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

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ABSTRACT

Private equity funds tend to select relatively small firms with low EBITDA multiples. Publicly traded equities with these characteristics have high risk-adjusted returns after controlling for common factors typically associated with value stocks. Hold-to-maturity accounting of portfolio net asset value eliminates the majority of measured risk. A passive portfolio of small, low EBITDA multiple stocks with modest amounts of leverage and hold-to-maturity accounting of net asset value produces an unconditional return distribution that is highly consistent with that of the pre-fee aggregate private equity index. The passive replicating strategy represents an economically large improvement in risk- and liquidity-adjusted returns over direct allocations to private equity funds, which charge average fees of 6% per year.

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The professional and active management of private equity investments is widely believed to have many unique advantages over passive portfolios of publicly traded equities. Specialized knowledge (Leland and Pyle (1977)), monitoring (Diamond (1984)), and access to credit markets (Ivashina and Kovner (2011)) are a few ways in which intermediated investing may provide advantages over a non-intermediated strategy. To the extent that these are material advantages in equity investing, the pre-fee returns on an aggregate private equity index are expected to outperform a passively managed portfolio comprised of otherwise similar public investments. This paper investigates whether an outside investor can replicate the risks and returns of a diversified private equity allocation with passive investments in public equities using similar investment selection, leverage, and the calculation of portfolio net asset value under a hold-to-maturity accounting scheme.

The Cambridge Associates Private Equity Index is used as a proxy for the returns earned by limited partners who have diversified allocations to private equity investments. Over the period 1986 to 2014, the mean excess return on the private equity index, before fees, is 18% per year with an annualized volatility of 17% and a market beta of only 0.7.

The literature on the cross section of expected stock returns suggests that a portfolio of low beta value stocks represent a promising starting point for matching the attractive risk and return properties of private equity. There is strong empirical evidence that value firms earn high stock returns (Stattman (1980), Rosenberg, Reid, and Lanstein (1985), Fama and French (1992)). These papers empirically link realized excess equity returns to a firm's ratio of book equity, *BE*, to market equity, *ME*. Interestingly, I find that the operating cash flow (EBITDA) multiple is a more powerful variable than *BE*/*ME* for sourcing a value premium in stocks, producing a larger spread in returns and driving out the statistical significance of *BE*/*ME* in Fama-MacBeth (1973) return regressions. There is also strong empirical evidence that low beta firms earn relatively high returns with risks that continue to be low (see Baker, Bradley, and Talliaferro (2014) for a recent review). Low risk firms are likely to be able to support higher leverage, both at the individual firm level and at the level of an outside investor's portfolio.

In the spirit of Modigliani and Miller (1958), an outside investor interested in the levered equity return of a firm that has chosen too little leverage can manufacture a return levered to the investor's desired level on their own using a brokerage margin account. A modest amount of portfolio leverage through a brokerage margin account is highly efficient because the debt is essentially riskfree due to over-collateralization and high frequency marking-to-market, allowing for borrowing rates close to the riskfree rate. This so-called homemade leverage will not manufacture the incentive and tax effects that increased leverage at the firm-level may produce, but can significantly alter the risk and return properties of the underlying equity. A prototypical private equity transaction increases a firm's leverage, measured as the ratio of market debt to firm value, from around 30 percent to 70 percent (Axelson, Jenkinson, Strömberg, and Weisbach (2013)). An outside investor would need to select a portfolio of comparable pre-transaction stocks and invest slightly more than two times their equity capital in this portfolio to match the post-transaction levered equity return, which is expected to essentially double the underlying market beta of the underlying stock.

To study the asset selection by private equity funds, I assemble a dataset of public-to-private transactions sponsored by financial buyers, similar to the approach used by Axelson, Jenkinson, Strömberg, and Weisbach (2013). A selection model finds that private equity investors consistently tend to target relatively small firms with low operating cash flow multiples. Interestingly, a firm's market beta is not a reliable predictor of whether a firm is selected for a going-private transaction. In fact, the average pre-transaction market beta for the public-to-private firms is 1.

Return smoothing is an acute concern for the private investments being considered here, particularly when comparing to the accurately measured risks of replicating portfolios comprised of relatively liquid publicly traded investments. A growing literature challenges the accuracy of the return reporting process for hedge funds, documenting both conditional and unconditional return smoothing (Asness, Krail, and Liew (2001), Getmansky, Lo, and Makarov (2004), Bollen and Pool (2008)), as well as manager discretion in marking portfolio NAVs (Cassar and Gerakos (2011), Cao et al. (2013)). Jurek and Stafford (2015) demonstrate that over the period from 1996 to 2014, return smoothing in just two key months (August 1998 and October 2008) is sufficient to statistically obscure the exposure to downside market risks. An investor relying on the accuracy of reported returns infers that average pre-fee hedge fund alphas are 6% to 10% per year, while an investor who is skeptical of the accuracy of reported returns cannot statistically reject the presence of downside market risks and pre-fee alpha estimates of zero.

In light of the evidence on the importance of return smoothing in altering the measured risk properties of hedge fund returns, special attention is focused on whether the strikingly attractive risk properties of the aggregate PE index could be due to the return reporting process. To investigate how the reporting process can alter inferences about risks, two different accounting schemes are used to report portfolio net asset values from which periodic returns are calculated. The first is the traditional market-value based rule where all holdings are reported at their closing price. Portfolios comprised of stocks with market betas averaging 1, with portfolio leverage of 2x, have measured portfolio betas near 2 under the market-value based accounting rule. The second accounting scheme is based on a hold-to-maturity rule, whereby securities that are intended to be held for long periods of time are measured at cost until they are sold. Over periods where security valuations are increasing on average, this accounting scheme appears to provide a conservative estimate of portfolio value and therefore will perhaps understate leverage. However, an additional feature of this accounting scheme is that it significantly distorts portfolio risk measures by recognizing the profits and losses on the underlying holdings only at the time of sale. Consequently, portfolios with highly statistically significant measured betas near 2 under the market-value reporting rule have measured beta that are statistically indistinguishable from zero under the hold-to-maturity reporting rule. This suggests that the long holding periods of private equity portfolios, combined with conservativism in measuring asset values can effectively eliminate a majority of the measured risk.

Overall, the results push against the view that private equity adds value relative to passive portfolios of similarly selected public equites. The mean returns can be matched in a variety of ways in passive portfolios with firms sharing the characteristics of those selected for private equity portfolios. The critical difference appears to be in the marking of the portfolios and the resulting estimates of portfolio risk.

The remainder of the paper is organized as follows. Section I evaluates a value investing strategy based on operating cash flow multiples. Section II studies the asset selection tendencies of private equity investors. Section III develops a simple strategy for replicating the risks and returns of the aggregate private equity index with firms with similar characteristics to those selected by private equity investors, similar portfolio leverage, and hold-to-maturity accounting for portfolio net asset value. Finally, Section IV concludes the paper.

I. Value Investing with EBITDA Multiples

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 more 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.

A simple rational asset pricing model suggests several reasons why a firm may have a low valuation multiple. From the perspective of the perpetuity value formula, the EBITDA multiple can be rewritten as:

$$M_{EBITDA} = \frac{\gamma}{R - g}$$

where γ is the fraction of EBITDA that is converted into cash flow, g is the constant cash flow growth rate, and R is the discount rate. Value firms may have relatively low multiples because of low conversion rates of EBITDA to cash flow, perhaps due to high capital expenditure needs; and/or relatively low cash flow growth rates; and finally due to high discount rates presumably because of highly systematic risk exposures of the underlying cash flows. The premise behind value investing is that low multiples occur through an additional discount rate channel, namely non-systematic risk exposures, or market mispricing, which is expected to translate into positive risk-adjusted returns.

Table I 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. The EBITDA multiple is calculated as the value of the firm 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. The value of the firm 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. Annual EBITDA is the four-quarter sum of quarterly EBITDA from Compustat.

Table 1 confirms the basic premise behind value investing. There is a strong monotonic relation in the realized excess returns across portfolios formed on M_{EBITDA} over the period 1986 to 2015. Portfolios comprised of low multiple stocks (i.e. the bottom quintile of all CRSP stocks with annual EBITDA in excess of \$1M) have high excess returns, averaging 20% per year for the equal-weight portfolio and 13.4% for the value-weight portfolio, while portfolios comprised of the high multiple stocks (top quintile) have average excess returns of 4.6% and 5.6% for equal- and value-weight portfolios, respectively. Over this same period, the excess return on the value-weight market portfolio is 7.8%. The annualized volatility is reasonably similar across portfolios, such that Sharpe ratios share the same pattern as the excess returns.

Finally, Table 1 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 portfolios excess return onto the zero-investment portfolios 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 (2014) five-factor model (FF5), or the FF5 plus a momentum factor, UMD, shares the same strong monotonic relation across M_{EBITDA} portfolios over this period.1 A long-short portfolio that is constructed by being long low M_{EBITDA} stocks and short high M_{EBITDA} stocks earns an alpha in excess of 1% per month (t-statistic over 8) against either the CAPM or FF3 model 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 80 basis points (t-statistic = 4.1) against the CAPM and a monthly alpha of 50 basis points (t-statistic = 3) against the FF3. 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 (2014) find that these factors weaken the statistical power of HML in explaining the cross section of returns. For the portfolios formed 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 and for the long-short portfolios.

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

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

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 2 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}. 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. 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. This suggests that the EBITDA multiple is a powerful variable for sourcing a value premium in stocks.[2]

[2] Further evidence in support of this conclusion is provided from a regression of a M_{EBITDA} factor, proxied as the VW long-short portfolio from Table 1, on the Fama-French three factors. The intercept from this regression is statistically positive (t-statistic = 2.4), while the intercept from a regression of HML on the remaining two Fama-French factors and the M_{EBITDA} factor is statistically indistinguishable from zero, 0.0015 with a t-statistic = 1.2. Qualitatively similar results are obtained with a M_{EBITDA} factor constructed from portfolios comprised of the bottom third and top third of M_{EBITDA}.

II. Asset Selection by Private Equity Funds

There is little empirical evidence on the specific asset characteristics that private equity (PE) funds select for their portfolios. Based on aggregates of activity, it appears that private equity investments are not evenly distributed throughout the economy, or through time (Kaplan and Strömberg (2009)). Most detailed data related to private equity investments is at the fund level, where cash flows are used to calculate the internal rates of return (IRRs) of individual funds. 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 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 are likely to be considerably larger than the private targets that are excluded. The sample of buyouts of public firms allows the pre-transaction financial characteristics to be collected from Compustat and CRSP.

The data on public targets taken private by private equity firms come from the Thompson Reuters Merger and Acquisition database where the acquiring firm is identified as a financial buyer and the transaction results in at least 80% ownership of the target firm over the period 1983 to 2014. This results in 711 firms that can be linked to CRSP and Compustat. The sample size is in line with the U.S. sample of 694 deals identified by Axelson, Jenkinson, Strömberg, and Weisbach (2013) over the period 1980 to 2008.

Table 3 reports results from regressions explaining which firm characteristics are associated with private equity buyouts from 1984 to 2014. 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 include year fixed effects. The reported OLS coefficients are multiplied by 100. 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 firm characteristics are all assumed to be known at the time of the event. The 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, PE funds tend to invest in 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 and relatively low profitability. 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. Interestingly, market beta and leverage are not reliable predictors of the PE selection. The leverage result is consistent with Axelson, Jenkinson, Strömberg, and Weisbach (2013) who 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.

To investigate the stability of these statistical relations over time, the logistic regressions are estimated over two sub-periods. Panel A of Table 4 reports results from 1984 to 1999, and Panel B reports results from 2000 to 2014. Overall, the results from this analysis are qualitatively similar to the full sample analysis, suggesting that the asset characteristics that attract PE investors are reasonably stable across the entire sample period. Within each half of the sample, there is a tendency for the PE-selected firms to be relatively small, value firms, with low net equity issuance, and modest profitability.

III. Replicating the Return Distribution of Private Equity Investments

Many of the characteristics of PE-selected firms are associated with subsequent stock returns. Two of the highly reliable characteristics associated with PE-selection are firm size and M_{EBITDA}, both of which are also reliably related to subsequent returns. Figure 1 displays the median characteristic value for PE-selected firms within a quarter along with the quartile breakpoints for that characteristic measured across a larger sample of public firms. Panel A displays the time series of M_{EBITDA} and quartile breakpoints using all public firms and Panel B shows equity market capitalization and NYSE quartile breakpoints. The figure confirms the regression results from Tables 3 and 4 that the PE-selected firms tend to be relatively small value firms consistently over the sample period. This section explores whether this relation can be used to create a passive replicating portfolio to match the risk and return properties of the aggregate private equity portfolio.

A. The Returns to be Replicated

The returns that an outside investor receives from an allocation to private equity are proxied by the U.S. Private Equity Index from Cambridge Associates. The Cambridge

Associates' Private Investments database is collected from over 1,700 institutional fund managers, covering 5,700 funds, and includes the quarterly net return to investors. Quarterly returns are calculated from the unaudited quarterly financial statements and the audited annual financial statements prepared by the fund managers for their limited partners (i.e. outside investors). The quarterly return series begins in 1986Q2 and extends to 2015Q2. Harris, Jenkinson, and Kaplan (2014) compare the private equity return data across various commercial datasets and find that the Cambridge Associates returns are consistent with those from Burgiss and Prequin, while the returns from Venture Economics appear to be biased downwards.

The basic premise being investigated is whether portfolios comprised of investments with similar characteristics earn similar returns, as opposed to how the returns are shared between the investor and the fund manager. Therefore, it is most natural to attempt to replicate the *pre-fee* return to private equity. To estimate pre-fee returns, I treat the observed net-of-fee time series as if it represented the return of a representative fund that was at its high watermark throughout the sample, charging a 2% fixed fee plus a 20% performance fee, both payable quarterly on positive returns.[3] The difference between the mean pre-fee and net-of-fee returns represents an approximation of the all-in fee paid by investors.

Table 5 reports a summary of the annual and quarterly excess returns to private equity, both pre-fees and net-of-fees, along with the returns to the value-weight U.S. stock market index. The returns are measured in excess of the one-month U.S. Treasury bill return. There are several striking features of the private equity return properties. First, the implied all-in fee paid by investors exceeds 6% per year, which is economically large. As a point of reference, the realized

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[3] Jurek and Stafford (2015) apply a similar calculation to hedge fund return indices.

market risk premium over this period is 8%. Second, the reported private equity returns have relatively little risk. The net-of-fee quarterly returns (i.e. the raw data) have an annualized volatility of 9.6% over a period where the market return volatility is 17.1%. Similarly, the measured CAPM beta from the net-of-fee quarterly excess returns is 0.4. The low measured volatility and beta result in economically large Sharpe ratios and risk-adjusted returns.

Taken at face value, private equity allocations have delivered roughly half the risk of the aggregate stock market index and roughly double the realized return. The high mean realized return seems to provide enough comfort to large institutional investors to make economically large allocations (Lerner, Schoar, and Wang, 2008). Further evidence that institutional investors find the risk/return profile of private equity highly attractive comes from the success of recent fund raising efforts with estimates of private equity buying power (including generous credit terms) exceeding $2 trillion at the end of the sample period (Bain & Co (2015)).[4]

Given the nature of the investments, return smoothing is a concern. Private investments require considerable discretion in marking the portfolio net asset value and this process is likely to destroy the covariance structure in returns and lead to downward biased estimates of risk, particularly over economically benign periods. Evidence from hedge fund returns suggests that unconditional (Asness, Krail, and Liew (2001), Getmansky, Lo, and Makarov (2004)) and conditional (Bollen and Pool (2008, 2009)) return smoothing, due to asset illiquidity and discretion in marking portfolio NAVs (Cassar and Gerakos (2011), Cao et al. (2013)), creates a significant downward bias in the measured risks in these portfolios. The challenge is likely to be

[4] Bain & Co. (2015) report that at the end of 2014, PE funds have over $1.2 trillion of dry powder (committed, but non-deployed capital) that is likely to be levered at least 2 times.

greater with a portfolio comprised entirely of private investments. A belief that the reported returns have been smoothed suggests the replicating strategy should primarily focus on matching the unconditional mean return measured over as long a sample period as possible, which is less affected by the smoothing.

B. Replicating Private Equity Returns

Table 1 demonstrates that a strategy that simply selects low EBITDA multiple firms and rebalances to equal-weights each month will match the mean reported private equity return before fees. This portfolio is tilted towards small firms relative to a value-weighted portfolio and consists only of value firms, two characteristics that are both related to subsequent returns and to the empirical selection criterion that appears to be used when publicly traded firms are targeted by private equity investors. Interestingly, this portfolio does not make use of leverage to match the mean private equity return. To the extent that the characteristic-matching of the investments in this portfolio and the private equity selection model are compelling, the risks of this portfolio should be indicative of the underlying risks of the private equity investments. The standard deviation is 19.4%, the market beta is 1.0, and the worst drawdown, occurring in 2008, is -61%. These risk properties fail to match those of the private equity returns. To the extent that the risk properties of private equity have been distorted through a discretionary marking-to-market process, the monthly rebalanced portfolio will be unable to replicate this distortion. The relatively frequent rebalancing of publicly traded securities offers little discretion in marking-to-market.[5]

[5] This monthly rebalanced replicating strategy is similar to one described by Chingono and Rasmussen (2015).

The private equity index is unlikely to represent a highly stable asset class as the industry composition is likely to change, leverage varies through time, and capital calls (investor flows) can significantly change the weights of new investments relative to older ones. In light of these issues, I proceed by first constructing a long-term buy-and-hold strategy that selects firms with low EBITDA multiples, combined with modest amounts of broker-supplied leverage through a portfolio margin account designed to mimic the underlying exposures of the private equity index. Second, I demonstrate how a conservative cash flow based net asset value rule, as opposed to a market value based rule, can effectively destroy all evidence of market beta and drawdowns, while preserving the mean return of the well-marked underlying portfolio over the sample period.

B.1. Constructing a Replicating Portfolio

At the end of each month from 1980 to 2014, all publicly traded firms listed on CRSP are sorted based on their EBITDA multiple, as calculated earlier. Firms with M_{EBITDA} in the bottom three deciles of the monthly distribution are selected to be included in the replicating portfolio. This choice reflects the tendency for private equity firms to select firms with low EBITDA multiples in the public deals analyzed in Tables 3 and 4 and for these value firms to be associated with relatively high average realized returns as demonstrated in Table 1.

A constant target portfolio leverage, L, of 2.0x is assumed based on the tendency for private equity transactions to increase the leverage of the underlying firms selected. Here, leverage is applied to the portfolio through a margin account. The typical publicly traded firm has a market debt-to-value ratio of roughly 30% (Assets/Equity = 1.43), while this ratio is increased to nearly 70% (Assets/Equity = 3.33) as the result of a private equity transaction (Axelson, Jenkinson, Strömberg, and Weisbach (2013)). An outside investor holding the pre-

LBO equity, but wanting the post-LBO levered return would need to apply portfolio leverage, measured as portfolio assets divided by portfolio equity capital, of 2.3x = 3.33 / 1.43. Borrowed funds are assumed to pay the one-month U.S. Treasury bill yield.

As argued earlier, a crucial component of the portfolio strategy is a fairly long holding period, providing some scope for discretion in the calculation of the portfolio net asset value. Investments are held in the replicating portfolio for 4 years in the portfolio referred to as Strategy 1. Over the course of a long holding period, many stocks initially selected for their value properties will no longer have these properties. Therefore, Strategy 2, which otherwise has identical portfolio management rules, exits individual positions that have realized annualized returns of 50% in addition to those that have been held for four years. This triggers nearly half of the positions to be liquidated prior to the four year default holding period.

Due to the long-term holding periods and the buy-and-hold strategy, portfolio weights for newly added positions are determined each month by calculating a target number of holdings as the sum of current positions plus the number of additions less the number of firms exiting the portfolio. The current equity capital times target portfolio leverage divided by the target number of holdings determines the amount that is equally invested in each new addition. This results in the realized portfolio leverage varying slightly through time.

B. 2. A Portfolio Marking Rule based on Portfolio Cash Flows

A portfolio consisting of long positions of liquidly traded securities like publicly traded equities is typically 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 over time by cumulating the daily profits and losses for the underlying securities based on daily changes in market values, net of interest expenses. Portfolio transactions to include or eliminate positions do not alter the equity capital since the cash flow associated with these transactions is assumed to occur precisely at the market value. For example, selling 100 shares of a stock at $20 per share, reduces the value of the stock holdings by $2,000 and increases the cash (or reduces the borrowing) by the same $2,000, leaving the equity value unaltered.

To investigate the scope for discretion in marking the portfolio net asset value when positions are held for long periods of time, I consider a simple hold-to-maturity accounting scheme that measures positions at their purchase price until they are sold. This is similar to the accounting rules for large U.S. banks for positions that are classified as "hold-to-maturity" investments. Under this accounting scheme, daily fluctuations in the prices of underlying investments do not impact the daily portfolio net asset value. Instead, the daily portfolio net asset value changes based primarily on the cumulative profit and loss of positions at the time of liquidation. Interest expenses and dividends will have a small periodic effect on the portfolio book value, but the majority of the variation in the portfolio net asset value will occur when the portfolio is rebalanced to eliminate positions. Selling 100 shares of a stock at $20 per share, that were originally purchased for $15 per share, reduces the book value of the stock holdings by $1,500 and increases the cash (or reduces the borrowing) by the transaction value of $2,000, thereby increasing the equity value by $500. Over a long time period, where the terminal portfolio book value is near its market value, the mean returns under these two accounting schemes will be similar, but the book value accounting scheme will alter the timing of the portfolio profits and losses, thereby distorting the covariance structure in returns relative to portfolio returns that make use of the mark value based accounting scheme, as in factor model regressions.

B. 3. Summarizing the Returns

Table 6 reports summary statistics for the returns on the two replicating portfolios, under both the market value and hold-to-maturity accounting schemes. Panel A reports results for portfolios that are marked-to-market value based on month-end security prices as reported in CRSP. Panel B reports results under the portfolio hold-to-maturity accounting scheme described above, with portfolio values primarily being updated when positions are liquidated.

Panel A shows that Strategy 1 earns an annualized excess return of 21% over the sample period, which is somewhat higher than the pre-fee private equity excess return of 16%. Similarly, Strategy 2, designed to more accurately represent a portfolio comprised of value stocks, earns an annualized excess return, averaging 19% over the period.

The risks of both replicating portfolios are extreme. Both replicating Strategy 1 and Strategy 2 experience a massive drawdown during the financial crisis of 2008, with both portfolios losing more than 85% of their value relative to their historical peak valuation. Arguably, this is consistent with secondary market transaction prices of private equity investments at the time. For example, in February 2009, Forbes describes the gap between market transaction values and the asset values reported by some of the private equity firms in the Harvard University endowment, managed by Harvard Management Company (HMC).[6]

> Mendillo did move quickly to deal with the private equity portfolio. One of her first moves at HMC, which she initiated before the markets started to fall in earnest, was to sell between $1 billion to $1.5 billion of Harvard's private equity assets in one of the biggest such sales ever attempted. The high bids on such assets have recently been 60 cents on the dollar, says Cogent Capital, an investment bank that advised Harvard on the sale. Cogent says the big discounts are due to "unrealistic pricing levels at which funds continued to hold their investments" and "fantasy valuations."

[6] http://www.forbes.com/2009/02/20/harvard-endowment-failed-business_harvard.html.

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> So what are Harvard's private equity stakes worth? Most private equity investors like Harvard have been waiting for their money managers to finish marking down their assets following a brutal 2008. It is a slow process that lags the public markets by as much as 180 days, says William Frieske, a performance consultant at Northern Trust, which administers endowment accounts.
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> But one clue to what may be coming can be found in Harvard's own portfolio. It owns units of Conversus Capital, a publicly traded vehicle that holds slices of 210 private equity funds. Conversus has cut its net asset value by 21% since last summer to make a "best estimate." Yet stock investors think things are a lot worse. Conversus shares have fallen 67% since June 30 and are trading at a 62% discount to the net asset value.

The estimated market betas of the replicating portfolios are 1.9 and 1.5, which is in line with what is expected for portfolios targeting leverage of 2x. Interestingly, the CAPM alpha for the Strategy 1 replicating portfolio is not reliably different from zero, although the point estimate is economically large at 7% per year. The Strategy 2 replicating portfolio, which liquidates positions after high realized returns in an attempt to more accurately maintain a value portfolio, has a marginally statistically significant alpha of 7% per year (*t*-statistic = 2.15).

The massive drawdowns in 2008 for the replicating portfolios are striking. The drawdown based on reported returns for private equity is only -20%. If the replicating portfolios are properly reflecting the risks, how can discretion in marking-to-market reduce the appearance of the risks so dramatically? The results in Panel B suggest a possibility. Panel B repeats the analysis shown in Panel A for the same two replicating portfolios, but under the hold-to-maturity accounting scheme. In other words, all transactions and portfolio holdings are identical under each accounting scheme, only the calculation of the portfolio net asset value is different. Consequently, the mean excess returns continue to be large, averaging 15.8% and 15.0% per year for Strategy 1 and Strategy 2, respectively.[7] More interestingly, the annualized volatility, the worst drawdown, and the market beta indicate that these portfolios have very little risk. The market betas for both replicating portfolios are statistically indistinguishable from zero, whereas they were 1.9 and 1.5 with market value accounting. Remarkably, the worst drawdowns for the replicating portfolios with book value accounting are only -15% and -7%, whereas the identical portfolios with market value accounting exceeded -85%. As a consequence of the highly biased risk properties of these portfolios due to the book value accounting scheme, the resulting measures of risk-adjusted returns suggest highly significant unearned returns, or annualized alpha, averaging 15.8% for Strategy 1 and 15.0% for Strategy 2. These results clearly do not establish that private equity returns have distorted risks because of discretion in the marking of the net asset value, but do demonstrate that discretion in marking the portfolio net asset value can eliminate most of the measured risk. Moreover, this is a legitimate portfolio marking rule that is supported by market regulators for firms that are identified as systematically important for financial stability.

Taken at face value, the results in Table 6 push against the view that private equity adds value relative to what can be earned in public markets. Popular stories suggest that private equity investors add value through operating improvements, preferred access to financial leverage, and improved monitoring and governance. These stories most clearly map into private equity investments delivering higher mean returns than similarly selected public equities held with

[7] Note that since the returns at the end of the sample are relatively large and that the replicating portfolio is not liquidated at the end of the sample, the hold-to-maturity net asset value is considerably lower than the market value at the end of the sample. The terminal portfolio NAV discount from market value is 33% for Strategy 1 and 19% for Strategy 2.

similar amounts of leverage, but this does not appear to be the case *before fees*. After paying fees, which are estimated to be over 6% per year, investors who agree that the risk-match between the private equity index and the two replicating portfolios is appropriate are considerably underperforming the feasible alternative of investing in similar passive replicating portfolios.

IV. Discussion

The potential for highly smoothed returns is the critical feature of the data that will govern how the results are interpreted. Smoothed returns hinder traditional risk adjustment, allowing for highly competing beliefs about private equity performance to be sustained. The private equity structure – here viewed to be the combination of a value stock selection criterion, long holding periods, conservative net asset value accounting, and active management at the portfolio companies, including increased leverage – can mostly be reproduced with a passive portfolio strategy. The element that cannot be well reproduced is the active management at the portfolio companies, which necessitates the long holding periods. Concurrently, effective return smoothing, whether intentional or simply consequential, requires relatively long holding periods. This section evaluates how the various elements of the private equity structure contribute to performance, beginning with the robustness of the risk-match of the replicating portfolio strategy.

A. Have the Risks been Properly Matched?

Investors may not view the characteristic-matched and leverage-matched replicating portfolio to appropriately describe the risks of diversified private equity allocations. There will always be some uncertainty around this question. The empirical strategy in the previous section is to match the sample characteristics that are known to be linked to realized returns and to apply portfolio leverage to reproduce the increased corporate leverage typical in a private equity transaction. Rather than focus on the subtleties of precise factor exposures, the main investigation here is on whether the market betas of the replicating portfolios are plausible.

A reasonable starting point is that the equity market beta for a random firm is 1.0, such that if it is held in a portfolio with 2x leverage, the resulting equity component of the portfolio will have a market beta of 2.0. The average market beta for the sample of public firms taken private over the period 1984 to 2014 at the time of the transaction is 1.1.[8] According to Axelson, Jenkinson, Strömberg, and Weisbach (2013) the average corporate leverage more than doubles as a consequence of a private equity transaction. Together, these facts suggest that the replicating portfolio betas reported in Table 6, which range from 1.5 to 1.9, are likely to be conservative relative to those of actual private equity investors. These estimates stand in striking contrast to the market betas estimated directly from the Cambridge Associates Private Equity Index, which range from 0.4 to 0.7 depending on whether quarterly or annual returns are used.

Another perspective on the market betas for private equity investments can be gleaned from the market betas of PE-backed debt that was relatively actively traded during the financial crisis of 2008. Specifically, I identify all US corporate bonds in the Dealscan Facilities database issued prior to 2008, where the primary purpose is "LBO." Transaction prices and dates for these bonds are collected from Trace. For the sample of LBO-issued bonds with at least one transaction in each time period July 1, 2008 to August 31, 2008 and September 15, 2008 to

[8] This is roughly consistent with Frazzini and Pedersen (2013) who find the average beta for firms taken private to be 0.94 using a different procedure for estimating market beta.

March 31, 2009, I determine the median pre-crisis bond price and date and the low bond price and date during the crisis period, along with the corresponding S&P 500 Index return. There are 361 LBO-issued bonds with valid returns. The average bond return into the depths of the financial crisis is -39%, while the average calendar-time matched S&P 500 return is -29%. The mean difference of -9.8% has a *t*-statistic of -10.6. The ratio of the mean bond return to the mean market return provides a rough estimate of the PE-backed bond market beta, which equals 1.3. As the junior most claim in the capital structure, the equity of these firms is surely riskier than the associated bonds, consistent with the estimated replicating portfolio market betas.

B. Where does the Private Equity Investment Structure Add Value?

There are several distinctive elements of the private equity structure that are commonly viewed to add value. Among these are investment selection and the active engagement in the operating and financing policies at the portfolio companies. The passive replicating portfolio attempts to mimic the investment selection and the long holding periods, but clearly fails to carry out any operational or organization change.

To match the high pre-fee private equity returns with 2x portfolio leverage, it is important to select value firms. A similar replicating strategy (2x leverage with a four-year holding period) applied to a universe of all US public equities reproduces the high volatility and market beta of the replicating portfolios summarized in Table 6, but delivers a smaller mean annualized return of 14% when compared to the 20.6% mean annualized return on the portfolio of value stocks. The value tilt in private equity has been effective over the sample period. It is also interesting to note that private equity investors appear to have not pursued the low risk anomaly. Based on the public to private sample firms, the average market beta and volatility of PE-selected firms are indistinguishable from the mean values of the public equity market universe. Low risk stocks, in terms of market beta or volatility, would more efficiently support the use of high leverage over this sample period (Baker and Wurgler (2015)).

Previous research has documented that LBO firms experience, on average, improvement in operating margins (Kaplan (1989)). Given the passive nature of replicating strategy summarized in Table 6, any changes in the operating margins of firms held by the replicating portfolio are simply a feature of the average value stock experience. Figure 2 displays the time series of a few characteristics of the replicating portfolio companies. All data are reported as of the investment initiation date, averaged by year. For example, the 1990 value is calculated as the average metric at the time of purchase for all stocks initially included in the replicating portfolio in 1990, and the average metric at the time of eventual sale for these stocks. The first panel shows the average EBITDA multiple, confirming that the replicating portfolio buys low multiple stocks, which have consistently tended to mean-revert toward the market-wide average. The second panel plots the average operating margin for the replicating portfolio companies through time. At the time of the initial investment by the replicating strategy, average operating margins are roughly equal to the market-wide average, and tend to decline over the holding period. This provides additional support to the findings of Kaplan (1989) and others, suggesting that private equity improves operating margins relative to otherwise similar, but untreated firms.

C. Where does the Private Equity Investment Structure not Add Value?

There are two claimed benefits of the private equity investment structure that outside investors commonly promote that appear to be incorrect. These are (1) the long-term corporate debt used to increase leverage at portfolio companies provides the outside equity investors access to an advantaged form of leverage that allows them to avoid the economic costs associated with margin calls; and (2) holding illiquid assets allows long horizon outside equity investors to earn an illiquidity premium. The key challenge to both of these views is that they should show up in returns, but do not.

The first story involves both lenders and outside equity investors who presumably have a proper understanding of the high systematic risks of private equity. The lenders offer attractive long-term debt terms to portfolio companies because they forecast that loss rates will be relatively low.[9] The outside equity investors want large allocations to value stocks, but view the possibility of margin calls to be economically costly.

As a stand-alone portfolio, Strategy 1 will receive a margin call in 2008 and Strategy 2 will come close to receiving one. Of course, these exposures do not need to be held in stand-alone portfolios. Investors in private equity funds are typically well diversified, holding large public stock and bond portfolios in addition to their private equity allocations. Consider an endowment fund with a 20% allocation to private equity and an 80% allocation with a traditional mix of 60% public stocks and 40% bonds (i.e. 20% private equity, 48% public equity, and 32% bonds). The arguments and evidence in this paper suggest that the 20% private equity allocation can be viewed as a levered value stock allocation with systematic risks equivalent to 30% public stocks and -10% bonds, resulting in an overall endowment portfolio allocation equivalent to 78% stocks and 22% bonds. Such a portfolio will not be at risk of a margin call. This suggests that the economic costs of margin calls on well-marked portfolios can be effectively avoided for most private equity investors who have the institutional flexibility to manage exposures from the perspective of the overall portfolio.

[9] There is some evidence supporting this view. The Private Equity Council (2010) finds that during the 2008-2009 recession, PE-backed firms had a default rate of 2.8%, while similar firms had a default rate of 6.2%.

The notion that one earns an illiquidity premium from private equity investments is explicitly noted by some private equity investors. For example, the Harvard Management Company (HMC) 2013 Annual Report states: "When we invest in private equity, we lock up Harvard's money for multiple years. In exchange for that lock-up we expect to earn returns over time that are in excess of the public markets – an "illiquidity premium."[10] While these investments are in fact illiquid, they appear to not earn an illiquidity premium, as demonstrated by the passive liquid replicating portfolios having higher mean returns.

D. Some Underappreciated Costs of the Private Equity Investment Structure

The long holding periods of the private equity structure support the operational improvements that are realized by PE-backed firms. At the same time, there appear to be some material costs associated with long holding periods that more than offset the benefits.

The first of these subtle costs relates to the foregone benefit of rebalancing a value stock portfolio. A simple comparison of the results in Tables 1 and 6 show that long holding periods are costly to a value stock investment strategy. The Sharpe ratio for the monthly rebalanced value portfolios in Table 1 are considerably higher than those of the infrequently rebalanced portfolios summarized in Table 6. As noted earlier, many value stocks do not remain value stocks for long periods. Strategy 2, reported in Table 6, attempts to minimize the cost of holding value stocks once they have realized a high return and no longer are expected to outperform, and consequently achieves a higher Sharpe ratio than Strategy 1.

[10] In 2013, the Harvard endowment allocated 16% of its total portfolio to private equity.

A second advantage that the passive replicating portfolio has over the actively managed private equity structure is that these portfolios do not compete in bidding wars and do not pay takeover premia. The passive replicating portfolio purchases small fractions of the outstanding equity, avoiding the takeover, or control, premia typical in full-firm transactions. Control premia in the market for private firms have likely increased over time, as many private firm investments are now the result of a competitive auction process.

Another potentially large cost of the private equity structure arises from conservativism in the reporting of net asset values. Institutions with large allocations are likely either have significantly more risk than they realize and/or to have a meaningful internal agency conflict. Conditional on allocating any capital to private equity, investors typically have large allocations (Lerner, Schoar, and Wang (2008)).

To reconcile the large allocation with a proper understanding that the systematic risks are high and that the returns are somewhat lower than what can be earned passively with improved liquidity, it is possible that there are significant institutional constraints that lead sophisticated investment entities to prefer “hidden” or smoothed risks. For example, underfunded pensions need investments that are expected to deliver high returns, but well-marked portfolios that indicate high risks may not be institutionally feasible. Conservative portfolio marking may allow such allocations to occur. The fee for this service is economically large, including the 6% average all-in management fee, as well as the underperformance of the PE index relative to the risk-matched passive portfolio.

Under the alternative view that the market risk of private equity is falsely viewed to be low (say 0.7, as would be estimated from the annual returns in Table 5) when it is actually high (say 1.5, as argued above), it is likely that the high returns would appear to be compensation for illiquidity. Such an error in the risk assessment of private equity could produce large over-allocations to private equity by some investors who would consequently bear considerably more market risk than appreciated.

Consider again the HMC private equity allocation. In 2013, the Harvard endowment allocated 16% of its total portfolio to private equity, while benchmarking itself against a 60% stock and 40% bond portfolio. In terms of the benchmark market beta, the private equity allocation contributes roughly 1.5 / .6 = 2.5 times as much market exposure, such that the 16% private equity allocation is equivalent to 40% of the benchmark market exposure.

V. Conclusion

A popular belief about private equity is summarized in the following anonymous quote: “there are some things you simply cannot do as a public firm that you can do as a private firm.” This is likely to be true. Firms are likely to benefit from the active operating and financial management provided by private equity investors. At the same time, it appears that private equity investors overpay for the opportunity to provide these services.

This paper studies the asset selection of private equity investors and the risk and return properties of passive portfolios with similarly selected investments in publicly traded securities. Private equity investors tend to select relatively small firms with low EBITDA multiples. The reported private equity returns have little measured risk with market betas significantly below 1 and the worst time series drawdown in 2008 only -20%. Buy-and-hold portfolios comprised of firms with similar characteristics earn high risk-adjusted returns, exceeding the mean pre-fee private equity return with target portfolio leverage chosen to match the levered returns accruing inside private equity funds. However, the measured risks of replicating portfolios are high under traditional market-value based net asset value reporting, with market betas near 2 and the worst time series drawdown in 2008, near -90%. I demonstrate that a hold-to-maturity accounting scheme for measuring portfolio net asset value used to mimic the discretion available to private equity fund managers effectively eliminates the majority of measured risks for the replicating portfolios. The results indicate that sophisticated institutional investors appear to significantly overpay for the portfolio management services associated with private equity investments.

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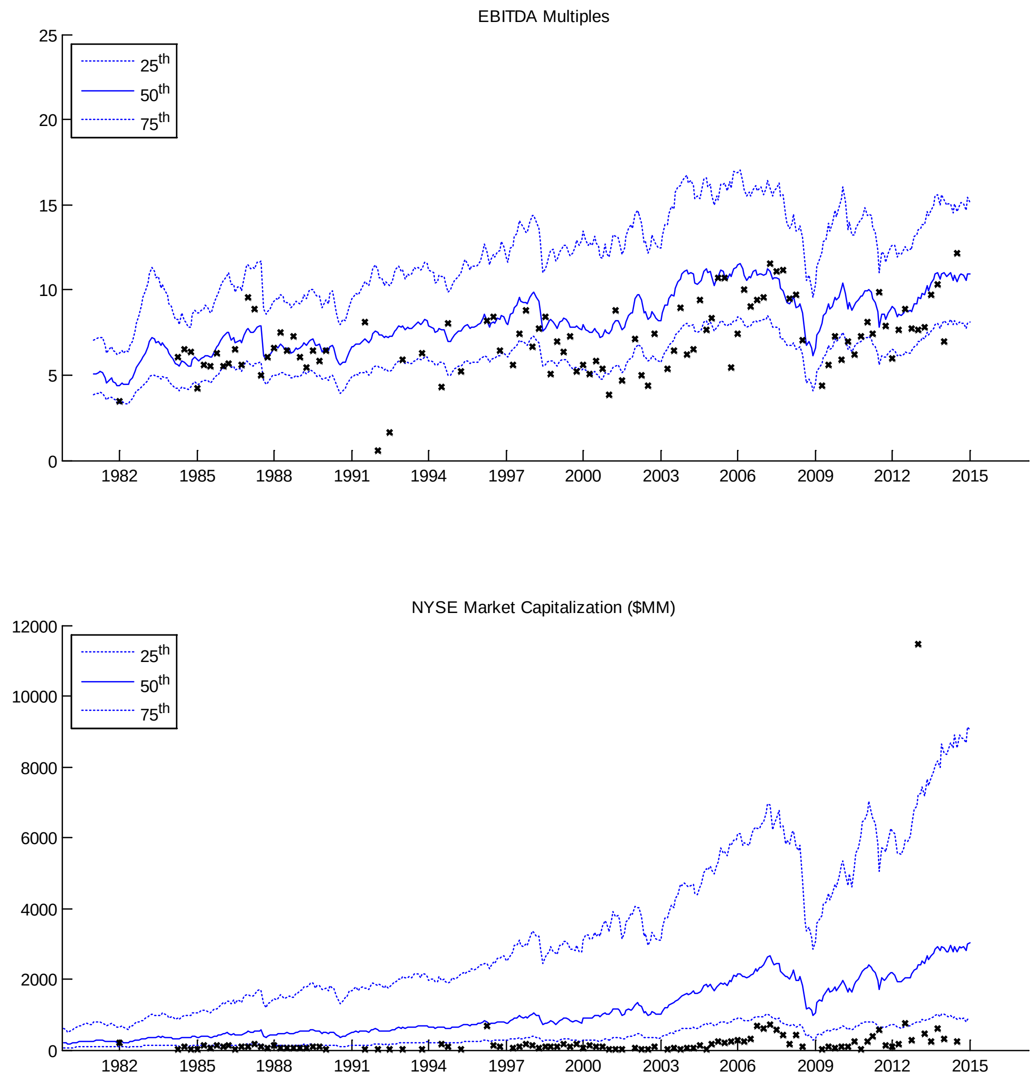

Figure 1. Characteristics of Public Equities Taken Private Relative to All Publicly Traded Equities.

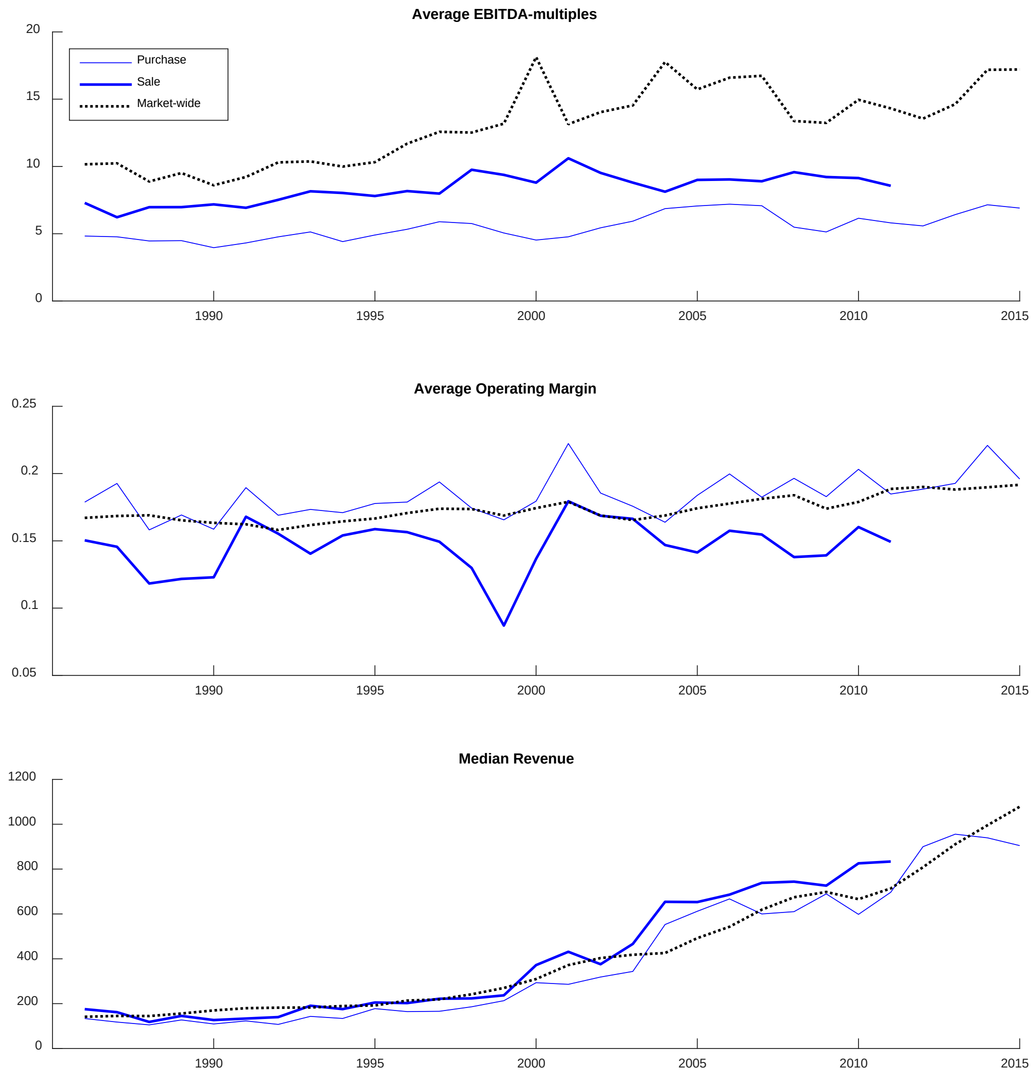

Figure 2. Time Series Characteristics of Replicating Portfolio Investments

Table I
Average excess and abnormal returns for portfolios formed on EBITDA multiples (1986-2015)

Each month from January 1983 to June 2015, 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. The EBITDA multiple for each firm is calculated as the ratio of firm market value to earnings before interest, taxes, depreciation, and amortization. The firm market value is the sum of long term debt and the market value of equity. Equity market values are assumed to be reported with no delay, while accounting information (long term debt and EBITDA) are assumed to be reported with a three month delay. The annualized excess return is calculated as the average monthly 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	0.195	0.145	0.103	0.075	0.046	0.150
Annualized Standard Deviation	0.193	0.169	0.161	0.166	0.203	0.106
Sharpe Ratio	1.01	0.86	0.64	0.45	0.23	1.41
CAPM alpha (%)	1.09	0.69	0.35	0.09	-0.18	1.27
t-statistic	(5.25)	(4.14)	(2.32)	(0.59)	(-0.81)	(8.18)
FF 3-factor alpha (%)	0.80	0.45	0.17	-0.04	-0.18	0.99
t-statistic	(5.55)	(4.25)	(1.88)	(-0.42)	(-1.42)	(8.44)
FF 5-factor alpha (%)	1.09	0.66	0.33	0.13	0.10	0.99
t-statistic	(9.35)	(8.78)	(5.52)	(2.06)	(1.56)	(8.52)
FF 5-factor plus UMD alpha (%)	1.25	0.77	0.39	0.16	0.11	1.14
t-statistic	(13.56)	(13.43)	(7.22)	(2.73)	(1.79)	(11.75)

Panel B: Value-weights	Low	2	3	4	High	L-H
Annualized Excess Return	0.134	0.102	0.077	0.061	0.056	0.078
Annualized Standard Deviation	0.179	0.147	0.147	0.155	0.198	0.134
Sharpe Ratio	0.75	0.70	0.52	0.39	0.28	0.58
CAPM alpha (%)	0.53	0.34	0.10	-0.07	-0.18	0.72
t-statistic	(3.37)	(3.05)	(1.04)	(-0.67)	(-1.04)	(3.67)
FF 3-factor alpha (%)	0.41	0.22	0.04	-0.07	-0.02	0.43
t-statistic	(2.71)	(2.11)	(0.39)	(-0.71)	(-0.14)	(2.61)
FF 5-factor alpha (%)	0.72	0.38	0.15	0.03	0.29	0.42
t-statistic	(6.00)	(4.39)	(2.25)	(0.49)	(3.25)	(2.47)
FF 5-factor plus UMD alpha (%)	0.82	0.45	0.18	0.04	0.27	0.55
t-statistic	(7.37)	(5.78)	(2.79)	(0.51)	(2.95)	(3.41)

Table II
Fama–MacBeth Regressions of Monthly Returns on Stock Characteristics

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. The time period is January 1986 to June 2015. *t*-statistics are reported in parentheses.

Regression Number	Constant	Beta	ln(ME)	ln(BE/ME)	ISS	ln(M_{EBITDA})
1	0.91	0.06				
	(5.79)	(0.40)				
2	2.34		-0.11			
	(4.60)		(-3.22)			
3	1.12			0.32		
	(4.51)			(3.85)		
4	1.02				-0.58	
	(4.23)				(-4.81)	
5	2.37					-0.64
	(8.51)					(-8.19)
6	2.29			0.11		-0.60
	(8.61)			(1.45)		(-8.70)
7	1.85	0.15	-0.08	0.18		
	(3.99)	(0.93)	(-2.17)	(2.29)		
8	3.05	0.21	-0.09	-0.02		-0.59
	(6.84)	(1.36)	(-2.42)	(-0.28)		(-10.20)
9	2.30				-0.39	-0.60
	(8.12)				(-3.48)	(-7.93)
10	1.13			0.29	-0.52	
	(4.58)			(3.60)	(-4.38)	
11	1.95	0.20	-0.09	0.16	-0.57	
	(4.24)	(1.28)	(-2.50)	(2.00)	(-6.46)	
12	3.06	0.25	-0.09	-0.03	-0.45	-0.56
	(6.86)	(1.64)	(-2.68)	(-0.39)	(-5.32)	(-9.77)

Table III
Regressions Explaining the Selection of Public Equities taken Private (1984-2014)

This table reports the results of 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. 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), 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 time period is 1983 to 2014. All specifications include year fixed effects. *t*-statistics are reported in parentheses.

Panel A: OLS Regressions

Regression Number	Beta	ln(ME)	ln(Sales)	ln(BE/ME)	ISS	ln(M_{EBITDA})	ln(Profit)	D/V
1	-0.15							
	(-2.89)							
2		-0.18						
		(-10.46)						
3			-0.09					
			(-4.69)					
4				0.34				
				(7.89)				
5					-0.52			
					(-5.12)			
6						-0.45		
						(-8.51)		
7							-0.24	
							(-5.49)	
8								0.32
								(2.05)
9	-0.04	-0.14		0.00	-0.47	-0.36	-0.18	-0.01
	(-0.70)	(-7.19)		(0.07)	(-4.42)	(-5.67)	(-3.58)	(-0.08)
10	-0.04		-0.13	0.02	-0.46	-0.49	-0.31	0.21
	(-0.69)		(-6.44)	(0.40)	(-4.34)	(-7.55)	(-6.52)	(1.17)
11	-0.03	-0.16		0.06	-0.49	-0.28		-0.08
	(-0.50)	(-8.41)		(1.14)	(-4.63)	(-4.76)		(-0.46)
12	-0.02		-0.11	0.18	-0.46	-0.35		0.02
	(-0.42)		(-5.55)	(3.37)	(-4.35)	(-5.69)		(0.14)

Table III - continued

Panel B: Logistic Regressions

Regression Number	Beta	ln(ME)	ln(Sales)	ln(BE/ME)	ISS	ln(M_{EBITDA})	ln(Profit)	D/V
1	-0.18							
	(-2.80)							
2		-0.24						
		(-10.44)						
3			-0.11					
			(-4.69)					
4				0.43				
				(8.08)				
5					-0.78			
					(-5.48)			
6						-0.61		
						(-8.71)		
7							-0.27	
							(-5.49)	
8								0.39
								(2.07)
9	-0.04	-0.18		-0.01	-0.65	-0.43	-0.20	0.05
	(-0.63)	(-6.95)		(-0.13)	(-4.60)	(-5.39)	(-3.42)	(0.24)
10	-0.04		-0.16	0.02	-0.65	-0.59	-0.37	0.32
	(-0.64)		(-6.21)	(0.26)	(-4.55)	(-7.31)	(-6.42)	(1.55)
11	-0.03	-0.21		0.06	-0.67	-0.35		-0.04
	(-0.45)	(-8.08)		(0.81)	(-4.73)	(-4.55)		(-0.18)
12	-0.03		-0.14	0.21	-0.64	-0.44		0.06
	(-0.44)		(-5.31)	(3.01)	(-4.50)	(-5.50)		(0.29)

Table IV

Sub-Sample Logistic Regressions Explaining the Selection of Public Equities taken Private

This table reports the results of logistic regressions of a binary variable indicating a public equity was taken private on various lagged firm characteristics. Panel A reports results for the period 1984 to 1999. Panel B reports results from the period 2000 to 2014. Beta is the estimated slope coefficient from a regression using the past 60 months of excess returns (requiring at least 36 valid returns), 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), 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. All specifications include year fixed effects. *t*-statistics are reported in parentheses.

Panel A: Logistic regressions (1984 to 1999)

Regression Number	Beta	ln(ME)	ln(Sales)	ln(BE/ME)	ISS	ln(M_{EBITDA})	ln(Profit)	D/V
1	-0.14							
	(-1.20)							
2		-0.16						
		(-4.62)						
3			-0.06					
			(-1.52)					
4				0.28				
				(3.12)				
5					-0.74			
					(-3.45)			
6						-0.68		
						(-5.93)		
7							-0.30	
							(-3.74)	
8								-0.08
								(-0.28)
9	0.02	-0.11		-0.20	-0.61	-0.71	-0.36	-0.20
	(0.19)	(-2.73)		(-1.75)	(-2.82)	(-5.18)	(-3.83)	(-0.64)
10	0.02		-0.10	-0.19	-0.61	-0.82	-0.46	-0.03
	(0.19)		(-2.64)	(-1.69)	(-2.81)	(-5.99)	(-5.07)	(-0.10)
11	0.05	-0.15		-0.08	-0.64	-0.55		-0.28
	(0.39)	(-3.81)		(-0.68)	(-2.98)	(-4.18)		(-0.88)
12	0.04		-0.08	0.03	-0.58	-0.62		-0.23
	(0.31)		(-1.98)	(0.27)	(-2.68)	(-4.61)		(-0.70)

Table IV - continued

Panel B: Logistic regressions (2000 to 2014)

Regression Number	Beta	ln(ME)	ln(Sales)	ln(BE/ME)	ISS	ln(M_{EBITDA})	ln(Profit)	D/V
1	-0.20							
	(-2.56)							
2		-0.30						
		(-9.78)						
3			-0.16					
			(-4.88)					
4				0.51				
				(7.83)				
5					-0.81			
					(-4.29)			
6						-0.57		
						(-6.44)		
7							-0.25	
							(-4.04)	
8								0.71
								(3.01)
9	-0.09	-0.24		0.07	-0.66	-0.28	-0.11	0.23
	(-1.12)	(-6.78)		(0.83)	(-3.53)	(-2.93)	(-1.45)	(0.91)
10	-0.09		-0.21	0.12	-0.66	-0.48	-0.32	0.60
	(-1.11)		(-5.95)	(1.36)	(-3.52)	(-4.81)	(-4.36)	(2.19)
11	-0.08	-0.25		0.11	-0.67	-0.25		0.17
	(-1.04)	(-7.40)		(1.23)	(-3.57)	(-2.61)		(0.66)
12	-0.08		-0.18	0.28	-0.66	-0.35		0.30
	(-1.00)		(-5.33)	(3.36)	(-3.52)	(-3.58)		(1.11)

Table V
Summary of Private Equity Excess Returns

This table reports summary statistics for private equity excess returns, reported in percentage. All returns are measured in excess of the one-month U.S. Treasury bill return. Quarterly net-of-fee returns come from the Cambridge Associates Private Equity Index and cover the period 1986Q1 to 2014Q4. The pre-fee returns are calculated assuming that the observed net-of-fee time series represents the return of a representative fund that is at its high watermark throughout the sample, charging a 2% flat fee plus a 20% performance fee, both payable quarterly on positive returns. The public market returns are those of the value-weight CRSP market index. Panel A reports summary statistics from the annual returns, which are compounded from the quarterly returns. Panel B reports summary statistics from the quarterly returns. The Sharpe ratio is calculated as the mean annualized excess return divided by the annualized standard deviation. Beta is the slope coefficient from a regression of portfolio excess returns on the market excess return and alpha is the intercept from this regression. Drawdown is the minimum index value relative to its previous maximum value in percent.

Year	Pre-Fee Private Equity Index	Net-of-Fee Private Equity Index	Public Market Equity Index
1986*	0.45	-2.05	-3.21
1987	1.81	-1.74	-3.87
1988	11.62	5.65	11.54
1989	7.26	1.83	20.50
1990	1.64	-2.38	-13.96
1991	10.16	4.70	29.15
1992	18.14	11.37	6.25
1993	31.09	21.33	8.22
1994	15.86	9.51	-4.11
1995	28.63	18.84	31.20
1996	33.10	22.27	15.96
1997	38.06	26.05	25.96
1998	18.93	10.78	19.47
1999	54.76	38.69	20.56
2000	4.37	-0.24	-17.59
2001	-14.08	-15.82	-15.19
2002	-8.12	-9.28	-22.75
2003	29.58	21.20	30.76
2004	34.91	24.76	10.74
2005	36.52	25.43	3.08
2006	35.07	23.90	10.61
2007	23.09	14.86	1.01
2008	-23.24	-23.91	-38.34
2009	19.88	13.31	28.27
2010	29.29	20.66	17.38
2011	17.47	11.31	0.42
2012	20.73	14.13	16.26
2013	30.18	21.34	35.18
2014	16.77	11.09	11.70
Panel A: Based on annual returns			
Mean	18.07	10.95	8.11
Std	17.21	13.80	17.92
Sharpe	1.05	0.79	0.45
Beta	0.69	0.56	1.00
Alpha	12.49	6.42	0.00
Panel B: Based on quarterly returns			
Mean x 4	16.27	10.06	7.78
Std x sqrt(4)	11.49	9.57	17.06
Sharpe	1.42	1.05	0.46
Beta	0.47	0.40	1.00
Alpha x 4	12.59	6.98	0.00
Drawdown	-24.31	-25.56	-45.08

Table VI
Return Summary for Replicating Portfolios

This table reports summary statistics and the results of regressions of monthly portfolio excess returns. Panel A displays results under market value accounting and Panel B reports results under book value accounting. Two different replicating portfolios are constructed. Both Strategy 1 and Strategy 2 are buy-and-hold portfolios that, each month, select all stocks with M_{EBITDA} in one of the bottom three deciles of the monthly distribution. Both portfolios target leverage of 2x, defined as the ratio of the current market value of portfolio holdings divided by the current equity capital of the portfolio. All stocks remain in the portfolio for four years in Strategy 1, while each month Strategy 2 sells positions that have realized an annualized holding period return in excess of 45%. The Sharpe ratio is the annualized mean excess return divided by the annualized standard deviation. The drawdown is measured each month as the current price level measured as a percentage of the historical maximum price level up to that month. Alpha corresponds to the intercept from the regression of monthly portfolio excess returns on the corresponding excess return on the value-weight market portfolio, Beta is the slope coefficient from this regression, and R^2 is the R-squared. M_{EBITDA} is as defined in Table I. The time period is 1986Q2 to 2015Q2. *t*-statistics are reported in parentheses.

Panel A: Market value accounting scheme for portfolio net asset value

	Strategy 1			Strategy 2		
Annualized mean excess return		20.6%			18.7%	
Annualized standard deviation		36.1%			29.9%	
Sharpe ratio		0.57			0.62	
Minimum drawdown		-89.9%			-86.0%	
Average portfolio leverage		1.89x			1.65x	
Terminal discount from MV		0.0%			0.0%	
CAPM regression	Alpha	Beta	R^2	Alpha	Beta	R^2
Coefficient	0.0057	1.86	0.64	0.0061	1.53	0.63
t-statistic	(1.68)	(24.98)		(2.15)	(24.35)	

Panel B: Hold-to-maturity accounting scheme for portfolio net asset value

	Strategy 1			Strategy 2		
Annualized mean excess return		15.8%			15.0%	
Annualized standard deviation		8.2%			5.0%	
Sharpe ratio		1.94			2.99	
Minimum drawdown		-15.1%			-6.8%	
Average portfolio leverage		2.33x			1.66x	
Terminal discount from MV		-33.0%			-18.5%	
CAPM regression	Alpha	Beta	R^2	Alpha	Beta	R^2
Coefficient	0.0132	0.00	0.00	0.0125	-0.01	0.00
t-statistic	(10.34)	(0.10)		(16.10)	(0.70)	