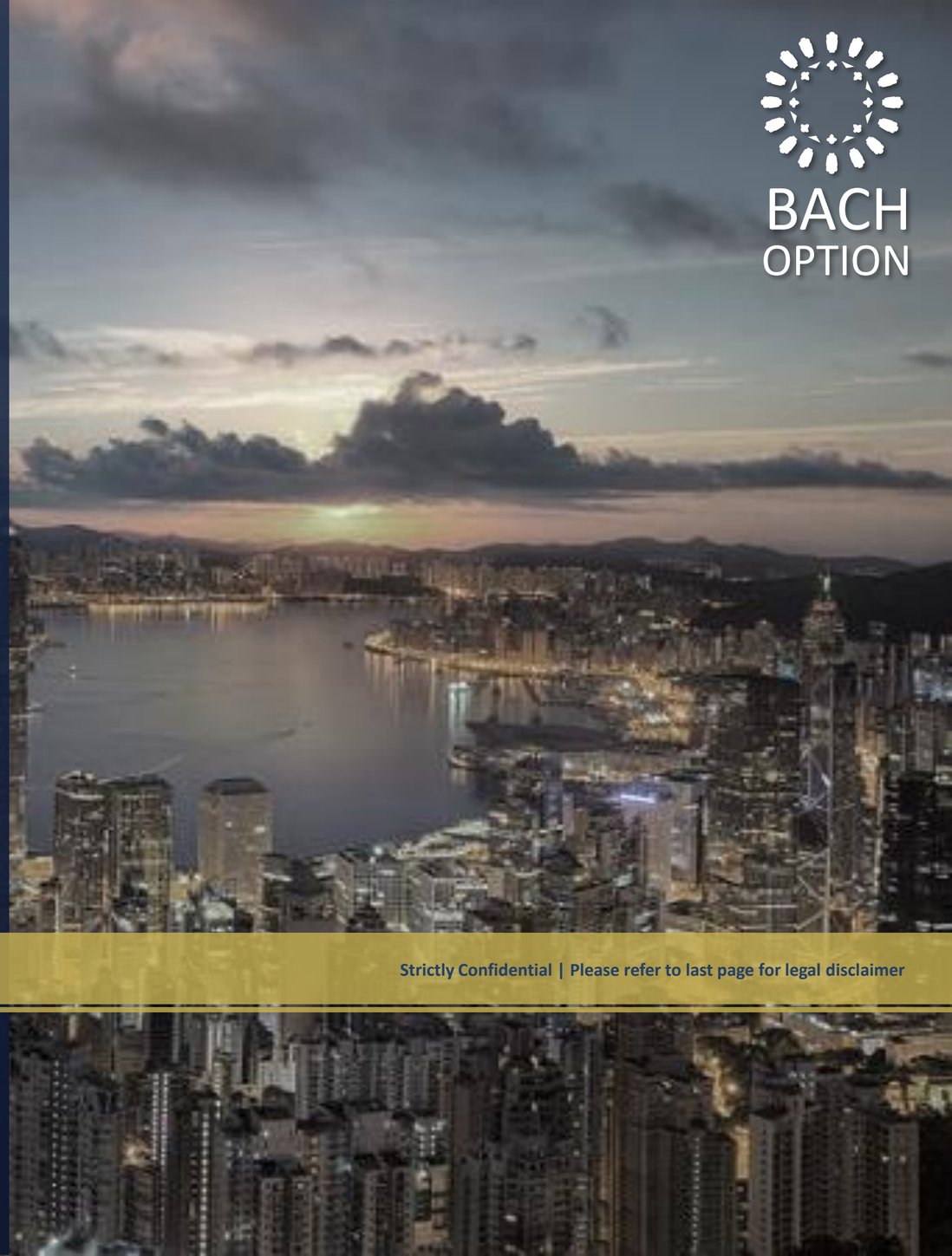
A Rigorous Analytical Framework for the Dispersion Strategy

A presentation by Dr. Miao-dan Wu | Founder & CIO of Bach Option

“Harmony with Uncertainty”



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Role of Correlation in Index Return Volatility

A stylized example:

Consider an index consisting of 2 equally weighted stocks:

$$X = \frac{S_1 + S_2}{2}$$

Assume the annualized volatility of both stocks are 30:

1. Perfect anti-correlation: $\mathrm{Var}(X) = 0,\ \mathrm{Vol}(X) = 0$
2. Zero correlation: $\mathrm{Var}(X) = \frac{\mathrm{Var}(S_1)+\mathrm{Var}(S_2)}{4} = 450, \mathrm{Vol}(X) \approx 21$
3. Perfect correlation:

$$\mathrm{Var}(X) = \frac{\mathrm{Var}(S_1) + \mathrm{Var}(S_2) + 2\sqrt{\mathrm{Var}(S_1)}\sqrt{\mathrm{Var}(S_2)}}{4} = 900, \mathrm{Vol}(X) = 30$$

Raison d'être

What is the dispersion trade?

- ❑ Long single stock volatilities,
- ❑ Short the corresponding index volatility

Why long dispersion?

- ❑ Index vols are rich
  - *Primary hedging instrument: index puts.*
- ❑ The median implied volatility risk premium (6m ATM implied vol – subsequent realized vol) for the SPX is 3 since 2005. The average for the S&P large cap stocks is 1.6.

Implied Correlation

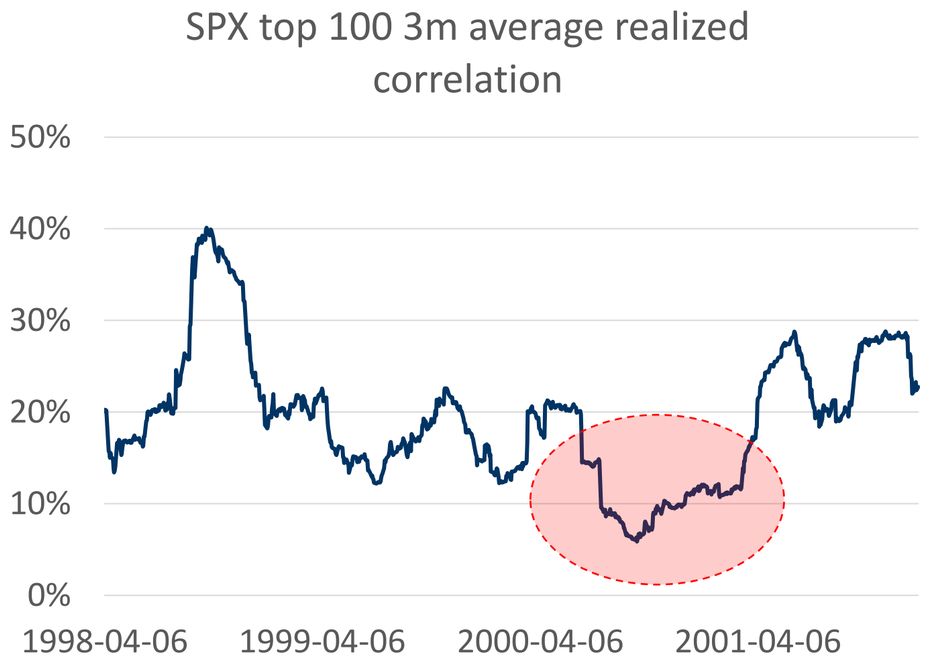
- How to measure the attractiveness of a dispersion position?
- Common heuristics: **Implied Correlation**
- Index return is a weighted sum of single stocks returns:

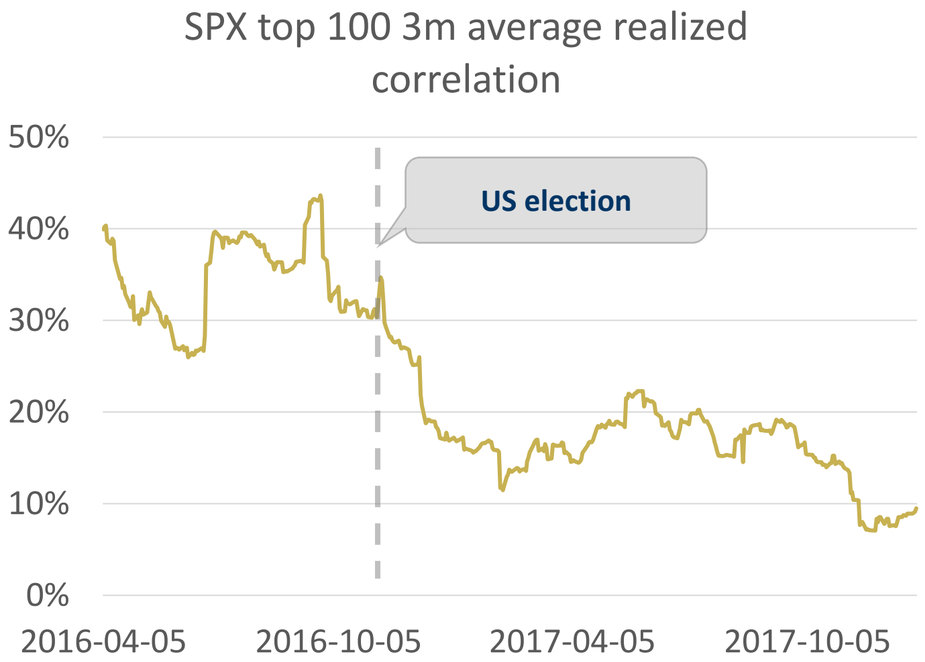
$$X = \Sigma w_i S_i$$

- Assuming the correlation between any pair of distinct stocks to be the same number ρ, then for a sufficiently diversified index:

$$\rho \approx \frac{Var(X)}{\left(\Sigma w_i \sqrt{Var(S_i)}\right)^2} = \left(\frac{\text{Index vol}}{\text{Avgerage Stock vol}}\right)^2$$

Realized Average Correlation





Pros & Cons of Implied Correlation

Advantage: intuitive & easy to apply

Disadvantage: simplistic & operationally inflexible

1. Use 1 variable to proxy the entire covariance matrix
2. It presupposes a one-factor model on single stock returns:

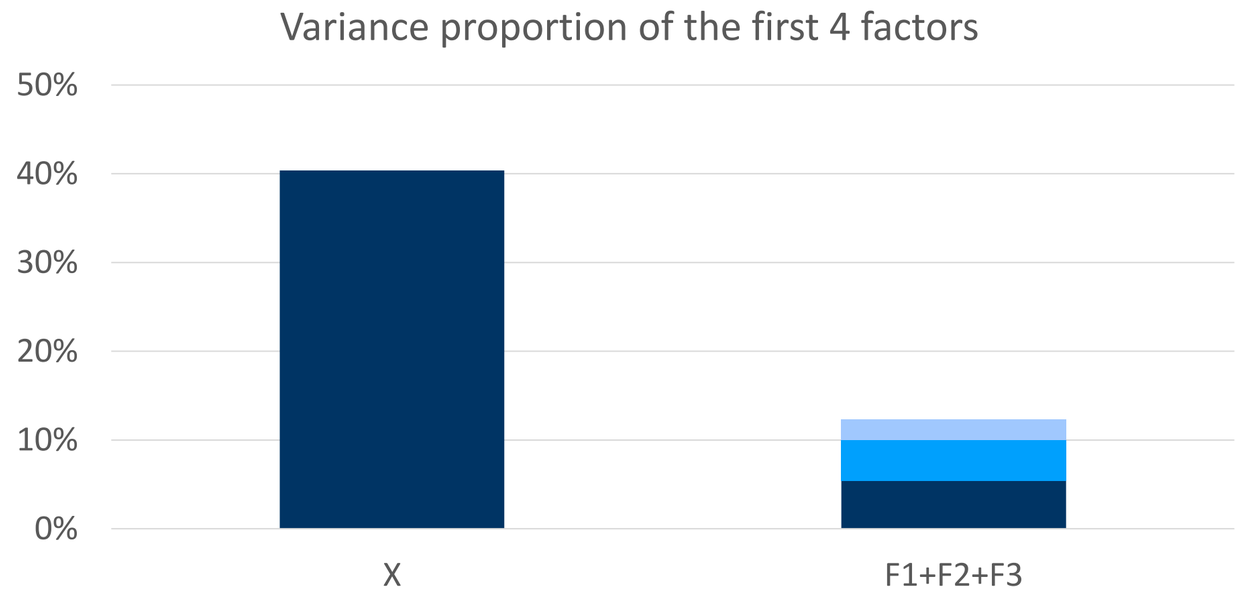
$$S = \beta X + \varepsilon,$$

X: macro/market return

ε: the company-specific idiosyncratic return

3. Each stock is assumed to have the same correlation with the common factor X
4. Cannot assess the cheapness of individual single stock vols vis-à-vis index

Factor analysis for S&P top 100 (2016-present)



- ❑ X: main factor, correlation with SPX > 0.98
- ❑ F1 + F2 + F3 explain > 10% variance
- ❑ One factor is inadequate

Pricing of Single Stock Volatility

- Single stock returns can be decomposed as:

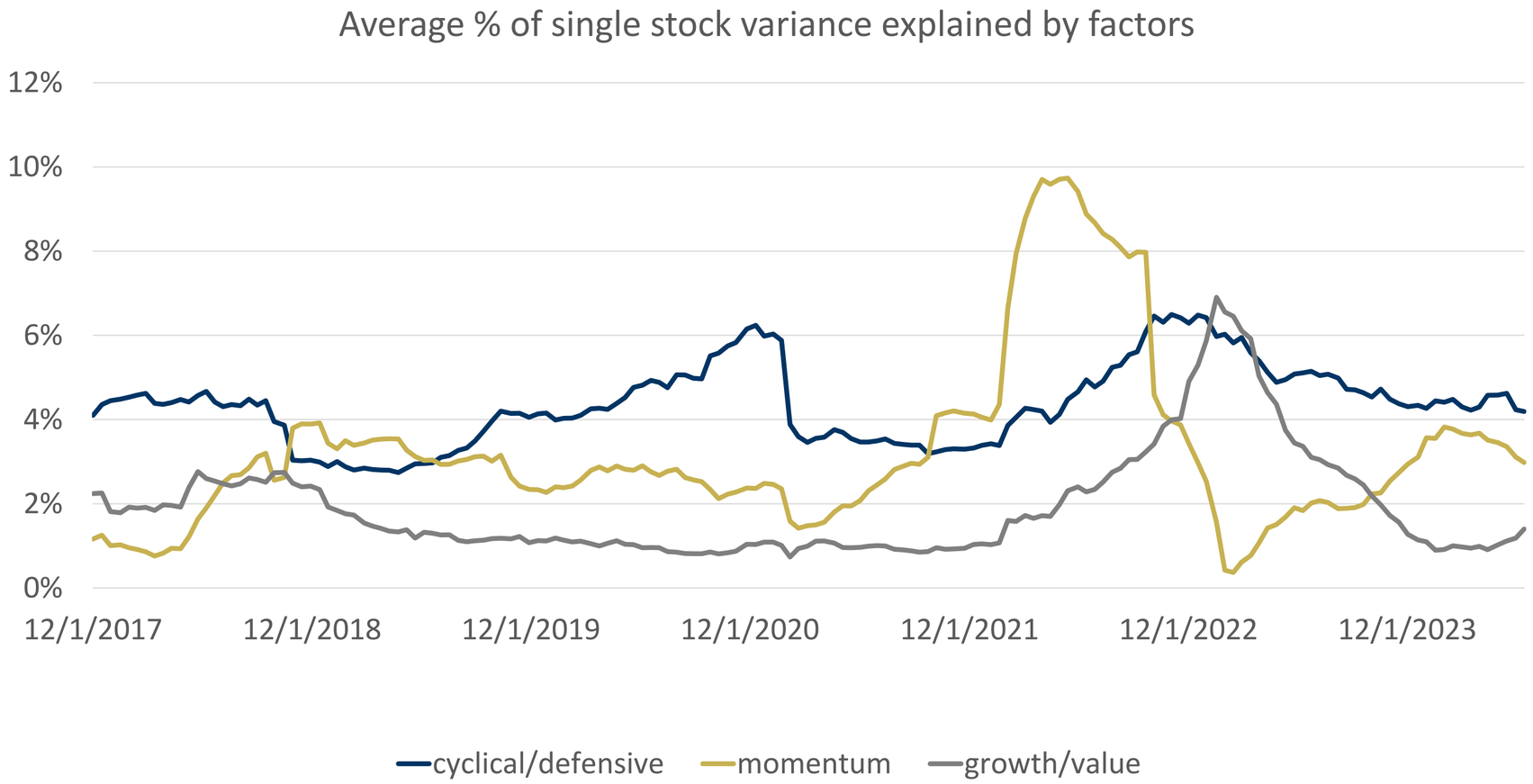
$$S = \beta X + c_1 F_1 + c_2 F_2 + c_3 F_3 + \varepsilon,$$

X: macro/market return
F_1: cyclical/defensive factor
F_2: momentum factor
F_3: growth/value factor
ε: the company-specific idiosyncratic return

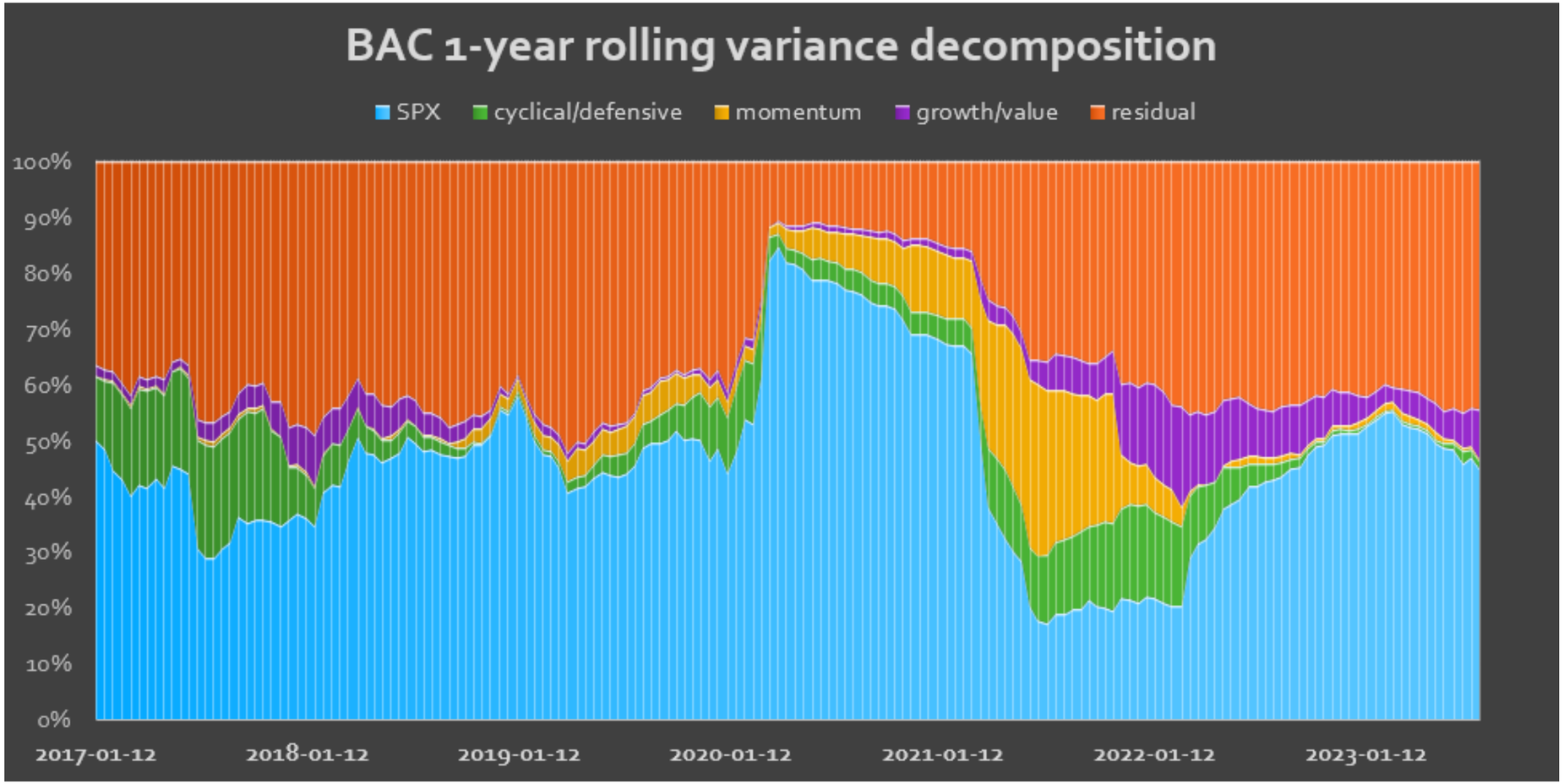
- Consequently:

$$\mathrm{Var}(S) = \beta^2 \mathrm{Var}(X) + c_1^2 \mathrm{Var}(F_1) + c_2^2 \mathrm{Var}(F_2) + c_3^2 \mathrm{Var}(F_3) + \mathrm{Var}(\varepsilon)$$

The Other Factors



Temporal Evolution of Factors



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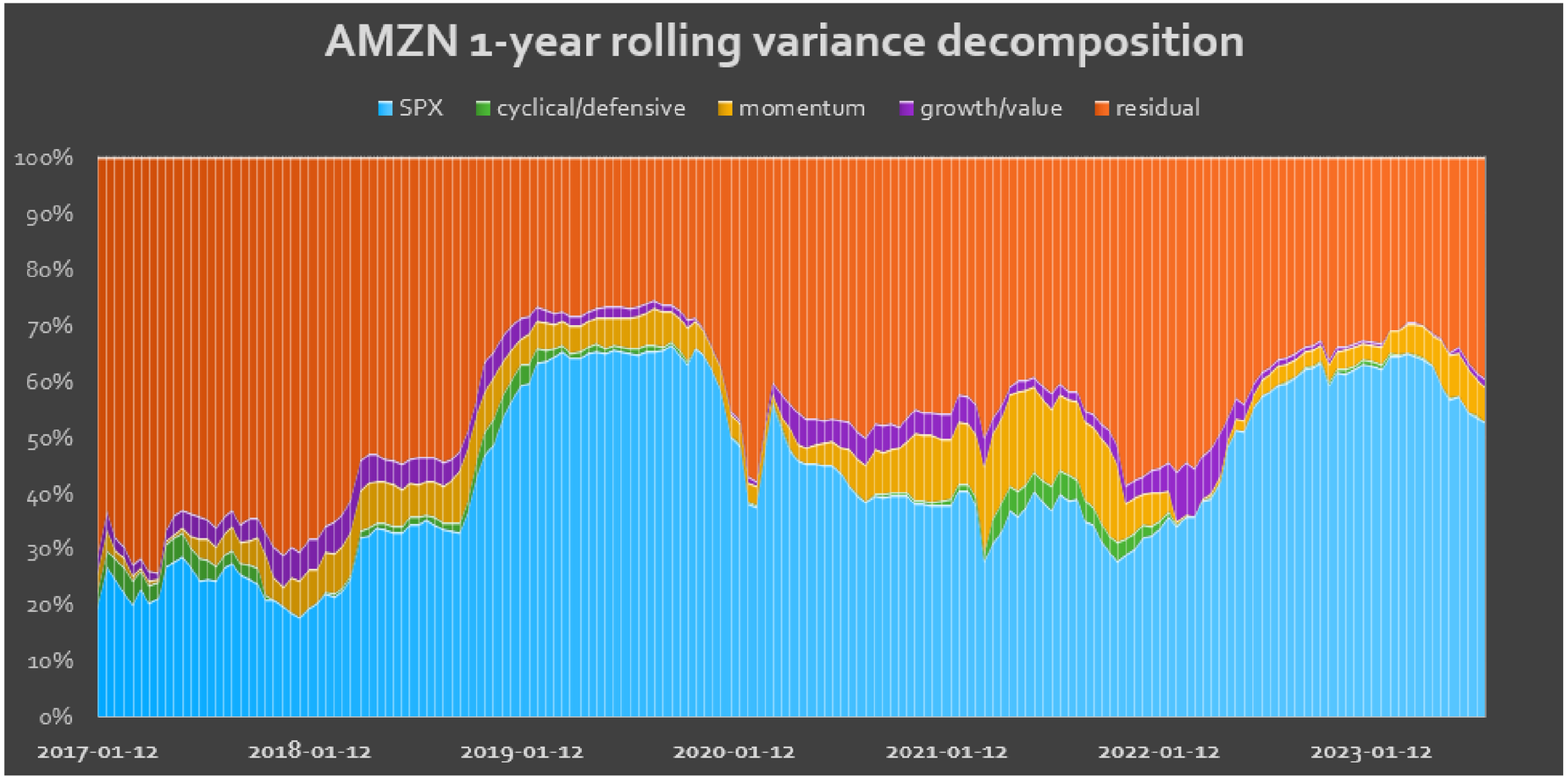


Market-vol Neutral Dispersion Portfolio

- Payoff of a portfolio consisting of long single stock vol positions and short index vol positions is:

$$\Sigma w_i \mathrm{Var}(S_i) - \left(\Sigma w_i \beta_i^2\right)\mathrm{Var}(X)$$

$$= \Sigma w_i \left(c_{1,i}^2 \mathrm{Var}(F_1) + c_{2,i}^2 \mathrm{Var}(F_2) + c_{3,i}^2 \mathrm{Var}(F_3) + \mathrm{Var}(\varepsilon_i)\right),$$

which has zero exposure to the volatility of the broad market while long the volatility of the individual factors as well as the idiosyncratic returns.

Payoff of a Conventional Dispersion Package

- Payoff of a portfolio consisting of long single stock vol swaps and short index vol swap in a theta-neutral fashion is :

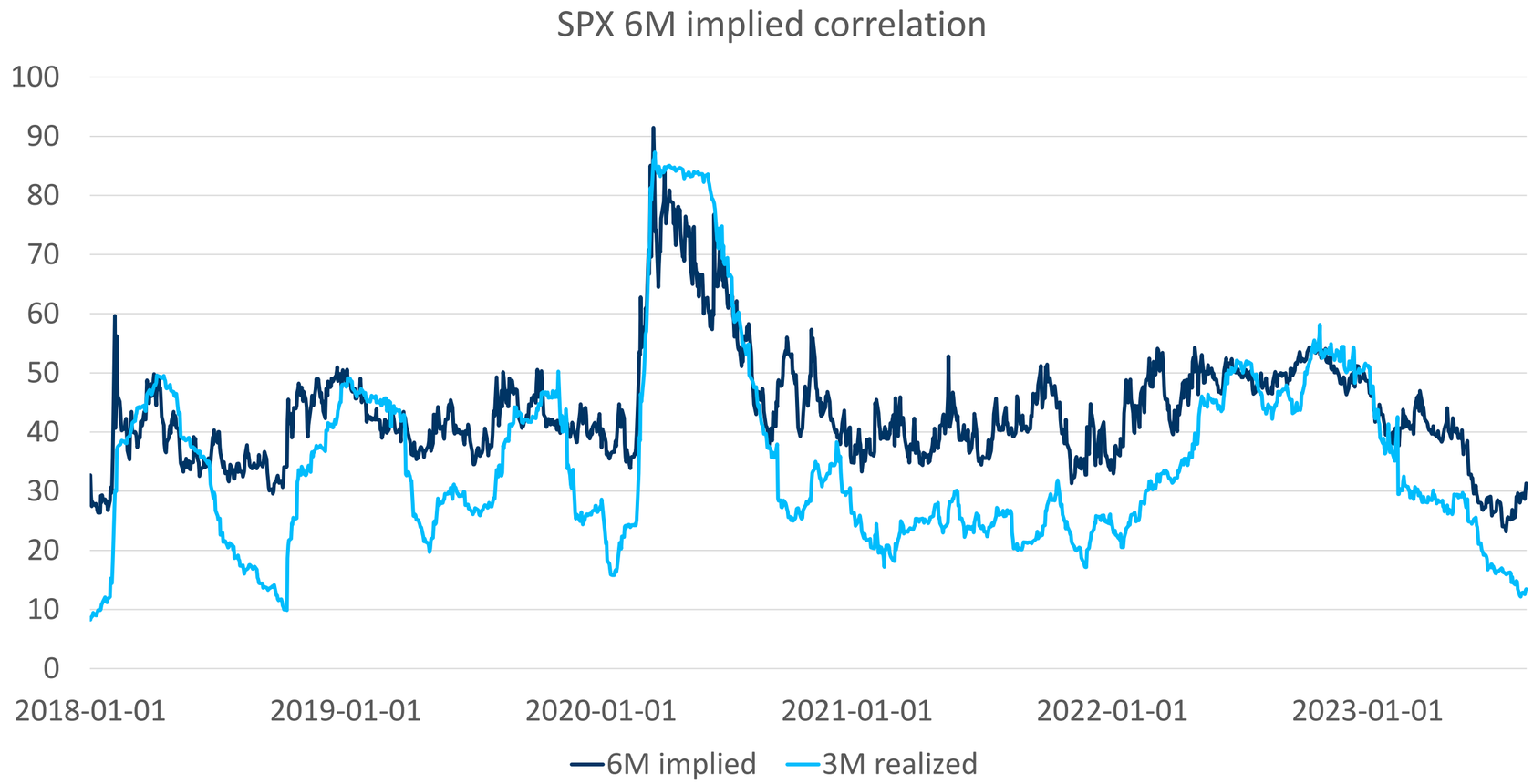
$$\frac{1}{\sqrt{\rho_i}} \times \text{Avgerage Stock Realized Vol} \times (\sqrt{\rho_i} - \sqrt{\rho_r})$$

- Payoff of a portfolio consisting of long single stock var swaps and short index var swap in a theta-neutral fashion is :

$$\frac{1}{\rho_i} \times \text{Avgerage Stock Realized Variance} \times (\rho_i - \rho_r)$$

- In a crash/distress scenario, realized vols and correlation invariably rise together, the left tail of the p&l distribution can be very heavy indeed.

Implied Correlation Time Series



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