The Fama-French factor portfolios

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Introduction

- Field's goal is to learn about the mapping from information into asset prices.
  - Alternatively, what is the sdf that links prices to future cashflows?
- Multifactor models of the sdf posit that:

$$m^* = a + \mathbf{b}'\mathbf{f}^* \quad \text{with} \quad \mathbb{E}[m^* r_i] = 0$$

for *any* excess return r_i and traded "factors" $\mathbf{f}^*$ that span the MVE portfolio.

- Implying that

$$\mathbb{E}[r_i] = \beta_i \boldsymbol{\lambda}$$

where $\boldsymbol{\lambda}$ is the price of risk, and β_i is (the vector of) projection coefficients of r_i onto $\mathbf{f}^*$.

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- which is motivation for time series regressions like:

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{i,m} \cdot (R_{m,t} - R_{f,t}) + \beta_{i,SMB} \cdot \mathrm{SMB}_t + \beta_{i,HML} \cdot \mathrm{HML}_t + \epsilon_t$$

Search for $\mathbf{f}^*$ in in the Space of Returns

- How do we discover $\mathbf{f}^*$?
- Timeline:
  1. Chen, Roll, and Ross (1986) economic factors:
     - Evidence of that there were premia associanted with innovations in macroeconomic variables, but the Sharpe ratios associated with these portfolios were small.
  2. Connor and Korajczyk (1988) statistical factors using PCA:
     - effective in explaining the covariance structure, but all but the first PC—which looks like the market—did not carry much of a premium.
  3. Fama and French (1993) characteristic sorted portfolios:
     - Because of the strong relationship between characteristics and returns, the FF factor-portfolios earn a high premium.
     - We can then try to link the realized returns of these factor-portfolios to macroeconomic or other risk.

FF Factors

- The characteristics-sorted portfolio approach pioneered by Fama and French (1993, 2015) is now standard in the asset-pricing literature.
- All of the FF factor-portfolios are value-weighted, are rebalanced infrequently (annually), and are based on sound economic logic.
  - They are examined using out-of-sample data in time and location.
- Fama and French (1993, 2015) develop, respectively, the 3- and 5-factor models
  - They explore aspects of these models more deeply in Fama and French (1995, 1996a,b, 1998, 2004, 2006a,b, 2008, 2012, 2015, 2016b,a, 2018)

Why BM?

- Firm i's market value ($ME_{i,t}$) should equal the present value of all future cashflows ($Y_{i,t+\tau}$).
- Suppose the ROIC on equity capital ($BE_{i,t}$) is κ for all firms i, so that the firm generates future cashflows to equity of:

$$Y_{i,t+\tau} = \kappa BE_{i,t} \quad \text{for} \quad \tau \in \{1, 2, \ldots, \infty\}.$$

- Then, for a firm with a cost of equity capital of r_i:

$$ME_{i,t} = \frac{\kappa BE_{i,t}}{r_i} \quad \text{or} \quad r_i = \kappa \left(\frac{BE}{ME}\right)_{i,t}$$

- So BM should be a proxy for the required rate of return on the firm's equity.
  - A mispricing argument would give a similar relationship between BM and future returns.

Why Profitability and Investment?

Fama and French (2015) motivate for the addition of the profitability (RMW) and investment (CMA) factors with the present-value relation:

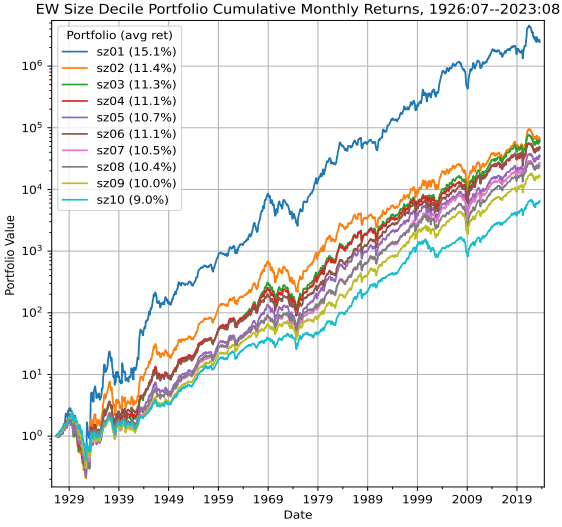
$$\frac{M_t}{B_t} = \frac{\sum_{\tau=1}^{\infty} \mathbb{E}\left(Y_{t+\tau} - dB_{t+\tau}\right)/(1+r)^{\tau}}{B_t}$$

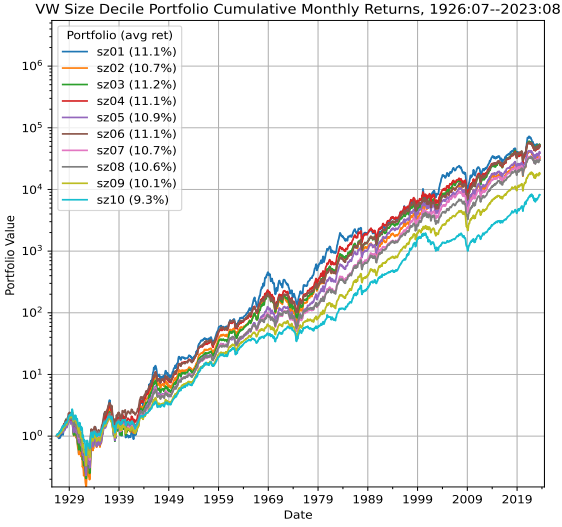
suggesting the following:

1. Holding everything fixed except M_t and r, higher B/M implies higher r.
2. Holding everything fixed except expected future earnings $Y_{t+\tau}$ and r, higher earnings implies higher r.
3. Holding everything fixed except expected required investment $dB_{t+\tau}$ and r, higher investment implies lower r.

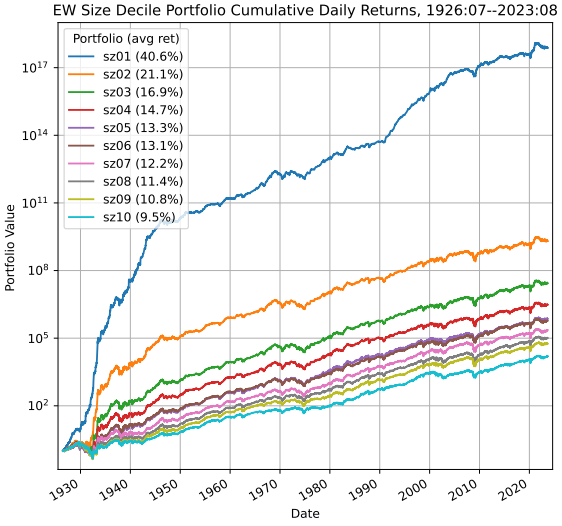
- An interesting outstanding question is what factors lead to higher ROICs (Y/B)

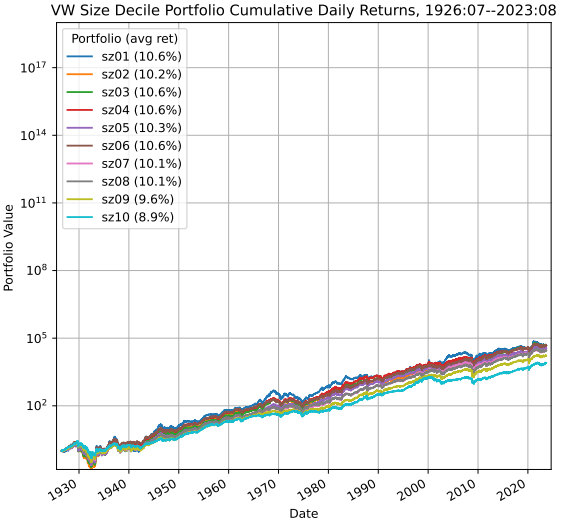
The size effect – equal- vs. value-weighting – monthly returns



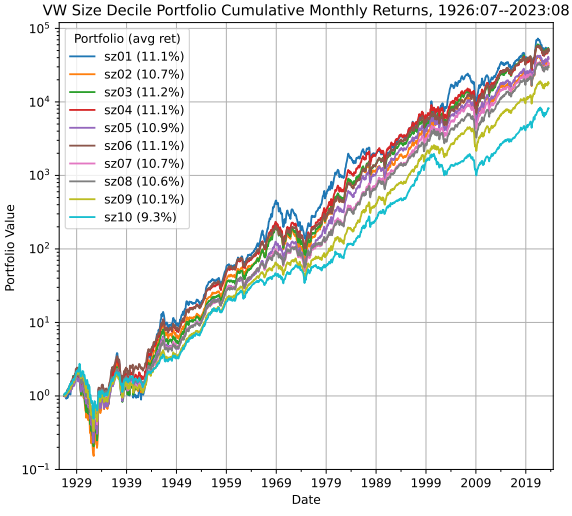


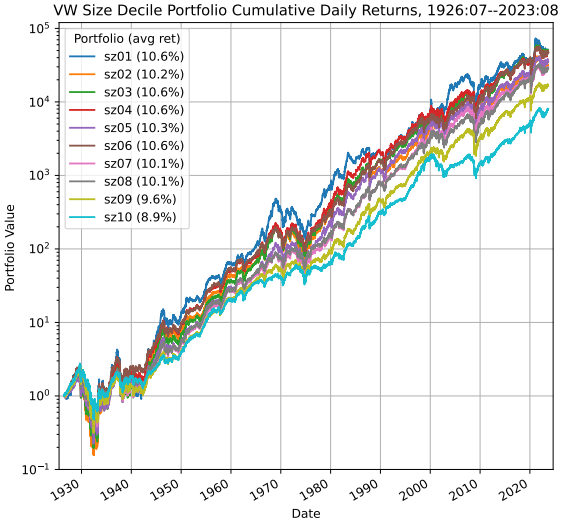
The size effect – equal- vs. value-weighting – daily returns





The size effect – value-weighed – monthly vs. daily returns

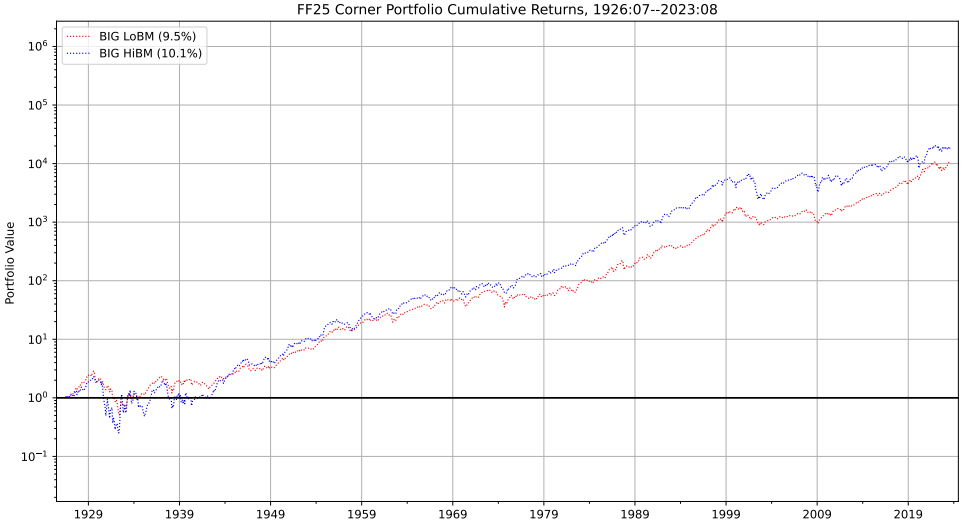




Why Size?

- Note that both Banz (1981) and Keim (1983) used equal-weighted portfolios.
  - This approach was standard at the time.
  - This likely explains their finding of a large unconditional size premium.
- The monthly CAPM alpha of the (VW) SMB portfolio is 0.06% ($t = 0.7$)
- Given the lack of a size premium, why should we care about size/market cap?
  - The size factor is important in explaining the cross-section of realized returns.
  - Size interactions are important in describing other premia.

Size-BM Interaction



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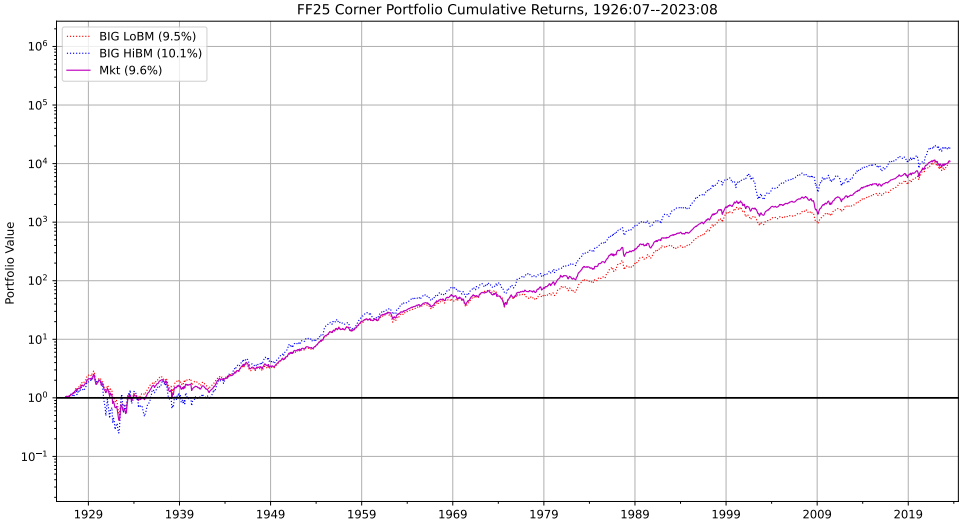

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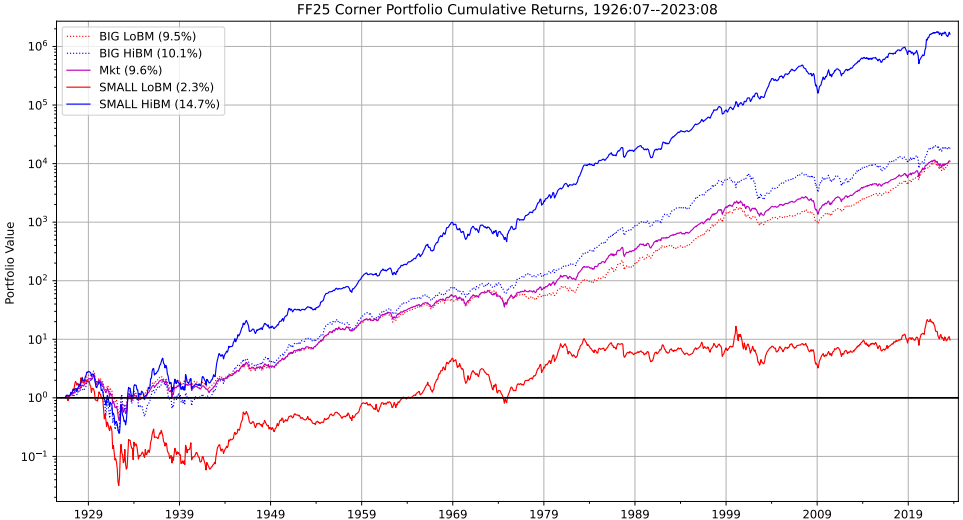

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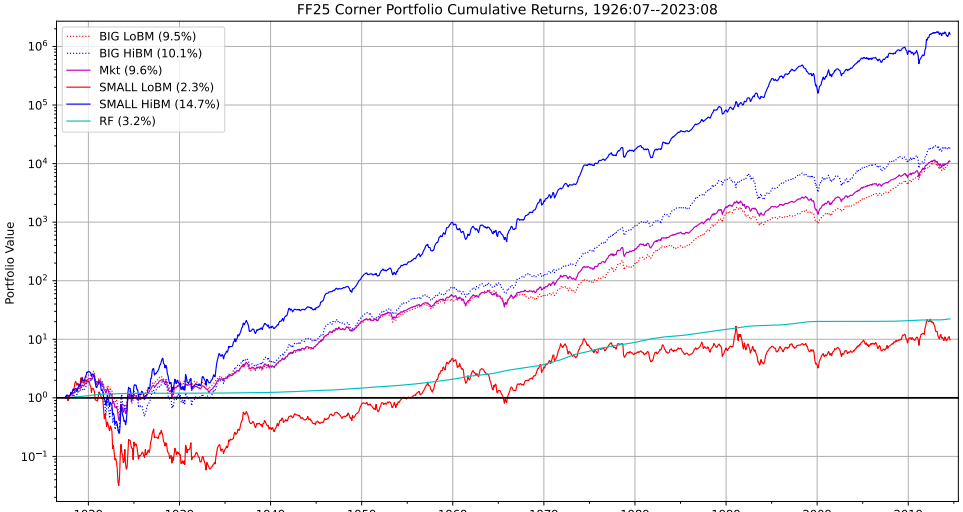
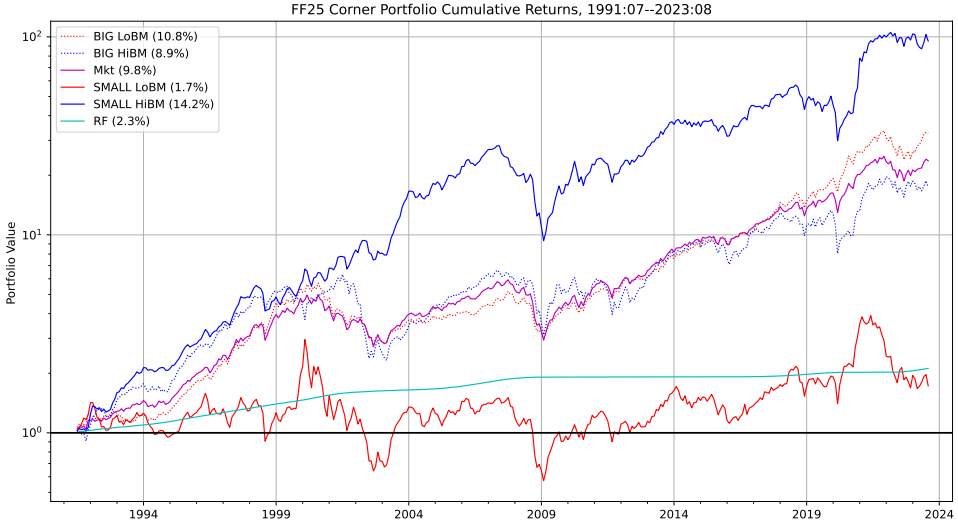


Size-BM Interaction, 1991:07-2023:08



Hedging Unpriced Risk

- The firm characterstics used in portfolio sorts are potentially good proxies for expected returns, and *not* for the firm's loading on the priced factor.
- Equivalently, given a set of J characteristic-vectors $\mathbf{c}_j$ that proxy for expected excess returns:

$$\boldsymbol{\mu} = \sum_{j=1}^{J} \lambda_j \mathbf{c}_j$$

a set of *characteristic-efficient* portfolios will span the MVE portfolio returns:

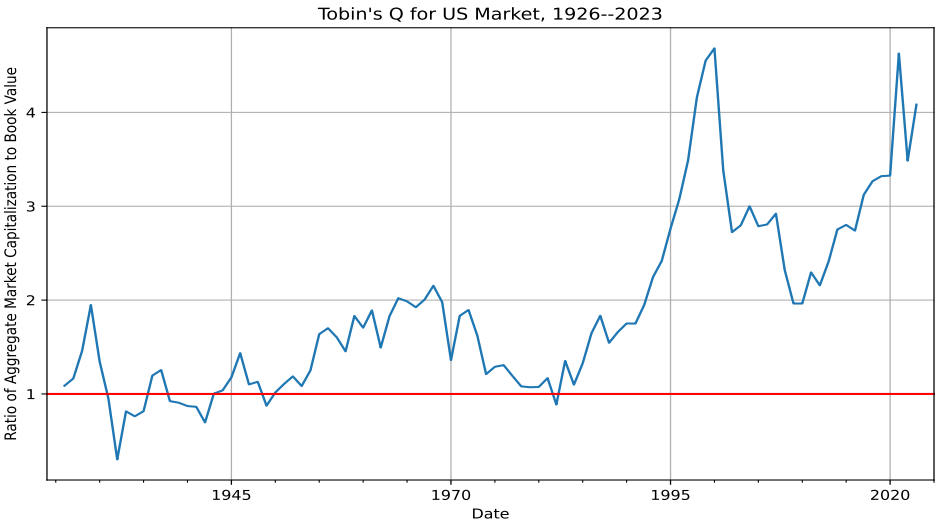
$$r_{MVE} = \boldsymbol{\Sigma}^{-1}\boldsymbol{\mu} = \sum_{j=1}^{J} \lambda_j \left(\boldsymbol{\Sigma}^{-1}\mathbf{c}_j\right)$$

- If characteristics are correlated with unpriced factor risk, the resulting characteristic-sorted portfolios will not be characteristic-efficient.

Hedging Unpriced Risk

- In Daniel, Mota, Rottke, and Santos (2020) we propse the use of a set of hedge-portfolio which are constrained to have zero-characteristics exposure, but are maximally correlated with the FF5 portfolios.
- For robustness, the portfolios are value-weighted, and rebalanced annually (following Fama and French, 1993).
- After hedging out the unpriced risk in the FF5 portfolios, SR^2 of the *ex-post* MVE combination of the portfolios increases from 1.17 to 2.13.
- Kozak and Nagel (2023) has an nicely updated approach to building characteristic-efficient porfolios.

US Market ME/BE Ratio, 1991:07-2023:07



Intangible Captial

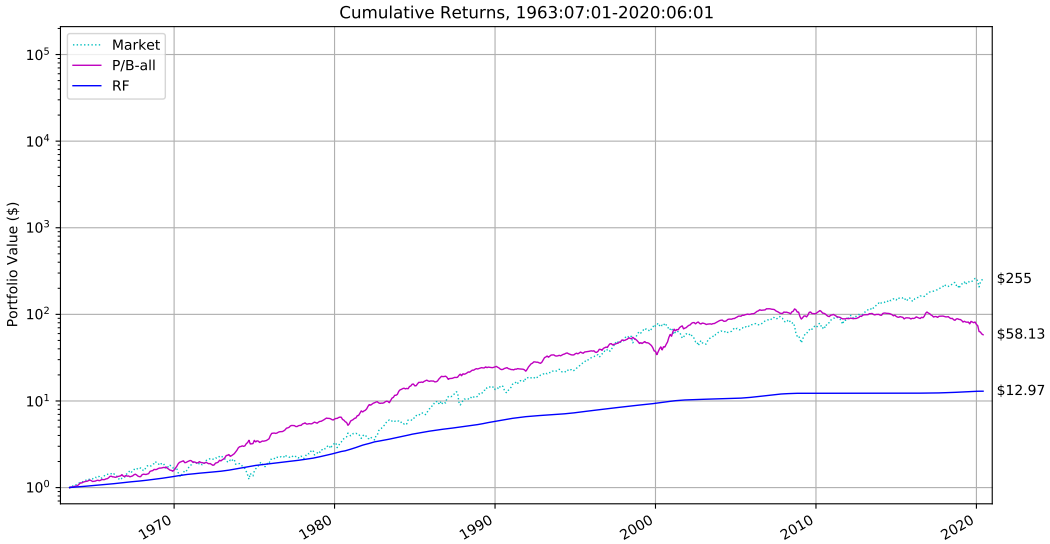
- Following Peters and Taylor (2017) and Park (2022), each fiscal year t, calculate *Organizational Capital* K_t^O and *Knowledge Capital* K_t^K as:[1]

$$\begin{aligned} K_t^O &= (1 - 0.2) \times K_t^O + 0.3 \times \text{SG\&A}_t \\ K_t^K &= (1 - \delta^{RD}) \times K_t^K + \text{R\&D}_t \end{aligned}$$

  where the industry-specific R&D depreciation rate δ^{RD} is taken from Li and Hall (2020).
- To calculate the *intangible-Adjusted Book Equity*, iBE, add K_t^O and K_t^K to standard book-equity, and subtract goodwill.
- Form portfolios in exactly the same way as Fama and French (1993) (VW, rebalanced annually) except using iBE in place of BE.

[1] where $\text{SG\&A}_t$ is net of R&D expenses. Eisfeldt, Kim, and Papanikolaou (2022) propose an alternative intangible value calculation that they show provides further performance improvement.

Returns of intangible-adjusted value portfolios



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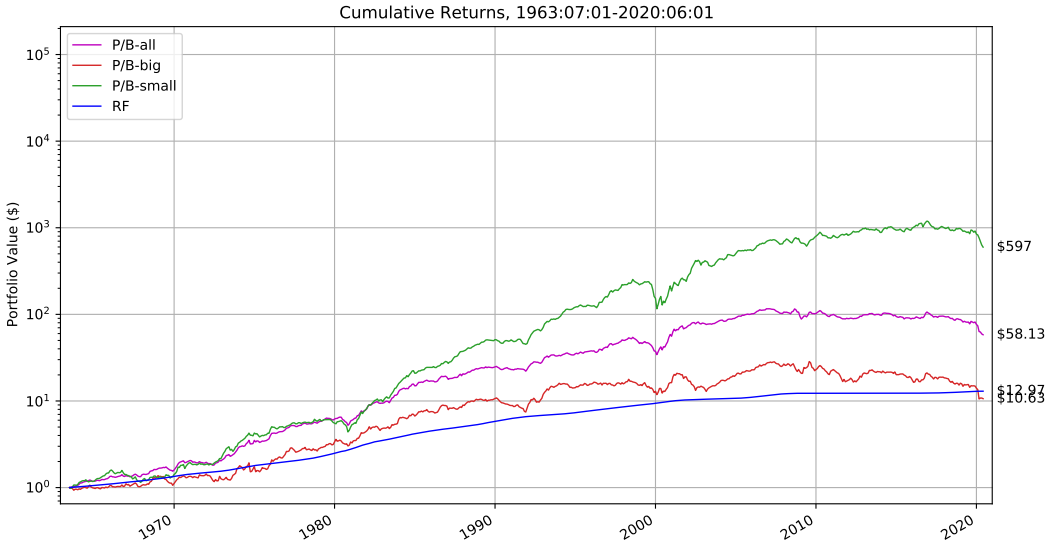

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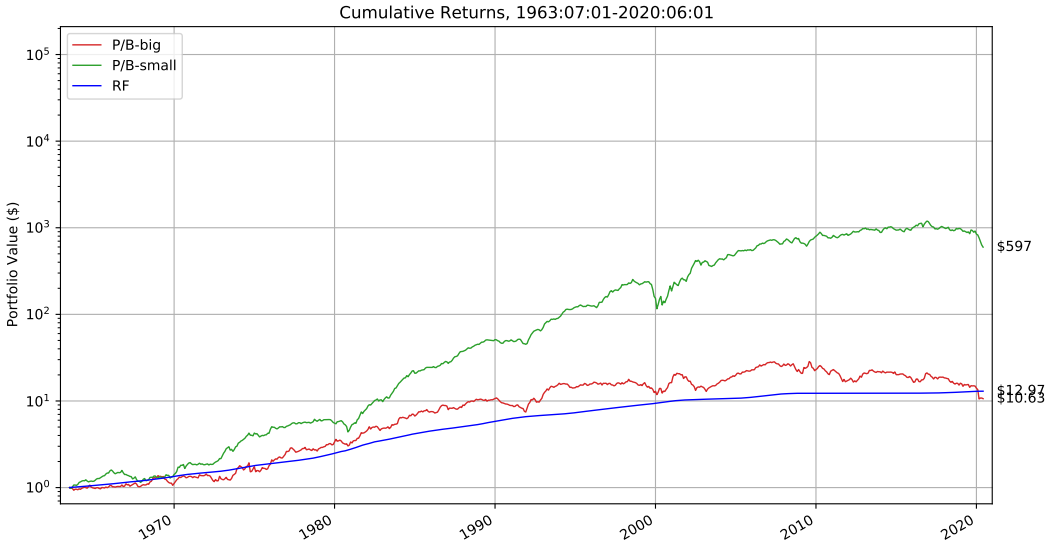

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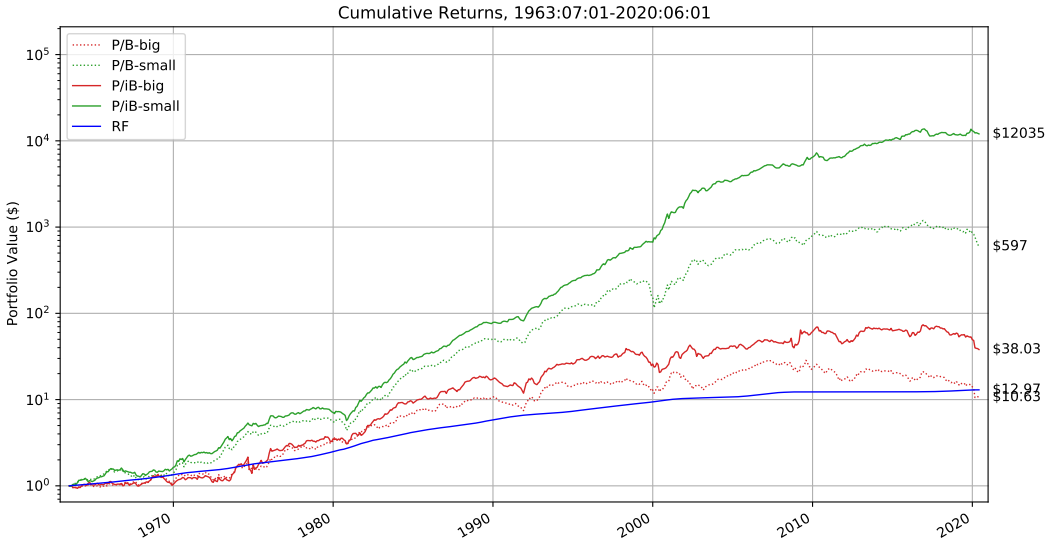

Intangible-adjusted value portfolios–*Summary Statistics*

The mean annualized returns, volatilities, and Sharpe Ratios over the 1980:01–2020:06 period are:

	mean	std	SR
P/B-big	-0.1%	14.4%	-0.00
P/iB-big	3.5%	16.2%	0.22
P/B-small	8.6%	15.2%	0.57
P/iB-small	15.0%	11.2%	1.35

- The difference between the returns to the small-cap HML and iHML portfolios is 6.4%/year ($t = 5.47$).
- Note that we are defining big and small as the top 30% and bottom 30% of firms by Market Capitalization, based on NYSE breakpoints (consistent with FF 93).

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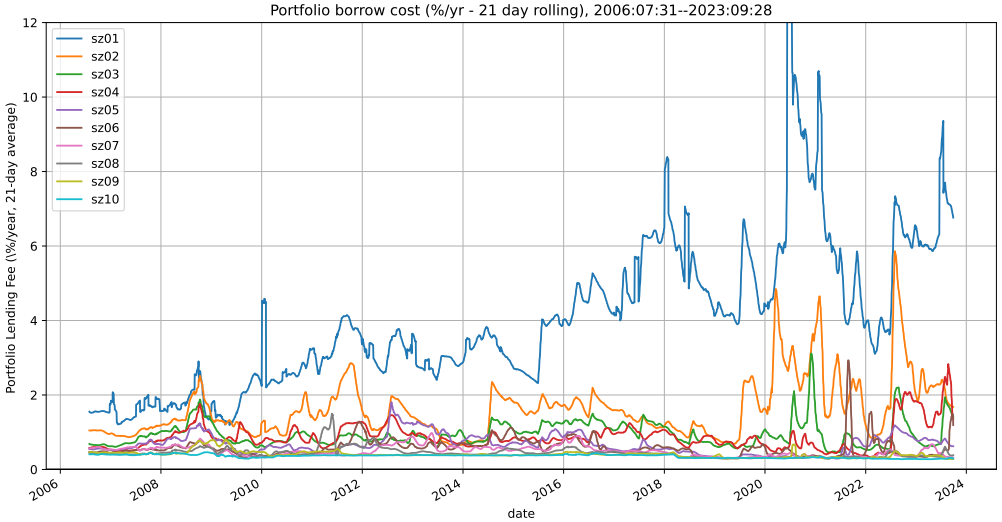
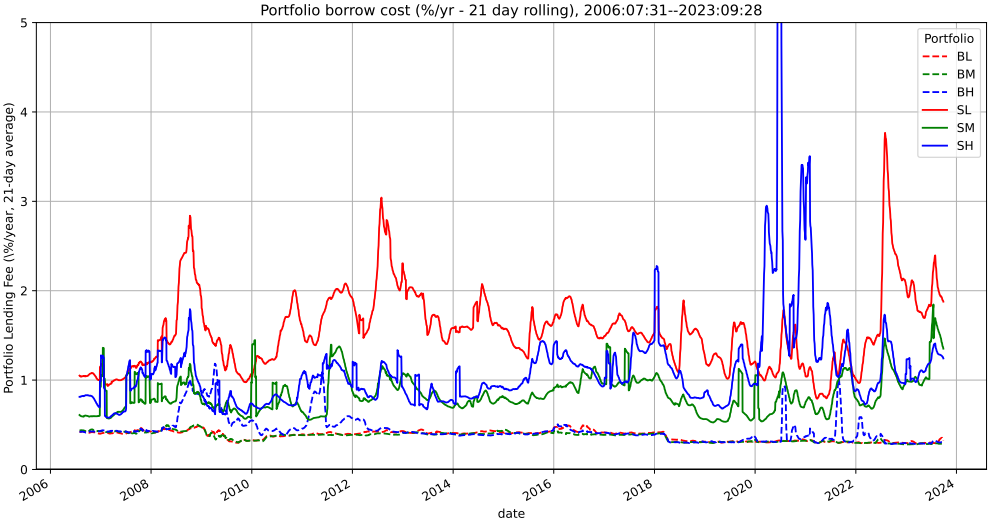
Borrow Costs for Size Decile Portfolios



Borrow Costs



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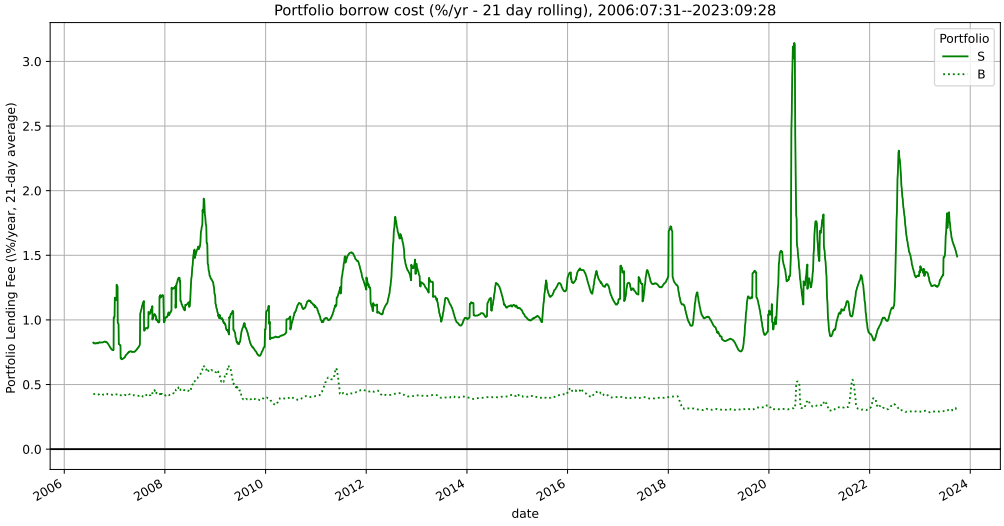

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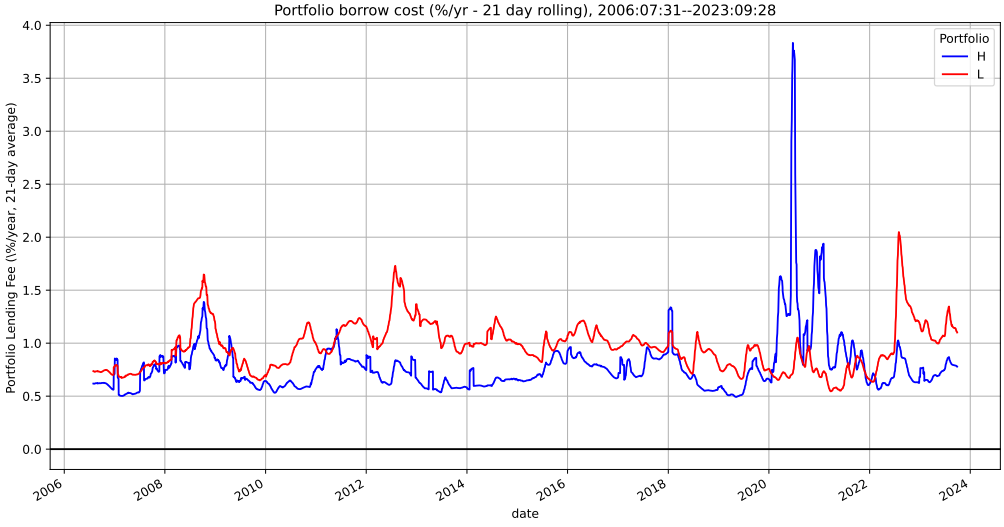

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