Hedging Risk Factors

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Risk Factors

- Expected return of an asset

$$\mathbb{E}\left[R_i^e\right] = \lambda_1 \beta_{i,1} + \lambda_2 \beta_{i,2} + \ldots = \lambda' \beta_i$$

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- Risk premium as compensation for risk

Risk Factors

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- Risk premium as compensation for risk
- Which factors?
  - Macro-based factors: track macroeconomic conditions (e.g. consumption, GDP, unemployment, ...)
    - Macro-finance literature: Parker-Julliard factor, Q4 consumption growth, unfiltered consumption growth.
  - Asset-pricing factors: explain cross section of returns (e.g. Mkt., SMB, HML, Momentum, ...)

Asset Pricing Models

Typical Approach

- Estimate prices of risk—e.g. Fama-MacBeth
- Test assets: portfolios sorted on BM, ME, MOM,...
- Test assets: dispersion in returns/characteristics

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Our Approach

Are risk factors costly to hedge?

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Our Approach

Are risk factors costly to hedge?

- Test assets: based on exposures
  - Test assets constructed under null that model is true
- This provides a good and natural test for factor models
- Breaks low dimensionality of standard test assets

Hedging Risk Factors

Our Findings

- Build (good!) hedge portfolios against risk factors
- Hedge portfolios perform well in "bad" times
  - Macro: low beta on Consumption, GDP, Recessions
  - Asset Pricing: low beta on Value, Momentum, etc.

Hedge portfolios are cheap

- Similar average returns regardless of exposure

Literature

1. Asset pricing models
    - Macro factors (e.g., Parker and Julliard 2005, etc)
    - Reduced form factors (e.g., Fama French 1996, etc)
2. Asset pricing tests
    - Critiques of standard test assets:
        - Lewellen Nagel Shanken 2010, Bryzgalova 2017
        - New test assets based on exposures
        - Overcome some of challenges with existing test assets
    - Weak beta and expected return relation:
        - Frazzini Pedersen 2013, Daniel Mota Rottke Santos 2017, Daniel Titman 1997
        - Weak beta relation is pervasive not just for market beta
        - Hedge factors are different from BAB and DMRS

Building Hedge portfolios

Data

- Asset pricing factors
  - Fama and French 5 factors
  - Momentum
  - Betting against beta
  - DMRS hedged factors from Kent Daniel
- Macro series (log changes)
  - Industrial production
  - Initial claims (unemployment), *flip sign*
  - Moody's BaaAaa spread, *flip sign*
  - Slope of term structure (5-year yield minus 3-month)
  - Combined macro series

    EW average of standardized macro monthly series
  - NBER recessions, GDP and consumption growth

Building Hedge portfolios

Hedge Portfolios

1. Fix a factor (e.g. combined macro factor)
2. Construct beta-sorted portfolios (quintiles)

$$R^e_{i,\tau} = a_{i,t} + \beta'_{i,t} f_\tau + \varepsilon_{i,\tau}$$

   - Daily data: betas from 24-month rolling windows
   - Monthly data: betas from 120-month windows (corr.) and 24-month (volatility using daily data)
   - Value weight within quintiles (NYSE breakpoints)
3. Hedged Portfolio
   - Long low-beta stocks and short high-beta ones

What to expect?

- Investors should pay a premium to hedge a risk factor

From the data

- Flat relation between premium and exposure
- Despite good spread in post-formation exposure

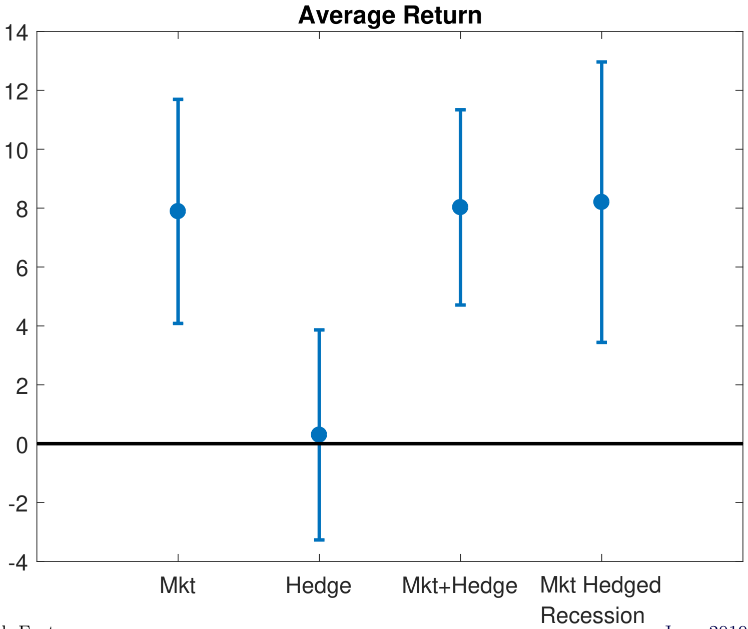
Macro Hedged Portfolio

Focus on 4 portfolios

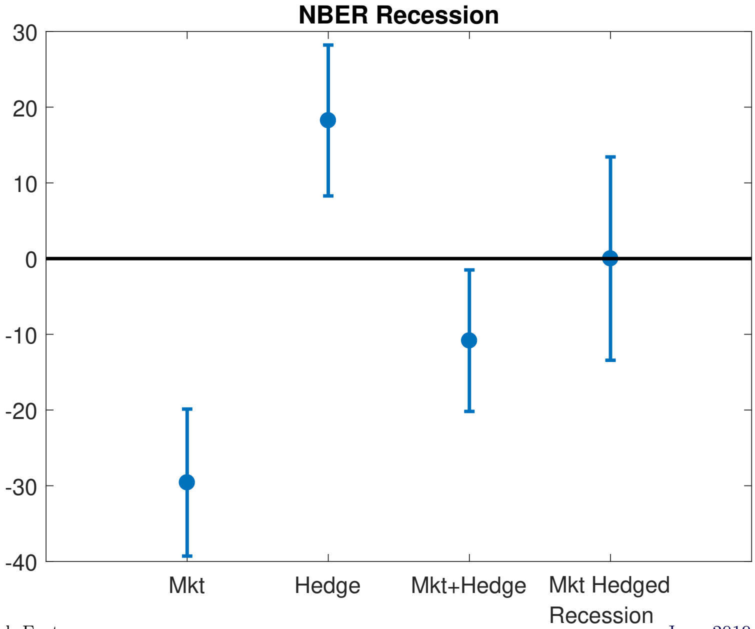
1. Market Portfolio
2. Hedge Portfolio (low beta minus high beta)
3. Market + Hedge
4. Market Recession Hedged (zero exposure to recession)

Show results for EW macro hedge (industrial production, unemmployment, credit spreads, term premium)

Macro Hedge


Average Return
14
12
10
8
6
4
2
0
-2
-4
Mkt
Hedge
Mkt+Hedge
Mkt Hedged
Recession

Macro Hedge


NBER Recession
30
20
10
0
-10
-20
-30
-40
Mkt
Hedge
Mkt+Hedge
Mkt Hedged Recession

Cumulative returns around selected recessions

1$ invested in December 2007

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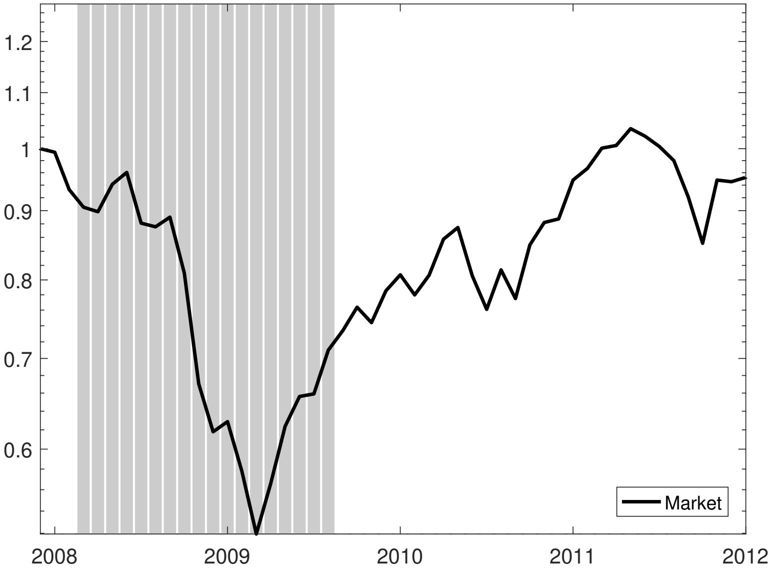

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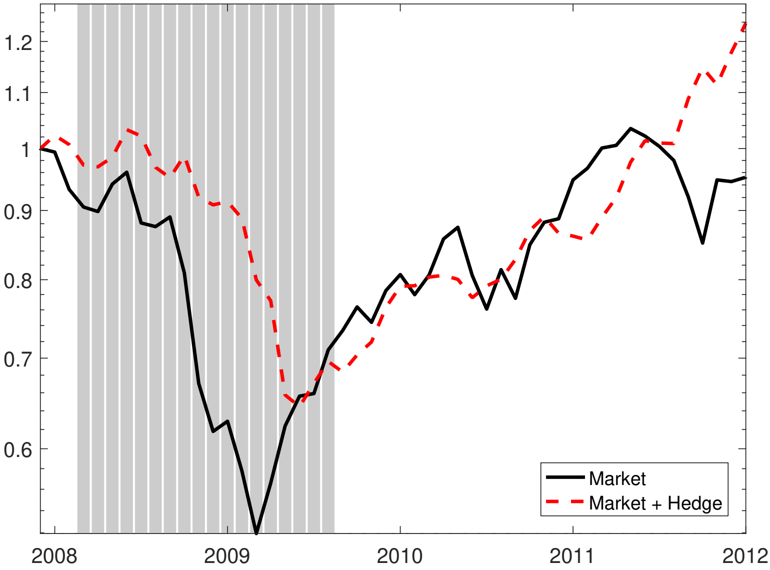

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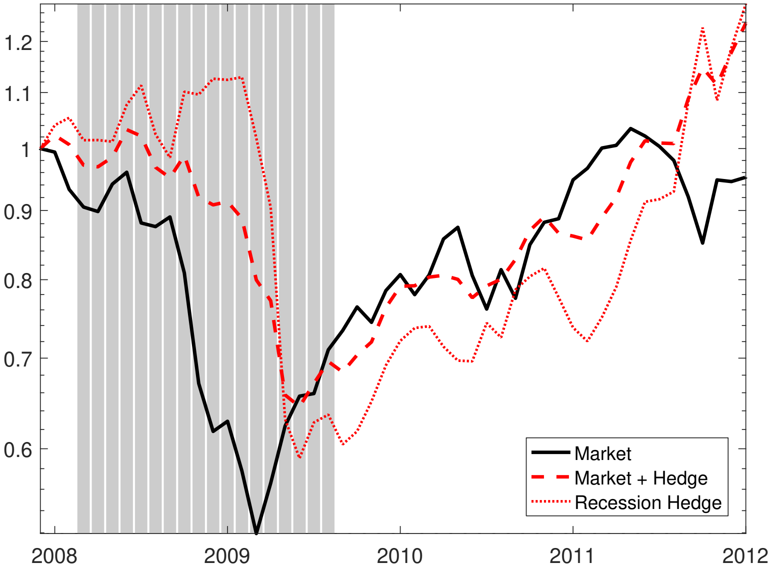
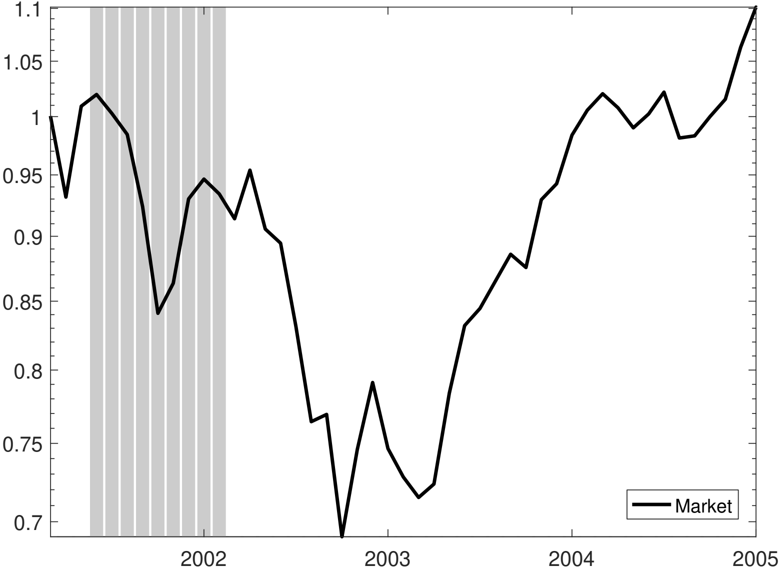


Cumulative returns around selected recessions

1$ invested in February 2001



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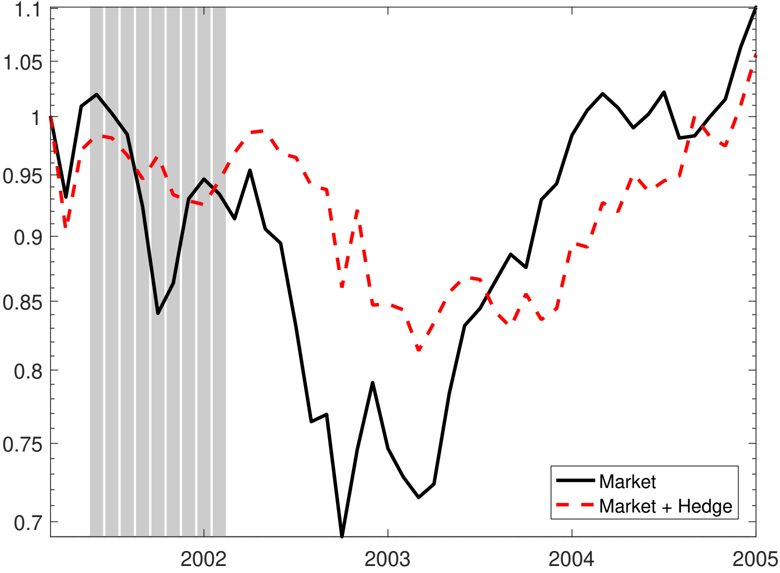

Cumulative returns around selected recessions

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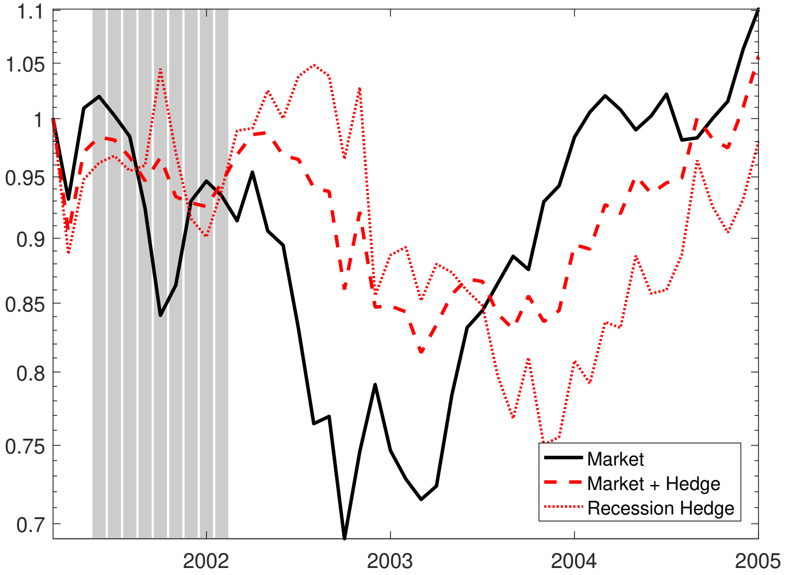


Macro Factors

Free hedge?

- Post-formation betas are negative and significant
- Average returns are close to zero
- Market-hedged portfolios:
  - No exposure to factors
  - Similar average returns
  - Similar Sharpe ratios
  - Market portfolio is exposed to these factors

- Market-hedged portfolio is also less exposed to:
  - Future NBER recessions, consumption and GDP growth, Parker-Julliard consumption factor, unfiltered consumption growth, Dividend and profit growth

Slope of factor betas

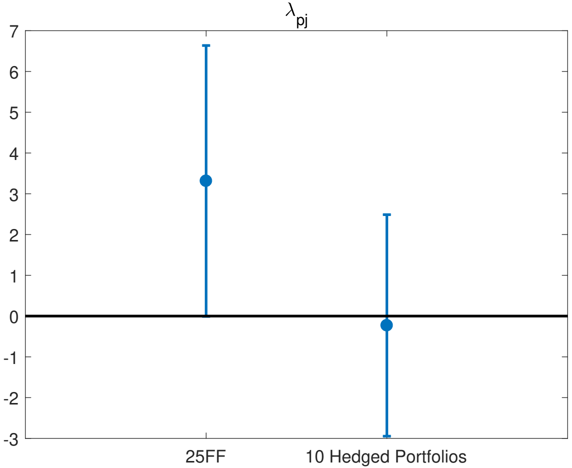
Slope of factor betas

$$E[R_i] = \lambda_0 + \lambda_1 \beta_{i,f}$$

- $\beta_{i,f}$: from a time series regression of returns on factor
- Test assets: beta-sorted portfolios based on each factor
- Macro-based risk factors
  - Parker and Julliard (2005) Factor
  - Q4 Consumption Growth (Jagannathan Wang 2007)
  - Unfiltered Consumption Growth (Kroencke 2017)

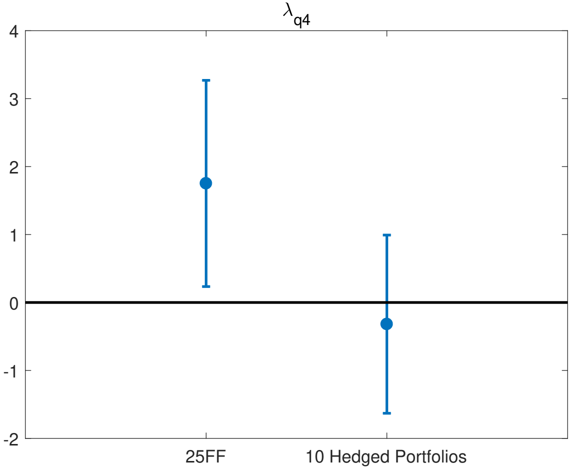
Parker and Julliard (2005) Factor

$$E[R_i] = \lambda_0 + \lambda_1 \beta_{i,f}$$



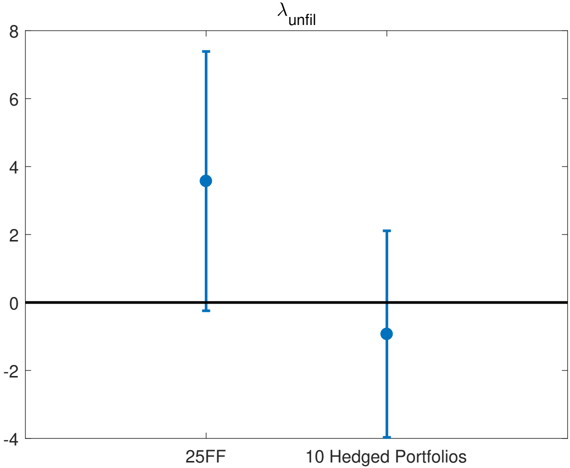
Consumption Growth (Jagannathan Wang 2007)

$$E[R_i] = \lambda_0 + \lambda_1 \beta_{i,f}$$



Unfiltered Consumption Growth (Kroencke 2017)

$$E[R_i] = \lambda_0 + \lambda_1 \beta_{i,f}$$



Revisiting prices of risk of macro factors

1. Literature arguing macro risk explains cross-section
2. Typical approach: FF25 to estimate price of macro risk
3. Several critiques to traditional approach:
   - strong factor structure of these portfolios (Lewellen Nagel Shanken 2010, Daniel Titman 2012),
   - weak spread in betas on the macro factors Bryzgalova 2017 (e.g., first stage of estimating beta is weak)
4. Our portfolios
   - New test assets to evaluate models
   - Stronger spread in betas directly related to macro risk
5. Conclusion
   - Very different price of risk estimates
   - Point estimate always lower, close to zero

How much of SDF is macro risk?

- So far: inconsistent w/ existing factors as *only* factors
- Can we say anything if other omitted factors? Yes!
- Challenge: hedge portfolio might load on unobserved pricing factors
- Idea: if Sharpe ratio still high after hedging macro risk, then macro risk can't explain too much SDF volatility. Provides bounds on SDF vol from macro risk.

How much of SDF is macro risk?

- Formally, let

$$m_t = 1 - b_z z_t + b_f f_t$$

where z is an observed risk factor,
f is an unobserved risk-factor.

- Let R_t^z be the portfolio with unit exposure to z
- Let R_t^m be the tangency portfolio
- Construct the tangency-hedged portfolio:

$$R_t^{m,-z} = R_t^m - \beta_{m,z} R_t^z$$

Then

$$\frac{b_z^2 \sigma_z^2}{\sigma_m^2} \leq 1 - \frac{\left(\frac{E[R_t^{m,z}]}{\sigma(E[R_t^{m,z}])^2}\right)}{\sigma_m^2}$$

How much of SDF is macro risk?

	Market	FF3	Carhart	FF5	FF5+UMD
SR	0.43	0.52	0.98	1.10	1.26
SR recession hedged	0.36	0.61	0.84	1.18	1.26
Recession upper bound share	0.54	0.33	0.29	0.02	0.03
Recession upper bound Sharpe ratio	0.39	0.42	0.53	0.15	0.23

Traded Factors

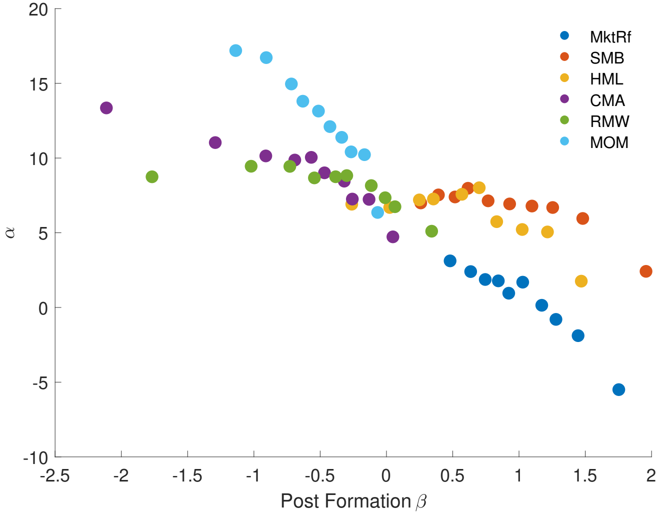
Traded Factors

$$R_{i,\tau} = a_{i,t} + \beta'_{i,t} f_\tau + \varepsilon_{i,\tau}$$

Same analysis, but:

- Two years daily data: more precision in beta
- Alpha tests: hedges "too cheap" equivalent to $\alpha > 0$
- Similar findings using traded factors

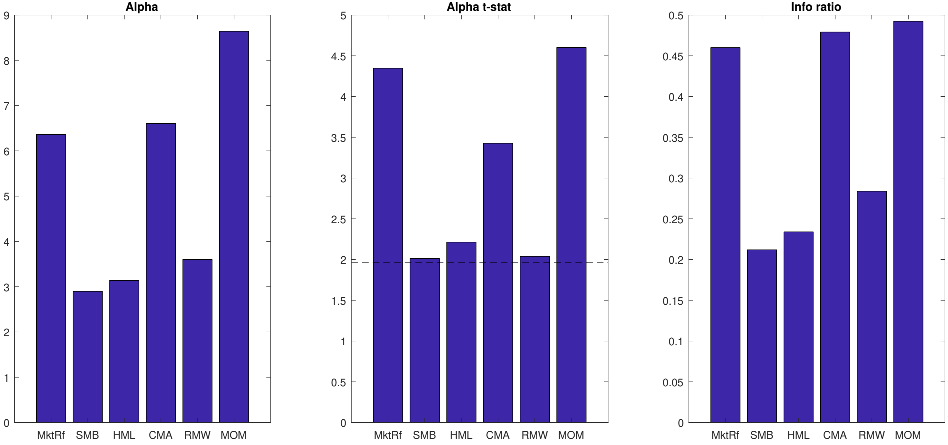
Form 10 portfolios sorted by beta of traded factor



Same finding: low beta have high alpha, hedges are "cheap"

Similar findings using traded factors

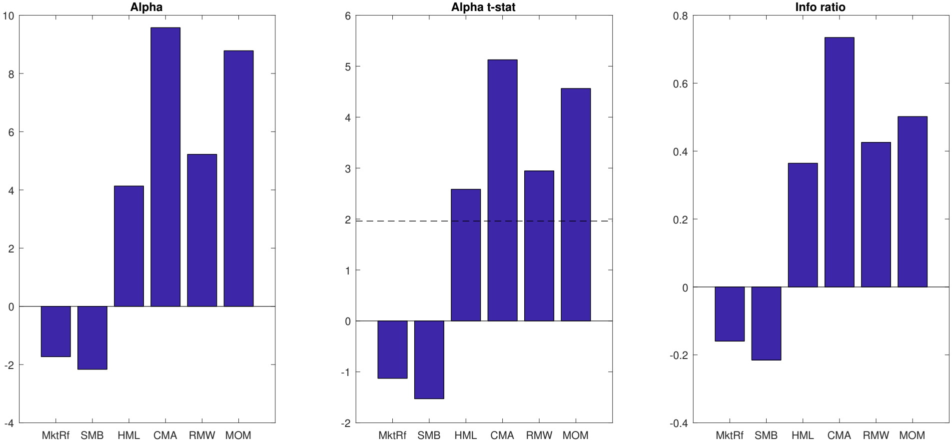
Alphas controlling for original factor



We plot alphas on beta sorted portfolios by factor. We sort stocks by their beta with respect to individual factors and then form a beta factor using the low minus high beta portfolio based on pre-ranking beta quintiles (NYSE breakpoints). These panels show the results controlling for the original factor used.

Similar findings using traded factors

Alphas controlling for original factor, BAB, DMRS portfolios



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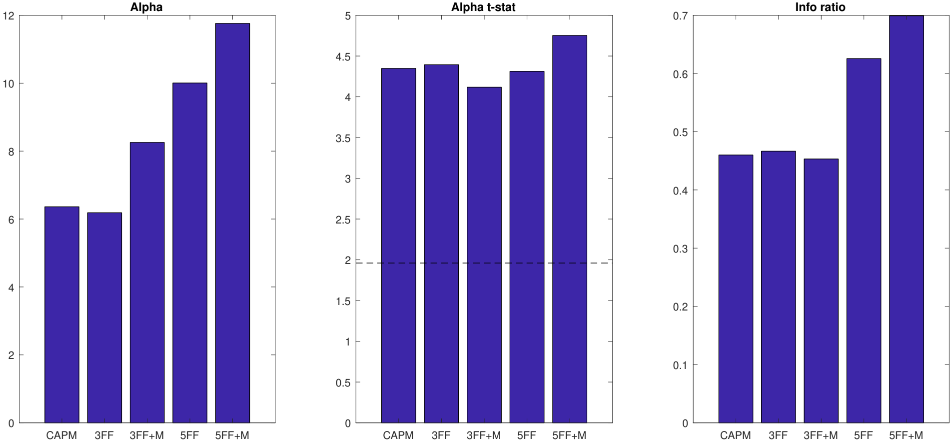
Remarks

- Portfolios based on exposures are natural way to evaluate models
- Construct portfolios with strong spread in exposures, find exposure vs expected return relation is “too flat”
  - Macro factor: unemployment, industrial production, credit, term structure
  - Asset pricing: Mkt, SMB, HML, CMA, RMW, MOM
- Important implications
  1. Build hedges against macro and asset pricing factors
  2. Hedge portfolios cheap. Limits contribution of business cycle risk to SDF, gives α for traded factors
  3. Useful set of test assets to evaluate models

Annex

Similar findings using MVE portfolios

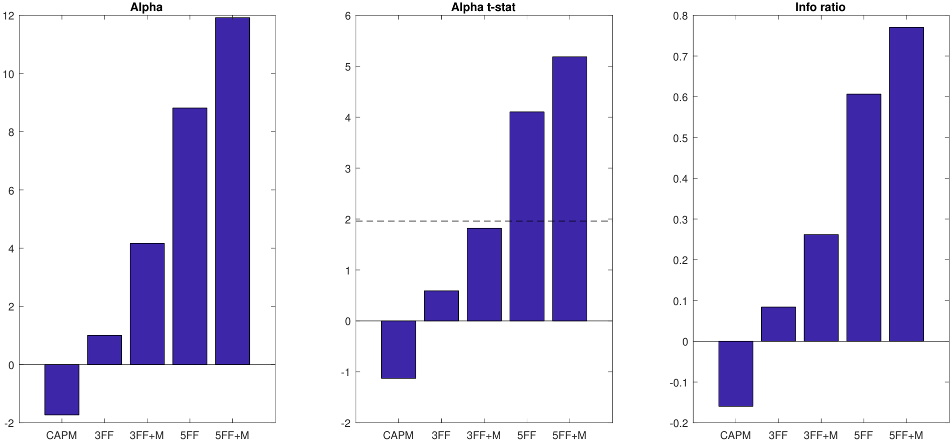
Alphas controlling for original factor



We plot alphas on beta sorted portfolios with respect to mutifactor benchmark r^*. We repeat the exercise from the last figure, but instead of using single factors to beta sort, we use ex-post MVE combinations of factors (e.g., $b'F$ where F is a set of factors and b is chosen to maximize full sample Sharpe ratios).

Similar findings using MVE portfolios

Alphas controlling for original factor, BAB, DMRS portfolios



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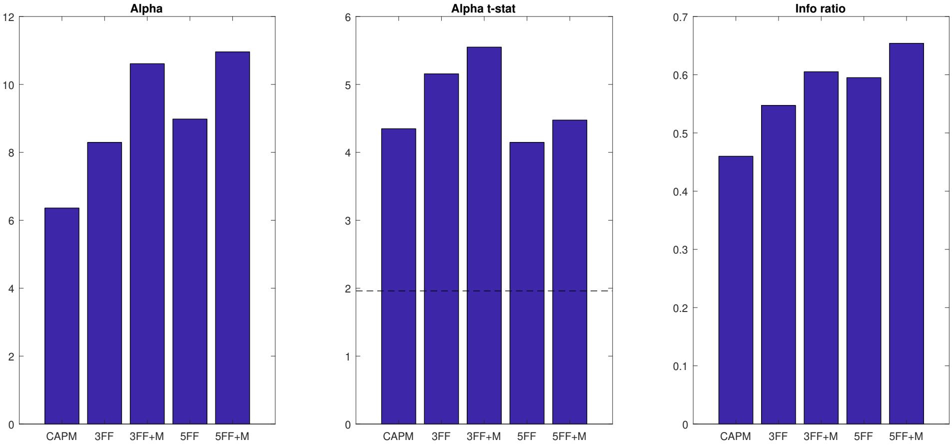
Similar findings using EW portfolios

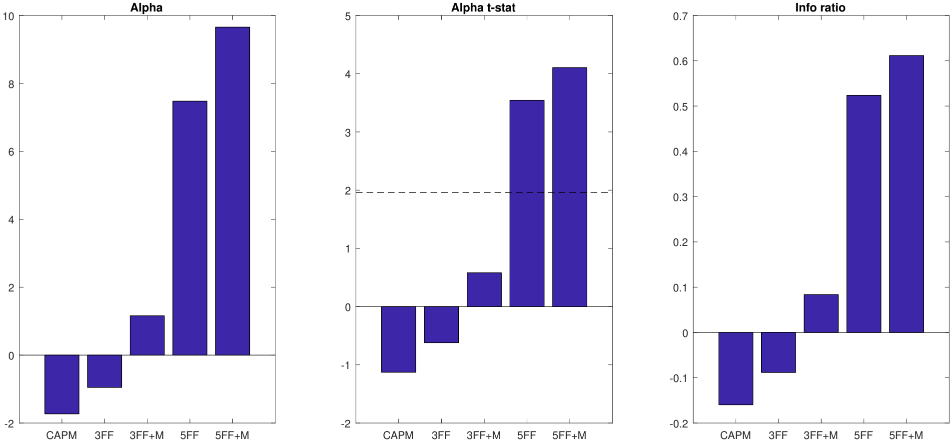
Alphas controlling for original factor



We plot alphas on beta sorted portfolios with respect to mutifactor benchmark r^*. We repeat the exercise from the last figure, but instead of using single factors to beta sort, we use ex-ante EW combinations of factors..

Similar findings using EW portfolios

Alphas controlling for original factor, BAB, DMRS portfolios



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Minimum Variance Portfolio

Assume constant expected returns:

1. Regress stock returns on asset pricing factor F (36-mth windows)

$$R_{i,\tau} = a_{i,t} + \beta'_{i,t} F_\tau + \varepsilon_{i,\tau}$$

2. Build proxy for var-cov matrix of all returns

$$\Sigma_t \equiv B_t \Omega_t B'_t + S_t$$

3. Compute the mean-variance efficient portfolio weights

$$\omega_t = \frac{1}{\mathbf{1}'\Sigma_t^{-1}\mathbf{1}} \mathbf{1}'\Sigma_t^{-1}$$

4. Form our low risk portfolio using monthly data

$$R_t^{\text{Low Risk}} = \sum_i \omega_{i,t} R_{i,t}$$

Minimum Variance Portfolio

- Low-risk portfolio

$$R_t^{\text{Low Risk}} = \sum_i \omega_{i,t} R_{i,t}$$

	Avg. excess return	t-statistic	Sharpe ratio
Mkt	8.05	9.82	0.82
Car	7.46	9.13	0.82
FF5	7.50	9.12	0.82

- High Sharpe ratios
- Exploits cross-sectional variation in volatility

Minimum Variance Portfolio

		CAPM	3FF	3FF +MOM	5FF	5FF +MOM	5FF +MOM +BAB
Mkt.	Alpha	6.16	6.07	5.66	3.40	3.41	1.93
	t-stat.	6.68	6.58	5.97	3.04	3.00	2.00
	Info. ratio	0.71	0.71	0.66	0.44	0.44	0.29
Car	Alpha	5.70	5.70	5.22	3.73	3.73	2.47
	t-stat.	6.65	6.63	5.92	3.47	3.41	2.56
	Info. ratio	0.71	0.71	0.65	0.50	0.50	0.37
FF5	Alpha	5.78	5.82	5.29	4.00	4.02	2.73
	t-stat.	6.70	6.74	5.98	3.68	3.64	2.80
	Info. ratio	0.72	0.72	0.66	0.53	0.53	0.41