MSCI A Clear View of Risk and Return

Innovations in Factor Risk Modeling

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Outline

- Overview of next-generation Barra US Equity Model (USE4)
- Innovations and advances in USE4 methodology:
  - Introduction of Country factor
  - Cross-sectional volatility techniques
  - Eigenfactor methodology for optimized portfolios
- Summary

Overview of Next-Generation Barra Risk Models

Barra US Equity Model (USE4) Highlights

- Eigenfactor methodology for removing biases of optimized portfolios and constructing better out-of-sample portfolios
- Use of factor cross-sectional volatility (CSV) to provide more responsive forecasts and reduce non-stationarity bias
- Improved specific risk model, including CSV-adjusted estimates
- Introduction of country factor for clean separation of market/industry effects and increased accuracy
- Full daily model updates for all investment horizon
- Multiple industry exposures based on Global Industry Classification Standard (GICS®)
- Enhanced style factors and increased explanatory power
- Pursuing patent protection so that we may continue delivering innovation and transparency to our clients

Country Factor

Interpretation of Country Factor

- Conventional single-country models do not include a country factor
- In conventional approach, the market effect is embedded within every industry factor

$$r_n = \sum_{indus} X_{ni} f_i + \sum_{styles} X_{ns} f_s + u_n$$

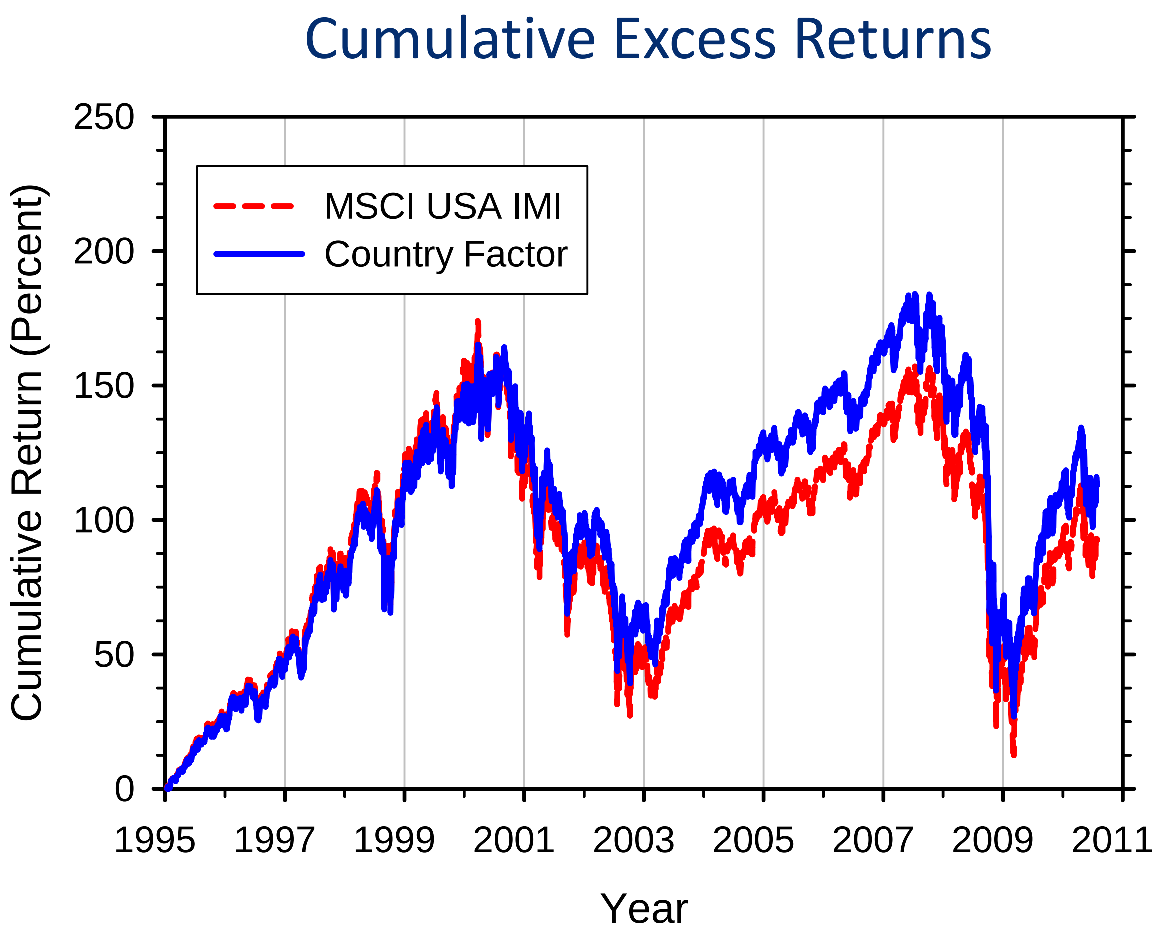
Conventional Approach
(No country factor)

- Including a country factor disentangles industry and market effects
- In new approach, the country factor represents the overall market
- Industry factors now represent the industry net of the market

$$r_n = f_c + \sum_{indus} X_{ni} f_i + \sum_{styles} X_{ns} f_s + u_n$$

New Approach
(With country factor)

Cumulative Return of Country Factor



- Country factor tracks index closely over 15-year period
- Two sources of return deviation:
  a) Index uses float-adjusted weights
  b) Cap-weighted specific returns do not sum to zero

Cross-Sectional Volatility (CSV)

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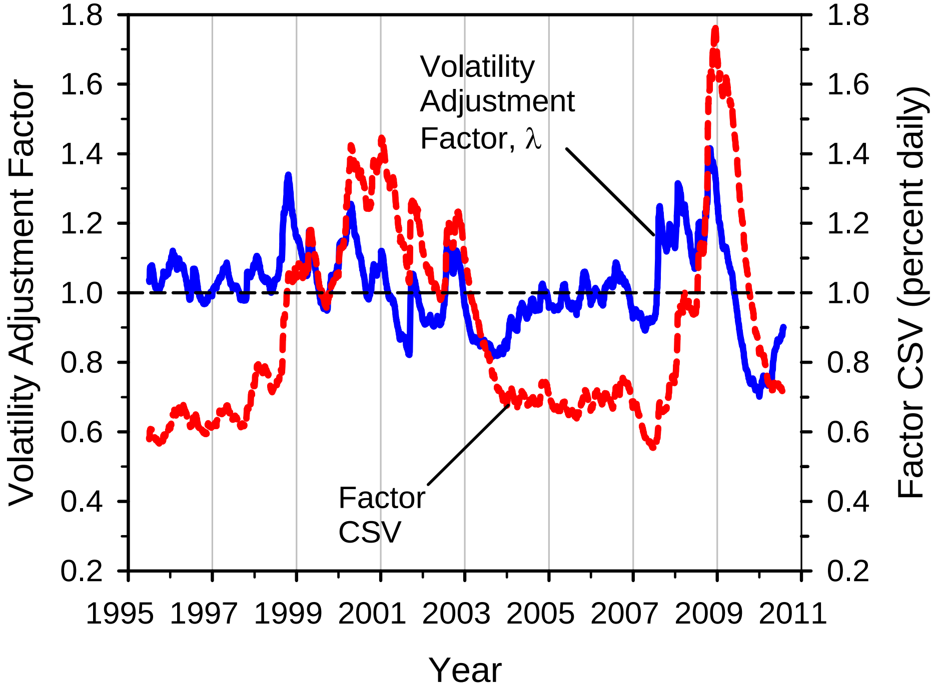
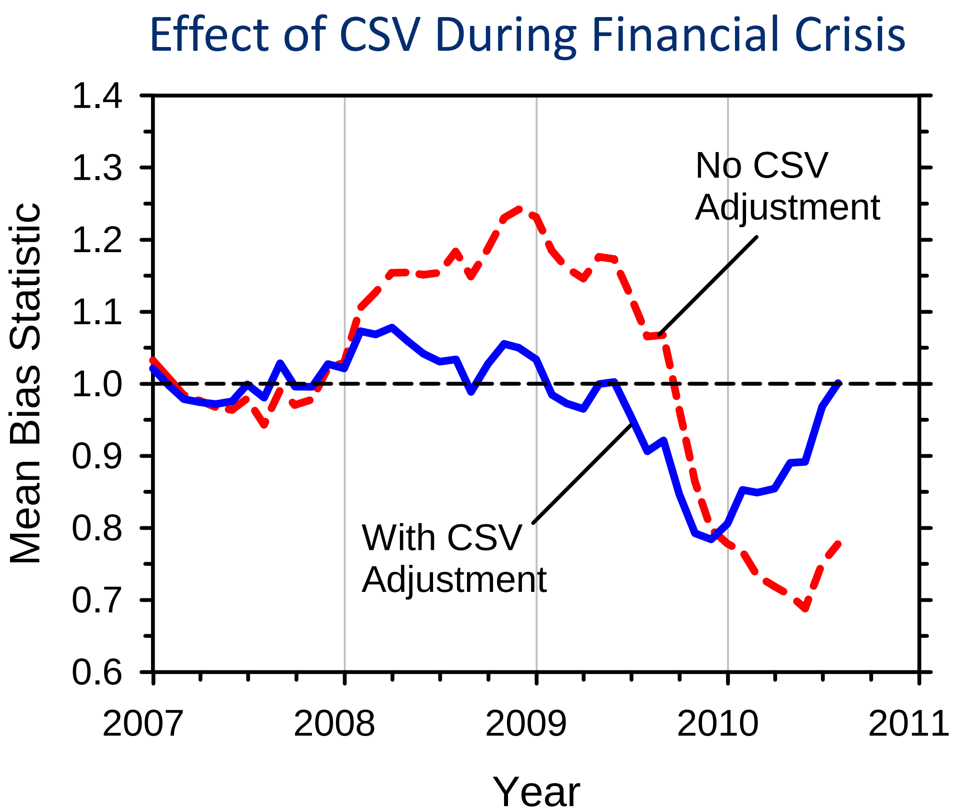
CSV Adjustments to Factor Covariance Matrix (FCM)

- Construct factor covariance matrix using “standard” time-series techniques (e.g., EWMA with serial correlation adjustments)
- Use cross-sectional observations to calibrate factor volatilities to current levels



- CSV provides an “instantaneous” estimate of factor volatility levels
- During stable periods, CSV adjustments are very small
- Adjustments are rapid and intuitive following market shocks
- CSV algorithm helps “when needed most”

MRAD Improvement with CSV Calibration (USE4 Factors)



- CSV estimates were "spot-on" through the financial crisis
- Exiting crisis, CSV method quickly detects reduced volatility levels
- Conventional approach underpredicts during crisis, and overpredicts after crisis

Entire Sample Period

Method	MRAD	Excess MRAD
No CSV	0.2213	513 bps
With CSV	0.2062	362 bps

CSV reduces MRAD by 150 bps over 15-year sample period (6/95 to 7/10); and by 500 bps since January 2008

Eigenfactor Methodology

Risk Forecasts of Optimized Portfolios

- Risk models tend to underpredict the risk of optimized portfolios (1)
- Analytic result for the bias (2):

$$\sigma_{true} \approx \frac{\sigma_{est}}{1-\left(K/T^{*}\right)}$$

K = Number of factors

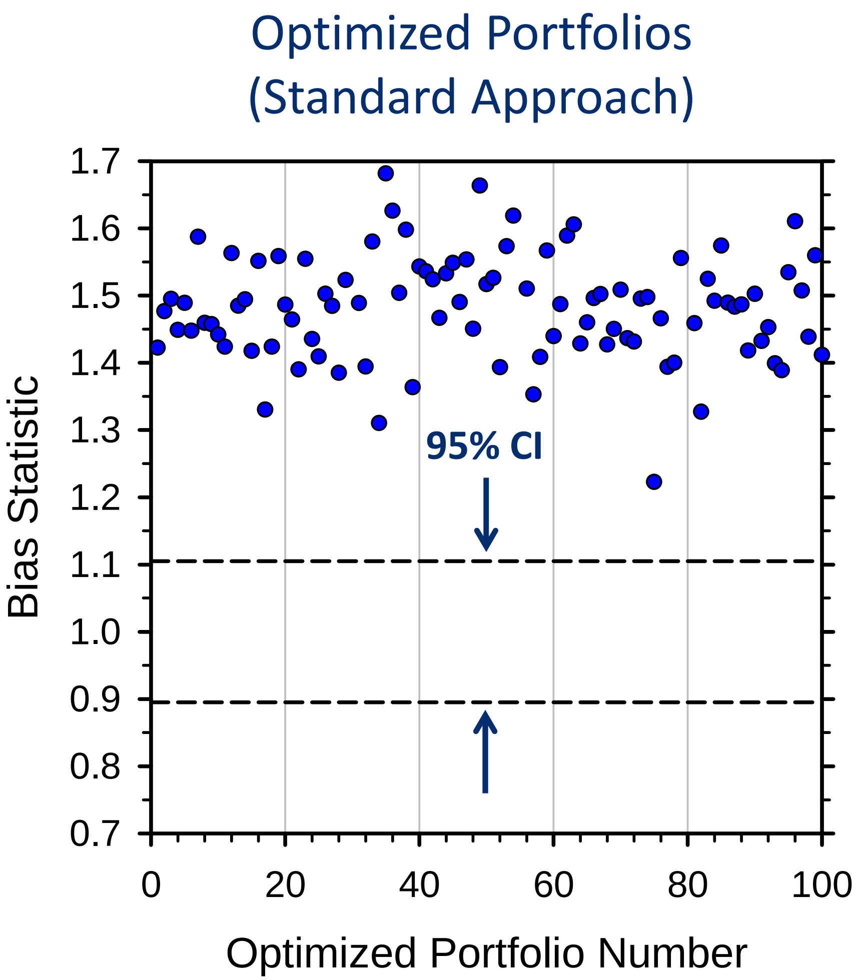
T^{*} = Effective number of observations

- Eliminating these biases by simple scaling of FCM introduces other biases and does not lead to improved portfolios
- Can we construct FCM that does not produce biased forecasts for optimized portfolios?
- If so, what is the effect of such adjustments on the quality of risk forecasts for both optimized and “standard” portfolios?

(1) Peter Muller, “Financial Optimization,” Zenios, Cambridge University Press, 1993

(2) Peter Shepard, “Second Order Risk,” http://arxiv.org/abs/0908.2455v1, August 2009

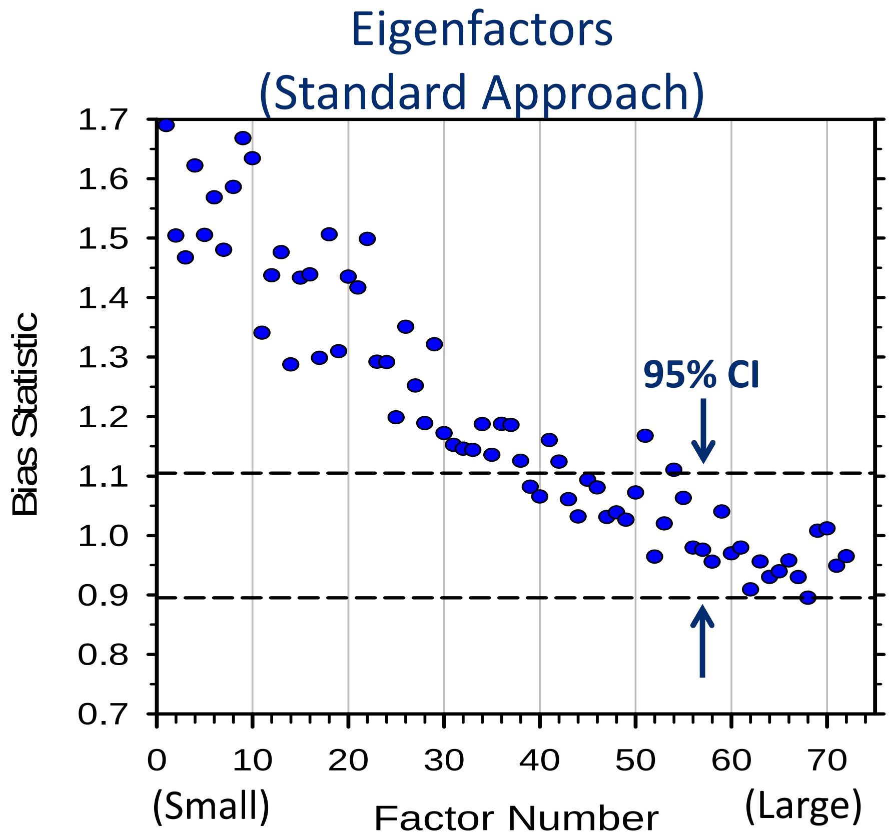
Bias Statistics of Optimized Factor Portfolios



- Compute Bias Stats from July 1997 to July 2010 (181 months)
- Standard approach systematically underpredicts volatilities of optimized portfolios
- Every optimized portfolio falls well outside of 95% confidence interval

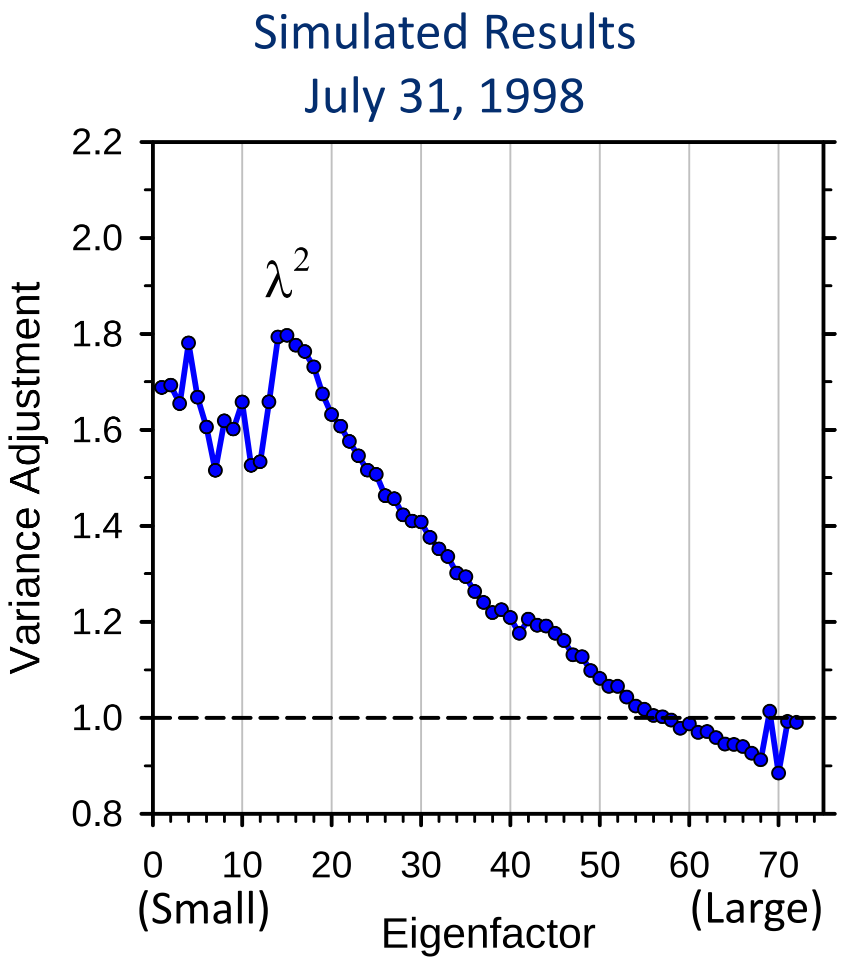
Eigenfactors

- Eigenfactors are uncorrelated *portfolios* of pure factors
- Unlike pure factors, eigenfactors are not economically intuitive
- Eigenfactors play an important role in portfolio optimization



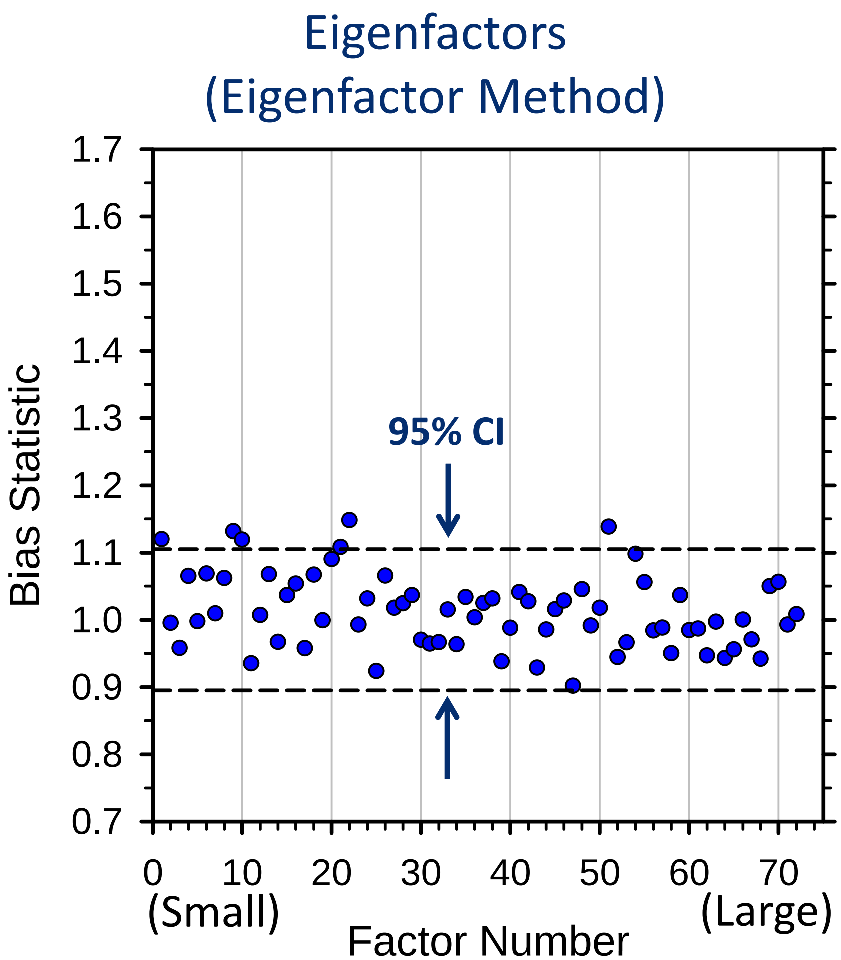
- Compute Bias Stats from July 1995 to July 2010 (181 months)
- We find large systematic bias for small eigenfactor portfolios
- Small eigenfactors fall well outside of 95% confidence interval

Eigenfactor Volatility Adjustment Function



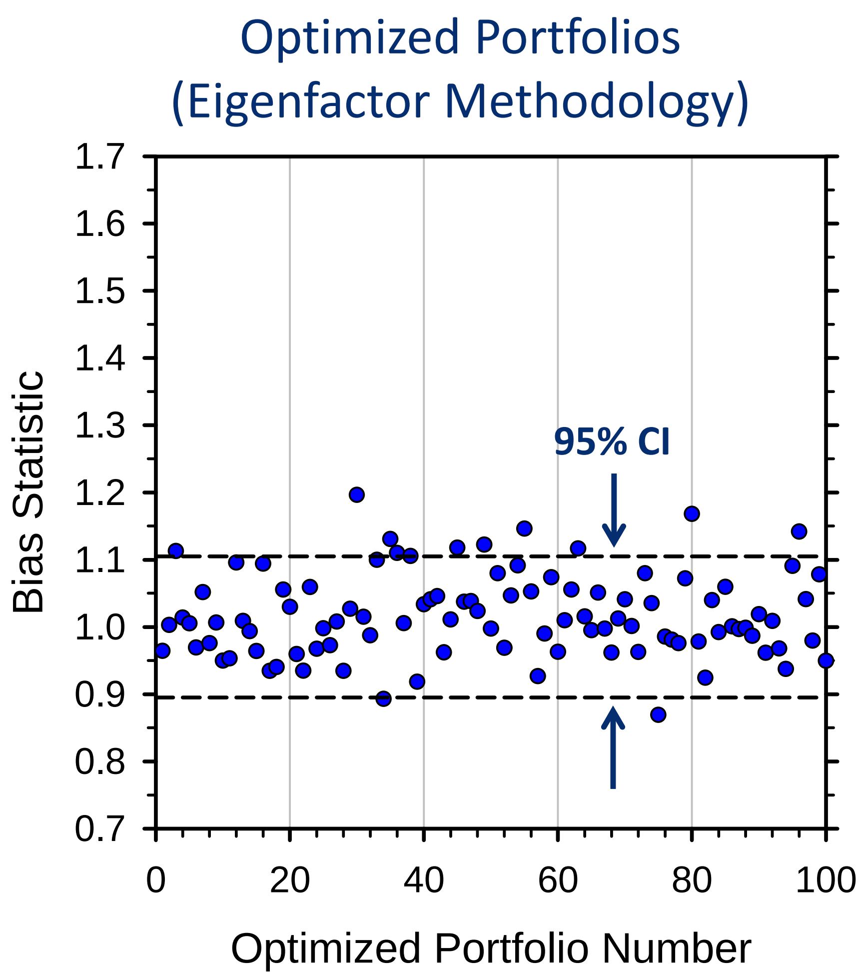
- Simulated results explain most of the observed bias in optimized portfolios
- Shape of curve is very robust across time
- Simulated results assume normally distributed returns
- Empirical factor returns have fat-tailed distributions
- Minor additional scaling is required to completely eliminate eigenfactor biases

Bias Statistics after Eigenfactor Adjustment



- Compute Bias Stats from July 1995 to July 2010 (181 months)
- Biases of eigenfactors have been eliminated across the spectrum

Bias Statistics of Optimized Portfolios (Eigenfactor Method)



- Compute Bias Stats from July 1995 to July 2010 (181 months)
- Biases of optimized portfolios have been eliminated

Performance of Models

- Compute Bias Stats from July 1995 to July 2010 (181 months)
- Consider the following test portfolios:
  a) 72 pure factors and 72 eigenfactors
  b) 100 random factors (dollar neutral)
  c) 100 optimized factor portfolios (minimum risk with α=1)

Portfolio Type	(Standard Approach)		(Eigenfactor Approach)	
	Bias Stat	MRAD	Bias Stat	MRAD
Pure Factors	1.0510	0.2213	0.9785	0.2174
Eigenfactors	1.2012	0.2916	1.0129	0.1956
Random Factors	1.0051	0.1978	0.9998	0.1980
Optimized Factors	1.4894	0.4425	1.0173	0.2055

- Eigenfactor method outperforms for all portfolio types
- Biases of optimized portfolios have been eliminated

Summary

- New USE4 model incorporates latest advances risk model methodology
- Country factor cleanly disentangles market effect from industry effect
- Country factor provides more responsive estimates of industry/industry correlations
- Cross-sectional volatility technique quickly adapts to new risk regimes
- Eigenfactor methodology removes biases from optimized portfolios
- Eigenfactor methodology helps reduce out-of-sample volatilities of optimized portfolios

Appendix

Bias Statistics: Evaluating Accuracy of Risk Forecasts

- Bias statistics give ratio of realized risk to forecast risk

$$b_{nt} = r_{nt} / \sigma_{nt}$$ Standardized Return

$$B_n = \sqrt{\frac{1}{T-1} \sum_{t=1}^{T} (b_{nt} - \bar{b}_n)^2}$$ Bias Statistic

- For perfect risk forecasts and normally distributed returns, about 95 percent of observations will fall inside the confidence interval

$$B_n \in \left[1 - \sqrt{2/T}, 1 + \sqrt{2/T} \right]$$ Confidence Interval

- For rolling 12-month windows, the mean absolute deviation $|B_n - 1|$ (MRAD) is approximately 0.17 (for perfect forecasts and normality)

USE4 Specific Risk Models

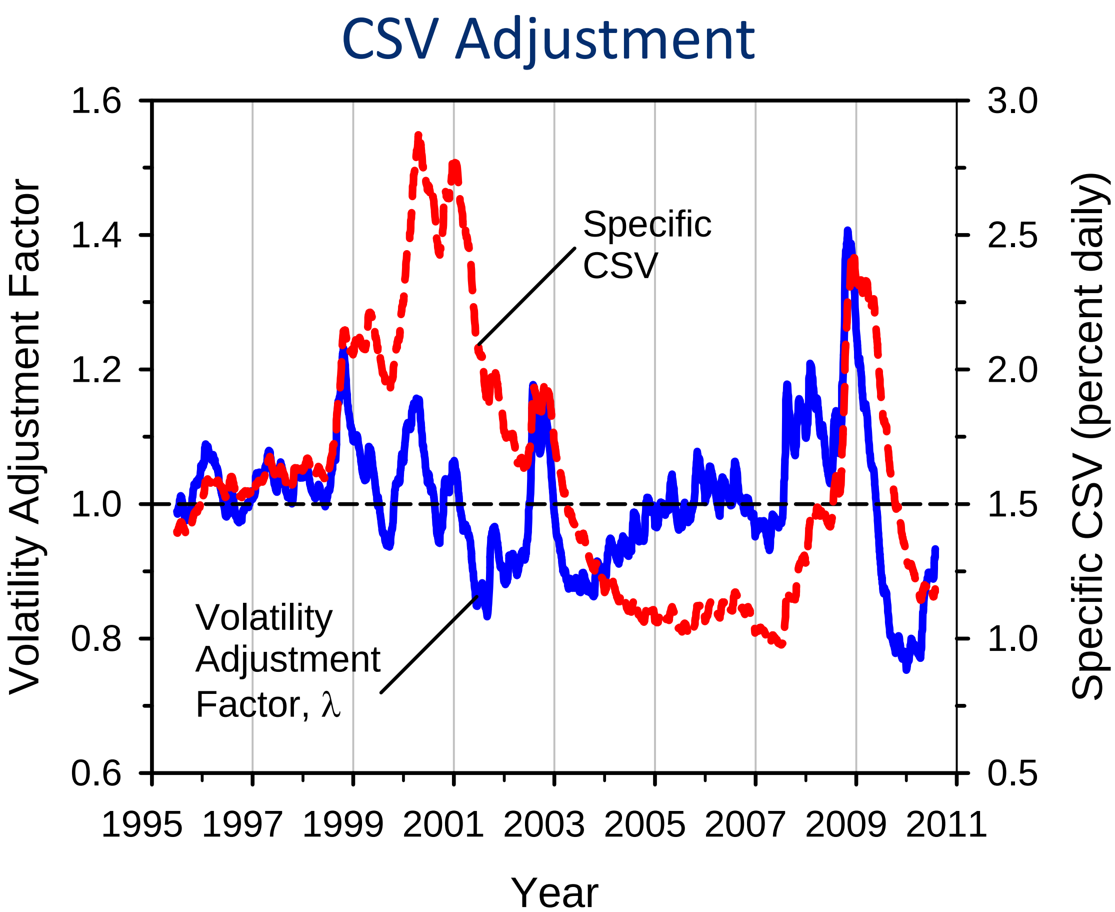
- Use asset-level model to directly estimate specific risk
  - Use daily observations to obtain responsiveness
  - Compute specific risk directly from asset level specific returns
  - Include adjustments for serial correlation effects
- Use cross-sectional observations to increase responsiveness and reduce sampling error
- Apply volatility adjustment factor based on daily cross-sectional data

$$\tilde{\sigma}_n = \lambda_S \sigma_n$$ USE4 Specific Risk Forecast

λ_S Volatility adjustment factor; based on cross-sectional data

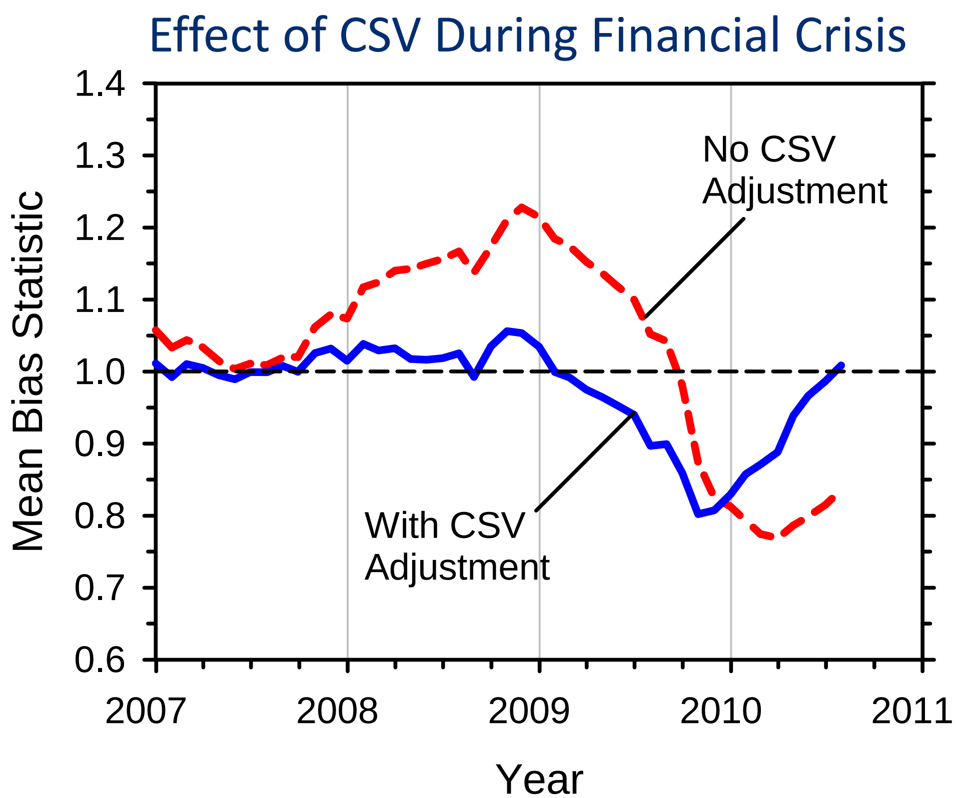
σ_n Asset level specific risk

Cross-Sectional Volatility (CSV) of Specific Returns



- Specific CSV peaked in 2000 following the internet bubble
- Specific CSV fell to roughly 100 bps/day from 2005-2007
- Volatility adjustment factor drops from 1.4 to 0.8 in 2009

Bias Stats with and without Specific CSV



- CSV estimates were "spot-on" through the financial crisis
- Exiting crisis, CSV method quickly detects reduced volatility levels
- Without CSV, Bias Stat has classic signature of under/over-prediction

Entire Sample Period

Method	MRAD	Excess MRAD
No CSV	0.2177	477 bps
With CSV	0.2118	418 bps

CSV reduces MRAD by 60 bps over 15-year sample period (6/95 to 7/10); and by 285 bps since January 2008

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