyout investment process. Throughout the paper, the focus is on the buyout segment of private equity, and the phrases “buyout,” “LBO,” “private equity,” and “PE” are used interchangeably. Hence, it is outside the scope of this paper to discuss nor evaluate risks and returns of other segments of the private capital markets, such as venture capital (VC), growth equity, or distressed funds. Given the quality of data and the maturity of the industry, the focus is on the U.S. segment of buyouts with risks and returns being assessed at the aggregate industry level, not at the portfolio company level.

2. Private equity and recent developments

This section provides an introduction to private equity and central developments for the asset class. While the number of unlisted companies is larger than the universe of publicly traded companies, the majority of unlisted companies in the global economy are not investable for institutional investors. This is the case as a big part of privately held companies are too small, or just controlled by owners who are not interested in giving up control to outsiders. Instead, such firms are typically financed by bank debt as well as equity provided by founders, friends, and family. In this paper, private equity is defined as investments in unlisted corporations by professional investors (Døskeland & Strömberg, 2018).

> "There's money everywhere today. There's almost no institution in the world – whether it's a sovereign fund, a foundation, an insurance company, banks, pensions funds – that doesn't do something in the private equity sector. Information today is better than ever before. Markets are pretty darn good. There's so much more transparency. Which also means our business has much more competition. I sort of liked it when it was just us."
>
> – Henry Kravis, Co-Founder and Co-CEO at KKR (Bloomberg, 2016)[2]

2.1. The private capital markets

The private capital markets are defined as the markets for investments in unlisted assets. The markets for private capital can be divided into different types of investments undertaken by professional investors. The types of investments can broadly be divided into five different classes, namely private equity, private debt, real estate, infrastructure, and natural resources. Common themes across these five categories are that, given that they are not listed on any exchange, the investments are illiquid. Because of this, private market transactions are usually much more complicated compared to trading in listed assets and thus require a substantial degree of screening and due diligence, on the part of the investor (Døskeland & Strömberg, 2018).

Table 2.1: Segments of the private capital market (Preqin, 2019)

Private Equity	Private Debt	Real Estate	Infrastructure	Natural Resources
Buyouts	Direct lending	Real estate	Infrastructure	Energy
Venture capital	Distressed debt	Fund of funds	Fund of funds	Agriculture
Growth	Mezzanine	Secondaries	Secondaries	Metals and mining
Turnaround	Special situations			Timberland
Other private equity	Venture debt			Water
Fund of funds	Fund of funds			Fund of funds
Secondaries				

[2] Kohlberg Kravis Roberts & Co. is an industry pioneer and leading global private equity firm based in the U.S.

As highlighted in Table 2.1, private equity is part of the broader private capital markets. Private equity investors that specialize in control-investments (buyouts) shape the future direction of their portfolio companies by exercising control over corporate governance and strategy. Private equity investors typically acquire a majority stake in the target companies, but will often also obtain significant control rights in the case of minority investments (Kaplan and Strömberg, 2003). The focus of this paper is on the leveraged buyout (LBO) market which is the largest segment of private equity. Kohlberg Kravis Roberts (KKR), founded in 1976, is often credited for pioneering the LBO investment model which has grown significantly in popularity since its introduction in the late 1970s (Døskeland & Strömberg, 2018).

Buyouts are acquisitions in which PE firms acquire majority ownership in mature companies. The term "buyout" refers to PE firms typically buying out existing owners, rather than making minority investments in businesses.[3] Within the buyout universe, PE firms apply different investment strategies. Some PE firms might have a preference for specific industries, company sizes, or other firm characteristics. However, the typical buyout target is a profitable company with room for operational improvements and unexplored avenues for future growth. Profitability is not a requirement for a buyout transaction per se, but most buyout firms target profitable businesses in order to leverage their assets – leverage that is also used to finance the acquisition itself. However, there are examples of PE firms, such as Providence Equity Partners and Vista Equity Partners that are successful in acquiring less profitable companies, specifically in the technology, media and telecommunication industries. In the investment process for traditional LBOs, financial leverage plays an important role. Axelson and colleagues (2013) studied a sample of 1,157 buyouts internationally from 1980 to 2008 and compared this to a subset of similar public companies. The authors found that the market D/EV of a matched public company was 30%, while this ratio increased to 65% following an LBO. In other words, they found that private equity owned businesses have more than double the debt financing of the average publicly listed company.

Generally, we can talk about three different ways of investing in PE. Typically, institutional investors invest in PE funds which provides exposure to the equity in the fund's portfolio companies in exchange of fee payments. An alternative to regular PE fund investments is to invest in so-called fund-of-funds. Funds-of-funds are portfolios of investments in PE funds, and thus provide exposure to a relatively larger and more diversified portfolio of private companies. Investors can also invest directly into PE, either as a sole investor or through a co-investment set-up alongside a PE fund. When investing directly, investors avoid the management fees and carried interest paid to the general partners of PE funds, but direct investments are also riskier in the sense that they often lead to larger and more concentrated equity stakes. Co-investing is the most common way for institutional investors to make direct investments in PE

[3] Existing owners often maintain a minority investment in the company following a buyout transactions.

(Døskeland & Strömberg, 2018). Institutional investors are usually passive owners, and by doing co-investments, they can get much of the upside from direct investments while relying on the financial, operational, and governing expertise of the PE firm.

By studying the investments of seven large institutional investors, Fang, Ivashina, and Lerner (2015) found that approximately 12% of total PE investments were co-investments. Since these investments were selected conditional on the investors having direct investment programs, this result likely overstates the share of total PE investments made up of co-investments. It is generally hard to estimate the total size of the co-investment market since information on the post-signing syndication of deals to LPs, which is the most common form of co-investment, is not publicly available. Døskeland and Strömberg (2018) estimate that over the period 1996-2016, LPs invested directly in 2.6% of all PE deals and this share is growing. In the case of buyouts, the share of deals with direct investments by LPs grew from less than 1% in the late 1990s to 5.2% of all deals from 2011 to 2016.

Table 2.2: % of PE deals with direct investment by an LP (Døskeland & Strömberg, 2018)

Period	Buyout	Growth	RE & Infra	VC	All PE
1996-2000	0.9%	1.7%	7.6%	1.9%	1.8%
2001-2005	2.2%	1.6%	6.4%	2.2%	2.4%
2006-2010	2.8%	2.2%	10.1%	1.5%	2.4%
2011-2016	5.2%	3.4%	16.2%	2.1%	3.2%
Whole period	3.3%	2.6%	12.6%	2.0%	2.6%

2.2. Private versus public equity

Ang (2014) suggests that the main differences between the public and private markets for equity ownership can be summarized in five main points. First, public equities are traded on a centralized exchange while private equity is traded over the counter which means that public equities are much more liquid than private equity investments. Second, transaction costs are much higher in private equity. As an example, the secondary market for LP commitments is thin, and discounts are often significant. Harvard University's endowment fund sold off PE commitments in the secondary market at a close to 50% discount during the financial crisis (Ang, 2014). Third, the value of public equity is easily observable given that shares are freely traded and continuously priced in the market. PE investments are harder to value and are valued much less frequently, and performance is generally measured using alternative performance measures such as the IRR and TVPI that have been shown to be easily manipulated by fund managers. Fourth, the time horizon for investments in the public market and private equity differs significantly. While public equities can be traded daily, the typical PE fund has a horizon of around ten years that can be extended for several years. The long holding horizon and irregular timing of capital calls make it harder for institutional investors to rebalance PE positions, rendering portfolio optimization models such as the mean-variance model obsolete. Lastly, contracts in the public market are generally standardized and easy to understand for investors, whereas contracts in private equity are far more complex and require more expertise from the investors (Ang, 2014).

Table 2.3: Overview of the main differences between public and private equity (Ang, 2014)

Category	Public equity	Private equity
Market	Centralized and liquid	Over-the-counter and illiquid
Transaction costs	Insignificant	Enormous
Valuation	Observable in real time	Infrequent and difficult to value
Horizon	Immediate	Long term (around 10 years)
Contracts	Standard	Complex

2.3. Structure and compensation of private equity funds

PE funds are typically organized as limited liability partnerships (LLPs) in which the PE fund manager is called the general partner (GP), and the investors in the fund are called limited partners (LPs). The GP manages the daily operations of the partnership and the portfolio companies. The LPs provide capital and are typically institutional investors such as pension funds, insurance companies, asset managers, sovereign wealth funds, endowments, and family offices, but can also be high net-worth individuals. PE funds are often organized as LLPs for tax purposes, to avoid double-taxation of fund returns to the LPs. The GP must provide at least 1% of the total capital committed to the fund in order to obtain the LLP status, and this also helps align incentives of the parties involved (Døskeland & Strömberg, 2018).

The average lifetime of a fund is ten years but varies from fund to fund. In the case of a ten-year fund, the investment period usually lasts about six years. During the investment period, the PE fund calls the LPs' capital as needed, and the LPs are obliged to honor their capital commitments when called upon. Once the PE fund has exited an investment, typically via a trade sale or an IPO, the proceeds are distributed to LPs according to a waterfall structure which is described later in this section. In case the PE fund has not successfully divested all of its assets by the end of the fund's lifetime, the life of the fund can usually be extended for an additional two or three years if approved by the LPs. PE firms typically manage a sequence of funds at any given time and often start raising a subsequent fund when a prior fund is about to be fully invested, as to obtain a continuous stream of fee income. According to Bain & Company (2019), PE firms had, on average, 3.9 active funds in 2018. Similarly, LPs usually invest in multiple funds across vintage years in order to obtain a certain vintage year diversification. This way LPs achieve a more even stream of cash outlays and inflows, helping them maintain a target PE allocation (Døskeland & Strömberg, 2018).

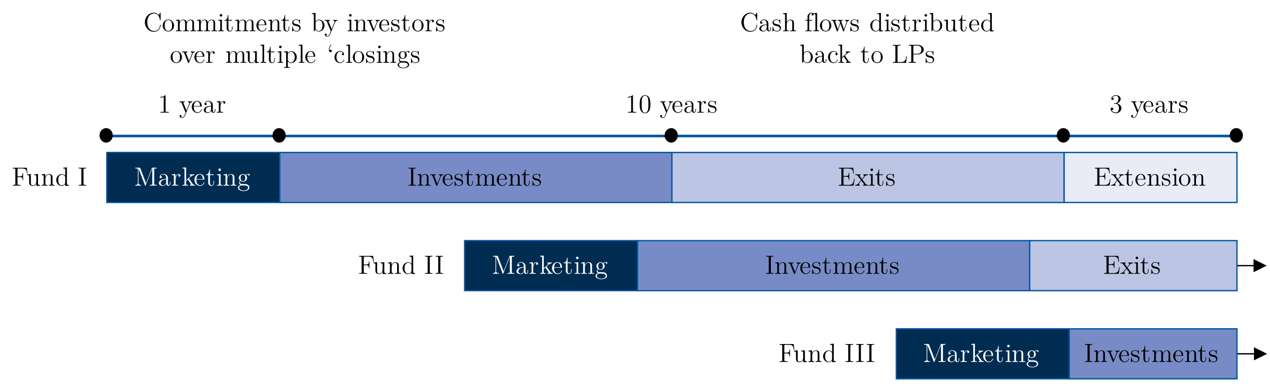

Figure 2.4: Example of PE firm fund sequencing (Døskeland & Strömberg, 2018)

GP compensation consists of two main elements. First, the GP charges a management fee covering ongoing management of the fund as well as costs related to transactions. The management fee is an annual fee in the range of 1.5% to 2.5% of committed capital, often declining after the investment period ends. Second, the GP gets a share of the profits by charging carried interest. The level of carried interest is 20% for most PE funds, with few top-tier funds charging upward of 30%. Typically, the carried interest will be subject to a hurdle rate of 7% to 8%, meaning that the PE fund will not take part in the profits before this hurdle return is reached. Figure 2.5 illustrates the PE model as discussed.

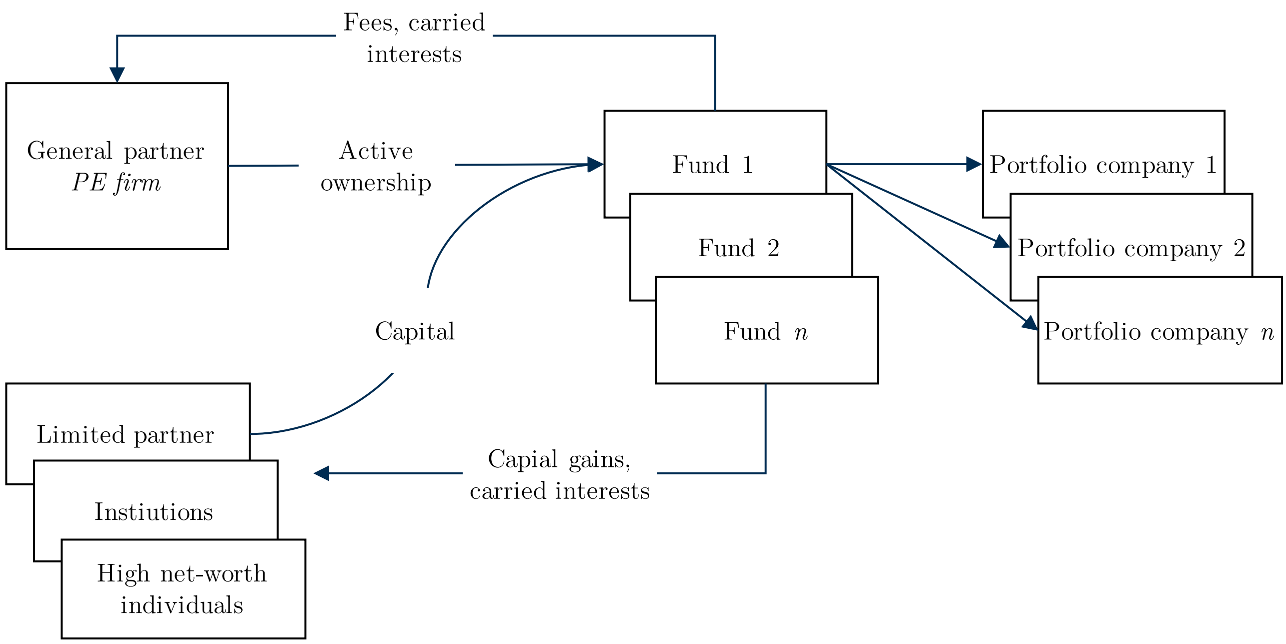

Figure 2.5: The private equity model (Gilligan & Wright, 2014)

Investment proceeds are distributed back to the LPs according to a waterfall structure which, for a fund with a 20/80 fee structure, works in the following way, (1) LPs first receive all cash flows until the invested capital has been fully returned; (2) LPs then receive all cash flows until their IRR equals the hurdle rate; (3) the GP receives all cash flows until profits are shared 20/80 ("catch-up period"); (4) the remaining cash flows are shared between the GP and the LPs 20/80 (Døskeland & Strömberg, 2018). Hence, the LPs will end up receiving a preferred return on the invested capital as well as 80% of any remaining profits.

McKinsey (2017) analyzed fee estimates from CEM Benchmarking and showed that the 2/20 fee structure with an 8% hurdle rate approximately led to an average all-in yearly fee of 5.7% of NAV for LP fund investments. Lower costs were reported for direct investments and co-investments, while fund-of-funds investments had all-in yearly fees close to 8%. However, the fee level varies significantly with the performance of the individual fund.

2.4. Private equity performance measurement

Measuring and evaluating performance in PE is not a straightforward exercise. Cash flow timing is irregular, and LP commitments of various sizes may be called upon at any time. Consequently, returns are calculated in a different way than what is typically done for more liquid asset classes, making benchmarking of returns against other assets difficult. The most widely used performance measures in PE includes the internal rate of return (IRR), the total value to paid-in capital multiple (TVPI), and the public market equivalent (PME). While not as popular in practice, the public market equivalent (PME) measure has gained considerable attention in academia given how the measure compares performance to an alternative investment in a public market index.

2.4.1. Total value to paid-in capital (TVPI)

Total value to paid-in capital is a cash-on-cash measure of how much investors are receiving, calculated by dividing the sum of capital distributions by the sum of capital calls,

$$\mathrm{TVPI} = \frac{\sum \mathrm{distributions_t}}{\sum \mathrm{calls_t}} \tag{2.1}$$

As explained in Section 2.3, capital calls are cash flows from LPs to the GP, including management fees, while distributions are cash flows from the GP to LPs in the form of investment proceeds net-of-fees. For funds that are not yet fully realized, the estimated value of unrealized assets is added to distributions to arrive at the TVPI. The metric is also referred to as the multiple on invested capital (MOIC). The TVPI is often used in PE due to its simplistic nature and given that it provides a scale of return that an investment has given, independent of the length of the fund. Some investors rely more heavily on the distributions to paid-in capital (DPI) metric instead, given that it does not include any assumptions about residual value, but solely calculates the return in terms of realized distributions (BVCA, 2015a).

2.4.2. The internal rate of return (IRR)

The internal rate of return is the discount rate that makes the net present value (NPV) of an investment equal to zero,

$$\sum_{t} \frac{\mathrm{FCF_t}}{(1+\mathrm{IRR})^{t}} = 0 \tag{2.2}$$

The metric is an annualized measure used to compare returns across different time periods. The numerator in Equation 2.2 is the total net cash flows to LPs. In the case of an unrealized fund, the estimated residual value of portfolio investments is also included in the numerator. Unlike the TVPI, the IRR allows an investor to compare investments with different timing of cash flows. However, one should be cautious when looking at the IRR. For funds with long holding periods, or if high returns have been generated early on, the IRR calculations may be significantly skewed (BVCA, 2015a). Due to the above characteristics, the IRR is not directly comparable to buy-and-hold returns as observed in public markets.

2.4.3. The public market equivalent (PME)

As mentioned above, comparing the IRR metric with public market returns is misleading. A better measure for such a comparison is the public market equivalent. This measure is derived from stochastic discount factor models and serves to compare PE returns with public market returns. There are various versions of the PME, but this paper solely focuses on the Kaplan Schoar PME (or KS-PME) presented by Kaplan and Schoar (2005) since this is the most widely used of the PME metrics. The KS-PME is calculated as the present value (PV) of distributions divided by the PV of calls, discounted using realized market returns over the same period,

$$\mathrm{PME} = \frac{\sum \mathrm{distributions_t}}{1+\mathrm{r_t}} \Big/ \frac{\sum \mathrm{calls_t}}{1+\mathrm{r_t}} \tag{2.3}$$

The PME effectively generates a hypothetical investment vehicle that mimics the cash inflows and outflows of a PE fund investment, through buying and selling shares in a public market index. In other words, if an LP had a capital call of \$100 million, the PME assumes that this amount is invested into the hypothetical investment vehicle. Similarly, if \$100 million were distributed back to the LP from the fund, then the \$100 million would be sold from the hypothetical vehicle (BVCA, 2015a). A PME above 1 means that the PV of distributions exceeds the PV of the calls. In other words, the investment in a fund had a positive NPV and outperformed the market benchmark. A downside of the PME is that it is not a return, meaning that it cannot be evaluated using factor models. Additionally, the choice of market benchmark for comparison is not universally agreed upon, which leaves a certain amount of discretion on behalf of the PE manager.

2.5. Is private equity overheating?

This section discusses PE in a broader portfolio context and looks at recent trends for the buyout industry. Empirical data is presented to support the discussion.

2.5.1. Private equity in a broader portfolio context

In 2017, the global asset management industry experienced its highest net inflow of capital since the global financial crisis. BCG (2018) estimates that the total global assets under management (AUM) grew by 12% in 2017 and reached $79.2 trillion. Assuming that BCG's estimates are somewhat correct, the market for private capital, with its $5.2 trillion AUM in 2017, makes up approximately 7% of total AUM globally (BCG, 2018; Preqin, 2018).

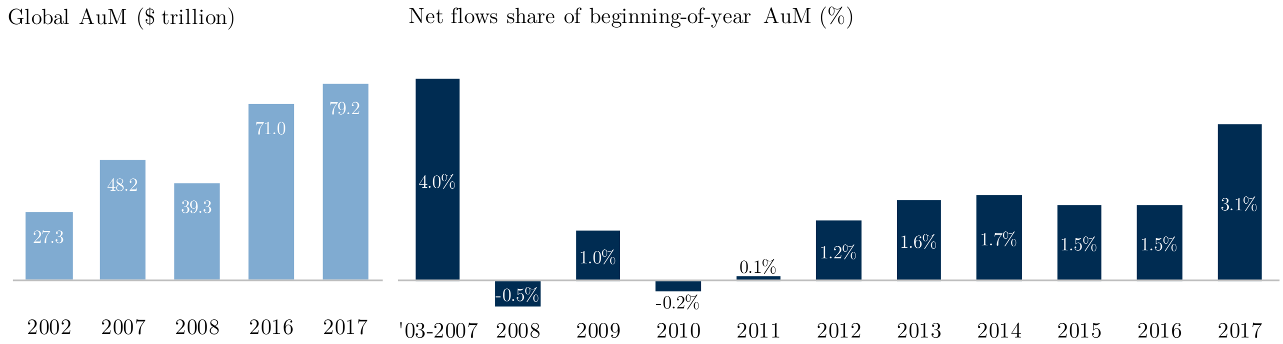

Figure 2.6: Global AUM reached $79.2tn in 2017, supported by record net flows (BCG, 2018)

AUM for private capital has been growing at a compound annual rate of 12% from 2000 until 2018, increasing from $0.7 trillion to $5.8 trillion. The post-crisis economic environment has led to an increase in capital flowing into private capital. Historically low-interest rates have given investors easy access to cheap credit, and the disappointing performance of bonds have helped push investors into alternative assets in the chase for performance.

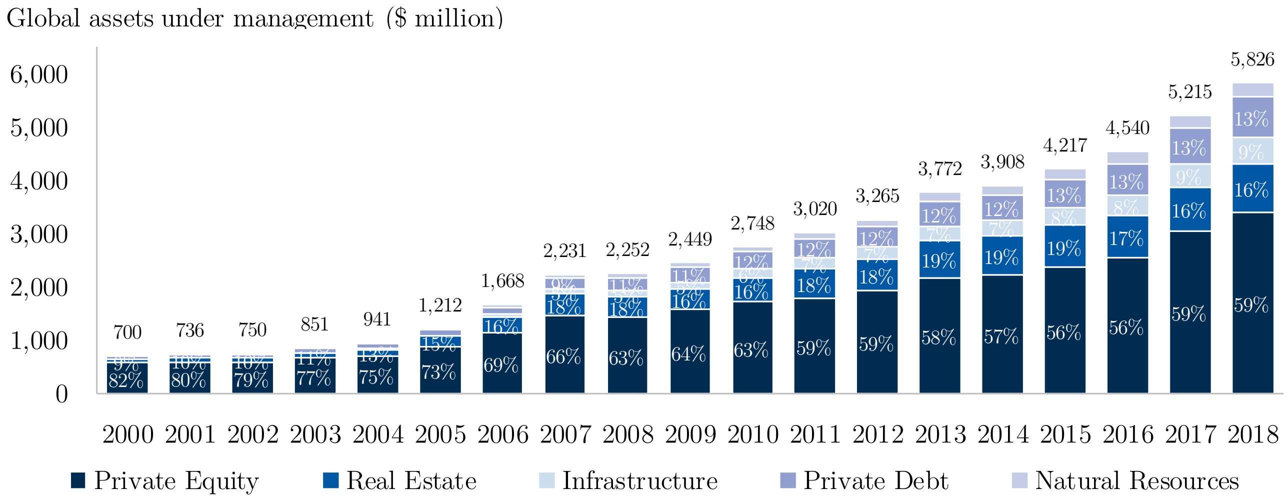

Figure 2.7: PE AUM has increased by 491% since 2000 (Preqin, 2019)

With $3.4 trillion AUM, PE accounted for 59% of all private capital in 2018.[4] $1.8 trillion of this was allocated to buyout funds. The PE industry has experienced steady growth with NAV increasing by a factor of close to 7.5 since 2002 which is more than twice that of public equity markets, as depicted in Figure 2.8. The number of PE-owned companies in the U.S. has increased by 106% since 2006 and totaled around 8,000 companies in 2017. At the same time, the number of publicly listed firms in the U.S. fell by 16% to a total of around 4,300 (McKinsey, 2019).

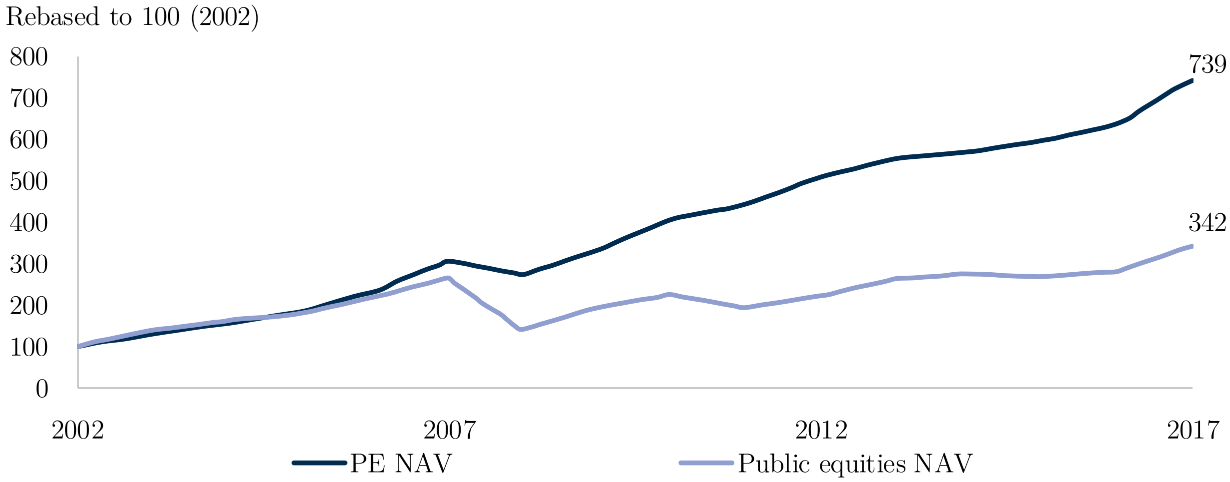

Figure 2.8: PE has outpaced the public markets since 2002 (Preqin, 2018; World Bank, 2019b)
PE net asset value (NAV) = AUM less dry powder; public equities NAV is the total market capitalization of all companies listed globally, as reported by World Bank (2019b).

2.5.2. Deal activity and valuation levels are high, pushing down holding period length

Deal activity in the global buyout industry has picked up following the financial crisis in 2008. In 2018, the total deal value of global buyouts, including add-on transactions, reached $582 billion, up by 10% from 2017. At the same time, the total number of deals reached 2,936, down by 13% compared to 2017. Figure 2.9 provides a picture of global PE deal activity. Despite 2018 not being on par with some of the best years in terms of aggregate activity, the recent five-year period marks the most active period for buyouts globally, both measured by deal value and deal count.

[4] AUM in PE is defined as the sum of dry powder (undrawn capital commitments) and unrealized value across funds.

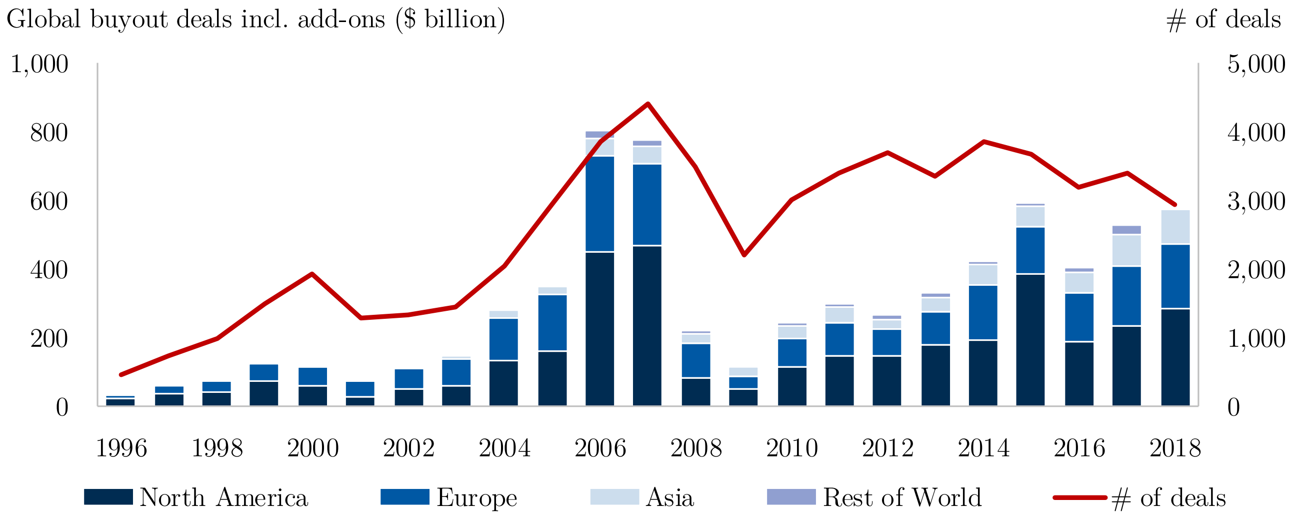

Figure 2.9: Historically high deal value; deal count reflects increasing competition for assets
Deals are limited to buyouts and include add-on acquisitions (Dealogic, 2019).

As the PE space has become more crowded, the increased competition for high-quality assets has pushed up valuation levels significantly. As a result, U.S. buyout valuations reached an all-time high with a median valuation of 12.4x EBITDA in 2018. The median private equity EV/EBITDA purchase multiples alongside the median EV/EBITDA of the S&P 500 since 1993 are plotted in Figure 2.10. As seen in the figure, PE firms have historically been able to acquire companies at lower multiples relative to the broader public market, particularly between 1998 and 2007. However, following the financial crisis, increased competition and capital inflows to PE has close to eliminated this gap. In 2018, the median private equity EV/EBITDA purchase multiple was 12.4x compared to a median EV/EBITDA of 12.8x for the S&P 500.

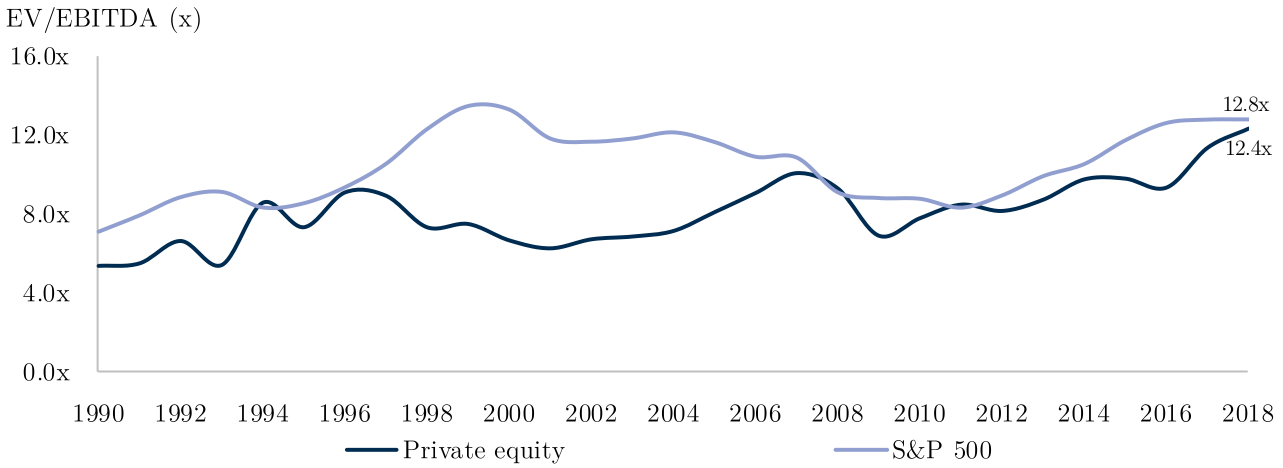

Figure 2.10: The valuation gap between U.S. PE and public equities is shrinking
The private equity EV/EBITDA multiple is computed by taking the mean of median estimates from the following data sources: Cambridge Associates and Capital IQ (1998-2016); PitchBook (2006-2018); S&P Global Leveraged Commentary & Data (2001-2017); a proprietary dataset of this paper obtained from Thomson Reuters and Bloomberg (1990-2018). The S&P 500 median EV/EBITDA multiple is obtained from the Bloomberg Terminal.

Increases in absolute valuation levels can be problematic for buyout funds. Higher purchase multiples call for more debt financing, which leads to higher interest costs and increased risk of bankruptcy. Rasmussen (2018) highlights an analysis on proprietary data from a single PE firm revealing that more than 50% of transactions done at a valuation above 10x EV/EBITDA lost money, with the aggregate TVPI just barely over 1x.

As a response to historically high valuation levels, the average holding period of portfolio companies has decreased in recent years. In 2018, the median holding period fell by 10%, from 5 years to 4.5 years. The median holding period is down by almost 1.5 years from an all-time high of 5.9 years in 2014. As shown in Figure 2.11, 24% of all buyout deals are exited within three years of the acquisition, indicating that so-called "quick flips" are becoming increasingly common again. Shorter holding periods reflect that PE firms can exit at "rich" valuations, but the trend might also reflect a fear of a coming economic downturn, with GPs selling out before a potential recession hits (Bain & Company, 2019).

Global buyout-backed exits, by lenght held in portfolio

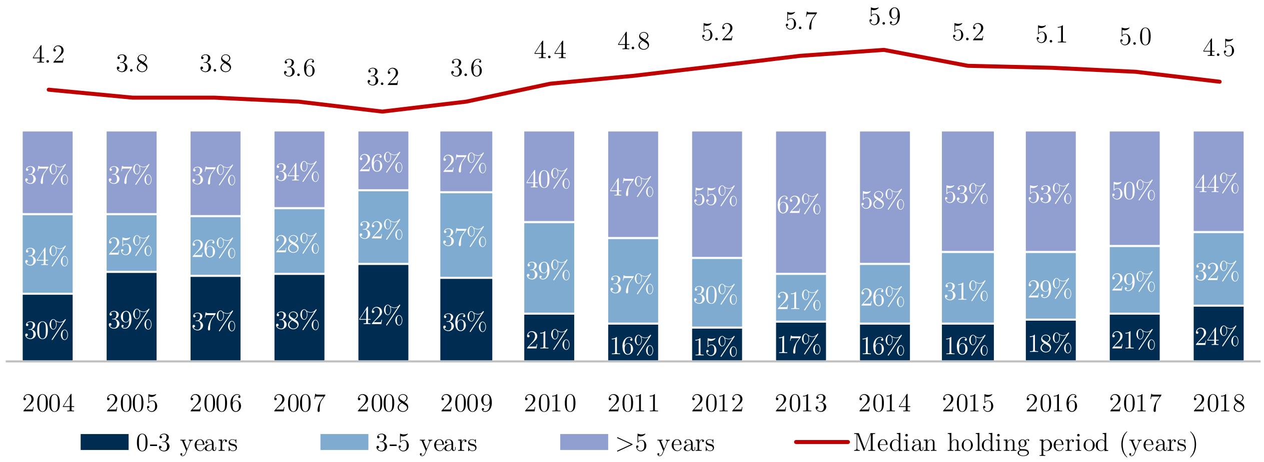

Figure 2.11: The median holding period for GPs are shrinking (Preqin, 2019)

2.5.3. Fundraising and dry-powder continues upward trend

As outlined above, the increased competition for PE assets has pushed valuation levels to all-time highs. As a result, the gap between public and private valuations is shrinking. Almost every year of the past decade has seen an increase in the number of buyout firms. By the end of 2018, the total number of PE firms specializing in buyouts was 1,305 with 46% of these focusing on investments in North America.

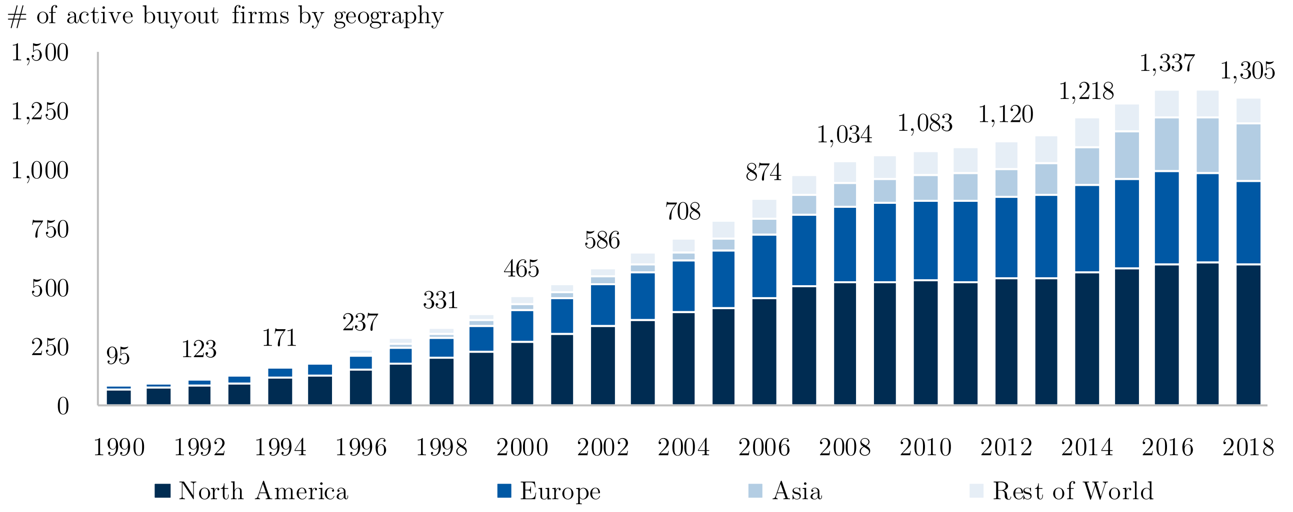

Figure 2.12: The number of active buyout firms continues to increase (Preqin, 2019)
The figure shows the total number of buyout firms (not the total number of buyout funds). A buyout firm is assumed to be active if it has been no more than 10 years since its last fund was raised. Geography is based on fund investment focus.

In 2018, buyout funds raised an all-time-high $320 billion globally, with an average fund size of $1.6 billion.[5] As seen in Figure 2.13, buyout funds have attracted significantly more capital over the past five years than in any other five-year period. The spike in fundraising has primarily been driven by an increased flow of capital toward mega-funds, defined as funds with more than $5 billion in capital commitments. In 2018 mega-funds raised a total $189 billion, corresponding to 59% of the total buyout fundraisings.

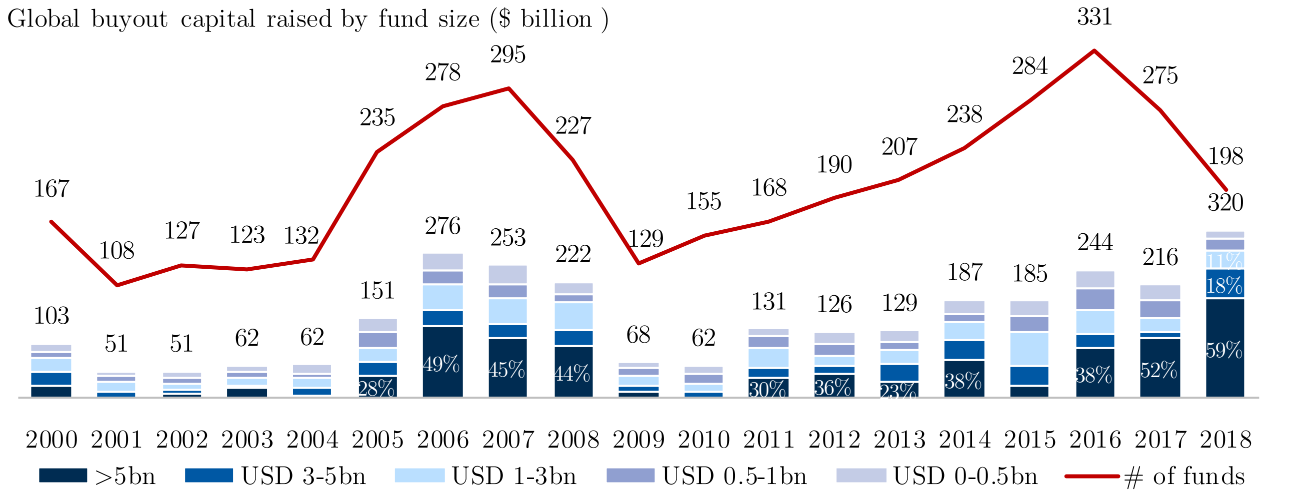

Figure 2.13: Driven by mega-funds, buyout fundraising continues to break records (Preqin, 2019)

Notable fundraisings in 2018 include EQT's $13.2 billion fund, by far the largest buyout fund ever raised by a Nordic PE firm, and The Carlyle Group's $18.5 billion fund VII, the largest

[5] Annual fundraising data counts the capital raised once a fund has held its final close.

fund raised in the firm's history. While LPs consistently rank mega-funds below other fund sizes, they offer an attractive opportunity for LPs to put a significant amount of capital at work (Bain & Company, 2019).

The favorable fundraising environment has left buyout funds with a record amount of capital to spend. This undeployed capital is also known as dry powder. More formally, dry powder is defined as undrawn capital commitments from LPs. By the end of 2018, buyout funds had a record-high \$695 billion waiting to be deployed (Preqin, 2019). While the increase in fundraising is a signal of positive sentiment toward the buyout asset class, the record-breaking dry powder shows that buyout funds are having a hard time putting their capital to work. The increase in idle capital could potentially be troubling for PE firm and could lead to GPs reducing their hurdle rates and invest in opportunities that they would otherwise have passed on (McKinsey, 2019). However, by April of 2019 several premium PE firms, EQT and The Carlyle Group included, have used the current positive market sentiment as an opportunity to launch new funds charging carried interest of up to 30% (The Financial Times, 2019). Thus, it could take a while before sentiments turn and the environment becomes more investor-friendly.

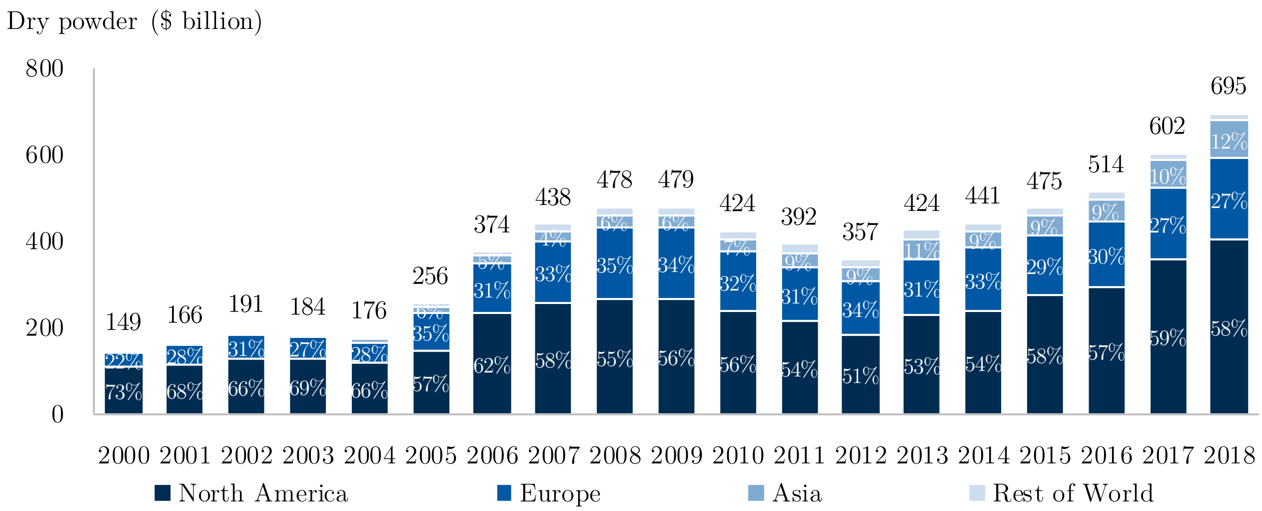

Figure 2.14: Dry powder held by buyout funds reached an all-time high in 2018 (Preqin, 2019)

2.5.4. Investor sentiment remains strong

While the surge in capital inflows has got some investors questioning whether the buyout industry is getting overheated, the most recent survey conducted by Preqin (2018) revealed that, over the past 12 months, 90% of LPs achieved a return from their PE investments that was either in line with or above expectations. 79% of LPs expect to obtain the same performance, or better, over the coming 12 months. By comparison, 34% of LPs in hedge funds experienced returns that were below their expectations, and 32% of LPs expects the performance of their hedge fund investments to be even worse over the next 12 months. The difference between PE and hedge fund performance could come from different investment horizons.

Most of the capital that is distributed to LPs are from funds with vintage between 2009 and 2014, times at which assets in the PE universe were much cheaper. Due to the illiquidity of assets, PE performance reporting is also lagged relative to public market returns which contributes to possible distortions in performance evaluation.

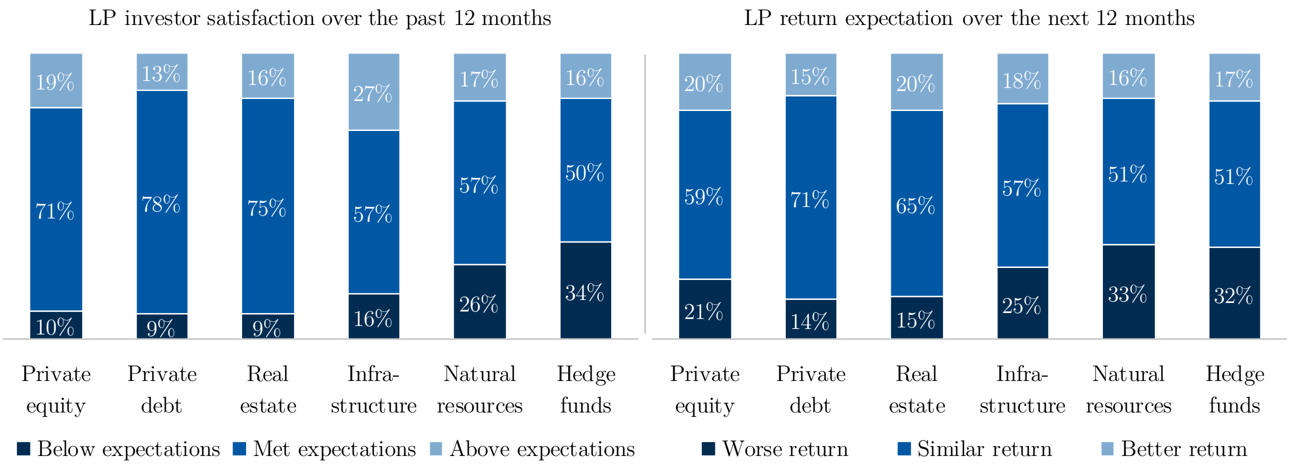

Figure 2.15: PE is still looking attractive in the eyes of the LPs (Preqin, 2018)
LP satisfaction and expectations for alternative investments over the previous and following 12 months as of June 2018. Data is based on interviews conducted by Preqin with more than 380 LPs.

PitchBook (2018) surveyed more than 120 investment managers across the buyout, growth, restructuring, mezzanine, and debt fund landscape. In line with the discussion in this section, valuation levels, lack of quality assets, and fierce competition were ranked as the most critical challenges by fund managers. GPs highlight that an increased focus on operational engineering, add-on acquisitions, and new deal sourcing tactics will be essential for success in this environment.

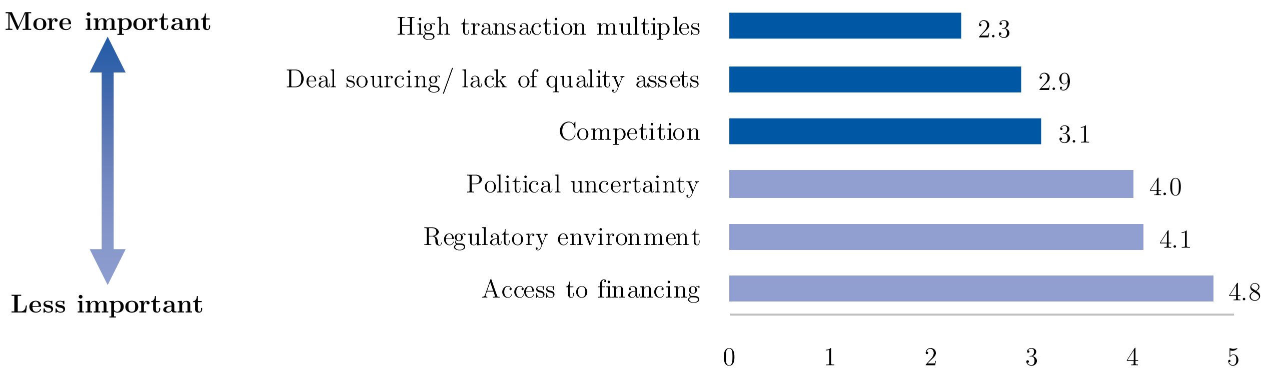

Figure 2.16: Biggest challenges for PE dealmakers in 2018? (PitchBook, 2018)
Results are based on a survey from PitchBook's 2018 Crystal Ball report. Respondents asked; "what do you anticipate to be the biggest challenges for PE dealmakers in 2018?" The ranking is based on the order of importance where 1 is most important, and 7 is the least important.

3. Literature review

This section covers the main findings of research into the risk and return characteristics of PE. To get a better understanding of PE, the ownership model and the theoretical reasons why investors require higher returns for PE investments are discussed. Lastly, the new and growing branch of literature analyzing the replication of PE returns in the public market are covered in great detail. This alternative approach provides a new framework for assessing the risk-return trade-off in PE which has for many years been a "black box" for many investors.

> "The absence of effective monitoring [in public corporations] led to such large inefficiencies that the new generation of active investors arose to recapture the lost value. These investors overcome the costs of the outmoded legal constraints by purchasing entire companies – and using debt and high equity ownership to force effective self-monitoring."
>
> – Jensen (p. 66, 1989)

3.1. Value creation in private equity

A high level of debt funding is a key characteristic of leveraged buyouts, and it is the mechanism that allows the limited partners to acquire large ownership stakes through relatively modest equity investments. While private equity firms have historically had a reputation as "corporate raiders," focused on short term gains and extracting value from portfolio companies for themselves and their limited partners, empirical evidence supports a thesis of long-term PE value creation. Jensen (1989) argues that the private equity ownership model is superior to that of the public corporation in that the PE model is,

> "… built around highly leveraged financial structures, pay-for-performance compensation systems, substantial equity ownership by managers and directors, and contracts with owners and creditors that limit both cross-subsidization among business units and the waste of free cash flow" (Jensen, p. 65, 1989).

Jensen (1989) suggests that the private equity ownership model is superior to that of publicly owned corporations, highlighting that private equity firms use concentrated ownership stakes in their portfolio companies and performance-linked compensation schemes to align incentives between ownership and management, something quite uncommon in publicly owned corporations in the 1980s. The breakthrough of the private equity ownership model happened in the 1980s and was driven mainly by the introduction of high-yield (non-investment grade) bonds, so-called "junk-bonds," by Michael Milken and his firm Drexel Burnham Lambert (Jensen, 1989). The issue of junk-bonds allowed for equity-like risk to be dispersed between countless different investors while maintaining concentrated controlling ownership stakes with the private equity partners.

Jensen (1989) argues that the private equity ownership model would become the dominant form of corporate organization. He noted that this organizational form produced *"…remarkable gains in operating efficiency, employee productivity, and shareholder value"* (Jensen, p. 61, 1989). These improvements were primarily credited to the model solving the primary source of conflict between management and shareholders, the fight for control- and use of corporate resources.

Public markets offer easy access to capital which makes it a particularly attractive source of financing for companies that have high growth-prospects and an abundance of attractive investment opportunities. On the other hand, Jensen (1989) argues that the public ownership model might not be the most suitable for high cash-flow generating companies that have slow long-term growth prospects and limited viable investment opportunities. Jensen (1989) suggests that the management of companies in the latter category will be tempted to deploy excess cash in a manner that is not the most beneficial for shareholders. On the other hand, the extensive use of financial leverage used in LBOs makes for a capital structure that incentivizes a more efficient corporate governance. With high-yield debt replacing much of the equity in more "traditional" publicly owned companies, the LBO model concentrates equity ownership.

Jensen points to four main differences between PE-owned companies and publicly held companies. First, a strong relationship between pay and performance aligns incentives of ownership and management. Second, LBO firms are more decentralized with PE offices being much smaller than the corporate offices that they ultimately oversee. Third, the heavy use of debt financing means that PE firms can acquire control of corporations without putting down as much money for equity as would otherwise have been the case. Fourth, well-defined obligations between creditors and residual claimants ensure that free cash is allocated more efficiently between stakeholders.

Kaplan and Strömberg (2009) sum up the key advantages of the PE model as three different kinds of engineering, governance, financial, and operational that PE managers introduce in portfolio companies. They call these "the levers of value creation." Governance engineering captures the way that the PE firms use common equity ownership as a means to align the interest of owners and management of the portfolio company. When acquiring a controlling stake in a company, private equity firms usually award management with considerable equity upside through equity and stock options. Kaplan (1989) estimated that average management equity ownership increased four-fold in companies that were acquired in public-to-private transactions during the 1980s. Studies of public-to-private transactions in the United States and the United Kingdom between 1996 and 2004 found that, when a company was taken private, the average CEO received 5.4% and 3.0% equity, respectively. The broader management team, on average, received 16% and 15%, respectively (Kaplan & Strömberg, 2009; Acharya, Gottschalg, Hahn, & Kehoe, 2012). While it is now much more common for public companies to have incentive-pay-schemes, in particular for high-level executives, the portion of equity awarded in public companies is significantly smaller compared to that of PE-owned firms. Critics of the public ownership model argue that specific characteristics of this model such as frequent disclosure requirements, incentivize management to focus on quarterly performance instead of the long run. The fact that private company equity is illiquid reduces the risk of management being blinded by so-called "short-terminism." This is argued to be true because management will only be rewarded if they prove themselves through a successful exit – typically an IPO or sale to a strategic buyer.

Aside from limiting agency conflicts by aligning management and investor interests the concentrated ownership of private companies also leads to a more actively engaged shareholder base. Private equity investors control the boards of their portfolio companies, boards that are typically smaller than those of public companies with more frequent board meetings.[6] Research on the relationship between the size and structure of boards and firm performance and characteristics find that companies with smaller boards dominated by outside members generally perform better (Hermalin & Weisbach, 1998; Coles, Daniels & Naveen, 2008). Private equity-owned companies replace one-third of their chief executives within the first 100 days of ownership and another two-thirds within the four years following the acquisition; thus, the boards of these companies seem very committed to upholding management accountability (Acharya et al., 2012). Private equity investors are generally also very structured in their implementation of procedures and routines from which they exercise governance through detailed business plans, KPIs, project implementation and general monitoring (Døskeland & Strömberg, 2018).

Second, PE firms use financial engineering to create value in their portfolio companies. Financial engineering refers to the capital structure changes that PE firms implement in their portfolio companies. Bifurcation of the capital structure with different tranches of debt and inclusion of shareholder loans results in a very slim portion of equity capitalization which allows for both the fund and management to acquire relatively larger equity stakes than what would otherwise have been the case (Levin, Perl & Hirschtrittr, 2004). Besides levering the returns of investors, Jensen (1986) argues that debt is a powerful agent for change. Unlike share buybacks and dividend payments, debt payments are not discretionary, and because of this, they can force companies to rethink strategies and business models. Thus, by limiting excess cash, which can work as a pillow and allow companies to sustain inefficient operations, debt forces management to allocate capital more efficiently.

[6] According to Acharya and colleagues (2012) private equity owned companies in the United Kingdom have around 12 formal meetings per year and many more meetings of informal character.

In addition to the incentive benefits, leverage also provides tax benefits through the tax deductibility of interest payments. However, Axelson and colleagues (2013) provide evidence that the tax benefits of debt are typically priced into LBO transactions, meaning that they mostly benefit the selling shareholders rather than the PE investors. Additionally, the tax deductibility of interest payments has been decreased in various countries, limiting the potential for buyout firms to acquire companies purely to extract the tax benefits of leverage.

The benefits of leverage are ultimately traded off against the increased risk of financial distress by the PE firms. All else equal, evidence point to PE-owned firms being able to sustain a higher degree of leverage given the PE firm's ability to inject more capital if needed as well as the expertise of various PE firms in handling restructuring situations (Hotchkiss, Smith, & Strömberg, 2016). Gompers, Kaplan, and Mukharlyamov (2016) revealed in their survey of 79 private equity firms that around two-thirds of PE firms use leverage to maximize the trade-off between tax benefits and the risk of default, while 40% use leverage to force operational improvements. Additionally, roughly two-thirds of the PE firms surveyed responded that they use as much debt as the markets allow when financing transactions.

Finally, PE firms add value to their portfolio companies by bringing industry and operating expertise to their portfolio companies; this is referred to as operational engineering. As the PE industry is becoming more mature and competitive, operational engineering plays an increasingly important role for buyout firms (Døskeland & Strömberg, 2018). PE firms increasingly organize around industries and hire professionals with operating backgrounds. An example of this is the PE firm Clayton Dubilier & Rice who hired Jack Welch in 2001 as a Special Advisor following, his 20-year tenure as CEO at General Electric. Additionally, most PE firms make use of specialized internal and external consulting groups (Kaplan & Strömberg, 2009). Buyout firms use their industry and operating expertise to identify attractive investment opportunities and develop strategic value-creation plans at the time of investment. Areas of post-acquisition value creation include cutting costs, increasing productivity, strategic repositioning, add-on acquisitions, as well as management changes (Kaplan & Strömberg, 2009).

To summarize, the levers of value creation in PE can broadly be covered under the areas of governance-, financial-, and operational engineering. While the active management of public equities is more of a zero-sum game, proponents of the PE model would argue that PE firms add value to their portfolio companies and increases total value in the economy (Døskeland & Strömberg, 2018; Fama and French, 2010).[7] However, the proposed value added to portfolio companies does not necessarily lead to superior returns for LP investors due to the steep fees paid to PE managers and the significant transaction premia paid to sellers.

[7] An exeception to this is activist investing which emperically has been shown to increase firm performance (Becht, Franks, Grant, & Wagner, 2017).

3.2. Why should investors require higher returns from PE investments?

A critical insight from asset pricing theory is that the expected return of an asset is dependent on its risk, more precisely, its undiversifiable systematic risk coming from the asset's market exposure. According to Døskeland and Strömberg (2018), there are three main reasons why PE investments might earn a premium relative to public markets. First, PE investments are illiquid; this makes them riskier than investments in liquid assets and is why investors believe in a liquidity premium. Second, the average PE investment may have risk factor loadings that are different from those of public companies. Third, assuming the existence of risks that are unique to PE, investors should be compensated for these through a premium.[8]

3.2.1. Liquidity risk

Because of the inherent illiquidity of PE investments, holding everything else equal, an investor would be willing to pay a higher price for a share in a public company vis-à-vis a private company – this is captured by the liquidity premium (or illiquidity discount). The liquidity premium is one of the most popular explanations for why the PE asset class should earn an excess return over public equities and is often cited by LPs as a motivating factor for investing in PE. For instance, the California State Teachers' Retirement System (CalSTRS) states that "*Illiquid investments offer investors a return premium due to the inability to quickly buy, sell or convert them to cash as quickly as liquid or freely traded assets. CalSTRS believes it can capture this risk premium by investing in real estate, private equity and other similar assets.*" (CalSTRS, p. 2, 2018).

As LPs typically invest in PE through funds, their primary concern is always to have appropriate financing for their investments; that is, there is an inherent funding risk. As outlined in Section 2.3, during the investment period of a fund, the PE manager will call LP commitments as needed, and LPs are obliged to honor their capital commitments. As a result, in the early years of a fund, LPs will see net negative cash flows, whereas later on when investments are realized, the net cash flow will turn positive, resulting in a payout profile known as the J-curve. These irregular cash flows demand a certain level of liquidity management on the part of LPs so that they are always able to meet capital calls.

In practice, LPs often manage this funding risk through vintage diversification, investing in PE funds across different vintage years such that distributions of older funds can cover the calls of younger funds, thereby smoothening out the net cash flows (Robinson and Sensoy, 2016). Robinson and Sensoy (2016) analyzed vintage diversification for a sample of LPs and found that vintage diversification can limit the funding risk, while it does little to limit the systematic market risk of the investments. More specifically, they show that net aggregate

[8] An alternative approach of measuring PE premia that takes into account all the above points and measures the expected return of PE, in excess of the public markets, is presented in Appendix A as put forward by Ilmanen et al. (2019).

cash flows for LPs are pro-cyclical, on average. In line with this finding, Lerner and Schoar (2004) showed that the secondary market for LP interests is illiquid, limiting the possibility for LPs to sell their PE fund shares at reasonable prices. In summary, the PE asset class is exposed to a higher degree of both market and funding liquidity risk compared to public markets. Because of this added layer of risk, investors should demand an excess return, an illiquidity premium, over the market.

3.2.2. Investment selection and loadings on risk factors

A central thesis in asset pricing theory is that the expected return of a financial asset can be explained by the asset's exposure to various risk factors. Treynor (1961), Sharpe (1964), Lintner (1965), and Mossin (1966) derived the capital asset pricing model (CAPM), to help explain the relationship between systematic market risk exposure and expected return for financial assets. The model rests on the assumption that investors can diversify away all non-systematic risks, leaving only the systematic risk component. The systematic risk is captured by β_i and is defined by the following equation,

$$\beta_i = \frac{\mathrm{Cov}[r_i, r_m]}{\mathrm{Var}[r_m]} \tag{3.1}$$

The expected return for a financial asset in the CAPM setting is then a linear function of the sum of the risk-free rate and the exposure to the market risk premium defined as follows,

$$\mathrm{E}[r_i] = \alpha + \beta_i(\mathrm{E}[r_m] - r_f) + r_f, \tag{3.2}$$

implying that investors will require a higher return as compensation for bearing systematic risk. Despite being the most well-known asset pricing model, the CAPM has been criticized in academia for its poor empirical record (Fama & French, 2004). Fama and French (1993) build on the insights from the CAPM, introducing the SMB (small-minus-big) and HML (high-minus-low) factors, capturing the public market equity premia relating to size and value, respectively. The authors found that stocks with "low" price-to-book ratios and "small" market capitalizations outperformed companies with "high" price-to-book ratios and "big" market capitalizations. This relationship is explained by the three-factor model,

$$\mathrm{E}[r_i] = \alpha + \beta_i(\mathrm{E}[r_m] - r_f) + \beta_s(SMB) + \beta_v(HML) + r_f \tag{3.3}$$

Fama and French (2015) later updated their asset pricing model by including the RMW (robust-minus-weak) and CMA (conservative-minus-aggressive) factors. The two factors capture premia related to profitability and re-investments, respectively. Including the RMW and CMA factors give the following five-factor model,

$$\mathrm{E}[r_i] = \alpha + \beta_i(\mathrm{E}[r_m] - r_f) + \beta_s(SMB) + \beta_v(HML) + \beta_r(RMW) + \beta_c(CMA) + r_f \qquad (3.4)$$

Researchers have also found empirical support for other risk factors in asset pricing, including WML (winners-minus-losers) by Carhart (1997), liquidity by Pástor and Stambaugh (2003), BAB (betting-against-beta) by Frazzini and Pedersen (2014) and QMJ (quality-minus-junk) by Asness, Frazzini and Pedersen (2014) among others. Applying these insights from asset pricing theory, Frazzini, Kabiller, and Pedersen (2018) studied Berkshire Hathaway's historical performance and found a positive alpha when controlling for traditional risk factors. However, when introducing Betting-Against-Beta (BAB) and Quality-Minus-Junk (QMJ) as additional risk factors, Buffet's alpha became insignificant. These results imply that the historical performance of Buffet and Berkshire Hathaway has not been due to luck, superior skills nor magic, but rather a reward for exposure to stocks that are cheap, safe and of high quality.

Various papers have estimated the systematic risk exposure of buyout funds, both based on fund-level and portfolio company data. At the fund-level, several approaches have been proposed to estimate systematic risk, resulting in beta estimates ranging from 0.7 to 2.0 (Jegadeesh, Kräussl, & Pollet, 2015; Ang, Goetzmann, & Phalippou, 2018; Stafford, 2017). At the portfolio company level, beta estimates range from 1.0 to 2.4 (Axelson, Sørensen, & Strömberg, 2014; Franzoni, Nowak, & Phalippou, 2012). Comparing PE risks and returns with traditional risk factors, however, is not as straightforward as it is with publicly traded assets. PE asset values are only marked-to-market upon entry, and exit of investments and accounting-based NAVs for unrealized investments are only updated a few times a year with significant reporting lag. The combination of stale prices and a certain degree of manager discretion in the marking of these means that reported PE returns have artificially low covariance with the market (Axelson et al., 2014; Stafford, 2017). This smoothing of returns leads to a downward bias in beta estimates based on fund-level data.

Welch and Stubben (2018) argue for the existence of a "diversification illusion" in PE. They show that the use of different accounting standards can result in a doubling of perceived market risk. While pointing out that the implementation of fair value accounting principles in 2006 has been an improvement, stale prices and manager discretion in marking asset values still masks the correlation between PE and the market. Furthermore, they highlight the problem that managers of capital have an incentive to invest in PE for the accounting benefits alone.

Jegadeesh and colleagues (2015) use market prices of publicly traded funds of funds (FOFs) and publicly traded direct PE funds to estimate the systematic risk of PE. Given that market prices are observed directly under such an approach, systematic risks of PE can be estimated using a standard time-series regression approach. The beta estimates for the listed FOFs and listed PE funds are 0.7 and 1.1, respectively, using the S&P 500 as the market benchmark (Jegadeesh et al., 2015). Additionally, positive loadings on the Fama-French SMB and HML factors are observed. A pitfall of Jegadeesh and colleagues' (2015) methodology is that the return of these FOFs and listed PE vehicles are affected by various stock market factors that are unrelated to the underlying PE investments. Hence, the risk of investing in publicly traded FOF or PE vehicles might not accurately represent the risk of PE fund investments.

Axelson and colleagues (2014) argue that a beta of around 1 likely understates the systematic risk of investing in PE and describes a PE market beta estimation of 1 as a "beta puzzle." The argument builds on the finding from Axelson and colleagues (2013) who showed that public companies on average had leverage of about one-third, while buyouts had leverage of about two-thirds. In other words, PE firms tend to lever up firms 2 times relative to their peers in the public market. If the average buyout target has a beta of 1, applying 2 times leverage would be more consistent with a beta of 2 in a Modigliani and Miller (1958) framework. Building on these insights, Axelson, and colleagues (2014) simulate the performance of 3,000 individual transactions and find betas of 2.2-2.4 based on performance gross-of-fees.

Most recently, Ang and colleagues (2018) proposed a Bayesian framework to estimate PE quarter-by-quarter returns from cash flow data. In their approach, the return is derived by finding discount rates that produce the smallest errors in the fund-level NPV equations over time and across funds. The intuition behind the methodology is that the *"… present value of capital distributions is equal to the present value of capital investments when the discount rate is the time series of the average realized returns across the set of underlying illiquid investments"* (Ang et al., p. 1753, 2018). Using their return computation for PE performance data from 1994 to 2015, Ang and colleagues (2018) find market beta estimates for U.S. buyout funds ranging between 1.2 and 1.8 based on a simple CAPM-model and various factor models. In line with Stafford (2017) the authors find that, after controlling for Fama-French risk factors SMB and HML as well as the Pástor-Stambaugh liquidity factor, the alpha for their U.S. buyout sample goes to zero.

Stafford (2017) examines whether an investor can *"… replicate the risks and returns of a diversified private equity allocation with passive investments in public equities using similar investment selection, holding periods, leverage, and the calculation of portfolio net asset value under a hold-to-maturity accounting scheme"* (Stafford, p. 1, 2017). Based on the financials of a sample of 711 public companies taken private in buyout transactions, the paper argues that buyout funds select relatively small firms with value characteristics. Following the analysis of buyout target characteristics, the author constructs both a PE-replicating portfolio, consisting of stocks similar to buyout targets, and a value portfolio sorted on EV/EBITDA multiples. Assuming 2 times leverage, both portfolios have betas close to 2, in line with Modigliani and Miller's (1958) framework. The exposure of the replicating portfolios to other risk factors, like the Fama-French factors as well as Pástor and Stambaugh's (2003) liquidity factor, are left unexplored in the paper. Nevertheless, the paper argues that the excess return of PE investments can be adequately explained by commonly known risk factors spanning public equity markets.

To summarize, many of the findings from existing literature on systematic risk exposure in PE has been challenged by the fact that asset prices are not regularly marked-to-market, making it difficult to estimate risk using traditional time-series regressions. Researchers have used various approaches to estimate systematic risk with beta estimates ranging from 0.7 to 2.4, with estimates in the low end likely biased downward due to artificial smoothing of reported PE fund returns. Several studies also support the thesis that PE investors lean toward relatively small companies and companies that trade at lower multiples compared to the average publicly listed company. A final summary of the most critical findings and approaches to estimating systematic risk at the fund-level is presented in Table 3.1.

Table 3.1: Overview of papers estimating risk exposure in PE

This table summarizes previous literature on systematic risk estimation in private equity. MktRf, SMB, HML, RMW, and CMA are the 5 Fama-French factors. WML is the momentum factor introduced by Carhart (1997), BAB is the return to low-beta stocks as introduced by Frazzini and Pedersen (2014), and LIQ is the traded liquidity factor introduced by Pástor and Stambaugh (2003)

	Axelson et al. (2014)	**Jegadeesh et al. (2015)**	**Stafford (2017)**	**Ang et al. (2018)**
Approach	Looks at individual PE deals in a continous time model	Estimates risk exposure from publicly traded FoFs and PE vechicles	Constructs replicating portfolios of public firms similar to LBO targets	Bayesian estimator used to generate underlying returns of PE from cash flows
Data	2075 individual buyout transactions obtained from a large LP	24 PE FoFs and pubicly traded PE vehicles	All firms in the CRSP universe are used to construct portfolios	U.S. buyout funds with vintage between 1994 and 2008, from Preqin
MktRf	2.2-2.4	0.7-1.1	1.8-2.0	1.2-1.8
SMB	n.a.	0.5-0.6	n.a.	0.0-0.6
HML	n.a.	0.3-0.4	n.a.	0.3-0.7
LIQ	n.a.	n.a.	n.a.	0.3-1.1
RMW	n.a.	n.a.	n.a.	1.1
CMA	n.a.	n.a.	n.a.	0.3
MOM	n.a.	-0.1-0	n.a.	n.a.

3.2.3. Other PE performance predictors

The excess return of PE over public equities may also be explained by performance predictors that are specific to the asset class. Vintage year performance for buyout funds decreases with the amount of capital committed to buyout funds, both on an absolute level and relative to total capital deployed in the public market (Harris et al., 2016). Kaplan and Schoar (2005) show that PE firms that performed better than average in their latest fund are likely to outperform with their subsequent fund as well. In other words, performance persistence might help explain fund outperformance and point to superior investment skills of some GPs.

3.3. Traditional private equity performance evaluation

This section focuses on fund performance as measured by the IRR, TVPI and PME metrics. Due to its ability to measure the relative performance of PE, the PME is widely popular in academia. However, the IRR and TVPI are, despite their limitations, the most popular metrics among professionals (Gompers et al., 2016). In a survey of 79 PE funds with combined AUM of more than $750 billion, Gompers and colleagues (2016) found that around two-thirds of the PE investors reported that absolute performance measures are the most critical performance metrics for their LPs. Only in less than 8% of the cases, did the PE fund managers believe that LPs view the PME as the most crucial return measure.

Harris and colleagues (2014; 2016) use data from the Burgiss database to analyze fund performance in a historical setting. Harris and colleagues (2016) find that U.S. buyout funds consistently outperform the S&P 500 with an average PME of 1.20 between 1984 and 2010, exceeding 1.0 in all three decades. Over the same period, the average IRR and TVPI are 15.7% and 2.02x, respectively. The PME exceeds 1.0 for 23 of the total 27 vintage years in the sample. These results suggest that U.S. buyout funds have been able to consistently outperform the S&P 500 by 20% over the life of a given fund, corresponding to 3% by year. Most recently, funds with post-2005 vintages have had performances roughly in line with the S&P 500. However, with newer funds not fully realized, one should be careful drawing conclusions based on return data from these. The average PMEs between 1984 and 2010 remain higher than 1.0 when using other benchmarks such as the Russel 3000, Russel 2000 and versions of the S&P 500 levered 1.5 and 2 times. The performance results of Harris and colleagues (2016) are reported in Appendix B. Robinson and Sensoy (2016) estimate fund performance in a historical setting using proprietary data from LPs instead of commercial data providers, obtaining results that are economically similar to those obtained by Harris and colleagues (2016). The similarity of the results points to reasonable robustness of the data.

Harris and colleagues (2016) find that vintage year performance for buyout funds decrease with the aggregate amount of capital committed to buyout funds. This relationship holds both on an absolute basis and relative to total capital deployed in public markets. The authors use the aggregate capital commitments to buyout funds as a proxy for dry powder. They find that investors have historically been better off investing in funds from vintage years with low aggregate dry powder. The authors also study fund size and performance but find no significant relationship between the two.

Researchers have also studied performance persistence in PE funds. Kaplan and Schoar (2005) pioneered the research on performance persistence, showing that PE firms whose latest fund has performed better than average are more likely to significantly outperform with their next fund as well. However, Harris and colleagues (2014) argue that the performance persistence of buyout funds have gone down since Kaplan and Schoar (2005) first documented this. Additionally, as the performance of a prior fund is not always fully known at the time LPs decide to commit to a subsequent fund of a PE manager, it can be hard for an LP to make investment decisions based on these insights (Phalippou, 2010). Various predictors of fund performance remain unexplored in the literature, including how valuation levels, both on an absolute basis and relative to the public market, influence subsequent fund performance. This unexplored area of research is analyzed in Section 5 of this paper.

3.4. Replicating private equity in public markets

As discussed previously, value creation in PE can be separated into three different components, namely, financial-, governance-, and operational engineering. An alternative way to look at this is to separate the value creation into an active component and a passive component. While many PE managers would argue that most of the value that they create stems from their active involvement in portfolio companies, elements like leverage, long holding periods, asset selection, and the use of different accounting schemes are passive and arguably does contribute to the value creation process. Chingono and Rasmussen (2015), and Stafford (2017) argue that investors can replicate the return distribution of private equity by creating portfolios that mimic the typical characteristics of companies acquired by PE funds. This discussion is highly relevant in the context of the recent growth of PE as outlined in Section 2, with global hedge funds such as AQR and Man Group working on providing investors with liquid PE alternatives (The Financial Times, 2018).

Using a sample consisting of all U.S. stocks listed between 1964 and 2014 from the CRSP database, Chingono and Rasmussen (2015) developed a ranking system for creating a leveraged small value portfolio, which prioritizes smaller, cheaper and more leveraged stocks. Annual portfolios of the top 25 stocks in the ranking system had a CAPM alpha of 9.6% and a CAPM beta of 1.7 in the period 1965 to 2013, significantly outperforming the broader market. Chingono and Rasmussen (2015) argue that PE outperformance can be boiled down to the use of leverage to finance acquisitions of cheap (value) companies. A significant advantage of the private ownership model is that differences in accounting schemes mask the volatility of the levered investment strategy (Chingono & Rasmussen, 2015).

> "The greatest challenge to this strategy is the volatility of returns, which is significantly higher than broader market indices. Private equity has solved this problem by taking the companies private and thus masking the price volatility."
>
> – Chingono & Rasmussen (p. 26, 2015)

Stafford (2017) identifies (1) asset selection, (2) long holding periods, (3) financial leverage, and (4) conservative estimates of portfolio NAVs as key passive elements of the PE investment process that can be replicated in a public market investment strategy. He constructs two portfolios, a "PE-select" portfolio that is sorted based on a predictive regression of characteristics of LBO targets as well as simple value portfolio sorted on EV/EBITDA multiples. In order to create the PE-select portfolio, Stafford (2017) analyzes the characteristics of PE targets by regressing the financials of public companies on a binary variable indicating whether a company was acquired in an LBO. He finds that PE funds target relatively small firms, with low recent net equity issuance, low profitability, and low EV/EBITDA.

Both portfolios are designed to incorporate long holding periods of investments, financial leverage, and conservative estimates of portfolio NAVs. Stocks in the replicating portfolio are held for at least six months. Investments that reach an annualized return of more than 50% after the first six months are sold off, while others are held for 3 years. Both portfolios are levered 2 times using a margin account to mimic the use of debt financing in PE. By comparing the results using both mark-to-market and hold-to-maturity accounting schemes, Stafford (2017) shows the smoothening effects that infrequent and conservative marking of net asset values can have on reported fund performance.

The PE-select and value portfolios earn compound average annual returns of 20.0% and 18.6%, respectively. Due to the use of leverage, both have betas close to 2. With drawdowns close to 90% during the great financial crisis, both portfolios exhibit extreme volatility. In comparison, the maximum drawdown of the CA U.S. Buyout Fund Index was less than 25%. The author also shows that using a hold-to-maturity accounting scheme, the drawdowns of the PE-select and value portfolios would have been reduced to just 27% and 32%, respectively. In this case, portfolio market beta estimates are close to zero. Hence, Stafford (2017) shows that the discretion of not marking the replicating portfolios to market could eliminate most of the measured risks.

Stafford (2017) finds that the returns of the replicating portfolio and the PE return benchmark are remarkably close, before fees, while the PE return benchmark seems to underperform relative to the passive replicating portfolios, after fees. Based on these findings, he questions if PE managers add enough value, beyond what can be replicated in public markets, to justify the current fees paid in the industry.

> "After paying fees, which are estimated to be 3.5% to 5% per year, investors who agree that the risk-match between the private equity index and the two replicating portfolios is appropriate are considerably underperforming the feasible alternative of investing in similar passive replicating portfolios."
>
> – Stafford (p.26, 2017)

In his critique of Stafford's (2015) findings, Kaplan (2016) argues that getting access to the risk factors of the replicating portfolios involves investing in public companies that are often too small and illiquid for institutional investors.[9] While the risk factor loadings of PE investments may be replicable using public equities, Kaplan (2016) argues that PE might still be a cheaper and more efficient way of getting exposure to these risk factors compared to implementing the strategy proposed by Stafford (2015). Another way to understand this point would be to consider an example. As seen in Figure 2.7, global PE funds had approximately \$3.4 trillion in AUM by the end of 2018, of which U.S. buyout funds had approximately \$1 trillion in AUM. Assuming 65% debt financing, this would imply investing roughly \$2.9 trillion in small value stocks. However, the total market capitalization of the Russell 2000 Index, representing the U.S. small-cap market segment is only at \$2.5 trillion (FTSE Russel, 2018). At the same time, 30-40% of the Russel 2000 Index is made up of financial companies not typically targeted by buyout funds. Hence, it seems quite clear that it would not be possible to invest in replicating public market portfolios of small value stocks at a scale that matches the U.S. buyout industry. Nonetheless, Stafford's (2017) alternative approach has paved the way for a new stream of literature and provides LPs with new insights concerning risk and return characteristics of PE investments.

[9] Kaplan's (2016) critique is based on Stafford's (2015) first working paper draft. However, the results and main conclusions are economically similar to those of Stafford (2017).

4. Data

This section focuses on the sources of data used in this paper and discusses any potential issues that might stem from using this. First, we discuss the sources of data used to analyze buyout fund performance in Section 5 and 6. Second, we go through the data used in the analysis of U.S. buyout target characteristics in Section 6.1.

4.1. Private equity fund-level performance data

Historically, PE research has been challenged by the difficulty of obtaining high-quality performance data. Privately held companies are not under the same disclosure requirements as publicly listed companies, and GPs are therefore not required to disclose fund performance publicly. Additionally, the lack of mark-to-market pricing in PE makes it more challenging to obtain high-quality data at the fund-level. Five major data providers have built comprehensive datasets of PE industry returns, namely Burgiss, Cambridge Associates, PitchBook, Preqin, and Venture Economics.

For the traditional PE performance evaluation in Section 5, we use PE performance data from Preqin. The Preqin database contains data collected from public filings, data sent in by GPs, and by requesting information from LPs. On their website, Preqin states that *"... 60,000 fund managers, institutional investors and service providers use our data to stay ahead in the alternative assets market"* (Preqin, 2019). Preqin's data is primarily collected from quarterly Freedom of Information Act (FOIA) requests, where investors such as CalPERS, Washington State Investment Board and Florida State Board of Administration provide information on capital invested, realizations, and net asset values every quarter. For this reason, Preqin may be missing data on PE firms that refuse to accept public pension funds as investors, precisely because they are subject to FOIA requests. Additionally, the data stemming from the FOIA requests on Preqin are quarterly aggregations of cash flows, rather than individually timed cash flows, as in the Burgiss database that sources data directly from LPs.

In addition to the FOIA requests, more than 1,300 GPs voluntarily share performance information on their funds with Preqin. Given that prospective investors in PE funds are using Preqin to evaluate fund investments, managers have an incentive not to share data on funds with poor performance. The incentive to hold out reporting on poor performing funds might mean that there is a slight upward bias in the Preqin performance data. Lastly, Preqin also uses data from various other sources, including financial reports for publicly listed firms, public filings, and annual reports.

In Section 6 the Cambridge Associates U.S. Buyout Fund Index is used as a performance benchmark for evaluating a PE-mimicking portfolio. The Cambridge Associates database mainly collects data from the quarterly partnership financial statements that GPs provide to their LPs. Their quarterly index of buyout fund performance is the most comprehensive and widely used index estimating the performance of the aggregate buyout universe.

While the Burgiss may have the most comprehensive and accurate dataset in terms of detailing the timing of cash flows to-and-from PE funds, in a detailed comparison of the leading data providers, Brown, Harris, Jenkinson, Kaplan, and Robinson (p. 25, 2015) conclude that *"... the Burgiss, Cambridge Associates, and Preqin data sets are quantitatively similar."* Hence, relying on the data from Preqin and Cambridge Associates should not lead to any material bias in results. One limitation of the Preqin dataset is the lack of cash flow data from before the year 2000. This limits the possibility of calculating cash flow based metrics such as the PME. However, we do obtain PME measures from before 2000 by using Harris and colleagues' (2014) PME regression coefficients together with available data on vintage year IRR and TVPI.

4.2. U.S. buyout targets and matching public companies

This section walks through the data used to analyze characteristics of public firms taken private by buyout funds, presented in Section 6.1. Companies that have been acquired in public-to-private (PTP) transaction (target sample) are compared to a control group of similar public companies that have not been acquired by a PE fund (matching non-target sample) to reveal characteristics unique to buyout fund targets. The reason for using a sample of PTP targets is that financial data on privately owned LBO targets is very scarce. Hence, while this is an imperfect method that captures characteristics that are unique to public-to-private transactions rather than the broader universe of PE transactions, we believe that this is the most accurate way to draw inferences about asset characteristics targeted by buyout funds.

4.2.1. Sample of U.S. public-to-private targets

Using the Thomson Reuters mergers and acquisitions database and the Bloomberg Terminal, we screen for acquisitions in which the target was a public company based in the U.S., and the acquirer was a financial buyer, defined as having a SIC code between 6000 and 6999. Since PE funds typically acquire close to 100% of the outstanding equity portfolio companies, we only consider transactions where at least 80% of the target company's shares are acquired. Since this study relies heavily on EBITDA multiples, all transactions in which the target was a financial services company (SIC code between 6000 and 6900) are excluded from the sample. The exclusion of financial services companies is standard practice since many companies in the financial industry generate most of their earnings from interest income which would not count toward EBITDA. Lastly, all target firms are matched with financial data from the CRSP and Compustat databases, using the PERMNO and GVKEY as unique identifiers for each target firm. In total, we arrive at 755 public-to-private transactions in the U.S. between 1982 and 2018 with adequate financial information to be included in the target PTP sample. A summary of the sample selection process is presented in Table 4.1.

Table 4.1: Summary of the public-to-private sample selection process

Description	Sample size
Unique Bloomberg and Thomson Reuters mergers and acquisitions in the U.S.	348,756
Transactions announced and completed between 1 Jan 1982 and 31 Dec 2018	270,830
Target is publicly listed	32,053
Acquirer is a buyout fund	1,183
Excluding financial target firms (SIC code between 6000 and 6999)	968
Target firm matched with financial data from CRSP and Compustat databases	755

4.2.2. Sample of matching public companies

Using the CRSP database, we collect financial information on 15,339 companies listed in the U.S. between 1982 and 2018. Inspired by the approach of Axelson and colleagues (2013) this sample of public companies is matched with the sample of PTP targets based on industry classification and month of available financial data. As an example, the one retail LBO in May 2005 is matched with 81 publicly listed retail companies with financial data available for that month. Matching on the industry level is essential in order to identify characteristics of the usual LBO target that are firm-specific and not just characteristic of specific industries that happen to be popular with PE managers. For the purpose of this matching process the Fama-French industry classifications, as presented on Kenneth French's website, are used.[10] After matching observations from the two samples, we end up with a final sample consisting of a total of 755 LBO targets and a control group of 12,722 publicly listed companies not targeted in LBO transactions.

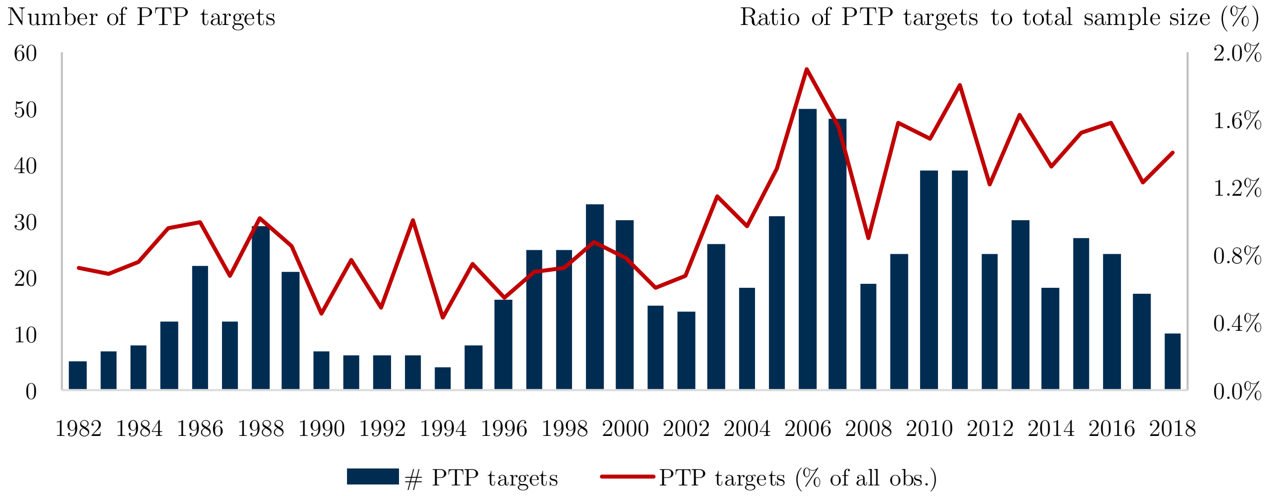

Figure 4.2: Distribution of the public-to-private target sample by year

This figure shows the distribution of the 755 PTP targets over the sample period. The red line displays the ratio of PTP targets to the entire sample, consisting of both the PTP targets and matching public companies.

[10] Fama-French provide classifications of 48 different industries which can be found at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/det_48_ind_port.html.

Figure 4.2 shows the distribution of identified public-to-private transactions over time.[11] The graph shows how the sample of PTP targets seem to follow the general activity level of the buyout industry over time with few observations in the 1990s and many observations in 2006 and 2007. The average ratio of targets to total sample size is 1.0% which means that, on average, each PTP target is matched with 100 similar public company observations. Figure 4.3 shows that the distribution of the PTP targets and non-targets, across industries, is similar. Similar industry distributions is a positive since the goal is to have the control group being comparable to the sample of PTP-targets.[12]

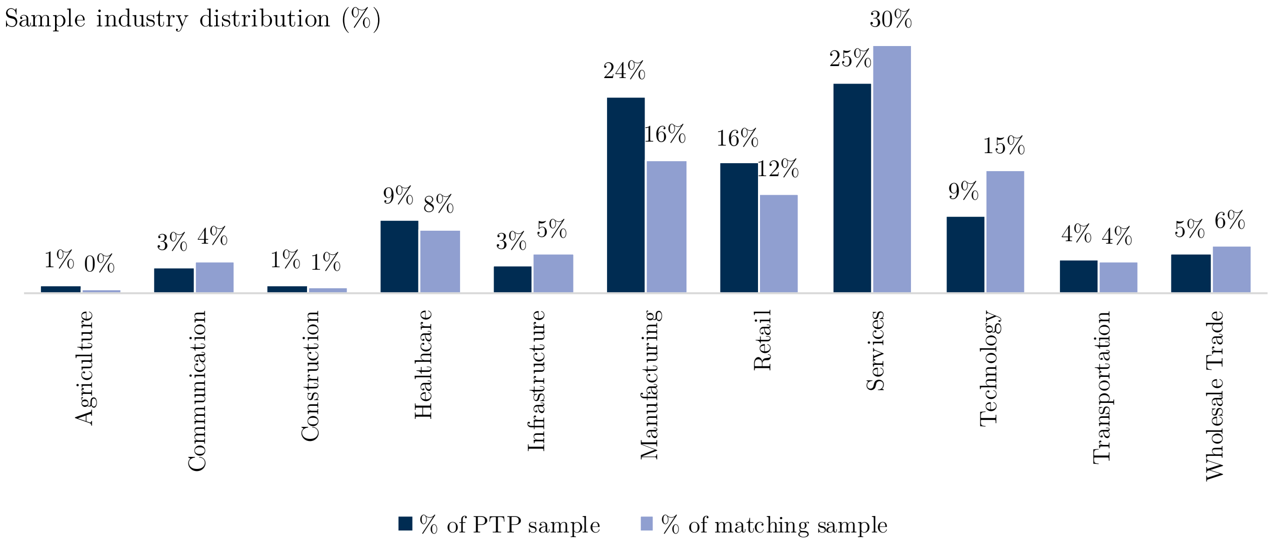

Figure 4.3: Distribution of the total sample by industry

This figure shows the industry distribution of the 755 PTP targets and the 12,722 matching companies.

4.2.3. Collection of financial data

The CRSP and Compustat databases are used to collect financial information on both the sample of PTP targets and the sample of similar non-target companies. Data on market equity value, shares outstanding, share price, dividends, and monthly returns are obtained from the Compustat North America database. The CRSP database is used to collect quarterly financial information such as revenue, profitability, and leverage. Quarterly financials are assumed to be known with a delay of 3-6 months while market prices are assumed to be known without delay. Both the CRSP and Compustat databases are frequently used in academia and contain some of the most comprehensive libraries of financial data.

[11] Figure C.1 in Appendix C includes a comparison of the yearly distribution of both the PTP target sample as well as the control group.

[12] Figure C.2 in Appendix C shows a comparison of distribution by industry according to the more detailed Fama-French industry classifications.

5. Traditional performance evaluation in private equity

The following section analyzes U.S. buyout fund performance between 1984 and 2016 using the IRR, TVPI, and PME measures. In addition to investigating aggregate buyout performance, we look at whether industry dry powder, valuation levels, and fund size are reliable predictors of vintage performance of buyout funds.

> "When we invest in private equity, we lock up Harvard's money for multiple years. In exchange for that lock-up we expect to earn returns over time that are in excess of the public markets – an 'illiquidity premium'."
> – Jane Mendillo, Former CEO of Harvard Endowment (HMC, p. 11, 2013)

5.1. Private equity has historically outperformed public markets

This section examines the performance of U.S. buyout funds with vintage years from 1984 until 2016. A fund's vintage year is defined as the year of the first drawdown of LP capital for investment purposes; that is the year in which the buyout fund makes its first investment. Table 5.1 reports summary statistics and vintage year distribution of the buyout fund sample. We have a total of 1,007 U.S. buyout funds in our sample, representing 65.6% of the total Preqin buyout fund dataset between 1984 and 2016, which includes funds across other geographies. By comparison, previous large-sample studies of Harris and colleagues (2014; 2016) analyzed samples of 598 (1984-2008) and 781 (1984-2010) U.S. buyout funds, respectively.

As seen in Table 5.1, the average number of vintage funds in the dataset has increased each decade, up from an average of 8 vintage funds in the 1980s to 43 in the 2010s. The increase in the number of funds corresponds well with the significant increase in industry fundraising and active PE firms, as covered in Section 2.5. The "median called up" column shows how capital called, as a percentage of total LP fund commitments, is decreasing in the vintage year. Funds with vintage years before 2010 have had close 100% of their capital commitments invested, while the median capital called is just 48.0% of total LP commitments for 2016 vintage funds.

The same trend is observed for total capital distributed to LPs as a percentage of total LP contribution. The median fund of vintage 2016 had only returned 2.7% of LP contributions. Performance reporting for later vintage funds is highly influenced by the considerable amount of unrealized value in these funds. The residual value to paid-in capital (RVPI) measures a fund's unrealized value as a percentage of total LP contributions. Table 5.1 shows a dramatic increase in unrealized value for funds of vintage year 2010 and onwards. For post-2012 vintage funds, the median RVPI exceeds 100%, meaning that the unrealized value exceeds total LP contributions. The RVPI exceeds total LP contributions when proceeds of early exited investments are greater than the total capital returned to LPs. Pre-2009 vintage funds are mainly realized funds with median RVPI of less than 40%.

Table 5.1: Overview of the Preqin buyout fund dataset

Panel A highlights summary statistics for U.S. focused buyout funds analyzed in this paper while Panel B provides an overview of Preqin's buyout fund data across all geographies. Median called is a measure of the cumulative LP capital invested including management fees as a percentage of total LP commitments for the median fund; it may exceed 100% due to the recycling of capital. Median distribution is a measure of the total capital distributed to the LP as a percentage of the total LP contribution for the median fund. Median RVPI is a measure of the unrealized value of a fund as a percentage of the total LP contribution for the median fund. *Average except for the total number of funds.

	Panel A: U.S. buyout funds				Panel B: Global buyout funds				U.S. funds % of total funds in Preqin dataset
Vintage year	# of funds	Median called up (%)	Median distribution (%)	Median RVPI (%)	# of funds	Median called up (%)	Median distribution (%)	Median RVPI (%)	
1984	4	100.1	391.7	0.0	4	100.1	391.7	0.0	100.0
1985	3	103.1	266.2	0.0	4	101.6	266.1	0.0	75.0
1986	8	100.4	307.7	0.0	10	100.0	307.7	0.0	80.0
1987	9	100.0	321.9	0.0	9	100.0	321.9	0.0	100.0
1988	11	100.0	213.2	0.0	13	100.0	210.4	0.0	84.6
1989	11	96.3	335.0	0.0	15	100.0	321.0	0.0	73.3
1990	13	100.0	315.0	0.0	18	100.0	281.1	0.0	72.2
1991	5	100.0	300.9	0.0	8	100.0	282.1	0.0	62.5
1992	15	100.0	220.0	0.0	22	100.0	214.3	0.0	68.2
1993	13	100.0	229.2	0.0	17	100.0	229.2	0.0	76.5
1994	26	100.0	184.4	0.0	37	99.1	188.9	0.0	70.3
1995	23	100.0	190.1	0.0	32	100.0	179.9	0.0	71.9
1996	24	99.7	178.3	0.0	35	99.3	180.1	0.0	68.6
1997	32	99.8	147.8	0.0	51	100.0	149.7	0.0	62.7
1998	50	99.7	140.2	0.0	71	99.5	157.3	0.0	70.4
1999	40	98.9	173.7	0.0	68	98.1	174.6	0.0	58.8
2000	59	99.5	197.0	0.0	90	99.2	201.8	0.0	65.6
2001	29	98.4	213.2	0.0	52	98.5	211.8	0.0	55.8
2002	23	98.0	173.6	0.0	41	98.2	184.8	0.0	56.1
2003	21	100.0	163.0	1.4	49	99.6	173.0	0.0	42.9
2004	31	95.5	171.0	1.6	54	98.7	184.9	0.5	57.4
2005	59	99.1	152.5	8.1	100	100.0	152.2	4.0	59.0
2006	70	97.5	140.6	18.4	120	98.1	141.8	12.2	58.3
2007	62	97.5	156.5	25.4	113	97.5	145.0	23.2	54.9
2008	51	97.3	144.7	36.1	91	97.8	140.8	31.4	56.0
2009	17	98.9	99.1	58.8	42	98.0	104.7	53.6	40.5
2010	33	97.6	80.8	73.3	53	97.0	79.2	64.9	62.3
2011	31	96.3	69.7	90.1	61	95.9	69.7	84.1	50.8
2012	51	97.6	61.0	94.1	80	94.4	64.3	94.2	63.8
2013	45	85.9	30.8	104.0	79	87.0	33.2	103.1	57.0
2014	46	82.0	18.1	111.8	71	80.0	20.0	112.2	64.8
2015	51	61.5	9.4	111.0	80	60.8	7.9	109.2	63.8
2016	41	48.0	2.7	104.4	69	48.0	1.3	104.4	59.4
Average*	1,007	95.4	175.7	25.4	1,659	95.3	174.9	24.1	65.6
Average 2010s	43	81.3	38.9	98.4	70	80.4	39.4	96.0	60.3
Average 2000s	42	98.2	161.1	15.0	75	98.5	164.1	12.5	54.6
Average 1990s	24	99.8	207.9	0.0	36	99.6	203.7	0.0	68.2
Average 1980s	8	100.0	306.0	0.0	9	100.3	303.1	0.0	85.5

For funds with unrealized investments in the portfolio, the estimated residual value of these unrealized investments is included as positive cash flows in the calculation of fund NAVs, and since these values are not marked-to-market, they are subject to some degree of manager discretion. Previously buyout firms would value their portfolio NAVs at cost, but since 2006 U.S. buyout firms have been required to use fair value accounting in marking NAVs every quarter. Welch and Stubben (2018) document that this change has been an improvement and that it has led to higher risk estimates for PE funds. However, they argue that persisting return smoothing still leads to considerably understated estimates of systematic risk and volatility.

Table 5.2 shows the historical performance of U.S. buyout funds, as measured by the IRR, TVPI, and PME. The mean, median, and weighted-mean IRR and TVPI are reported for each vintage year. Averages over the four decades of the 1980s, 1990s, 2000s, and 2010s are shown at the bottom of the table. The weighted averages are weighted according to capital commitments of individual funds. Given that the Preqin database does not include cash flow data from funds of vintage years before the year of 2000, PME performance for early funds is estimated using regression coefficients made available by Harris and colleagues (2014), relying on known TVPI and IRR values. This approach allows us to achieve acceptable PME estimates without having access to the actual underlying cash flow data. Harris and colleagues (2014) found that PMEs estimated from known IRR and TVPI values closely track actual sample PMEs. Because regression coefficients are only available with the S&P 500 index as the performance benchmark, we are not able to show PME estimates with other benchmarks. Additionally, PME data is only available for the median fund which is why the table does not report average estimates. For post-2000 vintage year funds, PME estimates are obtained from the Preqin database.

For funds of vintage years between 1984 and 2016, the mean IRR is 20.0%, and the mean TVPI is 2.26x. These estimates are slightly higher than those of Harris and colleagues (2016), who, for the period 1984-2010, reports average IRR and TVPI of 15.7% and 2.02x, respectively (Appendix B). Fund performance peaked in the 1980s with an average IRR and TVPI for the decade of 31.5% and 4.00x, respectively. Since then absolute returns have been decreasing decade over decade, except the 2010s which saw returns in line with the 2000s. Buyout funds that started investing just before the IT bubble in the year 2000 and the financial crisis in the year 2008 have lower IRRs and TVPIs, on average, compared to other vintage years. In the case of both the IRR and TVPI, the weighted average estimates are slightly lower than the simple means, although they appear to be economically similar, suggesting a weak relationship between fund size and performance.

Table 5.2: Overview of U.S. buyout performance since 1984

This table shows the IRR, TVPI, and PME by vintage year of the individual U.S. buyout funds using data obtained from Preqin. IRR is computed using the present sum of cash contributed, the present value of distributions, and the current value of unrealized investments. TVPI is computed as the sum of the fund's distributed capital and the unrealized value divided by the total LP contribution. As highlighted in Table 5.1, most of the early vintage funds have realized all of their investments, whereas the IRR and TVPI for later vintage funds mainly relate to the value of unrealized investments. The median PMEs by year has been estimated as a function of IRR and TVPI for the years 1984 to 1999 using regression coefficients from Harris and colleagues (2014). PMEs for the years 2000 to 2016 have been estimated using data from Preqin.

	Internal rate of return (%)			Total-value over paid-in			PME
Vintage year	Mean	Median	Weighted average	Mean	Median	Weighted average	Median
1984	37.7	23.7	29.9	3.49	3.92	4.58	1.74*
1985	15.5	13.7	12.8	2.51	2.66	2.02	1.01*
1986	62.2	31.7	39.6	7.64	3.08	7.81	1.36*
1987	20.7	22.1	12.9	3.49	3.22	2.43	1.36*
1988	19.1	13.1	12.2	2.72	2.13	2.09	0.73*
1989	33.8	30.0	31.1	4.18	3.35	3.21	1.49*
1990	25.4	26.1	25.0	3.01	3.15	3.05	1.36*
1991	35.4	33.8	36.0	2.92	3.01	3.01	1.34*
1992	24.1	21.2	37.5	2.10	2.20	2.22	0.83*
1993	26.5	21.1	25.8	2.44	2.29	2.49	1.14*
1994	31.8	19.8	23.9	2.16	1.85	2.14	1.06*
1995	18.3	14.6	15.0	1.83	1.90	1.73	1.19*
1996	17.7	10.7	14.5	1.90	1.79	1.65	1.39*
1997	7.6	8.4	6.6	1.49	1.48	1.46	1.28*
1998	6.2	7.4	1.9	1.47	1.42	1.24	1.34*
1999	10.0	11.9	8.5	1.73	1.75	1.57	1.75*
2000	16.7	16.3	16.9	2.11	2.08	1.99	1.47
2001	23.9	23.6	25.4	2.05	2.15	2.10	1.63
2002	13.7	16.3	18.1	1.65	1.74	1.93	1.32
2003	12.3	14.7	22.0	1.75	1.66	2.06	1.56
2004	15.6	12.7	15.3	2.12	1.84	1.94	1.44
2005	10.2	10.1	10.8	1.70	1.66	1.78	1.26
2006	8.4	9.6	8.0	1.62	1.67	1.58	1.08
2007	14.6	14.8	11.7	1.95	1.92	1.69	1.06
2008	18.5	14.7	16.8	1.87	1.74	1.84	1.07
2009	22.7	21.3	24.1	1.99	1.93	2.30	1.31
2010	15.8	16.0	15.3	1.96	1.85	1.81	1.14
2011	14.0	14.2	17.3	1.67	1.60	1.86	1.07
2012	19.1	16.9	20.3	1.67	1.56	1.67	1.23
2013	15.9	16.0	19.9	1.46	1.39	1.51	1.16
2014	18.9	17.2	17.8	1.37	1.32	1.40	1.08
2015	18.5	18.1	24.5	1.30	1.29	1.36	1.04
2016	8.2	7.9	13.9	1.12	1.10	1.14	0.89
Average	20.0	17.3	19.1	2.26	2.05	2.20	1.25
Average 2010s	15.8	15.2	18.4	1.51	1.44	1.54	1.09
Average 2000s	15.7	15.4	16.9	1.88	1.84	1.92	1.32
Average 1990s	20.3	17.5	19.5	2.10	2.08	2.06	1.27
Average 1980s	31.5	22.4	23.1	4.00	3.06	3.69	1.28

In order to compare the historical performance of U.S. buyout funds to that of the broader public markets, we look to the PME metric, calculated using the performance of the S&P 500 index. The median PME for buyout funds with vintage years between 1984 and 2016 is 1.25, suggesting that U.S. buyout funds, on average, have outperformed public equity markets over this period. The PME exceeds 1.0 for 30 of the 33 vintages studied in the paper, indicating that outperformance has been consistent throughout the period. The median fund PME has fluctuated between 1.27 and 1.32 for the 1980s, 1990s, and 2000s and decreased to 1.09 for the 2010s. It is clear to see from the data, that the performance of funds of more recent vintage years (post-2013) has roughly equaled the public market. Again, it is important to note that these funds are not fully realized and that the actual performance will depend on future realized investments.

Harris and colleagues (2016) find that the PME for the median fund exceeds 1.0 for 19 of 27 vintage years, averaging 1.14, over the period 1984-2010 (see Appendix B). Hence, our findings suggest a slightly higher outperformance than previous studies. Comparing the numbers in Table 5.2 with Harris and colleagues' (2016) results in Appendix B, the results are similar. It seems fair to conclude that the median U.S. buyout fund has consistently outperformed the S&P 500 over the life of the fund.

5.2. Performance predictors specific to private equity

This section looks at whether there is a relationship between buyout fund performance and a series of industry and fund-level indicators. Specifically, we look at the sensitivity of fund performance to aggregate industry dry powder, valuation levels, and fund size. Due to limited data on funds from early vintage years, our sample only includes funds from vintage years 1990 to 2016.

5.2.1. Dry powder

Existing research has tested how the level of industry dry powder affects vintage year fund performance. Kaplan and Schoar (2005) do not find any relationship between aggregate fund-raising, which they use as a proxy for dry powder, and vintage buyout performance. However, Harris and colleagues (2014) find that aggregate fundraising is a negative predictor of vintage buyout fund IRR, TVPI, and PME, testing the period between 1993 and 2008.

Preqin only reports statistics on dry powder, defined as undrawn capital commitments from LPs to GPs, from the year 2000 and onwards. Because of this lack of data, we use the total capital committed over any two years as a proxy for total industry dry powder for the years 1990 to 2016. This method is imperfect, but it is similar to that used by Harris and colleagues (2014). Additionally, by comparing our estimate for dry powder with dry powder estimates by Preqin after the year 2000, we find that these are economically similar.

To control for changes in total capital commitments that are due to overall growth in financial markets, we scale the PE commitments relative to the total market capitalization of U.S. public equities.[13] Using this measure, we find dry powder, as a fraction of the total U.S. stock market value, is quite stable, fluctuating between 0.24% in 1993 and 0.73% in 1994, with an average ratio of 0.47% over the entire period. With a sample period of 27 years, this sample covers 11 years of additional data vis-à-vis the analysis by Harris and colleagues (2014). The relationship between dry powder scaled by the U.S. stock market and IRR has been plotted in Figure 5.3.

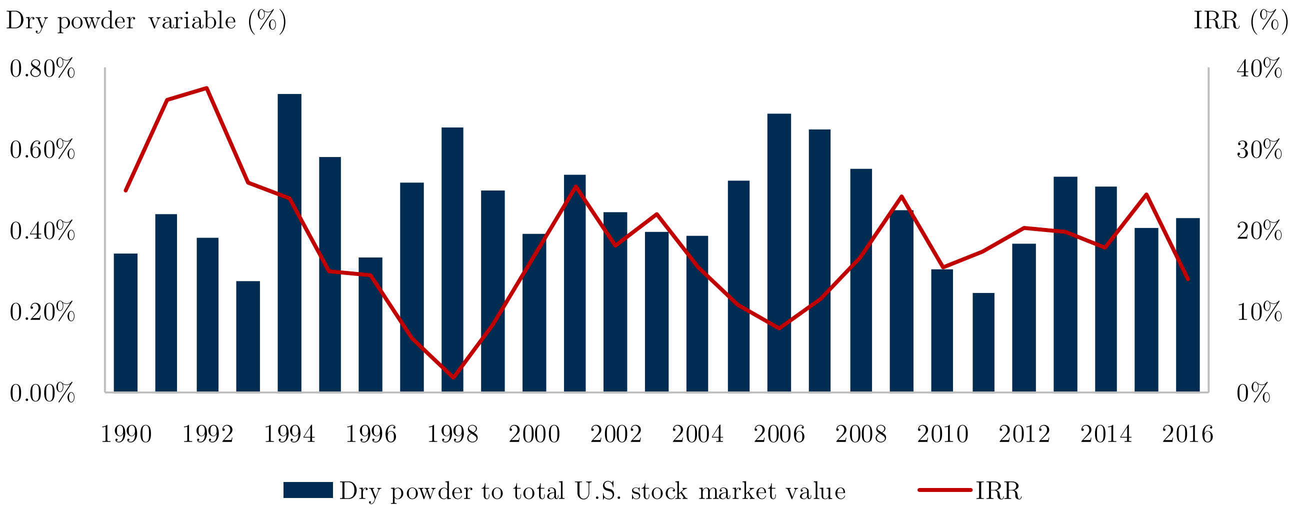

Figure 5.3: Industry dry powder to total U.S. stock market value and IRR by year (1990-2016)
This figure plots the weighted average IRR by year, together with aggregate PE dry powder scaled by the total U.S. stock market value. Dry powder has been estimated as the total capital committed over any two years as reported by Preqin.

As seen in Figure 5.3, with a weighted average IRR of 1.91%, 1998 is the vintage year with the worst fund performance to date. In 1998, the aggregate dry powder for buyout funds was \$80.3 billion, corresponding to 0.65% of the total value of the U.S. stock market. At the same time, the two highest IRRs were observed for the vintage years 1991 and 1992 – both years with dry powder, as a fraction of total stock market value, below the sample period average of 0.47%. Hence, Figure 5.3 suggests that there may be an inverse relationship between aggregate U.S. buyout dry powder and fund performance. To test whether this is the case, we regress the vintage year IRR, TVPI and PME on total industry dry powder as a fraction of total stock market capitalization. Regression results are reported in Table 5.4. Results are statistically similar for the weighted average and the simple average performance measures. The study is limited to 1990 and onwards to take into account the low sample size of the Preqin dataset for earlier vintage years.

[13] Data on the total market capitalization of U.S. public equity markets are made available by the World Bank (2019b).

Table 5.4: Relationship between dry powder and buyout fund performance (1990-2016)

This table examines the relationship between dry powder and buyout fund performance as measured by IRR, TVPI, and PME. The weighted-average measures are used for the IRR and TVPI, while the PME is based on the median performance. Dry powder has been estimated as the sum of committed capital to U.S. buyout funds for the previous two years for the years 1990 to 2016. Dry powder is measured relative to the total market capitalization of U.S. public equities for any given year. The model is estimated with robust standard errors. T-statistics are reported in parentheses. ***, ** and * denotes significance at the 1%, 5% and 10% level, respectively.

Dependent variable:	IRR	TVPI	PME
Dry powder to total U.S. stock market value	-23.913*	-1.133*	-0.103
	(-1.90)	(-1.77)	(-0.39)
Constant	29.369	2.398	1.289
	(5.02)	(7.25)	(9.59)
N	27	27	27
R^2	0.137	0.095	0.004

The analysis confirms a weak inverse relationship between aggregate dry powder of U.S. buyout funds and fund performance. The IRR and TVPI for U.S. buyout funds are negatively related with dry powder at the 10% significance level. The regression coefficients imply that the IRR and TVPI drop by 3.8% and 0.18x, respectively when dry powder moves from the bottom quartile of years (0.38%) to the top quartile of years (0.54%). This finding implies that investors that have committed capital to buyout funds during periods when dry powder has been low have fared relatively better. This result seems intuitive since high levels of dry powder is usually a result of increases in valuation levels and competition for assets, which makes it harder for fund managers to stay disciplined in their asset selection. Lastly, the PME is also negatively related to dry powder; however, this relationship is not statistically significant.

Overall, our results are consistent with the findings of Harris and colleagues' (2014) who show a negative relationship between performance measures and total dry powder. However, the authors also find a significant negative relationship between vintage fund performance and the PME, which our data does not show. Robinson and Sensoy (2016) also study the relationship between aggregate dry powder and vintage year fund performance. Their results are similar to ours in that they document significant negative relationships between dry powder and TVPI and IRR and an insignificant relationship between dry powder and PME. Hence, the findings in the literature suggest that the absolute performance measures are negatively related with dry powder, while the evidence for a negative relationship with the PME is less clear and is not supported by the findings in this paper. Despite not being significant for all three performance measures, the results are relevant to note for investors allocating capital to buyout funds at times of historically high levels of industry dry powder.

5.2.2. Valuation levels

In Section 2.5 we discussed how the valuation level, measured by the EV/EBITDA multiple, in PE have recently increased, reaching an all-time high of 12.4x in 2018 (Figure 2.10). This increase has mostly been influenced by the heavy competition for assets and the flood of capital rushing into the buyout asset class. Assuming a positive relationship between valuation levels and dry powder, the results from Section 5.2.1, could indicate that funds of the vintage year 2018 will see relatively poor performance. A direct relationship between valuation levels and vintage year fund performance has, to our knowledge, not yet been tested formally.

PE firms have historically been able to acquire companies at a discount compared to the multiples of average publicly listed companies. LBO discounts have been greatest between 1998 and 2007 (Figure 2.10). However, as discussed in Section 2.5, since the financial crisis in 2008, the gap between PE and public market valuations have slowly been shrinking. This might be troublesome for PE firms, given the heavy use of financial leverage in LBO transactions. Higher purchase multiples require a higher degree of debt, which leads to higher interest costs and increased risk of bankruptcy. At the same time, it makes it more challenging to profit from multiple expansion which is one of the key return drivers in buyouts.

To test whether there is an inverse relationship between valuation levels and vintage year fund performance, we look at both the absolute valuation levels as well as the valuation gap between private and public equity. First, we estimate the median EV/EBITDA multiple every year between 1990 and 2016. To arrive at the best estimate for median EV/EBITDA, we calculate the mean of median estimates from several different data sources: Cambridge Associates and Capital IQ (1998-2016); PitchBook (2006-2016); S&P Global Leveraged Commentary & Data (2001-2016); a proprietary dataset of this paper obtained from Thomson Reuters and Bloomberg (1990-2016). The median EV/EBITDA multiple for U.S. buyout transactions between 1990 and 2016 was 7.8x, with a minimum multiple of 5.4x in 1990 and a maximum multiple of 10.1x in 2007.

Figure 5.5 presents the buyout EV/EBITDA purchase multiples as well as weighted average IRRs, by year. The early 1990s were characterized by low purchase multiples and strong vintage fund performance. Funds of vintage years close to the financial crisis were invested during a period of historically high valuation levels and subsequently experienced below-average performance. Hence, the figure points to an inverse relationship between performance and vintage year valuation levels.

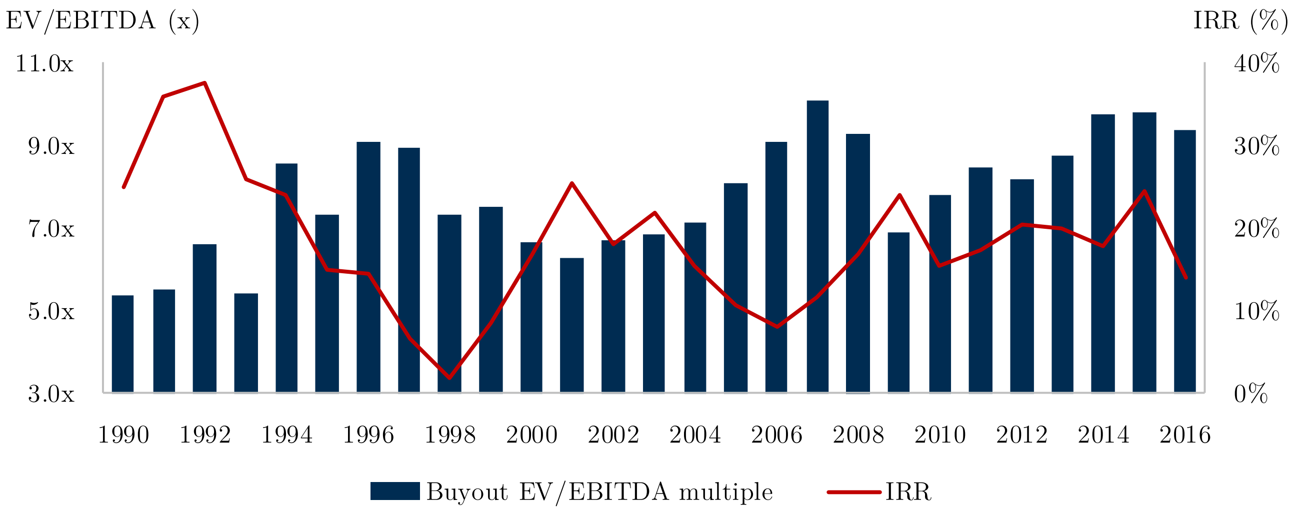

Figure 5.5: Buyout purchase EV/EBITDA multiples and IRR by year (1990-2016)
This figure plots the weighted average IRR by year together with buyout purchase multiples by year. Buyout EV/EBITDA multiples are computed by taking the mean of median estimates from the following data sources: Cambridge Associates and Capital IQ (1998-2016); PitchBook (2006-2018); S&P Global Leveraged Commentary & Data (2001-2017); a proprietary dataset of this paper obtained from Thomson Reuters and Bloomberg (1990-2018).

In addition to looking at absolute valuation levels, we look at a relative valuation measure calculated as the percentage difference between the median buyout EV/EBITDA variable and the median EV/EBITDA for the S&P 500. The median EV/EBITDA for the S&P 500 index has been obtained from the Bloomberg Terminal. The average valuation gap between the S&P 500 and U.S. buyouts was 36% between 1990 and 2016, with minimum and maximum gaps of -3% in 1994 and 100% in 2000, respectively.

Figure 5.6 shows the gap in valuation levels mapped against the median fund PME for each year between 1990 and 2016. The PME measure is chosen because it contains information about both public market performance and vintage year fund performance, something that neither the IRR nor the TVPI does. Between 1998 and 2004 the public-private valuation gap was at its highest and well above the sample average of 36%. During this same period, the buyout industry experienced its greatest outperformance compared to the S&P 500 with PMEs ranging from 1.32 to 1.75. PMEs for later vintage year funds have been falling, while the valuation gap has been diminishing. Hence, it seems that there may be a positive relationship between the PME and the valuation gap between public and private equity markets.

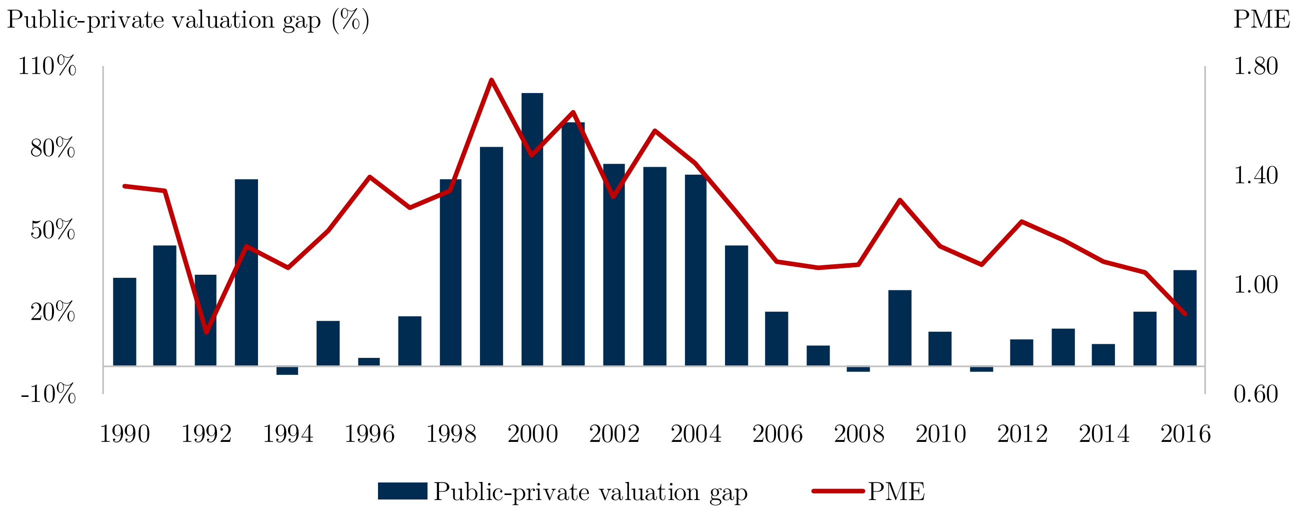

Figure 5.6: Public-private valuation gap and PME by year (1990-2016)

This figure plots the median fund PME by year together with the valuation gap between public and private valuation multiples by year. The public-private valuation gap variable is proxied by the percentage difference between the EV/EBITDA for the S&P 500 and the median EV/EBITDA purchase multiple in buyout transactions between 1990 and 2016.

We regress yearly valuation levels against vintage year performance to test the relationship between these two variables. Results on the relationship between vintage year fund performance and absolute valuation levels are reported in Panel A of Table 5.7. Similar to the test of performance and dry powder, we find a negative relationship between vintage year fund performance and absolute valuations levels. For all three performance measures, IRR, TVPI, and PME, this relationship is statistically significant at the 1% level. In other words, U.S. buyout fund performance has historically been worse for funds that made its first investment in a year characterized by high EV/EBITDA buyout purchase multiples. Vice versa, funds making their first investment in a year characterized by low buyout purchase multiples have historically seen relatively higher subsequent returns. The regression coefficients imply that the IRR, TVPI, and PME fall by 6.7%, 0.62x and 0.17, respectively when we move from the bottom quartile of valuation levels (6.7x EV/EBITDA) to the top quartile of valuation levels (9.1x EV/EBITDA). These results are interesting at a time of historically high valuation levels and support Rasmussen's (2018) anecdote that PE funds are challenged on their performance in environments characterized by high EV/EBITDA purchase multiples.

The relationship between vintage year fund performance and relative valuation levels in PE is reported in Panel B. We do not find any statistically significant relationship between the valuation gap and vintage fund performance measured by the IRR and TVPI. Hence, while the absolute valuation levels in PE predict a negative relationship to buyout fund IRR and TVPI, the two performance measures are not influenced by the difference in valuation levels between public and private equity. However, the PME measure is statistically significant at the 1% level, implying a robust positive relationship between the valuation gap and subsequent vintage fund returns. In other words, U.S. buyout funds perform better relative to public markets when they start investing their fund at times in which firms in private markets are cheap relative to public equities. It intuitively makes sense that if one invests in an asset class at a time when that asset class is cheap relative to other asset classes, all else equal, the cheap asset class should perform relatively better. A valuation gap between public and private markets also serves as an "arbitrage" opportunity for buyout funds, making it possible to acquire firms at low multiples in private markets while exiting investments at high multiples in public markets. The fact that the relationship between relative valuation levels and buyout performance is not captured by the IRR and TVPI could point to the PME being a superior metric from an asset allocation point of view.

Table 5.7: Relationship between valuation levels and buyout fund performance (1990-2016)

This table examines the relationship between valuation levels and buyout performance as measured by IRR, TVPI, and PME. The weighted-average measures are used for the IRR and TVPI, while the PME is based on the median performance. Panel A reports regressions results with absolute valuation level as the independent variable proxied by the median EV/EBITDA purchase multiple in buyout transactions between 1990 and 2016. Panel B reports regressions results with relative valuation level as the independent variable proxied by the percentage difference between the EV/EBITDA for the S&P 500 and the median EV/EBITDA purchase multiple in buyout transactions between 1990 and 2016. The model is estimated with robust standard errors. T-statistics are reported in parentheses. ***, ** and * denotes significance at the 1%, 5% and 10% level, respectively.

Panel A: Buyout performance and absolute valuation			
Dependent variable:	IRR	TVPI	PME
Buyout EV/EBITDA	-2.808***	-0.258***	-0.072***
	(-2.97)	(-5.42)	(-2.92)
Constant	40.182	3.886	1.804
	(5.18)	(9.92)	(8.45)
N	27	27	27
R^2	0.229	0.598	0.216
Panel B: Buyout performance and relative valuation			
Dependent variable:	IRR	TVPI	PME
Public-private valuation gap	0.003	0.003	0.005***
	(0.08)	(1.58)	(4.98)
Constant	18.137	1.769	1.078
	(10.15)	(1.58)	(26.86)
N	27	27	27
R^2	0.000	0.037	0.437

With median EV/EBITDA multiples of the S&P 500 being 80% to 100% higher than the median EV/EBITDA multiple of U.S. buyouts, the valuation gap was at its highest between 1999 and 2001. Over the same three-year period, buyout performance was also historically high, with PME measures spanning from 1.47 to 1.75. The regression coefficient implies that the PME increases by 0.29 when we move from a valuation gap of 11% (bottom quartile) to a valuation gap of 68% (top quartile).

The results in this section suggest a strong relationship between valuation levels and vintage year fund performance. All performance measures are negatively related to the absolute EV/EBITDA level for buyout transactions, while the PME is also influenced by the valuation gap between buyouts and the public market. These results are highly relevant in the context of recent developments in private equity. With historically high absolute valuation levels combined with a diminishing valuation-gap between public and private equities, we would expect buyout firms making their investments in the current environment to experience lower subsequent returns.

5.2.3. Fund size

Lastly, we want to analyze the relationship between buyout fund size and performance. This relationship is a topic that most practitioners are concerned with and is highly relevant given the recent trend of capital increasingly flowing toward mega-funds. In the 1980s, U.S. buyout funds had, on average, capital commitments of $536 million, while this figure had increased to $1,381 million for funds of vintage years in the 2010s. In one decade, between the 1990s and 2000s, the average buyout fund size more than doubled from $626 million to $1,336 million. Using data from the Burgiss PE database, Harris and colleagues (2014) showed a similar trend in fund size. According to Bain & Company (2019), LPs consistently rank mega-funds below other fund sizes when asked what fund size they consider most appealing. However, larger funds have one advantage over smaller funds in that they offer an opportunity for LPs to put a significant amount of capital to work.

Panel A of Table 5.8 presents a summary of the relationship between buyout fund size and buyout fund performance with funds classified into size quartiles by decade. Performance, as measured by the IRR, TVPI, and PME, is reported in Panel A for the bottom quartile, median and top quartile of funds. Mean fund performance is also shown. Comparing the median and mean performance across fund sizes, all metrics point to smaller funds generating slightly higher returns compared to larger funds. Over the entire sample period, the funds in the smallest quartile generate an average IRR, TVPI, and PME of 19.3%, 2.17x and 1.43, respectively. The average IRR, TVPI, and PME for the largest size quartile were 15.1%, 1.71x and 1.20 covering the same time period. Panel B reports regression results on the relationship between size and performance, using the size quartiles outlined in Panel A.

Table 5.8: Relationship between buyout fund size and buyout fund performance (1984-2016)
This table examines the relationship between fund size and buyout performance as measured by IRR, TVPI, and PME. Panel A reports size cutoffs for the different fund size brackets by decade and average IRR, TVPI, and PME for these quartiles. Panel B reports results of three regressions on fund size using IRR, TVPI, and PME as the dependent variable for the period 1990 to 2016. Model is estimated with robust standard errors and with year fixed effects. T-statistics are reported in parentheses. ***, ** and * denotes significance at the 1%, 5% and 10% level, respectively.

Panel A: Performance of U.S. buyout funds by size quartile

Size cutoffs ($m)	Bottom quartile	Median	Top quartile	Mean
1980s	65	217	594	536
1990s	163	347	736	626
2000s	223	481	1,204	1,336
2010s	275	525	1,300	1,381
IRR (%)				
Small funds	7.3	15.7	27.5	19.3
Second quartile	7.1	13.6	22.5	15.1
Third quartile	7.0	13.4	21.1	15.0
Large funds	8.1	13.4	21.9	15.1
TVPI				
Small funds	1.23	1.78	2.47	2.17
Second quartile	1.29	1.63	2.18	1.83
Third quartile	1.30	1.62	2.03	1.74
Large funds	1.30	1.62	1.98	1.71
PME				
Small funds	0.64	1.19	1.92	1.43
Second quartile	0.64	1.19	1.68	1.22
Third quartile	0.73	1.13	1.59	1.18
Large funds	0.81	1.13	1.58	1.20

Panel B: Regressions of IRR, TVPI and PME on fund size quartiles

Dependent variable:	IRR	TVPI	PME
Second quartile	-2.935	-0.330*	-0.040
	(-1.15)	(-2.02)	(-0.22)
Third quartile	-2.642	-0.326**	-0.061
	(-1.26)	(-2.72)	(-0.31)
Large funds	-1.457	-0.292**	-0.052
	(-0.61)	(-2.59)	(-0.27)
Funds	1,007	1,007	199
R^2	0.133	0.307	0.265

The findings suggest that smaller funds have historically generated higher return multiple, as measured by the TVPI, significant at the 5% level when comparing funds in the first quartile to funds in the third and fourth quartile. However, a significant relationship is not found for the IRR and PME metrics. The regression coefficients imply that the TVPI falls by 0.29x when we move from the smaller funds in the first quartile to larger funds in the fourth quartile. Panel A reports size cutoffs for the different fund size brackets by decade used in the regression. However, while the data points to smaller funds generating slightly better returns compared to larger funds, the relationship is only statistically significant when using the TVPI measure.

Despite weak evidence supporting a negative relationship between fund size and performance, the topic is particularly important in the current environment with an increasing amount of capital flowing to larger funds. On a side note, quantitatively similar results are obtained when classifying funds into size quartiles by vintage year rather than by vintage decade. The findings of a relatively weak relationship between fund size and performance are broadly in line with Harris and colleagues (2014) who do not find any significant relationship between fund size and PME for buyout funds. However, the authors do not test the relationship between performance and fund size using the IRR and TVPI. Overall, the data points to smaller funds generating slightly higher returns than larger funds, but the findings are not statistically significant across performance measures.

6. Private equity returns in public markets

In this section, we seek to mimic the return distribution of the aggregate buyout index using publicly listed equities. First, we present an analysis of PE target firm characteristics by comparing firm characteristics of 755 publicly listed companies that were taken private by PE funds between 1982 and 2018 to a matching sample of 12,722 publicly listed companies. Second, we examine the Cambridge Associates U.S. Buyout Fund Index and discuss potential shortcomings of comparing this with a public market index. Third, we construct and evaluate a set of monthly rebalanced portfolios to examine the sources of abnormal returns in PE. Lastly, building on the monthly rebalanced portfolios, we include additional elements like prolonged holding periods, conservative estimates of NAVs, and the use of leverage in order to fully mimic the passive components of PE. Evaluating this portfolio could give a better understanding of which known risk factors are driving abnormal returns in PE investments.

> "Illiquidity masks the relationship between fundamental drivers of company values and change in market price, causing private equity's diversifying power to appear artificially high."
>
> – Swensen (p. 222, 2009)

6.1. Investigating the characteristics of buyout targets

One argument made as to why buyout funds have historically generated returns above those of public markets is that buyout funds invest in companies that are fundamentally different from the average public company. In order to investigate whether this is the case, we examine the characteristics of a large sample of companies targeted in buyout transactions. Due to the limited availability of financial information on privately owned companies, this study, like Axelson and colleagues (2013) and Stafford (2017), focuses on the subset of buyout transactions where public firms are taken private, so-called public-to-private (PTP) transactions. Using a sample of public companies acquired in buyouts allows for the use of pre-transaction financials. By comparing the financial information of PTP targets to a sample of similar public companies, we can estimate which characteristics are typical of a buyout target. If buyout funds are found to target specific characteristics, it could provide insight into how PE investors benefit from the PE asset selection process. Mimicking this asset selection process is the first step in replicating the PE return distribution in public markets.

6.1.1. Selecting key financial variables

Consistent with the findings of Gompers and colleagues (2016) we argue that some of the key return drivers of PE investments are (1) multiples expansion, (2) growth, (3) margin improvements, and (4) the use of financial leverage. Multiples expansion can be directly determined by both internal and external factors. PE valuations, like for most other capital markets, will rise and fall with economic expansions and contractions and since investors in buyout funds face significant fee payments, they are right to demand more than just exposure to the cyclicality of capital markets. In return of steep fee payments, investors expect PE managers to provide additional value through active management of portfolio companies. While multiples expansion is determined mainly by external factors, PE managers spend considerable resources implementing measures to boost growth and increase the operational efficiency in their portfolio companies. Gompers and colleagues (2016) find that the return drivers most commonly identified by PE managers, both ex-ante and ex-post investments, are growth in the underlying businesses, operational improvements, and leverage. Improvements in corporate governance and management incentives are also some of the most utilized sources of value creation.

According to the framework of Kaplan and Strömberg (2009), the returns generated as a direct consequence of leveraging portfolios with debt falls under the bucket of financial engineering. The introduction of measures enabling growth and margin improvements to boost firm value can be categorized as operational engineering. Corporate governance improvements and the aligning of incentives fall under the governance engineering column. The framework of Kaplan and Strömberg (2009) and other empirical evidence on PE value creation have guided the choice of financial measures used to analyze the characteristics of firms selected as targets in LBOs.

Many of the governance engineering techniques, that are central to the PE value creation process, like replacing management and increasing the alignment of incentives between owners and leadership, cannot be replicated through minority equity investments in public companies and are therefore not relevant for this analysis. Instead, we are looking at firm characteristics can be targeted in an investment strategy in order to "passively" mimic the risk exposures of typical buyout fund investments. For this purpose, we focus on measurements that may be indicative of a PE manager's ability to successfully introduce measures of operational and financial engineering. Specifically, for take-private transactions, we propose that considerations around size, valuation, profitability, leveragability, and systematic risk are relevant when PE managers select new investments to their portfolios. Existing studies argue that investing in buyout funds is essentially a value strategy tilted toward smaller companies. Additionally, LBOs are known to target mature companies with strong cash flow generating capabilities that can sustain high amounts of debt.

Using the CRSP and Compustat databases, we collect monthly information on companies' market exposure captured by their CAPM beta; size estimated by market equity capital and trailing 12-months sales; valuation levels measured by the enterprise value to sales ratio (EV/Sales), enterprise value to EBITDA ratio (EV/EBITDA), and price-to-book (P/B) ratio; the ratio of net interest-bearing debt to enterprise value (NIBD/EV) is used as the measure of financial leverage.[14] Share price data is expected to be known without delay, while financials are expected to be known with a delay of 3 to 6 months. We regress these financial metrics against a binary variable indicating whether a company was taken private in an LBO. All variables and calculations are summarized in Table 6.1.

Table 6.1: Variable descriptions

This table explains the different variables used in the analysis of the financial characteristics of companies in the PTP target sample.

Dependent variable:	
PTP	Binary variable; 1 denotes a firm taken private by a PE firm; 0 denotes a public company matched with a PTP transaction by year, month and industry.
Independent variables:	
Beta	Market risk exposure from a regression of the past 60 months of returns, requiring at least 36 returns for estimation.
Mkt. Cap.	Market capitalization calculated by the total number of shares outstanding from quarterly financial data (lagged by three months) times the current share price.
Sales	12-months trailling revenue calculated from quarterly financial data (lagged by three months).
EV/Sales	Enterprise value (mkt. cap. plus long-term debt minus cash and marketable securities) divided by 12-months trailling revenue (lagged by three months).
EV/EBITDA	Enterprise value divided by 12-months trailling earnings before interest, taxes, depreciation and amortization (lagged by three months).
P/B	Price-to-book ratio; calculated by dividing the current share price by the book value of equity per share (lagged by three months).
EBITDA/Sales	Profitability measure calculated as 12-months trailing EBITDA (lagged by three months) divided by 12-months trailing revenue (lagged by three months).
NIBD/EV	Net-interest-bearing-debt (long-term debt minus cash and marketable securities) divided by enterprise value.
Control variables:	
Year	Year dummies for the years 1982 to 2018.
FF Industry	Industry dummies following the Fama and French 48-industry classification scheme.

Using the Thomson Reuters and Bloomberg databases, we collect a sample of 755 companies that were taken private in LBO transactions (the PTP sample). The control group consisting of 12,722 publicly listed companies that were not acquired by PE funds, is obtained through the CRSP database. Control group observations are matched with the PTP target observations

[14] CAPM beta is estimated from the previous 60 months returns requiring at least 36 months of valid returns.

according to industry, year, and month to ensure comparability between the sample and control groups. By inspecting the data and comparing the sample of PTP targets to the control group of matching public companies, we see that the companies targeted in public-to-private buyouts are consistently smaller than the publicly listed companies from the sample of matching observations.

Over the entire period spanning from 1982 until 2018, the mean market capitalization of publicly listed companies in the control group was $2,822 million, whereas the comparable number for PTP targets was $599 million. This difference is almost entirely driven by the presence of a few mega-cap companies that would not be realistic targets for even the largest of buyout funds. If instead, we compare median values, we find that the difference is much smaller, with a median market capitalization of PTP targets being $136 million over the entire sample period compared to $154 million for matching companies that were not acquired in buyouts. Appendix D includes descriptive statistics for both the sample of PTP targets and the control group of matching companies.

Figure 6.2 illustrates the differences in size, valuation, profitability, and leverage for the PTP sample and the control group with the sample period split in two. From the figure, it is clear that the comparable difference in size, as measured by market capitalization, between PE-targeted companies and other publicly listed companies has increased considerably over time. Between 1982 and 1999 the median company targeted in a public-to-private LBO was larger than the median public company not targeted in an LBO. However, in 17 out of the 19 years from 2000 until 2018, the median PTP target was smaller than the median company from the control group, being 46% smaller on average.

Loughran and Wellman (2011) show that the enterprise value multiple (EV/EBITDA) is a better variable for sourcing a value premium in stocks compared to the price-to-book ratio, which is more frequently used in academia. The strength of the EV/EBITDA multiple as a value indicator might be explained by the way that modern companies have fundamentally changed over recent decades. Previously, the book value of equity might have been a good anchoring point for the intrinsic value of a company. Today, many of the biggest companies in the world have a large part of their value directly tied to their brand, intellectual property rights, and customer loyalty, which are all intangible assets that do not show up on the balance sheet and are thus not captured by the book value of equity.

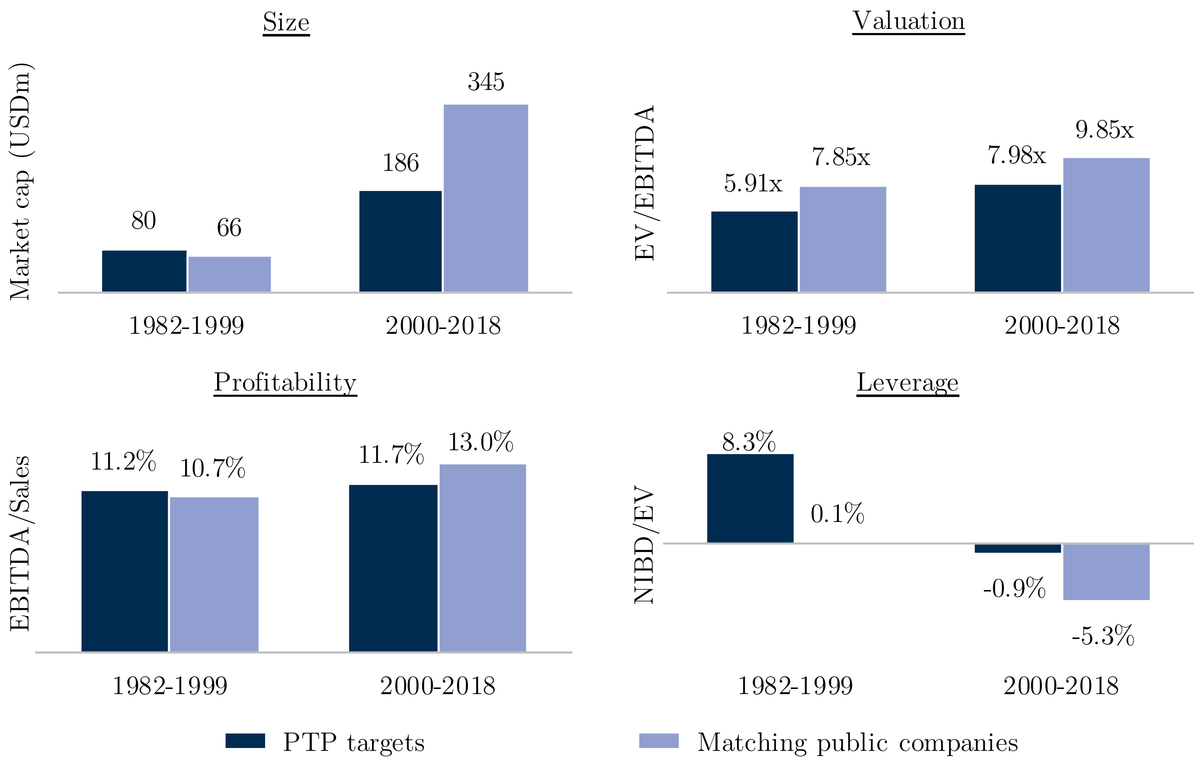

Figure 6.2: Comparison of the sample of PTP targets and the control group
This figure shows median values for the PTP targets and matching public companies of market capitalization, EV/EBITDA, EBITDA/Sales, and NIBD/EV for the two periods 1982-1999 and 2000-2018. A comparison of average values is presented in Appendix E.

There can be several reasons as to why companies trade at low valuation multiples. Starting from Gordon's (1962) perpetuity growth model, the EBITDA multiple can be written as,

$$\text{EV/EBITDA} = \frac{\mu}{r-g}, \tag{6.1}$$

where μ is the ratio of cash flows to EBITDA, r is the discount rate, and g is the perpetual growth rate. From Equation 6.1 we see that there can be three different reasons for a lower EBITDA multiple. First, a low conversion of EBITDA into cash flow, due to for example a high degree of capital expenditures and working capital requirements. Second, a lower expected cash flow growth rate increases the denominator, resulting in a lower multiple. Third, a high discount rate due to the systematic risk exposure being high in expectation. The thesis of value investors is that multiples are low due to the market pricing in additional non-systematic risks that are essentially diversifiable. Value investors hope to exploit this market mispricing to achieve abnormal risk-adjusted returns.

Looking at the EV/EBITDA multiple across our datasets of PTP targets and comparable companies, we see that PE managers tend to buy companies with relatively low valuations. Comparing the years before- and after 2000 shows that this pattern is persistent over time with median LBO valuations being 25% and 19% lower than valuations of similar listed companies, respectively.

Figure 6.3 shows the relative within-industry size difference between the PTP target sample and the control group. For each industry, we calculate the median company market capitalization, EV/EBITDA, EBITDA/Sales, and NIBD/EV for both the PTP target sample and for the control group. The relative size difference is then given by the ratio of the sample group measure to the control group measure. We see a discount of almost 20% in EV/EBITDA multiple when accounting for industry differences, in line with previous research pointing toward buyout investing being a value strategy.[15]

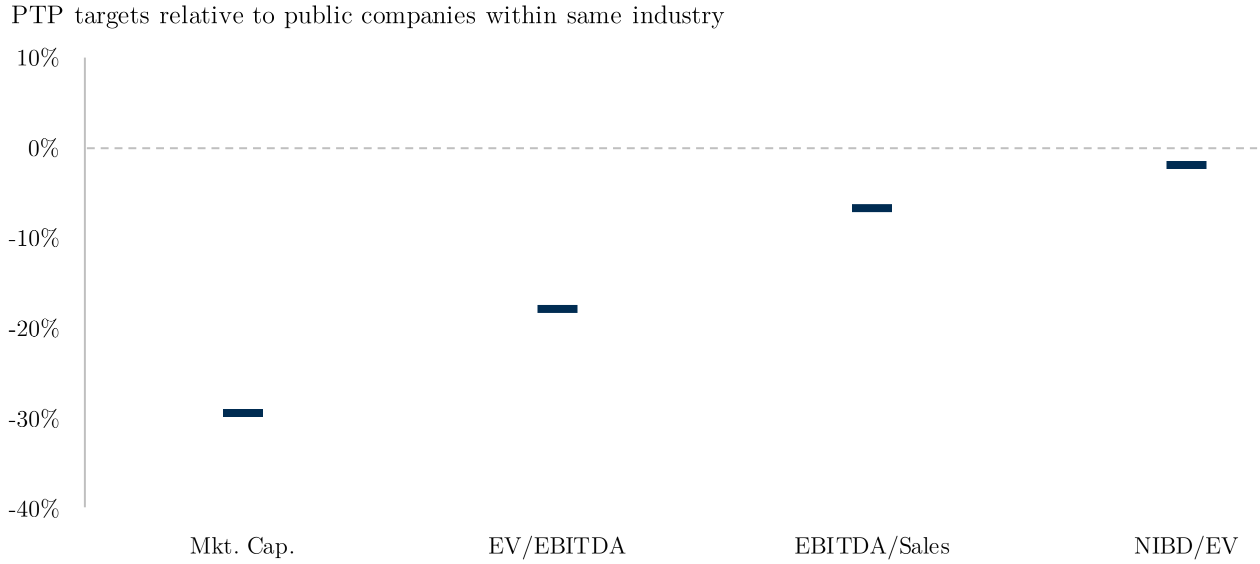

Figure 6.3: Within-industry comparison of PTP targets and the matching public companies
This figure shows the size of within-industry median values of market capitalization, EV/EBITDA, EBITDA/Sales, and NIBD/EV for the PTP target sample, relative to the sample of non-target companies. A value above 0 indicates that the median company in the PTP sample have X% higher value of that measure relative to the median non-target company within the same industry.

In our analysis of which financial characteristics that are predominant in LBO targets, we only focus on companies that are profitable, in that they are generating positive cash flows, as proxied by EBITDA. The reasoning for this is that it is quite well documented that buyout funds generally acquire mature firms with stable positive cash flows. The significant amount of debt financing used in LBO transactions demands the ability of the firm to be able to service the debt payments associated with carrying this leverage. Comparing the profitability of the

[15] Figure E.2 in Appendix E shows a comparison of the relative within-industry size differences of financial measures between the sample of PTP targets and the control group, based on mean numbers rather than median numbers.

companies in our sample of PE targets to the companies in the control group, it seems that PE managers tend to pick companies that are slightly less profitable than other similar public companies. This low profitability, however, is conditional on the compared companies having last-twelve-months rolling EBITDA above zero. An unconditional comparison points to PE-selected companies being more profitable than non-selected companies, in line with the above reasoning. The within-industry comparison of the EBITDA/Sales ratio of the sample and control groups also points to relatively higher profitability for the control group companies, suggesting that while PE managers target profitable businesses, they might skew to the ones with relatively more room for improvement.

The NIBD/EV comparison in Figure 6.2 indicates that take-private companies are more levered compared to other similar public companies, being the case both before and after the year of 2000. Specifically, the sample of PTP targets have median NIBD/EV ratios of 8.3% before- and 0.1% after 2000 while the matching public companies have leverage ratios of -0.9% and -5.3%, respectively. However, this is without taking into account possible differences persisting within industries. The analysis of within-industry differences pictured in Figure 6.3 shows that the NIBD/EV ratio of the median PTP target is almost indistinguishable, though slightly lower, from that of the median control group observation.

The preliminary descriptive analysis points to PE funds selecting companies that are relatively small, trade at lower valuations, and have moderately lower profitability. It is well documented that companies of small sizes and with low valuations have historically outperformed the market. In order to understand if any of these observed characteristics are statistically significant, and for us to implement our findings in a predictive model to be used for portfolio construction, we need to perform regression analyses. Such regression analyses will allow us to control for industry- and time specific differences in a more comprehensive manner.

6.1.2. Statistical methodology

Our objective is to understand the preferences of PE managers when it comes to selecting investment targets. We do not just want to explore how PE-selected companies differ from the typical non-target; instead, we want to explore how these companies differ from other companies that have otherwise similar characteristics. For each company in the PTP target sample, we create a control group of public companies operating in the same industry. The financials that are used in the analysis are matched to the PTP transactions based on year and month. A binary dependent variable, indicating whether a company was acquired in an LBO, is regressed against the selection of financial measures discussed above. The resulting regression estimates are used to predict the probability of companies being targeted by PE managers.

The OLS regression attempts to model a continuous linear relationship between the dependent and independent variables. We write the following multiple regression equation,

$$y = \alpha + \beta_1 x_1 + \cdots + \beta_k x_k + \varepsilon, \tag{6.2}$$

where y is the binary variable which takes on one of two unique values, 0 or 1, depending on whether the company was acquired in an LBO. x_k and β_k denotes variables $\{k = 1,2, \dots, K\}$ and their coefficients, respectively. ε is the error term that captures exposure to variables that are not defined. Since the dependent variable, y, is binary and only takes on the values 0 or 1, the coefficient estimate β_j cannot be interpreted as the change in y given a one-unit increase in x_j. Rather, assuming that the zero conditional mean assumption holds and y is a binary variable, it will be true that $P\ (y = 1|\boldsymbol{x})\ = E(y|\boldsymbol{x})$; the probability that $y = 1$ is equal to the expected value of y, given the current set of independent variables (Woolridge, 2015). This is called the linear probability model,

$$P\ (y = 1|x)\ = \alpha + \beta_1 x_1 + \cdots + \beta_k x_k, \tag{6.3}$$

where $P\ (y = 1|x)$ is the predicted probability of having $y = 1$ for given values of $x_1 \dots x_k$. There are several drawbacks of using OLS regressions to fit a linear probability model, including the fact that the normal distribution and homogeneous error variance assumptions of the OLS are likely to be violated with a binary dependent variable (Pohlmann and Leitner, 2003). As a result of these violations, the use of a linear probability model with a binary dependent variable will predict probabilities not confined by the range [0, 1] which does not make sense in the realm of probability thinking. However, due to the ease of interpreting OLS coefficients, we include this output together with that of our logit model.

One model that does not share the same limitations as the linear probability model when working with a binary dependent variable is the logit model. The logit model is a logistic regression model that transforms the probability estimate based on the assumption that errors follow a standard logistic distribution with mean 0 and variance $\frac{\pi^2}{3}$ (Kennedy, 2008). The dependent variable is transformed using the logistic transformation, solving the unboundedness of the OLS,

$$\ln\left(\frac{y}{1 - y}\right) = \alpha + \beta_1 x_1 + \cdots + \beta_k x_k, \tag{6.4}$$

where y is the probability of a firm being a PE target and $\frac{y}{1-y}$ is referred to as the odds ratio. Maximum likelihood estimation (MLE) is used to fit the model in Equation 6.4.

Given that the dependent variable is the log odds ratio, the regression coefficients are not as straightforward to interpret as in the OLS regression. However, by taking the antilog of Equation 6.4, one derives the equation to predict the probability of a firm being a PE target (Peng, Lee & Ingersoll, 2002),

$$y = \frac{e^{xb}}{1 + e^{xb}}, \tag{6.5}$$

where xb is a linear predictor given by,

$$xb = \alpha + \beta_1 x_1 + \cdots + \beta_k x_k \tag{6.6}$$

This equation is used to predict which firms, based on the analysis of buyout target characteristics, are most likely to be targeted by a PE firm. The predictions are used in Section 6 for sorting PE-mimicking portfolios that invest in publicly listed firms resembling buyout targets.

The logit model is intended for problems with a binary dependent variable and produces probability estimates that are bound by the range [0, 1]. In other words, by using a logit model the predicted probability of $y = 1$ is never below 0 or above 1. A comparison of the probability estimates derived using the linear probability model and the logit model is presented in Figure 6.4, highlighting the issue of using the linear probability model with a binary dependent variable.

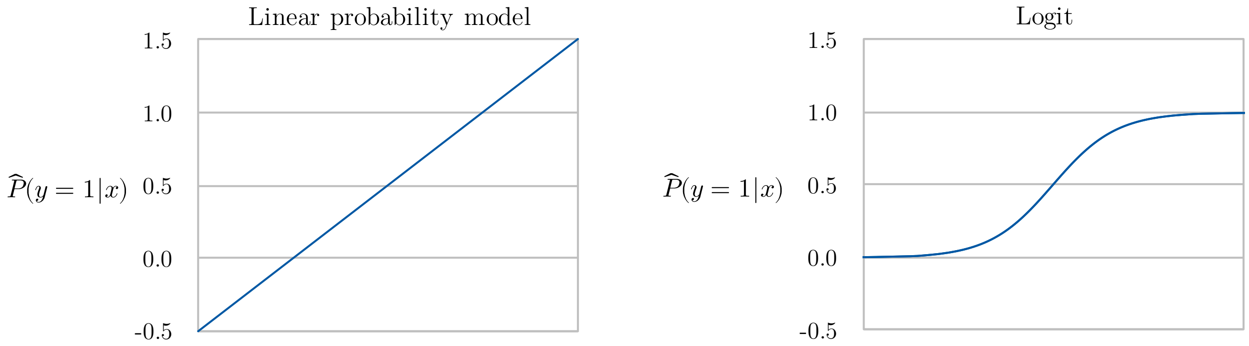

Figure 6.4: Comparison of probabilities resulting from the linear probability and logit models
Figures illustrate the limitations of the linear probability model compared to the logit model.

As we are looking to explain characteristics that are specific to PE-targeted companies, we want to sift out any differences that might be due to particular industry preferences of PE managers. Thus, if we find that PE-targeted companies have lower valuation levels compared to publicly listed companies, we want to control for the potential of PE managers predominantly investing in industries with lower valuations, on average. We want to control for omitted variables that are constant across industries but vary over time, like changes in the size of public companies or changes in public valuation levels that are due to economic cyclicality. We also want to control for omitted variables that are time-invariant and constant within industries, like differences in profitability across industries. Explained differently, we are looking to compare PE-selected companies, not just to the average publicly listed company, but to the average publicly listed company that operate in the same industry at the same time as the PE target. We control for omitted variables by including year- and industry fixed effects in our regression models, which means that we use dummy variables for both year and industry.[16] Using a sample consisting of $i = 1,2, \dots, N$ companies in $j = 1,2, \dots, M$ different industries with data stretching over $t = 1,2, \dots, T$ years we can write the following regression equation,

$$\begin{aligned} \ln\left(\frac{y_{ijt}}{1-y_{ijt}}\right) &= \alpha + \beta_1 x_{1it} + \dots + \beta_k x_{kit} + (\gamma_1 d_1 + \dots + \gamma_{m-1} d_{m-1}) \\ &\quad + (\delta_1 p_1 + \dots + \delta_{t-1} p_{t-1}), \end{aligned} \tag{6.7}$$

$$\ln\left(\frac{y_{ijt}}{1-y_{ijt}}\right) = \beta_1 x_{1it} + \dots + \beta_k x_{kit} + \gamma_j d_j + \delta_t p_t, \tag{6.8}$$

where $\ln\left(\frac{y_{ijt}}{1-y_{ijt}}\right)$ is the log-odds of PE-selection, $d_1, d_2, \dots, d_{n-1}$ are industry dummy variables, $p_1, p_2, \dots, p_{t-1}$ are year dummies, x_{kit} is the k^{th} variable for company i at time t, and γ_i and δ_t are industry- and year fixed effects, respectively.

6.1.3. Evaluating results and robustness of variables

To ensure the robustness of our results, we inspect each variable to check whether extreme observations might have undue influence on any results produced by our regressions. Several financial measures are highly skewed by the presence of extreme outliers. Specifically, EBITDA/Sales, EV/Sales, EV/EBITDA, P/B, NIBD/EV, and NIBD are influenced by such outliers. Instead of dropping extreme values we winsorize the variables at the 2.5% level, meaning all observations beyond the 97.5$^{\text{th}}$ and the 2.5$^{\text{th}}$ percentiles are adjusted inwards to equal the values of the 97.5$^{\text{th}}$ and the 2.5$^{\text{th}}$ percentile, respectively.

Additionally, certain variables are logarithmically transformed. Using the natural logarithm of a variable significantly reduces its variability, making the regressions less prone to influence from outliers. The distribution of the equity market values of public companies is highly skewed to the left, dominated by a few huge outliers. Through log transformation, we control for this skewness which results in a distribution of equity market values that more comparable to the normal distribution. For the regressions, we have used logarithmic transformations of market capitalization, Sales, EV/EBITDA, EV/Sales, P/B, and EBITDA/Sales.

[16] Industries are classified according the the Fama-French classification system, consisting of 48 different industries.

Table 6.5: Binary regressions of the selection of public-to-private targets (1982-2018)

We regress a binary variable, indicating whether a firm was acquired by a buyout fund, against a series of different financial measures. Panel A presents results from the OLS regressions while Panel B reports results from the logistic regressions. OLS regression coefficients are multiplied by 100 for improved readability. All regressions include year and industry fixed effects. T-statistics are reported in parentheses. ***, ** and * denotes significance at the 1%, 5% and 10% level, respectively.

Panel A: OLS regressions

Regression number	Beta	ln(Mkt. Cap.)	ln(Sales)	ln(EV/ Sales)	ln(EV/ EBITDA)	ln(P/B)	ln(EBITDA/ Sales)	NIBD/ EV	N
1	-0.091								55,050
	(-1.53)								
2		-0.115***							69,645
		(-7.25)							
3			0.010						63,087
			-0.64						
4				-0.347***					59,680
				(-9.84)					
5					-0.445***				44,413
					(-6.59)				
6						-0.309***			64,988
						(-7.78)			
7							-0.153**		46,568
							(-2.40)		
8								-0.019	66,094
								(-0.17)	
9		-0.131***		0.023	-0.448**	0.011	-0.20		43,256
		(-5.14)		(0.11)	(-2.15)	(0.90)	(-0.99)		
10		-0.151***			-0.434***		-0.167**		44,399
		(-6.22)			(-6.24)		(-2.33)		

Panel B: Logistic regressions

Regression number	Beta	ln(Mkt. Cap.)	ln(Sales)	ln(EV/ Sales)	ln(EV/ EBITDA)	ln(P/B)	ln(EBITDA/ Sales)	NIBD/ EV	N
1	-0.071								55,050
	(-1.30)								
2		-0.124***							69,645
		(-6.60)							
3			0.009						63,087
			(0.49)						
4				-0.386***					59,680
				(-9.34)					
5					-0.461***				44,413
					(-6.78)				
6						-0.371***			64,988
						(-7.25)			
7							-0.114**		46,568
							(-2.51)		
8								-0.022	66,094
								(-0.21)	
9		-0.118***		0.057	-0.456**	-0.013	-0.199		43,256
		(-4.12)		(0.34)	(-2.46)	(-0.17)	(-1.29)		
10		-0.134***			-0.403***		-0.139**		44,399
		(-5.04)			(-5.70)		(-2.29)		

Table 6.5 presents the results of simple- and multiple regressions on the different predictor variables. We regress a binary variable, indicating whether or not a company was acquired in a public-to-private transaction, against the financial characteristics of size, measured by either

market capitalization (Mkt. Cap.) or total annual sales (Sales); valuation, measured by the Sales multiple (EV/Sales), EBITDA multiple (EV/EBITDA), and the price-to-book ratio (P/B); profitability, as measured by a firm's EBITDA to Sales margin (EBITDA/Sales); and its net debt ratio (NIBD/EV). Panel A shows OLS regression coefficients which are included for interpretation reasons. OLS regression coefficients are multiplied by 100 for better readability, with t-statistics in parenthesis. Panel B shows coefficients from logistic regressions, taking into account both year- and industry fixed effects by including year- and industry dummy variables.

Size is only a significant predictor when measured by market capitalization. The ln(Mkt. Cap) coefficient is significantly negative at the 1% level while the ln(Sales) coefficient is slightly positive and insignificant. The negative coefficient on market capitalization indicates that PE managers typically target companies that are relatively small compared to their peers, consistent with previously discussed findings. We find that companies that are targets of public-to-private transactions have lower valuation multiples, measured using all three value measures EV/Sales, EV/EBITDA, and P/B ratios. Lower valuation multiples are consistent with findings of PE fund returns having positive exposure to the HML factor (Jegadeesh et al., 2015; Stafford, 2017). When including all three measures in the same regression, EV/Sales and P/B loses their statistical significance, meaning that EV/EBITDA is the measure with the highest explanatory power. Considering that the majority of PE managers rely on comparable EBITDA multiples when evaluating investment opportunities, this seems reasonable (Gompers et al., 2016). Since the EV/EBITDA multiple has been logarithmically transformed, its coefficient should be interpreted as a percentage change.

The regressions also point to PE managers selecting companies with relatively low profitability, measured as EBITDA/Sales, conditional on profitability being positive in the first place. This is in line with the initial descriptive analysis that pointed to generally lower profitability for companies targeted in LBOs when evaluating on an industry basis. The regression controls for both time and industry fixed effects, so the negative relationship between PE-selection and the EBITDA/Sales measure indicate that PE managers tend to look for companies with lower profitability relative to similar businesses. It might not be the case that PE funds target industries with low profitability, but rather target companies that they deem have relatively more room for improvements compared to their peers.

The leverage measure NIBD/EV is slightly negative, but insignificant, suggesting that a company's leverage is not critical in the PE-selection process. Although, if we exclude industry fixed effects from the regression the leverage ratio is a negative predictor significant at the 10% level.[17] The difference in significance before and after including industry fixed effects

[17] Appendix F provides a comparison of logistic regression output with- and without industry fixed effects.

suggests that PE firms might predominantly target industries, rather than individual companies, with greater leveragability than others. The beta coefficient indicates a slightly negative relationship between PE-selection and market risk exposure but is statistically insignificant. In summary, market capitalization, EV/EBITDA, and EBITDA/Sales seem to be the most significant financial predictors of PE-selection in U.S. public markets.

We test the persistence of the discussed predictor variables by running logistic regressions over each of the four decades covering the sample period. As can be seen in Table 6.6, it is only in the later decades that size has been a significant negative predictor of PE-selection. In fact, over the 1980s the size coefficient is significantly positive, at the 5% level, consistent with PE being dominated by mega-sized LBO transactions like KKR's fabled $24 billion takeover of RJR Nabisco in 1988.

Table 6.6: Multiple logistic regression coefficients over time (1982-2018)

The table shows the coefficients of the multiple logistic regression for every decade in the sample period. We regress a binary variable, indicating whether a firm was acquired by a buyout fund, against a series of different financial measures. The coefficients report the effects of a unit change in a variable, holding other variables constant. All regressions include year and industry fixed effects. T-statistics are reported in parenthesis. ***, ** and * denotes significance at the 1%, 5% and 10% level, respectively. *N* indicates the number of observations.

	1982-1989	1990-1999	2000-2009	2010-2018	1982-2018
ln(Mkt. Cap)	0.145**	-0.023	-0.202***	-0.242***	-0.134***
	(2.13)	(-0.36)	(-4.45)	(-5.21)	(-5.04)
ln(EV/EBITDA)	-0.535**	-0.784***	-0.421***	-0.096	-0.403***
	(-2.36)	(-4.36)	(-3.51)	(-0.80)	(-5.70)
ln(EBITDA/Sales)	-0.274	-0.219	-0.136	0.029	-0.139**
	(-1.35)	(-1.39)	(-1.37)	(0.28)	(-2.29)
N	6,826	11,536	14,867	10,915	44,399

Value, as measured by the EV/EBITDA multiple, is the most consistent predictor with negative coefficients throughout all four periods. However, while the value coefficient is highly significant over each of the first three decades, during the last eight years, the coefficient has lost its significance. As pointed out in Section 2 of this paper, LBO valuations have been increasing since the financial crisis, and the gap between public and private market valuations have been narrowing. The closing of the valuation gap has made public-to-private transactions relatively more attractive, which might explain why the difference between average market valuations and take-private purchase multiples is less now than before. Over each decade from 1982 until 2010, the profitability coefficient is negative, but since 2010 this is no longer the

case. Even though the EBITDA/Sales coefficient is significant at the 5% level when looking at the whole sample period, it is not statistically significant over any single decade.[18]
Before we apply these variables in a predictive logit model to be used for sorting our PE-mimicking portfolio, we must examine their statistical robustness. One concern when working with multiple regression models is multicollinearity. Any linear relationship between two independent variables makes it hard to measure the partial effects of any one of them. First, we look at the correlation between the independent variables selected. A simple correlation diagram can give a good indication of possible multicollinearity. Panel A in Table 6.7 shows no indication that this should be a problem, with the highest correlation being that between ln(EBITDA/Sales) and ln(Mkt. Cap.) of 0.37.

A more robust tool for evaluating possible multicollinearity of individual coefficients is the variance inflation factor (VIF) which measures to what extent the variance of a coefficient is inflated because of linear dependency on other predictor variables (Woolridge, 2015). The VIF for coefficient j is given as $VIF_j = 1/(1 + R_j^2)$ and is the factor by which the variance of coefficient j is higher because of linear correlation between the variable, x_j, and other predictor variables. By running a VIF test on the predictive variables in our multiple regression model we get VIF values of 1.32, 1.30, and 1.19 for the variables ln(EBITDA/Sales), ln(Mkt. Cap.), and ln(EV/EBITDA), respectively. As a VIF above 10 is often used as the cut-off point when evaluating the possibility of multicollinearity, there seems to be no significant risk in this case.

Table 6.7: Correlation matrix and VIF test for multicollinearity

Panel A shows the correlation matrix for the three independent predictor variables used in the multiple regression model. Panel B shows the VIF values for each of the three variables.

Panel A: Correlation matrix

	ln(Mkt. Cap.)	ln(EV/EBITDA)	ln(EBITDA/Sales)
ln(Mkt. Cap.)	1.00		
ln(EV/EBITDA)	0.20	1.00	
ln(EBITDA/Sales)	0.37	-0.24	1.00

Panel B: VIF test

Variable	VIF
ln(Mkt. Cap.)	1.30
ln(EV/EBITDA)	1.19
ln(EBITDA/Sales)	1.32

The final multiple regression model that is used to form the PE-mimicking portfolios include the variables, Mkt. Cap., EV/EBITDA and EBITDA/Sales. Despite the logistic regression coefficients being more accurate, the OLS regression coefficients are used for evaluating the results because of the relative ease at which they are interpreted. As the predictor variables are all log transformed, they are interpreted on a percentage change basis. Holding everything else equal, a 100% increase in the market capitalization of a publicly traded company will result in a $\ln(\frac{2.0}{1.0}) \times -0.00151 = -0.10\%$ change in the likelihood of that company being targeted by a buyout fund. Similarly, a doubling of the EBITDA multiple or the

[18] Appendix G shows additional regression coefficients from splitting the sample into the two periods.

EBITDA/Sales ratio would result in changes of -0.34% and -0.12% in the estimated likelihood of PE-selection, respectively.

These are of course minimal changes, but we have to consider that the probability of a public company being acquired in an LBO is tiny in the first place. According to the World Bank (2019a), between 2006 and 2017 there was on average 4,455 registered publicly listed companies in the U.S. and over the same period the average number of annual take-private buyout transactions was 54, corresponding to a 1.21% probability, on average, of a public company being acquired by a buyout fund in a given year (World Bank, 2019a; PitchBook, 2019).

6.2. The shortcomings of private equity returns indices

In Section 5.1, we showed that measured using the Kaplan and Schoar (2005) PME method, U.S. buyout funds have outperformed public markets every decade since 1984. This outperformance is net-of-fees, implying an even more substantial outperformance gross-of-fees. However, the PME metric does not control for the risk differential between buyout fund cash flows and investments in the public equity market (in this case the S&P 500). Comparing a levered, small, value strategy with a considerably less risky unlevered investment in the market index will naturally show historical outperformance.[19] An alternative to using the PME is to construct a portfolio of publicly listed companies that mimic the characteristics of the buyout model and compare its performance to that of the aggregate buyout index. Such an analysis allows us to evaluate at what degree PE managers add alpha, beyond what can be replicated in public markets.

6.2.1. Cambridge Associates U.S. Buyout Fund Index

For this analysis, the Cambridge Associates U.S. Buyout Fund Index serves as the benchmark for the aggregate performance of U.S. buyout funds. The index is computed by aggregating all quarterly cash flows and ending NAVs from the database into a dollar-weighted return. Alternative benchmarks could have been created using market prices of publicly traded PE funds of funds or publicly traded PE managers. However, purchasing the shares of a publicly listed PE firm is arguably different from investing in its funds. Additionally, most listed PE firms did not go public until 2007 and are still structured as partnerships, making it complicated for outside investors to hold stock in those companies because of additional tax filing requirements (PitchBook, 2016; Wall Street Journal, 2019).

Cambridge Associates mainly obtain their data from the quarterly partnership financial statements that GPs provide to their LPs. In total, the data is compiled from 849 U.S. buyout funds, including fully liquidated partnerships formed between 1986 and 2018. Of these, 272 are small-cap funds, 292 are mid-cap funds, 180 are large-cap funds, and 105 are mega-cap funds

[19] In Section 6.1, it was shown that buyout firms target smaller, less profitable firms with low EV/EBITDA multiples.

(Cambridge Associates, 2018a). Quarterly return data of the CA U.S. Buyout Fund Index, is available over the period Q3 1986 to Q2 2018. All returns are net of any fees, expenses and carried interest. The index is chosen over Preqin's Quarterly Return Index that only offers data from the start of the year 2000. In light of Brown and colleagues' (2015) conclusion that the data offered from these data providers are mostly similar, we do not expect that using one over the other will lead to material differences in results. Other indices measuring the performance of PE with a similar methodology include the State Street Index, AARM FOIA Index, and Thomson Reuters PE Buyout Research Index, but these also have limited historical data (Welch & Stubben, 2018).

Stafford (2017) uses the CA U.S. Private Equity Fund Index as a benchmark, rather than the CA U.S. Buyout Fund Index. The CA U.S. Private Equity Fund Index is constructed using the same methodology as the CA U.S. Buyout Fund Index, but in addition to buyout funds, it also aggregates cash flows from venture capital, growth equity, energy, and subordinated capital funds. Given this paper's focus on buyout funds, we argue that the CA U.S. Buyout Fund Index provides the best benchmark for return comparison. A comparison of the two return benchmarks, as shown in Appendix H, reveals that the performance of the two benchmarks has been highly comparable, which is likely due to the significant weighting on buyout funds in a dollar-weighted private equity return index. If anything, the private equity index used by Stafford (2017) slightly understates the returns of the buyout industry. Nonetheless, choosing the CA U.S. Buyout Fund Index over the CA U.S. Private Equity Fund Index will likely not lead to significant differences in results.

Given that the CA U.S. Buyout Fund Index is net-of-fees, expenses, and carried interest, we must estimate these in order to calculate the gross-of-fees benchmark. For this purpose, we assume a 2% fixed fee plus 20% in carried interest with a hurdle rate of 8%, as has historically been viewed as the industry standard. With fixed fees and carried interest assumed to be payable quarterly, this results in a yearly all-in fee paid that fluctuates between 2.0% and 9.2% throughout the period Q3 1986 to Q2 2018, averaging 5.6%. This fee estimate is significantly higher than that obtained by Stafford (2017), who estimates a yearly all-in fee ranging between 3.5% and 5.0%.

Døskeland and Strömberg (2018) criticize Stafford's (2017) fee estimation, stating that "*… Stafford (2017) claims that his mimicking strategy outperforms pre-fee PE returns, but his fee estimates of 3.5% to 5.0% likely underestimates actual fund fees, on the order of 6% or more.*" (Døskeland and Strömberg, p. 97, 2018). McKinsey (2017) analyzes fee estimates from CEM Benchmarking and shows that the 2/20 fee structure with an 8% hurdle rate approximately leads to an average all-in yearly fee of approximately 5.7% for LP fund investments.[20] Hence,

[20] CEM Benchmarking Inc. is a global benchmarking firm, specializing in benchmarking of cost and performance.

we argue that our estimate of the average all-in fee of 5.6% more closely resembles the actual fees paid by LPs than the proxy used by Stafford (2017). A comparison of the cumulative return of the U.S. Buyout Fund Index before and after fees is presented in Figure 6.8.

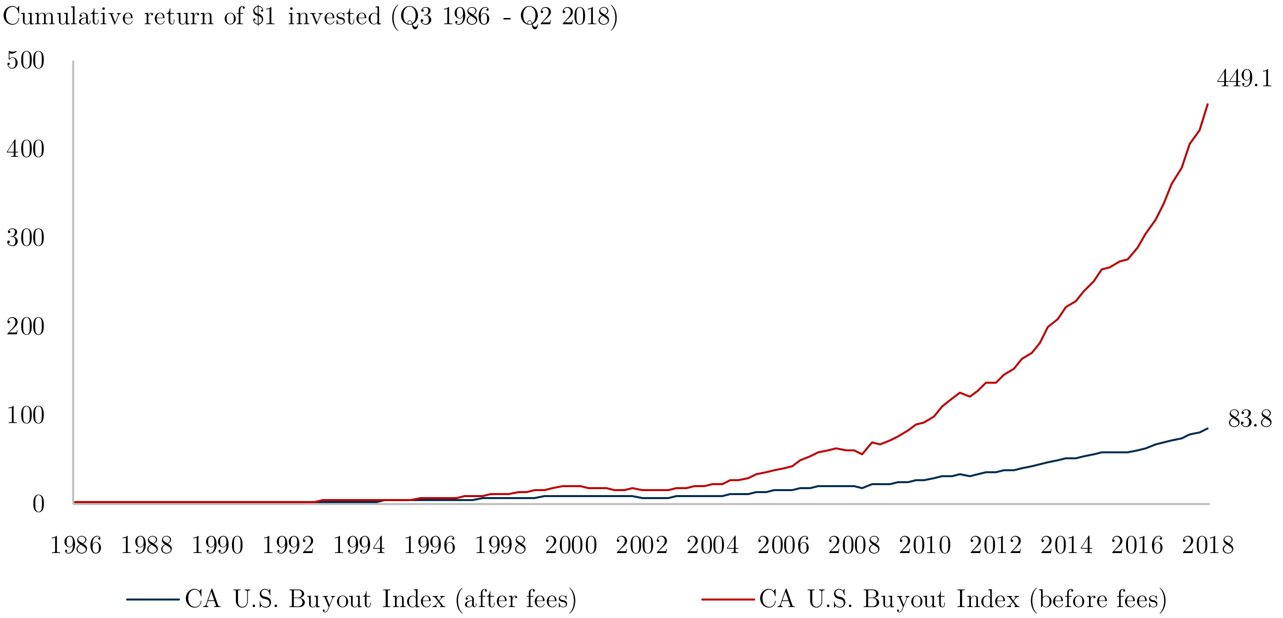

Figure 6.8: CA U.S. Buyout Fund Index before and after-fee comparison (Q3 1986 - Q2 2018)
The figure plots the cumulative value of $1 invested in the CA Buyout Fund Index, before and after fees. Fees have been estimated by treating the net-of-fee time series as if it represented the return of a fund that charges a 2% fixed fee plus a 20% carried interest subject to an annualized hurdle rate of 8%, when above its high water mark. Both fees are payable quarterly. The average yearly all-in fee is 5.6%.

6.2.2. The distorted risk characteristics of the aggregate buyout index

As highlighted by the quote from Swensen (2009) at the beginning of the section, the illiquidity of private equity masks the covariance between private equity performance and well-documented risk factors. Whereas the NAVs of buyout funds are infrequently and conservatively estimated, NAVs of public market investments are marked-to-market daily. The considerable degree of discretion that goes into marking the NAVs of a private equity fund, on the part of the fund manager, is likely to lead to downward biased risk estimates. If we consider investments in two otherwise identical companies, differing only with regards to one being private and the other being public, less frequent and conservative valuation estimates of the private company will lead the company to appear more stable than the public company that is marked-to-market daily – in particular, at times with volatile markets. However, we would expect both companies to react identically to fundamental corporate value drivers, meaning that the risk of the private company will be understated solely due to differences in accounting schemes.

From our regression analysis, we find evidence supporting the hypothesis that the true return distribution of the aggregate buyout industry is masked by the infrequent and conservative marking of net asset values in private equity. Given that the average buyout target has a beta of around 1 and that buyout investors approximately double the amount of leverage in portfolio companies, according to the Modigliani and Miller (1958) capital structure theory, we would expect the resulting market beta for buyout investments to be around 2. We can show this from a simplified scenario where EV = Debt + Equity. If we consider a firm with an EV/Equity ratio of 1.43 and an unlevered beta of 0.7, we can compute the levered beta as follows (assuming a debt beta of 0),

$$\beta_E = \beta_U + \frac{D}{E} \times \beta_U = 0.7 + 0.43 \times 0.7 = 1.0, \tag{6.9}$$

doubling leverage, such that EV/Equity = 2.86, leads to,

$$\beta_E = \beta_U + \frac{D}{E} \times \beta_U = 0.7 + 1.86 \times 0.7 = 2.0 \tag{6.10}$$

However, based on regressions of the CA U.S. Buyout Fund Index on a quarterly excess return series of CRSP stocks, we estimate net-of-fees and gross-of-fees CAPM betas of 0.29 and 0.33, respectively. Using annualized return series, the same CAPM beta estimates are 0.61 and 0.74 (Appendix I). To further account for the problems of nonsynchronous return data we use the techniques proposed by Dimson (1979) and Scholes and Williams (1977) and run regressions of returns on both contemporaneous and lagged market returns of the form,

$$R_{i,t} = \alpha_i + \beta_{0i} R_{m,t} + \beta_{1i} R_{m,t-1} + \beta_{2i} R_{m,t-2} + \dots + \varepsilon_{i,t}, \tag{6.11}$$

Specifically, we run regressions on current as well as three lags of market returns. We use quarterly data, but the lags are at a monthly level. Table 6.9 below shows the months included in a Q1 return calculation at different lags.

Table 6.9: Monthly lags of quarterly returns

Example of the months included at different lags of quarterly returns.

Q1	L_0	L_1	L_2	L_3
Begin	January	December	November	October
End	March	February	January	December

Summing the slope estimates from the different lagged regressions of the CA U.S. Buyout Fund Index quarterly returns series on the quarterly market return series gives net-of-fees and gross-of-fees beta estimates of 0.77 and 0.86, respectively. While these estimates are higher than the estimates from regressing on contemporaneous market returns only, they are still considerably lower than the expectation. This modest market exposure constitutes a statistical artifact and underestimates the systematic risk of investments in buyout funds.

Table 6.10 reports the results of the CA U.S. Buyout Fund Index return series regressed on various well-documented risk factors, both before and after fees. Regression results using annualized returns rather than quarterly returns are reported in Appendix I. The CAPM model, regression (1) in Panels A and B show that the broader U.S. buyout industry over a 33-year period have generated significant annualized abnormal returns of 14.3% and 9.0% before- and after fees, respectively.

Table 6.10: OLS factor regressions of quarterly CA U.S. Buyout Index (Q3 1986 - Q2 2018)

Quarterly returns of the CA U.S. Buyout Fund Index from Q3 1986 to Q2 2018, are regressed against different risk factors in 4 different regressions. Panel A reports regression results for the after fees return series while Panel B shows results for the return series before fees. MktRf, SMB, HML, RMW, and CMA are the 5 Fama-French factors. WML is the momentum factor introduced by Carhart (1997), BAB is the return to low-beta stocks as introduced by Frazzini and Pedersen (2014), and LIQ is the traded liquidity factor introduced by Pástor and Stambaugh (2003). OLS regression intercepts (alpha-estimates) are annualized and multiplied by 100 for improved readability. Standard errors are robust. T statistics are reported in parentheses. ***, ** and * denotes significance at the 1%, 5% and 10% level, respectively.

Panel A: CA U.S. Buyout Fund Index after fees											
Regression number	α	MktRf	SMB	HML	RMW	CMA	WML	BAB	LIQ	N	R^2
1	9.000***	0.290***								128	0.285
	(5.42)	(4.01)									
2	9.440***	0.261***	0.070	-0.117*						128	0.309
	(5.33)	(3.49)	(1.02)	(-1.76)							
3	10.320***	0.233***	0.011	-0.071	-0.152**	-0.012				128	0.321
	(7.57)	(4.06)	(0.16)	(-0.57)	(-2.14)	(-0.07)					
4	10.040***	0.255***	0.005	-0.005	-0.156	-0.050	0.074	-0.012	-0.075	128	0.332
	(5.91)	(5.44)	(0.08)	(-0.05)	(-1.53)	(-0.34)	(1.38)	(-0.11)	(-0.94)		
Panel B: CA U.S. Buyout Fund Index before fees											
Regression number	α	MktRf	SMB	HML	RMW	CMA	WML	BAB	LIQ	N	R^2
1	14.280***	0.327***								128	0.258
	(7.24)	(3.84)									
2	14.840***	0.293***	0.084	-0.141*						128	0.283
	(6.99)	(3.30)	(1.02)	(-1.81)							
3	15.760***	0.263***	0.021	-0.092	-0.163*	-0.012				128	0.290
	(9.61)	(3.87)	(0.27)	(-0.61)	(-1.93)	(-0.06)					
4	15.440***	0.295***	0.017	0.007	-0.157	-0.065	0.100	-0.032	-0.092	128	0.306
	(7.63)	(5.38)	(0.21)	(0.07)	(-1.32)	(-0.37)	(1.56)	(-0.25)	(-0.97)		

We argue that this substantial outperformance is overstated due to the masking of co-movement between reported buyout returns and public market returns, creating spurious diversifying characteristics. Although slightly lower, the regression results of the annualized return series also indicate substantial outperformance in the sample period (Appendix I). The significant outperformance is persistent when introducing additional factors to the regression model.

The lack of co-movement between reported PE returns and public market returns renders the regression results misleading. The use of buyout return indices as benchmarks *"… prevent investors from understanding the risk, return, and correlation characteristics of private equity"* as argued by Idzorek (p. 101, 2007). Hence, one should be cautious about concluding on the return distribution of the buyout asset class from fund-level cash flow data alone. However, as evidenced by the British Private Equity & Venture Capital Association (BVCA), there may be a general misconception in the investment management industry that fund-level NAVs can be used to accurately evaluate the risk- and return characteristics of PE investments. In their 2015 report on risk in private equity, the BVCA argues that *"… with NAVs as substitutes [of real continuous market prices], it is possible to calculate typical public market measures such as periodic returns, their volatilities and correlations with returns from other asset classes"* (BVCA, p. 9, 2015b).

Figure 6.11 presents the cumulative returns and quarterly drawdowns of the aggregate buyout index between 1986 and 2018, both before- and after fees, alongside those of the public market index with 2 times leverage. By the end of 2002, the drawdown levels for the buyout index reached its maximum of 23.1% (27.0%) before (after) fees. By comparison, the levered public market index experienced a maximum drawdown of 75.8% during the financial crisis. Despite the substantial risk of leveraged buyout investments, the buyout index barely reported any drawdown during the financial crisis, highlighting how the infrequent and conservative marking of NAVs in buyout funds contributes to an illusion of diversification.

The graph also reveals that the cumulative returns of the after-fee buyout index and the 2 times levered public market index, over the period Q3 1986 to Q2 2018, are broadly in line. The cumulative return series shows that an LP investing $1 in the aggregate universe of buyout funds and $1 in the levered public market index in July 1986 would have been close to equally well off over the sample period following the two strategies. That is, of course, when disregarding any additional headaches resulting from holding on to a 2 times levered investment in the market during times of market turmoil. Before fees, the buyout index has outperformed the levered public market substantially, underscoring the ability of the buyout industry to generate wealth.

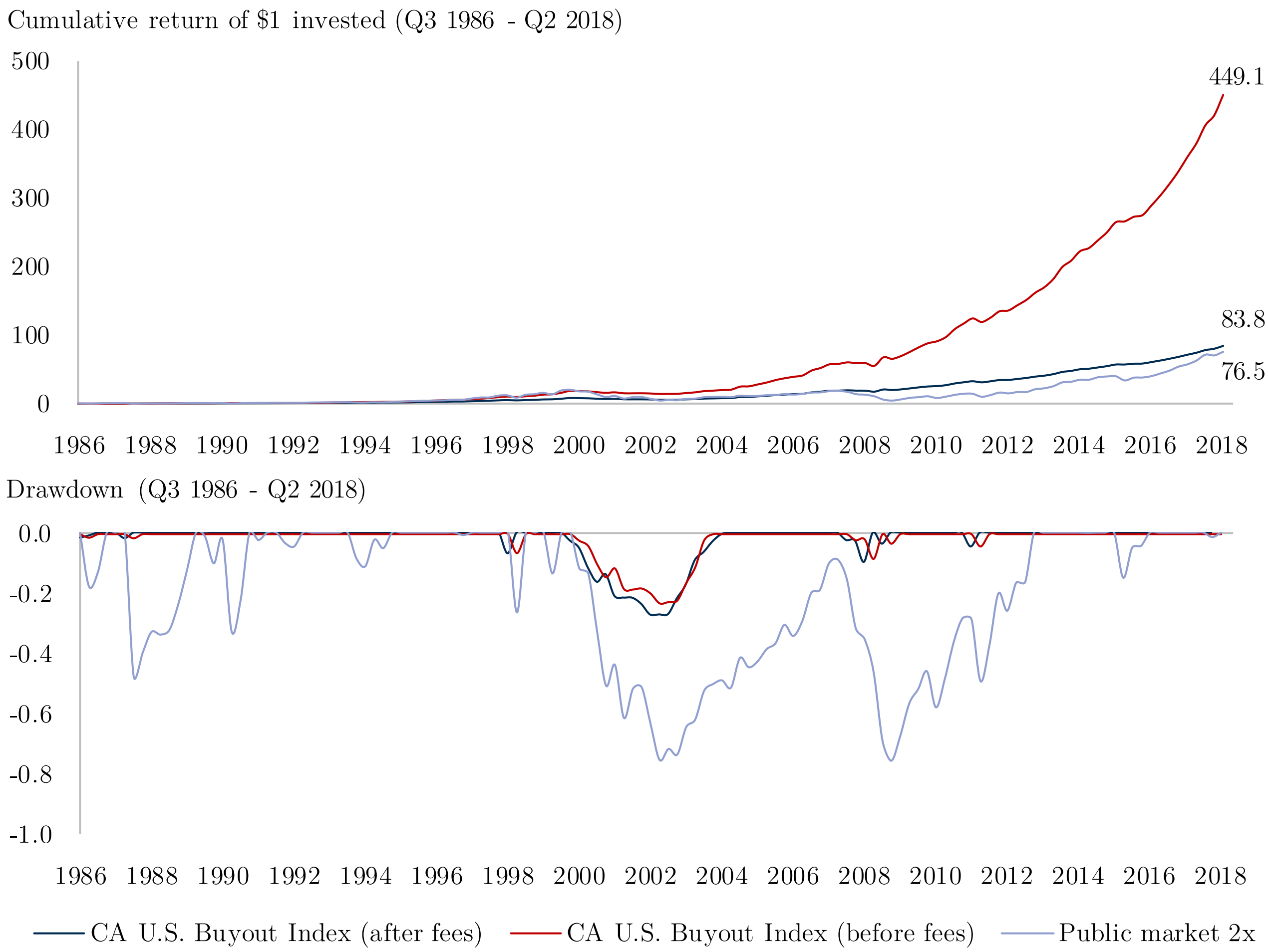

Figure 6.11: Comparison of U.S. Buyout Index and levered public stocks (Q3 1986 - Q2 2018)
The top panel plots the cumulative value of $1 invested from a quarterly return series in the CA U.S. Buyout Fund Index before- and after fees and a portfolio that levers the value-weight CRSP index by 2x. Fees for the buyout index have been estimated by treating the net-of-fee time series as if it represented the return of a fund that charges a 2% fixed fee plus a 20% carried interest subject to an annualized hurdle rate of 8%, when above its high water mark. The public market 2x index pays the monthly one-month U.S. Treasury yield and a monthly index fee of 10bps. The bottom panel plots the series of quarterly drawdowns, calculated using the formula $(\mathrm{HWM}_t - \mathrm{P}_t)/\mathrm{HWM}_t$.

The following sections explore in greater detail if the substantial, gross-of-fees, outperformance of the buyout industry can be explained by aforementioned passive components of the PE model, or if the outperformance is a result of the manager's active involvement in portfolio companies, and thus due to manager skill.

6.3. Sources of abnormal returns in private equity

As just shown, on a pre-fee basis, U.S. buyout funds have historically outperformed the broader public market by a substantial margin. In this section, the findings from the analysis of PE target characteristics are examined to investigate whether these can explain the abnormal returns of buyout funds.

A core component of asset selection in PE is to acquire small companies at low valuation multiples. Private companies are smaller than public companies, on average, which makes PE a small-cap strategy by definition. For reasons of data availability, this paper focuses on take-private transactions. Within this subsample of buyout transactions, we see that PE managers tilt toward smaller companies in their asset selection process. Additionally, the data support that a low EV/EBITDA multiple is a strong predictor of a firm being a likely acquisition target for a PE fund.

Value and size factors have long been associated with higher excess returns. Fama and French (1993) built on the insights from the CAPM, introducing the SMB (small-minus-big), and HML (high-minus-low) factors, capturing size and value premia in public markets, respectively. The authors found that stocks with low price-to-book ratios and small market capitalization outperformed companies with high price-to-book ratios and big market capitalization. The price-to-book and EV/EBITDA multiples are highly interlinked and have in academia been shown to be predictors of future stock returns. Loughran and Wellman (2011) studied the historical relationship between stock returns and EV/EBITDA multiples, showing that firms with low EV/EBITDA multiples have outperformed firms with high EV/EBITDA multiples historically. Their findings point to the EV/EBITDA multiple being a superior measure for sourcing a value premium in stocks, compared to the price-to-book ratio.

First, we want to test how much of the outperformance of the aggregate buyout index that can be attributed to the exposure to value stocks. We test this by constructing quintile portfolios, sorted monthly according to the EV/EBITDA multiples of CRSP constituents from the beginning of July 1986 through June 2018. The portfolios are formed at the beginning of each month based on information assumed to be known at the end of the previous month. Stock market values are assumed to be known without delay. Other financials are collected on a quarterly rolling basis with a 3 to 6-month delay. Market values of debt are assumed to be equal to book values. At the beginning of each month, the quintile portfolios are sorted according to the EV/EBITDA multiples calculated at the end of the previous month. We only consider firms with annual EBITDA above $1 million and a share price above $1 to ensure that companies are of an investable size. All data used is collected from the CRSP and Compustat databases.

Table 6.12 reports excess and abnormal returns for the monthly rebalanced portfolios formed on EBITDA multiples. As seen in the table, firms with low EV/EBITDA multiples have seen relatively higher excess returns over the period between July 1986 and June 2018. There is a clear monotonic relationship between the quintile portfolios and excess return. Overall performance is strongest for portfolios with lower EV/EBITDA multiples as can be seen in how the Sharpe ratio declines as we move from the low multiple to the high multiple portfolio.

Table 6.12: Excess and abnormal returns for portfolios formed on EBITDA multiples

This table provides an overview of performance, as measured by excess and risk-adjusted returns, for quintile portfolios sorted each month based on EBITDA-multiples. Annual excess returns are calculated by multiplying the average monthly excess returns by 12. Standard deviations are annualized by multiplying the monthly standard deviations by the square root of 12. The Sharpe ratio is found by dividing the annualized excess returns by the annualized standard deviations. Alpha is estimated based on regressions of value portfolio returns against various known risk factors and represent the abnormal returns after adjusting for these risk factors. Alpha estimates are annualized. Percentage figures are multiplied by 100 for better readability. Standard errors are robust. T statistics are reported in parentheses. ***, ** and * denotes significance at the 1%, 5% and 10% level, respectively. The sample covers all stocks in the CRSP universe between July 1986 and June 2018.

Panel A: Equally-weighted portfolios

Portfolio	Low	2	3	4	High	LMH
Annualized excess return	17.70	13.54	10.25	8.08	6.32	8.26
Annualized standard deviation	20.42	18.35	17.25	17.35	21.66	12.51
Sharpe ratio	0.87	0.74	0.59	0.47	0.29	0.66
CAPM alpha (%)	9.37***	5.51***	2.42*	0.05	-3.42*	9.65***
	(4.33)	(3.31)	(1.68)	(0.04)	(-1.89)	(4.49)
FF 3-factor alpha (%)	7.62***	4.02***	1.30	-0.33	-2.51***	7.00***
	(4.71)	(3.54)	(1.44)	(-0.40)	(-2.97)	(4.04)
FF 5-factor alpha (%)	7.19***	3.01**	-0.07	-1.40	-1.00	5.09***
	(3.70)	(2.33)	(-0.08)	(-1.59)	(-1.38)	(2.59)
FF 5-factor + WML + BAB + LIQ alpha (%)	8.57***	3.86***	0.04	-1.60**	-1.15	6.60***
	(5.88)	(4.31)	(0.06)	(-2.18)	(-1.54)	(4.48)

Panel B: Value-weighted portfolios

Portfolio	Low	2	3	4	High	LMH
Annualized excess return	11.14	9.61	9.12	7.52	6.68	1.34
Annualized standard deviation	16.08	15.85	14.52	15.46	18.41	13.65
Sharpe ratio	0.69	0.61	0.63	0.49	0.36	0.10
CAPM alpha (%)	4.40***	2.62*	2.40**	0.11	-2.04	3.31
	(2.67)	(1.76)	(2.21)	(0.11)	(-1.64)	(1.40)
FF 3-factor alpha (%)	3.26**	1.48	1.68	0.09	-0.40	0.53
	(2.11)	(1.10)	(1.63)	(0.09)	(-0.42)	(0.28)
FF 5-factor alpha (%)	1.90	-0.17	-0.45	-2.40***	0.47	-1.68
	(1.09)	(-0.12)	(-0.43)	(-2.65)	(0.50)	(-0.79)
FF 5-factor + WML + BAB + LIQ alpha (%)	2.17	0.15	-0.35	-2.50***	-0.18	-0.76
	(1.37)	(0.11)	(-0.36)	(-2.71)	(-0.20)	(-0.41)

Panel A shows that an equally-weighted portfolio that invests in the bottom quintile of companies, according to their EV/EBITDA multiples, would have achieved an annual excess return of 17.7%. In comparison, a portfolio invested in the top quintile would have achieved annual excess returns of just 6.3%. Panel B shows that a value-weighted portfolio investing in firms in the bottom quintile would have generated an annualized return over the risk-free rate of 11.1%, compared to an annualized excess return of 6.7% for a value-weighted portfolio investing in firms in the top quintile.

The bottom quintile equally-weighted portfolio generates significant abnormal returns in each of the regressions. The bottom quintile value-weighted portfolio only generates significant abnormal returns when measured using the CAPM and the Fama-French 3-factor model – this significance disappears when the RMW and CMA factors are added to the regression (the Fama-French 5-factor model). Thus, the returns generated by the value-weighted portfolio seem to be explained by its exposure to systematic market risk, small, cheap, as well as profitable companies, and companies with low reinvestment rates.

The substantial outperformance of the equally-weighted portfolios, compared to the value-weighted portfolios, reveals that smaller firms have generally outperformed larger firms, consistent with the notion of a size premium in the public markets. Additionally, the monthly rebalancing required to maintain an equally-weighted portfolio also entails that one sells winners and buys losers, adding a contrarian element to the strategy, as argued by Plyakha, Uppal, and Vilkov (2012).

In addition to value being a predictor of PE-selection, in Section 6.1 we also find that small size and a relatively low, but positive, profitability are characteristics of take-private targets. To further investigate premia related to investing in "PE-like" firms, we again compute five quintile portfolios with monthly rebalancing over the period July 1986 to June 2018, this time sorted on PE-selection likelihood, as predicted by our logit model. Again, we only consider firms with annual EBITDA above \$1 million and a share price above \$1. All companies of the CRSP universe are evaluated at the end of each month using the regression coefficients from the logistic regression estimated in Section 6.1.[21]

[21] The universe of investable stocks consist of 15,339 companies registered in the CRSP database between 1982 and 2018.

Using the selected financial characteristics, the regression can be written as,

$$\ln\left(\frac{y}{1-y}\right) = \alpha + \beta_1 \times \ln(Mkt.\,Cap.) + \beta_2 \times \ln\left(\frac{EV}{EBITDA}\right) + \beta_3 \times \ln\left(\frac{Sales}{EBITDA}\right) + \gamma_j d_j + \delta_t p_t, \quad (6.12)$$

where d_j is the industry dummy variable and p_t is the year dummy variable. By taking the antilog of Equation 6.12, we can predict the probability of a firm being a PTP target (Peng, Lee & Ingersoll, 2002),

$$y = \frac{\mathrm{e}^{\alpha+\beta_1\times\ln(Mkt.Cap.)+\beta_2\times\ln\left(\frac{EV}{EBITDA}\right)+\beta_3\times\ln\left(\frac{Sales}{EBITDA}\right)+\gamma_j d_j+\delta_t p_t}}{1+\mathrm{e}^{\alpha+\beta_1\times\ln(Mkt.Cap.)+\beta_2\times\ln\left(\frac{EV}{EBITDA}\right)+\beta_3\times\ln\left(\frac{Sales}{EBITDA}\right)+\gamma_j d_j+\delta_t p_t}} \quad (6.13)$$

The logistic regression prediction estimates are based on expanding regression windows and only takes into account known information. For instance, the likelihood that a company in 1990 is a PE target is estimated from a regression model based on take-private transactions between 1982 and 1989. This way we avoid any hindsight bias and the exposure to the different characteristics will vary over time. Thus, in the early years of the sample period, portfolio companies will be larger and likely more profitable than in the later years (Appendix G). Given that the EV/EBITDA multiple is a consistently significant predictor of PE-selection likelihood, in terms of asset selection, we would expect some similarity between PE-select portfolios and the value portfolios. However, including size and profitability, and taking into account industry and year fixed effects will impact the predicted probabilities and hence the portfolio sorts.

Table 6.13 reports the excess and abnormal returns for the monthly rebalanced portfolios, formed on PE-selection likelihood. As seen in the table, firms associated with a high probability of being PE targets have generated higher excess returns between July 1986 and June 2018. As with the value portfolios, we see a monotonic relationship between quintile portfolios and excess returns.

Panel A shows that an equally weighted portfolio investing in the top quintile of PE-like stocks would have generated an annual excess return of 15.1% which is more than any of the four lower quintile portfolios. The same is true for the Sharpe ratios of the portfolios, with the top quintile portfolio generating a Sharpe ratio of 0.77 and the bottom quintile portfolio generating a Sharpe ratio of 0.35. As reported in Table 6.13, a value-weighted portfolio investing in the top quintile of PE-like stocks would have generated annual excess returns of 11.1%, compared to annual excess returns of 6.6% for a value-weighted portfolio investing in the bottom quintile of stocks.

Table 6.13: Excess and abnormal returns for portfolios formed on PE-selection probabilities

This table provides an overview of performance, as measured by excess and risk-adjusted returns, for quintile portfolios sorted each month based on predicted PE-selection probabilities. The predictive variables are ln(Mkt. Cap.), ln(EV/EBITDA), ln(EBITDA/Sales), as defined in Table 6.1. Annual excess returns are calculated by multiplying the average monthly excess returns by 12. Standard deviations are annualized by multiplying the monthly standard deviations by the square root of 12. The Sharpe ratio is found by dividing the annualized excess returns by the annualized standard deviations. Alpha is estimated based on regressions of value portfolio returns against various known risk factors and represent the abnormal returns after adjusting for these risk factors. Alpha estimates are annualized. Percentage figures are multiplied by 100 for better readability. Standard errors are robust. T statistics are reported in parentheses. ***, ** and * denotes significance at the 1%, 5% and 10% level, respectively. The sample covers all stocks in the CRSP universe between July 1986 and June 2018.

Panel A: Equally-weighted portfolios						
Portfolio	Low	2	3	4	High	HML
Annualized excess return	7.54	10.31	11.08	12.38	15.10	4.44
Annualized standard deviation	21.46	18.11	17.67	18.21	19.71	12.97
Sharpe ratio	0.35	0.57	0.63	0.68	0.77	0.34
CAPM alpha (%)	-1.92	2.12	3.16**	4.39***	6.82***	5.60***
	(-1.00)	(1.39)	(2.06)	(2.64)	(3.46)	(2.47)
FF 3-factor alpha (%)	-0.82	1.64*	1.96*	2.80**	5.14***	2.82
	(-0.74)	(1.77)	(1.93)	(2.58)	(3.72)	(1.59)
FF 5-factor alpha (%)	0.97	1.21	0.97	1.69	3.79**	-0.29
	(0.95)	(1.23)	(0.90)	(1.44)	(2.42)	(-0.17)
FF 5-factor + WML + BAB + LIQ alpha (%)	1.17	1.22	1.24	2.24***	4.85***	0.57
	(1.10)	(1.45)	(1.58)	(2.63)	(4.05)	(0.37)

Panel B: Value-weighted portfolios						
Portfolio	Low	2	3	4	High	HML
Annualized excess return	6.60	8.29	7.81	10.75	11.10	1.39
Annualized standard deviation	19.34	15.02	14.76	16.29	17.47	15.10
Sharpe ratio	0.34	0.55	0.53	0.66	0.64	0.09
CAPM alpha (%)	-2.32	1.17	0.95	3.26***	3.38**	2.57
	(-1.57)	(1.14)	(0.82)	(2.60)	(2.19)	(0.98)
FF 3-factor alpha (%)	-0.66	0.83	0.09	2.36**	1.75	-0.72
	(-0.55)	(0.82)	(0.09)	(2.03)	(1.33)	(-0.34)
FF 5-factor alpha (%)	0.46	-0.44	-1.85*	0.62	-0.29	-3.85*
	(0.36)	(-0.43)	(-1.67)	(0.54)	(-0.21)	(-1.75)
FF 5-factor + WML + BAB + LIQ alpha (%)	0.65	-0.48	-2.02*	0.90	0.51	-3.25
	(0.51)	(-0.50)	(-1.83)	(0.74)	(0.41)	(-1.61)

The top quintile equally-weighted portfolio generates significant abnormal returns in each factor regression. According to the CAPM, the top quintile value-weighted portfolio achieves significant abnormal returns of 3.4% annually, over the sample period. However, the significance disappears when introducing the SMB and HML factors of the Fama-French 3-factor model, implying that the significant abnormal returns, seen from the CAPM regression, can be explained by exposure to value and size characteristics.

The alpha-estimates for the value-weighted portfolios are slightly lower for the "high" PE-selection portfolio than for the "low" portfolio sorted on EV/EBITDA. Overall, similar conclusions can be reached from tests of both the EV/EBITDA and PE-selection portfolios, with both showing that buyout funds have generally targeted firms with exposure to risk factors that are known sources of above-market returns. In the following section, we combine the elements of (1) asset selection, (2) long holding periods, (3) conservative marking of portfolio net asset values, and (4) the use of leverage in an attempt to capture the entire passive component of the buyout investment process in an investable strategy.

6.4. Mimicking private equity in public markets

We now aim to construct a portfolio of public stocks mimicking all identified passive components of the PE investment process. On top of the characteristics of the asset selection process, as examined above, we introduce additional elements of long holding periods, conservative marking of NAVs, and leverage, to test how these contribute to the abnormal returns of the aggregate buyout index. We hypothesize that analyses of the mimicking portfolio can paint a better picture of the risk and return characteristics of a diversified portfolio of buyout funds. Additionally, this can show us if the significant outperformance of PE before fees persists when comparing the performance with a PE-mimicking portfolio as the benchmark.

The fundamental idea is that PE is made up of both active and passive components. Hence, we can measure the active contribution in PE by subtracting the contribution of the passive components.

$$\mathrm{PE}_{\mathrm{performance}} = \mathrm{Active}_{\mathrm{contribution}} + \mathrm{Passive}_{\mathrm{contribution}} \tag{6.14}$$

Comparing the PE-mimicking portfolio with the CA U.S. Buyout Fund Index should, therefore, reveal insights about the value added from active fund management, beyond what investors can obtain by mimicking the passive components of the investment strategy in the public market.

6.4.1. Passive components of the private equity investment process

The PE model includes several elements that are not readily implementable in minority investments in publicly traded companies. However, like Stafford (2017) we argue that there are central components to the PE model that can be mimicked, or at least approximated in a strategy investing in public equities. In the following sections the components of (1) asset selection, (2) long holding periods, (3) conservative marking of net asset values, and (4) leverage are discussed in more detail. It is acknowledged that the components of active management and the operational engineering following PE ownership are principal value drivers of the PE model that will not be captured in such a public market investment strategy.

Asset selection is a core component of the investment strategy for any investor, in both public and private markets. The analysis of public-to-private targets in the U.S. supported previous studies by showing that buyout funds tend to select smaller firms with low EV/EBITDA multiples and modest profitability.[22] As argued in the previous section, these characteristics have historically been associated with above-market returns. The thesis is that by targeting stocks of companies with similar characteristics to those targeted by PE managers, investors can mimic the investment selection criteria of a diversified portfolio of buyout funds.

PE funds are characterized by the *long holding periods* of portfolio companies. In 2018, the median holding period fell by 10% to 4.5 years (Figure 2.11). At the same time, 24% of all buyout deals were exited within three years, indicating that so-called “quick flips” are becoming increasingly common again. Part of this decrease in the average holding periods can be explained by the fact that many funds have unloaded some of the last unrealized investments from before the great financial crisis – these have previously pushed up the holding time considerably. Investors in public markets can mimic long holding periods by setting up portfolio rules for holding-period length in a buy-and-hold scheme.

Section 6.2 showed how *conservative and infrequent estimates of portfolio NAVs* in buyout funds lead to spurious diversifying characteristics. The modest exposure of PE return benchmarks to the market factor constitutes a statistical artifact that results in a significant underestimation of the actual risk characteristics of investing in buyout funds. While public market investors cannot avoid the daily marking-to-market of their investments, approximating the effect of infrequent and conservative marking of net asset values is still a fruitful exercise in that it can illustrate how significant an effect this masking of risk can have on the performance of an equity portfolio. For this purpose, we consider a hold-to-maturity scheme in which assets are measured at cost until they are sold, similar to the held-to-maturity accounting scheme for U.S. banks in which debt positions intended to be held until maturity are accounted for at

[22] Low profitability is conditional on company EBITDA margins being positive in the first place.

amortized cost (Fuster & Vickery, 2018). As daily price fluctuations do not impact daily portfolio NAVs under such an accounting scheme, portfolio NAVs will solely change based on the cumulative profit and loss at the time of sale. While hold-to-maturity accounting is an extreme case, it provides insights about how risk is distorted when NAVs are not marked-to-market regularly.

Financial leverage also plays a vital role in the buyout investment process. Axelson and colleagues (2013) studied a sample of 1,157 public-to-private buyouts internationally from 1980 to 2008 to understand how PE firms apply leverage to portfolio companies. The authors found that the average Debt/EV ratio of a matched public company was around 30%, while this ratio increased to around 65% following a buyout transaction. Using the simplified formula where EV = Debt + Equity, we can see that the EV/Equity ratio, on average, increases from 1.43 to 2.86 as a result of a buyout transaction. Hence, an investor would need to apply portfolio leverage of 2.86/1.43 = 2x in order to obtain the post-LBO levered return from pre-LBO equity. For the purpose of this study, leverage is applied through a margin account.[23] We acknowledge that the indirect disciplining effects of adding more debt to the capital structure, like limiting corporate waste and focusing management, cannot be approximated through leverage in a margin account.

6.4.2. Constructing the private equity mimicking portfolio

At the end of each month between June 1986 and May 2018, all firms in the CRSP universe are sorted based on their predicted likelihood of being taken private by a buyout firm. Firms in the top quintile are included in the portfolio. As explained previously, the likelihood is predicted using the logistic regression, taking only into account known information. In line with historical PE holding periods, all stocks in the PE-mimicking portfolio are held for 4 years. However, stocks that have been held for a minimum of 12 months are sold early if their annualized return exceeds 50%. This way we mimic the tendency of PE funds to exit winners relatively early on while holding on to their dogs. Additionally, once a stock has been exited from the portfolio, it will not be considered for portfolio re-entry until at least 1 year later. Businesses with 12-months rolling EBITDA of less than $1 million or a share price of less than $1 are excluded from the sorting to avoid the inclusion of un-investable micro-cap stocks in the portfolio. However, if a company, already included in the portfolio, sees its 12-months rolling EBITDA fall below $1 million or its share price drop to less than $1, this company will not subsequently be exited for this reason.

Portfolio leverage is defined as the market value of the portfolio equity divided by the portfolio NAV. When entering new investments, a 2 times position leverage, L, is applied. That is, for a new $500 portfolio position, $250 will be financed in the form of debt from a margin account

[23] Leverage is defined as the market value of long positions divided by the portfolio equity capital.

while the remaining \$250 is financed by the cash position in the portfolio. This way we consistently target a level of leverage comparable to that used in LBOs, as estimated by Axelson and colleagues (2013). The portfolio net asset value is defined as the residual asset value net of debt, given by the equation,

$$\mathrm{NAV} = \mathrm{Portfolio}_{\mathrm{cash}} + \mathrm{Portfolio}_{\mathrm{equity}} - \mathrm{Portfolio}_{\mathrm{debt}} \tag{6.15}$$

All transactions are assumed to occur at market prices, and portfolio entries do not have any impact on the portfolio NAV. For instance, if we buy 50 stocks at \$10 per share, the portfolio equity value would increase by \$500, our cash position would fall by \$250, and portfolio debt would increase by \$250. The \$250 cash and debt entries reflect that the \$500 position is partly financed by portfolio cash and portfolio debt, resulting in a 2 times position leverage. Borrowing costs are assumed at the one-month U.S. Treasury bill yield. While this likely understates the actual borrowing costs from such an investment strategy, it is assumed for the sake of simplicity.

The first portfolio investments are completed at the beginning of July 1986. An equal amount of capital is allocated to the top quintile CRSP companies, sorted by the predicted likelihood of being PE targets, as calculated at the end of June 1986. At the end of each month, we calculate a target number of portfolio holdings, which will determine the allocation to new positions for months t=2,…,T. The target number of holdings is given by,

$$\text{Target number of holdings} = \mathrm{Holdings}_{\mathrm{t}-1} + \mathrm{Additions}_{\mathrm{t}-1} - \mathrm{Exits}_{\mathrm{t}-1} \tag{6.16}$$

This calculation is based on the simple assumption that the current month’s additions and exits to the portfolio make the best estimate for the following month’s additions and exits. The amount to be invested in each new position is given by,

$$\text{Investment allocation (\$)} = \frac{\text{Equity capital}_{\mathrm{t}} \times L}{\text{Target number of holdings}} \tag{6.17}$$

Given that we consider a buy-and-hold investment strategy, in which neither long positions nor debt is rebalanced, the portfolio leverage ratio will vary over time as the market value of the portfolio equity changes and the debt accumulates interest.

To assess the effect of conservative and infrequent estimates of NAV in PE, we consider both a traditional mark-to-market accounting scheme as well as a hold-to-maturity accounting scheme as discussed previously. In the hold-to-maturity scheme, stock positions in the portfolio are measured at cost until they are sold. That is, the change in portfolio NAV will primarily be driven by the cumulative profit or loss of investments, calculated when individual portfolio holdings are liquidated. Hence, while the portfolio value will be updated continuously in the mark-to-market scheme, under the hold-to-maturity scheme the portfolio value will only be affected once investments are realized. While this is an extreme representation of the infrequent and conservative estimates of NAVs in PE, it illustrates how the covariance structure of returns becomes distorted when market prices are stale rather than marked-to-market daily. To ensure that the geometric return is the same in both the mark-to-market and hold-to-maturity accounting schemes, all positions are exited at the end of June 2018.

6.4.3. Risk and return characteristics of the private equity mimicking portfolio

Figure 6.14 shows the cumulative return of investing $1 in the CA U.S. Buyout Fund Index (before fees) and the PE-mimicking portfolio, using daily mark-to-market and hold-to-maturity accounting. Over the 33-year sample period, the PE-mimicking portfolio generates almost the same return as the pre-fee aggregate buyout index. However, it is clear that the return series of the mimicking portfolio that is marked-to-market daily is considerably more volatile compared to the other two return series. This is especially clear during the great financial crisis with the maximum drawdown of the levered marked-to-market portfolio reaching 94.4% at the beginning of 2009. By comparison, the maximum drawdown of the pre-fee aggregate buyout index is 27.0%. How much of this difference in measured risk is a result of differences in the risk of the underlying assets, and how much is a result of differences in the accounting measures used to value these assets?

Using a hold-to-maturity accounting scheme, the PE-mimicking portfolio experiences a maximum drawdown of 13.1% over the entire period, which clearly shows that conservative and infrequent marking of net asset values makes a significant difference in the perceived risk of an investment. Bear in mind that the sole difference between the two return series of the PE-mimicking portfolio is the accounting schemes that are used in the reporting of NAVs. With quarterly portfolio valuation reports being the industry standard, there is a considerable lag in the reporting of net asset values for PE investments (Welch & Stubben, 2018).

Asness, Krail, and Liew (2001) use summed beta estimates taken from regressions of both contemporaneous and lagged market returns to find that, in the case of hedge funds, the combination of stale and managed prices significantly understates the systematic risk of these investments. Correcting for this, much of the outperformance of hedge funds in the 1990s can be explained by simple market exposure – not manager generated alpha. Similarly, Welch and Stubben (2018) point to a “diversification illusion” in private equity investments, showing that although the introduction of fair value accounting principles in 2006 has been an improvement, the stale prices and manager discretion in marking asset values, still obfuscates the correlation between PE fund returns and the market. The difference in drawdown levels between the mark-to-market portfolio and the hold-to-maturity portfolio is a clear illustration of the diversification illusion.

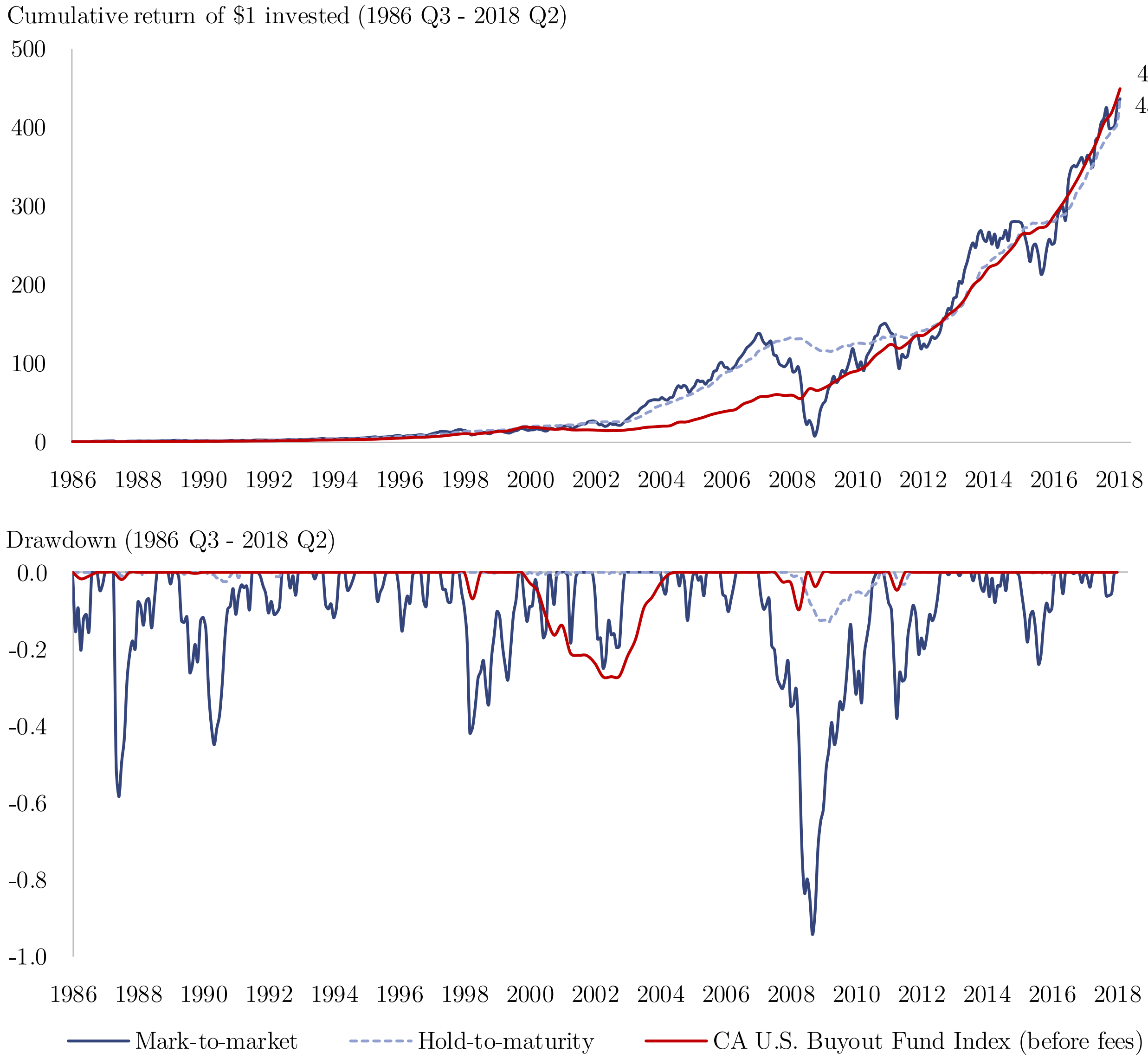

Figure 6.14: Realized risk and returns of PE-mimicking portfolio

The top graph shows the cumulative value of $1 invested in the Cambridge Associates Quarterly Buyout Fund Index (before fees) and the PE-mimicking portfolio based on the PE prediction model, using both mark-to-market accounting and hold-to-maturity accounting. Each month, the PE-mimicking portfolio selects stocks in the top quintile of PE-selection likelihood. Stocks are held between 1 and 4 years. Portfolio positions are levered 2x. The bottom graph plots the drawdowns of all three portfolios.

Figure 6.15 presents a more detailed comparison between the mark-to-market and hold-to-maturity accounting schemes. Using the unlevered PE-mimicking portfolio, it illustrates the effects of stale prices and conservative marking of net asset values for different holding period lengths. As all investments are liquidated in June 2018, the compound annual average return is the same, regardless of which of the two accounting schemes is used. As the top two graphs illustrate, the primary determinant of average yearly returns is the minimum holding period, with more frequent trading leading to higher returns.[24] However, when looking at return volatility, the differences between the two accounting measures become quite clear. Naturally, when only marking to market the value of an investment when the investment is realized, the perceived volatility will be extremely low. Although the mark-to-market portfolio reaches a relatively high Sharpe ratio of 0.75 when using hold-to-maturity accounting and a maximum holding-period of 4 years, the Sharpe ratio increases to 2.34.

The CAPM beta estimates are also substantially lower when using hold-to-maturity accounting compared to daily marking-to-market of net asset values. With holding periods resembling those in private equity (2-6 years), the measured market beta is close to 0 when using hold-to-maturity accounting, while mark-to-market accounting yields beta estimates close to 1. As shown in Appendix D, the average beta of the PTP targets in our sample is 1.05, so a beta of approximately 1 for the unlevered PE-mimicking portfolio seems reasonable.

As explained, the portfolio is designed in such a way that it exits winners early on (limited by minimum holding period of 12 months) while holding on to losers for a maximum of 4 years. Hence, by construct, the highest turnover will be during periods when public equity markets are surging. Combined with hold-to-maturity accounting the portfolio will see the highest volatility during up-markets and relatively low volatility during down-markets, which inevitably results in much lower drawdowns than would be the case if one was forced to mark-to-market daily.

The bottom graph in Figure 6.15 shows a negative monotonic relationship between holding period length and maximum drawdown, which is true under both accounting schemes. However, the relationship is much stronger when using hold-to-maturity accounting with drawdowns ranging from 54% with maximum holding periods of 6 months and 2% with maximum holding periods of 6 years. Again, we do acknowledge that this is an extreme approximation of PE fund valuation, but it is a good illustration of the possible effects of infrequent and conservative marking of net asset values.

[24] The stylized portfolio, discussed in Section 6.3, incorporates monthly trading and is the best example of this.

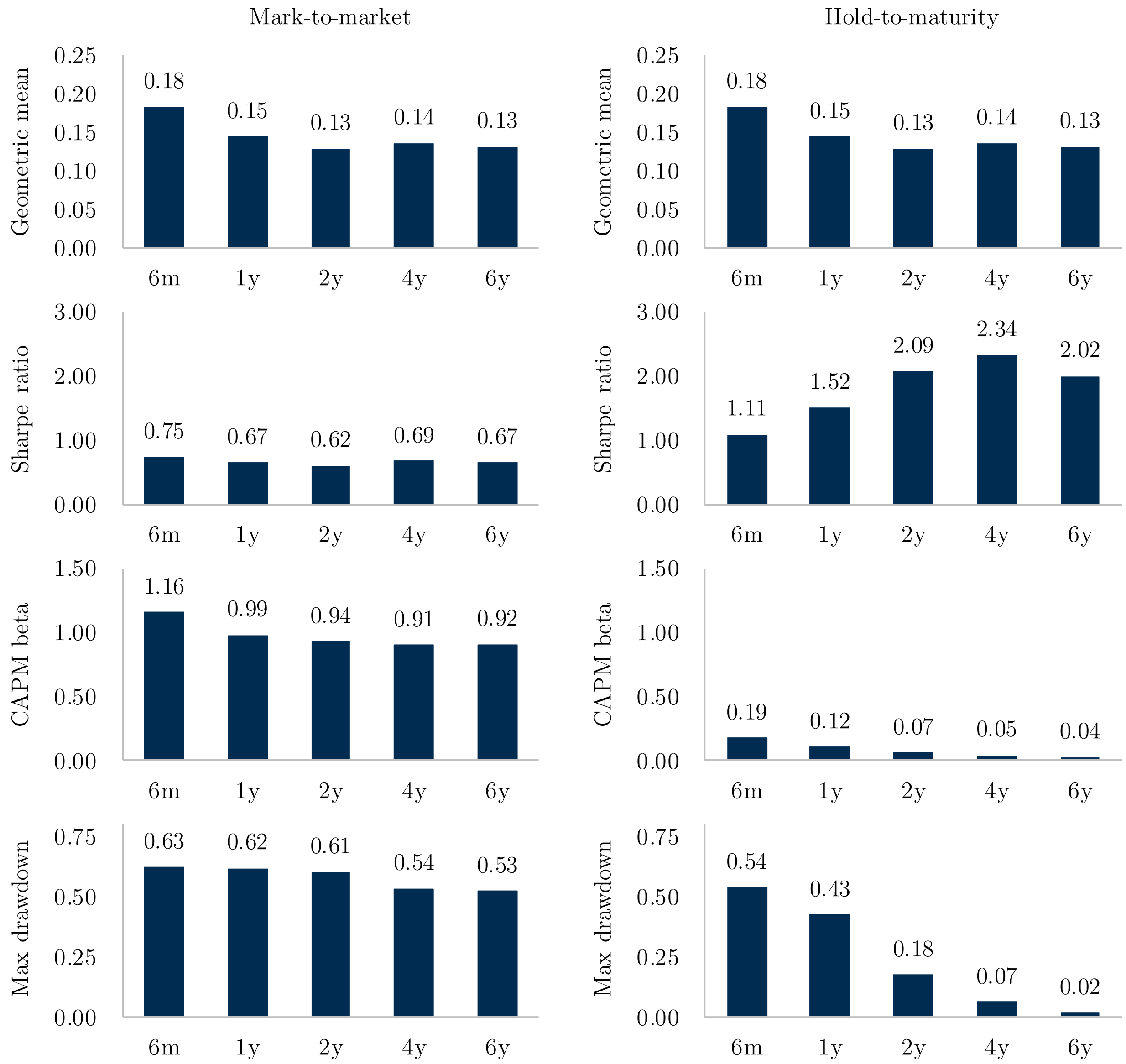

Figure 6.15: Properties of the unlevered PE-mimicking portfolio under varying holding periods
This figure shows summary statistics for the unlevered PE-mimicking portfolio under various holding period assumptions. Each month, the PE-mimicking portfolio selects stocks in the top quintile of PE-selection likelihood. The geometric mean is the compound annual average return of the different portfolios. Sharpe ratio is calculated by the mean annualized excess return divided by the annualized standard deviations. The CAPM beta is estimated from monthly return series regressions between July 1986 and June 2018. The max drawdown has been calculated by using the formula $(HWM_t - P_t)/HWM_t$. For additional information on assumptions, please refer to Appendix J.

Knowing that the two columns of Figure 6.15 show the same portfolio, the mark-to-market accounting scheme seems to be a considerably more accurate measure of the risk of the underlying investments compared to the hold-to-maturity accounting scheme. The graph points to long holding periods only being an advantage when combined with the conservative marking of NAVs. In actual PE investments, long holding periods are also what allow the GP to implement changes in the portfolio companies – changes that are assumed to drive up returns through higher exit values ultimately.

It is easy to see how the masking effects of lagged asset pricing, and the manager discretion in determining these, could alone be incentive enough for institutional investors to allocate a significant amount of capital to buyout funds. This misplaced incentive is evidenced by the following quote from Bob Maynard, Chief Investment Officer of Idaho's Public Employee Retirement System.

> "We did know that our actuaries and accountants would accept the smoothing that the accounting would do. It may be phony happiness, but we just want to think we are happy… even if it just gave public market returns, we'd be in favor of it [private equity]… we're happy if it gives public market returns, anything extra, because of its effect of having some smoothing of the risk, [would be a plus]… Private equity has outside than [just] return benefits and those are good enough so that even with public market returns, I'll be happy. I may just be thinking I'm happy, like I said before, that is good enough for me."
>
> – Bob Maynard, CIO of Idaho's Public Employee Retirement System (2015)

Assuming that Bob Maynard is not the only investment manager with this opinion, the quote highlights that actual investors knowingly choose to invest in PE because of the accounting scheme benefits, regardless of any real diversification benefits. Warren Buffet and Charlie Munger of Berkshire Hathaway count some of the most notable critics of the increasing inflows of capital to buyout funds. During the Berkshire Hathaway's annual investor meeting in May 2019, Charlie Munger added that many pension funds invest in PE because they do not have to mark down investments as steeply during recessions and that this is a *"… silly reason to buy something."* (Bloomberg, 2019).

While Figure 6.15 only looks at the unlevered portfolio, Table 6.16 shows statistics for both the unlevered and levered portfolios. As shown in Panels A and B, the portfolio assumptions and general descriptive statistics, except for target leverage and average achieved leverage, are identical. As suspected, the leveraged portfolio generates a relatively higher return but is also riskier than the unlevered portfolio. While the addition of leverage decreases the Sharpe ratio when using mark-to-market accounting, it boosts the Sharpe ratio when assets are held at cost. Panel B shows how the use of leverage significantly increases return volatility of the portfolio and in Panel C we see how most of this added risk is masked by the NAV reporting and accounting scheme.

Table 6.16: Properties and summary statistics of unlevered and levered PE-mimicking portfolios

This table reports summary statistics for the unlevered and levered PE-mimicking portfolios under various assumptions. Each month, the PE-mimicking portfolio selects stocks in the top quintile of PE-selection likelihood. Investments with cumulative annualized returns exceeding the exit hurdle after the minimum holding period ends are exited. "Reinvestment" refers to the length of the period at which investments are not reconsidered once exited. All summary statistics in Panel B and C are annualized. "Early exits (%)" in panel D shows the percentage of all exits that happen before the 4-year holding limit. "# of holdings at t=1" shows the number of portfolio companies at the end of the first month. The average number of entries and exits are calculated excluding the first and the last month. The average holding period is in months. Leverage is defined as the market value of long positions divided by the equity capital of the portfolio. Percentage figures are multiplied by 100 for improved readability.

Panel A: Portfolio assumptions		
Portfolio	Unlevered mimicking PE portfolio	Levered mimicking PE portfolio
Maximum holding period	4y	4y
Minimum holding period	1y	1y
Target leverage	1.0x	2.0x
Annualized exit hurdle	50%	50%
Reinvestment	1y	1y
Panel B: Mark-to-market		
Geometric average annual return	13.75	17.23
Average annual excess return	11.18	25.13
Standard deviation	16.23	44.95
Sharpe ratio	0.69	0.56
Max drawdown	53.86	94.37
Panel C: Hold-to-maturity		
Geometric average annual return	13.75	17.23
Average annual excess return	9.93	16.25
Standard deviation	4.24	6.71
Sharpe ratio	2.34	2.42
Max drawdown	6.71	13.12
Panel D: Portfolio statistics		
Average leverage	1.00x	1.65x
Average holding period	30.6	30.6
Early exits (%)	28.4	28.4
# of holdings at t=1	291	291
Average # of holdings	672.4	672.4
Average # of entries per month	21.3	21.3
Average # of exits per month	20.9	20.9

Since the two accounting schemes are applied to a single portfolio, the cumulative average annual return is ultimately the same across schemes. However, due to the difference in reported volatility, the average annual excess return is highest using mark-to-market accounting, by a large margin. This difference in excess returns is due to extreme outlier observations. Specifically, in March and April of 2009, the portfolio registered returns of 118% and 128%, respectively. However, at this time, due to massive losses in the preceding months, the portfolio equity value had been drawn down by more than 94% and was effectively levered 12 times.

Using hold-to-maturity accounting, an extreme drawdown like this is avoided due to its smoothing effects on returns.

Table 6.17 compares the PE-mimicking portfolio with some additional return benchmarks. The levered PE-mimicking portfolio sees compound average annual returns of 20.92%, which is considerably higher than that of the aggregate buyout index net-of-fees, and very close to the 21.03% gross-of-fees figure. The levered PE-mimicking portfolio has annual volatility of 44.95%, which is much higher than the 10.45% of the gross-of-fee buyout index. Because of this, the PE-mimicking portfolio realizes a much lower annual Sharpe ratio of 0.56 compared to 1.62 of the buyout index. Using hold-to-maturity accounting, the Sharpe ratios of 2.34 and 2.42 for the unlevered and levered replicating portfolios, respectively, are superior to the 1.62 Sharpe ratio of the aggregate buyout index.

Table 6.17: Back-test of return benchmarks and the PE-mimicking portfolio (1986-2018)

This table reports summary statistics for various return benchmarks and the PE-mimicking portfolio under both the mark-to-market and hold-to-maturity accounting scheme. Each month, the PE-mimicking portfolio selects stocks in the top quintile of PE-selection likelihood. Stocks are held between 1 and 4 years. Data is based on monthly return series from July 1986 to June 2018, except for the C.A. Buyout Index benchmarks which are based on quarterly return series over the same period. CRSP is the value-weighted CRSP index. Geomean return is the compound annual average return of the different portfolios. Average returns represent the average annual return above the risk-free rate. Sharpe ratios are found by dividing the annualized excess returns by the annualized standard deviations. All percentage figures in the table are annualized and multiplied by 100 for improved readability.

Asset	Geomean return	Average return	Standard deviation	Sharpe ratio	Max drawdown	CAPM beta	CAPM alpha
Panel A: Return benchmarks							
CRSP	10.13	7.74	15.39	0.51	50.39	1.00	0.00
CRSP levered 2.0x	14.52	15.39	30.33	0.51	79.47	2.00	0.00
CA U.S. Buyout Index (after fees)	14.84	11.30	8.82	1.28	26.99	0.29	9.00
CA U.S. Buyout Index (before fees)	21.03	16.91	10.45	1.62	23.13	0.33	14.28
Panel B: PE-mimicking portfolio							
Mark-to-market							
Unlevered	13.75	11.18	16.23	0.69	53.86	0.91	4.23
Levered 2.0x	20.92	25.13	44.95	0.56	94.37	2.07	9.08
Hold-to-maturity accounting							
Unlevered	13.75	9.93	4.24	2.34	6.71	0.05	9.93
Levered 2.0x	20.92	16.25	6.71	2.42	13.12	0.09	15.60

The hold-to-maturity portfolios both have market beta estimates close to 0. Using mark-to-market accounting of NAVs, the estimation is arguably much more accurate with CAPM betas of approximately 1 and 2 for the unlevered and levered PE-mimicking portfolios, respectively compared to beta values of around 0.3 for the aggregate buyout index, both before and after fees. The 2 times levered PE-mimicking portfolio, with an annual alpha of 15.60% when valuing assets at cost, is superior to the pre-fee buyout index with an alpha of 14.32%. When evaluated using mark-to-market accounting, the levered portfolio has an alpha similar to that of the buyout index, after fees.

Using hold-to-maturity accounting, the performance of the PE-mimicking portfolio is quite comparable to the aggregate buyout index, before fees. They have approximately the same returns, and their annual alphas are also very similar. However, the use of hold-to-maturity accounting results in considerably lower risk measures (standard deviation, drawdown, and beta) for the PE-mimicking portfolio relative to the buyout index. The relatively lower risk measures of the PE-mimicking portfolio is to be expected, given that measuring the value of investments at cost until they are sold is the most extreme implementation of conservative NAV estimation.

Evaluated based on the numbers in Table 6.17, the PE-mimicking portfolio, using hold-to-maturity accounting, is superior to both the levered market and the buyout index gross-of-fees. However, as real-world investors are not able to invest in a portfolio of publicly traded stocks and hold these at cost, the hold-to-maturity portfolio is not a realistic alternative to investing in buyout funds. The pre-fee aggregate buyout index is also not a good representation of the performance investors can expect from their allocation to buyout funds, as there is no way for LPs to avoid paying fees to GPs. Sure, LPs can co-invest, but co-investment opportunities are typically given in return for considerable fund commitments.

If we are to evaluate a portfolio that can actually be held by LPs, we ought to compare the performance of the PE-mimicking portfolio using mark-to-market accounting to the performance of the buyout index net-of-fees. When using mark-to-market accounting, the PE-mimicking portfolio significantly outperforms the net-of-fees buyout index on a pure return basis. Specifically, the levered PE-mimicking portfolio generates a geometric average annual return of 20.92%, while the comparable number of the net-of-fees buyout index is 14.84%.

However, this outperformance comes at the cost of considerably higher measured risk. With annual volatility of 44.95% the Sharpe ratio of the PE-mimicking portfolio is just 0.56 using mark-to-market accounting. Comparing this to a Sharpe ratio of 1.28 for the net-of-fees buyout index, investing in buyout funds seems like the more attractive option. However, the risk-adjusted returns of the two portfolios are very similar, with alpha estimates of 9.00% and 9.08% for the buyout index and the PE-mimicking portfolio, respectively.

We see that the return distribution of the PE-mimicking portfolio is quite similar to that of the gross-of-fees buyout index, with risk measurements being the main difference. However, using hold-to-maturity accounting shows that this gap in risk can be explained by the use of different accounting schemes. Table 6.18 shows output from regressions of the PE-mimicking portfolio against a series of well-known risk factors. We show regression output from using both of the two different accounting schemes in order to show how differences in these influences perceived portfolio performance.

Table 6.18: OLS factor regressions of the PE-mimicking portfolio (1986-2018)

Monthly returns of the PE-mimicking portfolio, from July 1986 to June 2018, are regressed against different risk factors in 4 different regressions. Each month, the PE-mimicking portfolio selects stocks in the top quintile of PE-selection likelihood. Stocks are held between 1 and 4 years. Portfolio positions are levered 2x. Panel A reports regression results for the mark-to-market portfolio while Panel B shows results for the portfolio under the hold-to-maturity accounting scheme. MktRf, SMB, HML, RMW, and CMA are the 5 Fama-French factors. WML is the momentum factor introduced by Carhart (1997), BAB is the return to low-beta stocks as introduced by Frazzini and Pedersen (2014) and LIQ the traded liquidity factor introduced by Pástor and Stambaugh (2003). Alpha estimates are annualized and multiplied by 100 for improved readability. Standard errors are robust. T statistics are reported in parentheses. ***, ** and * denotes significance at the 1%, 5% and 10% level, respectively.

Panel A: Mark-to-market											
Regression number	α	MktRf	SMB	HML	RMW	CMA	WML	BAB	LIQ	N	R^2
1	9.084*	2.072***								384	0.488
	(1.86)	(10.06)									
2	5.088	2.044***	1.314***	1.060***						384	0.618
	(1.38)	(10.20)	(7.06)	(3.68)							
3	5.232	2.018***	1.443***	1.628***	0.329	-0.634				384	0.624
	(1.11)	(12.48)	(6.43)	(2.80)	(1.51)	(-1.40)					
4	9.696	1.902***	1.500***	0.740**	0.437	-0.325	-0.748***	0.145	-0.137	384	0.681
	(1.60)	(16.91)	(6.70)	(2.31)	(1.46)	(-0.83)	(-2.43)	(1.16)	(-1.04)		

Panel B: Hold-to-maturity accounting											
Regression number	α	MktRf	SMB	HML	RMW	CMA	WML	BAB	LIQ	N	R^2
1	15.600***	0.088***								384	0.037
	(14.03)	(4.22)									
2	15.360***	0.089***	0.046	0.055						384	0.042
	(14.09)	(3.68)	(1.13)	(3.68)							
3	15.840***	0.071***	0.034	0.103***	-0.052	-0.089				384	0.044
	(14.50)	(2.61)	(0.94)	(2.28)	(-1.06)	(-1.37)					
4	15.000***	0.080***	0.012	0.115***	-0.127**	-0.146**	0.052***	0.101***	0.020	384	0.093
	(14.05)	(2.82)	(0.35)	(2.34)	(-2.51)	(-2.46)	(2.24)	(2.99)	(0.85)		

Factor regressions are evaluated based on the results presented in Panel A since these are from regressions of the mark-to-market returns. The CAPM regression shows a significantly positive alpha, with the alpha estimate being considerably higher when investments are held at cost. Under the hold-to-maturity accounting scheme, alpha is also much more persistent, being significant at the 1% level throughout all five sets of factor regressions. When NAVs are marked-to-market daily, the alpha is only significant when adjusting for market risk.

Regressions using the Fama-French 3-factor model reveal that most of the portfolio's outperformance can be explained by exposure to the factors of market, size, and value, which is consistent with the findings of Section 6.3 and is to be expected based on the criteria for portfolio selection. In regression 4 we see that, in addition to being driven by above three risk factors, portfolio return is also influenced by negative exposure to the momentum factor (WML), significant at the 1% level. Although the portfolio targets smaller companies, typically associated with lower liquidity, we see a slightly negative, and not significant, exposure to the liquidity factor (LIQ).

Looking at the regression coefficients in Panel B shows completely different results. The infrequent and conservative estimates of portfolio NAVs effectively distorts the covariance between portfolio returns and market returns, making it difficult to evaluate the actual risk factor exposure of a portfolio that uses hold-to-maturity accounting. Thus, the hold-to-maturity returns suffer from the same issues as the CA U.S. Buyout Fund Index, which is why the coefficients in Panel B are very different from, and much less consistent than, those in Panel A.

Assuming that the return distribution of the PE-mimicking portfolio resembles that of actual buyout funds, the results in Panel A indicate that buyout funds follow an investment strategy tilted toward small value companies with low momentum. This, combined with an estimated portfolio market beta of around 2, shows that the observable risk characteristics of buyout funds are severely understated as a direct result of differences between the governing accounting principles used in private and public markets.

With most of the outperformance of the pre-fee buyout index being explained by exposure to well-known risk factors, it seems that the value added by the active fund management is rather modest. In other words, investors mimicking the passive components of the PE model, using publicly traded assets, would have generated a performance comparable to that of the aggregate buyout index, before fees, beating the performance of the net-of-fees buyout index, substantially. This puts into question the historically, and currently, high fee payments that are charged by GPs to their investors. Additionally, the existence of an illiquidity premium, which is a central argument of many investors in PE, is called into question.

6.4.4. Deconstructing the portfolio

To investigate whether the PE-mimicking portfolio is a realistic investment alternative that can be implemented at scale, several of the portfolio's fundamental properties are covered. Figure 6.19 shows the number of stocks included in the PE-mimicking portfolio over time. During the first months of the sample period, in July 1986, 291 companies entered into the portfolio, and in the final month of June 2018, the portfolio counted 458 companies. On average, 672 companies were held in the portfolio, with 21.3 entries and 20.9 exits, on average, each month.[25] The number of companies in the portfolio is rather high and would have required a substantial amount of resources, in terms of direct transaction costs, to hold this portfolio in practice.

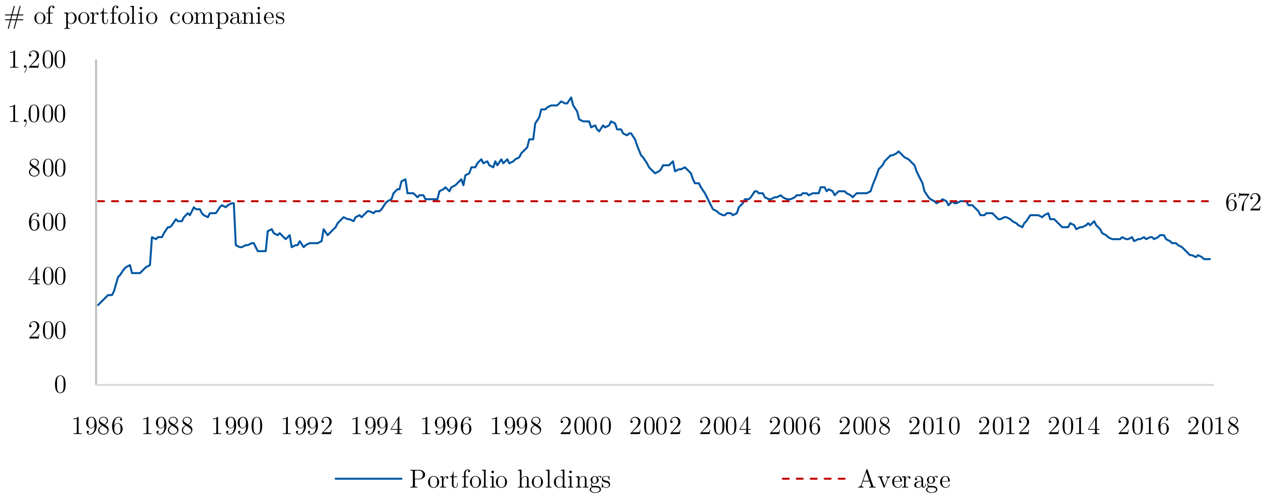

Figure 6.19: Distribution of the number of portfolio holdings over time
The figure plots the number of portfolio holdings in the PE-mimicking portfolio over time. The portfolio had 291 holdings at the beginning of July 1986 and 458 holdings at the end of June 2018. The red dotted line indicates the average number of portfolio holdings.

Figure 6.20 plots the annual median EV/EBITDA of the holding companies included in the mimicking portfolio together with the median EV/EBITDA for PE transactions and the S&P 500 index. Due to lack of data on median EV/EBITDA multiples for buyout transactions and the S&P 500 index, no data is plotted before 1990. The figure reveals that the median EV/EBITDA of the PE-mimicking portfolio is highly correlated with the median EV/EBITDA purchase multiple in buyout transactions – the correlation over the 29 years from 1990 until 2018 was 0.77. Over the same period, the correlation between the PE-mimicking portfolio and the median EV/EBITDA of the S&P 500 index constituents was 0.30. While the EV/EBITDA multiples of the PE-mimicking portfolio are generally in line with the purchase multiples of the buyout industry, the PE-mimicking portfolio multiples have been lower each year since the year 2005. In 2018, the median EV/EBITDA of the PE-mimicking portfolio was at 8.7x, while the median buyout purchase multiple was at 12.4x.

[25] Entry and exit figures do not count the first and the last month of the sample period.

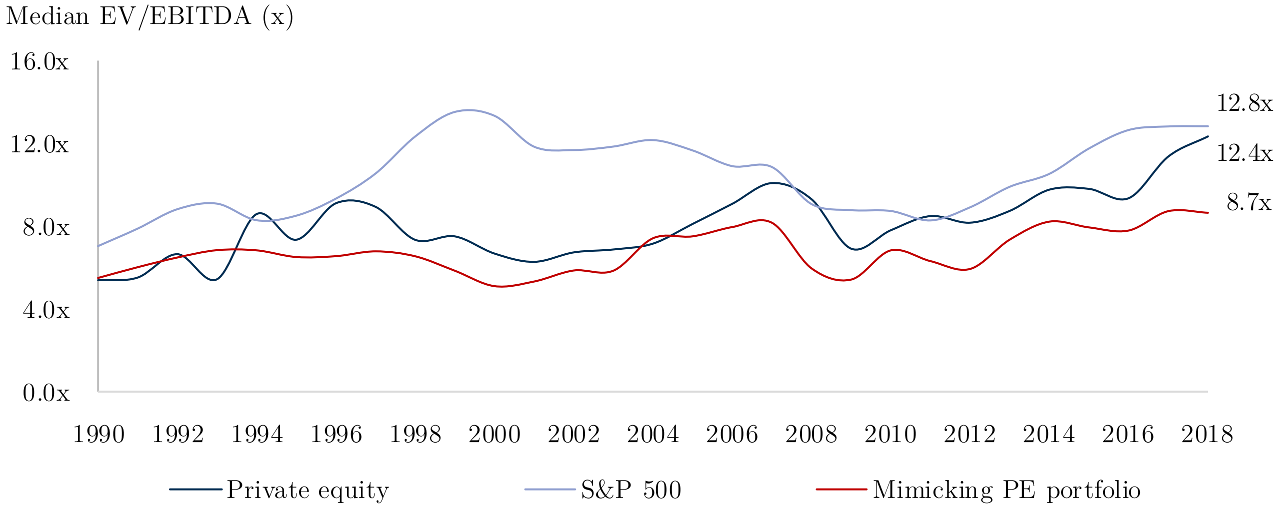

Figure 6.20: PE-mimicking portfolio annual median EV/EBITDA comparison over time
The portfolio plots the annual median EV/EBITDA multiples of the holdings in the PE-mimicking portfolio together with the annual median EV/EBITDA multiples for private equity and the S&P 500 from 1990 to 2018. The private equity median multiple is computed by taking the average of the median estimates from the following data sources: Cambridge Associates and Capital IQ (1998-2016); PitchBook (2006-2018); S&P Global Leveraged Commentary & Data (2001-2017); a proprietary dataset of this paper obtained from Thomson Reuters and Bloomberg (1990-2018). The S&P 500 median EV/EBITDA multiple is obtained from the Bloomberg Terminal.

Figure 6.21 plots the 25th, 50th, and 75th percentile market capitalization of the individual portfolio companies, as well as the total average market capitalization of portfolio companies throughout the sample period. The 25th, 50th, and 75th percentile market capitalization for the entire period was \$37 million, \$150 million, and \$692 million, respectively, while the average market capitalization of portfolio companies throughout the period was \$1,584 million. The fact that the total average exceeds each of the quartiles, by a considerable margin, throughout the entire period, shows that the portfolio generally holds smaller companies while the average is biased upward by a few big companies. For instance, the portfolio was invested in Netflix between August 2015 and June 2018 – during that period, Netflix's market capitalization increased from \$44.1 billion to \$170.5 billion, pushing the average market capitalization up significantly. Netflix was included in the portfolio in August 2015 due to its relatively modest profitability and low EV/EBITDA multiple, which led to a predicted PE-selection probability in the highest quintile of the CRSP universe for that given month, despite Netflix's size being far above average.

As can be seen from the distribution of size quartiles, the portfolio has significant exposure to smaller firms throughout the sample period. For instance, in October 1990, the 25th percentile market capitalization was \$14.7 million. Given that the portfolio was invested in 692 stocks at that time, this means that the portfolio was invested in 173 companies with market capitalizations of at most \$14.7 million.

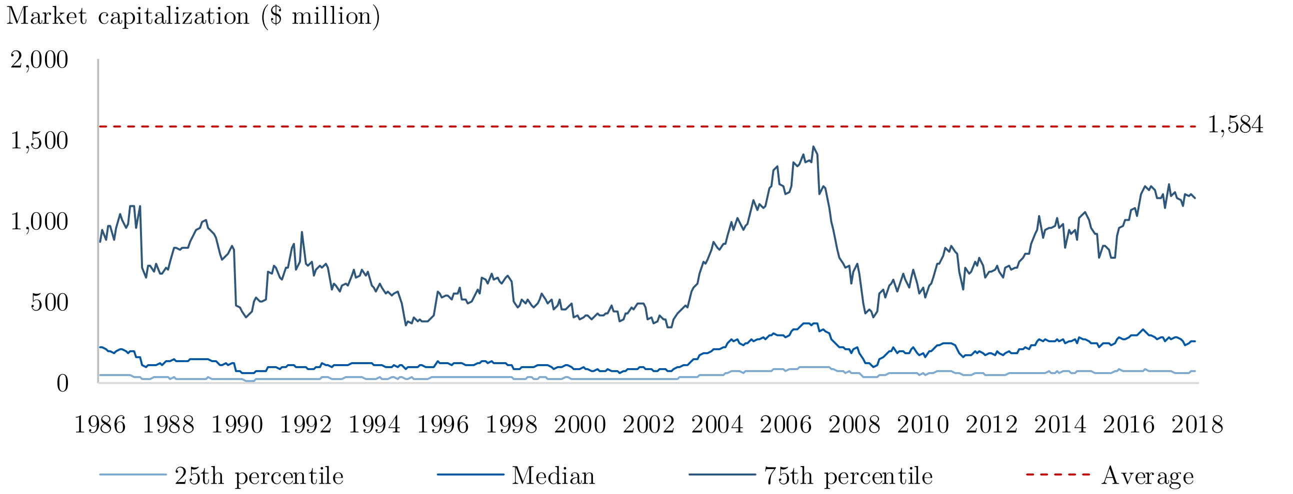

Figure 6.21: Distribution of portfolio market capitalizations over time
The figure plots the 25th, 50th and 75th percentile of the market capitalization of individual portfolio companies over time. The average market capitalization of the portfolio companies in the PE-mimicking portfolio for the period beginning of July 1986 until the end of June 2018 is represented by the red dashed line.

It is assumed that it is possible to invest in small and illiquid public companies with limited supply at the market price throughout the period. This is a simplistic assumption, and in reality, many of the trades made in this portfolio would likely not have been possible at scale due to lack of liquidity and the small size of many of the holdings.

Verdad Capital is a hedge fund founded on the idea of replicating PE returns though levered investments in small value stocks. In their Q1 2019 investor newsletter, the fund's founder, Dan Rasmussen, states that *"... to achieve the returns we hope for, we need to remain small enough to take advantage of the highest alpha opportunities, most of which are in less liquid small- and micro-cap equities. As a result, we are closing the fund to new investors"* (Verdad Capital, 2019). This statement highlights a central issue in terms of trying to replicate the return distribution of PE in public markets. Because of the significant exposure to small-cap stocks, institutional investors would very quickly run into scalability problems if they attempted to meet their PE allocation targets following this strategy. Dependence on small and illiquid public companies with limited supply was also highlighted by Kaplan (2016) as a critique of Stafford's (2015) idea of replicating PE with investments in small-cap stocks.

The portfolio targets leverage of 2 times portfolio equity capital, consistent with the leverage used by buyout funds in their portfolio companies. Leverage is defined as the market value of long positions divided by the equity capital of the portfolio. Since portfolio debt is not rebalanced but accumulates interest throughout the period, the leverage ratio varies over time dependent on the value of the underlying investments. The leverage ratio throughout the period is plotted in Figure 6.22.

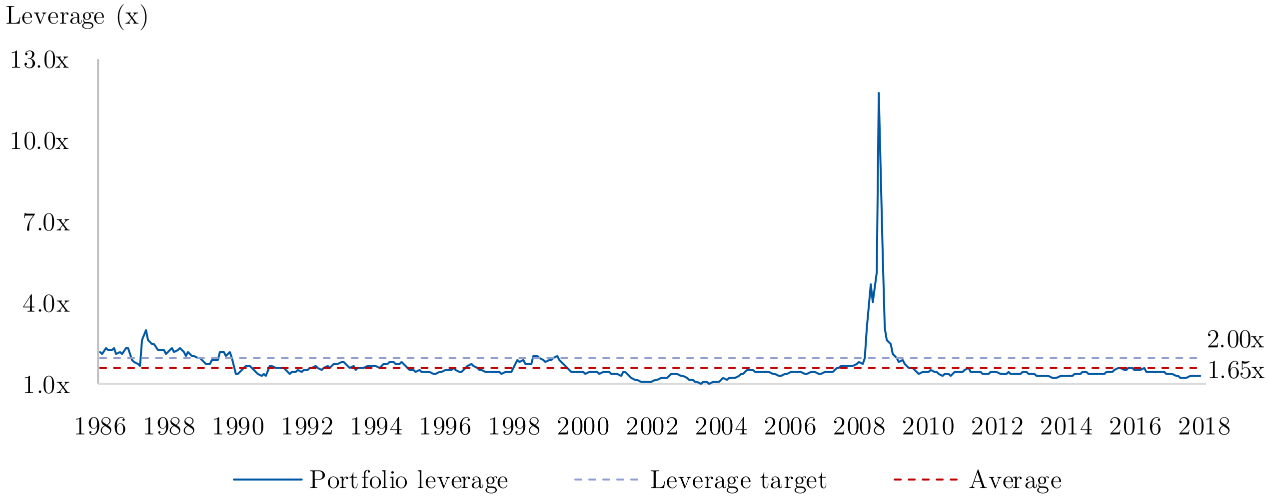

Figure 6.22: PE-mimicking portfolio leverage over time

The figure plots the leverage ratio of the PE-mimicking portfolio between July 1986 and June 2018. Leverage is defined as the market value of long positions divided by the equity capital of the portfolio. The average portfolio leverage for the entire time period is represented by the red dashed line, while the target leverage is represented by the blue dashed line. Leverage is defined as the market value of long positions divided by the equity capital of the portfolio.

The average leverage ratio throughout the period was 1.65x, implying that the value of the underlying investments generally increased at a higher rate than the debt. In October 2008, in the midst of the financial crisis, the portfolio equity capital was down by more than 71% compared to its previous high. This significant drawdown meant that portfolio leverage increased by more than 50% to 3.05x from 1.98x in the previous month. By February 2009, at a drawdown in the equity capital of more than 94%, the portfolio leverage reached a peak of 11.75x. Given that the portfolio is leveraged through a margin account, in practice, investors would have violated margin requirements and would likely have been stopped out of many of their positions.

7. Discussion of findings

In this section, we discuss our findings and put them into perspective. We evaluate the use and limitations of traditional PE performance metrics and discuss implications of our analysis of the PE-mimicking portfolio.

7.1. Traditional performance evaluation disregards the risks in buyout funds

Our study of the historical performance of U.S. buyout funds extends the literature on buyout fund-level performance by including an extended sample period compared to previous studies. The results on historical fund performance are broadly in line with those of Harris and colleagues (2016), and Robinson and Sensoy (2016), showing that buyout funds have consistently outperformed the S&P 500 index, with 30 of the 33 vintage years between 1984 and 2016 having PMEs above 1. With PMEs of around 1.3 in both the 1980s, 1990s, and 2000s, performance has been consistently strong throughout past decades, but since the great financial crisis buyout outperformance has been less impressive. However, we do caveat that the PME data for funds with unrealized investments may not be fully representative of vintage fund performance.

Through surveying 79 PE funds with combined AUM of more than $750 million, Gompers and colleagues (2016) find that around two-thirds of PE investors believe that the IRR and TVPI are the most frequently applied metrics for performance evaluation by LPs. The popularity of the IRR and TVPI is somewhat surprising, given the many limitations of these two metrics. Ilmanen, Chandra, and McQuinn (2019) argue that these metrics are problematic in that the IRR is “easily gamed” and that the TVPI solely provides a scale of the return that an investment has given, independent of the lifetime of the fund. If it is the case that most LPs base their investment decisions on return metrics that, to some degree, are subject to manager manipulation and do not say anything about relative performance, this could be an issue.

The Kaplan and Schoar (2005) PME is an arguably more robust measure but is not as widely applied in the investment community. Gompers and colleagues (2016) showed that only in less than 8% of the cases, did the PE fund managers believe that their LPs used the PME as the primary return measure. The PME metric is generally believed to be superior to the IRR and TVPI, as it provides a return measure that takes into account the relative performance of a chosen benchmark. However, the choice of market index used to compute the PME is not universally agreed upon, which leaves a certain amount of discretion on behalf of the PE manager. This is an issue that deserves some attention. This paper computes the PME using the S&P 500 as the benchmark, in line with how buyout funds market their outperformance and with most previous literature on PE outperformance (Harris et al., 2016; Robinson & Sensoy, 2016). We show that buyout funds, on average, target small and less profitable value firms, which makes using the S&P 500 index as a benchmark misleading. Since buyout funds tilt their portfolios toward characteristics that differ from that of the average public company, investors essentially compare "apples to pears" when comparing market benchmarks such as the S&P 500 index with a levered, small, value investment strategy. We argue that a more accurate "apples to apples" comparison can be approximated by constructing portfolios that mimics the buyout investment process in public markets. Investors should always consider the opportunity cost of an investment, but this is not possible without an accurate relative performance benchmark. In line with our argumentation, The Economist (2019) puts forward a similar critique of the prevailing narrative around private equity outperformance, stating that,

> "… after fees, private equity outperformed the S&P 500 index of large companies by an average of 2.3% a year between 1986 and 2017. That is quite the winning margin. But on closer examination, it looks less impressive. Buyout targets tend to be small firms that are going cheap—that is, they have a low purchase price relative to their underlying earnings. An investor would have achieved higher returns from a basket of small-capitalization 'value' stocks than by putting his money in private equity."
>
> – The Economist (2019)

7.2. Does private equity value creation justify current fee levels?

In Section 6.4, we suggest that PE performance consists of both a passive and an active component. This is a way of framing the problem that this paper is trying to explore, namely whether the risk and return characteristics of PE can be mimicked in public markets. By successfully constructing a portfolio of public equities that imitates the historic asset selection criteria, holding periods, and use of leverage, of U.S. buyout funds, we achieve an absolute return that is very similar to that of the pre-fee aggregate buyout index. This makes the cumulative return of the PE-mimicking portfolio significantly higher than the net-of-fees return obtained by investors.

If one accepts that the return distribution of the PE-mimicking portfolio is comparable to the return distribution of the CA U.S. Buyout Fund Index, then a liquid PE-mimicking portfolio is arguably the easiest and cheapest way of achieving this return. With the presence of an illiquidity discount and manager generated alpha, one should expect the pre-fee buyout index to outperform the levered PE-mimicking portfolio. Given that the return distribution of the aggregate buyout index can be replicated in public markets, the initial conclusion must be that, on average, there is not much value-added from active manager involvement. This conclusion brings into question the magnitude of the material advantages following from financial-, operational-, and governance engineering, as highlighted by Kaplan and Strömberg (2009). The fact that the PE-mimicking portfolio is a more liquid alternative, the existence of a liquidity premium can also be questioned.

With no compensation for illiquidity and with limited value-added from active manager engagement, LPs are not getting compensated for the tall fees that they pay to PE managers. As Clifford Asness of AQR Capital Management says, *"There is no investment product so good gross, that there isn't a fee that could make it bad net"* (Griffin, 2018). In the current environment, with capital inflows to the PE industry being greater than ever before, there is no sign that PE managers feel pressured to lower fee levels. These results, combined with the fact that capital inflows and private market valuation levels are currently at historic highs, suggest that there is reason for investors to be cautious with their PE allocations.

7.3. Misconceptions around the risk of private equity investments

The PE-mimicking portfolio is, as the name implies, only an attempt to imitate the portfolio characteristics of buyout funds. As the portfolio does not hold actual private assets, it is impossible to know with certainty if its return distribution accurately simulates that of the aggregate buyout index. The more critical issue is to consider whether the systematic risk estimate of the PE-mimicking portfolio is plausible, and perhaps a better representation of the risk in buyout funds.

As argued in Section 6.2, according to Modigliani and Miller's (1958) theory on capital structure, with PE businesses holding double the amount of debt of the average public company, one would expect the market beta of the aggregate buyout index to be approximately 2. We estimate portfolio betas of 0.91 and 2.07 for the unlevered and the levered PE-mimicking portfolios, respectively. These estimates are much closer to the expected values than the beta estimates of the CA U.S. Buyout Fund Index of 0.29, net-of-fess, and 0.33, gross-of-fees. While controlling for stale prices, by summing the beta estimates from regressions of the buyout return series on both contemporaneous and three lags of market returns, gives larger estimates of 0.77 and 0.86 net-of-fees and gross-of-fees, respectively, these estimates are still far from the expected levels.

According to the British Venture Capital and Private Equity Association, it is possible for investors to calculate standard public market measures, including volatilities and market correlation with other asset classes, using reported fund NAVs instead of continuous market prices (BVCA, 2015b). More than 400 of their members are institutional investors, professional advisors, and service providers, with many more reading their reports and following their guidelines. With this in mind, one could argue that investors are at risk of grossly underestimating the risk exposure of their allocations to PE, something that is critical in terms of upholding the correct asset allocation. As our results show, the low volatility and low market risk of the aggregate buyout index can be entirely explained by differences in accounting practices. This view was supported in a recent debate on the low volatility of private asset prices with Clifford Asness of AQR (2019) pointing out that, *"Prices move just as much or more (from leverage)* *in privates. If you valued them after a crash you'd find they crashed more. We all choose not to. That may be a feature for some managing their own psychology, but you just described them as really high returning bond"* (CliffordAsness, 2019).

As argued by Stafford (2017), if investors are under the misconception that the market risk of their PE investments is low, the reported outperformance can be interpreted as compensation for illiquidity and subsequently lead to large over-allocations to the asset class. We argue that the risk estimated from the PE-mimicking portfolio is a much better representation of the risks inherent in the returns of the aggregate buyout index. The stark discrepancy between the reported- and actual risk of buyout funds is something that LPs should take into consideration when making their investment decisions. One way to achieve an improved PE performance evaluation would be to use a combination of the traditional metrics such as IRR, TVPI, and PME estimated using a benchmark that is riskier than the S&P 500. In addition to this, a PE-mimicking portfolio of public stocks can be used to simulate the return distribution of buyout funds to arrive at more reasonable estimates.

7.4. The limitations of liquid private equity alternatives

The risk and return characteristics of our PE-mimicking portfolio are broadly consistent with the ones obtained by Stafford (2017). However, our process of identifying asset characteristics, and our portfolio analysis are both more detailed and thorough. In our analysis of the characteristics of private equity targets, we include both year and industry fixed effects, whereas Stafford (2017) only includes year fixed effects. Hence, in addition to accounting for variation in firm-level data that is due to macro-level changes over time, we also account for variation that is due to firms operating in different industries. This way our analysis actually compares private equity targets to similar companies and not just the average public company.

Our analysis of PE-targeted companies is quite limited in that it is based exclusively on financial data on U.S. listed companies that have been taken private in LBOs. Thus, constructing a PE-mimicking portfolio is solely an exercise in simulating the passive elements of the specific niche of buyouts that are public-to-private transactions. In reality, most LPs have exposure to multiple funds across different PE strategies. Ang and colleagues (2018) find that the time series variation in PE returns is highly cyclical, but differs across subclasses. Thus, by being invested in various strategies, such as buyout funds, venture capital, and infrastructure, an investor will likely obtain an overall risk profile that is significantly different from the PE-mimicking portfolio of this paper. Thus, we acknowledge that a diversified PE portfolio covering multiple strategies and vintage years is likely to achieve returns that are not entirely spanned by public markets.

Although weaker in recent years, historical performance persistence of PE managers is well documented. Managers whose latest fund are in the top quartile of performing funds are relatively more likely to see their next fund in the top quartile as well. Thus, LPs with superior access to top funds can likely achieve returns superior to the aggregate buyout index. A good example of this is the $29.4 billion Yale Endowment, managed by David F. Swensen, which is recognized by its large allocation to alternative assets, in particular, private equity (Yale, 2018).[26] The high allocation to alternative assets has been key to achieving a return of 13% per annum over the past 30 years, unrivaled by other endowments. Swensen and his colleagues have exploited the university alumni network as well as relationships with PE managers, developed over decades, to get early access to funds of top-performing managers (Lerner, 2015). With PE being subject to a much higher degree of market friction, the opportunities for outperformance are arguably greater compared to public markets.

We show that a PE-mimicking portfolio invested in public equities between 1986 and 2018 experiences a drawdown of more than 94% during the great financial crisis. If actual investors had been invested in the portfolio over the same time period, they likely would have been forced out of their positions due to failure in meeting margin calls. Additionally, this is just the scenario for the portfolio that is initiated in 1986. For example, if the portfolio had instead been initiated at the beginning of 1990, drawdowns would have exceeded 100%, and the portfolio would have been closed. Of course, this risk can be managed, to some degree, by varying the portfolio leverage, but that would also result in a less attractive return. We show that the maximum drawdown of the same portfolio using hold-to-maturity accounting is just 13%. Some might argue that "the game is rigged," but the reality is that investors currently have incentives, beyond that of just asset class performance, to invest in PE. PE managers have additional tools in their toolbox that allow them to mask the worst of the volatility and market risk of fund returns – an option that is not available for investment managers in liquid markets. The quotes of Clifford Asness (above) and Bob Maynard (page 86) illustrate quite well that the accounting benefits alone can be reason enough for investors to allocate capital to private equity.

Leverage is not the only obstacle in implementing a PE-mimicking portfolio in real-life. As we show, 25% of all portfolio investments have market capitalizations of $14 million or less, putting a natural restriction on the scalability of the strategy. Even under the assumption that investors can freely trade 100% of the market equity in these companies, the strategy would quickly become crowded. With buyout fund managers currently managing around $1.8 trillion in capital, a micro-cap strategy in public markets cannot replace what buyout funds are doing. Liquid alternatives to PE that emulate specific characteristics of the asset class might be a solution (or a partial solution) to some investors, perhaps retail investors in particular, but it

[26] AUM as of June 30, 2018.

cannot replace the return profile and the diversifying effects of PE on a large scale. Hence, our results support Kaplan (2016) in his critique of Stafford (2015). Nonetheless, by simulating the investment approach of buyout funds the results in this paper provides insights on risk and return characteristics that could be valuable to investors in PE.

8. Conclusions

This paper contributes to the growing branch of research investigating the risk and return characteristics of private equity investments. Building on the studies of Harris and colleagues (2014) and Stafford (2017), we investigate the performance of U.S. buyout funds from two different perspectives. While the well-known performance measures, the IRR, TVPI, and the PME paint a clear picture of buyout funds outperforming public equity markets, we argue that this is one-sided and does not adequately consider the risk and return trade-off. By constructing a portfolio that mimics the passive components of the private equity investment process, we show that the market risk of buyout funds is severely understated.

Based on data on 1,007 buyout funds from 1984 until 2016, we find that buyout funds have outperformed public markets substantially, net-of-fees. We find that buyout funds outperform the S&P 500 in 30 out of 33 vintage years. The average vintage year PME over the entire sample period is 1.25, supporting earlier findings that buyout funds have consistently outperformed the stock market. In more recent years this outperformance has been declining, but since later funds are largely unrealized, there is a reasonable degree of uncertainty around these numbers. Like that of Harris and colleagues (2014), our data points to a significant negative relationship between industry dry powder and absolute vintage year performance, as measured by the IRR and TVPI. We also see a negative relationship between the amount of dry powder and the PME measure of relative performance, but this relationship is not statistically significant.

Naturally, we see a strong negative relationship between valuation levels in the buyout industry and vintage year fund performance. Besides looking at the predicting power of absolute valuation levels, we also investigate the relationship between fund performance and the gap between public and private market valuations. We find that the magnitude of the valuation gap is a strong predictor of the relative performance of buyout funds compared to the public markets. We also find weak evidence that smaller funds outperform larger funds. Based on these findings it seems that today's environment of historically high private equity valuations and levels of dry powder is relatively unfavorable for new private equity investments, indicating that more recent funds can become challenged on their performance.

A weakness of the traditional performance metrics is that they do not capture the risks of investments in buyout funds. In order to better understand the risk and return characteristics of buyout funds, we construct a portfolio of publicly listed companies that mimics the passive components of the private equity investment process, identified as (1) asset selection, (2) long holding periods, (3) conservative estimates of portfolio net asset values (NAVs), and (4) use of leverage. Using a sample of 755 public-to-private transactions, we analyze the investment selection criteria of buyout funds by running logistic regressions of various financial characteristics against a binary variable indicating whether a company was acquired in a buyout. Controlling for both year- and industry fixed effects, our results show that private equity funds tend to acquire small value companies with modest profitability. These are similar to the characteristics identified by Stafford (2017), who, however, does not control for industry fixed effects.

While private equity funds seem to be increasingly targeting smaller companies, this was not the case back in the 1980s and 1990s where public-to-private LBOs were larger relative to the average public company compared to today. Value, as measured by the EV/EBITDA multiple, has been a more consistent predictor of private equity selection – however, over the past decade less so than before. Thus, while Stafford (2017) argues that the characteristics of private equity selected firms have been persistent over time, our results indicate that the preferences of private equity firms are changing.

Using the logistic regression results, we predict the probability of publicly listed companies in the CRSP universe being selected by private equity funds. The estimates are used to sort a portfolio that mimics the investment selection criteria of private equity funds over the period between 1986 and 2018. We find that this portfolio has high risk-adjusted returns, controlling for well-documented factor loadings. By including the additional passive components of long holding periods, conservative marking of NAVs, and leverage, we find that a portfolio of small stocks with relatively low EBITDA multiples and modest profitability, over a 33-year period, have generated an absolute return that is comparable to that of the pre-fee Cambridge Associates U.S. Buyout Fund Index, implying a considerable outperformance net-of-fees.

Kaplan and Strömberg (2009) argue that private equity ownership, through financial-, operational-, and governance engineering has substantial value-creating capabilities outside of those possessed by publicly owned corporations. In case these levers of value creation are material advantages of PE over public market investing, we would expect the pre-fee performance of PE funds to be superior to the performance of a portfolio mimicking the passive components of the PE investment process in the public market. If one accepts that the return distribution of the liquid private equity portfolio accurately mimics that of buyout funds, then one could argue that there is not much value added from the active components of the private equity model. The findings also bring into question the existence of a liquidity premium and the justification of the current fees of more than 5% paid by LPs annually.

However, with an annual volatility of 44.95% and a maximum drawdown of 94.37%, the private equity mimicking portfolio is significantly riskier than the aggregate buyout index. Evaluating the portfolio performance using two different accounting schemes, mark-to-market, and hold-to-maturity accounting, we simulate (1) the effect of lagged returns from infrequent reporting, and (2) the additional return smoothing resulting from the conservative marking of NAVs. We show that differences in accounting measures can explain the risk-differential between the buyout index and the private equity mimicking portfolio. Thus, our findings show that by measuring market risk and portfolio volatility using fund-level cash flow data and NAVs, investors and private equity professional arrive at severely understated estimates. Such misrepresentation of risk could easily lead to misallocation of capital, and unwanted risk exposure.

Our results support existing studies pointing to a mismatch between the actual and observed market risk of private equity funds. Through the analysis of private equity target characteristics, we show that the return distribution of the aggregate buyout index is comparable to that of a levered small value strategy with negative exposure to momentum. Based on aggregate quarterly return data, the estimated beta for U.S. buyout funds is only 0.29, after fees, and 0.33, before fees. We argue that this is vastly understated as a result of the infrequent and conservative marking of net asset values. We estimate a significantly higher beta of 2.07 for the private equity mimicking portfolio, which is in line with Modigliani and Miller's (1958) theory on capital structure assuming that private equity-owned companies have double the leverage of the average public company.

By deconstructing the private equity mimicking portfolio, we see that valuation levels are highly correlated to LBO transaction multiples over the sample period. We also see that in order to simulate the return distribution of the aggregate buyout index, the portfolio invests in tiny companies. Looking at the entire investment period, three-quarters of portfolio holdings have market capitalizations below $692 million with one quarter below $37 million. The small size of portfolio companies puts into question the scalability of the portfolio, and whether it is an investable alternative to sizeable private equity allocations.

While these results point to clear investor benefits from liquid alternatives to private equity, we believe that it is unlikely that a strategy tilting toward small value stocks can fully replace the benefits in terms of diversification and access to risk premia that are specific to private equity. Such a strategy is entirely an exercise in simulating the risk and return characteristics in private equity, and as there are inherent limitations in terms of scaling a strategy investing in publicly listed small value firms, private equity is likely the only way to get this exposure at a large scale.

8.1. Implications for future research

The results of this paper open up for a wide range of future research. Despite access to private equity data being very limited for countries other than the U.S., it would be interesting to carry out a similar study in other geographic regions. First, if similar results are found in other markets, it would work to support the findings in this paper. Second, if the risk and return characteristics vary significantly across different regions, the findings could help investors optimize their geographic allocations to private equity. Additionally, with better access to data on private equity transactions in general (not just public-to-private transactions), future researchers could create a more comprehensive understanding of private equity target characteristics. In countries like Denmark, Sweden, and Norway basic financial data on privately held companies is readily available, and with increasing private equity activity in the Nordic region, there is a good foundation for carrying out more comprehensive studies that cover all types of buyout transactions.

Due to its inherent limitations, the private equity mimicking portfolio of this paper is likely no large-scale substitute for private equity. Future research could explore the possibility of constructing more investable liquid alternatives to private equity. Large hedge funds and asset managers, including AQR and Man Group, are working on providing liquid alternatives to private equity for their investors (The Financial Times, 2018). In the future, with a long enough track-record, it would be interesting to see how such products compare to aggregate private equity indices.

Lastly, given access to large-sample fund-level cash flow data, a liquid private equity mimicking portfolio could be used as a benchmark for new vintage year PME calculations. We believe that this could give a more accurate picture of the performance of buyout funds and help investors better evaluate the opportunity costs of investing in private equity.

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Appendices

Appendix A: Ilmanen and colleagues' (2019) excess real return framework

Ilmanen and colleagues' (2019) paper is an AQR Whitepaper, introducing an excess real return framework for private equity. The authors argue that PE funds can boost returns by (1) higher yield through asset selection; (2) higher earnings growth stemming from operational improvements; (3) multiple expansion from superior timing of market entry and exits, and (4) financial leverage. The approach builds on the same DCF framework that AQR uses to forecast 5-10 year expected return of public equities and bonds. Ilmanen and colleagues (2019) estimated the expected return for net-of-fee PE and public equities, respectively. As shown in Figure A.1, PE has in recent years not offered an as attractive return edge over the public market as it did in the early days of PE. As of 2018, Ilmanen and colleagues (2019) estimated an expected return of 3.9% net of a 5.7% fee for PE and 3.1% for the public market net of a 10bps fee for investing in a passive index.

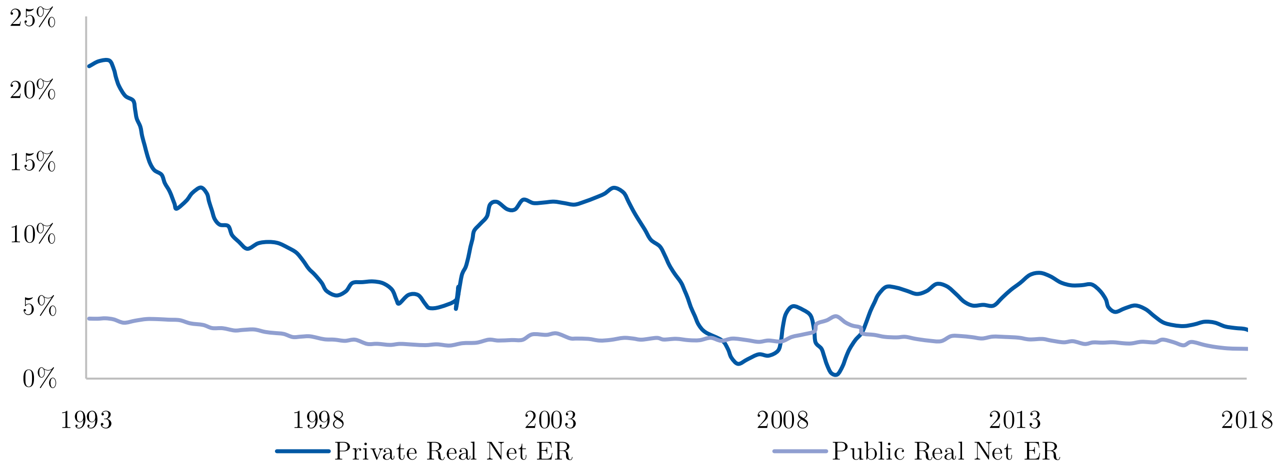

Figure A.1: Net-of-fee expected returns for PE and public equities (Ilmanen et al., 2019)

What has driven this development in expected excess return of PE over public markets? As illustrated in Figure A.2, the declining expected return differential can largely be explained by the decrease in PE leverage, reflected both in the levered yield and levered growth differential, as well as the convergence of valuations in PE and the public market. It is acknowledged that the magnitude of the estimates presented by Ilmanen and colleagues (2019) are highly sensitive to input assumptions. However, the paper provides a compelling new framework for understanding drivers of expected return in PE in a historical setting.

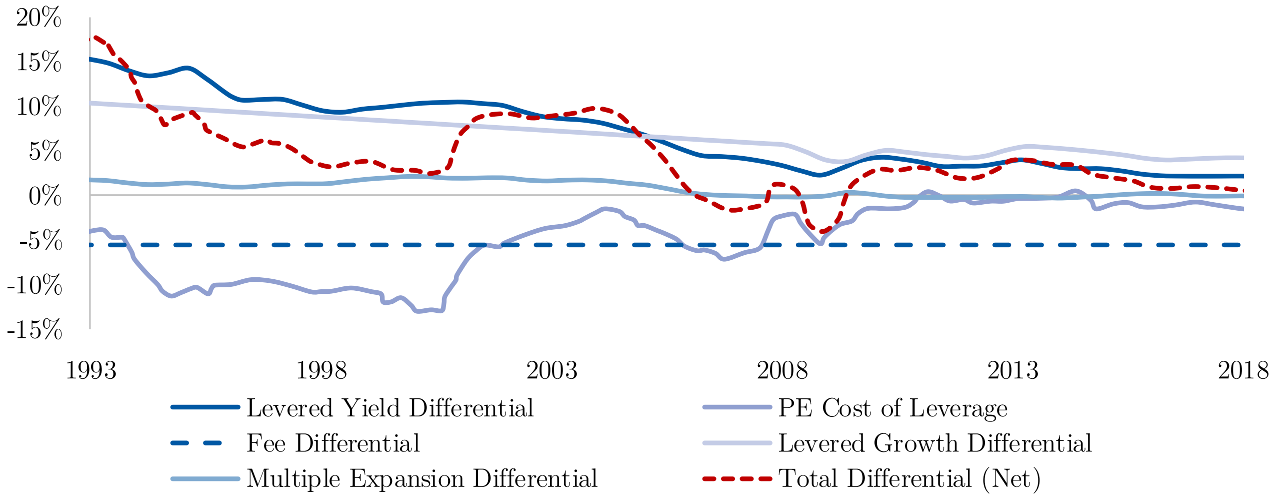

Figure A.2: Net-of-fee expected return differential of PE over public (Ilmanen et al., 2019)

The building blocks of their excess return estimation are presented below:

	Unlevered					Financial leverage		Levered								
	y_u Earnings yield		g_u Real growth rate		$r_u=y_{u+}g_u$ Real return	D/E Debt-to-equity	k_d Real cost of debt	$r_l=r_u+(D/E)*(r_u-k_d)$ Real return		m Multiple expansion (ann.)		$r_g=r_l+m$ Gross real ER		Fees		Net expected real return
Current	**2.1%**	+	**3.0%**	=	**5.1%**	**109%**	**1.2%**	**9.3%**	+	**0.3%**	=	**9.6%**	-	**5.7%**	=	**3.9%**
Historical average (1993-2018)	3.1%	+	3.0%	=	6.1%	181%	2.3%	12.9%	+	1.0%	=	13.8%	-	5.7%	=	8.1%

Figure A.3: Decomposition of Ilmanen and colleagues' (2019) PE expected real returns framework

The intuition behind the framework is as follow:

For public equities

$$\text{Net of fee public equity ER} = y_{pub} + g_{pub} + m_{pub} - f_{pub} \tag{A.1}$$

where

y_{pub} = dividend yield

g_{pub} = long term expected growth rate (assumed constant at 1.5%)

m_{pub} = multiple expansion (assumed to be 0)

f_{pub} = management fee (assumed to be 10 bps)

For private equity

$$\text{Net of fee PE ER} = r_u + \left(\frac{D}{E}\right) \times (r_u - k_d) + m_{pvt} - f_{pvt} \tag{A.2}$$

where

$$r_u = \text{unlevered PE ER}$$
$$\frac{D}{E} = \text{debt to equity}$$
$$k_d = \text{PE cost of debt}$$
$$m_{pvt} = \text{PE multiple expansion}$$
$$f_{pvt} = \text{PE fees (assumed constant at 5.7\%)}$$

Given that $r_u = y_u + g_u$, we can write Equation A.2 as

$$\text{Net of fee PE ER} = y_{pvt} + g_{pvt} - d_{pvt} + m_{pvt} - f_{pvt} \tag{A.3}$$

where

$$y_{pvt} = r_u \times \left(1 + \frac{D}{E}\right) \text{ (levered PE yield)}$$
$$g_{pvt} = g_u \times \left(1 + \frac{D}{E}\right) \text{(levered PE growth rate)}$$
$$d_{pvt} = k_d \times \left(\frac{D}{E}\right) \text{ (interest expense or payout to debtholders)}$$

Hence, if we subtract Equation A.1 from Equation A.3, we get the net-of-fee PE excess return over the public market which can be attributed to the following five components as shown in Figure A.2:

Levered yield differential: Computed as PE levered yield minus that of the public market. PE yield is computed by the average EV/EBITDA purchase multiple by year times 0.5, which serves as a proxy for the EV/EBIT multiple (0.5 is based on the historical average of public equities). The EV/EBIT multiple is then further multiplied by 0.5 as an approximation of the payout yield of PE. This is similar to AQR's methodology for public equities.

Levered growth differential: Constant unlevered growth rates of 1.5% and 3.0% assumed for public and PE, respectively. The 3.0% factors in operational improvements obtained by GPs.

Multiple expansion differential: Zero multiple expansion assumed for public equities. For PE, multiple expansion is calculated as the annualized return if private equity EV/EBITDA multiples converged partly to the public market multiple.

Fee differential: Constant fee of 5.7% assumed for PE and 10bps for public equities, implying a constant fee differential of -5.6%.

PE payout to debtholders: Public firms also pay interest expense to debtholders. However, the method already accounts for this as public equity ER starts from the dividend yield which is net of interest expense.

Appendix B: Harris and colleagues (2016) performance results

Table B.1: U.S. buyout performance overview between 1984 and 2010

This table shows the average IRR, TVPI, and PME by vintage year of the individual buyout funds using data from the Burgiss database. The PME is estimated using the S&P 500. *Average except for number of funds.

			Internal rate of return (%)			TVPI			PME		
Vintage year	Funds	Median % realized	Mean	Median	Weighted average	Mean	Median	Weighted average	Mean	Median	Weighted average
1984	4	100	15.5	14.9	24.8	2.87	2.85	4.09	1.01	0.98	1.41
1985	3	100	28.0	15.7	36.9	2.42	2.42	2.39	1.14	1.00	1.25
1986	7	100	14.2	16.8	16.8	3.36	2.36	4.47	1.17	1.11	1.36
1987	10	100	17.1	15.1	15.0	2.97	2.28	2.28	1.24	1.04	1.09
1988	10	100	13.3	11.2	16.5	1.96	1.70	2.24	0.93	0.81	1.07
1989	9	100	26.4	27.3	24.8	2.88	3.23	2.85	1.49	1.61	1.35
1990	4	100	20.6	17.1	19.1	2.89	2.87	2.72	1.19	1.07	1.18
1991	5	100	36.8	37.5	33.2	3.65	2.97	3.48	1.82	1.65	1.63
1992	11	100	16.6	18.8	26.4	1.91	1.88	2.20	1.01	0.99	1.13
1993	10	100	21.2	18.3	21.4	2.23	1.94	2.29	1.11	0.97	1.13
1994	20	100	20.9	19.6	28.2	2.09	1.72	2.65	1.19	1.09	1.46
1995	23	100	18.3	10.5	15.8	1.88	1.49	1.74	1.24	1.01	1.17
1996	18	100	10.4	8.0	9.1	1.51	1.36	1.40	1.13	1.13	1.05
1997	31	100	3.9	3.5	7.1	1.26	1.24	1.47	1.09	1.03	1.27
1998	46	100	6.0	8.3	4.7	1.47	1.45	1.38	1.38	1.40	1.31
1999	34	98.4	3.6	7.4	3.5	1.32	1.48	1.29	1.15	1.21	1.13
2000	60	96.4	12.8	13.2	15.3	1.75	1.73	1.86	1.44	1.38	1.48
2001	31	93.1	19.5	17.3	19.2	1.81	1.91	1.97	1.42	1.49	1.48
2002	23	85.6	16.1	14.9	18.8	1.86	1.85	1.97	1.38	1.34	1.51
2003	23	83.4	16.4	13.6	21.2	2.05	1.76	2.00	1.57	1.40	1.55
2004	50	72.6	12.5	11.9	15.3	1.67	1.65	1.84	1.29	1.29	1.45
2005	66	63.9	10.8	9.5	9.8	1.67	1.53	1.63	1.25	1.12	1.26
2006	80	50.4	7.8	8.2	7.4	1.41	1.48	1.42	1.01	1.03	1.02
2007	86	42.8	10.4	10.4	10.5	1.44	1.40	1.43	1.01	0.97	0.99
2008	64	31.7	13.9	13.7	15.8	1.45	1.43	1.52	0.97	0.96	1.03
2009	19	25.9	15.8	14.1	18.2	1.42	1.38	1.52	0.96	0.92	1.01
2010	34	14.8	15.5	13.9	15.5	1.30	1.29	1.29	0.91	0.90	0.93
Average*	781	83.7	15.7	14.5	17.4	2.02	1.88	2.13	1.20	1.14	1.25
Average 2000s	502	64.6	13.6	12.7	15.2	1.65	1.61	1.72	1.23	1.19	1.28
Average 1990s	202	99.8	15.8	14.9	16.9	2.02	1.84	2.06	1.23	1.16	1.25
Average 1980s	43	100	19.1	16.8	22.5	2.74	2.47	3.05	1.16	1.09	1.25

Appendix C: Descriptive sample statistics

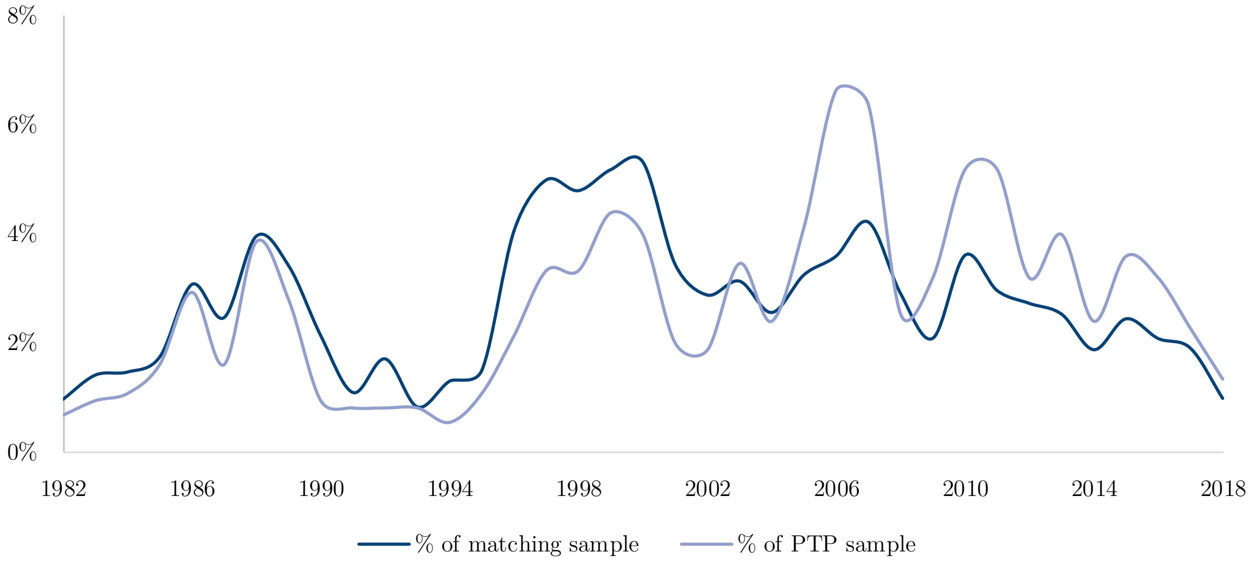

Figure C.1: Comparison of the distribution of the PTP- and matching samples by year
The figure shows the percentage distribution of the sample of PTP targets and the sample of matching companies by year.

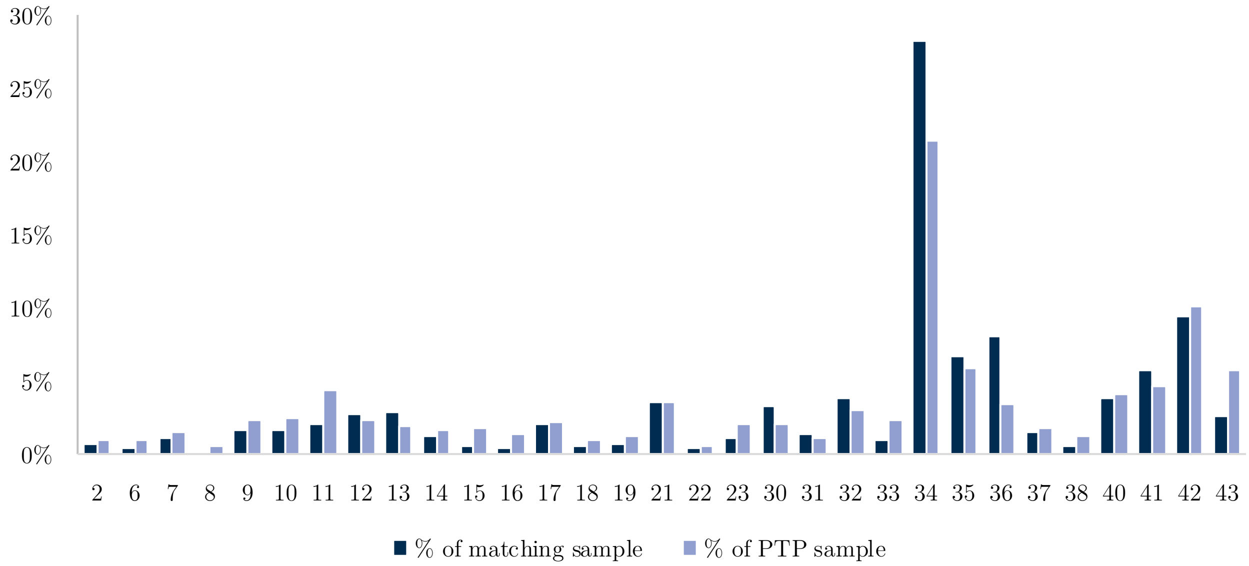

Figure C.2: Comparison of the distribution of the PTP- and matching samples by industry
This figure shows the percentage distribution of the sample of PTP targets and the sample of matching companies by industry. Industries are numbered according to the Fama-French industry classifications available at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/det_48_ind_port.html.

Appendix D: PTP sample and control group comparison

Table D.1: Descriptive statistics for the sample and the control group

This table shows the descriptive statistics for each of the variables evaluate in the regression analysis. Panel A show details for the sample of PTP targets and Panel B show details for the control group of non-target matching public companies. All financials are in USD million.

Panel A: Sample of PTP-targets ($N = 755$)					
Variables	Mean	Median	Min	Max	SD
Beta	1.05	0.98	-1.45	5.47	0.73
Mkt. Cap.	598.94	135.62	0.67	26,854.69	1,760.70
Sales	1,057.38	277.50	1.45	58,657.00	3,847.53
EBITDA/Sales	0.08	0.10	-2.67	0.49	0.30
EV/Sales	1.19	0.75	0.11	16.48	1.46
EV/EBITDA	10.79	7.24	2.06	74.80	13.65
P/B	2.24	1.61	0.35	16.94	2.38
NIBD/EV	0.00	0.03	-1.38	0.75	0.48
Panel B: Sample of matching public companies ($N = 12{,}722$)					
Variables	Mean	Median	Min	Max	SD
Beta	1.09	1.03	-5.64	14.11	0.77
Mkt. Cap.	2,822.33	153.65	0.01	878,361.60	16,848.20
Sales	2,354.02	178.19	0.00	485,621.00	12,660.13
EBITDA/Sales	-0.01	0.09	-2.67	0.49	0.51
EV/Sales	2.45	1.14	0.11	21.31	3.83
EV/EBITDA	13.38	8.61	2.06	74.80	14.73
P/B	3.25	2.01	0.35	16.94	3.54
NIBD/EV	-0.02	0.00	-1.38	0.75	0.43

Appendix E: Average PTP sample and control group comparison by decades

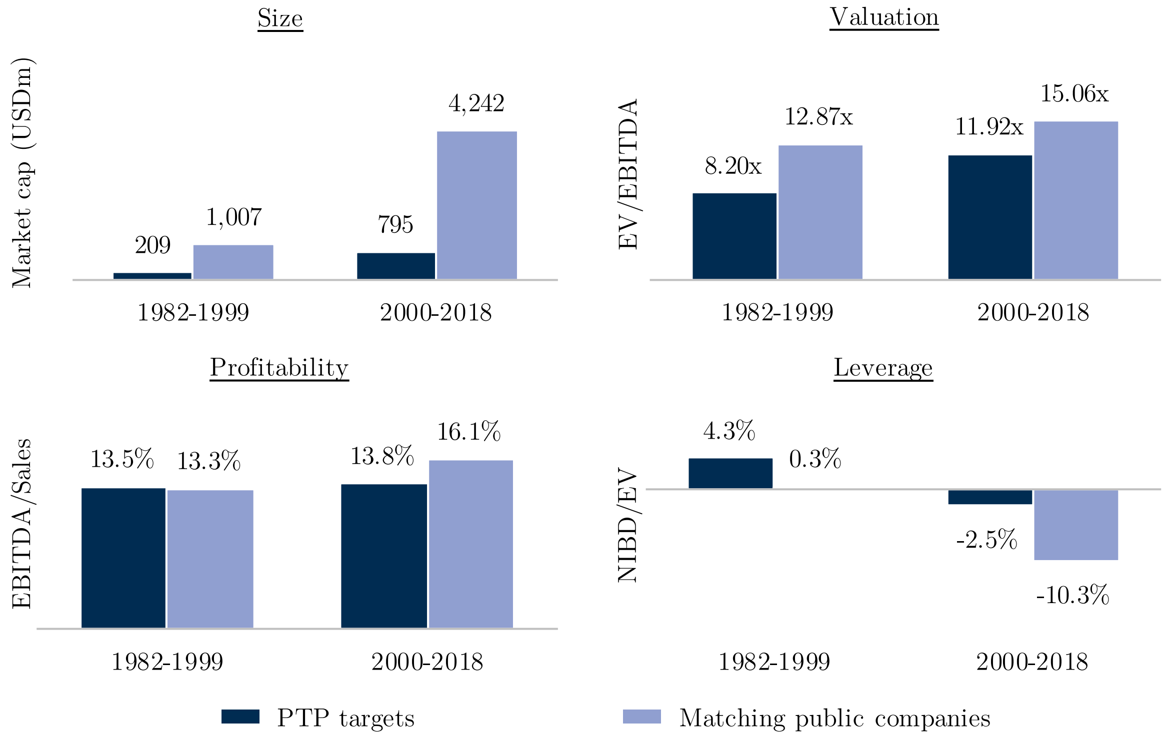

Figure E.1: Comparison of averages in the sample of PTP targets and the control group
This figure shows average values for the PTP targets and matching public companies of market capitalization, EV/EBITDA, EBITDA/Sales, and NIBD/EV for the two periods 1982-1999 and 2000-2018.

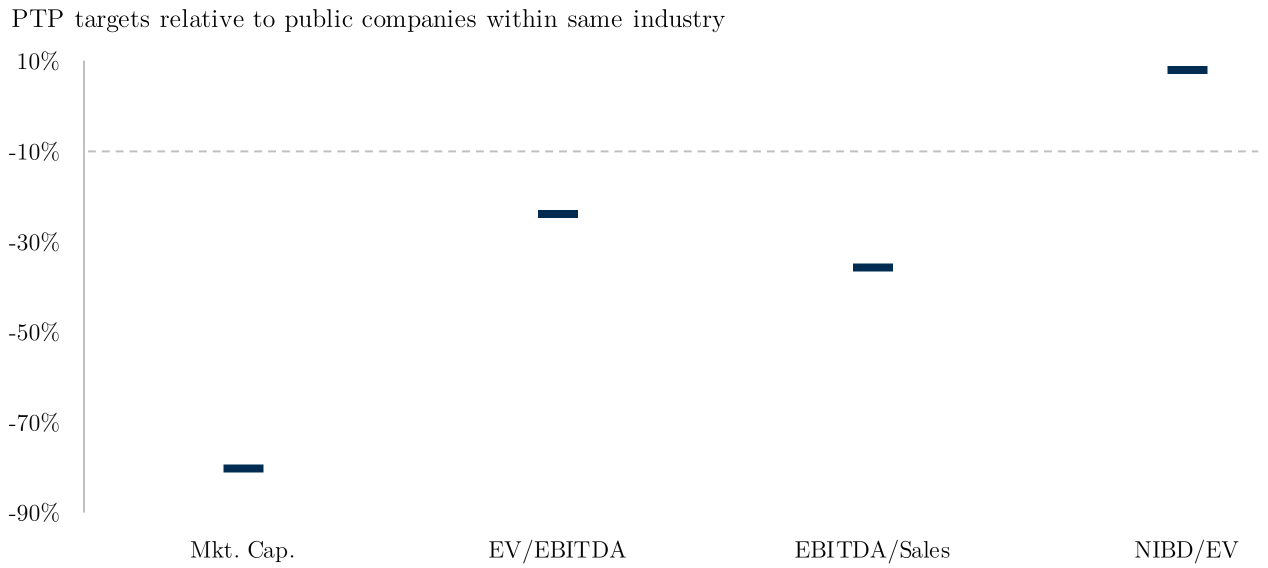

Figure E.2: Within-industry comparison of PTP targets and the matching public companies
This figure shows the size of within-industry average values of market capitalization, EV/EBITDA, EBITDA/Sales, and NIBD/EV for the PTP target sample, relative to the sample of non-target companies. A value above 0 indicates that the average company in the PTP sample have X% higher value of that measure relative to the average non-target company within the same industry.

Appendix F: Logistics regression output with- and without industry fixed effects

Table F.1: Logistic regressions of the selection of PTP targets for different time periods

We regress a binary variable, indicating whether a firm was acquired by a buyout fund, against a series of different financial measures. Panel A presents results for logistic regressions including industry fixed effects. Panel B presents results for logistic regressions without industry fixed effects. All regressions include year fixed effects. T-statistics are reported in parentheses. ***, ** and * denotes significance at the 1%, 5% and 10% level, respectively.

Panel A: With industry fixed-effects									
Regression number	Beta	ln(Mkt. Cap.)	ln(Sales)	ln(EV/ Sales)	ln(EV/ EBITDA)	ln(P/B)	ln(EBITDA/ Sales)	NIBD/ EV	N
1	-0.071								55,050
	(-1.30)								
2		-0.124***							69,645
		(-6.60)							
3			0.009						63,087
			(0.49)						
4				-0.386***					59,680
				(-9.34)					
5					-0.461***				44,413
					(-6.78)				
6						-0.371***			64,988
						(-7.25)			
7							-0.114**		46,568
							(-2.51)		
8								-0.022	66,094
								(-0.21)	
9		-0.118***		0.057	-0.456**	-0.013	-0.199		43,256
		(-4.12)		(0.34)	(-2.46)	(-0.17)	(-1.29)		
10		-0.134***			-0.403***		-0.139**		44,399
		(-5.04)			(-5.70)		(-2.29)		

Panel B: Without industry fixed-effects									
Regression number	Beta	ln(Mkt. Cap.)	ln(Sales)	ln(EV/ Sales)	ln(EV/ EBITDA)	ln(P/B)	ln(EBITDA/ Sales)	NIBD/ EV	N
1	-0.122**								55,050
	(-2.32)								
2		-0.116***							69,645
		(-6.33)							
3			0.038**						63,087
			(2.22)						
4				-0.383***					59,680
				(-10.22)					
5					-0.477***				44,413
					(-7.27)				
6						-0.400***			64,988
						(-7.99)			
7							-0.114***		46,568
							(-2.78)		
8								0.181*	66,094
								(1.85)	
9		-0.130***		0.031	-0.405**	-0.028	-0.143		43,256
		(-4.96)		(-0.19)	(-2.25)	(-1.24)	(-0.93)		
10		-0.146***			-0.413***		-0.121**		44,399
		(-5.85)			(-6.21)		(-2.27)		

Appendix G: Sub-sample logistics regressions of buyout characteristics

Table G.1: Logistic regressions of the selection of PTP targets for different time periods

We regress a binary variable, indicating whether a firm was acquired by a buyout fund, against a series of different financial measures. All regressions include year- and industry fixed effects. T-statistics are reported in parentheses. ***, ** and * denotes significance at the 1%, 5% and 10% level, respectively.

Panel A: 1982-1999									
Regression number	Beta	ln(Mkt. Cap.)	ln(Sales)	ln(EV/ Sales)	ln(EV/ EBITDA)	ln(P/B)	ln(EBITDA/ Sales)	NIBD/ EV	N
1	-0.019								22,640
	(-0.18)								
2		0.014							31,372
		(0.42)							
3			0.120***						27,217
			(3.56)						
4				-0.414***					25,760
				(-5.23)					
5					-0.630***				18,494
					(-4.85)				
6						-0.307***			29,194
						(-3.43)			
7							0.017		19,543
							(0.18)		
8								-0.190	29,738
								(-1.06)	
9		0.049			-0.726***		-0.259**		18,487
		(1.07)			(-5.22)		(-2.10)		

Panel B: 2000-2018									
Regression number	Beta	ln(Mkt. Cap.)	ln(Sales)	ln(EV/ Sales)	ln(EV/ EBITDA)	ln(P/B)	ln(EBITDA/ Sales)	NIBD/ EV	N
1	-0.084								32,410
	(-1.31)								
2		-0.183***							38,273
		(-8.21)							
3			-0.045*						35,870
			(-1.92)						
4				-0.375***					33,920
				(-7.68)					
5					-0.401***				25,840
					(-4.96)				
6						-0.406***			35,794
						(-6.47)			
7							-0.154***		27,025
							(-3.00)		
8								0.058	36,356
								(0.47)	
9		-0.222***			-0.266***		-0.062		25,833
		(-6.87)			(-3.18)		(-0.87)		

Appendix H: Comparison of Cambridge Associates return benchmarks

Cumulative return of $1 invested (Q3 1986 - Q2 2018)

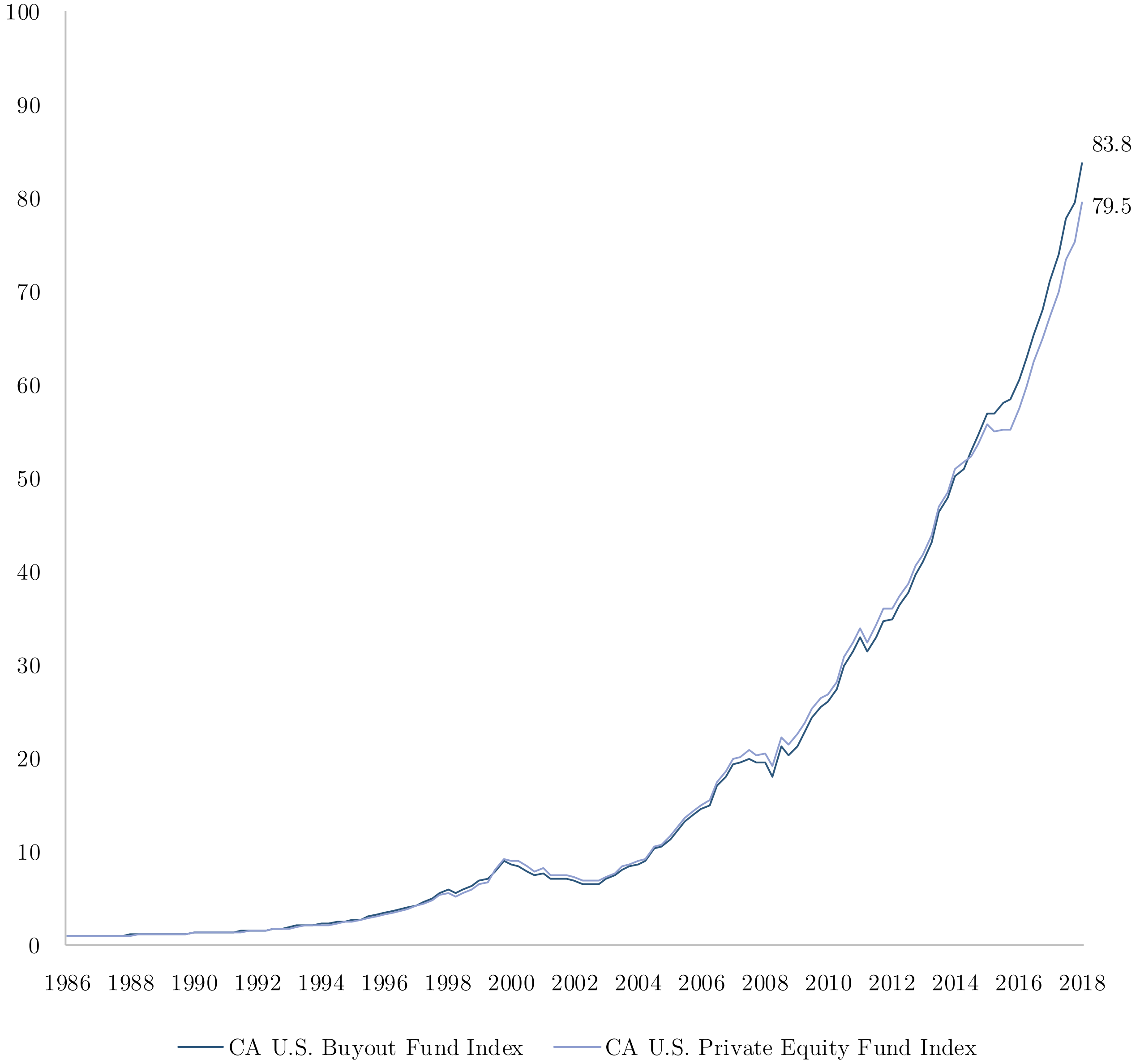

Figure H.1: Pre-fee index of Cambridge Associates return benchmarks (1986 Q3 - 2018 Q2)
The figure plots the cumulative value of $1 invested in the CA U.S. Buyout Fund Index and the CA U.S. Private Equity Fund Index net-of-fees from July 1986 to June 2018. Data has been obtained from Cambridge Associates (2018a) and Cambridge Associates (2018b).

Appendix I: Cambridge Associates annualized factor regressions

Table I.1: OLS factor regressions of annual CA U.S. Buyout Fund Index (Q3 1986 - Q2 2018)

Annualized returns of the CA U.S. Buyout Fund Index from Q3 1986 to Q2 2018, are regressed against different risk factors in 4 different regressions. Panel A reports regression results for the after fees return series while Panel B shows results for the return series before fees. MktRf, SMB, HML, RMW, CMA are the 5 Fama-French factors. WML is the momentum factor introduced by Carhart (1997), BAB is return to low-beta stocks as introduced by Frazzini and Pedersen (2014) and LIQ is the traded liquidity factor introduced by Pástor and Stambaugh (2003). Alpha estimates are annualized and multiplied by 100 for improved readability. Standard errors are robust. T statistics are reported in parentheses. ***, ** and * denotes significance at the 1%, 5% and 10% level, respectively.

Panel A: CA U.S. Buyout Fund Index after fees

Regression number	α	MktRf	SMB	HML	RMW	CMA	WML	BAB	LIQ	N	R^2
1	7.450***	0.606***								32	0.495
	(3.56)	(4.72)									
2	7.290***	0.637***	0.246	-0.131						32	0.491
	(3.56)	(5.53)	(1.65)	(-0.91)							
3	11.100***	0.459***	0.361***	0.321**	-0.230	-0.886***				32	0.672
	(5.66)	(4.06)	(3.00)	(2.25)	(-1.50)	(-4.14)					
4	11.600***	0.444***	0.317*	0.253*	-0.305	-0.870***	-0.178	0.066	0.118	32	0.667
	(5.28)	(3.49)	(1.81)	(1.83)	(-1.34)	(-3.75)	(-1.03)	(0.53)	(0.99)		

Panel B: CA U.S. Buyout Fund Index before fees

Regression number	α	MktRf	SMB	HML	RMW	CMA	WML	BAB	LIQ	N	R^2
1	13.000***	0.728***								32	0.463
	(4.93)	(4.93)									
2	12.800***	0.762***	0.268	-0.140						32	0.449
	(4.80)	(5.13)	(1.39)	(-0.76)							
3	17.300***	0.554***	0.411**	0.401*	-0.256	-1.079***				32	0.615
	(6.50)	(3.65)	(2.51)	(2.06)	(-1.21)	(-3.87)					
4	17.700***	0.569***	0.383	0.360*	-0.302	-1.080***	-0.188	0.030	0.155	32	0.594
	(5.82)	(3.37)	(1.62)	(1.98)	(-0.98)	(-3.56)	(-0.79)	(0.17)	(0.94)		

Appendix J: The effects of varying holding periods

Table J.1: Properties of the PE-mimicking portfolio under different holding periods

This table reports summary statistics for the unlevered PE-mimicking portfolio under various assumptions. Each month, the PE-mimicking portfolio selects stocks in the top quintile of PE-selection likelihood. Investments with cumulative annualized returns exceeding the exit hurdle after the minimum holding period ends are exited. "Reinvestment" refers to the length of the period at which investments are not re-considered once exited. All summary statistics in Panel B are annualized. All percentage figures are multiplied by 100 for improved readability.

Panel A: Portfolio assumptions					
Maximum holding period	6m	1y	2y	4y	6y
Minimum holding period	n.a.	6m	6m	1y	1y
Annualized exit hurdle %	50%	50%	50%	50%	50%
Reinvestment	6m	1y	1y	1y	1y
Panel B: Unlevered replicating PE portfolios					
Mark-to-market					
Geometric avg. annual return	18.43	14.55	13.03	13.75	13.30
Average annual excess return	16.48	12.23	10.67	11.18	10.78
Standard deviation	21.90	18.39	17.14	16.23	16.20
Sharpe ratio	0.75	0.67	0.62	0.69	0.67
Max drawdown	62.72	62.41	60.77	53.86	52.75
CAPM alpha	7.75	4.68	3.48	4.23	3.75
CAPM beta	1.16	0.99	0.94	0.91	0.92
Hold-to-maturity accounting					
Geometric avg. annual return	18.43	14.55	13.03	13.75	13.30
Average annual excess return	14.84	10.79	9.29	9.93	9.54
Standard deviation	13.36	7.09	4.45	4.24	4.73
Sharpe ratio	1.11	1.52	2.09	2.34	2.02
Max drawdown	54.26	42.90	17.99	6.71	2.32
CAPM alpha	14.25	10.36	9.10	9.93	9.65
CAPM beta	0.19	0.12	0.07	0.05	0.04