Chapter 25

Capturing Equity Risk Premia*

Security Analysis, Portfolio Management, and Financial Derivatives

By
Cheng Few Lee
Joseph Finnerty
John Lee
Alice C Lee
Donald Wort

* This chapter was written by Jose Menchero (MSCI barra), Andrei Morozov (MSCI Inc.) and John Guerard (McKinley Capital Management).

Outline

- 25.1 GLOBAL EQUITY RISK MODEL
  - 25.1.1 Estimation Universe
  - 25.1.2 GEM2 Factor Structure
- 25.2 FACTOR PORTFOLIOS
  - 25.2.1 Simple Factor Portfolios
  - 25.2.2 Pure Factor Portfolios
  - 25.2.3 Optimized Factor Portfolios
- 25.3 RESULTS
  - 25.3.1 Cumulative Factor Returns
  - 25.3.2 Summary Statistics
- 25.4 LEADING ECONOMIC INDICATORS AND BARRA FACTOR RETURNS
- 25.5 SUMMARY

25.1 GLOBAL EQUITY RISK MODEL

25.1.1 Estimation Universe

- The estimation universe is the set of stocks that is used to estimate the model. Judicious selection of the estimation universe is a critical component to building a sound risk model. The estimation universe must be sufficiently broad to accurately represent the investment opportunity set of global investors, without being so broad as to include illiquid stocks that may introduce spurious return relationships into the model. Furthermore, the estimation universe should be reasonably stable to ensure that factor exposures are well behaved across time. *Representation, liquidity,* and *stability*, therefore, represent the three primary goals that must be attained when selecting a risk model estimation universe.

- A well-constructed equity index must address and overcome these very issues, and therefore serves as an excellent foundation for the estimation universe. The GEM2 estimation universe utilizes the MSCI *All Country World Investable Market Index* (ACWI IMI), part of the MSCI Global Investable Market Indices family, which represents the latest in MSCI index-construction methodology. MSCI ACWI IMI aims to reflect the full breadth of global investment opportunities by targeting 99% of the float-adjusted market capitalization in both developed and emerging markets. The index-construction methodology applies innovative rules designed to achieve index stability, while reflecting the evolving equity markets in a timely fashion. Moreover, liquidity screening rules are applied to ensure that only investable stocks with reliable pricing are included for index membership.

25.1 GLOBAL EQUITY RISK MODEL

25.1.2 GEM2 Factor Structure

- The equity factor set in GEM2 includes a World factor (w), countries (c), industries (i), and styles (s). Every stock is assigned an exposure of 1 to the World factor. Hence, the local excess returns (i.e., currency hedged) can be written as

$$r_n = f_w + \sum_c X_{nc} f_c + \sum_i X_{ni} f_i + \sum_s X_{ns} f_s + u_n \quad (25.1)$$

- where X_{nk} is the exposure of stock n to factor k, f_k is the return of the factor, and U_n is the specific return of the stock. Mathematically, the World factor represents the intercept term in the cross-sectional regression. Economically, it describes the aggregate up-and-down movement of the global equity market. Typically, the World factor is the dominant source of risk for a diversified long-only portfolio.

25.1GLOBAL EQUITY RISK MODEL

25.1.2 GEM2 Factor Structure

- **Table 25-1** GEM2 Country Factors

- Average weights (based on total capitalization) are from January 1997 to January 2008. Market capitalizations are reported in trillions of US dollars.

Country Name	Average Weight	Jan-08 Weight	Jan-08 # Stocks	Jan-08 Float-Cap	Jan-08 Total-Cap
Argentina	0.10	0.09	13	0.02	0.04
Australia	1.62	2.48	236	1.05	1.20
Austria	0.17	0.37	35	0.09	0.18
Belgium	0.64	0.69	47	0.20	0.33
Brazil	0.65	1.87	140	0.53	0.90
Canada	2.59	3.44	297	1.37	1.66
Chile	0.18	0.26	34	0.05	0.13
China International	0.67	2.96	215	0.64	1.43
Colombia	0.03	0.07	11	0.01	0.03
Czech Republic	0.06	0.15	8	0.03	0.07
Denmark	0.39	0.46	57	0.15	0.22
Egypt	0.05	0.17	31	0.03	0.08
Finland	0.59	0.69	52	0.28	0.33
France	4.18	5.24	184	1.61	2.53
Germany	3.31	3.71	184	1.43	1.79
Greece	0.28	0.48	62	0.14	0.23
Hong Kong	1.07	1.50	165	0.40	0.72
Hungary	0.06	0.09	8	0.03	0.04
India	0.54	2.41	251	0.38	1.16
Indonesia	0.13	0.34	54	0.07	0.16
Ireland	0.26	0.27	30	0.11	0.13
Israel	0.20	0.32	69	0.09	0.15
Italy	2.05	2.09	161	0.63	1.01
Japan	11.52	8.96	1160	3.20	4.32
Jordan	0.03	0.05	17	0.00	0.02
Korea	1.02	2.06	332	0.60	0.99
Malaysia	0.43	0.53	119	0.11	0.26
Mexico	0.43	0.59	40	0.17	0.29
Morocco	0.03	0.09	10	0.01	0.05
Netherland	1.47	1.34	70	0.45	0.65
New Zealand	0.09	0.07	22	0.02	0.03
Norway	0.34	0.71	68	0.19	0.34
Pakistan	0.03	0.06	24	0.01	0.03
Peru	0.04	0.11	16	0.03	0.05
Philippines	0.06	0.14	27	0.02	0.07
Poland	0.11	0.33	66	0.07	0.16
Portugal	0.20	0.24	21	0.06	0.12
Russia	0.49	2.83	71	0.31	1.36
Singapore	0.48	0.72	104	0.19	0.35
South Africa	0.63	0.86	116	0.29	0.42
Spain	1.41	2.11	88	0.66	1.02
Sweden	1.05	1.05	105	0.39	0.51
Switzerland	2.54	2.41	118	1.02	1.16
Taiwan	1.25	1.34	411	0.44	0.65
Thailand	0.19	0.36	66	0.06	0.17
Turkey	0.18	0.45	68	0.07	0.21
UK	8.65	7.65	463	3.46	3.69
US	47.53	34.80	2468	15.74	16.79
Total	100.00	100.00	8414	36.92	48.27

25.1GLOBAL EQUITY RISK MODEL

25.1.2 GEM2 Factor Structure

Table 25-2 GEM2 Industry Factors

GICS Sector	GEM2 Code	GEM2 Industry Factor Name	Average Weight	Jan-08 Weight
Energy	1	Energy Equipment & Services	0.75	1.29
	2	Oil, Gas & Consumable Fuels	4.88	9.32
	3	Oil & Gas Exploration & Production	1.00	1.72
Materials	4	Chemicals	2.36	2.84
	5	Construction, Containers, Paper	1.38	1.24
	6	Aluminum, Diversified Metals	1.05	2.41
	7	Gold, Precious Metals	0.37	0.58
	8	Steel	0.79	1.83
Industrials	9	Capital Goods	7.33	8.60
	10	Commercial & Professional Services	1.43	0.77
	11	Transportation Non-Airline	1.82	2.32
	12	Airlines	0.37	0.45
Consumer Discretionary	13	Automobiles & Components	2.52	2.29
	14	Consumer Durables & Apparel	2.33	1.93
	15	Consumer Services	1.35	1.39
	16	Media	3.24	2.11
	17	Retailing	3.42	2.08
Consumer Staples	18	Food & Staples Retailing	1.82	1.76
	19	Food, Beverage & Tobacco	4.56	4.37
	20	Household & Personal Products	1.43	1.20
Health Care	21	Health Care Equipment & Services	2.13	1.93
	22	Biotechnology	0.78	0.68
	23	Pharmaceuticals, Life Sciences	6.17	3.82
Financials	24	Banks	10.52	10.83
	25	Diversified Financials	5.63	5.06
	26	Insurance	4.61	4.14
	27	Real Estate	2.08	3.07
Information Technology	28	Internet Software & Services	0.62	0.74
	29	IT Services, Software	3.24	2.56
	30	Communications Equipment	2.46	1.41
	31	Computers, Electronics	3.69	2.81
	32	Semiconductors	2.47	1.52
Telecom	33	Telecommunication Services	7.11	5.84
Utilities	34	Utilities	4.31	5.08

Weights are computed within the GEM2 estimation universe using total market capitalization. Average weights are computed from January 1997 to January 2008.

25.1 GLOBAL EQUITY RISK MODEL

25.1.2 GEM2 Factor Structure

- Unlike country and industry factors, which are assigned exposures of either 0 or 1, style factor exposures are continuously distributed. To facilitate comparison across style factors, they are standardized to have a mean of 0 and a standard deviation of 1. Each descriptor is also standardized similarly. That is, if d_{nl}^{Raw} is the raw value of stock n for descriptor l, then the standardized descriptor value is given by

$$d_{nl} = \frac{d_{nl}^{\text{Raw}} - \mu_l}{\sigma_l} \tag{25.2}$$

- where μ_l is the cap-weighted mean of the descriptor (within the estimation universe), and σ_l is the equal-weighted standard deviation. the convention of standardizing using the cap-weighted mean so that a well-diversified cap-weighted global portfolio, such as MSCI ACWI IMI, has approximately zero exposure to all style factors is adopted. For the standard deviation, however, the equal-weighted mean to prevent large-cap stocks from having an undue influence on the overall scale of the exposures is used.

25.1 GLOBAL EQUITY RISK MODEL

25.1.2 GEM2 Factor Structure

- Formally, descriptors are combined into style factors as follows:

$$X_{nk} = \sum_{l \in k} w_l \, d_{nl} \qquad (25.3)$$

- where w_l is the descriptor weight, and the sum takes place over all descriptors within a particular risk index. Descriptor weights are determined using an optimization algorithm to maximize the explanatory power of the model. Style factor exposures are rescaled to have a standard deviation of 1.

- Some of the style factors are standardized on a *global-relative* basis, others on a *country-relative* basis. In the former case, the mean and standard deviation in Equation 25.2 are computed using the entire global cross section. In the latter case, the factors have mean 0 and standard deviation 1 within each country. When deciding which standardization convention to adopt, both the intuitive meaning of the factor and its explanatory power are considered.

25.1GLOBAL EQUITY RISK MODEL

25.1.2 GEM2 Factor Structure

Table 25-3
Regression-Weighted Cross-sectional Correlation of Style and Industry Factor Exposures

Results are averages over the period from January 1997 to June 2008. Correlations above 0.10 in absolute value are shaded in gray.

Factor	Volatility	Momentum	Size	Value	Growth	NL Size	Liquidity	Leverage
Volatility	1.00	-0.05	-0.09	-0.25	0.27	-0.06	0.42	-0.07
Momentum	-0.05	1.00	0.12	-0.17	0.08	0.15	0.09	-0.08
Size	-0.09	0.12	1.00	-0.11	-0.05	0.11	0.10	-0.03
Value	-0.25	-0.17	-0.11	1.00	-0.24	-0.03	-0.15	0.22
Growth	0.27	0.08	-0.05	-0.24	1.00	-0.02	0.18	-0.17
Non-linear Size	-0.06	0.15	0.11	-0.03	-0.02	1.00	0.11	0.01
Liquidity	0.42	0.09	0.10	-0.15	0.18	0.11	1.00	-0.03
Leverage	-0.07	-0.08	-0.03	0.22	-0.17	0.01	-0.03	1.00
Energy Equipment & Services	0.06	0.02	-0.03	-0.02	0.06	0.02	0.07	-0.03
Oil, Gas & Consumable Fuels	-0.02	0.02	0.11	0.06	-0.03	-0.04	0.00	-0.01
Oil & Gas Exploration & Production	0.01	0.02	-0.01	0.01	0.00	0.00	0.02	0.01
Chemicals	-0.03	0.00	-0.01	0.04	-0.04	0.03	-0.01	0.00
Construction, Containers, Paper	-0.04	-0.01	-0.02	0.07	-0.06	0.04	-0.04	0.06
Aluminum, Diversified Metals	0.03	0.02	0.02	0.03	0.00	0.01	0.03	0.00
Gold, Precious Metals	0.00	-0.01	0.00	-0.06	0.00	0.00	-0.01	-0.04
Steel	0.04	0.02	-0.01	0.09	-0.02	0.01	0.03	0.03
Capital Goods	0.01	0.01	-0.07	0.04	-0.02	0.01	0.00	-0.01
Commercial & Professional Services	0.01	0.00	-0.09	-0.05	0.06	-0.01	-0.02	-0.03
Transportation Non-Airline	-0.06	0.01	0.00	0.02	-0.02	0.02	-0.04	0.08
Airlines	0.02	-0.02	0.01	0.02	-0.01	0.02	0.02	0.08
Automobiles & Components	0.01	0.00	0.01	0.10	-0.02	0.00	-0.01	0.00
Consumer Durables & Apparel	0.01	-0.01	-0.07	0.05	0.00	0.00	0.03	-0.06
Consumer Services	-0.02	0.00	-0.06	-0.03	0.04	0.02	0.01	0.02
Media	-0.01	-0.03	0.01	-0.12	0.02	0.02	-0.03	0.00
Retailing	0.03	0.01	-0.05	-0.01	0.05	0.01	0.04	-0.06
Food & Staples Retailing	-0.07	-0.01	0.02	-0.02	0.00	0.01	-0.03	-0.01
Food, Beverage & Tobacco	-0.14	0.00	0.02	-0.01	-0.05	0.02	-0.07	-0.01
Household & Personal Products	-0.05	0.00	0.03	-0.04	-0.02	-0.01	-0.03	-0.03
Health Care Equipment & Services	-0.02	0.02	-0.06	-0.08	0.09	0.01	0.04	-0.05
Biotechnology	0.09	0.00	-0.05	-0.17	0.07	-0.03	0.07	-0.05
Pharmaceuticals, Life Sciences	-0.04	0.00	0.06	-0.10	0.02	-0.04	0.00	-0.10
Banks	-0.08	0.00	0.12	0.12	-0.09	-0.05	-0.10	0.10
Diversified Financials	0.05	0.00	0.02	0.04	0.01	0.01	-0.03	0.04
Insurance	-0.06	0.00	0.04	0.11	-0.05	0.03	-0.06	-0.10
Real Estate	-0.13	0.02	-0.09	0.07	-0.08	0.03	-0.07	0.17
Internet Software & Services	0.15	-0.02	-0.04	-0.12	0.12	-0.03	0.07	-0.06
IT Services, Software	0.15	-0.01	-0.06	-0.14	0.12	-0.02	0.09	-0.12
Communications Equipment	0.16	-0.02	-0.01	-0.09	0.06	-0.03	0.08	-0.07
Computers, Electronics	0.11	-0.02	-0.02	-0.05	0.04	-0.03	0.09	-0.09
Semiconductors	0.21	-0.02	0.00	-0.10	0.09	-0.02	0.16	-0.08
Telecommunication Services	0.04	-0.02	0.15	-0.07	0.01	-0.07	0.01	0.05
Utilities	-0.17	0.01	0.06	0.11	-0.13	0.04	-0.07	0.20

25.1 GLOBAL EQUITY RISK MODEL

25.1.2 GEM2 Factor Structure

- GEM2 uses eight style factors. Specific details on the individual descriptors comprising each style factor can be found in Menchero *et al.* (2010). Below, a qualitative description of each of the style factors are provided:

(1) The *Volatility* factor is typically the most significant style factor. In essence, it captures market risk that cannot be explained by the World factor. The most important descriptor within the Volatility index is historical beta relative to the World portfolio (as proxied by the estimation universe). To better understand this factor, consider a fully invested long-only portfolio that is strongly tilted toward high-beta stocks. Intuitively, this portfolio has greater market risk than a portfolio with beta equal to one. This additional market risk is captured through positive exposure to the Volatility factor. Note that the time-series correlation between the World factor and the Volatility factor is typically very high, so that these two sources of risk add coherently in this example. If, by contrast, the portfolio is invested in low-beta stocks, then the risk from the Volatility and the World factors is partially canceled, as intuitively expected. The Volatility factor on a global-relative basis is standardized. As a result, the mean exposure to Volatility within a country can deviate significantly from zero. This standardization convention is a natural one for a global model, as most investors regard stocks in highly volatile markets as having more exposure to the factor than those in low-volatility markets. This view is reflected in the data, as it is found that the explanatory power of the factor is

25.1 GLOBAL EQUITY RISK MODEL

25.1.2 GEM2 Factor Structure

(2) The *Momentum* factor often ranks second in significance after Volatility. Momentum differentiates stocks based on recent relative performance. Descriptors within Momentum include historical alpha from a 104-week regression and relative strength (over trailing 6 and 12 months) with a one-month lag. As with Volatility, Momentum is standardized on a global-relative basis. This is also an intuitive convention for a global model. From the perspective of a global investor, a stock that strongly outperforms the World portfolio is likely to be considered a positive momentum stock, even if it slightly underperforms its country peers. The empirical results support this view, as the Momentum factor standardized globally has greater explanatory power than one standardized on a country-relative basis.

(3) The *Size* factor represents another well-known source of return covariance. It captures the effect of large-cap stocks moving differently from small-cap stocks. Size is measured by a single descriptor: log of market capitalization. The explanatory power of the model is quite similar whether Size is standardized globally or on a country-by-country basis. The country-relative standardization is adopted, however, since it is more intuitive and consistent with investors' perception of the markets. For instance, major global equity indices, such as the MSCI Global Investable Market Indices, segment each country according to size, with the largest stocks inside each country always being classified as large-cap stocks. Moreover, standardizing the Size factor on a global-relative basis would

25.1 GLOBAL EQUITY RISK MODEL

25.1.2 GEM2 Factor Structure

(4) The *Value* factor describes a major investment style which seeks to identify stocks that are priced low relative to fundamentals. Value is standardized on a country-relative basis. This again is consistent with the way major indices segment each market, with each country divided roughly equally into value and growth subindices. This convention also circumvents the difficulty of comparing fundamental data across countries with different accounting standards. GEM2 utilizes official MSCI data items for Value factor descriptors, as described in the *MSCI Barra Fundamental Data Methodology* handbook (2008).

(5) *Growth* differentiates stocks based on their prospects for sales or earnings growth. It is standardized on a country-relative basis, consistent with the construction of the MSCI Value and Growth Indices. Therefore, each country has approximately half the weight in stocks with positive Growth exposure, and half with negative exposure. The GEM2 Growth descriptors also utilize official MSCI data items, as described in the *MSCI Barra Fundamental Data Methodology* handbook.

25.1.2 GEM2 Factor Structure

(6) The *Nonlinear Size* (NLS) factor captures nonlinearities in the payoff to size exposure across the market-cap spectrum. NLS is based on a single raw descriptor: the cube of the log of market capitalization. Since this raw descriptor is highly collinear with Size, it is orthogonalized to the Size factor. This procedure does not affect the fit of the model, but does mitigate the confounding effects of collinearity, and thus preserves an intuitive meaning for the Size factor. The NLS factor is represented by a portfolio that goes long mid-cap stocks, and shorts large-cap and small-cap stocks.

(7) The *Liquidity* factor describes return patterns to stocks based on relative trading activity. Stocks with high turnover have positive exposure to Liquidity, whereas low-turnover stocks have negative exposure. Liquidity is standardized on a country-relative basis.

(8) *Leverage* captures the return difference between high-leverage and low-leverage stocks. The descriptors within Leverage include market leverage, book leverage, and debt-to-assets ratio. This factor is standardized on a country-relative basis.

25.2 FACTOR PORTFOLIOS

25.2.1 Simple Factor Portfolios

- Simple factor portfolios are formed from a univariate regression of local excess returns,

$$r_n = f_w^s + X_{ns} f_s^s + u_n^s \qquad (25.4)$$

- where the intercept term f_w^s is the return to the simple World factor, f_s^s is the return to the simple style factor, and u_n^s is the residual. The GEM2 model uses square root of market cap for the regression weights. This is appropriate for risk model construction since to a good approximation it minimizes sampling error. In this chapter, however, the objective is to study the performance of long/short investment strategies. For this purpose, it is more appropriate to focus on large-cap stocks which are more easily shorted than relatively illiquid small-cap stocks. Therefore, market-cap weights w_n is used in the regression.

25.2 FACTOR PORTFOLIOS

25.2.1 Simple Factor Portfolios

- As discussed by Menchero (2010), with style factor exposures standardized to be cap-weighted mean 0 and standard deviation 1, the World factor return is given by

$$f_w^s = \sum_n w_n r_n \qquad (25.5)$$

- which is simply the cap-weighted return (currency hedged) of the World portfolio. The simple style factor returns are given by

$$f_s^s = \sum_n \left(w_n X_{ns} \right) r_n \qquad (25.6)$$

- which represents the return of a factor-replicating portfolio that goes long stocks with positive exposure to the factor, and shorts stocks with negative exposure. The weights are also proportional to the market cap, so that the portfolio is dominated by large-cap stocks.

25.2 FACTOR PORTFOLIOS

25.2.2 Pure Factor Portfolios

- Pure factor returns f_k^p are estimated by cross-sectional regression of local excess returns against *all* the factors,

$$r_n = \sum_k X_{nk} f_k^p + u_n^p \qquad (25.7)$$

- The index k runs over the World factor, countries, industries, and styles. Again, although the GEM2 risk model uses square root of market cap for the regression weights, in this study market cap weights for the regression is employed.
- Every stock has unit exposure to the World factor, and exposure of 0 or 1 to countries and industries. As a result, the sum of all country factor exposures X_{nc} equals the World factor exposure, and similarly for industries, i.e.,

$$\sum_c X_{nc} = 1, \quad \text{and} \quad \sum_i X_{ni} = 1 \qquad (25.8)$$

- for all stocks . The GEM2 factor structure, therefore, exhibits exact two-fold collinearity. Constraints must be applied to obtain a unique solution.

25.2 FACTOR PORTFOLIOS

25.2.2 Pure Factor Portfolios

- We adopt constraints as in Heston and Rouwenhorst (1994) that require the cap-weighted country and industry factor returns to sum to zero,

$$\sum_c W_c f_c^p = 0, \quad \text{and} \quad \sum_i W_i f_i^p = 0 \tag{25.9}$$

- where W_c is the cap weight of the estimation universe in country c and W_i is the corresponding weight in industry i. These constraints remove the exact collinearities from the factor exposure matrix, without reducing the explanatory power of the model.
- A more precise interpretation to the factors can be provided now. Consider the cap-weighted world portfolio, with asset weights w_n. The currency-hedged return of this portfolio R_w can be attributed using the GEM2 factors,

$$R_w = f_w^p + \sum_c W_c f_c^p + \sum_i W_i f_i^p + \sum_s X_s^w f_s^p + \sum_n w_n u_n^p \tag{25.10}$$

- The first two sums in Equation (25.10) are equal to zero by virtue of the constraints of Equation (25.9). The third sum is zero since the style factors are standardized to be cap-weighted mean zero for the world portfolio; i.e., $X_s^w = 0$, for all styles s.

25.2 FACTOR PORTFOLIOS

25.2.2 Pure Factor Portfolios

- The final sum in Equation (25.10) is the cap-weighted specific return of the estimation universe, which is equal to zero by virtue of using cap-weights in the regression. Therefore,

$$R_w = f_w^p \qquad (25.11)$$

- which means that the return of the pure World factor is exactly the cap-weighted return of the world portfolio. That is, for this regression setting, the simple and pure World factors are identical.
- The pure style factor returns can be written as

$$f_s^p = \sum_n \Omega_{ns}^p r_n \qquad (25.12)$$

- Where Ω_{ns}^p is the weight of stock *n* in pure factor portfolio *s*. The pure factor portfolio has unit exposure to the particular style, but zero exposure to all other factors. This implies, for example, that the pure style factor portfolio has net zero weight in every industry and every country. For a more extensive discussion of pure factor portfolios, see Menchero (2010).

25.2 FACTOR PORTFOLIOS

25.2.3 Optimized Factor Portfolios

- Simple factor portfolios have unit exposure to the particular factor, and nonzero exposure to other factors. Pure factor portfolios have unit exposure to the particular factor, and zero exposure to all other factors. There is another important factor portfolio to consider. This is given by the minimum risk portfolio with unit exposure to the factor.
- The solution, as shown by Grinold and Kahn (2000), is given by

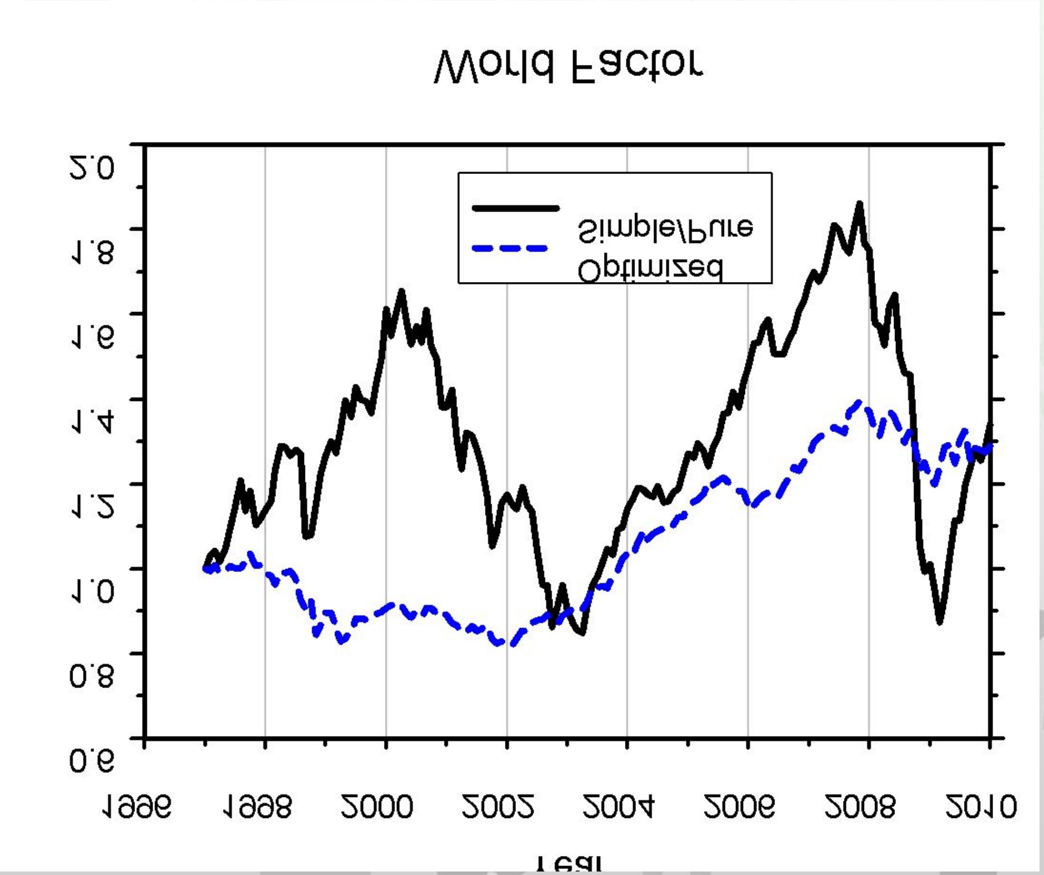
$$\Omega_{ns}^{o} = \left(\sum_{m} V_{mn}^{-1} X_{ms} \right) \left(\sum_{mn} X_{ns} V_{mn}^{-1} X_{ms} \right)^{-1} \quad (25.13)$$

- where V_{mn}^{-1} is the element (between stocks *m* and *n*) of the inverse asset covariance matrix. The intuition behind optimized factor portfolios is straightforward: the portfolio maintains unit exposure to the particular factor but reduces the risk by acquiring exposures to other factors.

25.3 RESULTS

25.3.1 Cumulative Factor Returns

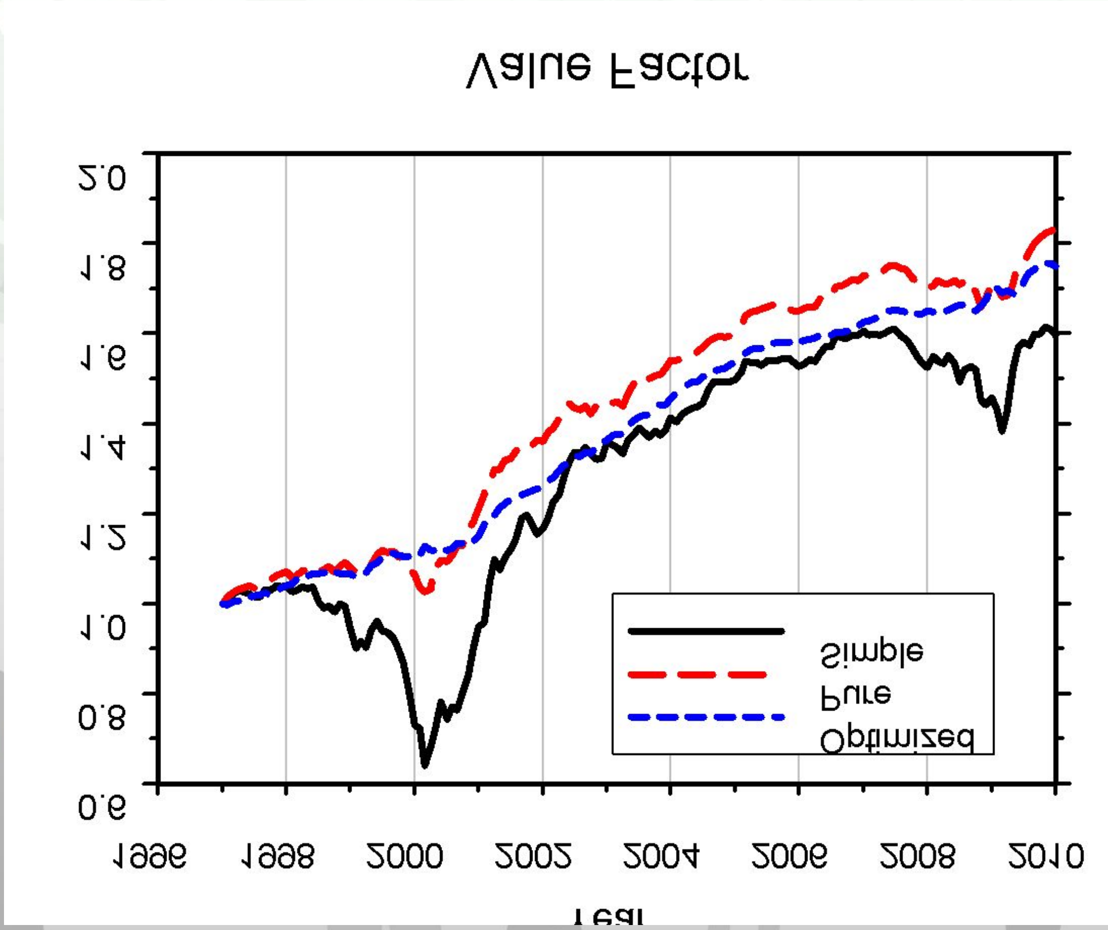
- **Figure 25-1** Cumulative Performance of World Factor



25.3 RESULTS

25.3.1 Cumulative Factor Returns

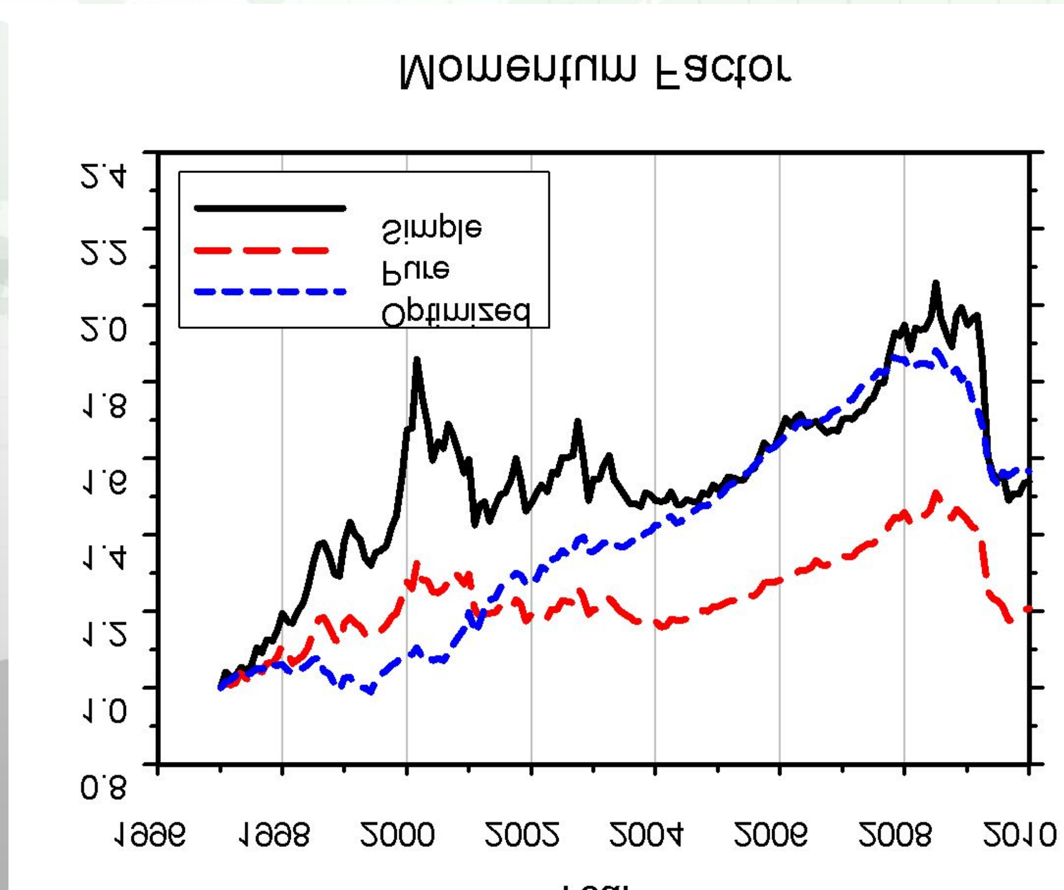
- **Figure 25-2** Cumulative Performance of Value Factor



25.3 RESULTS

25.3.1 Cumulative Factor Returns

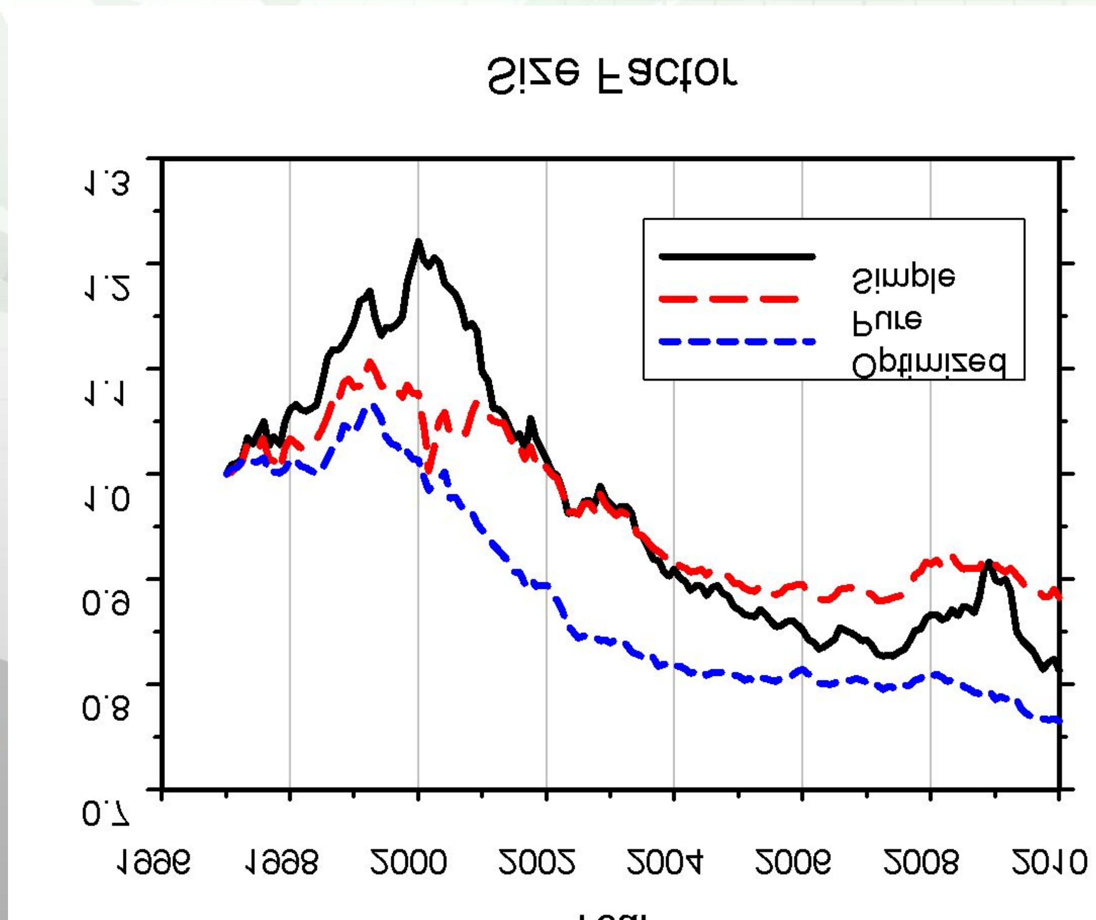
- **Figure 25-3** Cumulative Performance of Momentum Factor



25.3 RESULTS

25.3.1 Cumulative Factor Returns

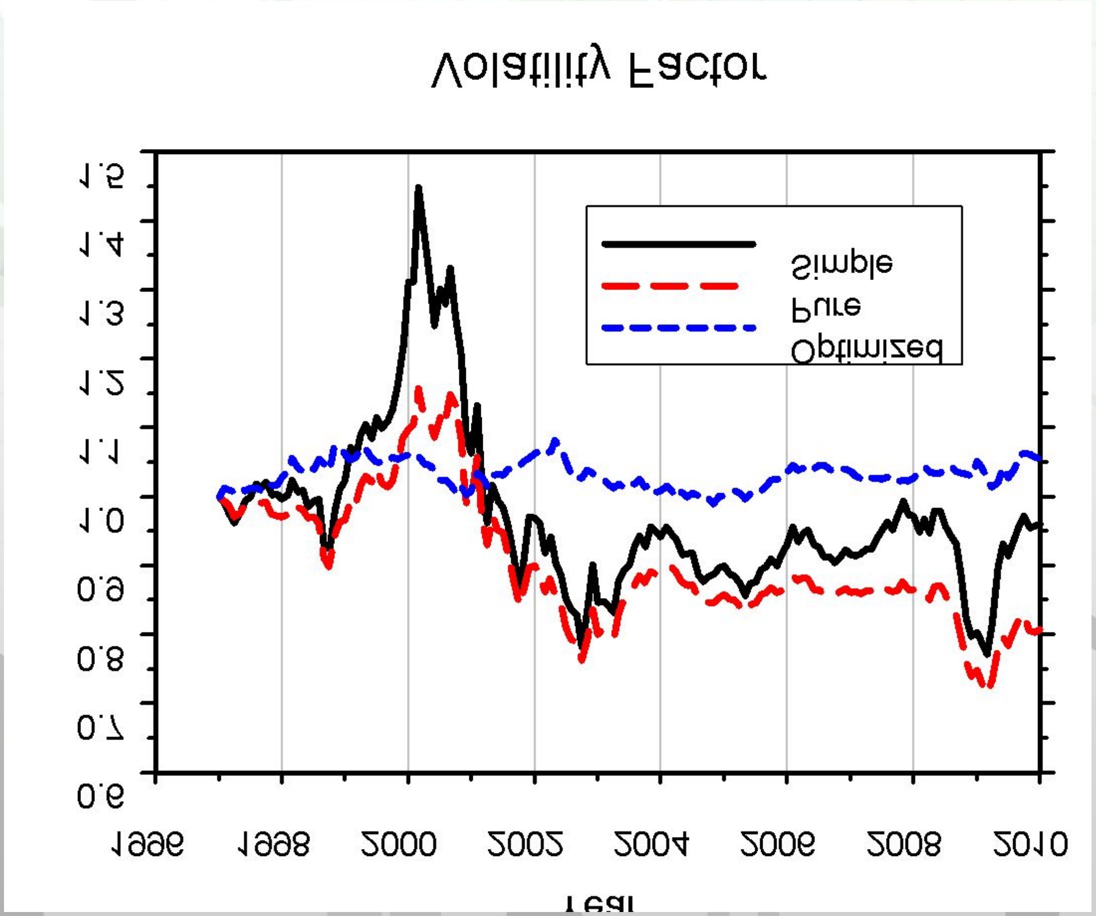
- **Figure 25-4** Cumulative Performance of Size Factor



25.3 RESULTS

25.3.1 Cumulative Factor Returns

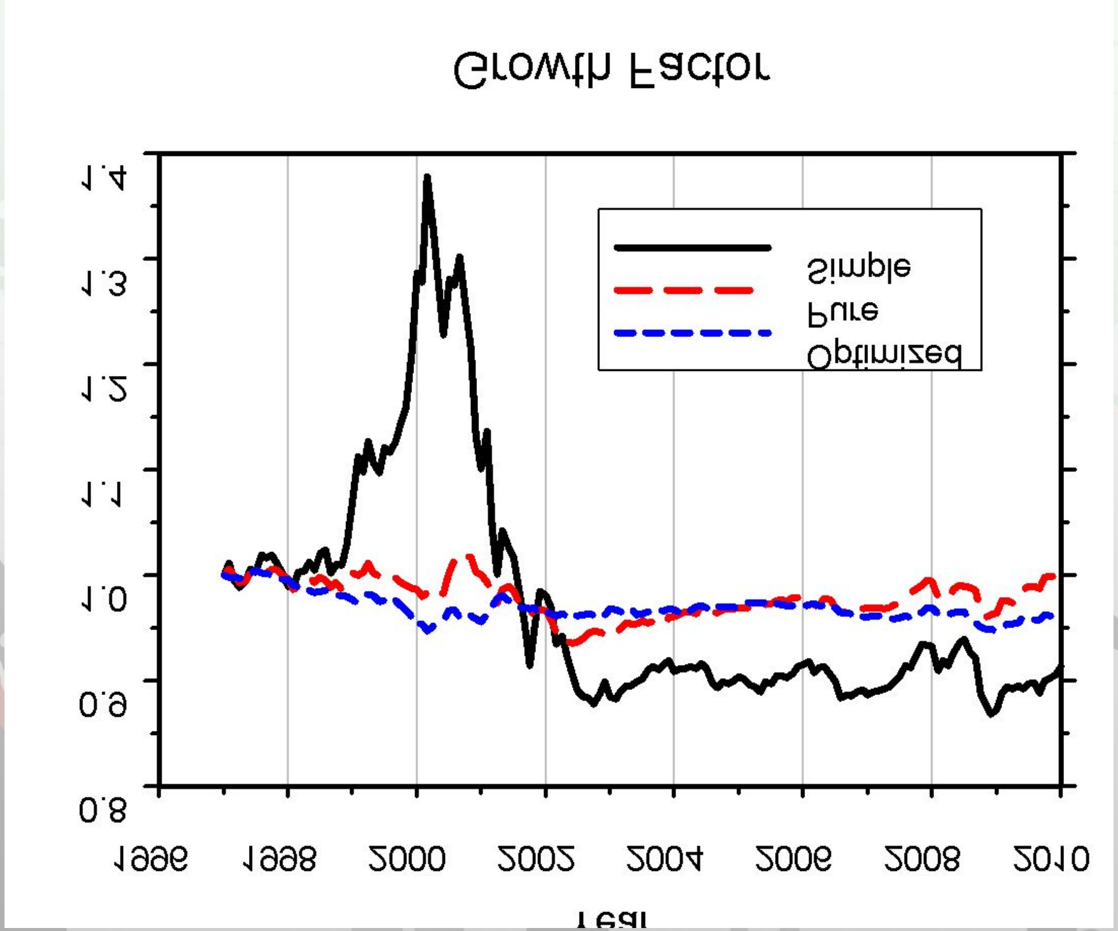
- **Figure 25-5** Cumulative Performance of Volatility Factor



25.3 RESULTS

25.3.1 Cumulative Factor Returns

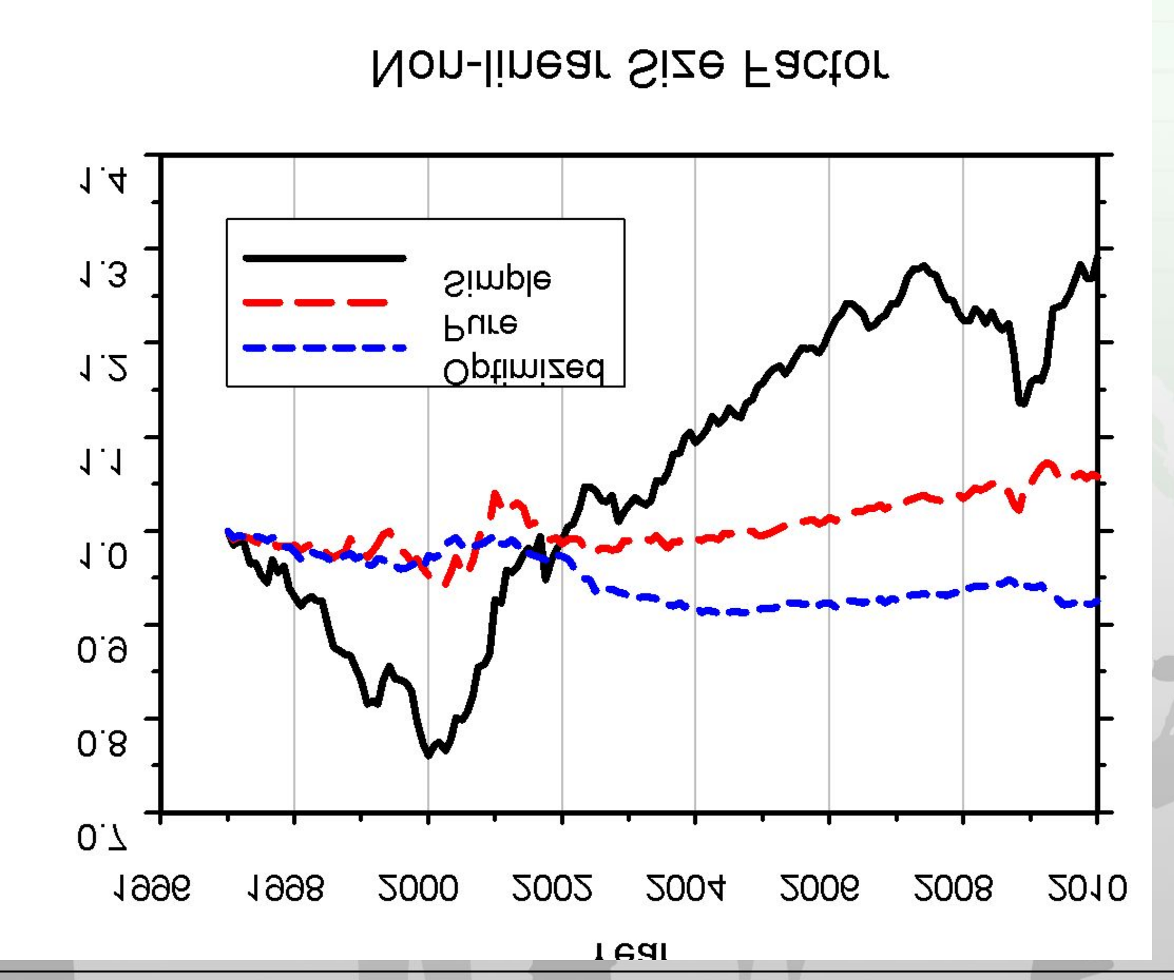
- **Figure 25-6** Cumulative Performance of Growth Factor



25.3 RESULTS

25.3.1 Cumulative Factor Returns

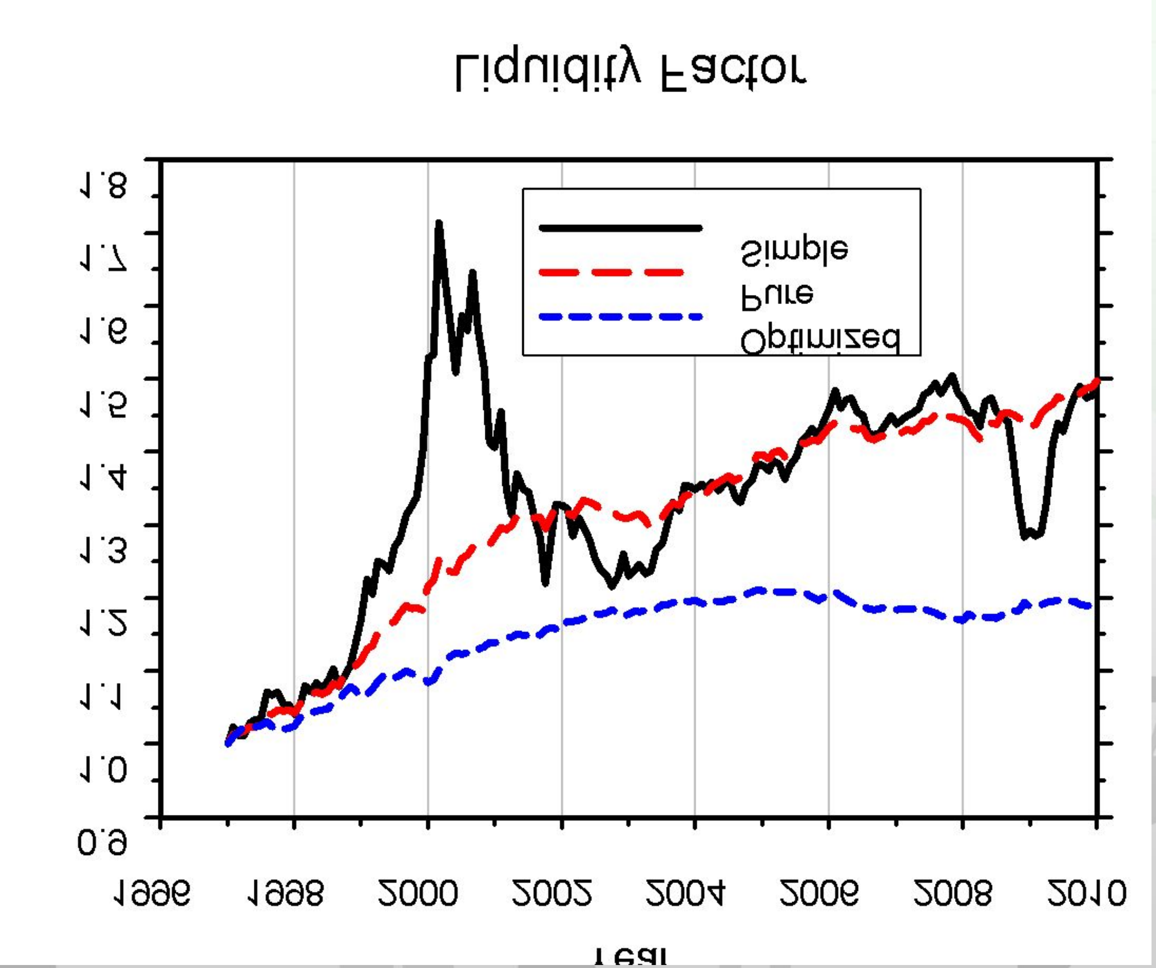
- **Figure 25-7** Cumulative Performance of NLS Factor



25.3 RESULTS

25.3.1 Cumulative Factor Returns

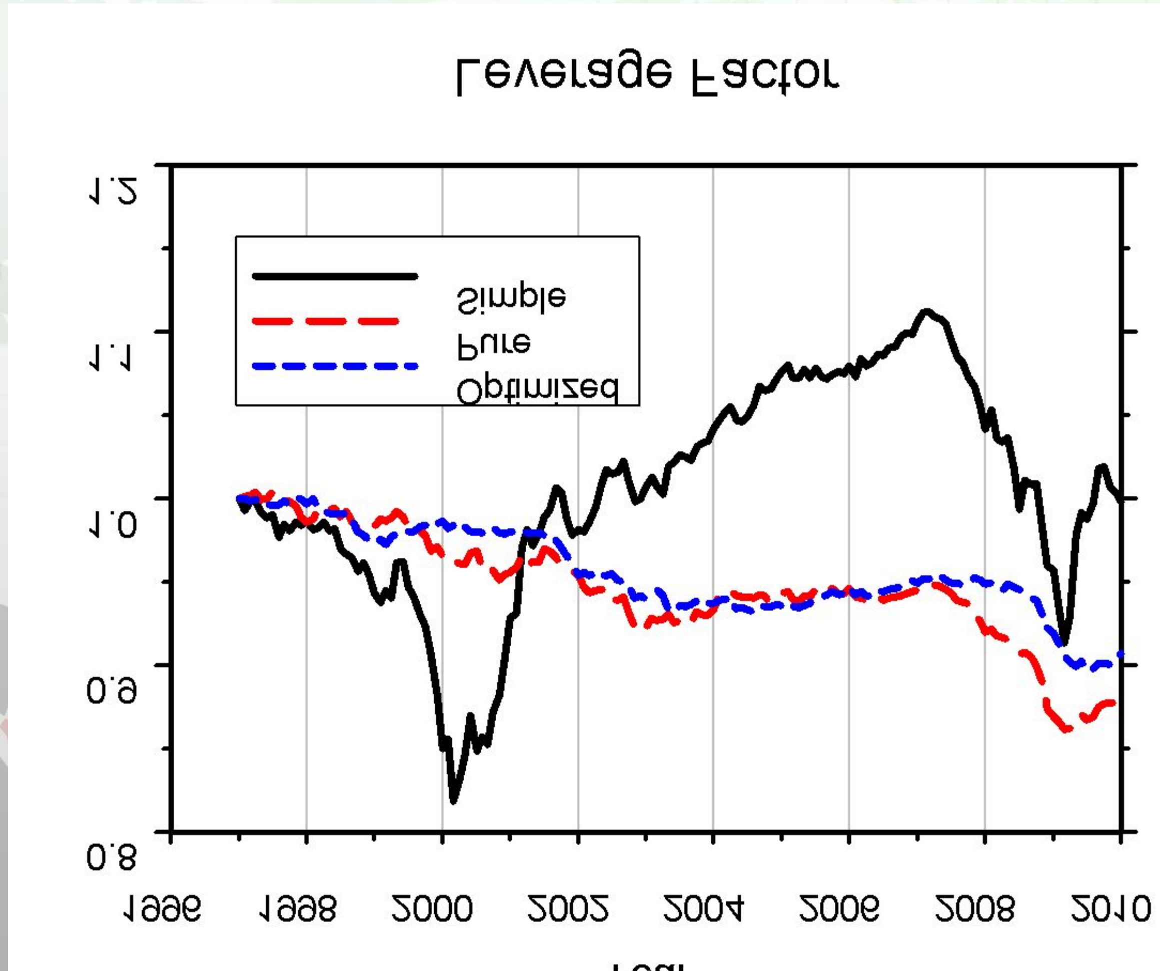
- **Figure 25-8** Cumulative Performance of Liquidity Factor



25.3 RESULTS

25.3.1 Cumulative Factor Returns

- **Figure 25-9** Cumulative Performance of Leverage Factor



25.1 GLOBAL EQUITY RISK MODEL

25.3.2 Summary Statistics

- **Table 25-4** Factor Returns, Volatilities, and IRs, January 1997 to December 2009

- Statistically significant *IR*s are highlighted in gray.

Factor Portfolio	Annualized Return	Annualized Risk	Information Ratio
Simple World	2.27%	16.11%	0.14
Pure World	2.27%	16.11%	0.14
Optimized World	1.96%	6.85%	0.29
Simple Value	3.64%	8.98%	0.41
Pure Value	4.73%	3.37%	1.40
Optimized Value	4.37%	1.69%	2.59
Simple Momentum	3.35%	10.60%	0.32
Pure Momentum	1.46%	6.11%	0.24
Optimized Momentum	3.49%	4.70%	0.74
Simple Volatility	-0.31%	11.50%	-0.03
Pure Volatility	-1.62%	7.97%	-0.20
Optimized Volatility	0.40%	2.96%	0.14
Simple Size	-1.57%	3.87%	-0.41
Pure Size	-0.95%	3.07%	-0.31
Optimized Size	-2.03%	2.01%	-1.01
Simple Growth	-0.70%	6.90%	-0.10
Pure Growth	0.01%	1.91%	0.01
Optimized Growth	-0.31%	1.07%	-0.29
Simple Non-linear Size	1.97%	5.26%	0.38
Pure Non-linear Size	0.43%	2.38%	0.18
Optimized Non-linear Size	-0.59%	1.38%	-0.43
Simple Liquidity	3.13%	8.47%	0.37
Pure Liquidity	3.14%	2.23%	1.40
Optimized Liquidity	1.35%	1.33%	1.01
Simple Leverage	-0.02%	4.29%	0.00
Pure Leverage	-1.03%	1.45%	-0.71
Optimized Leverage	-0.75%	1.03%	-0.72

25.1 GLOBAL EQUITY RISK MODEL

25.3.2 Summary Statistics

- **Table 25-5** Time-Series Correlations, January 1997 to December 2009

Factor Portfolio	Simple	Pure	Optimized	World
Simple World	1.00	1.00	0.25	1.00
Pure World	1.00	1.00	0.25	1.00
Optimized World	0.25	0.25	1.00	0.25
Simple Value	1.00	0.67	0.10	-0.15
Pure Value	0.67	1.00	0.38	0.11
Optimized Value	0.10	0.38	1.00	0.12
Simple Momentum	1.00	0.90	0.63	-0.15
Pure Momentum	0.90	1.00	0.70	-0.18
Optimized Momentum	0.63	0.70	1.00	-0.06
Simple Volatility	1.00	0.94	0.38	0.79
Pure Volatility	0.94	1.00	0.41	0.79
Optimized Volatility	0.38	0.41	1.00	0.31
Simple Size	1.00	0.61	0.47	-0.17
Pure Size	0.61	1.00	0.68	-0.06
Optimized Size	0.47	0.68	1.00	-0.02
Simple Growth	1.00	0.53	-0.15	0.54
Pure Growth	0.53	1.00	0.30	0.35
Optimized Growth	-0.15	0.30	1.00	-0.04
Simple Non-linear Size	1.00	0.47	0.15	0.12
Pure Non-linear Size	0.47	1.00	0.46	-0.06
Optimized Non-linear Size	0.15	0.46	1.00	-0.07
Simple Liquidity	1.00	0.69	-0.02	0.68
Pure Liquidity	0.69	1.00	0.27	0.40
Optimized Liquidity	-0.02	0.27	1.00	-0.08
Simple Leverage	1.00	0.51	0.16	0.00
Pure Leverage	0.51	1.00	0.39	0.28
Optimized Leverage	0.16	0.39	1.00	0.17

25.4 LEADING ECONOMIC INDICATORS AND BARRA FACTOR RETURNS

- Let $LET(t)$ be the LEI level at the end of month t. Generally, these values are published with a one or two-month lag. The "return" to the LEI over month t is then given by

$$L_t = \frac{LEI(t) - LEI(t-1)}{LEI(t-1)} \qquad (25.14)$$

- The lagged correlation between the GEM2 factor return and the LEI return is

$$\rho_k^m = \text{corr}\left(f_{kt}^P, L_{t-m} \right) \qquad (25.15)$$

- where f_{kt}^P is the pure return to factor k over period t, and m is the number of lags in months.

- A factor-timing strategy can be devised whose returns are given by

$$R_t = f_{kt}^P \cdot L_{t-m} \qquad (25.16)$$

In other words, the strategy takes long or short positions in the pure factor portfolio depending on the changes in the LEI months prior.

25.4 LEADING ECONOMIC INDICATORS AND BARRA FACTOR RETURNS

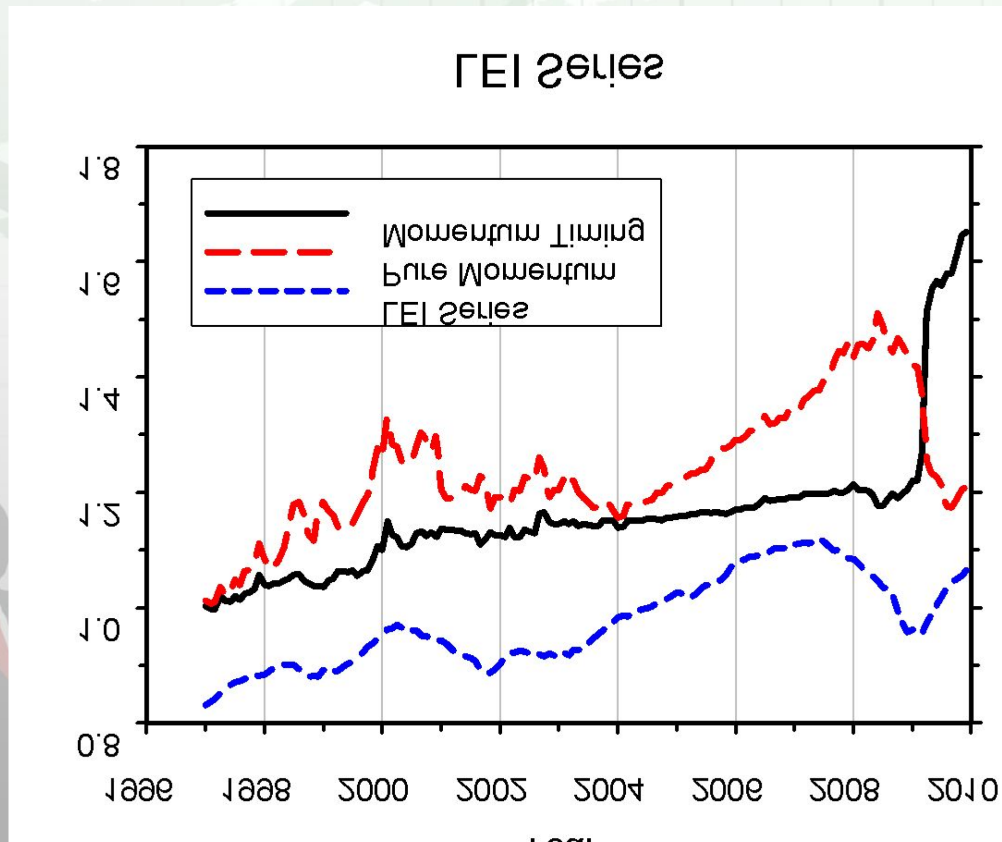
- **Table 25-6** Lagged Correlations between Monthly GEM2 Pure Factor Returns and Monthly Percentage Changes in the European LEI Levels

Lags	Momentum	Volatility	Value	Size	NL Size	Growth	Liquidity	Leverage
0	-0.08	0.40	0.12	-0.17	-0.12	0.06	0.17	0.36
1	0.14	0.03	0.00	-0.17	-0.18	-0.03	0.05	0.23
3	0.08	0.10	0.04	0.04	-0.08	0.03	0.03	0.22
6	0.30	-0.05	-0.13	0.12	0.06	0.03	0.04	-0.02
9	0.13	0.00	-0.05	0.16	0.09	0.08	0.10	-0.01
12	0.03	-0.04	0.01	0.09	0.16	-0.01	0.00	0.20

- Analysis period: January 1997 to December 2009.

25.4 LEADING ECONOMIC INDICATORS AND BARRA FACTOR RETURNS

- **Figure 25-10** Leading Economic Indicators Index Level, and Cumulative Performance of Pure Momentum Factor and Momentum Timing Strategy. The LEI Series has been Divided by 100 to be Placed on the Same Scale as the Other Lines



25.5 SUMMARY

- The three long/short strategies for capturing equity risk premia were presented. The simple approach goes long stocks with positive exposure, and shorts those with negative exposure. Although this provides the desired exposure to the factor, it also leads to incidental exposures to other factors. This may increase the volatility of the portfolio and potentially be detrimental to the performance.
- In the pure approach, the portfolio obtains an exposure of 1 to the desired factor, but has zero exposure to all other factors. This has the benefit of precisely controlling portfolio exposures, but does not explicitly take risk into consideration.
- The optimized approach leads to portfolios with unit exposure to the desired factor, while achieving minimum risk. This is accomplished through volatility-reducing hedges to other factors.

25.5 SUMMARY

- The performance of eight style factors and the World factor over a 13-year period were examined. None of the simple strategies achieved a statistically significant *IR* over this period. For the pure style factors, three were statistically significant, versus five for the optimized factors. For Value, Size, and Momentum, the optimized strategies had far higher *IR*s than the pure counterparts.

- Finally, an illustrative example of a Momentum "factor timing" strategy that uses lagged LEI values as the input signal was considered. It was found that, on a risk-adjusted basis, the factor timing strategy outperformed the pure Momentum factor over the sample period.