Replicating Private Equity with
Value Investing, Homemade Leverage, and Hold-to-Maturity Accounting

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ABSTRACT

The contributions of asset selection and incremental leverage to buyout investment performance are more important than typically assumed or estimated to be. Buyout funds select small firms with distinct value characteristics. Public equities with these characteristics have high risk-adjusted returns relative to common factors. Adding incremental leverage to a publicly traded stock portfolio increases both risks and mean returns in this sample. Direct investments in private equity funds earn lower mean returns than a replicating strategy designed to mimic these key economic features of their investment process with public equities and brokerage loans.

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The private equity (PE) buyout investment approach combines several essential activities: focusing on an investment universe with distinctive characteristics; purchasing assets at favorable prices; employing leverage; implementing operating improvements; and optimally timing the re-marking and exits of holdings. There is widespread interest in understanding how each of these components of the strategy contribute to the whole. This paper investigates the contributions of asset selection and incremental leverage to PE buyout investment performance.

Evidence presented in this paper suggests that the asset selection and incremental leverage of the PE buyout investment process are more important than typically assumed or estimated to be in the evaluation literature. The distinctive characteristics of firms in the private equity buyout universe explain far more of the historical track record than previous studies suggest. I find that investing in public firms with similar characteristics to those selected by PE buyout funds – without having to purchase controlling interests at favorable prices or implementing any operating improvements – is sufficient to match the historical performance of the limited partners of PE buyout funds. Adding additional leverage to this successful asset selection strategy increases mean returns in this sample.

This conclusion is at odds with the existing literature for two reasons. First, I find that PE buyout funds focus substantially more on firms with characteristics associated with high returns – value firms with strong earnings – than factor analysis is able to uncover. Second, I find that the rapid growth of the PE buyout asset class as a whole, when combined with the investment life-cycle of the typical buyout fund, obscures the degree of leverage deployed in the average investment.

Asset selection is the first step of the PE buyout investment process and because the risk premium sourced from this activity is levered greatly by the leveraged buyout (LBO) transaction,[1] its total risk and return contributions can be large. The combined contributions of

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[1] Kaplan and Strömberg (2009) report, "The buyout is typically financed with 60 to 90 percent debt—hence the term, leveraged buyout."

asset selection and incremental leverage can be underestimated by a factor model analysis of PE buyout returns or cash flows (e.g. Lin, Dreissen, and Phalippou (2012) and Ang, Chen, Goetzmann, and Phalippou (2018)) because the considered factors do not fully describe the relevant characteristics of the strategy and because the covariances between PE investment data and factors are not estimated accurately enough to properly identify the passive component of these investments. It is typically agreed that factor model risk estimates from PE buyout returns are likely to be biased towards zero (e.g. Gompers and Lerner (1997)).[2] A public market equivalent (PME) analysis, introduced by Kaplan and Schoar (2005), evaluates the risk-adjusted performance of PE cash flows by discounting at the realized return of the public market return.[3] Sorensen and Jagannathan (2015) show how the PME can be interpreted as the stochastic discount factor corresponding to the Rubinstein (1976) CAPM. Korteweg and Nagel (2016) develop a generalized PME and note, "One could augment the SDF [stochastic discount factor] with additional risk factors to capture other assets that the investor may have access to as well as other state-variable risks that he or she may care about." This raises the questions – what are the relevant characteristics of PE buyout investments and how would they perform outside of the PE investment process?

To empirically investigate the characteristics most closely associated with the asset selection component of the PE buyout investment process, I assemble a dataset of public-to-private transactions sponsored by private equity buyers, similar to Opler and Titman (1993) and Axelson, Jenkinson, Strömberg, and Weisbach (2013). I estimate a selection model on this sample as a relatively direct method for understanding the characteristics associated with the PE

[2] There is a large literature studying the effects of return smoothing in hedge fund performance evaluation originating from illiquidity and managerial discretion in estimating periodic net asset values (e.g. Asness, Krail, and Liew (2001), Getmansky, Lo, and Makarov (2004), Bollen and Pool (2008, 2009), Cassar and Gerakos (2011), and Cao, Farnsworth, Liang, and Lo (2015)). These issues are likely more severe in PE portfolios. Several recent papers analyze incentives to manipulate reported PE fund values (e.g. Jenkinson, Sousa, and Stucke (2013), Barber and Yasuda (2017), Chakraborty and Ewens (2017), and Brown, Gredil, and Kaplan (2018)).

[3] There is a large literature using PME-style analyses. Benchmarks reflecting the assumed asset composition (e.g. Phalippou (2014)) and incremental leverage (e.g. Robinson and Sensoy (2013)) of PE buyouts have been shown to affect inferences.

buyout investment selection process. The analysis finds that the characteristics that predict public buyouts are somewhat distinct from those used to construct common factors. Additionally, portfolios formed on the characteristics most closely associated with public buyouts earn positive risk-adjusted returns when measured against common factors. This suggests that public buyouts make use of a highly successful asset selection strategy. A feasible mimicking portfolio that manages this asset selection strategy without adding any incremental leverage earns higher returns than direct PE buyout investments and is considerably more liquid.

The sample of public-to-private transactions account for only 40% to 50% of the dollars invested in PE buyouts.[4] To the attractive selection strategy identified from public-to-private transactions, PE buyout funds also select private deals, add substantial amounts of incremental leverage, hold their positions for long periods while altering operations, before selling, and eventually distributing a share of the profits to limited partners (LPs). PE buyout funds also charge guaranteed management fees. These combined activities appear to reduce mean returns for limited partners. The net risk contributions of these activities are not well identified.

With an assumption that the private-to-public transactions make use of an equally attractive selection rule, a replicating strategy can be constructed to explore the combined contributions of asset selection and incremental leverage.[5] With the additional assumption that asset selection and incremental leverage are the economically relevant components of the investment process, the replicating portfolio can serve as a simple empirical model of PE buyout investments. The replicating strategy is effectively calibrated by assuming an initial amount of incremental leverage for all new positions and then matching the quarterly aggregate cash flows into and out of the Burgiss PE buyout fund sample. This analysis finds a number of interesting

[4] The public-to-private transactions represent a small fraction of all buyout transactions, but about 40% of the aggregate value of buyout transactions over a similar period from 1980 to 2005 (Davis, Haltiwanger, Handley, Jarmin, Lerner, and Miranda (2014)), and accounting for 50% of aggregate buyout value in 2007 (Preqin (2014)).

[5] An argument to support this assumption is that the PE buyout funds could mimic their own public-to-private transaction selection strategy for their private-to-private transactions relatively efficiently if they were otherwise relying on an inferior selection strategy. Note that the improvement in private transactions could come from selecting lower risk firms.

empirical properties relating to the joint contributions of the asset selection and incremental leverage of LBO investments.

The combined contributions of asset selection and incremental leverage to the mean return of the buyout strategy can be economically large. The replicating strategy can match 100% of the time series variation of the quarterly aggregate LP cash flows, ending the sample with a positive surplus value, using a wide range of plausible initial leverage assumptions. A replicating portfolio that adds a similar amount of initial leverage as the average LBO initially adds to the balance sheet of its portfolio companies has an annualized internal rate of return (IRR) that is 3% higher than the direct investments in PE buyout funds.[6]

The leverage of the replicating portfolio behaves differently from intuition based on fund-level dynamics, where fund leverage starts relatively high and declines over time conditional on investment success. The replicating portfolio leverage is highly time varying and has a time series average not much below the initial leverage level of newly added positions. The relatively high portfolio leverage comes from two sources. In periods of poor stock market performance like 2008, portfolio leverage increases meaningfully as equity values decline. This is not surprising to observe, but perhaps the magnitudes are not fully anticipated before observing. In addition, even in times of good investment performance, the large and steady inflows into PE buyout funds over the sample period has the effect of placing the average dollar allocated to the asset class in a recently launched fund, and recently launched funds have relatively high leverage. This suggests that the leverage embedded in the PE buyout asset class will be high over periods with rapidly growing capital inflows.

Finally, the measured market risks and other common factor exposures of the replicating portfolio are considerably higher than those typically assumed or estimated, suggesting the potential for the un-modeled activities to effectively hedge these exposures or for the buyout

[6] The primary focus of this paper is on the after-fee cash flows to LPs, which is the same focus as the PE buyout evaluation literature. There is an analysis of estimated pre-fee cash flows in the Discussion section of the paper.

fund investment data to not be fully revealing of these exposures. The relatively high market beta estimates are consistent with the estimates from secondary market PE transactions (Boyer, Nadauld, Vorkink, and Weisbach (2018). Applying hold-to-maturity accounting to the replicating portfolio, as a means of proxying for sluggish reporting of fund values, is shown to destroy return covariances with common factors in this sample, leading to risk estimates closer to zero than to those estimated from the well-marked portfolio. The analysis also demonstrates that the time series of quarterly aggregate cash flows of PE buyout LPs are equally well explained by a replicating portfolio that adds no incremental leverage and one that averages 2x this leverage, with both portfolios ending the sample with positive surplus values. These analyses illustrate the empirical challenge of accurately identifying the joint contributions of asset selection and incremental leverage from cash flows, but do not rule out the hedging possibility. Overall, these results are consistent with factor models underestimating the contributions of asset selection and incremental leverage both because the considered factors do not fully describe the relevant characteristics of the strategy and because the covariances between PE investment data and factors are not estimated accurately enough to properly identify the passive component of returns.

The remainder of the paper is organized as follows. Section 1 describes the PE buyout investment data and methods of evaluation. Section 2 investigates the asset selection based on a sample of public-to-private transactions. Section 3 evaluates the return properties of portfolios comprised of firms with the characteristics shown to be associated with the highest buyout likelihood. Section 4 describes a simple strategy for matching the quarterly cash flows in and out of the PE buyout fund sample using a replicating strategy. Section 5 offers a discussion of the main results and Section 6 concludes the paper.

1. Data and Methods for Evaluating Private Equity Buyout Investment Performance

1.1 The Data on PE Buyout Cash Flows, Fund Values, and Returns

There are several data sources used by academics and practitioners to study the investment performance of private equity buyouts (see Harris, Jenkinson, and Kaplan (2014) for a comparison of datasets). The two most prominent sources of underlying cash flow and fund value data are Burgiss and Preqin. Additionally, Cambridge Associates produces a time series of quarterly returns for an aggregate index of private equity investments beginning in 1986 and a private equity buyout index beginning in 1994.

The Burgiss and Preqin databases provide fund-level time series observations of contributions, net-of-fee distributions, and reported fund values, as well as information on the overall fund like total committed capital and whether the fund has liquidated or remains active. The datasets are fairly sparse before 1990, and extend through 2017. Figure 1 displays some summary properties of the available investment data for the aggregate PE buyout asset class from these data sources. For both the Burgiss and Preqin databases, I aggregate the fund-level cash flows and reported values for all buyout funds each quarter. The long time series of fund values reported in the first panel of Figure 1 illustrates the remarkable growth in aggregate fund values over time, as more funds are launched each year, average fund sizes increase, and existing funds generate returns. The second panels plot the aggregate cash flows (contributions in red and distributions in green) for both the Burgiss and Preqin datasets. The time series patterns are quite similar between the two datasets. The data before 1994, are less reliable as the average number of reporting funds in both datasets is under 10 funds from 1980 to 1994. From the reported fund values and the cash flows, I calculate total return indices for both the aggregate Burgiss and Preqin PE buyout samples beginning in 1994.[7] The third panel of Figure 2 plots these total return indices and the Cambridge Associates PE Buyout Index. The final panel displays the time series

[7] The periodic return is calculated as the change in fund value plus distributions minus contributions, all divided by beginning of period fund value.

of drawdowns for these indices. The Burgiss and Cambridge Associates total return indices are nearly identical, while the Preqin index exhibits a lower compounded return and a different drawdown pattern prior to 2003.

Table 1 summarizes some properties of the cash flow data from Burgiss and Preqin, organized by vintage year (i.e. year of fund launch) from 1994 through 2010. As is common in the literature, I focus on funds launched after 1993 and before 2011.[8] The last considered vintage contains the funds launched in 2010, which have largely liquidated by the end of the sample period in December 2017. Table 1 also reports the initial committed funds by vintage and the sum of the eventual contributions to each of the funds within a vintage. The net cash flows, defined as distributions minus contributions, for all funds within a vintage are aggregated by quarter and then the internal rate of return (IRR) is calculated, assuming any residual fund value at the end of the sample in December 2017 is distributed. Thus, these IRRs are effectively value-weighted across funds within each vintage. The average annualized IRRs across vintages are very similar for both datasets, averaging 13.2% for the Burgiss funds and 13.4% for the Preqin funds. The Burgiss database covers more funds, although the aggregate committed capital across the datasets is fairly similar, suggesting that the Burgiss coverage is more complete for smaller funds. Consequently, I use the Burgiss dataset as the primary source for cash flows and reported fund values because it appears somewhat more comprehensive than the Preqin dataset and to produce a return series more consistent with the Cambridge Associates index.

Figure 2 compares the investment data for the aggregate PE buyouts using the full sample of the Burgiss dataset with the subset of funds within the 1994 to 2010 vintages. The properties of these two samples are useful to summarize since both will be investigated in later sections. For the 1994-2010 vintages, the cash flow patterns and the aggregate fund values reflect that there are relatively few inflows to the aggregate index after 2013, as these funds are being

[8] For example, Ang, Chen, Goetzmann, and Phalippou (2018) focus on funds launched in 1994 through the end of 2008, while using a cash flow dataset that ends in the second quarter of 2015.

liquidated. The total return indices show that the return calculated from the reported data appear somewhat better for the funds outside of these vintages, although the drawdown patterns are essentially identical across these samples, suggesting that inferences about risks will be similar.

1.2 Evaluation Methods and Issues

Estimating risks for PE buyouts directly from reported fund values and cash flows, or returns calculated from these data, is challenging because neither the reported fund values nor the cash flows are likely to be very informative about their covariance with other investments. Gompers and Lerner (1997) argue that private equity buyout funds have historically tended to report sluggishly updated assessments of the portfolio valuation, such that "the stated returns of private equity funds may not accurately reflect the true evolution of value." Recent efforts to estimate PE buyout risks directly from the cash flows of liquidated funds rely on the time series of cash flows revealing risks. Since returns do not reveal risks, and returns include cash flows, it is not obvious that this empirical method will be fully successful.[9] The challenges here are that the fund-level cash flow distributions represent the combined contributions of alpha, risk premia, and errors and these combined contributions have compounded over multi-year periods before being distributed, such that there will effectively be few observations from which to precisely measure covariation with other portfolios.

Lin, Dreissen, and Phalippou (2012) and Ang, Chen, Goetzmann, and Phalippou (2018) both develop methods to estimate PE buyout risks from cash flows by imposing a constant structure over the systematic risks across funds and through time. Both papers estimate the market beta of PE buyouts to be around 1.3. Neither paper estimates these market betas precisely. In both sets of analyses, these market betas are indistinguishable from 1. Lin, Dreissen,

[9] Stock returns are driven by shocks to expected cash flows and shocks to discount rates. The literature measuring the relative importance of cash flow and expected return shocks for returns (e.g. Campbell and Shiller (1988a, 1988b) and Campbell (1991)) finds that expected return variance dominates cash flow news variance. At the individual firm level, Vuolteenaho (2002) shows that cash flow news is substantially more important and that it is largely diversifiable, suggesting why discount rate news dominates in portfolios.

and Phalippou (2012) develop a generalized method of moments estimator for a linear factor model applied to the quarterly aggregate PE buyout net cash flows. Ang, Chen, Goetzmann, and Phalippou (ACGP) estimate a latent factor model within a Bayesian framework that effectively recovers both a quarterly time series of returns for a latent PE buyout factor and estimated exposures to common factors from a panel of PE buyout fund cash flows. Their latent PE buyout factor is not investable, leading them to conclude that PE buyouts cannot be passively replicated.

One interpretation of these analyses is that the risks are not being accurately measured from the cash flows and that the inferences about PE buyout investment performance are not too different from those from standard return regressions, which also may not be accurately measuring risks. Table 2 summarizes PE buyout portfolio returns measured from a variety of sources over the period 1996 through 2014. Total return indices are calculated for both the Burgiss and Preqin PE buyout datasets, as described in Section 1.1. Cambridge Associates (CA) reports a quarterly return series for its PE Buyout Index. ACGP (2018) construct the quarterly returns for their PE Buyout Index from the combined contributions of the estimated risk exposure and the estimated latent PE buyout factor.[10]

The mean returns, standard deviations, and market betas measured directly from the CA, Burgiss, and Preqin return series are all fairly similar. The mean returns are around 13% to 14% with annualized standard deviations of about 12%. The CAPM betas are around 0.8, which are in line with the estimates from Ewens, Jones, and Rhodes-Kropf (2013) who use similar total returns indices to estimate market beta. The ACGP PE buyout index returns have a higher arithmetic mean of 17% and a lower geometric mean of 13%, due to its considerably higher annualized standard deviation of 27%. By construction, the geometric mean of the ACGP PE buyout index matches that of the Preqin index, as this is the value-weighted portfolio they are decomposing into common risk exposures, a mean-zero latent PE buyout factor, and an alpha.

[10] The quarterly returns for the ACGP (2018) PE Buyout Index come from the Journal of Finance online appendix and the riskfree rate and value-weight public stock market returns are from Ken French's data library.

Consistent with the risks being poorly identified from the cash flow data, ACGP (2018) essentially recover their priors about systematic risk exposures. This implies that the cash flow data are not contributing to their risk estimates at all. Specifically, ACGP report a prior for the CAPM beta of PE buyouts of 1.25 and estimate the CAPM beta to be 1.25 with a standard error of 0.25. Because their latent factor has zero-mean by construction, any underestimate of common risk exposure is allocated to the alpha. Their estimated annualized alpha of 4% is reliably different from zero and in line with the estimated alphas of 5% based on standard return regressions. Additionally, ACGP (2018) demonstrate that alpha estimates are meaningfully affected by the specific set of factors considered.[11]

Another set of evaluation approaches do not attempt to estimate risks directly, but instead rely on an economic-equivalence argument to identify an appropriate benchmark portfolio. Kaplan and Schoar (2005) is an important example of this approach. Their public market equivalent (PME) methodology relies on an argument rather than an estimation. The initial argument in Kaplan and Schoar is that one can either invest in public or private equities, the aggregate stock market is an efficient portfolio for sourcing public equity exposure, and therefore the value-weight market is a reasonable benchmark. A general concern with this method is evaluating whether the benchmark accurately represents an equivalent-risk portfolio for a sophisticated investor with access to a broad set of risk exposures. The strength of this approach is that it is both transparent and based on a feasible alternative use of capital, making it a highly practical method of evaluation.

Leveraged buyouts typically increase the target firm's financial leverage by more than two times (Axelson, Jenkinson, Strömberg, and Weisbach (2013)), so some adjustment for

[11] A regression of the ACGP (2018) PE buyout index excess returns on the Fama and French 3-factor model finds a modest exposure to SMB (small firms) and no exposure to HML (value firms). In contrast, a replicating portfolio mimicking the asset selection and incremental leverage of LBOs developed in this paper has a larger exposure to the market, a full unit of SMB exposure and a full unit of HML exposure (see Table 10). This is consistent with any or all of the following: (1) PE ownership effectively providing an economically large hedge of these exposures; (2) the risk exposures being underestimated from cash flows; and (3) the risk exposures being overestimated from the replicating portfolio, presumably because the replicating portfolio is mis-specified.

incremental leverage seems appropriate. Robinson and Sensoy (2013) note that “reliably estimating betas at the fund level is difficult, and no accepted method to do so exists in the literature.” Referencing the increased incremental leverage typical of LBOs, they use a market beta of 1.3 in their beta-adjusted PME based on the estimates in Lin, Dreissen, and Phalippou (2012). It is clear that adding incremental leverage to a portfolio is predicted by standard corporate finance theories to increase market beta, but it is far less clear that the market beta estimate of 1.3 is accurate.

Jegadeesh, Kräussl, and Pollet (2015) estimate risks from the returns of portfolios comprised of publicly-listed fund-or-funds holding unlisted PE buyout allocations and portfolios of listed PE buyout funds. Because these portfolios are publicly-listed, periodic returns should more accurately reflect the market's assessments of asset values at each point in time. They estimate market betas for PE buyouts in the range of 0.7 to 1.0. Their sample differs in a few important ways from the PE buyout samples most commonly used in the evaluation literature. First, their sample of listed-firms is mostly non-US, having just a handful of US firms, while US PE buyout funds are the focus of most other research. Second, the mean returns for their sample firms are very low relative to the after-fee returns of US PE buyout funds. For example, the after-fee returns for the PE buyouts studied in this paper average over 10%, while their sample of listed firms have mean returns well under 5%.[12]

Another interesting method for indirectly estimating the risks of PE buyouts is developed in Boyer, Nadauld, Vorkink, and Weisbach (2018), who construct a hedonic price index from secondary market transactions. Regressions of their index excess return on the excess market return find betas well over 2. These estimates are generally consistent with the analyses in this paper. Their sample covers the period 2006 to 2017, which includes the financial crisis. During

[12] Table 6 in Jegadeesh, Kräussl, and Pollet (2015) reports CAPM regression results for their sample of fund-of-funds, estimating market beta of 0.71 and a monthly intercept of -0.32, over the period 1994 through 2008. The annualized (x12) mean excess return on the value-weight market factor from Ken French’s website over this period is 3.7% and the average riskfree rate is 3.7%, suggesting that the required return is 6.3%. On average, the fund-of-funds portfolio earns 3.8% less than this per year, equivalent to 2.5%.

this period, secondary market prices are very low relative to reported fund values. Additionally, as illustrated in this paper, the fund leverage is much higher during large stock market drawdowns, such that the usual pattern where leverage decreases over the life of the fund does not occur in periods of poor market conditions, so very high betas during episodes like the financial crisis seem plausible. At the same time, it can be argued that these low prices for secondary private transactions reflect illiquidity rather than some notion of fundamental risk.

Overall, the current state of the literature evaluating aggregate PE buyout returns is one where there is generally agreement that PE buyout funds have historically delivered after-fee returns that are high relative to public markets when compared with no adjustments for the incremental leverage of LBOs or for asset selection. Adjusting for asset selection seems appropriate, as there is evidence that PE buyout funds select firms with specific characteristics (e.g. Opler and Titman (1993)) and that some of these characteristics may be associated with higher returns than the value-weighted market portfolio (e.g. Fama and French (1992, 1993)). Adjusting for the incremental leverage typical of LBOs also seems appropriate. The leverage adjustment will increase the benchmark return in samples with successful investment performance, as experienced in the US over the past 40 years. However, it is not established how large the adjustment should be. Market betas of 1.0 and 1.3 are commonly used, but these estimates are not precisely measured. Secondary market transaction prices suggest that market betas could be as high as 2.4.

2. Asset Selection by Private Equity Buyout Funds

Based on aggregates of activity, it appears that private equity investments are not evenly distributed throughout the economy, suggesting that they target specific asset types (Kaplan and Strömberg (2009)). Early research on the determinants of LBO activity finds that firms selected for LBOs tend to have relatively low Tobin's Q and relatively high cash flows (e.g. Opler and Titman (1993)). The highly limited data availability on the financials and governance of private firms is a major obstacle to knowing which asset characteristics are associated with private equity asset selection. The approach in this paper follows Opler and Titman (1993) and Axelson, Jenkinson, Strömberg, and Weisbach (2013), whereby the subsample of public equities that have been taken private is studied, recognizing that the investments in private firms are not completely representative of the full sample. For example, the public targets in this sample tend to be somewhat larger than the private targets that are excluded. Phalippou (2014) reports that 95% of all buyout investments (public and private) fall in the Fama-French small-cap index. For the sample of public buyouts studied in this paper, roughly 50% are smaller than the 5th percentile of the NYSE market equity distribution and 85% are smaller than the 20th percentile of the NYSE market equity distribution. The sample of buyouts of public firms allows the pre-transaction financial characteristics to be collected from Compustat and CRSP.

The dataset of public-to-private transactions comes from the unique set of transactions identified from Capital IQ and Thompson-Reuters and is summarized in Table 3. Similar to Axelson, Jenkinson, Strömberg, and Weisbach (2013), I identify all M&A transactions classified as "going private," or "leveraged buy out," or "buyout," announced between January 1984 and December 2017, where the target is a US publicly traded firm from the Capital IQ M&A database. This results in 421 firms that can be linked to CRSP and Compustat.[13] The set of buyers from these transactions are defined as "private equity firms," and are used to help identify additional buyout transactions from a second set of transactions from the Thompson-Reuters merger and acquisition database. I first require that the acquirer is identified as a financial buyer and the transaction results in at least 80% ownership of a publicly traded target firm over the period 1984 to 2017. Additionally, I require that the "deal synopsis" mentions "going private," or "leveraged buy out," or "buyout," or that at least one of the acquiring parties is a "private equity firm." This results in 497 firms that can be linked to CRSP and Compustat. The unique

[13] Axelson, Jenkinson, Strömberg, and Weisbach (2013) study a sample of 694 US LBOs over the period 1986 to 2008, assembled largely from the Capital IQ dataset. They identify 365 of these as public-to-private transactions, which is consistent with the 421 identified from Capital IQ over the slightly longer period studied in this paper.

observations from the combination of these datasets is used as the main sample, resulting in 668 transactions.

Table 4 reports results from regressions explaining which firm characteristics are associated with buyouts from 1984 to 2017. Both ordinary least squares (OLS) and logistic regressions of a binary "PE-selected" variable on firm characteristics are reported (OLS in Panel A and logistic in Panel B). All of the specifications use the time series of coefficients from annual cross sectional regressions in the spirit of Fama and MacBeth (1973). The reported coefficients are calculated as the time series average estimated coefficients and the standard errors of the mean are used to calculate *t*-statistics. The reported coefficients are multiplied by 100 to improve readability.[14] There are 34 annual cross sections with an average of 1,916 firms in each cross section. The firm characteristics are firm size, proxied by either equity market capitalization (ME) or total revenues (sales); EBITDA multiple (M_{EBITDA}); market beta; profitability measured as the ratio of EBITDA to sales; market leverage ratio measured as long-term debt to the sum of long-term debt and ME; the three-year net equity issuance variable (ISS) described in Daniel and Titman (2006); and the book-to-market equity ratio (BE/ME). The EBITDA multiple is calculated as the firm enterprise value divided by EBITDA, so long as EBITDA exceeds $1 million. Firms that do not satisfy the minimum EBITDA requirement at the time of portfolio formation are excluded from the analysis. Additionally, to be consistent with other research that relies on EBITDA multiples, financial firms identified as those with SIC codes between 6000 and 6999 are excluded from the analysis. The firm enterprise value is the sum of the market value of equity from CRSP (price per share multiplied by shares outstanding) and the book value of long-term debt from Compustat less cash and marketable securities from Compustat.[15] The firm characteristics are all assumed to be known at the time of the event. The

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[14] The OLS regressions report an adjusted R-square and the logit regression report a log-likelihood ratio, as a pseudo-R-square.

[15] Adjusting the enterprise value calculation for excess cash (defined as cash above 2% of sales) or skipping the subtraction of cash altogether has virtually no quantitative effect on the results.

event time is measured as the announcement date. Stock market variables (ME) are assumed to be known with no delay. Accounting variables are assumed to be known with a three-month delay.

The regressions indicate that among the public firms taken private, the selected investments are relatively small firms as proxied by either ME or sales, with these variables being highly statistically significant in all specifications. The selected firms tend to have relatively low recent net equity issuance, indicating that the selected firms are more likely to be repurchasing their own shares than issuing new shares. The negative coefficient on profitability suggests that the selected firms are not highly profitable, although these regressions condition on firms having EBITDA over $1M.[16] The coefficient on profitability is positive without this condition (results not reported). Additionally, the selected firms tend to be value firms. BE/ME is positively associated with the event (firms with high BE/ME are considered value firms) and M_{EBITDA} is negatively associated with the event. When both variables are included in the same specification, M_{EBITDA} tends to eliminate the statistical reliability of BE/ME. Market beta is negatively related to the likelihood of PE selection, although the average market beta of event firms is equal to 1. A firm's leverage is positively related to buyout likelihood, although is not statistically reliable in logit specifications. Axelson, Jenkinson, Strömberg, and Weisbach (2013) find that the leverage choice by the PE fund for the target firm is unrelated to the target firm's leverage and the industry average leverage ratio at the time of the transaction, seemingly determined by aggregate credit market conditions.

The time series of coefficients from the annual cross sectional regressions lead to qualitatively similar results throughout the full sample period, suggesting that the asset characteristics that are most closely associated with buyout transactions are reasonably stable through time. Within each period, there is a tendency for the PE-selected firms to be relatively

[16] A similar analysis based on a Sales multiple, which does not require firms to be profitable, produces qualitatively similar inferences for the selection analysis and all subsequent related analyses.

small, value firms, with low net equity issuance, and modest profitability. The one exception is that leverage is negatively related to buyout likelihood in the first half of the sample and then positively predicts being selected for buyout in the second half of the sample. The reported regressions make use of the full sample to illustrate which characteristics are most closely associated with public-to-private buyouts. However, the actual replicating portfolios will rely only on information available at the time of portfolio formation.

3. The Returns to Investing in Buyout-Selected Stocks

The literature studying the cross-section of stock returns typically measures a value premium from the time series mean of a long-short portfolio that is long stocks in the top third of the book-to-market equity (BE/ME) distribution and is short stocks from the bottom third of this distribution (Fama and French (1993)). The firms with high BE/ME are considered value stocks, while the firms with low BE/ME are considered growth stocks. Firms identified as being value stocks earn relatively high returns and are sometimes referred to as being distressed (Fama and French (1996)).

A common metric for identifying value stocks in practice is the EBITDA multiple, M_{EBITDA}. This multiple represents the price per unit of operating income available to the capital providers of the firm (i.e. debt- and equity-holders). To the extent that debt is priced consistently across firms, sorting stocks on their firm's M_{EBITDA} provides an alternative means to sourcing a value premium in stocks, which according to the regressions reported in the previous section more accurately reflect the public-firm selection method of PE buyers.

Table 5 summarizes returns for five portfolios formed on M_{EBITDA}. The portfolios are formed monthly based on information assumed to be known at the beginning of the month. Equity market values are assumed to be known with no delay. Debt market values are assumed to equal their book values and to be known with a reporting delay of three months. Similarly, all other accounting data are assumed to be known with a three month reporting delay.

Table 5 confirms the basic premise behind value investing with EBITDA multiples. There is a strong monotonic relation in the realized excess returns across portfolios formed on M_{EBITDA} over the period 1986 to 2018. Portfolios comprised of low multiple stocks (i.e. the bottom quintile of all CRSP stocks with annual EBITDA in excess of $1M ranked on the basis of M_{EBITDA}) have high excess returns, averaging 18% per year for the equal-weight portfolio and 13.7% for the value-weight portfolio, while portfolios comprised of the high multiple stocks (top quintile) have average excess returns of 5.7% and 7.5% for equal- and value-weight portfolios, respectively. Over this same period, the excess return on the value-weight market portfolio is 8.8%. The annualized volatility is reasonably similar across portfolios, such that Sharpe ratios share the same pattern as the excess returns.

Additionally, Table 5 shows that systematic risk exposure does not explain this pattern. The unexplained mean excess return (or alpha), as measured by the intercept from a time series regression of the portfolio excess returns onto the zero-investment portfolio returns suggested by either the Sharpe (1964) and Lintner (1965) capital asset pricing model (CAPM), the Fama and French (1993) three-factor model (FF3), the Fama and French (2015) five-factor model (FF5), or the FF5 plus a momentum factor (Carhart (1997)), UMD, shares the same strong monotonic relation across M_{EBITDA} portfolios over this period.[17] A long-short portfolio that is constructed by being long low M_{EBITDA} stocks and short high M_{EBITDA} stocks earns an alpha of 1% per month (t-statistic = 5.6) against the CAPM when stocks are equally weighted in the portfolio. Value-weighting produces smaller alphas for the long-short portfolio, but they remain reliably positive, with a monthly alpha of 58 basis points (t-statistic = 2.7) against the CAPM. The Fama and French five-factor model includes a factor called RMW, which is long stocks with robust profitability and short stocks with weak profitability, and CMA, which is long low investment stocks and short high investment firms. Fama and French (2015) find that these factors weaken the statistical power of HML in explaining the cross section of returns. For the portfolios formed

[17] Factor returns are from Ken French's website.

on M_{EBITDA}, HML remains statistically significant after including these factors. Additionally, with regressions that include these additional factors result in economically large and highly reliable intercepts for the low M_{EBITDA} portfolios using both equal weights and value weights.

These results are qualitatively similar to those reported in Loughran and Wellman (2011) who also examine excess and abnormal returns to portfolios formed based on sorts of EBITDA multiples.[18] The results here are slightly stronger primarily due to the use of quarterly updates to EBITDA rather than annual updates and a more recent sample period. These results serve to confirm the premise that sourcing a value premium via EBITDA multiples is very effective over the sample period where I am considering the performance of private equity returns.

The buyout selection analysis in the previous section also identifies several additional characteristics that are reliably associated with public equities taken private by financial buyers. Consequently, I also rank stocks on their predicted likelihood for being "PE-Selected." Specifically, each year, an expanding dataset, including only information available at that point in time, is used to estimate the PE-selection model. Stocks are sorted on their fitted values, with the top quintile of stocks being viewed as the most similar to those being selected. Table 6 summarizes the excess and abnormal returns to five portfolios formed on sorts of the predicted PE-selection model.

The portfolio comprised of stocks most similar to PE-selected stocks (i.e. the top quintile of predicted PE-selection) have high excess returns, averaging 18% per year for the equal-weight portfolio and 16% for the value-weight portfolio, while portfolios comprised of the high multiple stocks (top quintile) have average excess returns of 6.8% and 7.8% for equal- and value-weight portfolios, respectively. Again, the Sharpe ratios share the same pattern as the excess returns. The equal-weighted portfolio of stocks most similar to the PE-selected stocks has a Sharpe ratio of 0.92, which is highly similar to the 0.89 Sharpe ratio of the low EBITDA multiple portfolio. The time series correlation between these two portfolios is 0.97.

[18] These monthly rebalanced strategies are similar in spirit to one described by Chingono and Rasmussen (2015).

In light of the success of M_{EBITDA} in producing a large spread in returns and abnormal returns, it is interesting to investigate the statistical power of this characteristic in explaining the cross section of stock returns in the presence of other characteristics known to be reliable explanatory variables. In particular, I am interested in regressions that include the book-to-market equity ratio and the net equity issuance a firm has done over the past three years, the latter of which Daniel and Titman (2006) have shown to be a highly reliable explanatory variable in cross sectional monthly return regressions. Table 7 reports the results from Fama-MacBeth (1973) regressions of monthly excess returns, R_t, on various stock characteristics known at the beginning of the period, X_{t-1}. There are 396 months with an average of 1,922 firms in each cross section. The independent variables include Beta, ln(ME), ln(BE/ME), ISS, and ln(M_{EBITDA}), where Beta is the estimated slope coefficient from a regression using the past 60 months of excess stock returns (requiring at least 36 valid returns) onto the excess return on the VW market portfolio with 2% Winsorisation, ME is the equity market capitalization, BE/ME is the book-to-market equity ratio, ISS is the three-year net equity issuance measure from Daniel and Titman (2006), and M_{EBITDA} is as defined earlier. The regressions confirm the findings of prior research that the premium earned for market beta is not statistically reliable and that size, book-to-market, and net issuance are associated with statistically reliable premia in this sample. The regressions also find that M_{EBITDA} is associated with a statistically large premia and that in regressions that include both BE/ME and M_{EBITDA}, only M_{EBITDA} is statistically distinguishable from zero. These regressions suggest that the EBITDA multiple is a powerful variable for sourcing a value premium in stocks during this sample period, and that several of the most reliable stock characteristics of the PE-selection strategy have tended to be associated with high subsequent excess returns.[19]

[19] Further evidence in support of this conclusion is provided from a regression of a M_{EBITDA} factor, proxied as a value-weight long-short portfolio that is long stocks in the bottom quintile of M_{EBITDA} and short stocks in the top quintile, on the Fama-French three factors. To be consistent with the construction of the Fama-French factors, this M_{EBITDA} factor includes financial firms, which are excluded from all other analyses presented in this paper. The intercept from this regression is statistically positive at 34 basis points per month (*t*-statistic = 2.2), while the

4. Evaluating PE Buyout Investments against a Replicating Strategy

The previous sections show that the public-to-private buyout firms tend to have distinct characteristics relative to those used to construct common factors and that portfolios of stocks with the characteristics most similar to those selected for buyouts experience excellent investment performance over the period 1986 to 2018. To this selection rule, the replicating strategy applies brokerage portfolio leverage to mimic the incremental leverage of leveraged buyout transactions and relies on long holding periods like PE investments. The replicating portfolio strategy will effectively have its total risk determined by the assumed initial incremental leverage, the assumed debt pay down rate, and the time series of quarterly cash flows in and out of the aggregate PE buyout fund sample.

4.1 Constructing the Replicating Strategy

At the end of each month, all publicly traded firms listed on CRSP are sorted by their predicted likelihood of being selected for a public buyout transaction, relying on information known at the time of portfolio formation. Firms in the top quintile of PE-selection likelihood are selected to be included in the "PE-Selected" replicating portfolio. Financial firms, identified with SIC codes 6000-6999 are excluded, as are stocks with prices below $5. Equal weights are used for newly added positions, but due to the long holding periods, the buy-and-hold strategy, and the time varying net flows into the portfolio, the overall portfolio weights will deviate from equal weights.

A constant initial leverage of 2.0x is applied for each new position. Axelson, Jenkinson, Strömberg, and Weisbach (2013) (AJSW) report that the typical publicly traded matched-firm has a market debt-to-value ratio of roughly 35% (Assets/Equity = 1.54), while this ratio is increased to nearly 70% (Assets/Equity = 3.33) as the result of a private equity buyout transaction. An outside investor holding the pre-LBO equity, but wanting the post-LBO levered

intercept from a regression of HML on the remaining two Fama-French factors and this M_{EBITDA} factor is statistically indistinguishable from zero, 15 basis points per month with a *t*-statistic = 1.3.

return would need to apply portfolio leverage, measured as portfolio assets divided by portfolio equity capital, of 2.17x = 3.33 / 1.54.

There is limited empirical evidence on the debt repayment behavior of PE buyouts. Kaplan (1989) finds that some early buyouts repaid large amounts of their debt quickly, while Kaplan (1991) finds little evidence of buyout leverage declining in a sample of LBOs from the early 1980s. Cohn, Mills, and Towery (2014) find that debt levels in buyouts are persistent, averaging essentially the same level 5-years after the initial transaction. I model the debt repayment through amortizing debt and repayment of the remaining associated debt balance upon liquidation of the position. AJSW report that 23.4% of the debt used in their sample of LBOs is amortizing with 68% having a maturity within 5 years. I assume that 25% of the portfolio leverage is amortizing with a 4-year maturity.[20] Leverage is applied to the portfolio through a brokerage margin account. Borrowed funds are assumed to pay the one-month U.S. Treasury bill yield plus an annual spread of 1%. Because of the long-term holding periods and the buy-and-hold strategy the realized portfolio leverage will vary over time.

The replicating portfolio, consisting of long positions of liquid securities, is marked-to-market value based on the day's closing prices of each underlying position. The equity capital is determined as the residual of the total portfolio asset value net of any borrowing. Under this market value based accounting system, the equity capital evolves through time by cumulating the daily profits and losses for the underlying securities based on daily changes in market values, net of interest expenses, and net of new contributions received and cash distributions. Additionally, I calculate a simple hold-to-maturity (HTM) portfolio equity value that measures positions at their purchase price until they are sold. Under this accounting scheme for book equity value, daily

[20] The 25% amortizing debt share (bank loan A) comes from Table 2 in AJSW. Cotter and Peck (2001) study a sample of 763 LBOs over the period 1984-1989. They report that the average maturity of the debt is 8.5 years, which is consistent with the overall debt maturities reported in AJSW, since the amortizing debt tends to be shorter maturity. AJSW also report that the use of amortizing debt *declined* prior to the financial crisis. It seems unlikely that the non-amortizing debt issued before the financial crisis was repaid early, given the financial challenges created by the crisis.

fluctuations in the prices of underlying investments do not impact the daily portfolio net asset value. Instead, the portfolio net asset value changes primarily due to contributions in and out of the fund and based on the cumulative profit and loss of positions at the time of liquidation.

4.2 Comparing Cash Flows and Reported Fund Values

In December 1994, the cumulative contributions, net of any distributions, for the year are summed across all PE buyout funds launched in 1994, and provides the initial equity investment into the replicating strategy. Two times (2x) this capital is invested in PE-selected stocks with the remaining funds being borrowed in a portfolio margin account. The amortization schedule for the portfolio debt is based on monthly payments and a four-year maturity for the amortizing portion of the debt, assumed to be 25% of the incremental leverage. Interest on the brokerage loan is accrued daily. To compare the replicating portfolio cash flows and fund values with those of the after-fee distributions of PE buyout funds, the replicating strategy pays a 1.0% annual management fee, paid monthly based on the total portfolio assets being managed.[21] At the end of each quarter, the quarterly distributions of the aggregate PE buyout sample are matched by selling positions, inclusive of the debt used to initiate the position, based on a first-in-first-out rule. When there are many positions of the same age, securities are ranked according to their realized return, and the best performing positions are sold first.

Figure 3 and Table 8 summarize this analysis and compare the cash flows and fund values to the Burgiss PE buyout fund sample. The first row of Figure 3 shows that the replicating portfolio is able to perfectly match the quarterly contributions and distributions for all PE buyout funds from the 1994 to 2010 vintages. The second row of Figure 3 plots the reported fund values,

[21] The long holding periods and rule-based selection strategy lead to lower turnover relative to most mutual fund portfolios. For some context on the likely management fees for executing the replicating strategy, the Vanguard Small-Cap Value Index Fund has an expense ratio under 0.2% per year when managed as a mutual fund and 0.07% when managed as an exchange-traded fund (ETF). The iShares Micro-Cap ETF, with over 1,300 holdings that are, on average, considerably smaller than those in the replicating portfolio, has an annual expense ratio of 0.6%. Since the management fee is assumed to be charged on assets, the levered strategies pay higher fees per dollar of equity capital (e.g. a 2x levered strategy pays 2.0% per year).

showing that along with matching the quarterly cash flows of the aggregate PE buyout sample, the replicating portfolio market value of equity ends the sample with a substantial cushion over the reported value of these funds, which have largely been liquidated.[22] The final row of Figure 3 plots the replicating portfolio debt-to-assets, showing an overall tendency to maintain leverage fairly close to the initial level of 2x, but increasing meaningfully during the 2008 financial crisis, when market values drop, before declining as these funds are liquidated towards the end of the sample.

Table 8 reports an annual summary of these cash flow data and the resulting IRRs for the aggregate PE buyouts and the replicating portfolio strategy. Following the norms of the literature, the annual net cash flows used to calculate the IRRs are the distributions minus contributions, assuming that any residual fund value is an additional distribution in the final period.[23] The PE buyout sample has an IRR of 11.4% and the replicating portfolio has an IRR of 14.8%.[24] The 11.4% return for the PE buyout sample is lower than the 13.2% average IRR across vintages from Table 1, as the vintage level IRRs are negatively correlated with vintage level committed capital, such that the relatively large inflows earn lower returns. In addition, a value multiple (TVPI), calculated as the sum of distributions plus the residual fund value all divided by the cumulative contributions, is reported.[25] The PE buyout sample has a TVPI of 1.65, while the replicating portfolio TVPI is 2.23.

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[22] Driessen, Lin, and Phalippou (2012) estimate that reported fund values for "aged" funds tend to overestimate the value of their remaining cash flows and eventual liquidating distribution by 30%. Jenkinson, Sousa, and Stucke (2013) find that valuations over the life of the fund tend to understate subsequent distributions by around 35% on average.

[23] Note that if the replicating portfolio was liquidated at market value at the end of the sample, the terminal book value would settle up to the market value and the IRRs would be the same, since all other cash flows are identical.

[24] Although these funds have largely liquidated, they have not completely liquidated. A sample that includes vintages 1994 to 2005, results in a PE buyout IRR of 11.9% with the cash flow matched replicating portfolio earning an IRR of 14.2%. Results are also similar based on a sample that includes all vintages from 1994 through 2017, with the PE buyout IRR equaling 12.0% and the replicating portfolio IRR equaling 15.0%.

[25] The TVPI does not account for the timing of cash flows, which may be helpful if cash flow timing is manipulated to increase IRR calculations.

Each of the two components of the PE buyout investment strategy implemented in the replicating portfolio contributes to this result. The table below summarizes the IRRs from replicating strategies that vary stock selection and leverage to match the time series of PE buyout cash flows that result in the IRR of 11.4% for actual funds.

IRRs for Portfolios matching the times series of PE Buyout Cash Flows

Benchmark	No Incremental Leverage	With 2x Incremental Leverage
All public stocks	7.2%	9.6%
PE-Selected stocks	11.6%	14.8%

A comparison to the benchmark that invests in all stocks with no incremental leverage is similar in spirit to the original PME analysis in Kaplan and Schoar (2005), and finds a meaningful outperformance of PE buyout funds in the Burgiss database. To this all public stock portfolio, adding a similar amount of incremental leverage of LBOs increases the benchmark return and alters inferences about PE buyouts outperforming public equities.[26] A PE-selected portfolio that matches the time series of cash flows with no incremental leverage is also able to keep pace with the after-fee cash flows of PE buyout funds. The PE-selected portfolio with similar incremental leverage to LBOs more than doubles the benchmark portfolio IRR relative to the original PME-style analysis, meaningfully altering inferences about PE buyout investment performance. The difference in after-fee returns between PE buyout funds and the replicating portfolio (similar types of stocks and similar incremental leverage) indicates that, direct investments in PE buyouts earn 3.4% per year lower returns over the period 1994 through 2017.

4.3 Risk Properties of the Replicating Portfolio

One of the striking properties of the replicating portfolio, illustrated in Figure 3, is the time series variation in the portfolio leverage. This occurs despite the fact that the strategy adds a

[26] It is useful to note that the replicating portfolio that invests in all publicly traded stocks (i.e. not focused on the PE-selected stocks) with 2x incremental leverage has its portfolio leverage increase substantially beyond what would be feasible according to standard portfolio margin account rules.

constant amount of incremental leverage for all newly initiated positions. Time varying leverage implies that portfolio risks are changing through time, and in a way that may be unexpected based on common intuition about PE buyout leverage.

When PE funds perform well, fund-level leverage tends to fall over time. Of course, when funds do not perform well, fund-level leverage can increase. In a portfolio context, periods of wide-spread poor fund-level performance can increase portfolio leverage. This is clearly seen in the replicating portfolio in 2008. Additionally, in the context of the asset class, there has been a generally steady inflow of capital to the strategy, which means that the average dollar invested in the asset class is allocated to a relatively new fund, and new funds have relatively high leverage. Figure 4 displays the share of total fund value contributed by newly launched funds, defined as funds within three years of their launch date. This net inflow dynamic keeps the leverage of the replicating portfolio high. This feature of the asset class risk profile is likely to be important for evaluation analyses that focus on specific vintages. Additionally, these results suggest that it may be important to allow for time varying systematic risks exposures across both time and funds when attempting to estimate risks directly from PE buyout investment data.

Table 9 presents a summary of the monthly returns of the replicating portfolio. A CAPM-style regression of monthly portfolio excess returns on the aggregate market excess return, including two lags of the market excess return, produces a beta (summed across the three exposures) of 1.6. This is fairly similar to the average portfolio leverage of the replicating portfolio, which averages 1.5x. The market betas for the replicating portfolio are estimated with a *t*-statistic in excess of 15. The replicating portfolio return has an annualized standard deviation of 27% and a minimum drawdown of -78%.

The risk estimates for the same portfolio strategy – same holdings, bought and sold at the same times at the same prices, with the same incremental leverage added at position initiation and repaid when the position is liquidated – using the returns based on hold-to-maturity accounting show considerably diminished evidence of risk. The sum of market betas across the three market exposures is 0.02 (*t*-statistic = 0.4), and the annualized standard deviation of returns is 7%, and a minimum drawdown of only -5%. In the spirit of Scholes and Williams (1977), I explore whether the inclusion of additional lagged market excess returns can improve the risk estimates for the HTM portfolio returns. Specifically, I run regressions with the monthly market excess returns and various lagged market excess returns, where the number of lags ranges from 1 to 60. I then sum the slope coefficients and search over the specifications to find the highest summed exposure. For the baseline specification, this is found in a specification with 14 lags, where the summed market exposure is 0.28 (t-statistic = 1.6). It is interesting to note that all of these risk estimates are closer to zero than to the estimates recovered from the well-marked portfolio. The key to the empirical challenge in recovering accurate estimates from sluggishly updated portfolios with long holding periods in this sample is that the large drawdowns of 2001 and 2008, completely revert within the holding period. If the portfolios are not marked while down, and then asset values recover, there will be no evidence of the asset value ever being down. Adding lagged market returns does not address this feature of the data. The average holding period in the baseline replicating portfolio (2x portfolio leverage with 25% of the debt amortizing) is 3.9 years.

It is also useful to compare the common factor exposures of the replicating portfolio and the ACGP (2018) PE Buyout Index. For context, I consider two versions of the replicating portfolio, the one that adds positions with 2x leverage and one that uses no incremental leverage. Quarterly portfolio excess return regressions on the Fama and French (1993) three factor model and the Fama and French (2015) five factor model over the period 1994 to 2014, are summarized in Table 10. The mean returns to the ACGP index and the replicating portfolio with no incremental leverage (1x) are roughly similar, but their factor exposures are quite different. Based on the FF three factor model regressions, the ACGP index has a market exposure of 1.2 (*t*-statistic = 12.1), a coefficient on SMB of 0.4 (*t*-statistic = 2.3), and an HML coefficient of 0 (*t*-statistic = 0.02), while the 1x replicating portfolio has a market exposure of 0.8 (*t*-statistic = 17.7), and SMB coefficient of 0.9 (*t*-statistic = 9.9), and an HML coefficient of 0.5 (*t*-statistic = 8.1). The replicating portfolio that adds incremental leverage (2x) has substantially higher factor exposures, roughly 60% larger than the replicating portfolio with no incremental leverage (1x). Regressions on the FF five factor model find similar results highlighting the economically large differences in SMB and HML exposures between the ACGP index and the replicating strategies that mimic the asset selection of public PE buyouts.

The selection analysis finds that size and value characteristics are the most important determinants of public PE buyouts, and the portfolios formed on these characteristics have economically and statistically large exposures to related common factors, while the ACGP index does not. The ACGP (2018) PE Buyout Index is a proxy for the whole of PE buyouts, representing the combined contributions of all of the elements of the investment strategy, while the replicating portfolios are only mimicking the asset selection (1x) and the joint contribution of asset selection and incremental leverage (2x).[27] One interpretation is that PE ownership alters the actual exposures to common factors. For example, active management by PE funds could make these firms more like large publicly traded stocks and eliminate the value-growth dimension of returns. It seems unlikely that the private transactions would be the source of these hedges, as these investments would need SMB exposures equivalent to the largest quintile of publicly traded stocks and the lowest quintile of HML exposures based on the portfolio sorts in Fama and French (1993), while actually being relatively small. It is also possible that the factor model exposures have been underestimated because the PE buyout fund cash flows do not accurately reveal covariances with factors.

Overall, the feasible replicating portfolio designed to mimic the joint contributions of the asset selection and incremental leverage of LBOs generates substantially higher returns than direct investments in PE buyout funds after fees. Additionally, the replicating portfolio has substantially higher systematic risks than are typically assumed or estimated for PE buyout performance evaluation. The results are quantitatively similar based on matching the aggregate

[27] By matching the aggregate cash flows of the PE buyout fund sample, the replicating portfolios are also effectively mimicking the long holding periods of PE buyout investments.

cash flows associated with PE vintages 1994 through 2017. The robustness of these results is explored further in the subsequent section.

4.4 Effect of Initial Incremental Leverage

Consider fifteen versions of the replicating strategy that all rely on the same asset selection strategy, but vary the initial amount of incremental leverage. Specifically, the initial position leverage ranges from 1x to 2.5x, with 0.1 increments. Recall that the baseline specification assumes 2x incremental leverage, while AJSW report that 2.2x incremental leverage is typical. Table 11 summarizes the risk and return properties of these portfolios. Panel A reports results based on the assumption that 25% of the portfolio debt is amortizing over 4 years and Panel B reports results based on the assumption that none of the portfolio debt is amortizing, being repaid in full when the associated position is liquidated. Each of these portfolios perfectly match the aggregate net cash flows of the PE buyout funds from vintages 1994 to 2010, in the Burgiss dataset over the period 1994 to 2017, but result in different terminal surplus market values of the replicating portfolio.[28] The fact that 100% of the time series variation in aggregate cash flows is explained by fifteen strategies that clearly have different systematic risk exposures, highlights that the aggregate PE buyout cash flow data cannot reliably identify which one of these strategies describes their time series risk properties most appropriately.

This exercise illustrates some interesting performance properties of the replicating strategy relevant for interpreting the attractiveness of PE buyout investments. All of the replicating portfolio IRRs exceed the PE buyout IRR of 11.4% calculated over this period from the Burgiss dataset. Similarly, all of the replicating portfolio PMEs exceed the PE buyout PME of 1.17,[29] and all of the replicating portfolio TVPIs exceed the PE buyout TVPI of 1.65. This

[28] The surplus (or shortfall) in the terminal value as a free parameter is conceptually similar to the regression intercept in a factor model in that they both reflect the mean of the unexplained component of returns.

[29] The PME is calculated as the ratio of the present value of the aggregate quarterly distributions (including the terminal value as a liquidating distribution) to the present value of the aggregate quarterly contributions. The present

confirms the basic finding – mimicking the asset selection of public PE buyouts generates higher after-fee returns than direct investments in PE buyouts – is not sensitive to the amount of incremental leverage or the rate of debt repayment. Of course, the amount of incremental leverage in the replicating portfolio does matter for risks and the realized mean return. All of the return performance measures – IRRs, PMEs, and TVPIs – for the replicating strategy tend to be increasing in the amount of incremental leverage used, consistent with the notion that the risk-return properties of the asset selection strategy are attractive relative to the value-weight market portfolio. In addition, the average outstanding portfolio leverage and the market betas tend to be increasing in the amount of incremental leverage, including when a substantial portion of the portfolio debt is amortizing.

5. Discussion

5.1 Interpreting the Replicating Strategy Analysis

The key result is that the asset selection identified from the public-to-private transactions has been excellent historically. The selection analysis of public buyouts finds that characteristics beyond those used to construct common factors are important. Portfolios managed to match these characteristics earn positive risk-adjusted returns after controlling for common factors. This suggests that PE buyout managers may be skilled at asset selection. There is no direct evidence that their individual stock selection improves returns over their style-tilts, but these managers were early to value investing, using a selection strategy that performed better than other commonly available versions, and in the process, improved investor access to these difficult to invest in exposures. To the extent that PE fund managers are skilled at asset selection, they may optimally deviate from their historical rules in the future. Looking back, an allocator is almost surely pleased to have allocated to PE buyouts.

values are calculated based on the realized value-weight market return (see Kaplan and Schoar (2005) and Sorensen and Jagannathan (2015)).

This main result is fairly robust. In order for the differences between private and public transactions to nullify the attractiveness of asset selection, private transactions would need to contribute negative risk-adjusted returns (i.e. relatively high risks and relatively low mean returns). If private transactions have lower risk than public buyouts, then the risk estimates from the replicating portfolio are too high, but the inference that asset selection is important survives.

The PE buyout investment data do not allow me to accurately determine how much incremental leverage is appropriate. However, it is clear that adding a plausible amount of incremental leverage to a successful asset selection strategy increases mean returns and exposures to common factors in this sample, including when a substantial portion of this debt is amortizing over four years. The brokerage leverage used in the replicating strategy will not manufacture the incentive, tax effects, and costs of financial distress that increased leverage at the firm-level will produce. Any net benefits accrue to PE buyouts, but not to the replicating portfolio.

The replicating portfolio is essentially used as a simple empirical model of PE buyout investments to illustrate some comparative statics. The model is easily calibrated to match the aggregate quarterly cash flows of the PE buyout fund sample with an asset selection rule identified from the public-to-private transactions and initial incremental leverage equal to that of the average LBO. This analysis suggests that the leverage embedded in the asset class is likely to be time varying and to remain relatively high in periods of large inflows to the asset class. The time series patterns in portfolio leverage are robust to different initial leverage targets, although the average level cannot be well identified. The time series patterns are economically plausible, but perhaps not fully anticipated.

5.2 Contributions of the Un-Modeled Components of the PE Buyout Investment Process

By focusing on the asset selection and incremental leverage of LBOs, the replicating strategy leaves many elements of the actual PE investment process un-modeled. The evidence suggests that the un-modeled components of the PE buyout investment process reduce mean returns. Because the total risks of PE buyouts are not easily observed, the net contribution of the un-modeled risks cannot be easily assessed. It is interesting to consider how the un-modeled components may affect these interpretations.

A large portion of the un-modeled components of PE buyout investments require PE ownership. In principle, these may add or reduce risks relative to the modeled contributions of asset selection and incremental leverage. PE ownership may reduce systematic risks, as the operating adjustments, the financing agreements, and the potential for asset selection to rely on unobserved risk differences combine to effectively create a systematic risk hedge. It is also possible that PE ownership contributes additional systematic risks for the allocator. This argument would lean heavily on the illiquidity of PE buyouts being systematic, the uncertainty over the investment properties potentially leading to some systematic adverse selection, and the costs of financial distress being systematic (e.g. Almedia and Philippon (2007)). Teasing out these possibilities is beyond the scope of this paper, but the potential contributions of some key un-modeled components of the PE buyout investment process are discussed in this section.

First, a frequently stated objective of PE buyout ownership is to improve operating performance. It is possible that these activities also reduce systematic risks, but this has not been directly documented. What has been documented is that firms operate more productively with PE ownership (e.g. Kaplan (1989), Davis, Haltiwanger, Handley, Jarmin, Lerner, and Miranda (2014), Bloom, Sadun, and van Reenen (2015), and Bernstein and Sheen (2016)). For example, Davis, et al., report, “In short, buyouts improve productivity mainly through the directed reallocation of resources across units within target firms. These TFP results and our results on worker earnings imply that private equity buyouts materially improve operating margins at target firms.” Note that this does not imply that investors benefit from these outcomes. Generating these outcomes is likely to be costly in a few ways, including acquisition premia, transaction and implementation costs that are often charged to investors (Metrick and Yasuda (2010)), and long holding periods.[30] For example, a 10% acquisition premium requires a 10% increase in firm value just to get back to flat. The general point is that the PE buyout investment process is costly to implement. There is little direct evidence on the value consequences of these operating improvements for investors, which require accounting for these costs and any risk adjustments that arise from altering operating decisions. Matching the aggregate cash flows with the replicating strategy can be done relatively economically compared to executing the specific actual transactions that require negotiations, fund raising, debt raising, and implementing actual operating adjustments.

Second, PE buyout investments are surely less liquid than the replicating portfolio comprised of publicly traded stocks and broker-supplied portfolio leverage. The nature of the illiquidity may be systematic, such that transaction prices may be especially low in poor market conditions (Shleifer and Vishny (1992, 1997)), therefore requiring an additional illiquidity premium. This would magnify the underperformance of PE buyouts relative to the replicating portfolio since the benchmark comprised of publicly traded stocks is not earning an illiquidity premium. The results in Boyer, Nadauld, Vorkink, and Weisbach (2018) can be viewed as being consistent with the notion that the secondary market prices of PE buyout investments are lower in periods of poor market conditions.

Additionally, the illiquidity is almost surely contributing to the empirical challenges of estimating PE buyout risk properties directly from the return and cash flow data. Because many of the activities associated with PE ownership require long holding periods to implement, the distortion in measured risks of illiquid assets can be magnified over sample periods where large stock market drawdowns tend to recover relatively quickly, as experienced in the US since 1980. For example, the hold-to-maturity accounting rule applied to the replicating portfolio produced

[30] Long holding periods are necessary for implementing operating improvements, but are costly for a value strategy, as the value premium decays with holding periods beyond around one year. It is also useful to interpret the value investing risk premium as multiple expansion in the language of PE investing. On average, the positions being held passively in the replicating portfolio experience multiple expansion, demonstrating that operating improvements are not required to achieve this feature of investment performance.

risk estimates that were closer to zero than they were to the risk estimates of the well-marked replicating portfolio, highlighting the sensitivity of risk estimates to sluggish reporting of asset values. The analysis also suggests that the time series variation in aggregate PE buyout cash flows is unable to identify the better match between a replicating portfolio with zero incremental leverage and one that adds substantial incremental leverage. Uncertainty over the actual risk properties could adversely select some allocators into a poorly understood asset class.

A third direct consequence of PE ownership is economically large management fees relative to the 1% fee assumed for the replicating portfolio assets (e.g. Metrick and Yasuda (2010) and Phalippou, Rauch, and Umber (2018)). The California pension plan known as CalPERS, reports that its private equity returns were 12.3% annually in the 20 years ending June 30, 2015, but they would have been 19.3% without fees and costs[31], implying an all-in annual fee of 7% (note this is measured as a percentage of equity). To explore how PE buyout fees can affect inferences, I apply the replicating strategy to estimates of aggregate pre-fee buyout fund cash flows to get a sense for whether the replicating strategy can keep pace with both the after-fee distributions to LPs and pay out the estimated dollar fees to fund managers (see Appendix A for details of the fund-level fee calculations). Since this exercise is designed to compare pre-fee cash flows, I do not also pay the 1% management fee on the replicating portfolio assets. I adjust the quarterly LP cash flows based on simplified assumptions about aggregate fees (fixed management fees and carry paid to the fund manager, or general partner (GP)) to estimate the pre-fee fund cash flows and have the replicating strategy match the cash flows as before.

Table 12 reports the results from an analysis where the replicating strategy is used to invest the aggregate fund contributions and to match the combined distributions paid to both the LPs and those estimated to be distributed to the GPs. Panel A reports results with fixed fees only and Panel B reports results with both fixed fees and carry to investigate the relative contributions

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[31] The Wall Street Journal, "Calpers is Sick of Paying too much for Private Equity," https://www.wsj.com/articles/calpers-is-sick-of-paying-too-much-for-private-equity-1492254008.

to risk and returns for each fee type. These analyses are comparable to Panel A in Table 11, where various initial incremental leverage is applied to the mimicking asset selection strategy with 25% of the portfolio debt being amortizing over four years. This analysis finds that with plausible amounts of initial incremental leverage the replicating strategy tends to be able to keep pace with the estimated pre-fee cash flows, but just barely. The estimated after-fee PE buyout cash flows have an IRR of 11.4%. After accounting for the estimated aggregate dollar fees (fixed management fees plus carry), the estimated pre-fee PE buyout cash flows have an IRR of 15.8%, which implies a fee of 4.4%. The baseline replicating strategy with 2x initial position leverage, matching the estimated quarterly pre-fee fund cash flows, ends the sample with a market value slightly higher than the residual aggregate PE fund value, resulting in an IRR of 16.5%.[32] However, with slightly less initial leverage, the replicating strategy ends the sample with a lower market value, highlighting that this is essentially establishing the break-even performance level between estimated pre-fee returns of PE buyouts and the replicating strategy.

Panel C provides a summary comparison of the 2x levered replicating strategy with the estimated pre-fee PE buyout cash flows for fund vintages 1994-2010 and vintages 1994-2005, which have nearly fully liquidated to verify the robustness of the result. The fixed fees are essentially guaranteed to the GP, as they are primarily derived from the committed capital over the first 5-years and the contractually specified fixed percentage. The fixed fees make up a substantial portion of the total estimated aggregate fees, averaging 2.7% per year. The estimated carry adds 1.7% annually, on average for the 1994-2010 fund vintages and 2.0% for the 1994-2005 vintages. The average portfolio leverage and the market betas are not meaningfully different based on whether the fixed fee only or the fixed fee plus carry cash flows are considered, consistent with this analysis not being able to identify a reliable risk-sharing role of the carry component of fees.

[32] Note that because the replicating portfolio is making larger distributions each quarter, its IRR is higher than when only matching the distributions to LPs, suggesting that the reinvested capital earns lower returns later in the sample period.

To the extent that actual management fees are larger than estimated, the replicating portfolio will no longer be able to keep pace with the pre-fee cash flows and the inference would be that the additional activities of PE buyout funds beyond asset selection and incremental leverage contribute positively to pre-fee returns. It is important to note that this exercise relies on estimating pre-fee fund performance without access to all of the data necessary to ensure accurate estimates for the level of fees or for the precise timing of these fee, so these estimates are best viewed as demonstrating how economically large the combined contributions of asset selection and incremental leverage to mean returns are in this sample.

6. Conclusion

The asset selection rule identified from a sample of public-to-private transactions experiences highly attractive historical investment performance since 1986. Even with zero incremental leverage, the mean return associated with this asset selection rule exceeds the after-fee returns to PE buyouts. Adding a similar amount of incremental leverage as LBOs to a replicating strategy that matches the cash flows in and out of the asset class offers some interesting insights into the likely behavior of the leverage embedded in the asset class.

An important theme emphasized by the analysis is that because the investments are illiquid with infrequent and irregularly timed cash flows the investment data may not satisfy the data accuracy requirements of standard risk adjustment methods. The conceptual exercise of unbundling the PE buyout investment process is demonstrated to be useful in this setting. It highlights that asset selection occurs before the incremental leverage of the LBO is applied, and therefore if successful, its total contribution can be economically large. This insight can be missed in a factor model, which does not separately identify contributions from asset selection and incremental leverage, may underestimate the combined contributions if the data are not sufficiently revealing of covariances with the considered common factors, and may exclude relevant factors.

These results can be related to the literature studying venture capital (VC) investment performance, which is often focused on measuring how “screening” and “monitoring” are linked to outcomes (e.g. Kaplan and Strömberg (2001) and Sorensen (2007)). The first stage of the PE buyout investment process, asset selection, is similar to what is referred to as screening in the VC investment performance literature, and it appears that both are important contributors to overall performance. In contrast to the conclusions from the VC literature, where the VC fund manager’s ability to identify attractive investments is viewed to belong to individual partners’ ability, the analysis in this paper demonstrates that buyout fund managers’ selection strategy can be relatively easily and cheaply mimicked.

The economically large fees and the significant inflows to the asset class are consistent with a belief among allocators that the components of PE buyout investment performance that require PE ownership are responsible for the attractive historical investment performance. The analysis in this paper demonstrates that components of the strategy that one can execute on their own earn higher mean returns than direct investments in PE buyouts. The discussion highlights that research on the outcomes associated with PE ownership tend to focus on identifying operating improvements relative to untreated similar firms rather than quantifying the likely value consequences that arise from the altered cash flows and systematic risks, net of all associated costs. Thus, there is little direct evidence that the activities that require PE ownership are a reliable source of value creation for limited partners.

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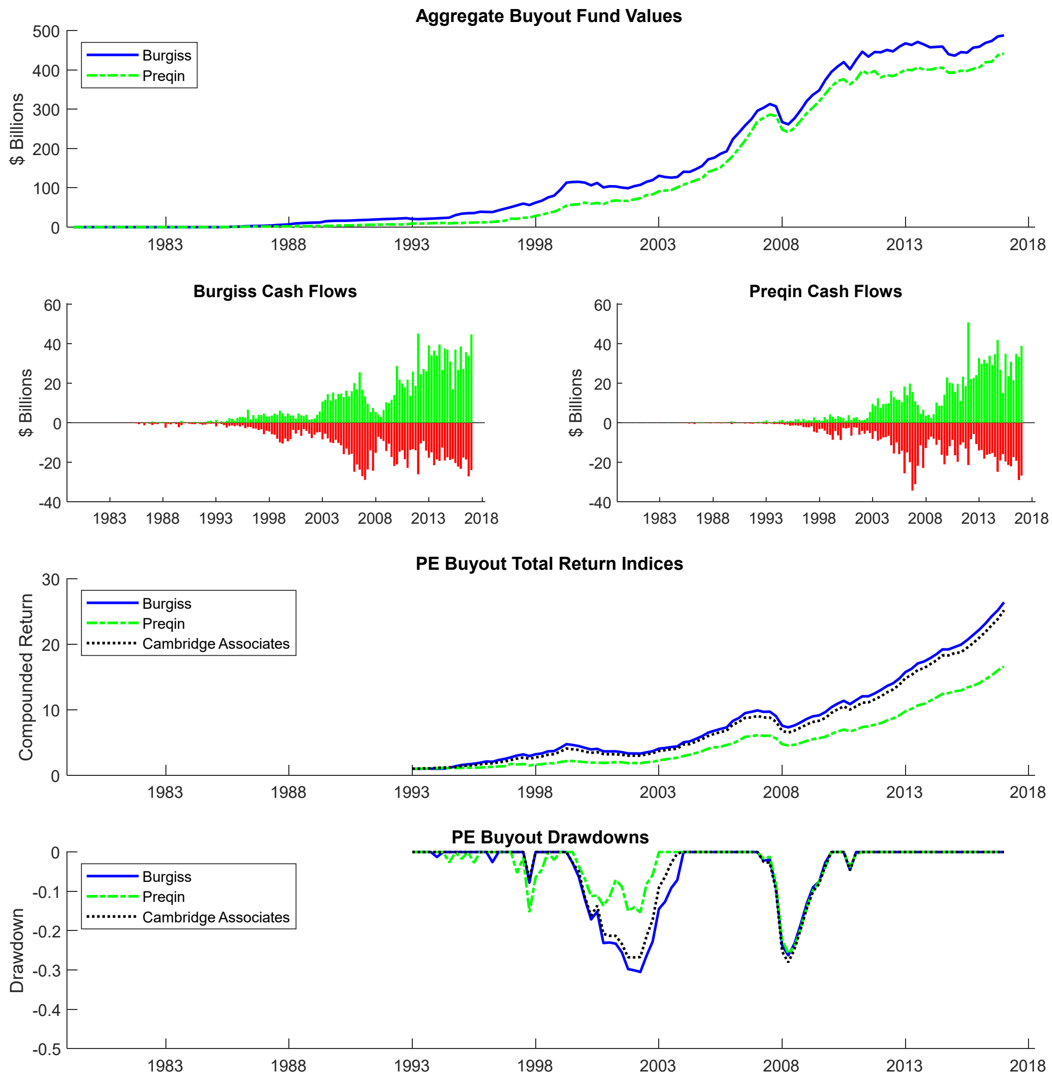

Figure 1. Private Equity Buyout Investment Data Summary (1980 – 2017).
This figure compares quarterly investment data for private equity (PE) buyout funds available from three datasets. The top panel plots the aggregate quarterly reported fund values for PE buyout funds in the Burgiss and Preqin datasets. The second row plots the aggregate after-fee distributions (green) and contributions (red) from the Burgiss dataset on the left and the Preqin dataset on the right. The third panel plots the after-fee total return indices, calculated from the Burgiss and Preqin fund value and cash flow data and as reported by Cambridge Associates for US PE buyout funds, over the period 1994-2017. The fourth panel plots the corresponding quarterly drawdown series for the PE total return indices. Drawdown is measured as the percentage change in the current index level relative to its prior maximum.

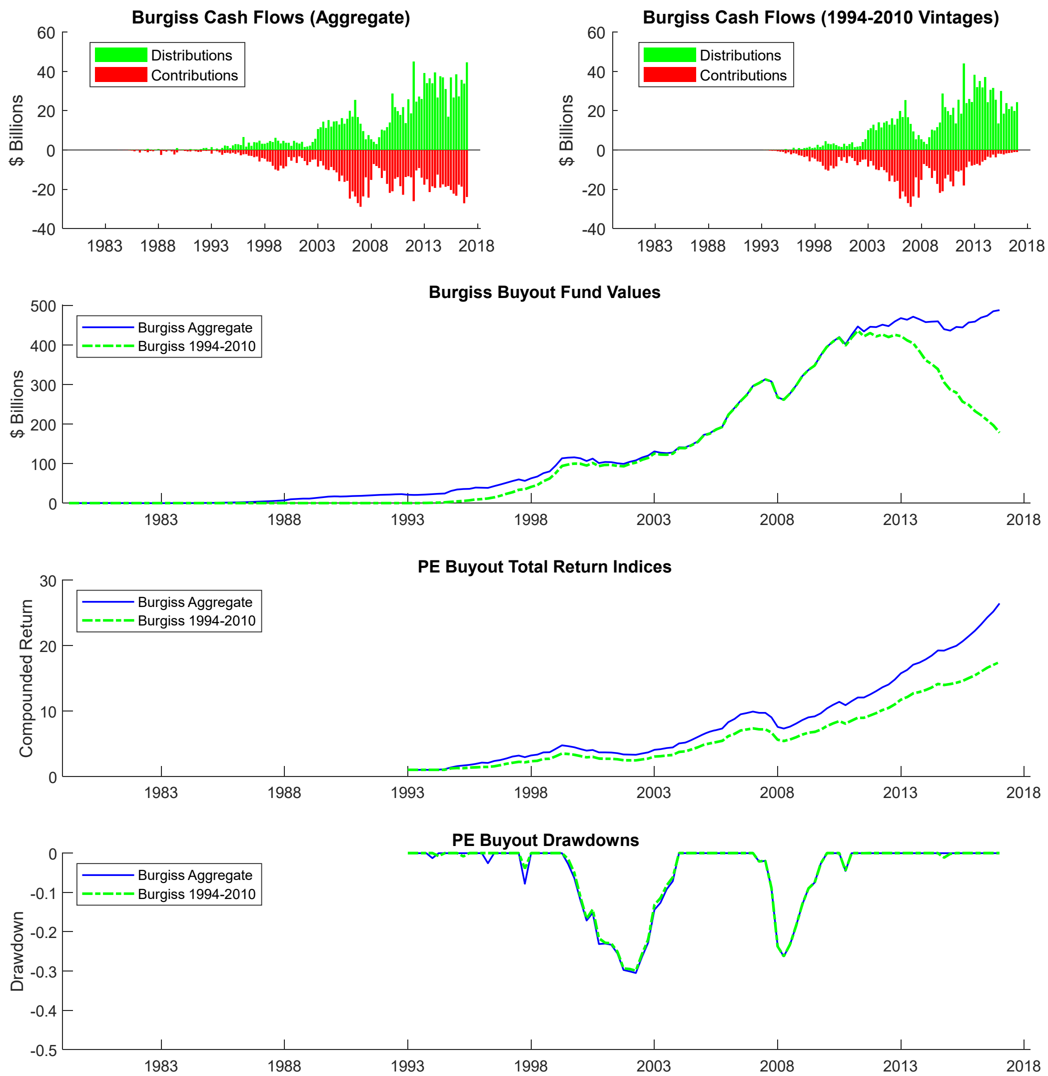

Figure 2. Burgiss Private Equity Buyout Investment Data (1980 – 2017).
This figure compares quarterly investment data for the full sample of private equity (PE) buyout funds from the Burgiss dataset to the subset of these funds that have a launch date between 1994 and 2010. All cash flows and reported fund values extend through 2017. The top panels plot the aggregate after-fee distributions (green) and contributions (red) from the full sample on the left and for the subset of funds with launch dates beginning in 1994 through the end of 2010 on the right. The second row plots the aggregate quarterly reported fund values. The third panel plots the after-fee total return indices, calculated from the fund value and cash flow data. The fourth panel plots the corresponding quarterly drawdown series for the PE total return indices. Drawdown is measured as the percentage change in the current index level relative to its prior maximum.

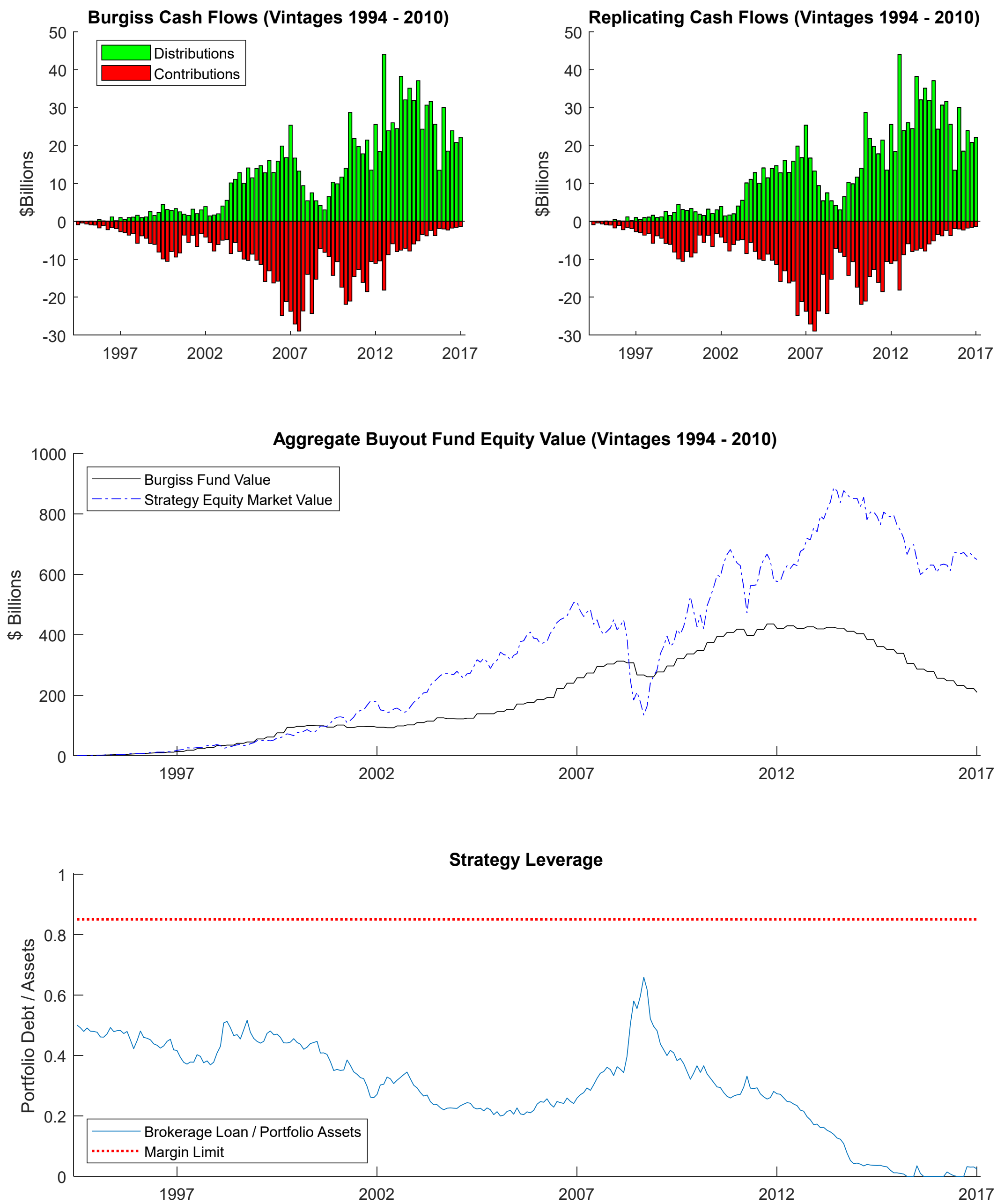

Figure 3. Replicating the Asset Selection and Incremental Leverage of Private Equity Buyout Cash Flows.
This figure compares quarterly cash flows and fund values for the sample of private equity (PE) buyout funds launched between 1994 and 2010 from the Burgiss dataset with the cash flows generated from a replicating strategy that mimics the selection-rule and incremental leverage used in leveraged buyouts. The replicating portfolio pays a management fee of 1% per year on portfolio assets (i.e. 2% on equity levered 2x). All cash flows and reported fund values extend through 2017. The top panels plot the aggregate after-fee distributions (green) and contributions (red) from the Burgiss PE buyout funds on the left and the replicating portfolio on the right. The second row plots the aggregate quarterly reported fund values. For the replicating portfolio, the book value is based on hold-to-maturity accounting, while the market value is based on the end-of-quarter market values of portfolio stocks less the debt balance. The third panel plots the portfolio debt to market value and a portfolio leverage limit.

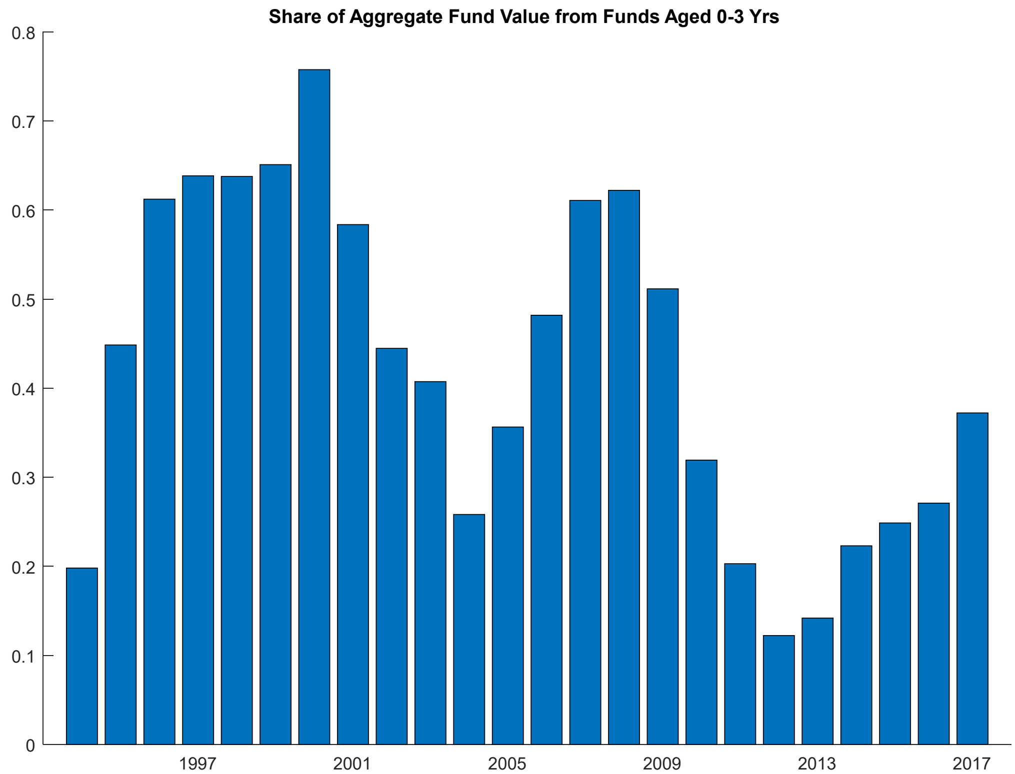

Figure 4. Share of Aggregate PE Buyout Fund Value from Funds Aged 0-3 Years.
This figure displays the share of aggregate private equity buyout fund values accounted for by young funds, defined as those within three years of their launch date. Fund values and shares are measured at the end of each year from 1994 to 2017, from the Preqin private equity buyout database.

Table 1
Private Equity Buyout Return Summary (Vintages 1994-2010)

This table reports summary statistics for private equity buyout fund returns from the Preqin and Burgiss databases for all funds launched between 1994 and 2010. The cash flow data for these funds begin in 1994 and extend through 2017. The vintage corresponds to the fund launch date. The sum of all commitments and the sum of the total actual contributions for all funds within a vintage are reported in billions of dollars ($B). The internal rate of return (IRR) is calculated for a vintage based on the aggregate net cash flows from the perspective of the end investor, measured as the after-fee quarterly distributions minus the quarterly contributions, assuming that any remaining reported fund value is distributed at the end of the sample in June 2017.

	Preqin				Burgiss			
Vintage	Number of Funds	Commitments $B	Sum of Contributions ($B)	IRR	Number of Funds	Commitments $B	Sum of Contributions ($B)	IRR
1994	13	5.9	6.4	0.190	19	8.7	8.5	0.193
1995	11	8.4	8.3	0.102	28	17.4	17.4	0.117
1996	16	6.2	6.0	0.094	18	4.9	5.0	0.145
1997	19	21.4	22.4	0.109	29	25.4	26.6	0.078
1998	29	25.8	25.3	0.031	48	40.8	40.2	0.052
1999	26	27.5	27.0	0.079	34	33.2	33.4	0.074
2000	30	51.1	51.9	0.164	48	53.8	54.0	0.148
2001	15	16.5	18.1	0.242	32	24.5	24.7	0.209
2002	18	12.8	14.6	0.178	24	21.5	23.1	0.167
2003	16	30.6	35.1	0.212	24	21.5	23.1	0.193
2004	24	25.6	26.0	0.128	44	39.0	39.4	0.134
2005	38	54.9	52.6	0.104	66	58.0	59.5	0.099
2006	51	156.0	164.2	0.069	76	129.7	134.5	0.071
2007	42	106.0	109.9	0.094	74	127.3	133.5	0.106
2008	38	87.6	89.7	0.147	70	105.8	117.5	0.130
2009	16	20.1	19.6	0.185	26	20.7	20.5	0.185
2010	29	23.8	24.6	0.148	34	38.9	40.9	0.143
Average	25.4	40.0	41.3	0.134	40.8	45.4	47.2	0.132

Table 2
Return Summary for Private Equity Buyout Portfolios (1996-2014)

This table summarizes returns for various private equity (PE) buyout portfolios. The quarterly returns are from the period 1996 through 2014. The Burgiss and Preqin return indices are calculated from aggregate quarterly contributions, distributions, and reported fund values for PE buyout funds from the respective datasets. All cash distributions are net-of-fees. The Cambridge Associates private equity index is a quarterly time series of net-of-fee returns calculated in a similar way by Cambridge Associates. The market beta and CAPM alpha are calculated from quarterly excess returns regressed on the excess returns of the value-weight stock market and three lags of the market excess return. The CAPM Alpha is annualized. The Beta is the sum of the four market coefficients. The ACGP PE Buyout Index is from Ang, Chen, Goetzmann, and Phalippou (2018), constructed from a combination of common factors and a latent PE buyout factor model. This table reprints the estimated coefficients and standard errors reported in their Table 3, Panel C.

	Burgiss	Preqin	Cambridge Assoc.	ACGP (2018) PE Buyout Index	VW Public Market
Mean	0.144	0.139	0.147	0.171	0.105
Geometric Mean	0.137	0.131	0.141	0.131	0.087
Standard Deviation	0.115	0.119	0.111	0.268	0.180
CAPM Alpha	0.046	0.053	0.051	0.043	0.000
Std error	0.02	0.02	0.02	0.01	na
Beta	0.87	0.72	0.85	1.25	1.00
Std error	0.08	0.12	0.08	0.25	na
R2	0.63	0.37	0.62	na	1.00
N	76	76	76	76	76

Table 3
Summary of Public-to-Private Sample

This table reports the number of observations from the two datasets of public-to-private transactions by year and the number of unique observations that are used as the sample in this paper. The Capital IQ dataset contains completed merger and acquisition transactions of publicly traded firms with the transaction identified as "going private," "leveraged buyout," or "buyout" announced between January 1984 and December 2017. The set of buyers from these transactions are defined as "private equity firms," and are used to help identify additional buyout transactions from a second set of transactions from the Thompson-Reuters merger and acquisition database. I first require that the acquirer is identified as a financial buyer and the transaction results in at least 80% ownership of a publicly traded target firm over the period 1984 to 2017. Additionally, I require that the "deal synopsis" mentions "going private," or "leveraged buy out," or "buyout," or that at least one of the acquiring parties is a "private equity firm."

Year	Thompson	Capital IQ	Unique
1984	12	5	13
1985	11	2	12
1986	10	1	10
1987	15	2	16
1988	26	10	32
1989	18	12	27
1990	4	4	6
1991	4	3	7
1992	1	3	4
1993	2	4	5
1994	2	3	4
1995	4	4	5
1996	11	14	18
1997	15	17	23
1998	13	18	23
1999	28	33	41
2000	28	35	40
2001	12	27	29
2002	13	14	17
2003	22	23	26
2004	17	20	26
2005	20	22	25
2006	34	35	43
2007	37	39	45
2008	15	16	19
2009	12	13	17
2010	14	29	31
2011	19	10	22
2012	14	0	14
2013	18	1	19
2014	7	1	8
2015	6	1	7
2016	19	0	19
2017	14	0	14
Total	497	421	667

Table 4
Regressions Explaining the Selection of Public Equities taken Private (1984-2017)

This table reports the results of Fama-MacBeth (1973) regressions of a binary variable indicating a public equity was taken private on various lagged firm characteristics. Panel A reports results from ordinary least squares (OLS) regressions with all coefficients multiplied by 100. Panel B reports results from Logistic regressions. The EBITDA multiple for each firm is calculated as the ratio of firm enterprise value to earnings before interest, taxes, depreciation, and amortization. The firm enterprise value is the sum of long term debt and the market value of equity less cash and marketable securities. Equity market values are assumed to be reported with no delay, while accounting information (long term debt, cash, and EBITDA) are assumed to be reported with a three month delay. Beta is the estimated slope coefficient from a regression using the past 60 months of excess returns (requiring at least 36 valid returns) with a 2% Winsorisation, ME is the market capitalization, BE/ME is the book-to-market equity ratio, ISS is the three-year net equity issuance measure from Daniel and Titman (2006). Profit is the ratio of annual EBITDA to annual Sales. The leverage ratio, D/V, is calculated by dividing long-term debt by the sum of long-term debt and ME. The time period is 1984 to 2017. All specifications are based on the time series of annual cross sectional regressions, where reported coefficients are calculated as the time series mean coefficient and standard errors of the mean are used to calculate *t*-statistics, which are reported in parentheses. The OLS R-squared is denoted R^2 and the Log-likelihood ratio is denoted LLR. There are 34 annual cross sections, each with an average of 1916 observations.

Panel A: Fama-MacBeth OLS Regressions

Reg. Num.	Beta	ln(ME)	ln(Sales)	ln(BE/ME)	ISS	ln(M_{EBITDA})	ln(Profit)	D/V	R^2
1	-0.19 (-4.47)								0.001
2		-0.22 (-6.96)							0.003
3			-0.14 (-4.88)						0.001
4				0.29 (3.11)					0.002
5					-0.48 (-3.38)				0.001
6						-0.47 (-5.28)			0.002
7							-1.68 (-6.10)		0.001
9								0.79 (2.48)	0.001
10	-0.10 (-2.02)	-0.21 (-7.71)		-0.17 (-1.64)	-0.42 (-2.75)	-0.39 (-3.88)	-1.13 (-3.53)	0.62 (1.98)	0.005
11	-0.09 (-1.96)		-0.20 (-7.17)	-0.12 (-1.15)	-0.42 (-2.73)	-0.54 (-5.07)	-2.14 (-6.93)	0.97 (3.04)	0.004
12	-0.08 (-1.64)	-0.19 (-6.48)			-0.43 (-2.79)	-0.32 (-3.76)	-0.99 (-3.46)	0.47 (1.52)	0.004

Table 4 (*continued*)

Panel B: Fama-MacBeth Logit Regressions

Reg. Num.	Beta	ln(ME)	ln(Sales)	ln(BE/ME)	ISS	ln(M_{EBITDA})	ln(Profit)	D/V	LLR
1	-0.30 (-4.10)								0.007
2		-0.29 (-7.44)							0.034
3			-0.17 (-5.92)						0.014
4				0.36 (3.81)					0.022
5					-0.65 (-3.37)				0.012
6						-0.57 (-6.29)			0.019
7							-4.21 (-3.89)		0.018
9								0.39 (1.23)	0.012
10	-0.21 (-2.56)	-0.21 (-6.28)		-0.12 (-1.34)	-0.73 (-2.59)	-0.44 (-4.77)	-3.42 (-3.24)	0.08 (0.27)	0.092
11	-0.20 (-2.40)		-0.23 (-6.34)	-0.10 (-1.00)	-0.74 (-2.56)	-0.62 (-6.71)	-5.00 (-3.80)	0.50 (1.58)	0.093
12	-0.19 (-2.45)	-0.20 (-5.79)			-0.71 (-2.88)	-0.37 (-4.31)	-3.29 (-3.08)	0.02 (0.07)	0.082

Table 5
Average excess and abnormal returns for portfolios formed on EBITDA multiples (1986-2018)

Each month from January 1986 to December 2018, five portfolios are formed from sorts of EBITDA multiples for CRSP stocks. Panel A reports results for equal-weight portfolios and Panel B reports results for value-weight portfolios. Returns are measured in excess of the one-month Treasury bill rate. The EBITDA multiple for each firm is calculated as the ratio of firm enterprise value to earnings before interest, taxes, depreciation, and amortization. The firm enterprise value is the sum of long term debt and the market value of equity less cash and marketable securities. Equity market values are assumed to be reported with no delay, while accounting information (long term debt, cash, and EBITDA) are assumed to be reported with a three month delay. The annualized excess return is calculated as the average monthly excess return times 12. Annualized standard deviation is calculated as the monthly standard deviation times the square root of 12. The Sharpe ratio is calculated by dividing the annualized excess return by the annualized standard deviation. The CAPM alpha is the intercept (times 100) from a time series regression of the monthly portfolio excess return on the CRSP value-weight market portfolio excess return. The Fama-French three-factor alpha (FF 3-factor alpha) is the intercept (times 100) from a time series regression of the monthly portfolio excess return on the CRSP value-weight market portfolio excess return, SMB, and HML. The Fama-French five-factor model adds RMW and CMA and the final specification adds UMD.

Panel A: Equal-weights	Low	2	3	4	High	L-H
Annualized Excess Return	0.180	0.136	0.102	0.076	0.057	0.123
Annualized Standard Deviation	0.201	0.176	0.168	0.173	0.218	0.128
Sharpe Ratio	0.89	0.78	0.61	0.44	0.26	0.96
CAPM alpha (%)	0.84	0.50	0.21	-0.02	-0.18	1.02
t-statistic	(3.82)	(2.82)	(1.31)	(-0.10)	(-0.74)	(5.63)
FF 3-factor alpha (%)	0.66	0.35	0.11	-0.06	-0.14	0.79
t-statistic	(4.25)	(3.12)	(1.16)	(-0.63)	(-0.89)	(5.80)
FF 5-factor alpha (%)	0.91	0.55	0.28	0.13	0.22	0.69
t-statistic	(7.09)	(6.45)	(4.40)	(2.00)	(3.33)	(5.33)
FF 5-factor plus UMD alpha (%)	1.10	0.68	0.35	0.18	0.24	0.86
t-statistic	(10.61)	(10.19)	(6.19)	(2.90)	(3.62)	(7.77)

Panel B: Value-weights	Low	2	3	4	High	L-H
Annualized Excess Return	0.137	0.099	0.090	0.069	0.075	0.062
Annualized Standard Deviation	0.170	0.142	0.142	0.148	0.190	0.149
Sharpe Ratio	0.81	0.70	0.64	0.47	0.39	0.42
CAPM alpha (%)	0.48	0.21	0.11	-0.09	-0.10	0.58
t-statistic	(3.06)	(1.99)	(1.16)	(-0.91)	(-0.55)	(2.75)
FF 3-factor alpha (%)	0.40	0.14	0.08	-0.06	0.07	0.34
t-statistic	(2.68)	(1.39)	(0.85)	(-0.60)	(0.49)	(1.96)
FF 5-factor alpha (%)	0.57	0.21	0.15	0.05	0.35	0.22
t-statistic	(4.35)	(2.41)	(1.95)	(0.66)	(4.00)	(1.26)
FF 5-factor plus UMD alpha (%)	0.69	0.28	0.18	0.06	0.31	0.39
t-statistic	(5.70)	(3.32)	(2.49)	(0.86)	(3.53)	(2.45)

Table 6
Average excess and abnormal returns for portfolios formed on Predicted PE-Selection (1986-2018)

Each month from January 1986 to December 2018, five portfolios are formed from sorts of predicted values from a PE-Selection model estimated for CRSP stocks. The PE-Selection model is a regression of a binary variable indicating a public equity was taken private on various firm characteristics and the predictions are updated monthly based on information known at that time. The predictive variables are the ln market capitalization, net equity issuance, ln M_{EBITDA}, and ln Profit, as defined in Table 1. The Panel A reports results for equal-weight portfolios and Panel B reports results for value-weight portfolios. Returns are measured in excess of the one-month Treasury bill rate. The annualized excess return is calculated as the average monthly excess return times 12. Annualized standard deviation is calculated as the monthly standard deviation times the square root of 12. The Sharpe ratio is calculated by dividing the annualized excess return by the annualized standard deviation. The CAPM alpha is the intercept (times 100) from a time series regression of the monthly portfolio excess return on the CRSP value-weight market portfolio excess return. The Fama-French three-factor alpha (FF 3-factor alpha) is the intercept (times 100) from a time series regression of the monthly portfolio excess return on the CRSP value-weight market portfolio excess return, SMB, and HML. The Fama-French five-factor model adds RMW and CMA and the final specification adds UMD.

Panel A: Equal-weights						
	Low	2	3	4	High	H-L
Annualized Excess Return	0.068	0.087	0.108	0.123	0.184	0.116
Annualized Standard Deviation	0.191	0.168	0.179	0.185	0.200	0.139
Sharpe Ratio	0.36	0.52	0.60	0.66	0.92	0.83
CAPM alpha (%)	-0.07	0.08	0.23	0.37	0.94	1.01
t-statistic	(-0.33)	(0.49)	(1.31)	(1.93)	(4.04)	(5.14)
FF 3-factor alpha (%)	-0.02	0.02	0.12	0.23	0.77	0.78
t-statistic	(-0.11)	(0.22)	(1.22)	(2.03)	(4.55)	(4.63)
FF 5-factor alpha (%)	0.29	0.20	0.31	0.41	1.02	0.73
t-statistic	(3.83)	(3.30)	(4.38)	(4.82)	(7.05)	(4.30)
FF 5-factor plus UMD alpha (%)	0.30	0.25	0.40	0.53	1.20	0.90
t-statistic	(3.85)	(4.29)	(6.61)	(7.32)	(9.61)	(5.89)

Panel B: Value-weights						
	Low	2	3	4	High	H-L
Annualized Excess Return	0.078	0.090	0.108	0.135	0.163	0.086
Annualized Standard Deviation	0.148	0.145	0.168	0.187	0.217	0.166
Sharpe Ratio	0.52	0.62	0.65	0.72	0.75	0.52
CAPM alpha (%)	0.03	0.11	0.19	0.40	0.62	0.59
t-statistic	(0.25)	(1.06)	(1.43)	(2.29)	(2.69)	(2.53)
FF 3-factor alpha (%)	0.12	0.05	0.08	0.24	0.39	0.27
t-statistic	(1.13)	(0.51)	(0.76)	(1.89)	(2.33)	(1.62)
FF 5-factor alpha (%)	0.36	0.15	0.21	0.41	0.60	0.24
t-statistic	(6.16)	(1.99)	(2.49)	(3.77)	(4.14)	(1.45)
FF 5-factor plus UMD alpha (%)	0.33	0.19	0.30	0.55	0.80	0.47
t-statistic	(5.77)	(2.70)	(3.92)	(5.91)	(6.58)	(3.31)

Table 7
Fama–MacBeth Regressions of Monthly Returns on Stock Characteristics (1986-2018)

This table reports the results of Fama–MacBeth regressions of monthly returns on lagged stock characteristics. Beta is the estimated slope coefficient from a regression using the past 60 months of excess returns (requiring at least 36 valid returns) with a 2% Winsorisation. ME is the equity market capitalization, BE/ME is the book-to-market equity ratio, ISS is the three-year net equity issuance measure from Daniel and Titman (2006), and M_{EBITDA} is as defined in Table I. Profit is the ratio of annual EBITDA to annual Sales. The leverage ratio, D/V, is calculated by dividing long-term debt by the sum of long-term debt and ME. The monthly time period is January 1986 to December 2018, with an average of 1,922 firms in each cross section. The adjusted R-square is denoted R^2 and *t*-statistics reported in parentheses.

Regression Number	Intercept	Beta	ln(ME)	ln(BE/ME)	ISS	ln(M_{EBITDA})	ln(Profit)	D/V	R^2
1	0.87	0.07							0.02
	(5.34)	(0.42)							
2	2.33		-0.11						0.01
	(4.06)		(-3.12)						
3	1.09			0.26					0.01
	(4.05)			(3.02)					
4	0.99				-0.52				0.00
	(3.90)				(-3.55)				
5	2.02					-0.49			0.01
	(6.48)					(-5.26)			
6	0.81						-0.07		0.01
	(3.56)						(-1.07)		
7	0.94							0.07	0.01
	(3.69)							(0.24)	
8	1.94			0.10		-0.44			0.01
	(6.79)			(1.23)		(-5.21)			
9	2.75	0.17	-0.08	0.01	-0.42	-0.43	-0.03	-0.34	0.04
	(6.32)	(1.17)	(-2.33)	(0.19)	(-3.99)	(-5.45)	(-0.54)	(-1.59)	

Table 8
Comparing the Annual Cash Flows of Private Equity Buyouts with a Replicating Portfolio (Vintages 1994-2010)

This table reports the annual cash flows for private equity buyout funds from the Burgiss databases for all funds launched between 1994 and 2010. The quarterly cash flow data for these funds begin in 1994 and extend through 2017. The sum of contributions, distributions, and end-of-year fund values for all funds within a calendar year are reported in billions of dollars ($B). The internal rate of return (IRR) is calculated from the quarterly net cash flows (distributions minus contributions) assuming that the terminal fund value is an additional distribution. The replicating portfolio invests based on PE-Selected rule (top quintile of predicted value from PE-Selection model). All new positions added to the replicating portfolio are associated with incremental portfolio leverage of 2x the target weight, with 25% of the debt amortizing over 4 years and repayment of remaining debt at the time that the position is liquidated. The replicating portfolio pays a management fee of 1% per year on portfolio assets (i.e. 2% on equity levered 2x). The replicating portfolio receives inflows equal to the PE buyout contributions, and liquidates positions to match PE buyout distributions each quarter. The replicating portfolio book value is calculated with hold-to-maturity accounting, while the market value is based on end of period market values of stock positions less the outstanding debt balance.

	Burgiss Buyout Funds			Replicating Portfolio			
Year	Contributions	Distributions	Fund Value	Contributions	Distributions	Fund Value (Book)	Fund Value (Market)
1994	0.9	0.0	0.8	0.9	0.0	0.9	0.9
1995	3.1	0.2	4.2	3.1	0.2	3.8	4.1
1996	6.7	1.8	10.0	6.7	1.8	8.9	11.9
1997	11.2	2.6	23.4	11.2	2.6	18.2	27.3
1998	17.3	4.9	41.0	17.3	4.9	33.4	36.2
1999	29.9	10.9	76.2	29.9	10.9	53.6	59.0
2000	36.2	11.8	99.4	36.2	11.8	80.0	84.5
2001	19.4	8.6	96.5	19.4	8.6	88.9	143.8
2002	20.8	10.0	98.8	20.8	10.0	108.9	157.8
2003	24.4	21.6	125.5	24.4	21.6	124.6	254.4
2004	33.8	48.1	139.0	33.8	48.1	142.1	317.6
2005	46.2	52.9	171.0	46.2	52.9	187.9	337.9
2006	69.8	64.7	222.9	69.8	64.7	240.2	441.0
2007	100.8	72.1	295.7	100.8	72.1	339.0	450.0
2008	77.2	27.8	267.1	77.2	27.8	399.2	210.7
2009	38.8	24.0	320.9	38.8	24.0	425.1	418.0
2010	70.8	64.2	395.1	70.8	64.2	445.8	596.9
2011	61.8	80.8	417.7	61.8	80.8	438.8	566.4
2012	50.1	101.5	421.3	50.1	101.5	399.3	628.8
2013	30.3	112.5	422.1	30.3	112.5	399.0	875.9
2014	26.0	136.0	361.3	26.0	136.0	454.5	791.8
2015	13.4	112.1	286.7	13.4	112.1	423.1	645.4
2016	7.9	85.9	232.9	7.9	85.9	405.2	672.0
2017	5.1	87.2	178.2	5.1	87.2	355.9	649.2
IRR			11.4%			12.9%	14.8%
TVPI			1.65			1.87	2.23

Table 9
Return Summary for Replicating Portfolios

This table reports summary statistics and the results from regressions of monthly portfolio excess returns over the period 1995 to 2017. The replicating portfolio invests based on PE-Selected rule (top quintile of predicted value from PE-Selection model). All new positions added to the replicating portfolio are associated with incremental portfolio leverage of 2x the target weight, with 25% of the debt amortizing over 4 years and repayment of remaining debt at the time that the position is liquidated. The replicating portfolio pays a management fee of 1% per year on portfolio assets (i.e. 2% on equity levered 2x). The replicating portfolio receives inflows equal to the PE buyout contributions, and liquidates positions to match PE buyout distributions each quarter. The replicating portfolio book value is calculated with hold-to-maturity accounting, while the market value is based on end of period market values of stock positions less the outstanding debt balance. The replicating portfolio matches the net cash flows for PE buyout funds launch between 1994 and 2010, over the period 1994 to 2017. Panel A (B) displays results under market (book) value accounting for replicating portfolios that match the aggregate cash flows for PE buyout funds launched between 1994 and 2010, where returns are measured over the period January 1995 through June 2017. Panel C (D) displays similar results for funds launched between 1994 and 2017. Alpha is the intercept from a CAPM-style return regression of the excess replicating portfolio return on the excess value-weight market excess return and two monthly lags of the market excess return, where b1, b2, and b3 are the market exposures, respectively. The annualized mean, geometric mean, and standard deviation (std) of the replicating portfolio are reported. The average portfolio leverage is calculated as the time series mean of the ratio of portfolio asset market value divided by portfolio equity market value.

Alpha	b1	b2	b3	R2 / N	Mean	Geometric Mean	Std	Min Drawdown	Avg Leverage
A. Market value portfolio returns -matching cash flows for PE buyout vintages 1994-2010									
0.0024	1.338	0.355	-0.091	0.64	0.185	0.159	0.268	-0.784	1.48
(0.83)	(20.61)	(5.47)	(-1.40)	271					
B. Book value portfolio returns -matching cash flows for PE buyout vintages 1994-2010									
0.0076	-0.009	0.019	0.011	-0.05	0.117	0.120	0.072	-0.050	1.60
(5.79)	(-0.29)	(0.63)	(0.39)	271					
C. Market value portfolio returns -matching cash flows for PE buyout vintages 1994-2017									
0.0025	1.351	0.352	-0.095	0.64	0.187	0.161	0.270	-0.784	1.50
(0.87)	(20.74)	(5.41)	(-1.46)	271					
D. Book value portfolio returns -matching cash flows for PE buyout vintages 1994-2017									
0.0077	-0.007	0.015	0.016	-0.05	0.118	0.121	0.072	-0.050	1.64
(5.89)	(-0.24)	(0.53)	(0.55)	271					

Table 10
Factor Model Exposures of Private Equity Replicating Portfolios

This table reports results from regressions of quarterly portfolio excess returns over the period 1994 to 2014, on the Fama and French (1993) three factors model. The Ang, Chen, Goetzmann, and Phalippou (2018) (ACGP) PE Buyout Index and two versions of a replicating portfolio are considered. The replicating portfolio invests based on PE-Selected rule (top quintile of predicted value from PE-Selection model). All new positions added to the replicating portfolio are associated with incremental portfolio leverage of Lx the target weight (L is 1 or 2), with debt repayment at the time that the position is liquidated. The replicating portfolio pays a management fee of 1% per year on portfolio assets (i.e. 2% on equity levered 2x). The replicating portfolio receives inflows equal to the PE buyout contributions, and liquidates positions to match PE buyout distributions each quarter. The replicating portfolio matches the net cash flows for PE buyout funds launch between 1994 and 2010, over the period 1994 to 2017.

Portfolio	Int	MKT-RF	SMB	HML	RMW	CMA	R2
ACGP PE Buyout Index	0.010	1.171	0.409	0.003			0.737
	(1.19)	(12.06)	(2.29)	(0.02)			
	0.005	1.284	0.476	-0.127	0.376	-0.163	0.749
	(0.54)	(10.76)	(2.66)	(-0.65)	(1.81)	(-0.60)	
Replicating with 1x Portfolio Leverage	0.006	0.835	0.858	0.503			0.896
	(1.43)	(17.71)	(9.88)	(8.11)			
	0.003	0.896	0.905	0.305	0.182	-0.047	0.909
	(0.66)	(16.08)	(10.84)	(3.34)	(1.87)	(-0.37)	
Replicating with 2x Portfolio Leverage	0.009	1.345	1.361	0.858			0.841
	(1.06)	(13.89)	(7.63)	(6.74)			
	0.005	1.438	1.483	0.661	0.380	-0.389	0.864
	(0.57)	(12.72)	(8.76)	(3.58)	(1.93)	(-1.51)	

Table 11
Effect of Initial Incremental Leverage of Replicating Portfolio

This table summarizes returns, market beta, and average leverage for various replicating portfolios that rely on different amounts of initial incremental leverage when initiating new positions. The replicating portfolios are constructed based on PE-Selected (top quintile of predicted value from PE-Selection model). The replicating strategy creates a buy-and-hold portfolio that, each month, selects all stocks in the relevant quintile of the monthly distribution (top quintile for predicted PE-Selection and low quintile for EBITDA multiples). The replicating portfolio pays a management fee of 1% per year on portfolio assets (i.e. 2% on equity levered 2x). The replicating portfolio matches the net cash flows for PE buyout funds launch between 1994 and 2010, over the period 1994 to 2017. The internal rate of return (IRR) for the replicating portfolio is calculated from the time series of net cash flows with the final cash flow including the terminal market value. The PME is calculated as the ratio of the present value (PV) of distributions divided by the PV of contributions, where the present value of cash flows are discounted at the value-weight stock market return. TVPI is the sum of distributions plus the residual fund value, all divided by the sum of contributions. LP represents the limited partner. The market beta is calculated from monthly excess returns regressed on the excess returns of the value-weight stock market including two lags of the market factor. The portfolio leverage is calculated each month as the ratio of total portfolio asset value to equity value. The terminal value ratio is the market value of the replicating portfolio equity divided by the aggregate value of the PE buyout funds at the end of the sample.

Initial Position Leverage	IRR	PME	TVPI	Market Beta	Average Leverage	Terminal Value Ratio
LP Cash Flows	0.114	1.16	1.65			
A. 25% of portfolio debt is amortizing over 4 years:						
1.0	0.116	1.17	1.67	1.01	1.03	1.13
1.1	0.120	1.19	1.73	1.04	1.05	1.39
1.2	0.123	1.21	1.78	1.08	1.09	1.58
1.3	0.127	1.23	1.84	1.12	1.12	1.85
1.4	0.129	1.24	1.87	1.20	1.18	2.01
1.5	0.133	1.27	1.94	1.26	1.23	2.31
1.6	0.137	1.29	2.01	1.32	1.28	2.66
1.7	0.140	1.31	2.06	1.36	1.31	2.88
1.8	0.143	1.33	2.12	1.46	1.38	3.14
1.9	0.141	1.32	2.09	1.48	1.41	3.01
2.0	0.148	1.37	2.23	1.60	1.48	3.64
2.1	0.149	1.38	2.26	1.63	1.51	3.76
2.2	0.151	1.40	2.31	1.72	1.57	3.98
2.3	0.149	1.38	2.26	1.78	1.61	3.74
2.4	0.155	1.44	2.42	1.86	1.66	4.47
2.5	0.154	1.42	2.38	1.91	1.71	4.31
B. Portfolio debt is non-amortizing:						
1.0	0.116	1.17	1.67	1.01	1.03	1.13
1.1	0.124	1.21	1.78	1.10	1.09	1.61
1.2	0.129	1.24	1.87	1.20	1.17	1.99
1.3	0.135	1.28	1.97	1.26	1.25	2.45
1.4	0.139	1.31	2.05	1.36	1.34	2.83
1.5	0.144	1.34	2.14	1.43	1.41	3.23
1.6	0.146	1.36	2.20	1.49	1.48	3.51
1.7	0.149	1.38	2.26	1.61	1.56	3.78
1.8	0.152	1.41	2.33	1.70	1.64	4.06
1.9	0.157	1.45	2.46	1.76	1.70	4.67
2.0	0.159	1.48	2.52	1.83	1.77	4.94
2.1	0.167	1.55	2.73	1.93	1.84	5.86
2.2	0.168	1.56	2.76	2.01	1.92	5.99
2.3	0.172	1.61	2.91	2.11	1.99	6.68
2.4	0.173	1.62	2.93	2.18	2.08	6.75
2.5	0.174	1.64	2.97	2.27	2.18	6.97

Table 12
Applying the Replicating Strategy to Estimates of Pre-Fee Cash Flows

This table summarizes returns, market beta, and average leverage for various replicating portfolios that rely on different amounts of initial incremental leverage when initiating new positions. The replicating portfolios are constructed based on PE-Selected (top quintile of predicted value from PE-Selection model). The replicating strategy creates a buy-and-hold portfolio that, each month, selects all stocks in the relevant quintile of the monthly distribution (top quintile for predicted PE-Selection and low quintile for EBITDA multiples). All new positions added to the replicating portfolio are associated with incremental portfolio leverage with 25% of the debt amortizing over 4 years and repayment of remaining debt at the time that the position is liquidated. The replicating portfolio matches the estimated pre-fee cash flows for PE buyout funds launch between 1994 and 2010, over the period 1994 to 2017, by adding fixed fee and carry estimates to the reported after-fee cash flows (see Appendix for details). The internal rate of return (IRR) for the replicating portfolio is calculated from the time series of net cash flows with the final cash flow including the terminal market value. The PME is calculated as the ratio of the present value (PV) of distributions divided by the PV of contributions, where the PV of cash flows are discounted at the value-weight stock market return. TVPI is the sum of distributions plus the residual fund value, all divided by the sum of contributions. LP represents the limited partner. The market beta is calculated from monthly excess returns regressed on the excess returns of the value-weight stock market including two lags of the market factor. The portfolio leverage is calculated each month as the ratio of total portfolio asset value to equity value. The terminal value ratio is the market value of the replicating portfolio equity divided by the aggregate value of the PE buyout funds at the end of the sample.

Initial Position Leverage	IRR	PME	TVPI	Market Beta	Average Leverage	Terminal Value Ratio
A. Calculated fund cash flows are measured gross of estimates of fixed management fees:						
1.0	0.130	1.24	1.66	1.02	1.04	0.33
1.1	0.133	1.25	1.70	1.06	1.05	0.50
1.2	0.136	1.27	1.74	1.08	1.07	0.68
1.3	0.138	1.27	1.76	1.11	1.10	0.77
1.4	0.138	1.27	1.76	1.15	1.14	0.77
1.5	0.147	1.33	1.92	1.19	1.18	1.41
1.6	0.150	1.35	1.99	1.28	1.24	1.67
1.7	0.153	1.38	2.05	1.32	1.27	1.94
1.8	0.154	1.38	2.07	1.38	1.31	2.01
1.9	0.157	1.41	2.14	1.47	1.37	2.28
2.0	0.160	1.43	2.19	1.51	1.40	2.52
2.1	0.161	1.44	2.22	1.57	1.44	2.64
2.2	0.159	1.42	2.18	1.59	1.47	2.46
2.3	0.165	1.48	2.32	1.59	1.50	3.03
2.4	0.165	1.48	2.32	1.71	1.57	3.03
2.5	0.154	1.38	2.07	1.71	1.58	2.00
B. Calculated fund cash flows are measured gross of estimates of fixed management fees and carry:						
1.0	0.135	1.24	1.57	1.03	0.98	0.00
1.1	0.136	1.25	1.59	1.04	1.05	0.00
1.2	0.140	1.27	1.64	1.07	1.01	0.00
1.3	0.140	1.27	1.63	1.13	1.07	0.00
1.4	0.142	1.28	1.67	1.44	1.60	0.00
1.5	0.146	1.31	1.74	1.25	1.21	0.09
1.6	0.144	1.29	1.71	1.27	1.23	0.00
1.7	0.153	1.35	1.86	1.36	1.28	0.61
1.8	0.154	1.36	1.87	1.40	1.32	0.65
1.9	0.152	1.34	1.84	1.47	1.37	0.51
2.0	0.165	1.44	2.10	1.52	1.40	1.58
2.1	0.166	1.44	2.11	1.61	1.46	1.63
2.2	0.156	1.37	1.92	1.62	1.48	0.83
2.3	0.162	1.42	2.04	1.66	1.53	1.33
2.4	0.176	1.54	2.38	1.76	1.59	2.70
2.5	0.157	1.38	1.93	1.68	1.56	0.89

Table 12 (continued)

C. Comparison of Burgiss PE Buyout Fund LP cash flows and estimated GP fees with Baseline Replicating Strategy

	IRR	PME	TVPI	Portfolio Average Leverage	Portfolio Market Beta
Vintages 1994 to 2010					
PE Buyout cash flows to LPs after-fees	0.114	1.16	1.65	n.a.	n.a.
Replicating cash flows	0.148	1.37	2.23	1.60	1.48
PE Buyout cash flows to LPs + fixed fees paid to GPs	0.141	1.29	1.82	n.a.	n.a.
Replicating cash flows	0.160	1.43	2.19	1.51	1.40
PE Buyout cash flows to LPs + fixed fees and carry paid to GPs	0.158	1.39	1.96	n.a.	n.a.
Replicating cash flows	0.165	1.44	2.10	1.52	1.40
Implied fixed fees	0.027				
Implied fixed fees + carry	0.044				
Vintages 1994 to 2005					
PE Buyout cash flows to LPs after-fees	0.119	1.31	1.71	n.a.	n.a.
Replicating cash flows	0.142	1.48	2.27	1.28	1.38
PE Buyout cash flows to LPs + fixed fees paid to GPs	0.147	1.46	1.90	n.a.	n.a.
Replicating cash flows	0.160	1.59	2.32	1.22	1.32
PE Buyout cash flows to LPs + fixed fees and carry paid to GPs	0.167	0.16	2.10	n.a.	n.a.
Replicating cash flows	0.172	1.64	2.27	1.22	1.33
Implied fixed fees	0.028				
Implied fixed fees + carry	0.048				

Appendix

A. Calculating fund-level fees:

The Burgiss Private Equity Buyout Fund cash flow dataset contains the time series of cash contributions by limited partners (LPs) to specific funds and the after-fee cash distributions from these funds to LPs. I calculate quarterly fund-level contributions by summing all contributions to a fund within a quarter. Quarterly fund-level distributions are calculated in the same way. Over the life of the fund, the LPs as a group will cumulatively contribute the total fund committed capital amount, which is also reported in the Burgiss dataset.

Table A.1 presents an annual example of the fund-level calculation for a fund that has $100 in committed capital. I separately estimate the fixed management fees (Panel A of Table A.1), which are essentially guaranteed payments to the GP, and the carry (Panel B of Table A.1). Over a several year period, the LP will cumulatively contribute $100 to the fund and receive distributions from the fund based on the performance of the fund investments and the fees charged by the fund manager, or general partner (GP).

For each private equity buyout fund in the Burgiss dataset, the quarterly dollar value of management fees and carry are estimated based on the reported cash contributions and distributions and some simplified assumptions about the fee agreements. I calculate LP cash flows as the reported distributions minus the reported contributions. The reported LP cash flows are used to calculate the internal rate of return (IRR), and the value multiple (TVPI), requiring no additional assumptions. The TVPI is calculated as the sum of distributions plus any residual fund value, all divided by the sum of contributions. In this example, the fund has fully liquidated, leaving no residual fund value.

The LP contributions bifurcate with one portion covering the fixed management fees and the other representing capital contributions for the fund to invest. Thus, the fund contributions are equal to the LP contributions less the estimated management fees. I assume that the management fee is 2% annually over a 5-year investment period, charged on committed capital. In this example with $100 committed capital, the management fee is $2 in each of the first five years. I use the fund contributions and the LP distributions to calculate a Fund Cash Flow series (as if there is no carry) and the associated IRR and TVPI. The difference in this IRR (fund with fixed mgmt. fee and no carry) and the LP IRR provides an estimate of the fixed management fee. In the example illustrated in Table A.1 the estimated fixed management fee is 2.9%, which is similar to the 2.7% average for the actual dataset, and not too far from what is estimated by Metrick and Yasuda (2010).

The carry is a performance-linked fee that is distributed to the GP from the unobserved fund distributions. The exercise is to estimate what the fund distribution is likely to have been, given the observed distribution to the LP and this assumed profit-sharing arrangement. Metrick and Yasuda (2010) report that 100% of the buyout funds in their sample charge a performance fee of 20%, which I assume in this calculation. Once a fund has cumulatively distributed to the LP an amount equal to the cumulative LP contributions, the remaining fund distributions are shared 80% to the LP and 20% to the GP (i.e. equivalent to 25% of the LP's distribution). In the example illustrated in Panel B of Table A.1, the GP becomes eligible for profit sharing in year 7. At the end of the fund's life (and at the end of the sample), the terminal reported fund value is assumed to be distributed with the profit-sharing applied if the fund has been profitable. The sum of the LP distributions and the estimated carry are used to calculate a fund-level pre-fee distribution, from which the associated pre-fee IRR and TVPI are calculated. The difference between this fund IRR and the LP's IRR is an estimate of the total percentage fee.

It is important to note that there are several common features of fee agreements that are not included in these calculations. For example, it is common for management fees to be paid on the net invested capital after the initial 5-year period, which I do not include in this calculation. Additionally, I do not include monitoring and transaction fees, which are reported to average 1.4% for each investment by Metrick and Yasuda (2010). The carry calculation is typically also governed by a preference rate for the LP, such that the timing of the carry payments tends to be shifted later in time than assumed in this calculation. It is therefore useful to interpret this analysis as a rough sketch of the role management fees play in interpreting the baseline results.

Table A.1 illustrates the calculation for an annual example for a fund with $100 in commitments.

Yr	Contribution (LP)	Distribution (LP)	Cash Flow (LP)	Mgmt Fee (GP)	Contribution (Fund)	Distribution (Fund)	Cash Flow (Fund)
1	25.0	0.0	(25.0)	2.0	23.0	0.0	(23.0)
2	30.0	3.0	(27.0)	2.0	28.0	3.0	(25.0)
3	20.0	5.0	(15.0)	2.0	18.0	5.0	(13.0)
4	15.0	12.0	(3.0)	2.0	13.0	12.0	(1.0)
5	10.0	20.0	10.0	2.0	8.0	20.0	12.0
6		30.0	30.0	0.0	0.0	30.0	30.7
7		55.0	55.0	0.0	0.0	55.0	55.0
8		30.0	30.0	0.0	0.0	30.0	30.0
9		20.0	20.0	0.0	0.0	20.0	20.0
10		5.0	5.0	0.0	0.0	5.0	5.0
11		3.0	3.0	0.0	0.0	3.0	3.0
12		1.0	1.0	0.0	0.0	1.0	1.0
Sum	100.0	184.0	84.0	10.0	90.0	184.0	94.0
IRR			16.0%				18.9%
TVPI			1.84				2.04

Yr	Contributed Capital (LP)	Cumulative Distribution (LP)	Cumulative Profit (LP)	Carry (GP)	GP Share of Cumulative Fund Profit	Distribution (Fund)	Cash Flow (Fund)
1	25.0	-	-	-		-	(23.0)
2	55.0	3.0	-	-		3.0	(25.0)
3	75.0	8.0	-	-		5.0	(13.0)
4	90.0	20.0	-	-		12.0	(1.0)
5	100.0	40.0	-	-		20.0	12.0
6	100.0	70.0	-	-		30.0	30.0
7	100.0	125.0	25.0	6.3	0.20	61.3	61.3
8	100.0	155.0	55.0	7.5	0.20	37.5	37.5
9	100.0	175.0	75.0	5.0	0.20	25.0	25.0
10	100.0	180.0	80.0	1.3	0.20	6.3	6.3
11	100.0	183.0	83.0	0.8	0.20	3.8	3.8
12	100.0	184.0	84.0	0.3	0.20	1.3	1.3
Sum				21.0		205.0	115.0
IRR							21.3%
TVPI							2.28