The profitability factor

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This notebook will illustrate how the Fama-French 3-factor model can be used to evaluate new investment ideas. Specifically, we will think about a style called *profitability*. The idea is to invest more in stocks that have higher profitability.

The notebook will compare two different ratios you might use to implement that idea:

1. The first is the ratio of cash flow to price.
2. The second is the ratio of operating profitability book assets.

In both cases, the numerator is a measure of cash flow or profits, and the denominator is a scaling factor. It turns out that the difference in the numerator is not very important. (I would use the same numerator in each if I could, but the data are not easily available.) On the other hand, the choice of denominator makes a big difference, even though it's just meant to be a scaling factor.

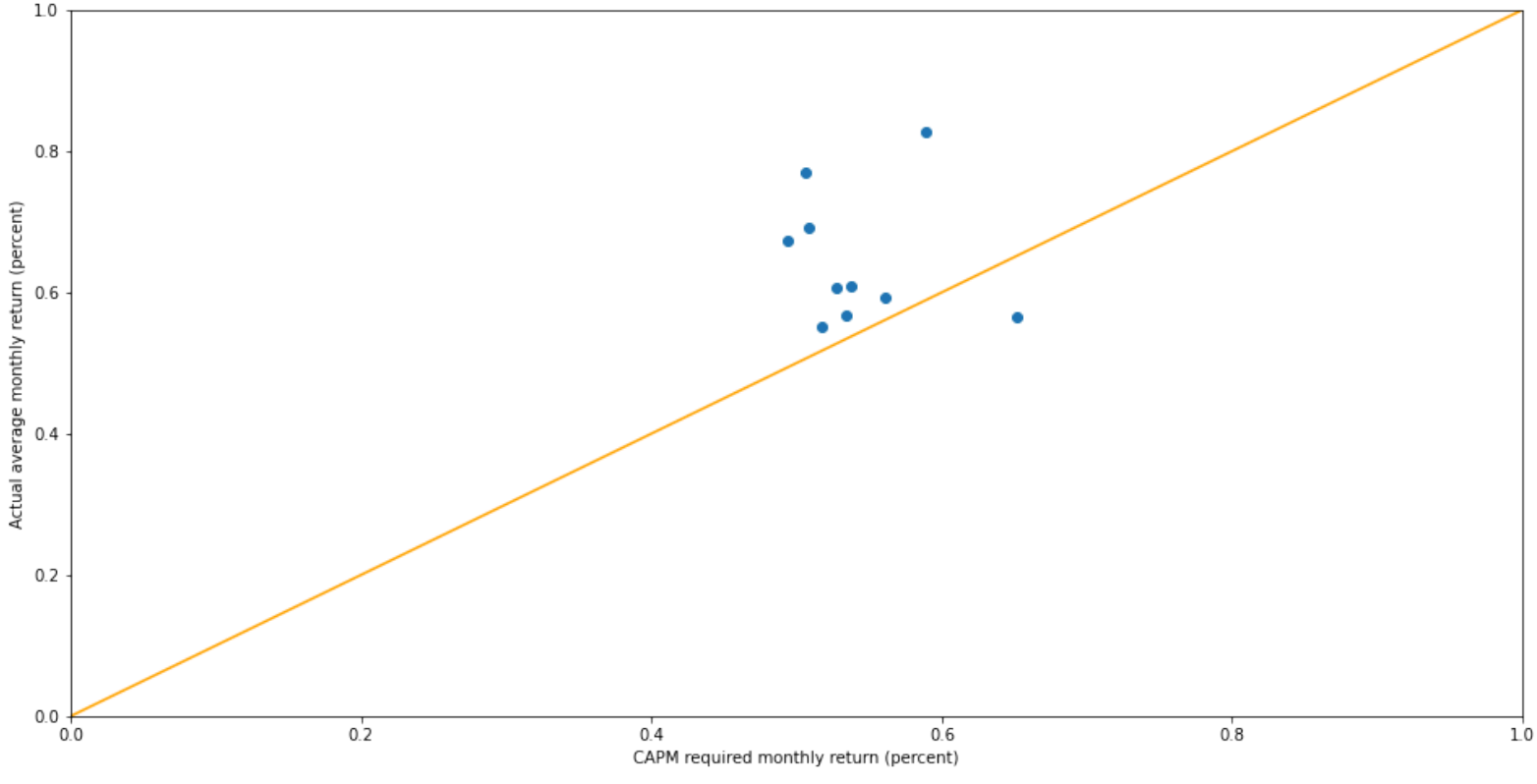
More specifically, for each ratio we will look at the spread of returns of stocks with high or low values of the ratios. We will think of that spread as telling us about the returns of a corresponding investment strategy, and we will evaluate the spread using the Fama-French 3-factor model. This model will reveal that a strategy based on ratio #1 is economically no different from investing in a simple value strategy. On the other hand, a strategy based on ratio #2 will indeed represent something new. This second ratio is the basis for the well-known "profitability" strategy that is widely implemented today.

The basic reason for the different results using the two different ratios, is that *any* strategy based on a price ratio will tend to steer you towards the same set of value stocks. Prices move around so much that nothing else can really come through in the data. In this case, portfolios formed on cash flow to price are very similar to our typical value portfolios, which are based on book value to price. When we switch the denominator to something more stable, there is at least the opportunity for this strategy to look different.

Analysis of portfolios sorted on cash flow to price, using the CAPM

In [3]:
```
CF_CAPM_figure
```

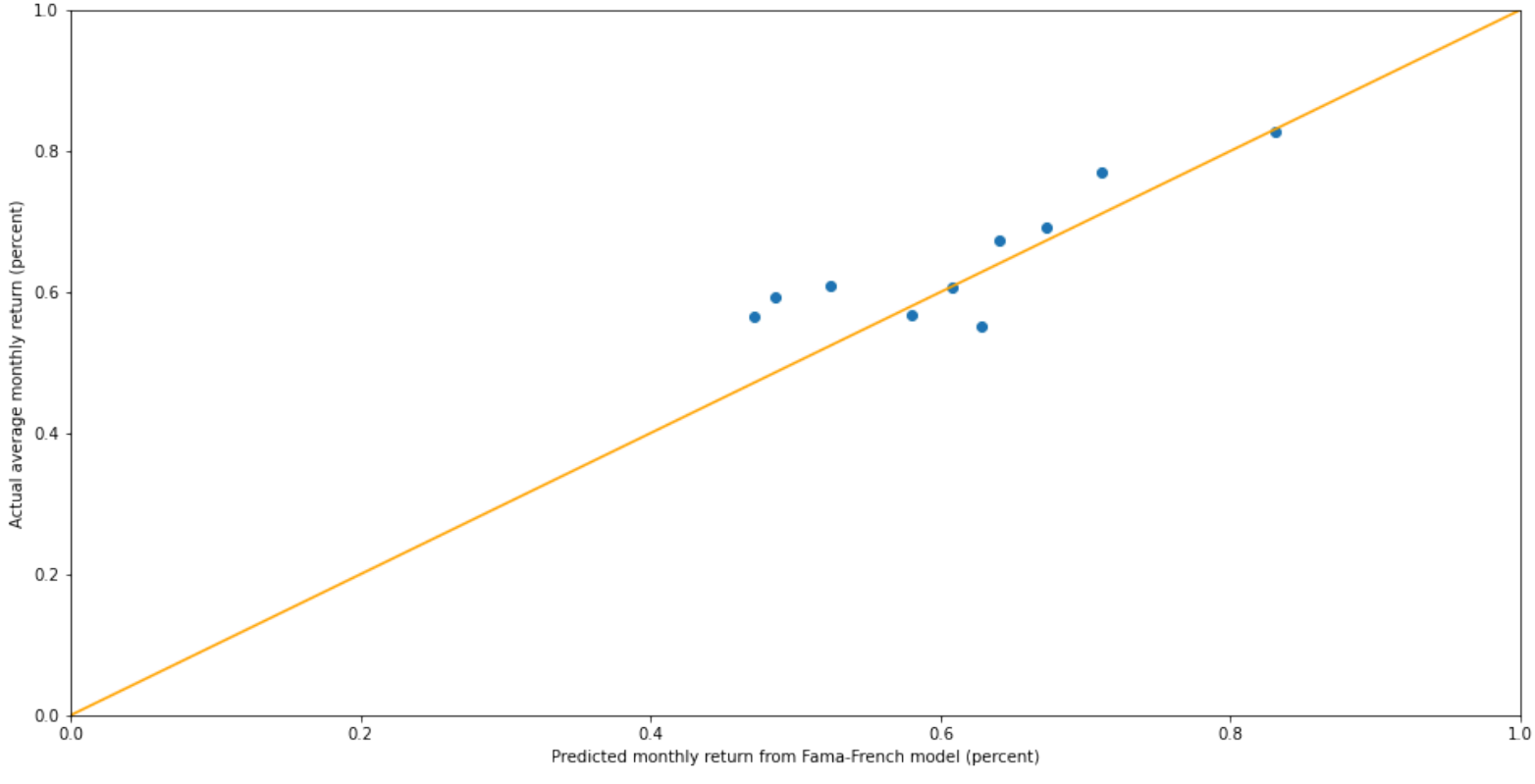
Out[3]:



Analysis of portfolios sorted on cash flow to price, using the Fama-French 3-factor model

In [4]:
```
CF_FF3F_figure
```

Out[4]:



Analysis of portfolios sorted on cash flow to price: Takeaways

This strategy beats the CAPM, but that performance is completely explained by its three-factor loadings.

This is not surprising when you think about it: We sorted on cash flow to *price*. Investment strategies based on any ratio involving price is going to look a lot like a strategy based on HML, because stock price is so much more volatile than any other financial variable. You could say that HML already captures the general idea of trading on any ratio of "price over anything" or "anything over price".

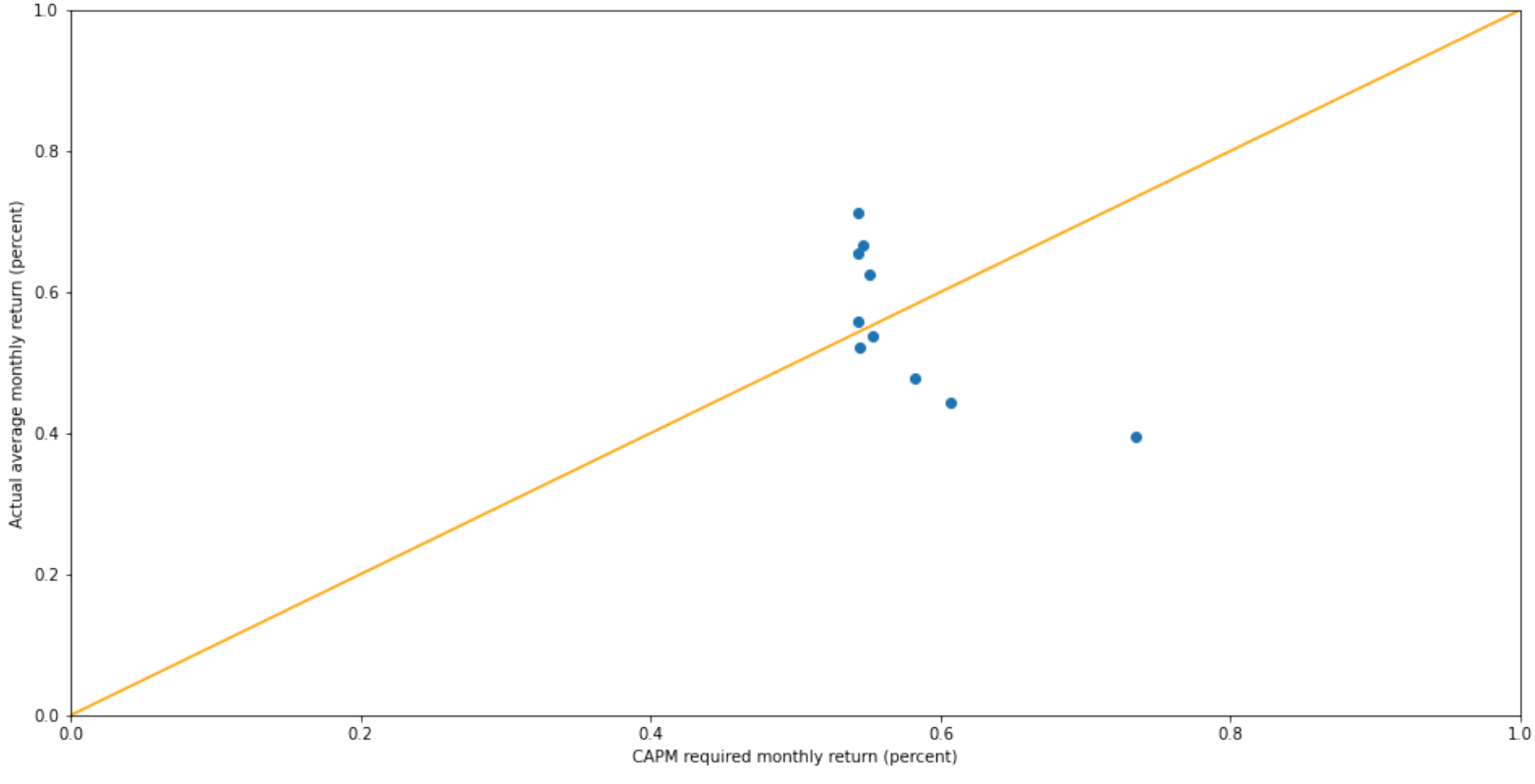
This doesn't mean that investing based on "cashflow over price" is a *bad* strategy, just that it's nothing new. We already know that you could have made money investing based on "book value over price" during the time period that we are using for this analysis. Now we see that investing based on "profitability over price" would steer us toward the same stocks and generate the same performance.

Conclusion: If we want to come up with something we didn't already know about, we need to find a different way to build the profitability measure, so that it doesn't divide by price and end up looking just like HML.

Analysis of portfolios sorted on operating profitability, using the CAPM

In [6]:
```
OP_CAPM_figure
```

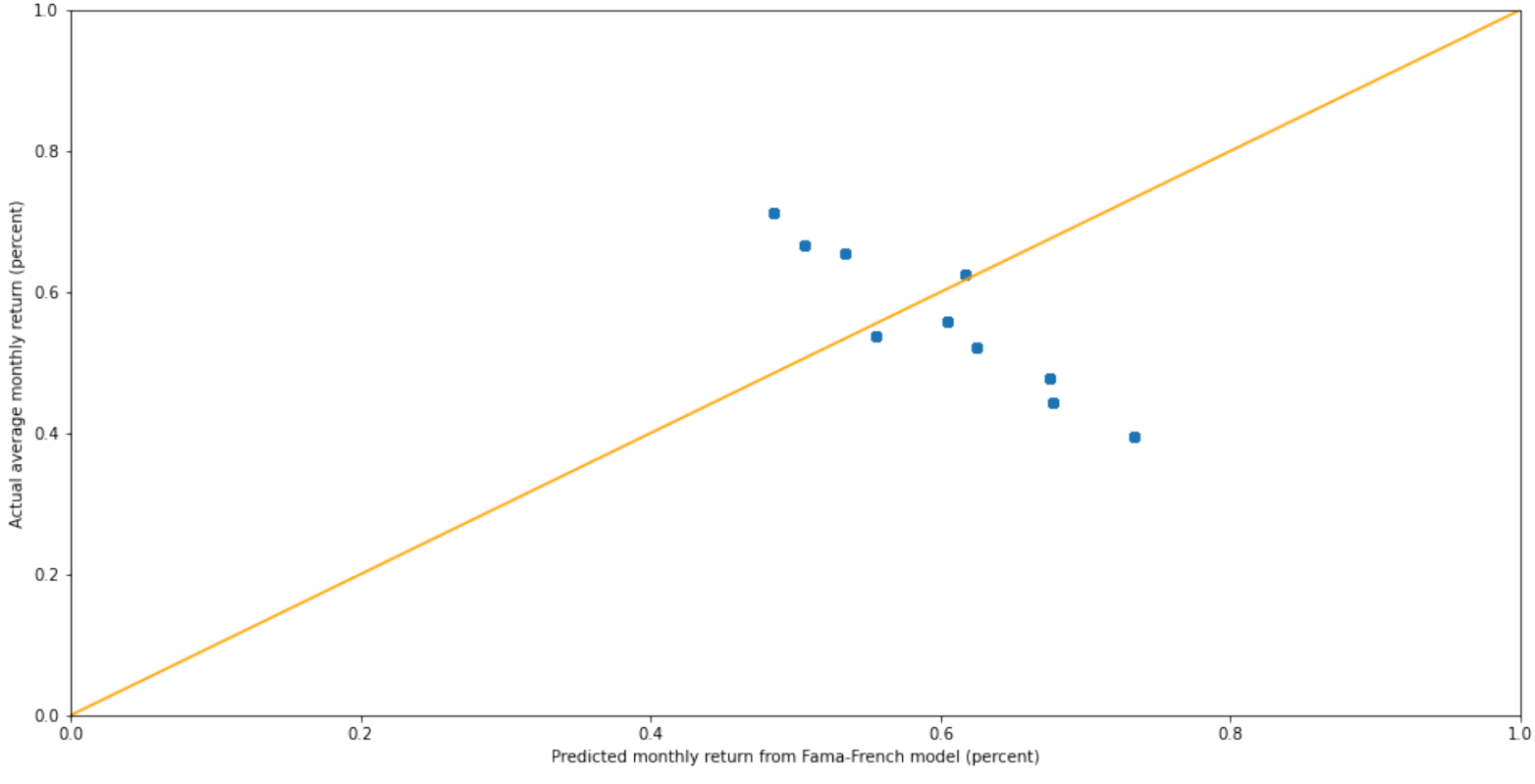
Out[6]:



Analysis of portfolios sorted on operating profitability, using the Fama-French three-factor model

In [7]:
```
OP_FF3F_figure
```

Out[7]:



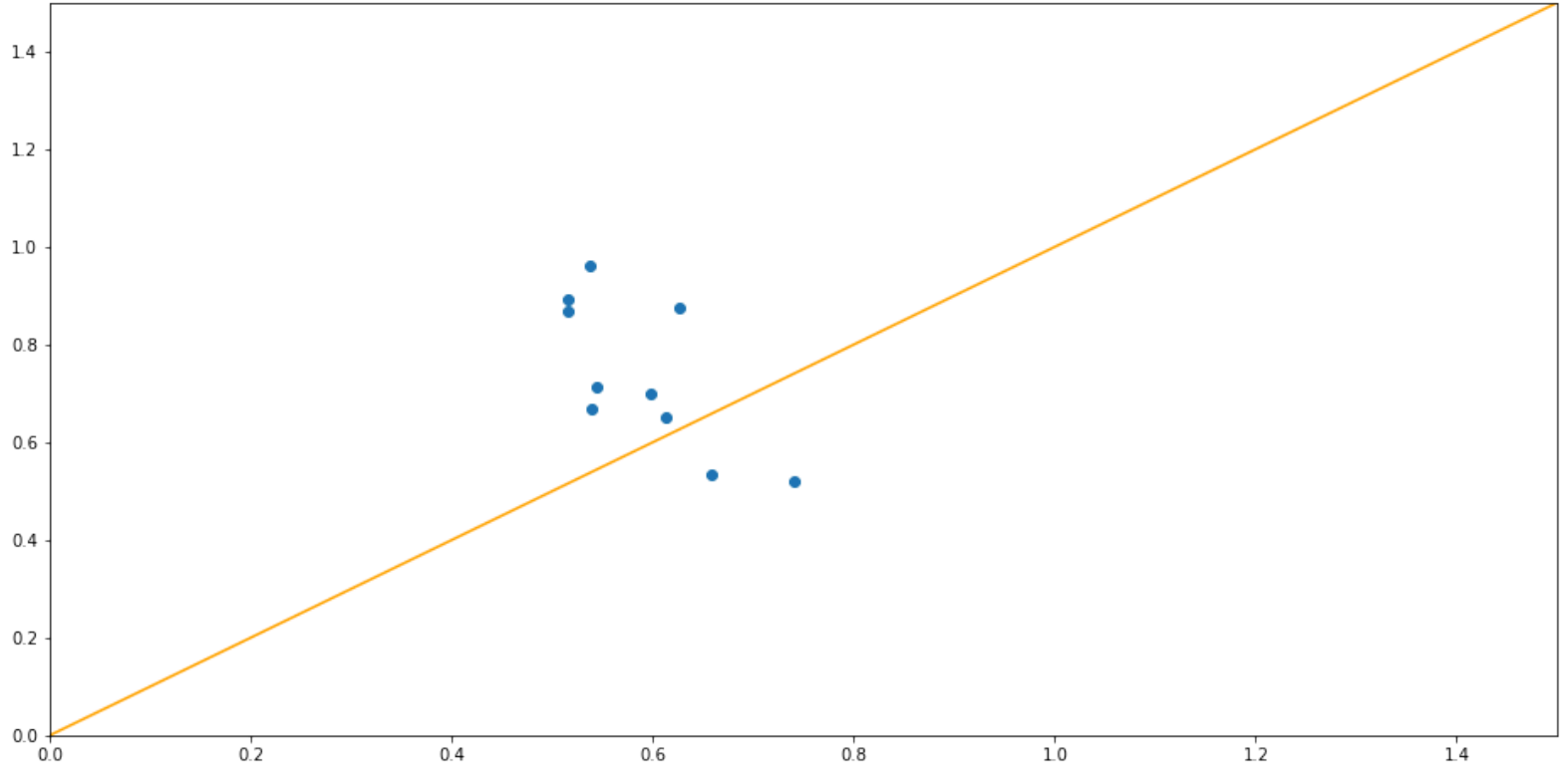
The data we downloaded unfortunately only go back to 1963, so we can't examine the 1926-present evidence as we did with other strategies.

But we can show that the strategy has held up in the last 20 years, unlike value:

First using the CAPM analysis:

In [10]:
```
OP_CAPM_figure_last20
```

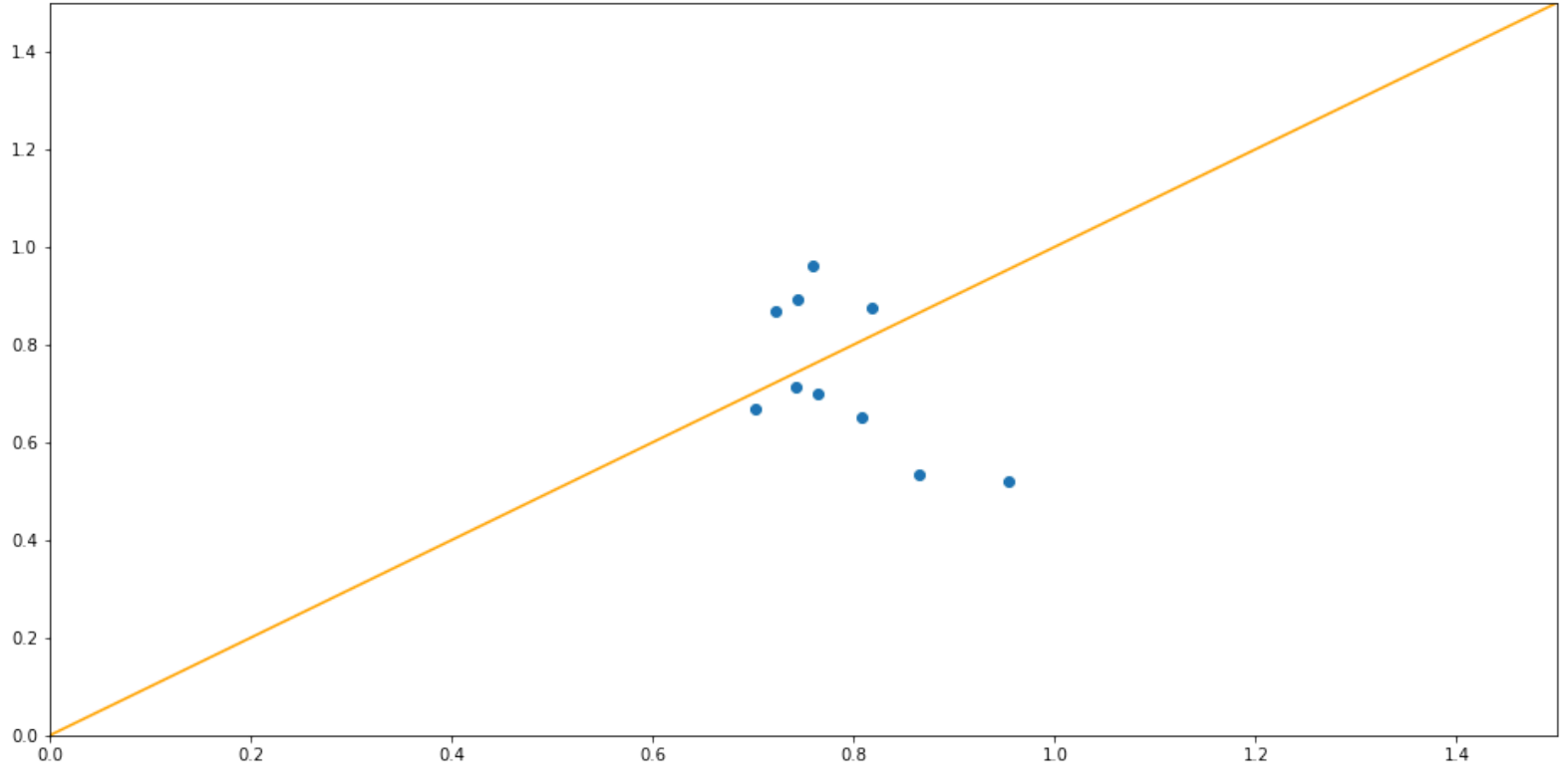
Out[10]:



And following the Fama-French analysis:

In [11]:
```
OP_FF3F_figure_last20
```

Out[11]:



Analysis of portfolios sorted on operating profitability: Takeaways

Here we are sorting on operating profitability scaled by book assets. The numerator is not all that different from cash flow, which is what we used in the prior section. The main difference is the use of book assets instead of market value in the denominator. Because book assets are more stable, this avoids the situation we ran into before, where the market value dominates everything else in the sorting approach due to its high volatility and causes the strategy to just look like HML.

The portfolios plotted here are used to calculate the well-known "profitability" factor.

Performance of profitability compared with other Fama-French factors

This section does a quick comparison of the Fama-French implementation of the five factors that we have discussed so far:

- The market excess return
- SMB (small-cap minus big-cap stocks)
- HML (value stocks minus growth stocks)
- UMD (high-momentum minus low-momentum stocks)
- RMW (high-profitability minus low-profitability stocks)

Average monthly % returns on each factor:
"MKTRF" represents the excess return on the value-weighted market portfolio.
The others are the factor returns as defined in the class notes.

In [12]:
```
for factor in ('mktrf','smb','hml','umd','rmw'):
    print(f"{factor.upper()}: {100*FF3F[factor].mean():.2f}%")
```

```
MKTRF: 0.56%
SMB: 0.23%
HML: 0.29%
UMD: 0.60%
RMW: 0.28%
```

Loading of profitability on market, SMB, HML, UMD:

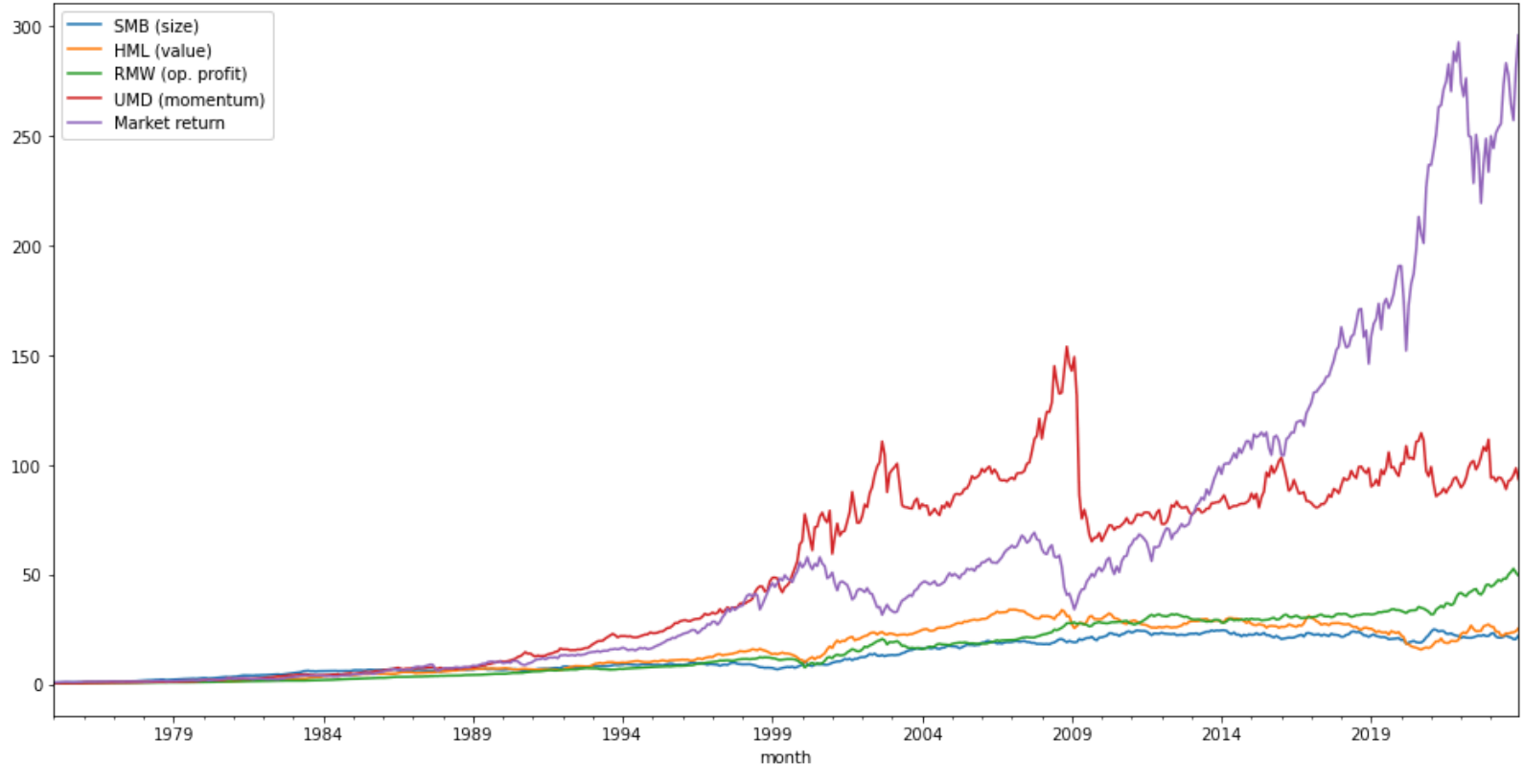
In [13]:
```
sm.ols( "rmw ~ mktrf + smb + hml",data=FF3F).fit().summary().tables[1]
```

Out[13]:

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	0.0035	0.001	4.390	0.000	0.002	0.005
mktrf	-0.0403	0.018	-2.200	0.028	-0.076	-0.004
smb	-0.2432	0.027	-9.150	0.000	-0.295	-0.191
hml	0.0482	0.026	1.828	0.068	-0.004	0.100

Cumulative return on all five factors since 1975:

In [14]:
```
FF3Fb = FF3F['1975':'2023']
(1+FF3Fb['rf']+FF3Fb['smb']).cumprod().plot(legend=True,label="SMB (size
(1+FF3Fb['rf']+FF3Fb['hml']).cumprod().plot(legend=True,label="HML (valu
(1+FF3Fb['rf']+FF3Fb['rmw']).cumprod().plot(legend=True,label="RMW (op.
(1+FF3Fb['rf']+FF3Fb['umd']).cumprod().plot(legend=True,label="UMD (mome
(1+FF3Fb['rf']+FF3Fb['mktrf']).cumprod().plot(legend=True,label="Market
```

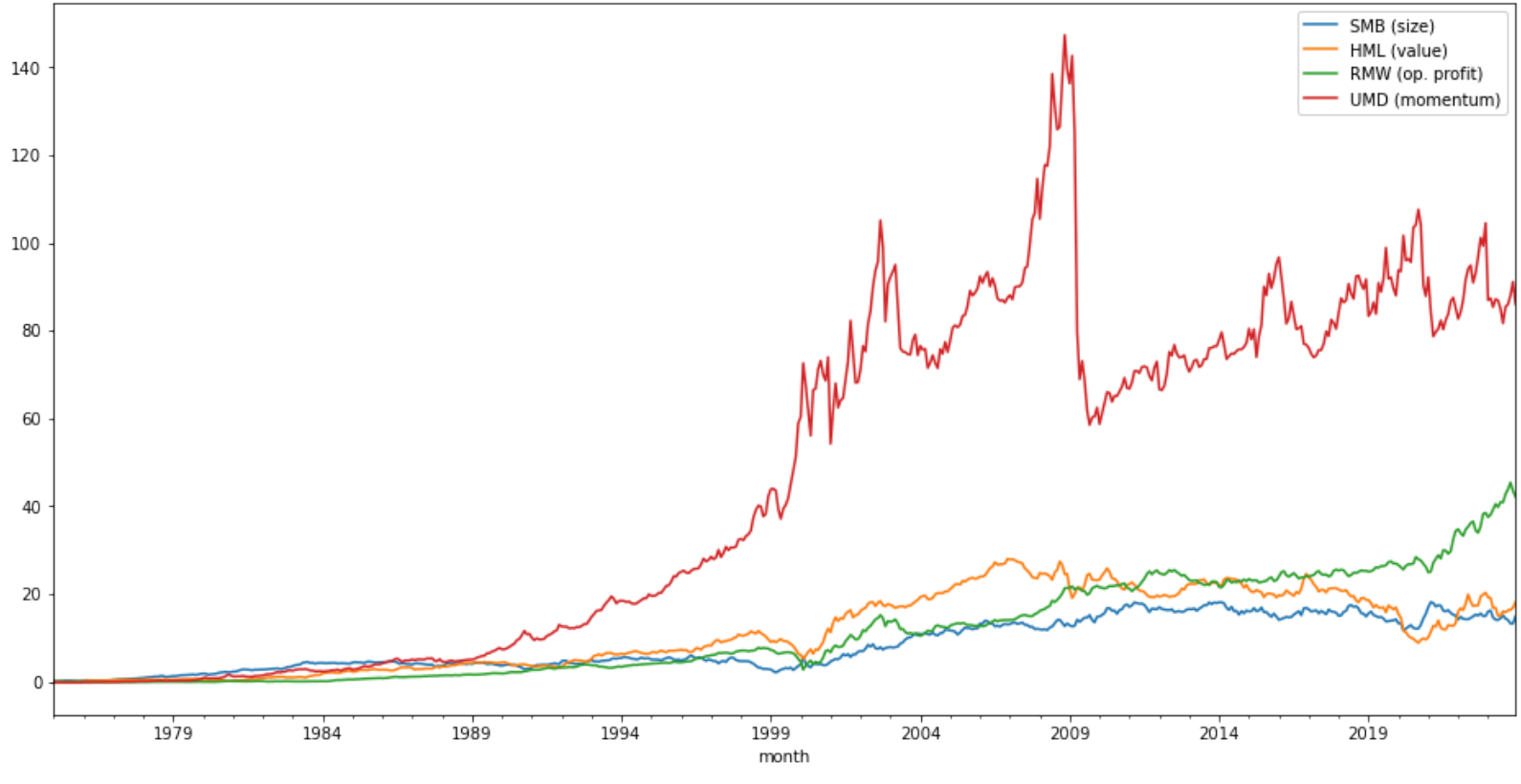


Takeaways from the previous figure:

The figure is dominated by the market return. This makes sense given the much larger monthly return that we calculated for MKTRF compared to the others. However, it is a bit "apples to oranges" to plot this "factor" alongside the others: By definition it has a beta of 1 and all the others have beta of zero. A risk-averse investor should *expect* a higher return from the market than any of the others. The point of constructing the other zero-beta factors is to find something that is valuable to hold alongside the market. So, let's redo the figure without the market return.

Cumulative return on just the zero-beta factors since 1975, minus the cumulative risk-free return:

In [15]:
```
FF3Fb = FF3F['1975':'2023']
((1+FF3Fb['rf']+FF3Fb['smb']).cumprod() - (1+FF3Fb['rf']).cumprod()).plo
((1+FF3Fb['rf']+FF3Fb['hml']).cumprod() - (1+FF3Fb['rf']).cumprod()).plo
((1+FF3Fb['rf']+FF3Fb['rmw']).cumprod() - (1+FF3Fb['rf']).cumprod()).plo
((1+FF3Fb['rf']+FF3Fb['umd']).cumprod() - (1+FF3Fb['rf']).cumprod()).plo
```



Takeaways from the previous figure:

Now the figure is dominated by UMD. Momentum has delivered astonishing performance over this long time period. However, we can also see that this is mainly driven by its performance leading up to the global financial crisis. At that point momentum experienced a spectacular crash, and since then it has delivered positive returns but not on the same level as the others.

We also have to be careful in general comparing UMD with the others, since it assumes monthly rebalancing of portfolios while the others are annual, and the strategy is inherently high turnover. This makes it a bigger issue that we are ignoring transaction costs. However, this issue is unlikely to greatly change the results of this figure.

Let's redo the previous figure without momentum:

In [16]:
```
FF3Fb = FF3F['1975':'2023']
((1+FF3Fb['rf']+FF3Fb['smb']).cumprod() - (1+FF3Fb['rf']).cumprod()).plo
((1+FF3Fb['rf']+FF3Fb['hml']).cumprod() - (1+FF3Fb['rf']).cumprod()).plo
((1+FF3Fb['rf']+FF3Fb['rmw']).cumprod() - (1+FF3Fb['rf']).cumprod()).plo
```

Takeaways from the previous figure:

If we set aside momentum, the other three factors tell a clear story on their own. Up to about the financial crisis, all three delivered positive cumulative return. Since they are designed to have low correlation with the market and with each other, this means each one would have been a valuable strategy for an investor to pursue.

- Since about the time of the financial crisis (or even a little earlier for HML), all three factors suddenly become less impressive. SMB and RMW basically stagnated, while HML has actually been declining.
- Since the pandemic, things have only gotten worse for HML while RMW has suddenly taken off and delivered astonishing returns. As a result, there is a lot of renewed attention on strategies based on profitability or other measures of "quality".

The performance of RMW seems to vindicate the classic Benjamin Graham and Warren Buffett approach to stock selection. However, the careful measurement here shows that these patterns also come and go. Why did this strategy suddenly improve so much over the last five years? Why is it present in the first place, given that everyone in the market knows that profitable companies are good ones? Shouldn't the prices of those stocks rise to the point that the returns go away? Factor models give us a way to quantify these questions but cannot answer them.

Buffett's Alpha

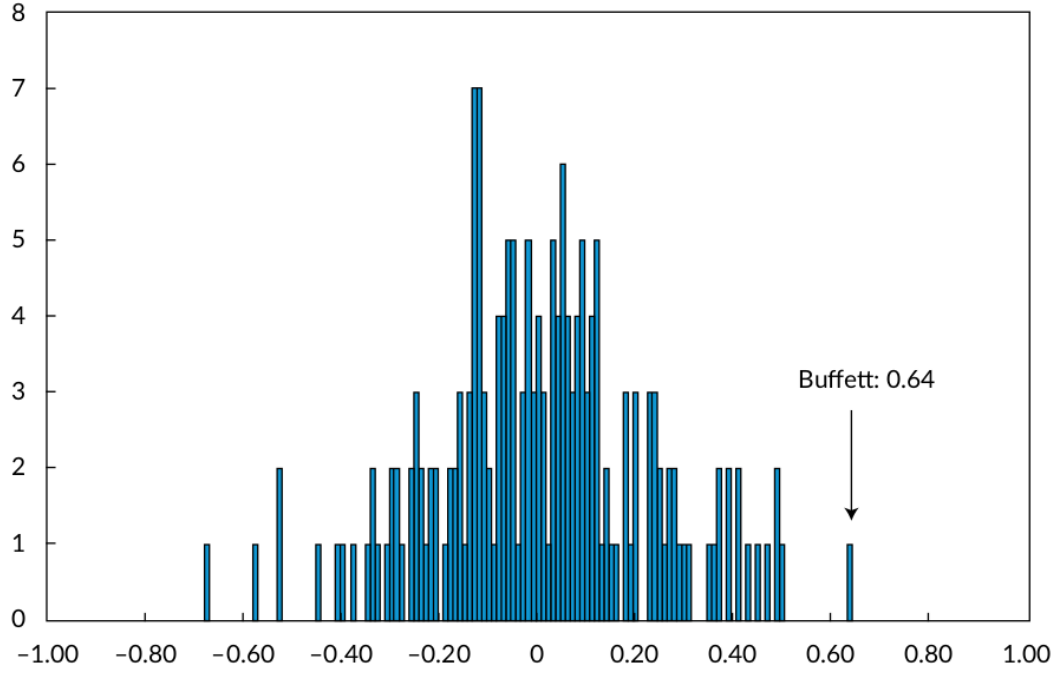
Discussion of paper by Frazzini, Kabiller, and Pedersen

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	0.08	0.76	1.39	3.04	1,655	92.9%
All stocks alive in 1976 and 2017	504	0.18	0.37	0.43	0.64	1	100.0%
All stocks alive in 1976 with at least 10-year history	3,774	0.14	0.43	0.58	0.81	17	99.6%
All stocks with at least 10-year history	9,523	0.13	0.45	0.60	1.03	70	99.3%
All stocks with at least 30-year history	2,021	0.13	0.35	0.45	0.64	1	100.0%
All stocks with at least 40-year history	1,111	0.13	0.33	0.42	0.64	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.

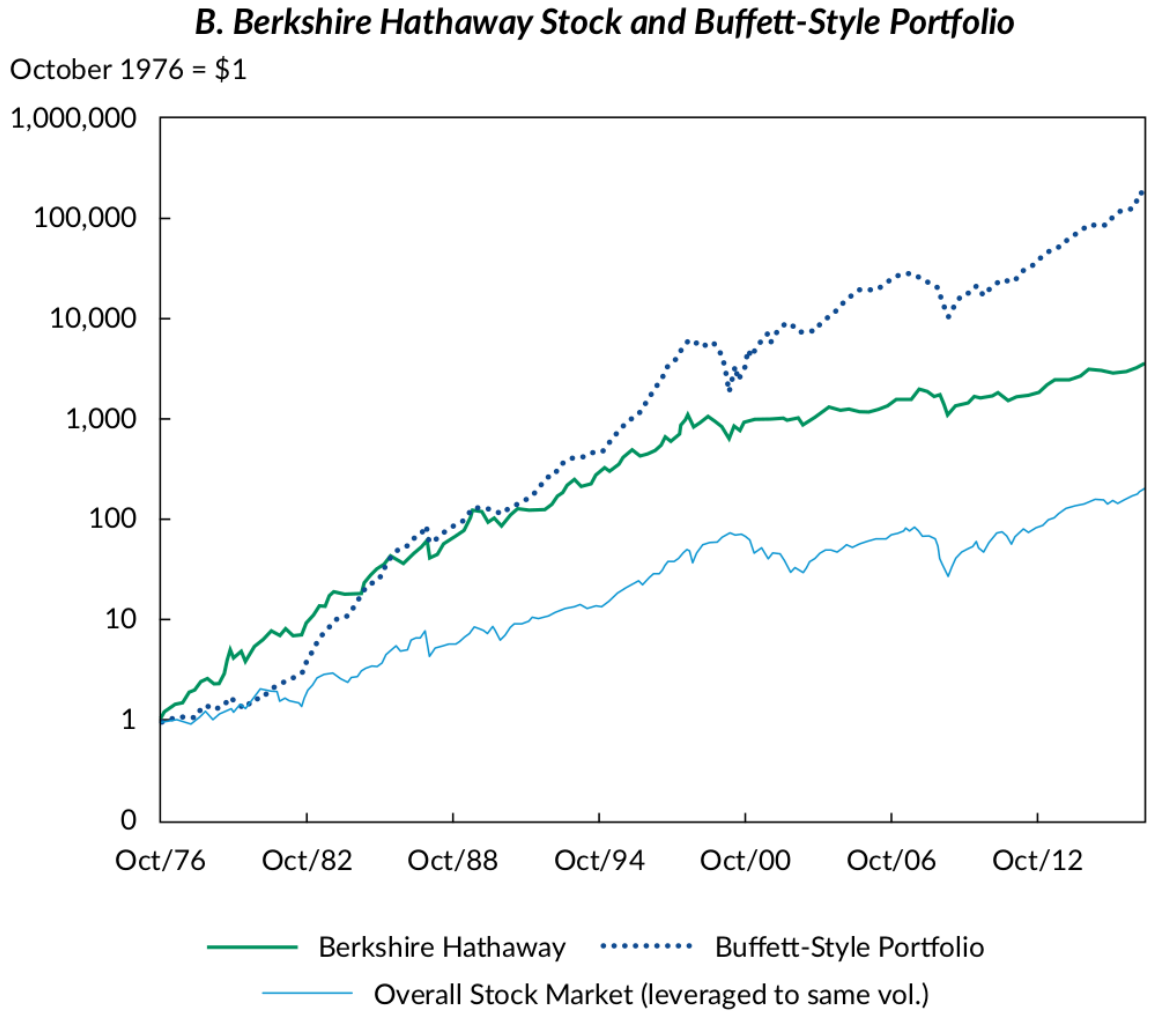
Figure 1. How Berkshire Stacks Up in the Mutual Fund Universe



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.

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 a result that is nearly the optimal Sharpe ratio.[5]

	Berkshire Stock, 10/1976–3/2017			
Alpha	**13.4%**	**11.0%**	**8.5%**	5.4%
	(4.01)	(3.30)	(2.55)	(1.55)
MKT	**0.69**	**0.83**	**0.83**	**0.95**
	(11.00)	(12.74)	(12.99)	(12.77)
SMB		**–0.29**	**–0.30**	–0.13
		(–3.11)	(–3.19)	(–1.17)
HML		**0.47**	**0.31**	**0.40**
		(4.68)	(2.82)	(3.55)
UMD		0.06	–0.02	–0.05
		(1.00)	(–0.25)	(–0.80)
BAB			**0.33**	**0.27**
			(3.79)	(3.04)
QMJ				**0.47**
				(3.06)
$\bar{R}^2$	0.20	0.25	0.27	0.29
Obs.	486	486	486	486


B. Berkshire Hathaway Stock and Buffett-Style Portfolio
October 1976 = $1
1,000,000
100,000
10,000
1,000
100
10
1
0
Oct/76
Oct/82
Oct/88
Oct/94
Oct/00
Oct/06
Oct/12
Berkshire Hathaway
Buffett-Style Portfolio
Overall Stock Market (leveraged to same vol.)