Taking the Private out of Private Equity, with the Morningstar PitchBook Buyout Replication Index

Underpinned by PitchBook data and research

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Introducing the Morningstar PitchBook Buyout Replication Index

Key takeaways

- Using take-private transaction data, quarterly financial statements, and stock price data, we created a neural network to systematically capture the fundamental characteristics of buyout investing within a portfolio of public equities. We then adjusted this model-based portfolio for leverage and sector exposures to construct a portfolio that replicates a PE buyout strategy: the Morningstar PitchBook Buyout Replication Index.

- Buyout portfolios have a structural underweight to financial services, which has increasingly been offset by an overweight to information technology. The overweighting to information technology has been a tailwind to relative performance. At year-end 2024, PitchBook's estimate of sector exposures across buyout portfolios indicated an underweight of 15.2% to financial services and an overweight of 13.8% to information technology compared with the Morningstar US Small Cap Extended Index.

- In a backtest starting in 2014 and running through November 2024, the Buyout Replication Index outperformed the Morningstar US Small Cap Extended Index by 6.1 percentage points on an annualized basis. Sector selection, leverage, and security selection contributed 0.9, 1.3, and 3.9 percentage points, respectively, to this outperformance. Free cash flow is a key variable in the security-selection criteria and the best indicator of how buyout managers typically view "value." As of the end of 2024, the Buyout Replication Index had a market-value/free-cash-flow ratio of 28.9x compared with 44.1x for the broader public small-cap universe.

- In addition to being an index built for investability, the Buyout Replication Index can be used by LPs as a better way to benchmark buyout funds that more appropriately captures their risk/return profile than commonly used public equity indexes. An analysis using PMEs revealed that buyout funds launched in 2014 through 2018 performed mainly in line with the Buyout Replication Index.

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Introduction

While PE buyout is often touted as an alternative investment strategy, it shares many of the fundamental investment characteristics of "traditional" public equity strategies. At their cores, both private and public equity investing involve the ownership of current and future earnings of corporate businesses. By extension, managing a portfolio of private companies has key similarities to actively managing an equity portfolio of public companies in terms of generating excess returns, or alpha. The most important of these similarities is security selection, which involves picking individual companies that outperform, and sector selection, which includes allocating more capital to sectors that outperform. Buyout managers have other tools at their disposal that public equity managers do not, however, given that they typically take a controlling ownership position in their portfolio companies. This provides them with an additional alpha opportunity to improve companies' operations (known as operational alpha) and the ability to optimize their capital structures, often through an increased allocation to debt.

Outside of operational alpha, which may be less important to the buyout value proposition than advertised,[1] it may be possible to replicate much of the risk/return profile of buyout investing in the public markets. A key component of this replication is a security-selection model that can identify publicly traded companies with similar characteristics to the companies that buyout managers purchase. While there is often little transparency in the companies that buyout managers purchase because most of them are private, take-private transactions of public companies provide a valuable window into their selection criteria. Previous research found that buyout managers tend to exhibit repeatable and predictable patterns in take-private security selection.[2]

Given these patterns, the first step in replicating buyout investing is to build a security-selection model based on take-private transactions that can be used to create a portfolio of public companies with fundamentals that match those of large buyout portfolios—a holdings-based replication approach. Then, we adjust this portfolio's financial leverage and sector allocations using PitchBook data for the broader universe of private buyout transactions. This process yields the Morningstar PitchBook Buyout Replication Index: a liquid portfolio built for investability that seeks to replicate the core characteristics of buyout investing and, by extension, the performance of illiquid buyout funds. In this context, "replication" refers to matching the investment characteristics and sector exposures of the underlying buyout fund holdings in a systematic manner with a similar amount of leverage rather than replicating a specific index that tracks buyout fund performance.[3] We prefer a holdings-based approach in this context to more traditional approaches such as regression- or risk-based factor models due to the difficulty of obtaining reliable model estimates for illiquid buyout portfolios.

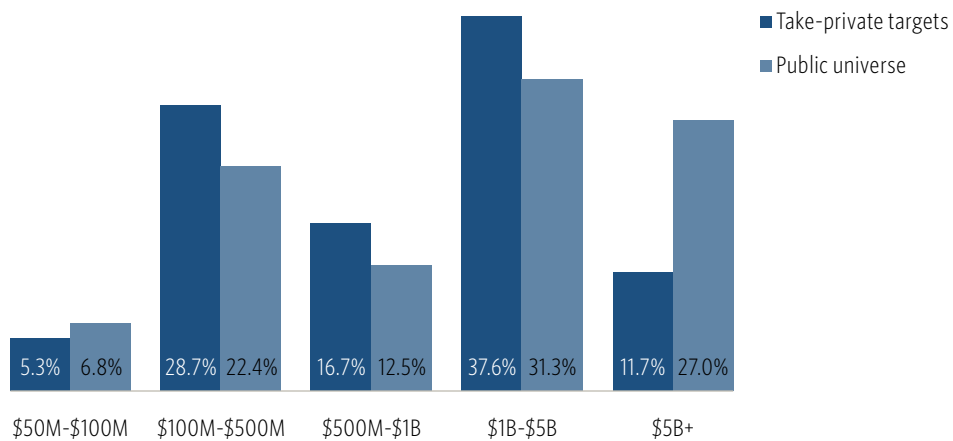1 "Is Private Equity Actually Worth It?" Financial Times, Robin Wigglesworth, March 4, 2024.

2 "Replicating Private Equity With Value Investing, Homemade Leverage, and Hold-to-Maturity Accounting," SSRN, Erik Stafford, September 18, 2020.

3 Indexes that are created from quarterly private fund data, such as the PitchBook Private Capital Indexes, provide useful information about the state of private fund performance, but they are inappropriate to try to replicate for several reasons. They are not investable even in the private market and, more importantly, they compound unrealized gains from smoothed fair value accounting valuations.

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Identifying likely buyout take-private targets

Since the inception of the buyout strategy in the 1980s, buyout managers have maintained a core playbook:
At a reasonable price, invest in relatively small, underperforming companies that still generate enough free cash flow
(FCF) to service an increased debt burden. Evidence from take-private transactions over the past 30 years confirms
this playbook is being used. We found that take-private targets are more likely to be relatively cheap with respect to a
variety of equity price ratios despite relatively neutral EBITDA and cash flow margins. Underperformance is
apparent in both the trailing one-year stock return of these take-private targets as well as their operating efficiency
in terms of revenue generated per employee.

Distribution of market capitalization

Legend: ■ Take-private targets ■ Public universe

Range	Take-private	Public
$50M-$100M	5.3%	6.8%
$100M-$500M	28.7%	22.4%
$500M-$1B	16.7%	12.5%
$1B-$5B	37.6%	31.3%
$5B+	11.7%	27.0%

Sources: Morningstar and PitchBook. Geography: US. As of December 31, 2024
Note: This chart includes data from the beginning of 2000 for US public companies listed on the New York Stock Exchange (NYSE) and the Nasdaq,
excluding commercial banks, holding companies, and investment trusts.

Distribution of fundamental characteristics of take-private targets relative to the small-cap universe
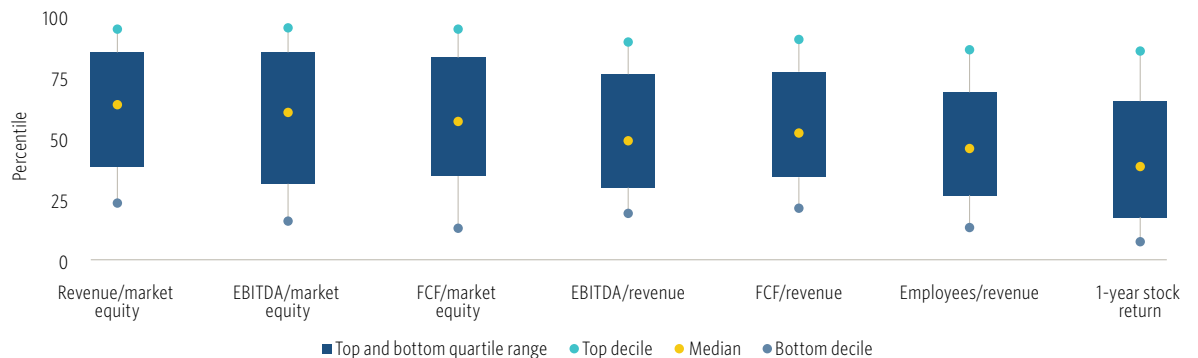
Legend: ■ Top and bottom quartile range ● Top decile ● Median ● Bottom decile

Sources: Morningstar and PitchBook. Geography: US. As of December 31, 2024
Note: This chart includes data from the beginning of 2000 for US public companies listed on the NYSE and the Nasdaq with a market cap between $50
million and $30 billion, excluding commercial banks, holding companies, and investment trusts.

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Because of this core playbook, we believe it is reasonable to assume quarterly financial statements and stock price data can provide valuable information about the public companies that buyout managers are most likely to target. For this exercise, the public company universe included all stocks traded on the NYSE and the Nasdaq that had at least two years of history.[4] We then collected quarterly financial statements and daily stock prices for each company and used this data to train a machine learning model to predict the probability that a company will be taken private by a PE manager in the next 18 months.[5] The model was trained and validated on a quarterly basis from the end of 2013 to the end of 2024, with only information that was known at each period used for training. Because it would take 18 months to know whether a company had been taken private within the forward prediction window, the last period that could be validated was Q2 2023, resulting in 36 quarterly models whose performance we could validate.

While we found that take-private targets have typically aligned with the core buyout playbook—small, underperforming, reasonably priced, and with positive FCF—these characteristics were not sufficient to create a useful prediction model. Additionally, defining them required manually selecting the corresponding financial information and ratios. For example, how should it be determined whether a company is trading at a reasonable price? It was also difficult to determine how many lags and the size of look-back windows to use when calculating the data inputs. For example, when looking at a company on a certain date, should more than just the most recent quarterly financial information be included? To circumvent these challenges, we decided to use a long short-term memory (LSTM) neural network to model the data, which naturally takes sequences (such as a quarterly time series) as inputs. Therefore, the LSTM architecture allowed us to feed in the raw quarterly financial statement and stock price data. Further, the model can learn its own features and how much weight to place on historical data within the context of the prediction problem. For more technical details about the methodology, please see the appendix.

Predicting individual take-private targets is a challenging task. Despite target companies sharing common characteristics, it is like searching for a needle in a haystack. Even after removing companies with a market cap greater than $30 billion, there are typically around 2,000 potential targets in the universe at any given time, and, on average, only about 40 to 60 of them get taken private in an 18-month forward window. Therefore, the model does not produce confident predictions that a company will be taken private, even for those with the highest probabilities. However, this does not mean that the model does not possess discriminative power to distinguish companies that will be taken private from those that will not. On average, the model-implied probability of a take-private was roughly twice as high for companies that were acquired by a PE buyout manager compared with those that were not. Further, about 30% of all take-privates came from the top 10% of companies ranked by the model. Finally, the area under the curve (AUC)—a common discriminative evaluation metric that can be interpreted as the probability that a randomly sampled positive observation has a higher prediction than a randomly sampled negative prediction—averaged 0.74 across the 36 quarterly validation periods, which is well above the neutral value of 0.50 that would be achieved from random guessing. These performance metrics are based on comparing the model's predictions as of a certain date with the actual take-private transactions that occurred in the following 18 months, suggesting that the model is indeed able to identify some common patterns in the types of public companies that buyout managers target.

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Top 15 take-private targets

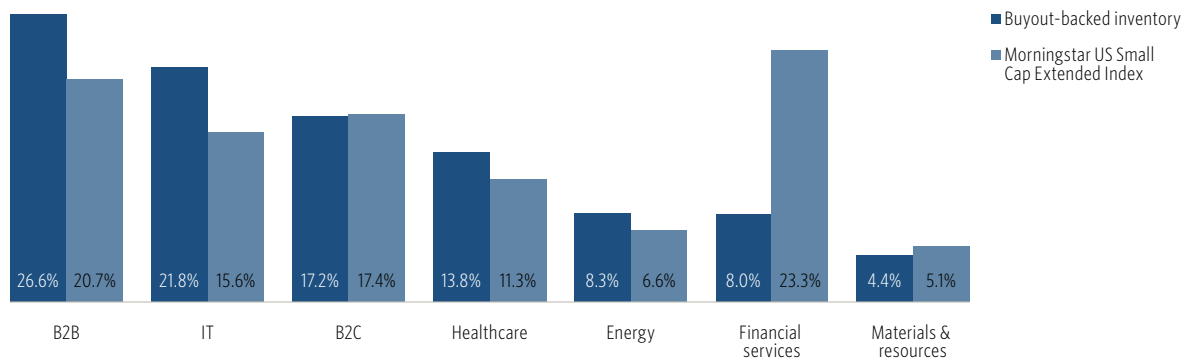| Company	Ticker	Industry	Take-private probability (%)	Market cap ($M)	TTM revenue ($M)
First Advantage	FA	Software	14.70	3,233.8	755.6
SolarWinds	SWI	Software	14.20	2,430.6	784.7
E2open	ETWO	Software	14.20	822.0	619.3
Informatica	INFA	Software	13.50	7,918.3	1,656.9
Paycor	PYCR	Software	13.20	3,336.3	623.7
N-able Technologies	NABL	Software	13.10	1,749.6	450.0
Jamf	JAMF	Software	12.80	1,804.7	615.1
HealthEquity	HQY	Software	12.60	8,315.3	1,099.1
EverCommerce	EVCM	Software	12.60	2,020.2	672.5
Blackbaud	BLKB	Software	12.50	3,749.1	1,148.3
Cerence	CRNC	Software	12.20	337.5	331.5
CCC Intelligent Solutions	CCCS	Software	12.10	7,337.1	925.1
MeridianLink	MLNK	Software	11.70	1,559.6	300.0
Bumble	BMBL	Software	11.60	880.6	1,083.6
nCino	NCNO	Software	11.30	3,888.4	506.1

Sources: Morningstar and PitchBook. Geography: US. As of December 31, 2024
Note: Rankings are based on the model-implied probability of a take-private transaction occurring in the next 18 months.

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# Constructing the Morningstar PitchBook Buyout Replication Index

In addition to security selection, several other important factors distinguish buyout portfolios from a typical small-cap public equity portfolio such as the Morningstar US Small Cap Extended Index. The first is sector selection. Given that buyout managers mostly avoid financial companies because of regulations, especially commercial banks, and REITs are typically acquired in separate real estate strategies, buyout portfolios have a structural underweighting to financial services. Over the past 10 years, this underweighting has been offset by an increasing overweight position in information technology.

Sector exposures

Legend:
- Buyout-backed inventory
- Morningstar US Small Cap Extended Index

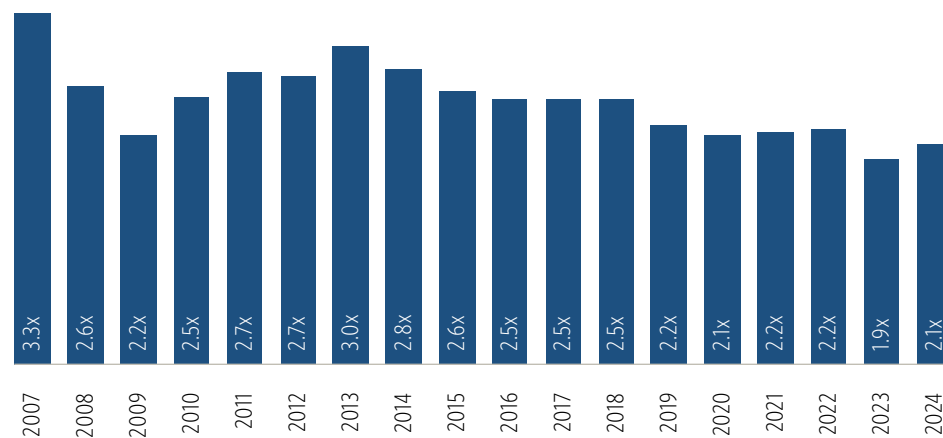|	B2B	IT	B2C	Healthcare	Energy	Financial services	Materials & resources
Buyout-backed inventory	26.6%	21.8%	17.2%	13.8%	8.3%	8.0%	4.4%
Morningstar US Small Cap Extended Index	20.7%	15.6%	17.4%	11.3%	6.6%	23.3%	5.1%

Sources: Morningstar and PitchBook. Geography: US. As of December 31, 2024
Note: Buyout-backed inventory includes large LBOs greater than $500 million. Companies that have been held longer than eight years were excluded.

Select sector differences between buyout-backed companies and the Morningstar US Small Cap Extended Index
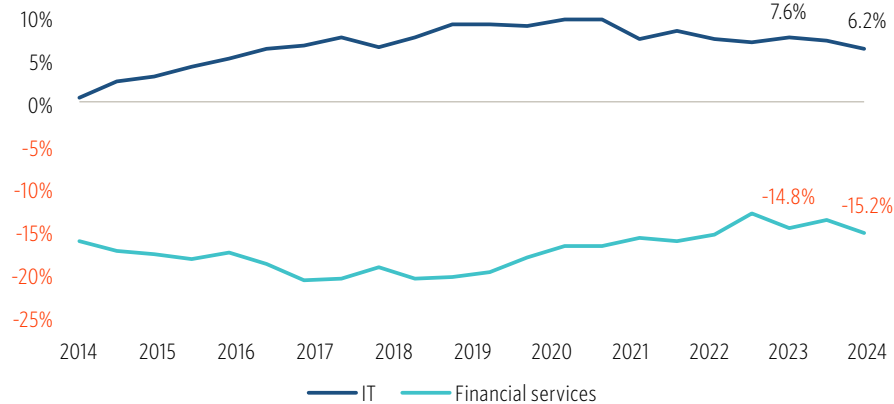
IT: 7.6% — 6.2%
Financial services: -14.8% — -15.2%

Legend: IT, Financial services

Sources: Morningstar and PitchBook. Geography: US. As of December 31, 2024
Note: Buyout-backed inventory includes large LBOs greater than $500 million. Companies that have been held longer than eight years were excluded.

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The first step in constructing the Morningstar PitchBook Buyout Replication Index (the Index) combines security and sector selection. At the end of each semiannual reconstitution period, we rank the investable public company universe by the model-implied probability of a take-private.[6] Then, we determine the target sector allocations based on the inventory of buyout-backed companies tracked by PitchBook. Finally, we construct an equally weighted portfolio of the top-ranked companies in each sector commensurate with the target sector allocations. The number of holdings in the portfolio is equal to 10% of the total investable universe, which typically results in about 200 companies. If there were 200 holdings in the portfolio and the target allocation to information technology was 20%, for example, the portfolio would hold the 40 top-ranked information technology companies based on the model-implied probability of a take-private.

Greater leverage is another key distinguishing characteristic of buyout-backed companies. Over the past 10 years, the average publicly traded small-cap company has had a financial leverage ratio of total assets to market equity of around 1.4x. Meanwhile, postdeal buyout-backed companies typically have had financial leverage ratios of around 2.5x during this same period, although they have come down recently in response to higher interest rates. Greater financial leverage has been an important tailwind to buyout fund performance during the analysis period, as the return on portfolio companies' assets has easily outpaced the historically low cost of debt.

Financial leverage for buyout deals by deal year

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
3.3x	2.6x	2.2x	2.5x	2.7x	2.7x	3.0x	2.8x	2.6x	2.5x	2.5x	2.5x	2.2x	2.1x	2.2x	2.2x	1.9x	2.1x

Source: PitchBook | LCD. Geography: US. As of December 31, 2024.

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A key challenge in determining how much additional leverage to add to the Index comes from having robust leverage data for buyout-backed companies only at the time the deals have closed. Anecdotally, we know that some of the debt used to fund buyout deals may be amortizing, and that buyout managers often pay down debt during their holding periods—both factors work to decrease average financial leverage over the holding period. On the other hand, buyout managers may also releverage their portfolio companies through dividend recapitalizations when the conditions warrant it. An analysis of corporate tax returns found that these two dynamics likely offset each other, and financial leverage in postbuyout companies remains relatively stable over buyout managers' holding periods, at least in a sample of deals completed between 1995 and 2007.[7]

For simplicity, we apply constant incremental leverage of 1.5x to the unleveraged Index (that is, borrow $50 for every $100 of invested equity in the portfolio). Assuming the portfolio companies already have aggregate embedded leverage of 1.4x, for example, incremental leverage would result in total portfolio leverage of 2.1x ($1.4 \times 1.5 = 2.1$). Additional leverage in the Index is implemented through a hypothetical brokerage margin account and resets at each semiannual reconstitution date. This means that effective leverage in the portfolio will drift between reconstitution periods. When the portfolio value increases, effective leverage will decrease, and when the portfolio value decreases, effective leverage will increase.

We assume that the cost of the margin debt is the federal funds rate plus 200 basis points, reflecting the broker call money rate—the rate at which banks charge brokers for money used to finance margin loans—plus an additional brokerage spread.[8] Interest on the margin debt is assumed to accrue daily and be paid monthly. Given that the equity collateral is relatively liquid, the cost of the margin debt is likely cheaper than the direct cost of debt to fund buyout deals. For example, the average spread above the benchmark rate for newly issued B-rated syndicated loans—the typical rating received by buyout-backed companies—has been 408 basis points since 2014. However, interest paid on this debt is tax deductible, whereas interest paid on margin debt is not for most institutional investors because they are tax exempt, which can help to even out the scale. Other than any potential after-tax cost-of-debt differences, these methods of leverage are mechanically equivalent from an investor return perspective.

7 "The Evolution of Capital Structure and Operating Performance After Leveraged Buyouts: Evidence From U.S. Corporate Tax Returns," SSRN, Journal of Financial Economics, Jonathan B. Cohn, Lillian F. Mills, and Erin Towery, April 10, 2013.

8 Brokerage spreads relative to the call money rate can vary widely across institutions and account sizes. We conservatively assumed an additional 50-basis-point spread over the call money rate, which is typically the fed funds rate plus 200 basis points. However, many brokerages offer margin debt to large accounts at or below the call money rate as an incentive.

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Portfolio performance and insights

The Index would have performed well in the past 10 years on both an absolute and a relative basis, especially in the period after the March 2020 sell-off. It would have returned an annualized 14.7% from the beginning of 2014 through November 2024, 6.1 percentage points higher than the Morningstar US Small Cap Extended Index.[9] Adjusting the small-cap benchmark in a stepwise fashion provides insight into what drove this outperformance with respect to sector selection, leverage, and security selection. All three of these components contributed positively to relative performance, although security selection was the main driver. Over the full period, sector selection, leverage, and security selection contributed 0.9, 1.3, and 3.9 percentage points, respectively, to the Index's annualized outperformance over the small-cap benchmark. While it is impossible to pinpoint the exact reasons security selection was such a positive contributor to performance, it was likely influenced by the tendency of the portfolio to hold relatively cheap companies with stock prices that have underperformed despite strong profitability and margins and stable cash flow generation. This can be characterized as a selective value strategy, as we will show in the following returns- and holdings-based analyses.
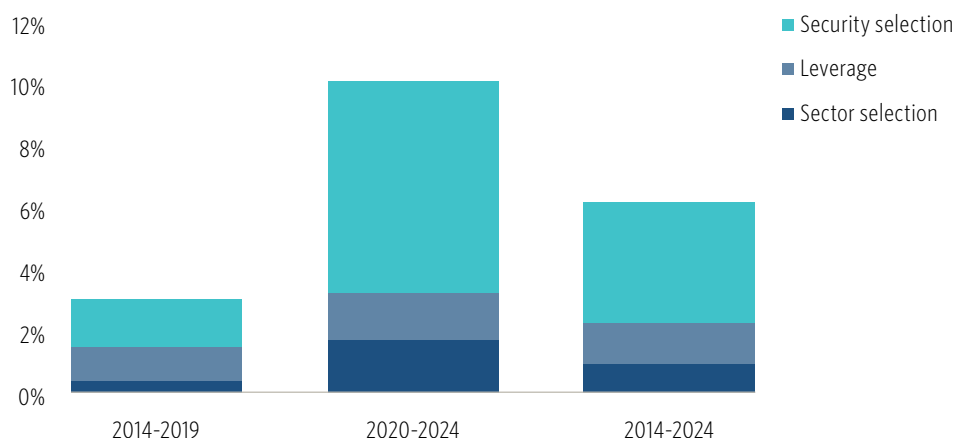
Hypothetical growth of $100 invested by index
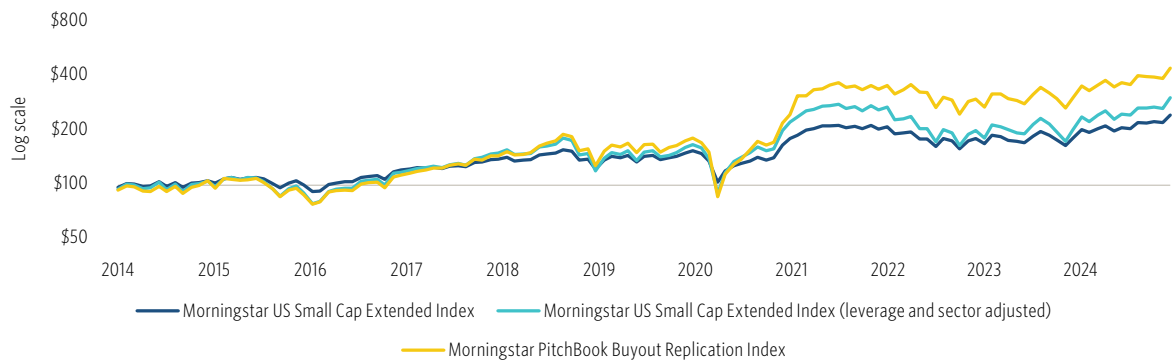
Sources: Morningstar and PitchBook. Geography: US. As of November 30, 2024
Note: Sector adjustments to the Morningstar US Small Cap Extended Index were based on the quarterly sector exposures of the buyout-backed inventory; leverage adjustments were made in the same manner as the Index described in the prior section.

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Morningstar PitchBook Buyout Replication Index excess performance attribution (annualized)

Sources: Morningstar and PitchBook. Geography: US. As of November 30, 2024
Note: Excess performance is relative to the Morningstar US Small Cap Extended Index.

10 "A Five-Factor Asset Pricing Model," ScienceDirect, Journal of Financial Economics, Eugene F. Fama and Kenneth R. French, April 2015.

11 "Replicating Private Equity With Value Investing, Homemade Leverage, and Hold-to-Maturity Accounting," SSRN, Erik Stafford, September 18, 2020.

A returns-based factor analysis using the Fama-French five-factor model plus momentum reveals that the positive alpha from security selection can be explained primarily by a higher market beta.[10] On average, the Index had a monthly excess return of 0.2%, which was not statistically significant. The Index loaded strongly on the broader market with an equity beta of 1.7, but this was consistent with the equity beta of the sector- and leverage-adjusted Morningstar US Small Cap Extended Index, suggesting that the high beta was driven by leverage rather than the model selecting higher beta stocks. The Index had a higher beta to the size factor than the adjusted Morningstar US Small Cap Extended Index, which is consistent with the fact that take-private deals involve companies at the smaller end of even the small-cap universe. Interestingly, we did not find a significant loading to the value factor, making it different from similar past studies.[11] In the holdings-based analysis that follows, we show that this is likely due to buyout managers having a different definition of value than the academic definition, which compares equity book value to market value.

Fama-French regression results of monthly returns from 2014 to 2024

	Morningstar US Small Cap Extended Index			Morningstar PitchBook Buyout Replication Index		
	Coefficient	t-statistic	p-value	Coefficient	t-statistic	p-value
Intercept (alpha)	−0.17%	−1.37	0.17	0.21%	0.81	0.42
Market	1.66	53.85	0.00	1.68	26.70	0.00
Size	1.13	21.06	0.00	1.32	12.03	0.00
Value	0.06	1.20	0.23	0.04	0.43	0.67
Profitability	−0.04	−0.59	0.55	0.01	0.04	0.97
Investment	−0.01	−0.15	0.88	0.53	3.52	0.00
Momentum	0.01	0.38	0.71	0.06	0.85	0.40

Sources: Kenneth French Data Library, Morningstar, PitchBook. Geography: US. As of November 30, 2024

In contrast with the common perception that PE is less risky than comparable public equity benchmarks—which we have written about previously using fund return data—we found that the Index had an annualized volatility of 33.5%. Additionally, the portfolio had sharp drawdowns of 54.9% from August 2018 to March 2020 and 32.9% from June 2021 to September 2022. This risk was compensated, however, with the portfolio achieving a Sharpe ratio of 0.40, above a 0.30 Sharpe ratio for the sector- and leverage-adjusted Morningstar US Small Cap Extended Index. Portfolio risk was heavily influenced by the incremental leverage, as the unleveraged version had an annualized volatility of 22.2% and a maximum drawdown of 34.2%.

Digging into the latest holdings of the Index and comparing them with the broader public small-cap universe provides additional insights. It reveals that FCF is a key variable in the security-selection criteria. The Index is value oriented across a variety of metrics, particularly in terms of FCF with a price ratio of 28.9x compared with 44.1x for the broader small-cap universe. Additionally, the Index has an FCF margin that is slightly higher than that of the small-cap universe at 3.7%. The Index holding companies are also less efficient with respect to return on assets and revenue per employee, which may indicate an opportunity to implement operational improvements. Lastly, the Index had higher financial leverage and a lower EBITDA coverage ratio despite its higher profitability.

Fundamental portfolio metrics

	Value			Size		Profitability	
	Market value/ revenue	Market value/ EBITDA	Market value/ FCF	Median market cap ($M)	Median revenue ($M)	EBITDA margin	FCF margin
Morningstar PitchBook Buyout Replication Index	1.1x	11.8x	28.9x	$2,622.3	$1,832.2	9.10%	3.70%
Public small-cap universe	1.4x	12.8x	44.1x	$2,598.8	$1,237.6	10.60%	3.10%

	Efficiency			Stability		Leverage	
	Return on assets	Return on equity	Revenue per employee	EBITDA margin volatility	FCF margin volatility	Total assets/ market equity	EBITDA/ interest costs
Morningstar PitchBook Buyout Replication Index	3.10%	11.00%	$260,130	5.60%	4.60%	1.3x	3.0x
Public small-cap universe	3.50%	10.00%	$337,220	5.20%	4.80%	1.0x	5.9x

Sources: Morningstar and PitchBook. Geography: US. As of December 31, 2024
Note: The public small-cap universe includes companies in the Morningstar US Small Cap Extended Index, excluding commercial banks, holding companies, investment trusts, and pre-revenue companies. EBITDA and FCF margin volatility is based on the trailing eight quarters.

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A better benchmark for buyout funds

Appropriately benchmarking closed-end private market funds is a difficult exercise. Not only do investors need to come up with a metric that accounts for the lack of market values and irregular cash flow timing, but they also must select something against which to compare this metric. We believe the private market equivalent (PME) metric is one of the best closed-end fund performance metrics because it adequately controls for cash flow timing and uses an investable index for comparing performance.[12] At a high level, PMEs calculate the hypothetical returns that an investor would have earned by investing the same amount of capital in a public market index instead of a closed-end fund. However, the usefulness of PMEs can be corrupted by using an inappropriate public market index. A key implicit assumption baked into PMEs is that private funds have a beta of 1.0 to the public index, making it essential to use an index with an equivalent risk profile. Using a large-cap index such as the S&P 500 or even a total market index such as the Russell 3000 to benchmark buyout funds is clearly inadequate in this regard. As we have shown, even a small-cap benchmark such as the Russell 2000 or Morningstar US Small Cap Extended Index fails to capture the fundamental characteristics of buyout investing.

Given its purpose to systematically match the risk/return profile of buyout investing, the Index is a better option to assess private fund performance using PMEs than standard indexes are. At the very least, investors should consider a sector- and leverage-adjusted small-cap benchmark like the one discussed in the prior section, which better captures the systematic risk profile of buyout but ignores security-selection differences. In the accompanying chart, we show that conclusions drawn from PMEs will vary dramatically depending on the benchmark used. Because the Index return history begins in 2014, we included Kaplan and Schoar PMEs (KS-PMEs) by vintage for the years 2014 through 2018.

KS-PMEs of $1 billion-plus buyout funds for select vintages

Legend:
- ■ Morningstar US Large Cap Index
- ■ Morningstar US Small Cap Extended Index
- ■ Morningstar US Small Cap Extended Index (leverage and sector adjusted)
- ■ Morningstar PitchBook Buyout Replication Index

Vintage year

Sources: Morningstar and PitchBook. Geography: US. As of June 30, 2024

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Buyout funds that launched in 2014 were the only ones able to (marginally) outperform the Index of the four vintage years analyzed. The Index's PMEs for vintage years other than 2014 were all within 0.1 of the neutral value of 1.0, however, suggesting the replication portfolio did its job relatively well. If an investor appropriately adjusted for size by using the Morningstar US Small Cap Extended Index but failed to adjust for sector exposure and leverage, they would be misled about the relative performance because of the general underperformance of small-cap stocks over the past 10 years. Buyout funds did handily outperform the adjusted Morningstar US Small Cap Extended Index in all four vintages, indicating positive alpha that was not attributable to sector bets and financial engineering. Lastly, the Morningstar US Large Cap Index and adjusted Morningstar US Small Cap Extended Index produced similar results only due to the coincidence that large-cap outperformance was offset by the positive contributions of sector adjustment and additional leverage.

Conclusion

This analysis and the resulting replication portfolio provide LPs with a useful framework to improve buyout fund benchmarking and to better understand relative performance drivers. Buyout managers need to demonstrate outperformance through operational alpha or differentiated security-selection skill (that is, security-selection skill that cannot be systematically replicated) to justify their fees and the additional complexity that closed-end funds bring to portfolios. As institutional and retail investors alike pile into private markets, it is important for them to take a step back and consider how differentiated these exposures truly are and what purpose they will serve within the context of their broader portfolios. In the case of PE buyout, we have shown that a good portion of the value proposition—leverage, sector selection, and security selection—can be systematically modeled and replicated with a portfolio of public equities, at least over the past 10 years. Additionally, our analysis provides further evidence that PE is not a diversifying alternative asset class, nor is it less risky than traditional public equities.

However, the fact that PE is not a magic bullet does not mean that it does not have a place in investors' portfolios. We highlight two potential benefits that cannot be replicated in the public markets: the breadth of the private investment universe and the ability to gain a controlling interest in portfolio companies. First, the private company universe is drastically larger than the public universe. There are thousands of potential private companies that buyout managers can acquire versus hundreds of realistic public targets. A broader investment universe should allow skilled managers more opportunities to find value in a less efficient market. Second, gaining a controlling interest allows buyout managers to implement operational improvements in their portfolio companies, particularly via margin expansion, providing an additional potential alpha source. While buyout managers have not been able to tap in to this potential in aggregate, it has provided an edge for top deals and managers.[13] Taking advantage of these potential benefits requires investors to exhibit skill in manager selection as well as the scale and ability to access these top managers.

13 "Global Private Equity Report 2024," Bain & Company, Hugh MacArthur, et al., n.d., accessed January 23, 2025.

Appendix: Take-private model details

Inclusion criteria, label definition, and input data

For any given quarter, the public companies included in the training data consisted of those that traded on the NYSE or the Nasdaq for at least eight consecutive quarters at any time prior to the training date and with headquarters in the US. Commercial banks, holding companies, and investments trusts were excluded from the universe because they do not fit the profile of assets that buyout managers target. In addition to the training inclusion criteria, a company must have been actively trading on the quarter-end date with a stock price greater than $1.00 to be eligible for a prediction and inclusion in the Index. Companies with an announced take-private acquisition were excluded from portfolio eligibility as of the announcement date. On average, the prediction set contained 2,318 eligible companies from 2014 to 2024.

The binary training labels were defined as one if a company was taken private in the 18 months following the input data date, and zero otherwise. The announcement date was used to determine the time elapsed from the input data date to the take-private deal occurring. Failed and canceled deals were considered positive examples given that they captured characteristics of companies PE managers wanted to acquire.

The input feature data used to train the model came primarily from the three main quarterly financial statements. All the financial statement inputs were lagged one quarter to ensure the information was available at the time the predictions were made. The specific data points from each of the three statements included:

- Income statement: Revenue, cost of goods sold, operating profit, research & development expenses, EBITDA, net interest expense, tax rate, and normalized net income.

- Balance sheet: Total assets, net debt, cash and short-term equivalents, net property, plant and equipment, inventories, intangible assets, enterprise value, and book value.

- Cash flow: Net operating cash flow, net financing cash flow, net investing cash flow, FCF, and cash dividends paid.

The input data also contained various items related to the stock price, including adjusted closing price, diluted shares outstanding, market capitalization, time since the IPO, and the two-year rolling beta to the Morningstar US Large Cap Index. Lastly, we included input variables for industry, the number of PIPE deals, and the year-over-year return of the Morningstar US Large Cap Index (to capture general market conditions).

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Model training and validation

A separate model was trained each quarter beginning June 30, 2012. Given that the binary labels contained forward-looking information by definition, it was important to ensure that the training and validation sets remained isolated. Therefore, the validation date was moved forward by 18 months, the size of the forward window. Because the first training iteration used data through June 30, 2012, the first validation date was then December 31, 2013. We then implemented a step-ahead validation process where both the training and validation dates were moved forward one quarter at a time. As it takes 18 months for the binary labels to become known, the last validation date for this analysis was June 30, 2023. However, we continued to train models through the end of 2024 to create the Index.

This process resulted in 36 quarterly models that could be validated and were implemented via the PyTorch library and optimized using the Adam algorithm.[14] The first half of these models was used to validate the number of training epochs via early stopping and other model hyperparameters, including the number of LSTM layers and size of the hidden cell. The second half was used as a test set with a fixed number of training epochs and hyperparameters. The models achieved an average AUC of 0.74 and top 10% recall of 29.5% across the 36 validation and test periods.

14 "PyTorch Documentation," PyTorch, n.d., accessed January 23, 2025.

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