

Factor models

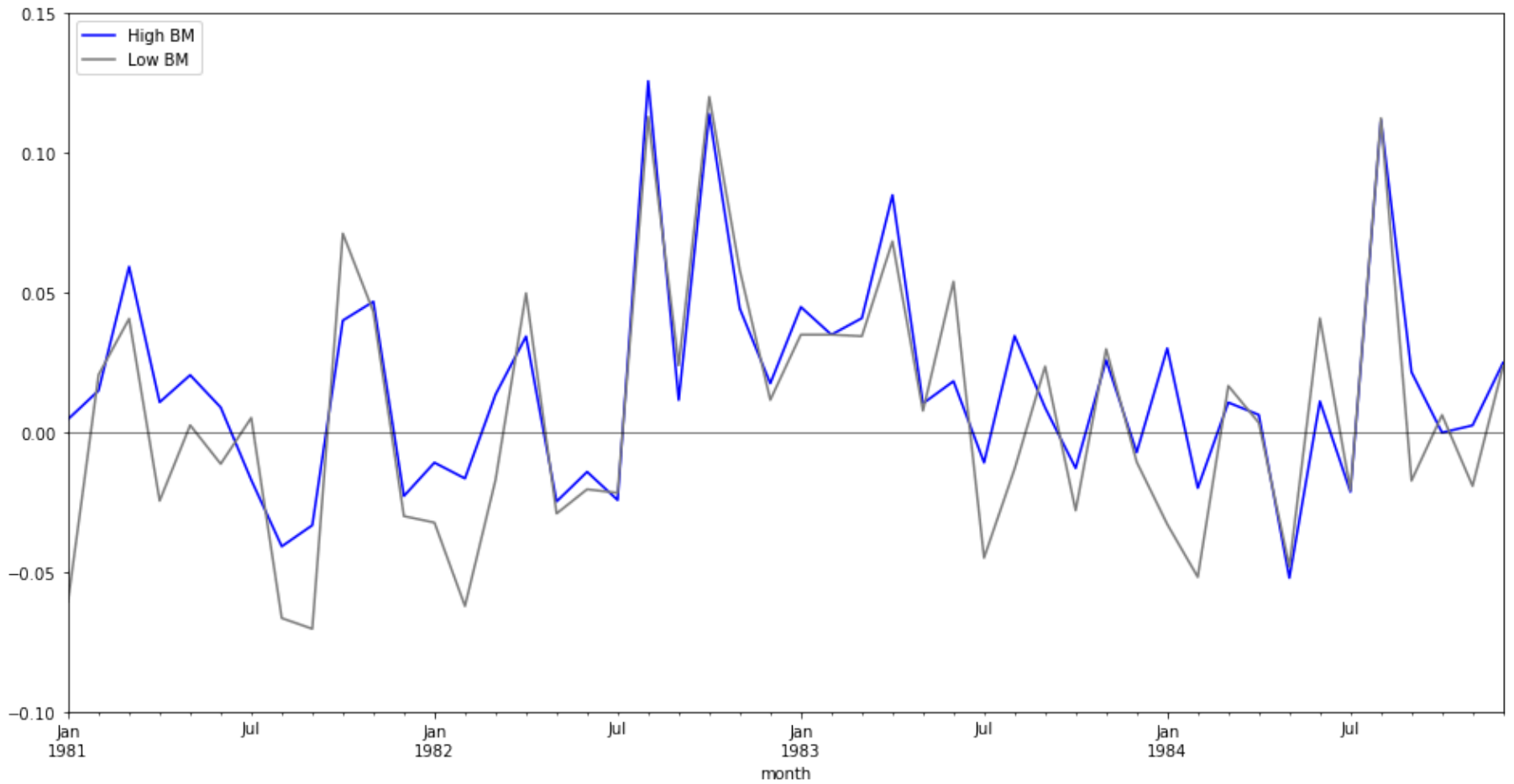
William Mann



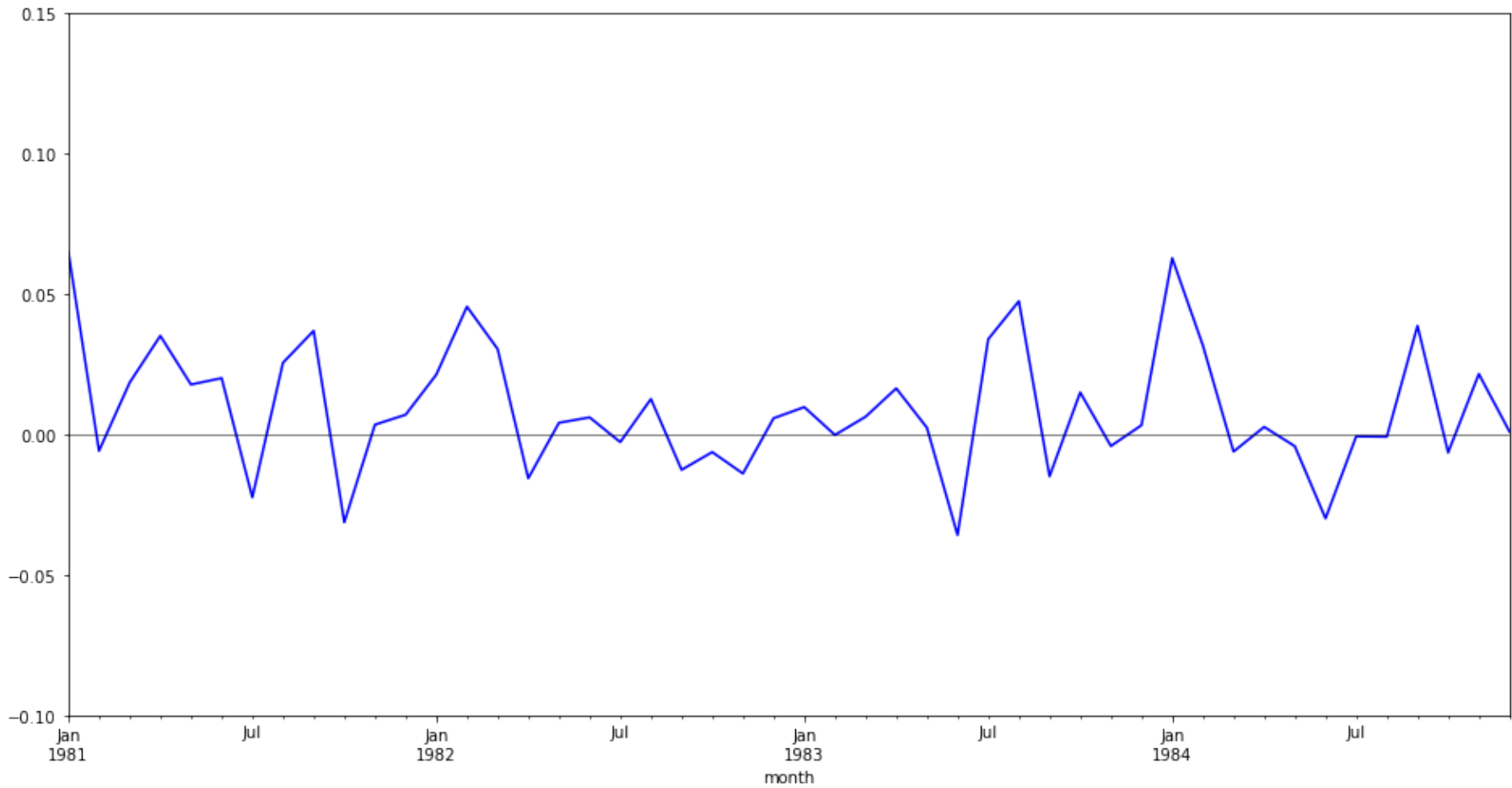
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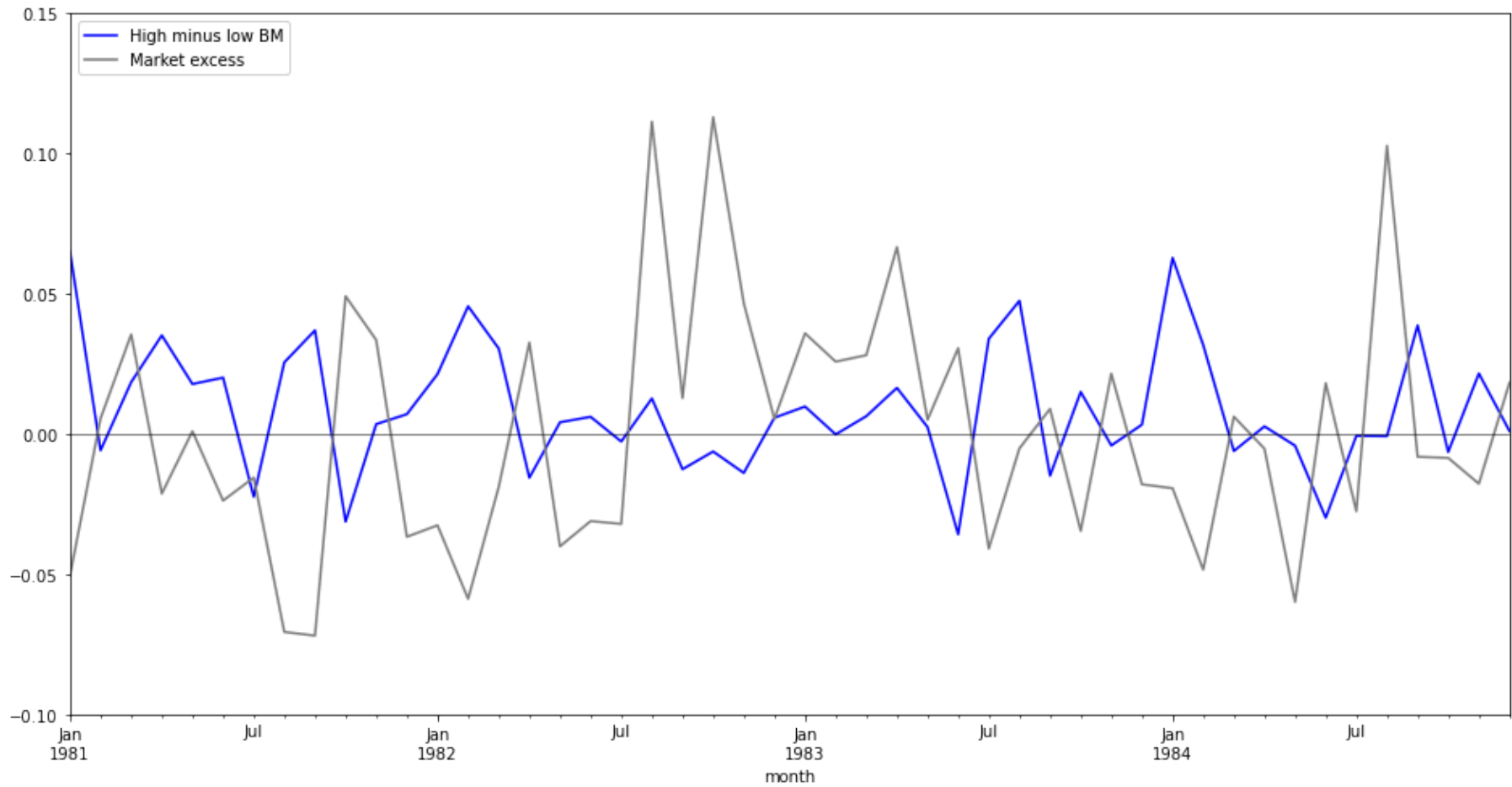
Monthly returns on portfolios with high and low B/M



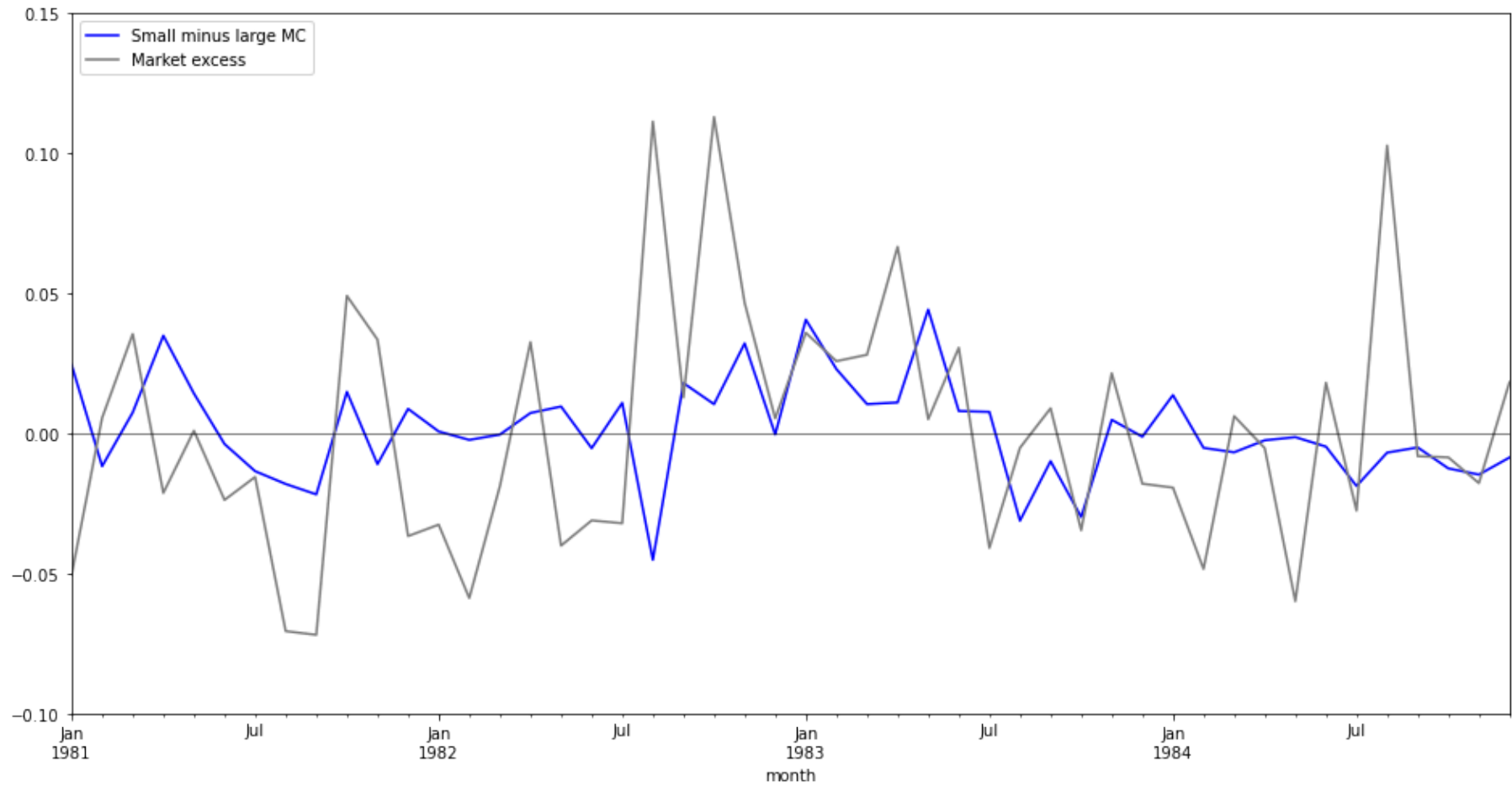
Difference between the returns in the previous figure



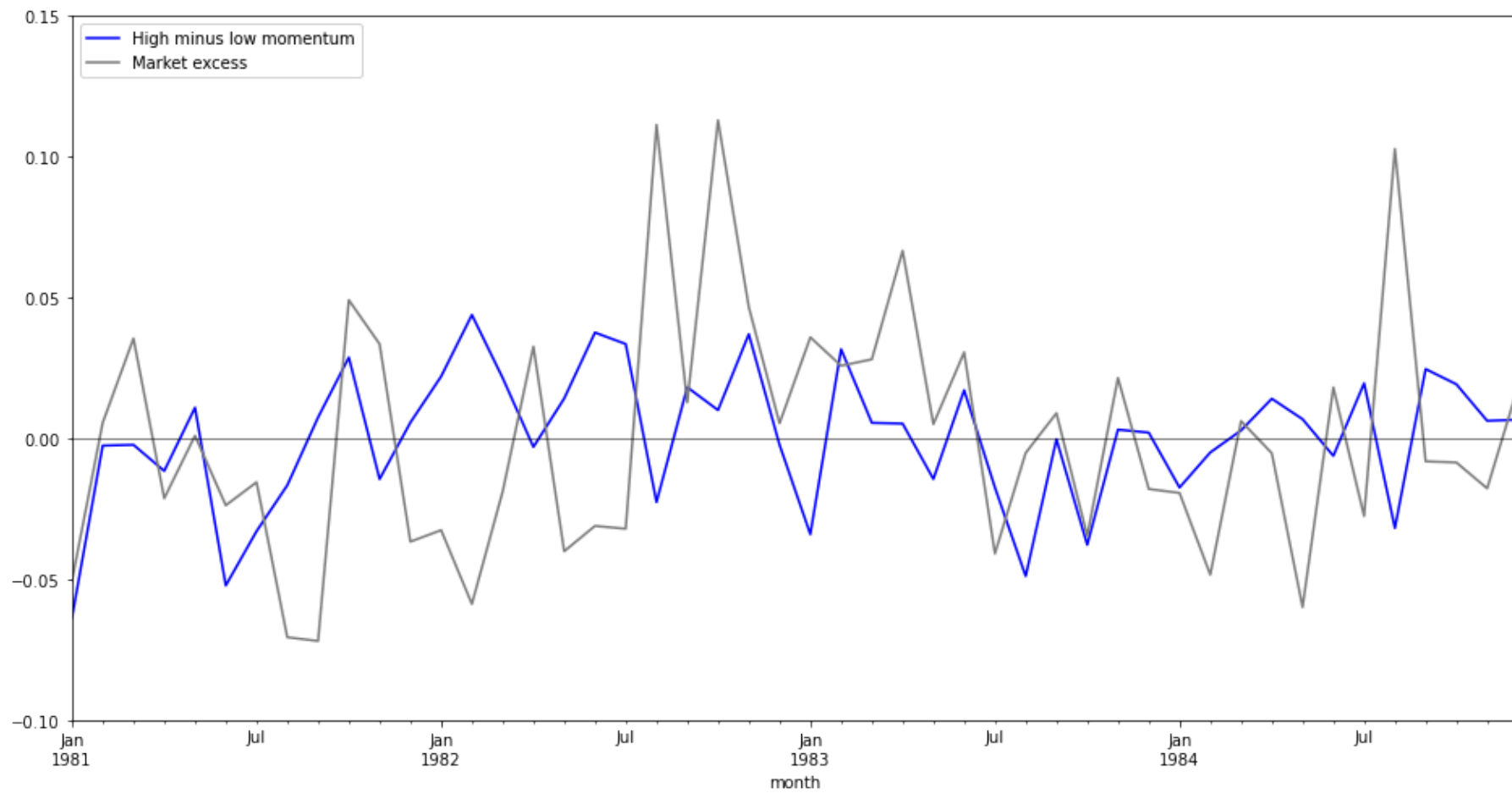
Comparing this difference with the market return



Same comparison for portfolios formed on size



Same comparison for portfolios formed on momentum



Why are return spreads a useful measure?

In addition to being easy to calculate, return spreads:

- Are investable: We saw last week that a hedge fund can earn the return spread as the excess return on a dollar-neutral portfolio.
This means that any performance we find was actually available to investors in the past, and is not just theoretical.
- Have low beta: Any return experienced by the entire market will cancel out to have no effect on the return *spread*.
This means that it represents a very different strategy from passive investing, and its return will be almost pure alpha.

The Fama-French approach

The general idea for measuring factor performance is to use the return spread between “good” and “bad” portfolios.

Within this idea, there are many details to consider, and many different potential approaches that you could take.

The best-known approach was developed by Eugene Fama and Ken French in a series of papers decades ago.

Their approach is known as the “Fama-French” approach, and it is now the most popular measure of factor performance.

Their numbers are continually updated on French’s [website](#).

The rest of these slides explain the details of their approach. The textbook discusses some of these issues on pages 419–420.

Detail 1: Size and value together, then momentum

When the FF approach was first developed, size and value were widely accepted factors, but momentum was not.

Thus, the FF measures of size and value performance are closely connected to each other, as we will see in the next few slides.

In contrast, the FF measure of the momentum effect was developed later and is somewhat separate from the others.

We'll first explain their size and value measures, SMB and HML, then their momentum measure, UMD.

Detail 2: Timing of the market cap and BM measures

We sort stocks by market cap to exploit the size premium, and by the book/market ratio to exploit the value premium.

The Fama-French approach does this once every year.

To construct the BM ratio, they use the book value of equity from the company's fiscal year-end.

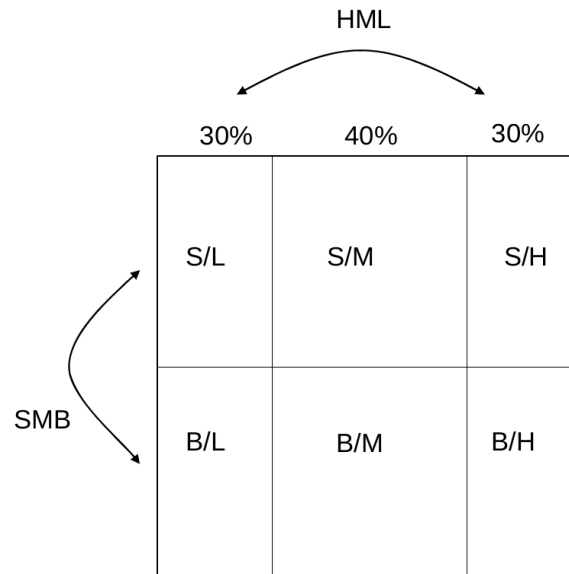
However, investors cannot access 10-Ks immediately on Dec 31, and we want our numbers to reflect an investable strategy.

So, FF wait until *June* of each year to sort the stocks, and then sort based on market cap from the beginning of June, but on BM ratios calculated as of the prior Dec 31.

Detail 3: Double-sort on size and BM at the same time

Each June, sort stocks on both dimensions at once, and separate into six portfolios with a few hundred stocks each:

- Big versus Small market cap;
- High, Medium, or Low B/M ratio. Calculate a VW return on each portfolio: $r_{S/L}$, $r_{B/L}$, etc.



Return spread formulas (textbook p.408)

$$r_{SMB} = \frac{1}{3}(r_{S/L} + r_{S/M} + r_{S/H}) - \frac{1}{3}(r_{B/L} + r_{B/M} + r_{B/H})$$

$$r_{HML} = \frac{1}{2}(r_{S/H} + r_{B/H}) - \frac{1}{2}(r_{S/L} + r_{B/L})$$

Measure the size premium as “small minus big” (SMB):

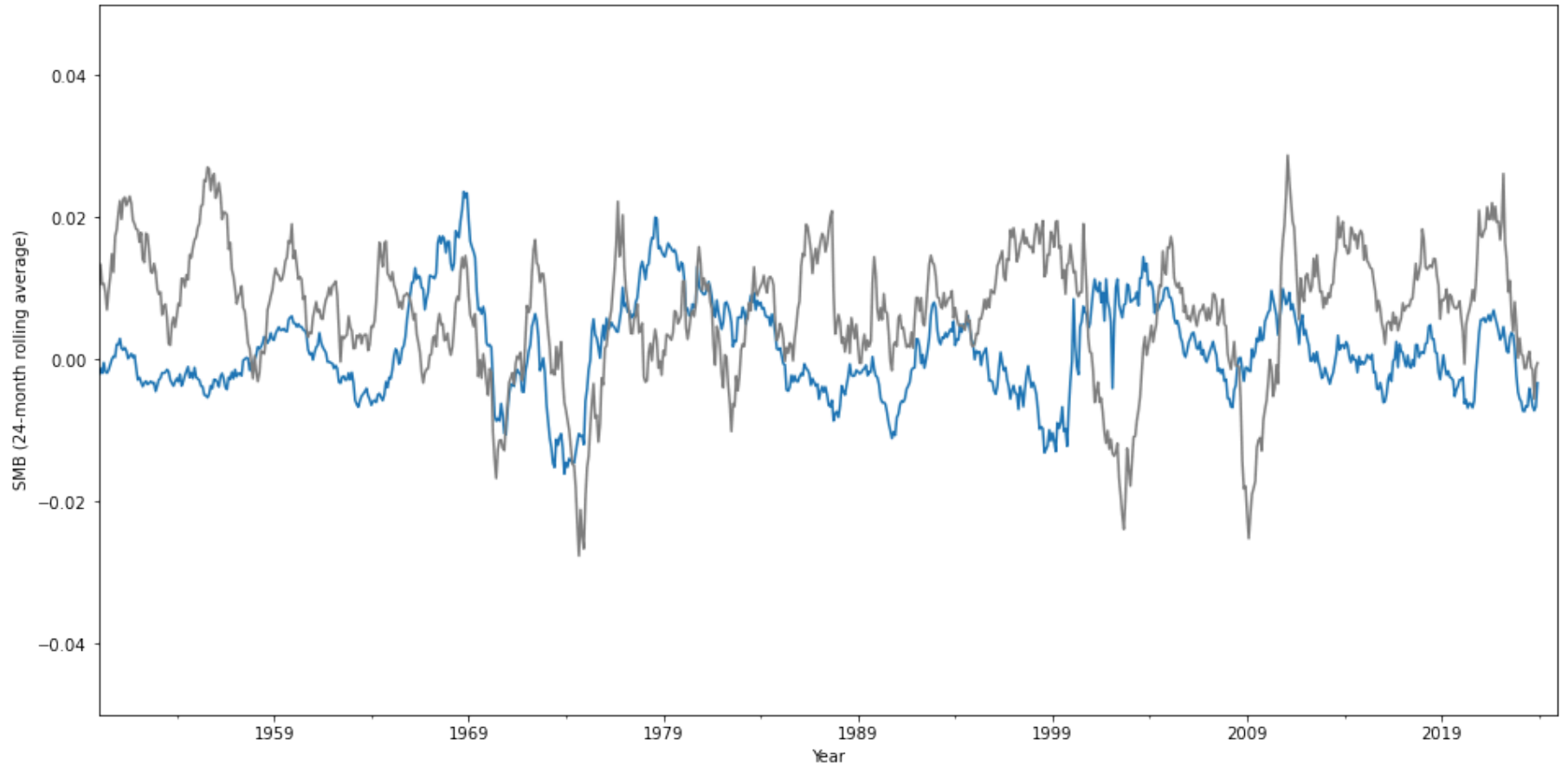
the average return on the three “small” portfolios, minus the average return on the three “big” portfolios.

Measure the value premium as “high minus low” (HML):

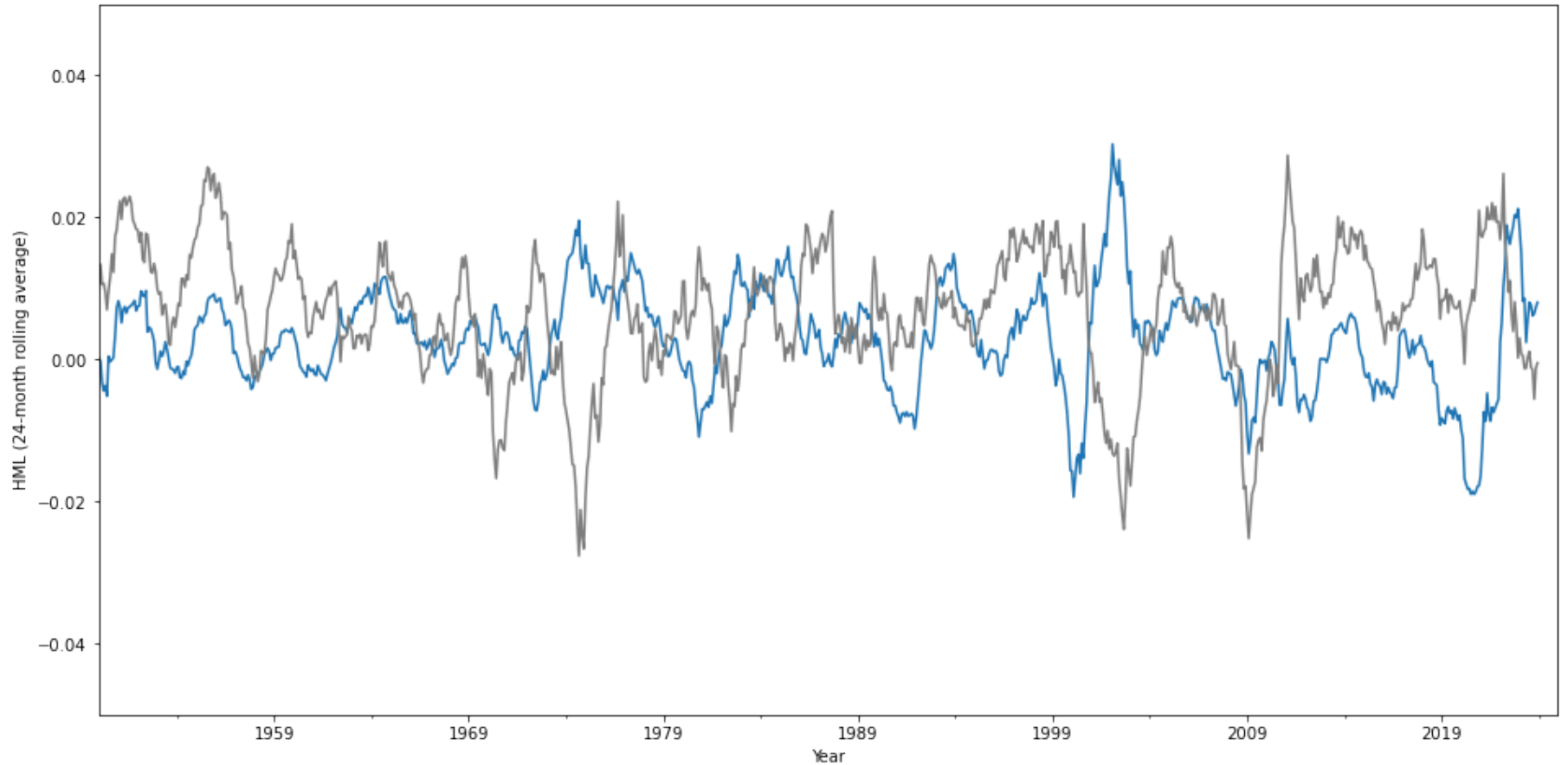
the average return on the two highest-BM portfolios, minus the average return on the two lowest-BM portfolios.

SMB and HML are neutral against the market *and* each other.

A look at the SMB factor since 1950



A look at the HML factor since 1950



What about momentum?

The FF momentum factor is labeled “up minus down” (UMD), or sometimes “winners minus losers” (WML).

Each *month*, double-sort stocks on size and momentum.

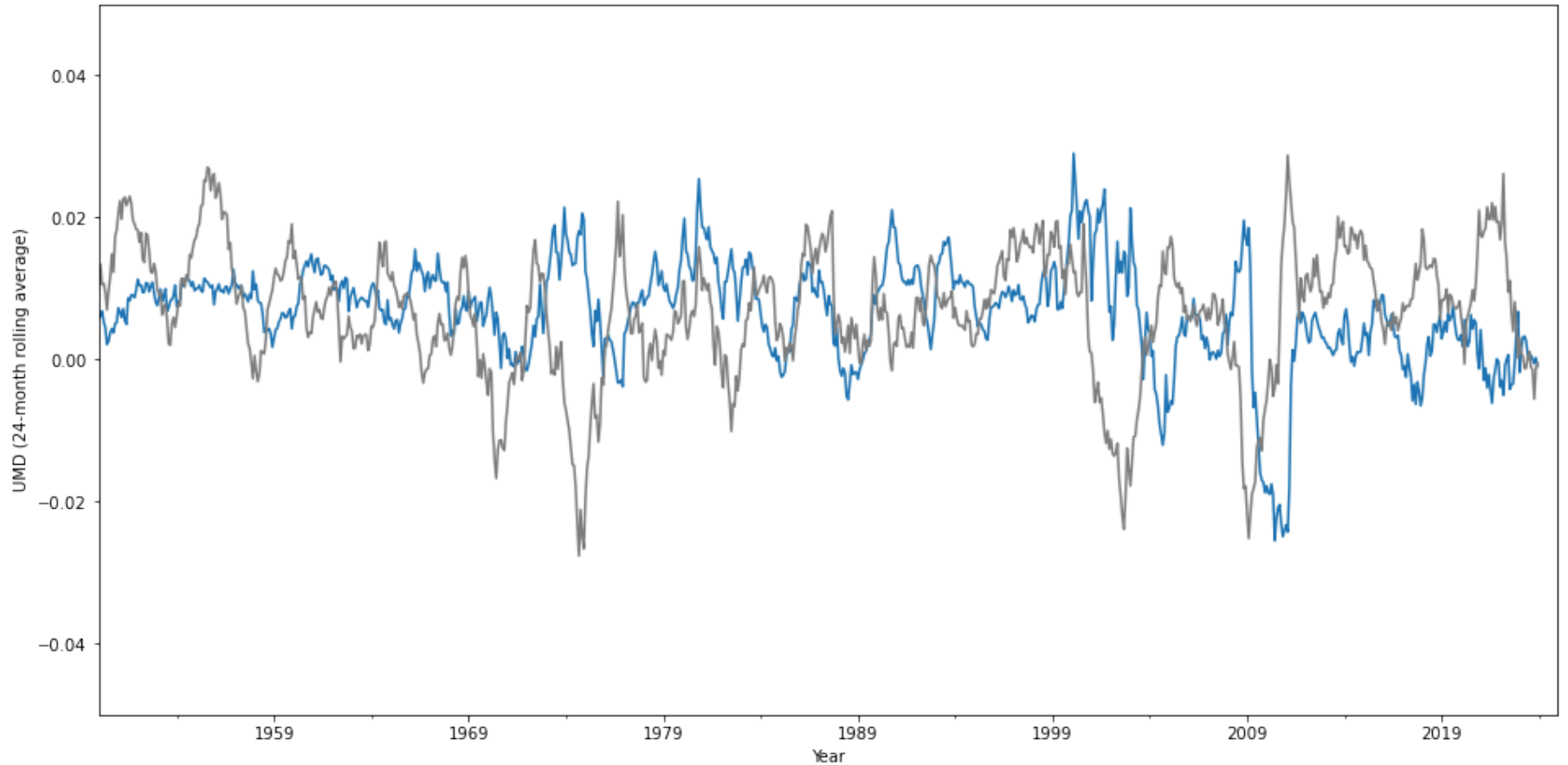
After that, the approach is much the same as HML:

- Divide the stocks into groups in the same way as slide 12, but with high and low momentum in place of high and low BM.
- Then measure the momentum factor as:

$$r_{UMD} = \frac{1}{2}(r_{S/H} + r_{B/H}) - \frac{1}{2}(r_{S/L} + r_{B/L})$$

where S/H means small-cap, high-momentum, etc.

A look at the UMD factor since 1950



Using multifactor returns to evaluate investments

Once we have measures of factor performance, we can use them to better understand the risks and returns of other strategies.

Many strategies tilt towards buying small-cap or value stocks, creating a natural correlation with size and value factors.

Other strategies don't literally involve buying small-cap or value stocks, yet still exhibit reliable correlations with these factors.

These correlations can help us to understand whether a strategy is really new, or just repackages already-known factors.

The basic idea is just to expand the CAPM regression, to a multivariate regression that uses additional factor measures.

The Fama-French three-factor model

Models the returns to any strategy using the following factors:

- The market return, to capture market risk, as in the CAPM.
- The SMB measure of the size premium.
- The HML measure of the value premium.

Step 1: Estimate the “factor loadings” through a regression:

$$r_i = \alpha + \beta_M \times r_M + \beta_{SMB} \times r_{SMB} + \beta_{HML} \times r_{HML} + e$$

(Note that r_i and r_M must be *excess* returns.)

Step 2: Predicted rate of return based on the factor loadings is:

$$\beta_M \times \mathbb{E}[r_M] + \beta_{SMB} \times \mathbb{E}[r_{SMB}] + \beta_{HML} \times \mathbb{E}[r_{HML}]$$

Interpreting the results

This analysis helps to simplify the investing landscape.

The factor loadings from step 1 tell us how to construct a synthetic strategy with the same size and value exposures.

Then you can ask: (1) if this strategy is the cheapest available way to get those size and value effects, and (2) if it has extra performance beyond those effects that is worthwhile investing.

Many strategies beat the CAPM, but can be fully explained by their connection with known factors like size and value.

Alternatives to the Fama and French factors

The F-F factors are widely used, partly because they were the first, which makes them a natural benchmark for later research.

Their approach also pioneered many important ideas. Most importantly, they were careful to maintain the connection with investable strategies, by only using information that would have actually been available to an investor.

However, some of their details were also essentially arbitrary.

Some practitioners advocate different approaches to some of these details, and show that it can make a big difference. Factor investing involves lots of arguments about these details.

A problem is, there's no model to tell us the "right" approach, because we don't know why factor returns exist to begin with!

Factor investing implementation

All the returns we've shown so far are "on-paper," ignoring the costs of actually creating these strategies.

How effectively can you actually implement these strategies? And, how expensive is it to do that?

The answer is always evolving, and it depends on who you are (an individual, an institutional investor, a fund manager).

Whoever you are, it is never simple, but gets easier every year.

Factor investing through individual stock holdings

Factors like HML, SMB, UMD are built on a theoretical idea of buying and short-selling an equal number of stocks.

However, the typical investor will start from a value-weighted (passive) portfolio of all stocks, and then just allocate some amount at the margin to a factor strategy.

So, in the end, they will probably invest a positive net amount in every stock. That is, they will hold a long-only portfolio.

In principle, they could just buy stocks in exactly the right amount to match their desired net holdings.

But it makes more sense to delegate this to a fund (next slide).

Factor investing through long-only funds

Retail-facing factor products (mutual funds and ETFs) are often labeled smart beta or fundamental indexing.

Almost all are long-only, meaning they do not use short sales. Another way to say this is that they invest in the same stocks as a passive fund, but use a different weighting scheme.

For example, a value-focused fund might hold all S&P500 stocks, but weight value stocks by more than their market cap.

As a more extreme example, a fund might buy only the stocks in the “long leg” of a strategy (for example, only value stocks).

Because they are long-only, smart-beta funds still have high market beta, and their factor loadings are typically quite small.

Factor investing through market-neutral funds

The purest way to earn the factor returns we've studied is through a dollar-neutral or market-neutral strategy.

Hedge funds like Dimensional and AQR implement this idea.

But the short-sale requirements are extreme, and it becomes expensive to maintain and manage these positions.

For these funds, a lot the value-add is managing costs.

After initially backtesting a new strategy on historical price data, it is critical to see how much performance comes from the short leg, and how expensive it is to actually earn that performance.

Market-neutral factor investing by short-selling ETFs

Traditionally, market-neutral investing requires a hedge fund.

However, the growth of ETFs has opened up some opportunities for investors to build market-neutral strategies on their own:

Unlike a traditional mutual fund, an ETF can be sold short.

If you can find an ETF that tracks the long leg of a strategy (e.g. value stocks), and another that tracks the short leg (e.g. growth stocks), you can buy the first and short-sell the second to get a homemade market-neutral portfolio.

This is only recently feasible. It requires high-quality ETFs with strong and stable factor loadings, which can be hard to find. But they will probably become more common as time goes on.

