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Research

# Buffett's Alpha

**Andrea Frazzini, David Kabiller, CFA, and Lasse Heje Pedersen**

*Andrea Frazzini is a principal at AQR Capital Management, Greenwich, Connecticut. David Kabiller, CFA, is a founding principal at AQR Capital Management, Greenwich, Connecticut. Lasse H. Pedersen is a principal at AQR Capital Management and professor at Copenhagen Business School, Frederiksberg, Denmark.*

**Warren Buffett's Berkshire Hathaway has realized a Sharpe ratio of 0.79 with significant alpha to traditional risk factors. The alpha became insignificant, however, when we controlled for exposure to the factors "betting against beta" and "quality minus junk." Furthermore, we estimate that Buffett's leverage is about 1.7 to 1, on average. Therefore, Buffett's returns appear to be neither luck nor magic but, rather, a reward for leveraging cheap, safe, high-quality stocks. Decomposing Berkshire's portfolio into publicly traded stocks and wholly owned private companies, we found that the public stocks have performed the best, which suggests that Buffett's returns are more the result of stock selection than of his effect on management.**

Much has been said and written about Warren Buffett and his investment style, but little rigorous empirical analysis has been conducted to explain his performance. Every investor has a view on how Buffett has done it and the practical implications of his success, but we sought the answer via a thorough empirical analysis of Buffett's results in light of some of the latest research on the drivers of returns.[1]

Buffett's success has become the focal point of the debate on market efficiency that continues to be at the heart of financial economics. Efficient market supporters suggest that his success may simply be luck; Buffett is the happy winner of a coin-flipping contest, as articulated by Michael Jensen at a famous 1984 conference at Columbia Business School celebrating the 50th anniversary of the classic text by Graham and Dodd (1934).[2] Tests of this argument via a statistical analysis of Buffett's performance cannot fully resolve the issue. Instead, Buffett countered at the conference that it is no coincidence that many of the winners in the stock market come from the same intellectual village—that is, "Graham-and-Doddsville" (Buffett 1984). How can Buffett's counterargument be tested? Selecting successful investors who are informally classified as belonging to Graham-and-Doddsville *ex post* is subject to biases.

In our study, we used a different strategy to rigorously examine this issue. The standard academic factors that capture the market, size, value, and momentum premiums cannot explain Buffett's performance, so his success has to date been a mystery (Martin and Puthenpurackal 2008). We show that accounting for the general tendency of high-quality, safe, and cheap stocks to outperform can explain much of Buffett's performance.[3] This finding is consistent with the idea that investors from Graham-and-Doddsville follow similar strategies to achieve similar results and inconsistent with stocks being chosen based on coin flips. Hence, Buffett's success appears not to be luck, but, rather, Buffett personalizes the success of value and quality investment, providing real-world out-of-sample evidence on the ideas of Graham and Dodd (1934).

**Disclosure:** The authors are principals at AQR Capital Management, a global investment management firm, which may or may not apply similar investment techniques or methods of analysis as described in this article. The views expressed here are those of the authors and not necessarily those of AQR.

CE Credits: 1

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Buffett's record is remarkable in many ways, but we also examined just how spectacular the performance of Berkshire Hathaway has been when compared with that of other stocks or mutual funds.

To illustrate the practical relevance of our findings, we created a portfolio that tracked Buffett's market exposure and active stock-selection themes, leveraged to the same active risk as that of Berkshire Hathaway. We found that this systematic Buffett-style portfolio performed comparably to Berkshire.

Of course, explaining Buffett's performance with the benefit of hindsight does not diminish his outstanding accomplishment. He decided half a century ago to base his investments on the Graham and Dodd principles, and he found a way to apply leverage. Finally, he managed to stick to his principles and continue operating at high risk even after experiencing some ups and downs that have caused many other investors to rethink and retreat from their original strategies.

Finally, we consider whether Buffett's skill is the result of his ability to buy the right stocks or his ability as a CEO.

## Data Sources

Our data come from several sources. We used stock return data from the CRSP database, balance sheet data from the Compustat North America database as well as hand-collected annual reports, holdings data for Berkshire Hathaway from the Thomson Reuters Institutional (13F) Holdings Database (based on Berkshire's US SEC filings), the size and cost of the insurance float from hand-collected comments in Berkshire Hathaway's annual reports, and mutual fund data from the CRSP Mutual Fund Database. We also used factor returns from Kenneth French's website and from Frazzini and Pedersen (2014) and Asness, Frazzini, and Pedersen (Forthcoming 2018).[4] We describe our data sources and data filters in more detail in Appendix A.

## Buffett's Track Record

Warren Buffett's track record is clearly outstanding. A dollar invested in Berkshire Hathaway in October 1976 (when our data sample starts) would have been worth more than $3,685 in March 2017 (when our data sample ends). Over this time period, Berkshire realized an average annual return of 18.6% in excess of the US T-bill rate, significantly outperforming the general stock market's average excess return of 7.5%.

Berkshire Hathaway stock also entailed more risk than the market; it realized a volatility of 23.5%, higher than the market volatility of 15.3%. Berkshire's excess return was high even relative to its risk, however; it earned a Sharpe ratio of 18.6%/23.5% = 0.79, 1.6 times higher than the market's Sharpe ratio of 0.49. Berkshire realized a market beta of only 0.69, an important point that we discuss in more detail when we analyze the types of stocks that Buffett buys. Adjusting Berkshire's performance for market exposure, we computed its information ratio to be 0.64.

These performance measures reflect Buffett's impressive returns but also the fact that Berkshire Hathaway has been associated with some risk. Berkshire has had a number of down years and drawdown periods. For example, from 30 June 1998 to 29 February 2000, Berkshire lost 44% of its market value while the overall stock market was gaining 32%. Many fund managers might have had trouble surviving a shortfall of 76%, but Buffett's impeccable reputation and unique structure as a corporation allowed him to stay the course and rebound as the internet bubble burst.

To put Buffett's performance in perspective, we compared Berkshire's Sharpe and information ratios with those of all other US common stocks. If Buffett is more of a stock picker than a manager, then an even better reference group than other stocks might be the universe of actively managed mutual funds. **Table 1** shows a comparison of Berkshire with both of these groups.

Buffett is in the top 3% among all mutual funds and the top 7% among all stocks. The stocks or mutual funds with the highest Sharpe ratios, however, are often ones that have existed only for short time periods and had a good run, which is associated with a large degree of randomness.

To minimize the effect of randomness, Table 1 also provides a comparison of Berkshire Hathaway with all stocks or mutual funds with at least a 10-year, 30-year, and 40-year history. Buffett's performance is truly outstanding from this perspective. Among all stocks with at least a 40-year history from 1976 to 2017, Berkshire realized the highest Sharpe ratio and information ratio. If you could travel back in time and pick one stock in 1976, Berkshire would be your pick. **Figure 1** and **Figure 2** also illustrate how Buffett lies in the very best tail of the performance distribution of mutual funds and stocks that have survived at least 40 years.

## Table 1. Buffett's Performance Relative to All Other Stocks and Mutual Funds, 1976–2017

| | A. Sample Distribution of Sharpe Ratios | | | | | Buffett Performance | |
|---|---|---|---|---|---|---|---|
| Stock/Fund Measure | Number of Stocks/ Funds | Median | 95th Percentile | 99th Percentile | Maximum | Rank | Percentile |
| *Sharpe ratio of equity mutual funds* | | | | | | | |
| All funds in CRSP data | 4,585 | 0.356 | 0.69 | 1.10 | 3.20 | 137 | 97.0% |
| All funds alive in 1976 and 2017 | 133 | 0.36 | 0.54 | 0.63 | 0.79 | 1 | 100.0% |
| All funds alive in 1976 with at least 10-year history | 304 | 0.30 | 0.49 | 0.61 | 0.79 | 1 | 100.0% |
| All funds with at least 10-year history | 2,872 | 0.39 | 0.62 | 0.74 | 0.99 | 11 | 99.7% |
| All funds with at least 30-year history | 432 | 0.38 | 0.59 | 0.73 | 0.93 | 3 | 99.5% |
| All funds with at least 40-year history | 186 | 0.33 | 0.52 | 0.63 | 0.79 | 1 | 100.0% |
| *Sharpe ratio of common stocks* | | | | | | | |
| All stocks in CRSP data | 23,257 | 0.211 | 0.88 | 1.47 | 2.68 | 1,454 | 93.8% |
| All stocks alive in 1976 and 2017 | 504 | 0.36 | 0.51 | 0.57 | 0.79 | 1 | 100.0% |
| All stocks alive in 1976 with at least 10-year history | 3,774 | 0.28 | 0.51 | 0.62 | 0.89 | 8 | 99.8% |
| All stocks with at least 10-year history | 9,523 | 0.28 | 0.57 | 0.75 | 1.12 | 57 | 99.4% |
| All stocks with at least 30-year history | 2,021 | 0.32 | 0.52 | 0.61 | 0.81 | 2 | 100.0% |
| All stocks with at least 40-year history | 1,111 | 0.34 | 0.50 | 0.55 | 0.79 | 1 | 100.0% |

| | B. Sample Distribution of Information Ratios | | | | | Buffett Performance | |
|---|---|---|---|---|---|---|---|
| Stock/Fund Measure | Number of Stocks/ Funds | Median | 95th Percentile | 99th Percentile | Maximum | Rank | Percentile |
| *Information ratio of equity mutual funds* | | | | | | | |
| All funds in CRSP data | 4,585 | 0.356 | 0.69 | 1.10 | 3.20 | 137 | 97.0% |
| All funds alive in 1976 and 2017 | 133 | 0.358 | 0.54 | 0.63 | 0.79 | 1 | 100.0% |
| All funds alive in 1976 with at least 10-year history | 304 | 0.301 | 0.49 | 0.61 | 0.79 | 1 | 100.0% |
| All funds with at least 10-year history | 2,872 | 0.390 | 0.62 | 0.74 | 0.99 | 11 | 99.7% |
| All funds with at least 30-year history | 432 | 0.382 | 0.59 | 0.73 | 0.93 | 3 | 99.5% |
| All funds with at least 40-year history | 186 | 0.331 | 0.52 | 0.63 | 0.79 | 1 | 100.0% |

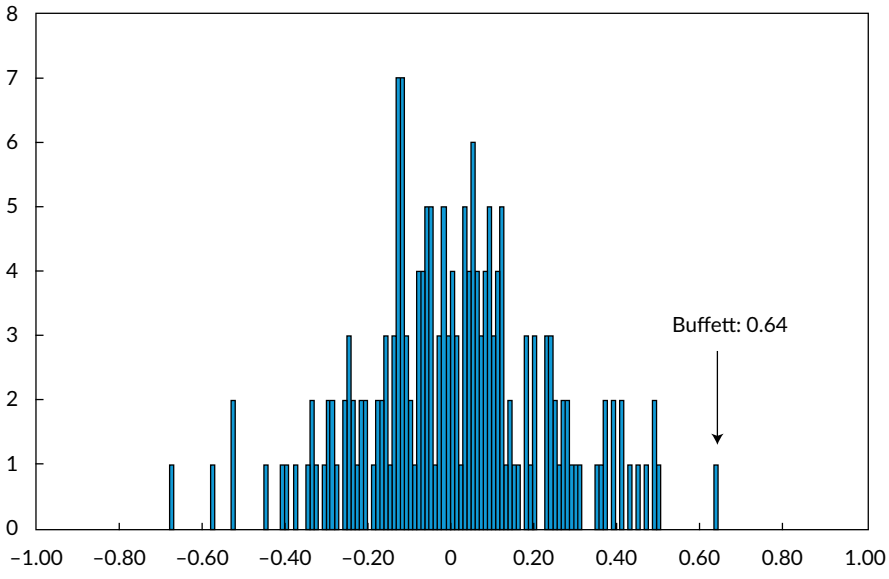
(continued)

## Table 1. Buffett's Performance Relative to All Other Stocks and Mutual Funds, 1976–2017 (continued)

| | B. Sample Distribution of Information Ratios | | | | | Buffett Performance | |
|---|---|---|---|---|---|---|---|
| Stock/Fund Measure | Number of Stocks/ Funds | Median | 95th Percentile | 99th Percentile | Maximum | Rank | Percentile |
| *Information ratio of common stocks* | | | | | | | |
| All stocks in CRSP data | 23,257 | 0.211 | 0.88 | 1.47 | 2.68 | 1,454 | 93.8% |
| All stocks alive in 1976 and 2017 | 504 | 0.357 | 0.51 | 0.57 | 0.79 | 1 | 100.0% |
| All stocks alive in 1976 with at least 10-year history | 3,774 | 0.276 | 0.51 | 0.62 | 0.89 | 8 | 99.8% |
| All stocks with at least 10-year history | 9,523 | 0.277 | 0.57 | 0.75 | 1.12 | 57 | 99.4% |
| All stocks with at least 30-year history | 2,021 | 0.323 | 0.52 | 0.61 | 0.81 | 2 | 100.0% |
| All stocks with at least 40-year history | 1,111 | 0.335 | 0.50 | 0.55 | 0.79 | 1 | 100.0% |

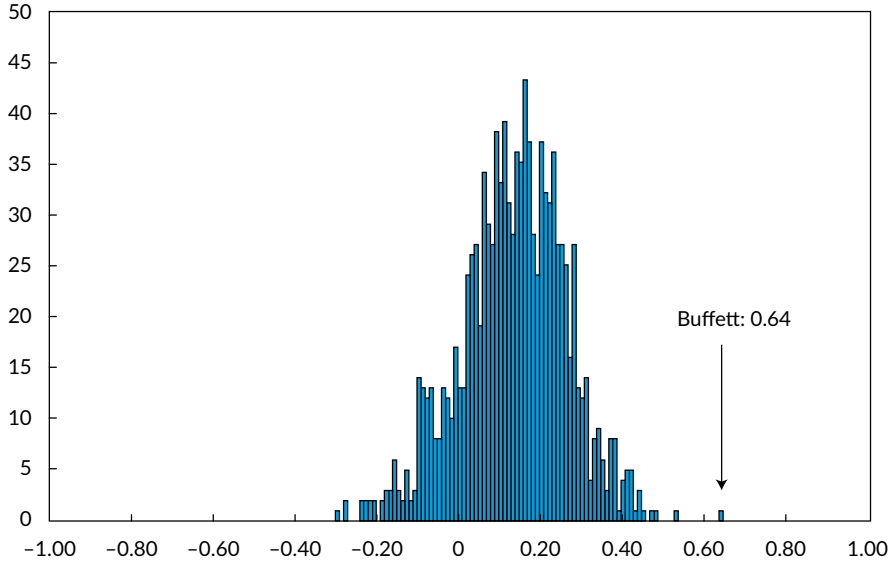
*Notes*: The information ratio is defined as the intercept in a regression of monthly excess returns on the excess return of the value-weighted market portfolio, divided by the standard deviation of the residuals. Sharpe ratios and information ratios are annualized.

**Figure 1.** How Berkshire Stacks Up in the Mutual Fund Universe




*Notes*: This figure shows the distribution of annualized information ratios of all actively managed equity funds in the CRSP mutual fund database with at least 40 years of return history. See also definitions in the notes to Table 1.

**Figure 2.** How Berkshire Stacks Up in the Common Stocks Universe




*Notes*: This figure shows the distribution of annualized information ratios of all common stock in the CRSP database with at least 40 years of return history. See also definitions in the notes to Table 1.

If an investment in Berkshire Hathaway were combined with an investment in the market, the optimal combination would put about 72% of the money in Berkshire, giving rise to a Sharpe ratio of 0.81. Hence, putting 100% of the money in Berkshire (rather than 72%) gives nearly the same as the optimal Sharpe ratio.[5]

## Buffett's Leverage: Magnitude and Cost

Warren Buffett's large returns come from both his high Sharpe ratio and his ability to leverage his performance to achieve large returns at high risk. Buffett uses leverage to magnify returns, but how much leverage does he use? Furthermore, what are Buffett's sources of leverage, their terms, and their costs? To answer these questions, we studied Berkshire Hathaway's balance sheet, which can be summarized as in Exhibit 1.

We can compute Buffett's leverage, $L$, as follows:

$$L_t = \frac{\text{TA}_t^{MV} - \text{Cash}_t^{MV}}{\text{Equity}_t^{MV}},$$

where $\text{TA}_t$ is total assets, $\text{Cash}_t$ is cash that Berkshire Hathaway owns, and $\text{Equity}_t$ is Berkshire's equity value. The superscript *MV* is market value. We computed this measure of leverage for each month. We wanted to compute the leverage always using market values, but for some variables, we could observe only book values (indicated with superscript *BV*). We considered the market value of Berkshire's equity to be the stock price multiplied by the shares outstanding. Cash holdings are from Berkshire's consolidated balance sheet (see Appendix A). The balance sheet also provides the book value of the total assets, $\text{TA}_t^{BV}$, and the book value of equity, $\text{Equity}_t^{BV}$, which allowed us to estimate the market value of the total asset as

$$\text{TA}_t^{MV} = \text{TA}_t^{BV} + \text{Equity}_t^{MV} - \text{Equity}_t^{BV}.$$

**Exhibit 1. Stylized Balance Sheet of Berkshire Hathaway**

| Assets | Liabilities and Shareholders' Equity |
|---|---|
| Publicly traded equities | Liabilities |
| Privately held companies | Equity |
| Cash | |
| Total assets | Total liabilities |

Using this method, we estimated Buffett's average leverage to be 1.7 to 1. This amount is a nontrivial use of leverage and helps explain why Berkshire Hathaway experiences high volatility despite investing in a number of relatively stable businesses.

By focusing on total assets to equity, we captured all kinds of liabilities. We found, as we discuss later, that Berkshire Hathaway's financing arises from various types of liability. The two main liabilities are debt and insurance float. If we computed leverage, instead, as $\left(\text{Equity}_t^{MV} + \text{Debt}_t + \text{Float}_t\right)\Big/\text{Equity}_t^{MV}$, then we found an average leverage of 1.4 to 1. In any event, note that our measure of leverage is subject to measurement noise.

Another expression of Buffett's use of leverage is shown in Berkshire Hathaway's stock price, which is significantly more volatile than the portfolio of publicly traded stocks that it owns, as we depict in **Table 2**. In fact, Berkshire's 23.5% stock volatility is 1.4 times higher than the 16.2% volatility of the portfolio of public stocks, which corresponds to a leverage of 1.4 if Berkshire's private assets are assumed to have similar volatility and if diversification effects are ignored. This leverage is similar to the leverage computed on the basis of balance sheet variables.

The magnitude of Buffett's leverage partly explains how he outperforms the market—but only partly. For example, if one applies 1.7-to-1 leverage to the market, it magnifies the market's average excess return to about 12.7%. Such a leveraged market return still falls far short, however, of Berkshire's 18.6% average excess return (and would result in a riskier and higher-beta portfolio than Buffett's).

In addition to the magnitude of Buffett's leverage, his sources of leverage, including their terms and costs, are interesting. Berkshire Hathaway's debt, enjoying a AAA rating from 1989 to 2009, has benefited from being highly rated. An illustration of the low financing rates enjoyed by Buffett is that Berkshire issued the first ever negative-coupon security in 2002, a senior note with a warrant.[6]

Berkshire Hathaway's anomalous cost of leverage arises, however, from its insurance float. Collecting insurance premiums up front and later paying a diversified set of claims is like taking a "loan." **Table 3** shows that the estimated average annual cost of Berkshire's insurance float is only 1.72%, about 3 percentage points below the average T-bill rate. Hence, Buffett's low-cost insurance and reinsurance businesses have given him a significant advantage in terms of unique access to cheap, term leverage. After hand collecting the float data from Berkshire's annual reports, we estimated that 35% of Berkshire's liabilities, on average, consist of insurance float.[7]

Based on the balance sheet data, Berkshire also appears to finance part of its capital expenditures with tax deductions for accelerated depreciation of property, plant, and equipment as provided for under US Internal Revenue Service rules. For example, Berkshire reported $28 billion of such deferred tax liabilities in 2011 (p. 49 of the 2011 Annual Report). Accelerating depreciation is similar to an interest-free loan in the sense that (1) Berkshire enjoys a tax saving earlier than it otherwise would and (2) the dollar amount of the tax when it is paid in the future is the same as the earlier savings (i.e., the tax liability does not accrue interest or compound). Of course, Berkshire does pay taxes, which we discuss in a later section.

Berkshire Hathaway's remaining liabilities include accounts payable and derivative contract liabilities. Indeed, Berkshire has sold a number of derivative contracts, including writing index options on several major equity indexes—notably, put options and credit default obligations. For example, Berkshire stated in the 2011 Annual Report (p. 45),

> We received the premiums on these contracts in full at the contract inception dates. . . . With limited exceptions, our equity index put option and credit default contracts contain no collateral posting requirements with respect to changes in either the fair value or intrinsic value of the contracts and/or a downgrade of Berkshire's credit ratings.

Hence, Berkshire's sale of derivatives may serve both as a source of financing and as a source of revenue because such derivatives tend to be expensive (Frazzini and Pedersen 2012). Frazzini and Pedersen showed that investors that are either unable or unwilling to use leverage will pay a premium for instruments that embed the leverage, such as option contracts and levered exchange-traded funds. Buffett can profit by supplying this embedded leverage because he has unique access to stable and cheap financing.

## Table 2. Berkshire Hathaway Return Decomposed into Leverage, Public Stocks, and Private Companies and Systematic Buffett-Style Strategies

| | Performance | | | | Buffett-Style Portfolio | | | Buffett-Style Long-Only Portfolio | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Berkshire Hathaway | Public US Stocks (from 13F filings) | Private Holdings | Overall Stock Market Performance | Berkshire Hathaway | Public US Stocks (from 13F filings) | Private Holdings | Berkshire Hathaway | Public US Stocks (from 13F filings) | Private Holdings |
| Sample | 1976–2017 | 1980–2017 | 1984–2017 | 1976–2017 | 1976–2017 | 1980–2017 | 1984–2017 | 1976–2017 | 1980–2017 | 1984–2017 |
| Beta | 0.69 | 0.77 | 0.29 | 1.00 | 0.69 | 0.77 | 0.29 | 0.85 | 0.86 | 0.87 |
| Average excess return | 18.6% | 12.0% | 9.3% | 7.5% | 28.5% | 19.0% | 18.1% | 8.4% | 8.6% | 8.3% |
| Total volatility | 23.5% | 16.2% | 20.6% | 15.3% | 23.5% | 16.2% | 20.6% | 13.7% | 13.8% | 14.3% |
| Idiosyncratic volatility | 21.1% | 11.2% | 20.1% | 0.0% | 21.1% | 11.2% | 20.1% | 4.4% | 4.5% | 5.1% |
| Sharpe ratio | 0.79 | 0.74 | 0.45 | 0.49 | 1.21 | 1.17 | 0.88 | 0.61 | 0.62 | 0.58 |
| Information ratio | 0.64 | 0.51 | 0.35 | 0.00 | 1.11 | 1.13 | 0.78 | 0.45 | 0.38 | 0.25 |
| Leverage | 1.71 | 1.00 | 1.00 | 1.00 | 5.09 | 2.99 | 4.14 | 1.00 | 1.00 | 1.00 |
| Subperiod excess returns: | | | | | | | | | | |
| 1976–1980 | 41.2% | 31.5% | | 7.3% | 5.8% | 27.3% | | 7.9% | 30.5% | |
| 1981–1985 | 28.6 | 21.3 | 18.4% | 4.8 | 52.5 | 28.1 | 38.2% | 7.0 | 6.3 | 9.7% |
| 1986–1990 | 17.3 | 12.6 | 9.6 | 5.7 | 23.2 | 14.0 | 18.1 | 9.5 | 10.7 | 8.3 |
| 1991–1995 | 29.7 | 18.8 | 22.9 | 12.6 | 38.1 | 23.2 | 25.9 | 11.5 | 11.5 | 12.0 |
| 1996–2000 | 14.9 | 12.1 | 8.7 | 12.1 | 37.1 | 23.1 | 26.0 | 16.2 | 16.2 | 14.1 |
| 2001–2005 | 3.2 | 2.2 | 1.8 | 0.9 | 28.0 | 14.2 | 13.8 | –0.8 | –1.6 | 1.1 |
| 2006–2010 | 6.1 | 4.1 | 4.0 | 2.5 | 1.9 | 3.6 | –5.7 | 2.7 | 1.1 | 1.0 |
| 2011–2015 | 10.8 | 9.9 | 5.0 | 12.1 | 33.8 | 21.8 | 21.8 | 11.2 | 11.5 | 11.0 |
| 2016–2017 | 19.3 | 13.6 | 11.1 | 15.0 | 45.3 | 32.9 | 20.3 | 15.0 | 14.6 | 14.5 |

*Notes*: Excess return is in excess to the US T-bill rate. To construct the mimicking portfolio of Berkshire's publicly traded stocks, at the end of each calendar quarter, under the assumption that the firm did not change holdings between reports, we collected Berkshire's common stock holdings from its 13F filings and computed portfolio monthly returns, weighted by Berkshire's dollar holdings. The stocks in the portfolio were refreshed quarterly on the basis of the latest 13F, and the portfolio was rebalanced monthly to keep constant weights. The mimicking portfolio of Berkshire's private holdings was constructed with the procedure described in Appendix B. The systematic Buffett-style portfolios were constructed from a regression of monthly excess returns. The explanatory variables are the monthly returns of the standard size, value, and momentum factors (Fama and French 1993; Asness 1994; Carhart 1997; Jegadeesh and Titman 1993), the betting-against-beta factor (Frazzini and Pedersen 2014), and the quality-minus-junk factor (Asness, Frazzini, and Pedersen Forthcoming 2018). Returns, volatilities, and Sharpe ratios are annualized. "Idiosyncratic volatility" is the volatility of the residual of a regression of monthly excess returns on market excess returns.

**Table 3. Buffett's Cost of Leverage: The Case of His Insurance Float**

| | | | Spread over Benchmark Rates | | | | |
|---|---|---|---|---|---|---|---|
| | Fraction of Years with Negative Cost | Average Cost of Funds (truncated)[a] | T-Bill | Fed Funds Rate | One-Month LIBOR | Six-Month LIBOR | 10-Year Bond |
| 1967–1970 | 0.75 | 0.29 | −5.20 | −6.03 | | | −5.93 |
| 1971–1975 | 0.60 | 4.45 | −1.18 | −2.38 | | | −2.51 |
| 1976–1980 | 1.00 | 0.00 | −7.52 | −8.61 | | | −8.88 |
| 1981–1985 | 0.20 | 10.95 | 1.10 | −0.26 | | | −1.28 |
| 1986–1990 | 0.00 | 3.07 | −3.56 | −4.60 | −4.79 | −4.90 | −5.30 |
| 1991–1995 | 0.60 | 2.21 | −2.00 | −2.24 | −2.46 | −2.71 | −4.64 |
| 1995–2000 | 0.60 | 2.36 | −2.70 | −3.10 | −3.33 | −3.48 | −3.56 |
| 2001–2005 | 0.60 | 1.29 | −0.82 | −0.96 | −1.05 | −1.19 | −3.11 |
| 2006–2010 | 1.00 | −4.73 | −6.94 | −7.18 | −7.43 | −7.73 | −8.59 |
| 2011–2015 | 1.00 | −2.37 | −2.42 | −2.48 | −2.57 | −2.86 | −4.68 |
| 2016–2017 | 0.50 | 0.23 | −0.39 | −0.46 | −0.57 | −1.03 | −1.85 |
| Full sample | 0.63 | 1.72 | −2.97 | −3.61 | −3.42 | −3.64 | −4.71 |

[a]In years when cost of funds is reported as "less than zero" and no numerical value is available, we set the cost of funds to zero.

*Notes*: The data were hand-collected from Warren Buffett's comments in Berkshire Hathaway's annual reports. Rates are annualized, in percentage points.

## Decomposing Buffett: Public Stocks vs. Private Companies

Berkshire Hathaway's stock return can be decomposed into the performance of the publicly traded companies that it owns, the performance of the privately held companies that it owns, and the leverage it uses. The performance of the publicly traded companies is a measure of Warren Buffett's stock-selection ability, whereas the performance of the privately held companies may additionally capture his success as a manager.

To evaluate Buffett's pure stock-selection ability, we used Berkshire Hathaway's 13F filings to collect the portfolio of publicly held companies and constructed a monthly time series of the market value of all Berkshire's public stocks, $\text{Public}_t^{MV}$, and the monthly return on this mimicking portfolio, $r_{t+1}^{Public}$. Specifically, at the end of each calendar quarter (under the assumption that the firm did not change holdings between reports), we collected Berkshire's common stock holdings from its 13F filing and computed portfolio monthly returns, weighted by Berkshire's dollar holdings. The stocks in the portfolio were refreshed quarterly on the basis of the latest 13F, and the portfolio was rebalanced monthly to keep the weights constant.

We could not directly observe the value and performance of Buffett's private companies, but based on what we do know, we could back them out. First, we could infer the market value of private holdings, $\text{Private}_t^{MV}$, as the residual because we could observe the value of the total assets, the value of the publicly traded stocks, and the cash (see Buffett's balance sheet in Exhibit 1):

$$\text{Private}_t^{MV} = \text{TA}_t^{MV} - \text{Public}_t^{MV} - \text{Cash}_t^{MV}.$$

We then computed the return of these private holdings, $r_{t+1}^{Private}$, in a way that is immune to changes in the public stock portfolio and to splits/issuances by using split-adjusted returns as follows:

$$r_{t+1}^{Private} = \frac{\Delta\text{Private}_{t+1}^{MV}}{\text{Private}_t^{MV}} = \frac{r_{t+1}^{f}\text{Liabilities}_t^{MV} + r_{t+1}^{Equity}\text{Equity}_t^{MV} - r_{t+1}^{Public}\text{Public}_t^{MV} - r_{t+1}^{f}\text{Cash}_t^{MV}}{\text{Private}_t^{MV}},$$

where $r^f_{t+1}$ is the risk-free T-bill return, $r^{Equity}_{t+1}$ is the return on Berkshire's stock, and the market value of liabilities is estimated as $\text{Liabilities}^{MV}_t = \text{TA}^{MV}_t - \text{Equity}^{MV}_t$.

Note that our estimate of the value of Berkshire Hathaway's private companies includes the value that the market attaches to Buffett himself (because it is based on the overall value of Berkshire Hathaway). To the extent that Berkshire's stock price is subject to randomness or mispricing (e.g., because of the Buffett-specific element), the estimated value and return of the private companies may be noisy.

Given our estimates for Buffett's public and private returns as well as his leverage, we could decompose Berkshire's performance; see Appendix B for a rigorous derivation. Berkshire's excess return can be decomposed into a weighted average of the return of the public stocks and the return of the private companies, leveraged up by *L*:

$$r^{Equity}_{t+1} - r^f_{t+1} = \left[w_t\left(r^{Private}_{t+1} - r^f_{t+1}\right) + (1 - w_t)\left(r^{Public}_{t+1} - r^f_{t+1}\right)\right]L_t.$$

Berkshire's relative weight, $w_t$, on the private holdings is naturally given by

$$w_t = \frac{\text{Private}^{MV}_t}{\text{Private}^{MV}_t + \text{Public}^{MV}_t}.$$

Empirically, we found that Berkshire owned 65% private companies, on average, from 1980 to 2017, the remaining 35% being invested in public stocks. Berkshire's reliance on private companies has been increasing steadily over time—from less than 20% in the early 1980s to more than 78% in 2017.

Table 2 shows the performance of Buffett's public and private positions. Both have performed well. Buffett's public and private portfolios have exceeded the overall stock market in terms of average excess return, risk, and Sharpe ratio. The public stocks have a higher Sharpe ratio than the private stocks, suggesting that Buffett's skill comes mostly from his ability to pick stocks, not necessarily his value added as a manager (but keep in mind that our imputed returns may be subject to noise).

Berkshire Hathaway's overall stock return is far above the returns of both the private and public portfolios. The reason is that Berkshire is not simply a weighted average of the public and private components. It is also leveraged, which magnifies returns. Furthermore, Berkshire's Sharpe ratio is higher than those of the public and private parts, which reflects the benefits of diversification (and possibly benefits from time-varying leverage and time-varying public/private weights).

## Buffett's Alpha and Investment Style: What Types of Stock?

We have noted that Warren Buffett's returns can be attributed to his stock selection and his ability to apply leverage, but how does he select his companies? To address this question, we considered Buffett's factor exposures:

$$r_t - r^f_t = \alpha + \beta_1\text{MKT}_t + \beta_2\text{SMB}_t + \beta_3\text{HML}_t + \beta_4\text{UMD}_t + \beta_5\text{BAB}_t + \beta_6\text{QMJ}_t + \varepsilon_t,$$

where MKT is the excess return of the overall equity market, SMB is the size factor (small minus big), HML is the value versus growth factor (high book to market minus low book to market), UMD is the momentum factor (up minus down), BAB is betting against beta, and QMJ is quality minus junk.

As shown in **Table 4**, we ran this regression for the excess return, $r_t - r^f_t$, of Berkshire Hathaway stock, the portfolio of publicly held stocks inferred from the 13F filings, and the portfolio of private companies computed as described previously. For each of these returns, we first ran a regression on the market return (MKT). Berkshire has a beta of less than 1 and a significant alpha. We next controlled for the standard factors that capture the effects of size and value (Fama and French 1993) and momentum (Asness 1994; Carhart 1997; Jegadeesh and Titman 1993). The size factor, SMB, is a strategy of going long small-capitalization stocks and short large-cap stocks. Hence, a positive loading on SMB reflects a tendency to buy small-cap stocks, so Berkshire's negative loading reflects a tendency to buy large-cap stocks. The value factor, HML, is a strategy of buying stocks of high book value to market value while shorting stocks of low book value to market value. Berkshire's positive loading thus reflects a tendency of buying stocks that are cheap—in the sense of having high book value relative to their market value. The last of the four "standard" factors is the

**Table 4. What Kinds of Companies Does Berkshire Hathaway Own? (*t*-statistics in parentheses)**

| | Berkshire Stock, 10/1976–3/2017 | | | | 13F Portfolio, 4/1980–3/2017 | | | | Private Holdings, 4/1980–3/2017 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alpha | **13.4%** | **11.0%** | **8.5%** | 5.4% | **5.8%** | **4.5%** | 3.0% | 0.3% | **7.0%** | 4.9% | 3.9% | 3.5% |
| | (4.01) | (3.30) | (2.55) | (1.55) | (3.09) | (2.46) | (1.62) | (0.16) | (1.98) | (1.40) | (1.10) | (0.91) |
| MKT | **0.69** | **0.83** | **0.83** | **0.95** | **0.77** | **0.85** | **0.86** | **0.95** | **0.30** | **0.39** | **0.40** | **0.42** |
| | (11.00) | (12.74) | (12.99) | (12.77) | (22.06) | (23.81) | (24.36) | (23.52) | (4.46) | (5.63) | (5.72) | (5.03) |
| SMB | | **−0.29** | **−0.30** | −0.13 | | **−0.19** | **−0.19** | −0.05 | | **−0.26** | **−0.25** | −0.23 |
| | | −(3.11) | −(3.19) | −(1.17) | | −(3.73) | −(3.79) | −(0.95) | | −(2.65) | −(2.56) | −(1.95) |
| HML | | **0.47** | **0.31** | **0.40** | | **0.28** | **0.19** | **0.25** | | **0.28** | 0.21 | 0.22 |
| | | (4.68) | (2.82) | (3.55) | | (5.20) | (3.25) | (4.32) | | (2.63) | (1.80) | (1.85) |
| UMD | | 0.06 | −0.02 | −0.05 | | −0.01 | −0.06 | **−0.09** | | 0.08 | 0.04 | 0.04 |
| | | (1.00) | −(0.25) | −(0.80) | | −(0.36) | −(1.66) | −(2.58) | | (1.24) | (0.62) | (0.51) |
| BAB | | | **0.33** | **0.27** | | | **0.19** | **0.15** | | | 0.15 | 0.14 |
| | | | (3.79) | (3.04) | | | (4.08) | (3.18) | | | (1.61) | (1.53) |
| QMJ | | | | **0.47** | | | | **0.37** | | | | 0.07 |
| | | | | (3.06) | | | | (4.55) | | | | (0.43) |
| $\bar{R}^2$ | 0.20 | 0.25 | 0.27 | 0.29 | 0.52 | 0.58 | 0.59 | 0.61 | 0.05 | 0.08 | 0.08 | 0.08 |
| Obs. | 486 | 486 | 486 | 486 | 444 | 444 | 444 | 444 | 399 | 399 | 399 | 399 |

*Notes*: This table shows calendar-time portfolio returns. Alphas are annualized. Boldface indicates statistical significance at the 5% level. See also the notes to Table 2.

momentum factor, UMD, which corresponds to buying stocks that have performed well relative to peers over the past year (winners) while shorting the stocks that are relative underperformers (losers). Berkshire's insignificant loading on UMD means that Buffett is not chasing trends in his stock selection.

Collectively, these four standard factors do not explain much of the alpha shown in Table 4. Because Buffett's alpha cannot be explained by standard factors studied by academics, his success has to date been considered a sign of his unique skill or simply a mystery.

Our innovation for this study was to also control for the factors betting against beta, BAB, described in Frazzini and Pedersen (2014) and quality, QMJ, of Asness, Frazzini, and Pedersen (Forthcoming 2018). A loading on the BAB factor reflects a tendency to buy safe (i.e., low-beta) stocks while shying away from risky (i.e., high-beta) stocks. Similarly, a loading on the QMJ factor reflects a tendency to buy high-quality companies—that is, companies that are profitable, growing, and safe and have high payout.[8]

Table 4 reveals that Berkshire Hathaway loads significantly on the BAB and QMJ factors, indicating that Buffett likes to buy safe, high-quality stocks. Controlling for these factors drives the alpha of Berkshire's public stock portfolio down to a statistically insignificant annualized 0.3%. That is, these factors almost completely explain the performance of Buffett's public portfolio. Hence, a significant part of the secret behind Buffett's success is the strategy of buying safe, high-quality, value stocks. These factors also explain a large part of Berkshire's overall stock return and of the private part in that their alphas become statistically insignificant when BAB and QJM are controlled for. The point estimate of Berkshire's alpha, however, drops only by about half.

Although Warren Buffett is known as the ultimate value investor, we find that his focus on safe, high-quality stocks may be at least as important to his performance. Our statistical finding is consistent with Buffett's own words from the Berkshire Hathaway 2008 Annual Report: "Whether we're talking about socks or stocks, I like buying quality merchandise when it is marked down."

We emphasize again that being able to explain Buffett's returns by using factors from academic papers written decades after Buffett put the strategies into practice does not make Buffett's success any less impressive. It is interesting, however, to discover the importance of leveraging low-beta, high-quality stocks for the person known as the "ultimate value investor."

## A Systematic Buffett Strategy

Given that we can attribute Warren Buffett's performance to leverage and his focus on safe, high-quality, value stocks, we naturally wanted to consider how well one could do by implementing these investment themes in a systematic way. Buffett is known as an active stock picker, but we tried to go back to Buffett's roots and, in the spirit of Graham and Dodd (1934), focused on systematically implemented screens.

We considered systematic Buffett-style portfolios that tracked Buffett's market exposure and active stock-selection themes. First, we captured Buffett's market exposure, $\beta^{Buffett}$, as the slope of a univariate regression of Berkshire Hathaway's excess returns on the market portfolio. Second, we captured Buffett's stock-selection tilts by running a regression of Berkshire's monthly beta-adjusted returns on the factors that help explain its performance, as described in the previous section:

$$r_t - r_t^f - \beta^{Buffett}\text{MKT}_t = \alpha + m\text{MKT}_t + s\text{SMB}_t + h\text{HML}_t + u\text{UMD}_t + b\text{BAB}_t + q\text{QMJ}_t + \varepsilon_t.$$

The regression coefficients are equal to those in the fifth column of Table 4, with the exception that the market loading is reduced by an amount equal to $\beta^{Buffett}$. The right-hand side excluding the alpha and the error term captures Buffett's *active* stock-selection tilts:

$$r_t^A = m\text{MKT}_t + s\text{SMB}_t + h\text{HML}_t + u\text{UMD}_t + b\text{BAB}_t + q\text{QMJ}_t.$$

We rescaled this active return series to match Berkshire's idiosyncratic volatility, $\sigma_I$, to simulate the use of leverage and to counter any attenuation bias:

$$r_t^{Active} = r_t^A \frac{\sigma_I}{\sigma_{r_t^A}}.$$

Finally, we added back Berkshire's market exposure and the risk-free return, $r_t^f$, to construct our systematic Buffett-style portfolio:

$$r_t^{Buffett\ style} = r_t^f + \beta^{Buffett} \text{MKT}_t + r_t^{Active}.$$

This systematic Buffett-style strategy is a diversified portfolio that matches Berkshire's beta, idiosyncratic volatility, total volatility, and relative active loadings.

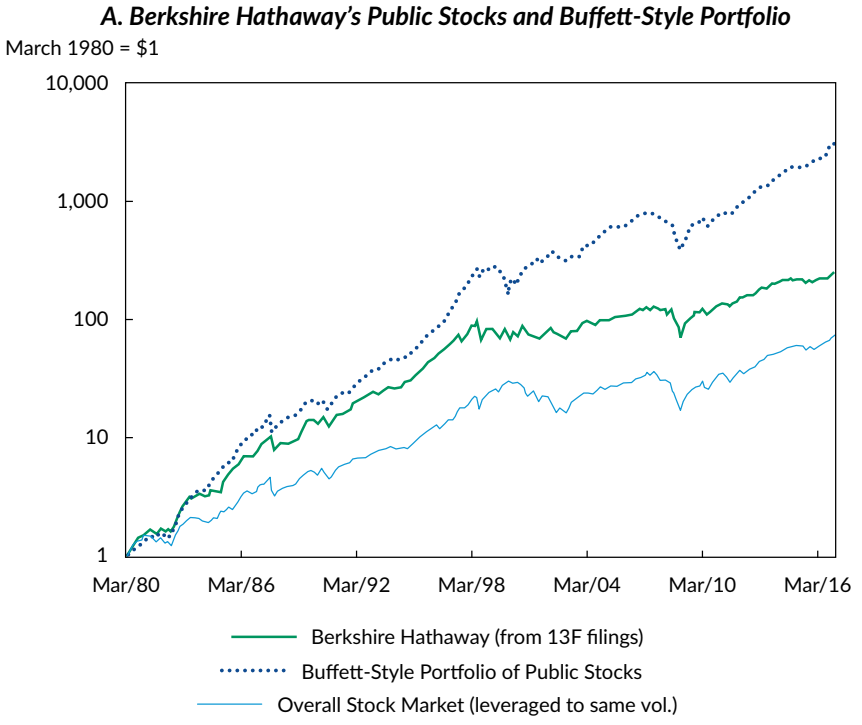
We similarly constructed a Buffett-style portfolio based on the loadings and volatility of Berkshire Hathaway's public and private equity holdings. Table 2 reports the performance of our systematic Buffett-style portfolios, and **Figure 3** shows the cumulative return of Berkshire, Buffett's public stocks, and our systematic Buffett-style strategies. Finally, **Table 5** reports correlations, alphas, and loadings for our systematic Buffett-style portfolios and their actual Buffett counterparts.

The performance of the systematic Buffett-style portfolios are comparable to Buffett's actual return. Because the simulated Buffett-style portfolios do not account for transaction costs and other costs and benefit from hindsight, their apparent outperformance should be discounted. The main insight here is the high covariation between Buffett's actual performance and the performance of a diversified Buffett-style strategy.

The Buffett-style portfolio matched the public stock portfolio especially closely, perhaps because this public portfolio was observed directly and its returns were calculated from public stock returns in a method that used the same methodology as our systematic portfolios. Berkshire's overall stock price, however, may have idiosyncratic price variation (e.g., because of the value of Buffett himself) that cannot be replicated by using other stocks. This idiosyncratic Berkshire variation is even more severe for the private part, which may also suffer from measurement issues.

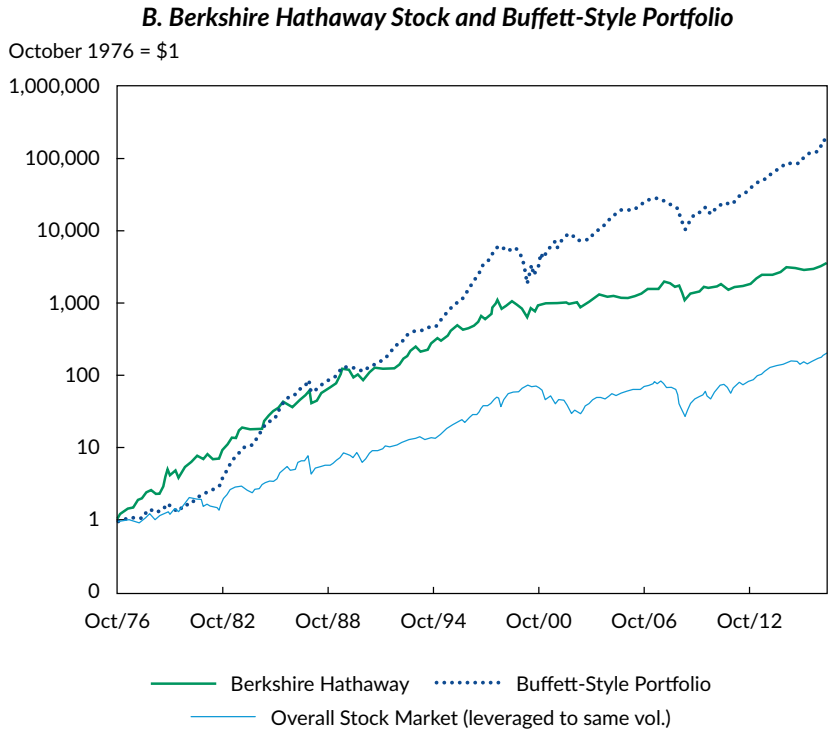
The comparison of Berkshire Hathaway's public stock portfolio and the corresponding Buffett-style portfolio is also the cleaner test of Buffett's stock selection because *both* are simulated returns without any transaction costs or taxes. Indeed, the correlation between our systematic portfolio and Berkshire's public stock portfolio (shown in Table 5) is 73%, meaning that our systematic portfolio explains 53% of the variance of the public stock portfolio. The correlations between the systematic

**Figure 3.** Performance of the Equity Market, Berkshire Hathaway, and a Systematic Buffett-Style Portfolio




(continued)

**Figure 3.** Performance of the Equity Market, Berkshire Hathaway, and a Systematic Buffett-Style Portfolio (continued)




*Notes*: Panel A shows the cumulative return of Berkshire Hathaway's portfolio of publicly traded stocks (as reported in its 13F filings), a corresponding systematic Buffett-mimicking portfolio, and the CRSP value-weighted market return (leveraged to the same volatility as Berkshire's public stocks). Panel B shows the cumulative return of Berkshire Hathaway, a corresponding systematic Buffett-mimicking portfolio, and the CRSP value-weighted market return (leveraged to the same volatility as Berkshire). The systematic Buffett-style strategy was constructed from a regression of monthly excess returns of Berkshire Hathaway stock and the portfolio of publicly held stocks inferred from the 13F filings (columns 5 and 9, respectively, in Table 4). The explanatory variables are the monthly returns of the six factors. The systematic Buffett-style portfolio excess return is the sum of the explanatory variables multiplied by the respective regression coefficients, rescaled to match the volatility of Berkshire's return.

portfolio and Berkshire's stock price and between the systematic portfolio and Buffett's private investments are lower (48% and 26%, respectively) but still large in magnitude. Table 5 also shows that our systematic portfolios have significant alphas with respect to their corresponding Buffett counterparts, whereas none of the Buffett portfolios have statistically significant alphas with respect to their systematic counterparts. This result may have arisen because our systematic portfolios have similar factor tilts as Buffett's but hold a much larger number of securities, thus benefiting from diversification.

The Berkshire Hathaway stock return does reflect incurred transaction costs and possibly additional taxes, so Buffett's performance is all the more impressive. Given Berkshire's modest turnover initially, transaction costs were probably small in the early days. As Berkshire grew, so did transaction costs, which could account for some of Berkshire's diminishing returns over time. Furthermore, Berkshire initially focused on small companies, which is reflected in a positive SMB loading in the first half of the time period (not shown) but may have been increasingly forced to focus on large-cap stocks. Indeed, Table 4 shows that Berkshire has a negative loading on the SMB factor. Hence, Berkshire's diminishing returns could also be related to capacity constraints.

Assessing the impact of taxes on Berkshire Hathaway's performance is complicated. For Berkshire's private holdings, the joint ownership in a multinational company is associated with tax advantages. For the public

**Table 5. Buffett's Returns vs. a Systematic Buffett Strategy (*t*-statistics in parentheses)**

| | Berkshire Regressed on Systematic Portfolio | | | Systematic Portfolio Regressed on Berkshire | | |
|---|---|---|---|---|---|---|
| | Berkshire Hathaway | Public US Stocks (from 13F filings) | Private Holdings | Berkshire Hathaway | Public US Stocks (from 13F filings) | Private Holdings |
| Sample | 1976–2017 | 1980–2017 | 1984–2017 | 1976–2017 | 1980–2017 | 1984–2017 |
| Alpha (annualized) | 5.4% | 0.3% | 3.5% | **18.7%** | **10.2%** | **14.2%** |
| | (1.64) | (0.17) | (0.98) | (5.85) | (5.99) | (4.10) |
| Loading | **0.34** | **0.43** | **0.23** | **0.34** | **0.43** | **0.23** |
| | (8.05) | (10.01) | (4.60) | (8.05) | (10.01) | (4.60) |
| MKT | **0.45** | **0.44** | **0.23** | **0.45** | **0.44** | **0.23** |
| | (6.87) | (9.59) | (3.45) | (6.87) | (9.59) | (3.45) |
| Correlation | 0.48 | 0.73 | 0.26 | 0.48 | 0.73 | 0.26 |
| $\bar{R}^2$ | 0.29 | 0.61 | 0.09 | 0.29 | 0.61 | 0.09 |

*Notes*: This table shows calendar-time portfolio returns. Alpha is the intercept in a regression of monthly excess return. Alphas are annualized. Boldface indicates statistical significance at the 5% level. See also the notes to Table 2.

stocks, Berkshire could face double corporate taxes—that is, the need to pay tax both indirectly in the portfolio companies' earnings and in Berkshire as it receives dividends or realizes capital gains. However, Berkshire can deduct 70%–80% of the dividends received, defer capital gains taxes by holding on to the positions so that gains remain unrealized,[9] and minimize taxes by allocating earnings abroad as a multinational.[10] Hence, assessing whether Berkshire is at a tax disadvantage overall is difficult.

In addition to the systematic long–short portfolios, we computed a long-only, unleveraged, systematic Buffett-style strategy. At the end of each calendar month, we sorted securities on the basis of the portfolio weights corresponding to our active tilts, $r_t^{Active}$, and constructed an equal-weighted portfolio that held the top 50 stocks with the highest portfolio weights. Table 2 shows that these simple Buffett-style portfolios also performed well, albeit not as well as when we allowed short selling.

As a final robustness check, we considered Buffett-style portfolios that did not rely on in-sample regression coefficients. Specifically, we created an implementable Buffett-style strategy by using only information up to month $t$ to construct portfolio weights for the next month, $t + 1$. These portfolios performed similarly to our full-sample Buffett-style portfolios and had similar alphas, as described in Appendix C.

In summary, if one had applied leverage to a portfolio of safe, high-quality, value stocks consistently over this time period, one would have achieved a remarkable return, as Buffett did. Of course, he started doing it more than half a century before we wrote this paper!

## Conclusion and Practical Implications of the Oracle's Alpha

We have showed just how spectacular the performance of Berkshire Hathaway has been when compared with that of other stocks or mutual funds. Indeed, for the sample we studied, we found that Berkshire Hathaway had the highest Sharpe ratio among all and a higher Sharpe ratio than all US mutual funds that have been around for more than 40 years. We found that the Sharpe ratio of Berkshire Hathaway was 0.79 over the period 1976–2017. Although this Sharpe ratio is nearly double that of the overall stock market, it is lower than many investors imagine. Adjusting for the market exposure, Buffett's information ratio is lower, 0.64. The Sharpe

ratio reflects high average returns but also significant risk and periods of losses and significant drawdowns.

If his Sharpe ratio is very good but not super-human, then how did Buffett become among the richest in the world? The answer is that he stuck to a good strategy—buying cheap, safe, quality stocks—for a long time period, surviving rough periods where others might have been forced into a fire sale or a career shift, and he boosted his returns by using leverage. We estimated that Buffett applies a leverage of about 1.7 to 1, boosting both his risk and excess return in that proportion. Thus, his many accomplishments include having the conviction, wherewithal, and skill to operate with leverage and significant risk over a number of decades.

We identified several general features of Buffett's chosen portfolio: He buys stocks that are safe (with low beta and low volatility), cheap (i.e., value stocks with low price-to-book ratios), and of high quality (profitable, stable, and growing stocks with high payout ratios). Interestingly, stocks with these characteristics tend to perform well in general, so these characteristics help explain Buffett's investment.

We created a portfolio that tracked Buffett's market exposure and active stock-selection themes and was leveraged to the same active risk as Berkshire Hathaway. We found that this systematic Buffett-style portfolio performed comparably to Berkshire. Buffett's genius thus appears to be at least partly in recognizing early on that these investment themes work, applying leverage without ever having a fire sale, and sticking to his principles. Perhaps this is what he means by his comment in the Berkshire Hathaway 1994 Annual Report: "Ben Graham taught me 45 years ago that in investing it is not necessary to do extraordinary things to get extraordinary results."

Finally, we considered whether Buffett's skill is the result of his ability to buy the right stocks or his ability as a CEO. We decomposed Berkshire Hathaway's returns into two parts—investments in publicly traded stocks and the private companies run within Berkshire. We found that both public and private companies contribute to Buffett's performance but the portfolio of public stocks performs the best, suggesting that Buffett's skill is mostly in stock selection.

We then asked why he relies heavily on private companies, including the insurance and reinsurance businesses. One reason might be taxes, and another might be that this structure provides a steady source of financing that allows him to leverage his stock-selection ability. Indeed, we found that 36% of Buffett's liabilities consist of insurance float (i.e., insurance premiums paid up front) with an average cost below the T-bill rate.

In summary, we found that Buffett has developed a unique access to leverage; that he has invested in safe, high-quality, cheap stocks; and that these key characteristics can largely explain his impressive performance.

Our results have the following three notable practical implications.

First, we shed new light on the efficiency of capital markets by studying in a novel way the famous coin-flipping debate at the 1984 Columbia conference between Michael Jensen representing the efficient market economists and Warren Buffett representing Graham-and-Doddsville. The 2013 and 2017 Nobel prizes reignited this debate; as a prototypical example, see the *Forbes* article "What Is Market Efficiency?" (Heakal 2013): "In the real world of investments, however, there are obvious arguments against the [efficient market hypothesis]. There are investors who have beaten the market—Warren Buffett."

The efficient market counterargument is that Buffett was simply lucky. Our findings suggest that Buffett's success is neither luck nor magic but is a reward for a successful implementation of value and quality exposures that have historically produced high returns. Second, we illustrated how Buffett's record can be viewed as an expression of the practical implementability of academic factor returns after transaction costs and financing costs. We simulated how investors can try to take advantage of similar investment principles. Buffett's success shows that the high returns of these academic factors are not simply "paper" returns; these returns can be realized in the real world after transaction costs and funding costs, at least by Warren Buffett. Furthermore, Buffett's exposure to the BAB factor and his unique access to leverage are consistent with the idea that the BAB factor represents reward to the use of leverage.

Third, our results illustrate what investment success looks like in the real world. Although optimistic asset managers often claim to be able to achieve Sharpe ratios above 1 or 2 and many chief investment officers seek similarly high performance numbers, our results suggest that long-term investors

might do well to set a realistic performance goal and brace themselves for the tough periods that even Buffett has experienced. Indeed, because Buffett became one of the richest people in the world with a Sharpe ratio of 0.79, most investors should seek to actually deliver a Sharpe ratio somewhere between this number and the market's Sharpe ratio, which was around 0.5 during this sample period, rather than making suboptimal investments in a futile attempt to consistently reach a much higher number.

**Editor's Note**

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## Notes

1. Based on the original insights of Black (1972) and Black, Jensen, and Scholes (1972), Frazzini and Pedersen (2014) showed that leverage and margin requirements change equilibrium risk premiums. They demonstrated that investors without binding leverage constraints can profit from betting against beta—that is, buying low-risk assets and shorting risky assets. Frazzini and Pedersen (2012) extended this finding to derivatives with embedded leverage, and Asness, Frazzini, and Pedersen (2012) added the risk–return relationship across asset classes. Asness, Frazzini, and Pedersen (Forthcoming 2018) considered fundamental measures of risk and other accounting-based measures of "quality"—that is, characteristics that increase a company's value.

2. Graham and Dodd's *Security Analysis* (1934) is credited with laying the foundation for investing based on value and quality, and Benjamin Graham and David Dodd were Buffett's professors at Columbia Business School.

3. Value stocks, on average, outperform growth stocks, as documented by Stattman (1980), Rosenberg, Reid, and Lanstein (1985), and Fama and French (1993), and high-quality stocks outperform junk stocks, on average, as documented by Asness, Frazzini, and Pedersen (Forthcoming 2018) and references therein.

4. The French website is http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

5. This result can be seen directly by optimizing numerically among these combinations or via the theoretical result of Treynor and Black (1973) that the highest Sharpe ratio arises as the square root of the sum of the squared market Sharpe ratio and the squared information ratio. See also the generalized result of Clarke, De Silva, and Thorley (2016).

6. See the Berkshire Hathaway news release of 22 May 2002 at www.berkshirehathaway.com/news/may2202.html.

7. For example, the 2017 Annual Report provides the float number on p. 7 and states on pp. 6 and 7, "Before I discuss our 2017 insurance results, let me remind you of how and why we entered the field. We began by purchasing National Indemnity and a smaller sister company for $8.6 million in early 1967 . . . , insurance business that usually delivered an underwriting profit. Even more important, the insurance operation carried with it $19.4 million of 'float'— money that belonged to others but was held by our two insurers. Ever since, float has been of great importance to Berkshire. . . . Premiums are generally paid to the company upfront whereas losses occur over the life of the policy. . . . As a result of our emphasizing that sort of business, Berkshire's growth in float has been extraordinary. We are now the country's second largest p/c [property and casualty insurance] company measured by premium volume and its leader, by far, in float."

8. See Asness, Frazzini, and Pedersen (Forthcoming 2018) for details.

9. For a corporation, capital gains are subject to corporate taxes (with no special provision for long-term capital gains). Capital gains taxes can be deferred from a *cash flow perspective* as long as they are unrealized, but the accrued capital gains tax does lead to an expense from the *perspective of generally accepted accounting principles*. That is, Berkshire Hathaway does not *pay* any taxes for unrealized capital gains, but such unrealized capital gains do lower its reported *earnings* and hence its book value of equity while raising the accounting liability called "principally deferred income taxes."

10. For instance, Berkshire Hathaway's 2011 Annual Report states, "We have not established deferred income taxes with respect to undistributed earnings of certain foreign subsidiaries. Earnings expected to remain reinvested indefinitely were approximately $6.6 billion as of December 31, 2011. Upon distribution as dividends or otherwise, such amounts would be subject to taxation in the U.S. as well as foreign countries. However, U.S. income tax liabilities would be offset, in whole or in part, by allowable tax credits with respect to income taxes previously paid to foreign jurisdictions. Further, repatriation of all earnings of foreign subsidiaries would be impracticable to the extent that such earnings represent capital needed to support normal business operations in those jurisdictions. As a result, we currently believe that any incremental U.S. income tax liabilities arising from the repatriation of distributable earnings of foreign subsidiaries would not be material."

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# Appendix A: Data Sources and Methodology

## Stock Return Data

Stock return and price data are from the CRSP database. Our data include all domestic common stocks (share codes 10 and 11) on the CRSP tape between December 1925 and March 2017. To compute Berkshire Hathaway's stock returns, we value-weighted share classes A and B on the basis of lagged market capitalization (Berkshire Hathaway introduced a share class B in April 1996).

The stock return data for Berkshire Hathaway on the CRSP tape start in 1976. Hence, we have data only for the last 41 years of Warren Buffett's record. He ran various private investment partnership from 1957 to 1969, started trading Berkshire in 1962, took control of Berkshire in 1965, and started using Berkshire as his main investment vehicle after he closed his partnerships in 1969 (Lowenstein 2008). At the time of this writing, we have been unable to collect data on Berkshire's stock price prior to its introduction on the CRSP tape and Buffett's partnership performance, so our study covers the period 1976 to 2017, which can be viewed as a conservative estimate of Buffett's complete track record and out-of-sample evidence relative to his first almost 20 years of success.

## Balance Sheet Data

Our main source of balance sheet data is the Compustat North America database. Because of several errors in the cash item (especially in the quarterly reports in the early part of the sample period), however, we checked and corrected these data with information extracted from the original Form 10-K filings as well as information from Berkshire Hathaway's annual letter to shareholders. Berkshire holds a significant amount of cash on its balance sheet, which we hand-collected from Berkshire's annual reports and Form 10-K filings.

We made the following adjustments: For the end of 1985, the official cash number included a significant amount of cash set aside for the purchases of Capital Cities Communications and the Scott Fetzer Company. Therefore, we used the pro forma consolidated balance sheet presented in note 18 on p. 42 of the 1985 Annual Report. For the end of 1987, we used the restated cash figure mentioned in the 1988 Annual Report, note 1(b), p. 25. For other balance sheet items, we also focused on annual balance sheet data.

## 13F Holdings Data

We downloaded holdings data for Berkshire Hathaway from the Thomson Reuters Institutional (13F) Holdings Database, which includes holdings of all US entities exercising investment discretion over $100 million or more and filed with the SEC. The data on Berkshire's public stock holdings run from 1980 to 2017.

## Mutual Fund Data

We collected mutual fund returns from the CRSP Mutual Fund Database. The data run from 1976 to 2017. We focused our analysis on open-end actively managed domestic equity mutual funds. Our sample selection procedure followed that of Kacperczyk, Sialm, and Zheng (2008); see their appendix for details about the screens that were used and summary statistics of the data.

## Appendix B: Decomposing Berkshire Hathaway's Returns

To decompose Berkshire Hathaway's returns into its public equity part, private equity part, and leverage, we first defined the private equity return as

$$r_{t+1}^{Private} = \frac{r_{t+1}^{f}\text{Liabilities}_t^{MV} + r_{t+1}^{Equity}\text{Equity}_t^{MV} - r_{t+1}^{Public}\text{Public}_t^{MV} - r_{t+1}^{f}\text{Cash}_t^{MV}}{\text{Private}_t^{MV}}.$$

Rearranging this expression so that the overall Berkshire return is on the left side yields

$$\begin{aligned} r_{t+1}^{Equity} &= r_{t+1}^{Private}\frac{\text{Private}_t^{MV}}{\text{Equity}_t^{MV}} + r_{t+1}^{Public}\frac{\text{Public}_t^{MV}}{\text{Equity}_t^{MV}} - r_{t+1}^{f}\frac{\text{Liabilities}_t^{MV} - \text{Cash}_t^{MV}}{\text{Equity}_t^{MV}} \\ &= \left(r_{t+1}^{Private}\frac{\text{Public}_t^{MV}}{\text{Private}_t^{MV} + \text{Public}_t^{MV}} + r_{t+1}^{Public}\frac{\text{Public}_t^{MV}}{\text{Public}_t^{MV} + \text{Public}_t^{MV}}\right)L_t - r_{t+1}^{f}\frac{\text{Liabilities}_t^{MV} - \text{Cash}_t^{MV}}{\text{Equity}_t^{MV}}, \end{aligned}$$

where we used

$$\begin{aligned} L_t &= \frac{\text{TA}_t^{MV} - \text{Cash}_t^{MV}}{\text{Equity}_t^{MV}} \\ &= \frac{\text{Private}_t^{MV} + \text{Public}_t^{MV}}{\text{Equity}_t^{MV}}. \end{aligned}$$

The excess return of Berkshire could now be written in terms of the weight of the private holdings, $w_t = \text{Private}_t^{MV} \Big/ \left(\text{Private}_t^{MV} + \text{Public}_t^{MV}\right)$, as follows:

$$\begin{aligned} r_{t+1}^{Equity} - r_{t+1}^{f} &= \left[w_t r_{t+1}^{Private} + (1-w_t)r_{t+1}^{Public}\right]L_t - r_{t+1}^{f}\left(\frac{\text{Liabilities}_t^{MV} - \text{Cash}_t^{MV}}{\text{Equity}_t^{MV}} + 1\right) \\ &= \left[w_t\left(r_{t+1}^{Private} - r_{t+1}^{f}\right) + (1-w_t)\left(r_{t+1}^{Public} - r_{t+1}^{f}\right)\right]L_t - r_{t+1}^{f}\left(\frac{\text{Liabilities}_t^{MV} - \text{Cash}_t^{MV}}{\text{Equity}_t^{MV}} + 1 - L_t\right) \\ &= \left[w_t\left(r_{t+1}^{Private} - r_{t+1}^{f}\right) + (1-w_t)\left(r_{t+1}^{Public} - r_{t+1}^{f}\right)\right]L_t. \end{aligned}$$

The Berkshire equity excess return, therefore, depends on the excess returns of private and public holdings, their relative importance, and the degree of leverage.

Note that the 13F holdings data and mimicking portfolio returns, $r_{t+1}^{Public}$, start in 1980. Our way of estimating returns from private holdings, however, produced very noisy estimates for the first three years of the sample. Also, there were several outliers in the imputed $r_{t+1}^{Private}$ in the first years of the sample, with several returns exceeding +100% monthly. Therefore, we focused most of the analysis on $r_{t+1}^{Private}$ in the period 1984–2017, for which our method produced less noisy estimates.

## Appendix C: Implementable Systematic Buffett Strategies

We constructed systematic Buffett-style portfolios that tracked Warren Buffett's market exposure and active stock-selection themes. We did this step as in Table 2, except here, the analysis is implementable in real time (i.e., out of sample).

At the end of each calendar month $t$, using data up to month $t$, we first captured Buffett's market exposure, $\beta^{Buffett}$, as the slope of a univariate regression of Berkshire Hathaway's excess returns on the market portfolio. Second, we captured Buffett's stock-selection tilts by running a regression of his monthly beta-adjusted returns on the factors that help explain his performance:

$$r - r^f - \beta^{Buffett}\text{MKT} = \alpha + m\text{MKT} + s\text{SMB} + h\text{HML} + u\text{UMD} + b\text{BAB} + q\text{QMJ} + \varepsilon.$$

We required at least 60 monthly observations to run the time-series regressions. The regression coefficients have the same interpretation as those in column 3 of Table 4, with the exception that the market loading is reduced by an amount equal to $\beta^{Buffett}$. The right-hand side excluding the alpha and the error term captures Buffett's *active* stock-selection tilts:

$$\tilde{r}^A_{t+1} = m_t\text{MKT}_{t+1} + s_t\text{SMB}_{t+1} + h_t\text{HML}_{t+1} + u_t\text{UMD}_{t+1} + b_t\text{BAB}_{t+1} + q_t\text{QMJ}_{t+1}.$$

We rescaled this active return series to match Berkshire's idiosyncratic volatility to simulate the use of leverage and to counter any attenuation bias:

$$r^{Active}_{t+1} = \tilde{r}^A_{t+1}\frac{\sigma_{t,I}}{\sigma_{t,\tilde{r}^A}},$$

where $\sigma_{t,I}$ is Berkshire's idiosyncratic volatility, estimated from data up to month $t$.

Finally, we added back Buffett's market exposure and the risk-free return, $r^f_t$, to construct our systematic Buffett-style portfolio:

$$r^{Buffett\ style}_{t+1} = r^f + \beta^{Buffett}_t\text{MKT}_{t+1} + r^{Active}_{t+1}.$$

Note that in our notation, the subscript $t$ indicates that quantities are known at portfolio formation date $t$.

Our systematic Buffett-style return, $r^{Buffett\ style}_{t+1}$, is a diversified portfolio that matches Berkshire Hathaway's beta, idiosyncratic volatility, total volatility, and relative active loadings. These portfolios use only information up to month $t$ to construct portfolio weights for the next month, $t + 1$.

We similarly constructed a Buffett-style portfolio from the loadings and volatility of Berkshire's public and private equity holdings. Table C1 shows the results for these Buffett-style portfolios.

In addition to the systematic long–short portfolios, we computed a long-only, unleveraged, systematic Buffett-style strategy. At the end of each calendar month, we sorted securities on the basis of the portfolio weights corresponding to our active tilts, $r^{Active}_t$, from data up to month $t$ and constructed an equal-weighted portfolio that held the top 50 stocks with the highest portfolio weights, also shown in Table C1.

## Table C1. Implementable Buffett-Style Strategies

| | Buffett-Style Portfolio | | | Buffett-Style Portfolio Long Only | | |
|---|---|---|---|---|---|---|
| | Berkshire Hathaway | Public US Stocks (from 13F filings) | Private Holdings | Berkshire Hathaway | Public US Stocks (from 13F filings) | Private Holdings |
| Sample | 1981–2017 | 1985–2017 | 1989–2017 | 1981–2017 | 1985–2017 | 1989–2017 |
| Beta | 0.64 | 0.68 | 0.29 | 0.83 | 0.83 | 0.93 |
| Average excess return | 39.9% | 19.3% | 20.8% | 9.6% | 9.3% | 8.6% |
| Total volatility | 29.6% | 18.4% | 27.5% | 13.4% | 13.5% | 14.8% |
| Idiosyncratic volatility | 28.0% | 15.2% | 27.2% | 4.4% | 4.5% | 5.7% |
| Sharpe ratio | 1.35 | 1.05 | 0.75 | 0.72 | 0.69 | 0.58 |
| Information ratio | 1.24 | 0.90 | 0.68 | 0.65 | 0.55 | 0.24 |
| Leverage | 6.93 | 3.84 | 6.03 | 1.00 | 1.00 | 1.00 |
| Subperiod excess returns | | | | | | |
| 1976–1980 | | | | | | |
| 1981–1985 | 87.1% | 41.2% | | 17.8% | 22.8% | |
| 1986–1990 | 27.9 | 10.2 | 41.3% | 9.9 | 11.4 | 3.3% |
| 1991–1995 | 63.9 | 32.5 | 54.5 | 14.5 | 12.9 | 15.5 |
| 1996–2000 | 42.0 | 22.3 | 17.6 | 12.8 | 18.4 | 15.6 |
| 2001–2005 | 29.8 | 17.6 | 12.5 | –1.2 | –2.4 | 1.3 |
| 2006–2010 | 0.2 | 4.1 | –10.3 | 1.9 | 0.8 | 0.7 |
| 2011–2015 | 35.1 | 22.3 | 22.4 | 11.4 | 11.5 | 10.8 |
| 2016–2017 | 45.2 | 34.1 | 18.0 | 14.9 | 14.7 | 14.0 |

*Note:* See the notes to Table 2.