

# Dissecting Factors

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- Fama and French (1996) reject the three factor model because it cannot price the “corner portfolios” when stocks are sorted by size and book to market
- Nonetheless, it remains widely used nearly twenty years later
- Rather than further map the model’s boundaries, we dissect what is already in the model

### Questions:

- ① Are all value stocks (and small stocks) created equal?
- ② If not, what implications does this have for performance evaluation and “new” anomalies (such as gross profitability)?

- HML and SMB can each be split into two systematic parts with different risk premia
  - One with a positive price of risk and the other with a zero price of risk
- Small stocks comove with other small stocks and value stocks comove with other value stocks
  - But not all flavors of size and value are compensated with higher average returns
- Because of the mismatch between covariances and average returns, the three-factor model incorrectly penalizes some small and value stocks

# Book-to-market ratio and changes in market values of equity

The evolution of book-to-market ratios:

$$bm_t \equiv bm_{t-k} + \sum_{s=0}^{k-1} dbe_{t-s} - \sum_{s=0}^{k-1} dme_{t-s}$$

A firm is a value firm if:

- 1 it has always been a value firm,
- 2 its market value of equity decreases, or
- 3 its book value of equity increases

# Firm size and changes in market values of equity

The evolution of firm size:

$$me_t \equiv me_{t-k} + \sum_{s=0}^{k-1} dme_{t-s}$$

A firm is small if:

- ① it was a small firm at the time of the IPO or
- ② its market value of equity decreases

Big chunk of cross-sectional variation in book-to-market ratios is due to recent changes in the market value of equity plus a fixed effect-like component

Firm size is about very long-term changes in market value of equity plus a fixed effect-like component

# Average returns and changes in the market value of equity

Estimate cross-sectional (Fama-MacBeth) regressions of returns on changes in the market value of equity

If book-to-market ratio and firm size predict returns because they correlate with changes in the market value of equity:

- $bm_t$  and  $me_t$  lose their significance as we control for changes in prices

# The cross-section of stock returns

Regressor	Model						
	(1)	(2)	(4)	(6)	(8)	(9)	(10)
$r_t^{1,1}$	-6.01 (-15.21)	-6.11 (-15.65)	-6.28 (-16.31)	-6.37 (-16.59)	-6.25 (-16.40)	-6.18 (-16.32)	-5.85 (-14.99)
$r_t^{2,12}$	0.63 (3.62)	0.64 (3.76)	0.60 (3.55)	0.57 (3.36)	0.65 (3.89)	0.68 (4.06)	0.74 (4.30)
$me_t$	<b>-0.10</b> <b>(-2.89)</b>	-0.10 (-2.88)	-0.10 (-2.83)	-0.09 (-2.73)	-0.05 (-1.75)	<b>-0.02</b> <b>(-0.65)</b>	
$bm_t$	<b>0.25</b> <b>(4.35)</b>	0.18 (2.98)	0.10 (1.70)	0.06 (1.04)	0.06 (1.04)	<b>0.06</b> <b>(1.15)</b>	
$dme_t$		-0.27 (-2.84)	-0.32 (-3.29)	-0.35 (-3.60)	-0.27 (-2.89)	-0.25 (-2.66)	-0.28 (-3.02)
$dme_{t-1}$			-0.27 (-3.34)	-0.32 (-3.93)	-0.23 (-2.96)	-0.21 (-2.73)	-0.26 (-3.04)
$dme_{t-2}$			-0.25 (-3.96)	-0.29 (-4.45)	-0.21 (-3.29)	-0.19 (-3.02)	-0.22 (-3.07)
$dme_{t-3}$				-0.24 (-3.86)	-0.16 (-2.71)	-0.16 (-2.58)	-0.21 (-3.15)
$dme_{t-4}$				-0.21 (-4.03)	-0.14 (-2.64)	-0.12 (-2.39)	-0.16 (-2.73)
rank chg <sub>t</sub>					<b>-0.31</b> <b>(-6.82)</b>	-0.34 (-6.61)	-0.38 (-5.86)
rank chg <sub>t</sub> <sup>2</sup>						0.19 (6.85)	0.23 (6.54)
Avg. $R^2$	4.16%	4.48%	4.93%	5.18%	5.34%	<b>5.51%</b>	<b>4.50%</b>

- ① Value stocks comove with other value stocks; growth stocks comove with other growth stocks
  - ② Small stocks comove with other small stocks; large stocks comove with other large stocks
- But stocks can be value or growth or small or large for many different reasons
    - ... **not all of which get a premium or discount in the data**
  - The three-factor model doesn't condition on enough information to pick up on this distinction:
    - If you are a small value stock, you get penalized in alphas; if you are a large growth stock, you get a credit
  - HML and SMB are bundles of multiple “**baby factors**”



Project book-to-market ratio on short-term changes in the market value of equity:  $dme_t, dme_{t-1}, dme_{t-2}, dme_{t-3}, dme_{t-4}$

Take the part of size orthogonal to value and project it on long-term changes in the market value of equity:  $\text{rank chg}_t$  and  $\text{rank chg}_t^2$

- The **priced** components are the projections
- The **unpriced** components are the residuals

# Portfolio sorts: Book-to-market ratio

Sorting variable	Model	Portfolio decile		High – Low	
		1	10	$\hat{\alpha}$	$R^2$
Current: $bm_t$	$\bar{r}^e$	0.40 (1.98)	0.87 (3.86)	<b>0.48</b> ( <b>2.58</b> )	
	CAPM	-0.06 (-0.83)	0.43 (3.09)	0.50 (2.67)	0.0%
	FF	0.15 (2.56)	-0.06 (-0.62)	-0.21 (-2.01)	70.0%
Priced: $\widehat{bm}_t$	$\bar{r}^e$	0.27 (1.09)	0.83 (3.35)	<b>0.56</b> ( <b>2.86</b> )	
	CAPM	-0.30 (-3.17)	0.33 (2.31)	0.63 (3.22)	1.8%
	FF	-0.10 (-1.22)	-0.03 (-0.23)	0.07 (0.48)	40.4%
Unpriced: $bm_t^e$	$\bar{r}^e$	0.45 (2.43)	0.45 (2.05)	<b>0.00</b> ( <b>0.01</b> )	
	CAPM	0.03 (0.41)	-0.02 (-0.21)	-0.05 (-0.34)	1.8%
	FF	0.19 (2.82)	-0.27 (-2.82)	<b>-0.46</b> ( <b>-3.55</b> )	34.3%

# Portfolio sorts: Firm size orthogonal to value

Sorting variable	$\hat{\alpha}$	Portfolio decile		High – Low	
		1	10	$\hat{\alpha}$	$R^2$
Current: $ome_t$	$\bar{r}^e$	0.62 (2.39)	0.42 (2.45)	<b>-0.20</b> <b>(-1.10)</b>	
	CAPM	0.09 (0.60)	0.01 (0.24)	-0.08 (-0.43)	7.6%
	FF	-0.11 (-1.76)	0.04 (1.31)	0.15 (2.13)	85.6%
Priced: $\widehat{ome}_t$	$\bar{r}^e$	0.83 (3.45)	0.47 (2.29)	<b>-0.36</b> <b>(-2.73)</b>	
	CAPM	0.32 (2.60)	-0.01 (-0.10)	-0.33 (-2.45)	1.2%
	FF	0.09 (1.15)	0.01 (0.15)	-0.08 (-0.81)	48.5%
Unpriced: $ome_t^e$	$\bar{r}^e$	0.57 (2.25)	0.42 (2.45)	<b>-0.15</b> <b>(-0.89)</b>	
	CAPM	0.04 (0.28)	0.01 (0.25)	-0.03 (-0.16)	8.7%
	FF	-0.14 (-2.37)	0.03 (1.27)	<b>0.17</b> <b>(2.64)</b>	86.4%

## Mutual fund performance evaluation

# Mutual fund performance evaluation

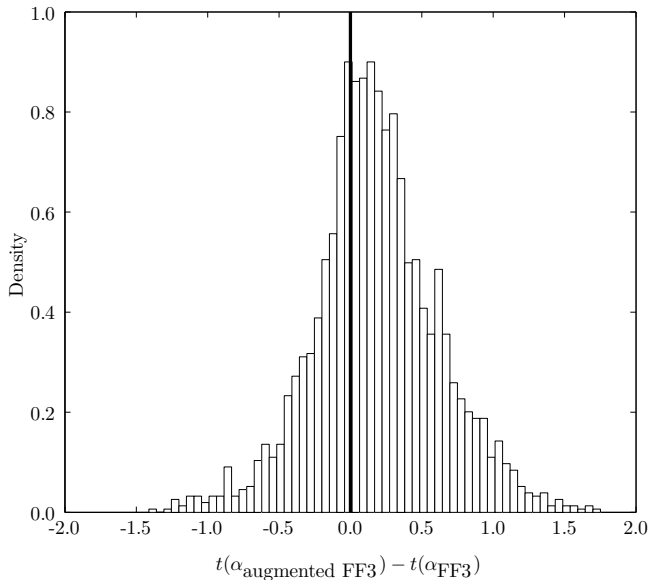
- What fraction of mutual fund managers have enough skill to offset the costs they impose on investors?
- Three-factor model alphas are sensitive to how funds over- or underweigh different flavors of value and size
- Augment the three-factor model with “control” factors:
  - The zero-mean strategies based on the unpriced parts of value and size

# Augmented three-factor model

Statistic	FF3 model			FF3 model augmented with control factors				
	$\hat{s}$	$\hat{h}$	$t(\hat{\alpha})$	$\Delta\hat{s}$	$\Delta\hat{h}$	$\Delta t(\hat{\alpha})$	$\hat{s}_{\text{control}}$	$\hat{h}_{\text{control}}$
$p_5$	-0.19	-0.49	-2.52	-0.65	-0.10	-0.53	-0.18	-0.14
$p_{10}$	-0.16	-0.39	-2.04	-0.48	-0.07	-0.35	-0.11	-0.09
$p_{25}$	-0.08	-0.18	-1.30	-0.29	-0.03	-0.07	-0.01	-0.03
$p_{50}$	0.09	0.03	-0.46	-0.13	-0.01	0.16	0.11	0.02
$p_{75}$	0.46	0.25	0.41	0.01	0.01	0.44	0.26	0.09
$p_{90}$	0.72	0.43	1.15	0.12	0.04	0.75	0.42	0.19
$p_{95}$	0.84	0.54	1.62	0.20	0.06	0.94	0.56	0.25
Mean	0.20	0.20	0.20	-0.16	-0.01	0.18	0.14	0.04
	(28.53)	(4.43)	(-17.05)	(-28.11)	(-9.86)	(14.46)	(27.60)	(13.41)
% > 0	61.4%	54.6%	36.6%	25.9%	39.2%	<b>66.9%</b>	<b>74.0%</b>	<b>60.9%</b>
	(11.36)	(4.52)	(-13.54)	(-26.65)	(-10.73)	(17.40)	(26.52)	(10.87)

Most managers trade the uncompensated flavors of size and value

Estimated alphas shift significantly to the right



# Fama and French (2010) luck vs. skill analysis

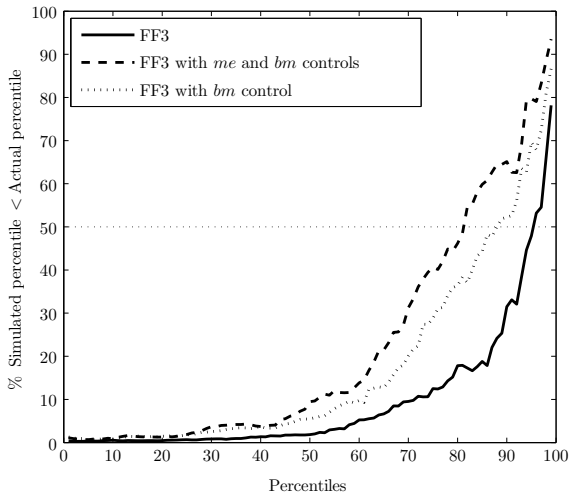
- 1 Estimate each fund's alpha using all available data;
- 2 Set funds' full-sample alphas to zero by subtracting estimated alphas;
- 3 Resample *months* with replacement to preserve the covariance structure of fund returns and factors;
- 4 Re-estimate alphas of all funds using the resampled data; and
- 5 Repeat the simulation procedure 10,000 times.

Compare the actual and simulated distributions of  $t(\alpha)$ s

How often does the actual distribution dominate the simulated distribution?

A number  $> 50\%$  indicative of skill





Fama and French (2010): only 2% of fund managers have enough skill to cover the costs they impose on investors

Augmented model: up to 18% of fund managers have skill

Gross profitability

Novy-Marx (2013): Firms with high gross profits-to-assets ratio earn higher returns than unprofitable firms

- The return on a 10 – 1 strategy is 4.7% per year ( $t = 2.80$ )
- Interesting strategy because it covaries **negatively** with HML
  - The loading on HML is  $-0.37$  ( $t = -7.75$ )
  - The strategy **buys growth stocks**, yet it gets high returns
- The three-factor model alpha much higher: 7.0% per year ( $t = 4.34$ )

**A strategy that combines value and profitability very attractive!**

- Augment the three-factor model with the control factors
- The negative correlation disappears:
  - ① The slope on HML increases to  $-0.04$  ( $t = -0.79$ )
  - ② The slope on the  $HML_{\text{control}}$  strategy is  $-0.46$  ( $t = -11.3$ )
- The negative correlation between gross profitability and value is entirely due to the unpriced component
- The (augmented) three-factor model alpha is  $4.1\%$  ( $t = 2.82$ )

The strategy is profitable but the negative correlation is due to the extra stuff in HML

HML and SMB are bundles of multiple “baby factors”

Value and size come in different flavors

- Covariances and average returns do not line up the same way

**What to do?**

Clean the factors or condition on additional information to distinguish between different flavors of size and value

Check robustness to perturbations to the asset pricing model

## Not all small and value firms are created equal

- A firm may have seemingly desirable characteristics for different reasons
- A raw sort on size and value picks up changes in the market value of equity

## What to do?

Clean your value signal by taking into account recent changes in the market value of equity

or

Combine book-to-market with gross profitability → it gets a bit at the same issue by separating “good” value from “bad” value