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Research

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POINT Annual Risk Model

Term Structure of Risk

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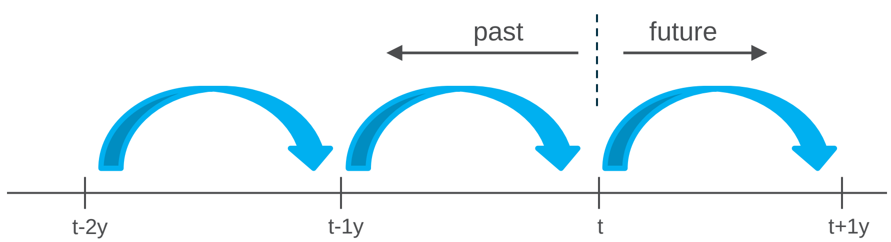
PLEASE SEE ANALYST CERTIFICATIONS AND IMPORTANT DISCLOSURES BEGINNING ON PAGE 25.

Motivation

Modeling Annual Volatility - Introduction

Direct Forecasting

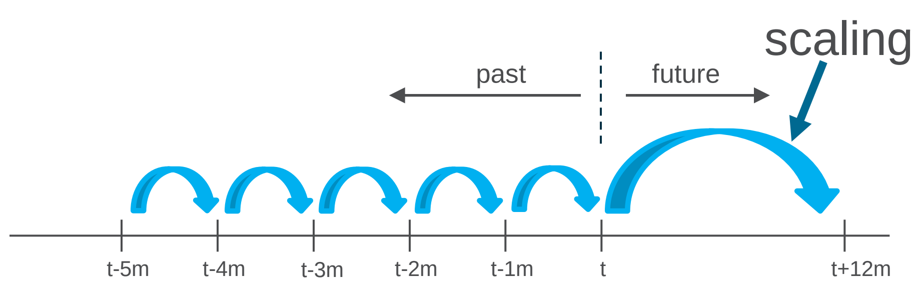
- Annual data to forecast annual volatility
- Challenges:
  - Very long data history
  - Very long look-back period
  - Very difficult to parameterize the model
- Infeasible approach



Source: Barclays Research

Scaling of Monthly Data

- Scale monthly to annual forecast horizon
  - Square-root rule
  - Parameterize
  - Adjust for serial correlation
- Annual overlapping data
- Model and parameter calibration are very difficult
  - Very limited number of non-overlapping annual observations



Source: Barclays Research

POINT Approach: Qualitative Criteria + Quantitative Model

Annual Volatility Approach

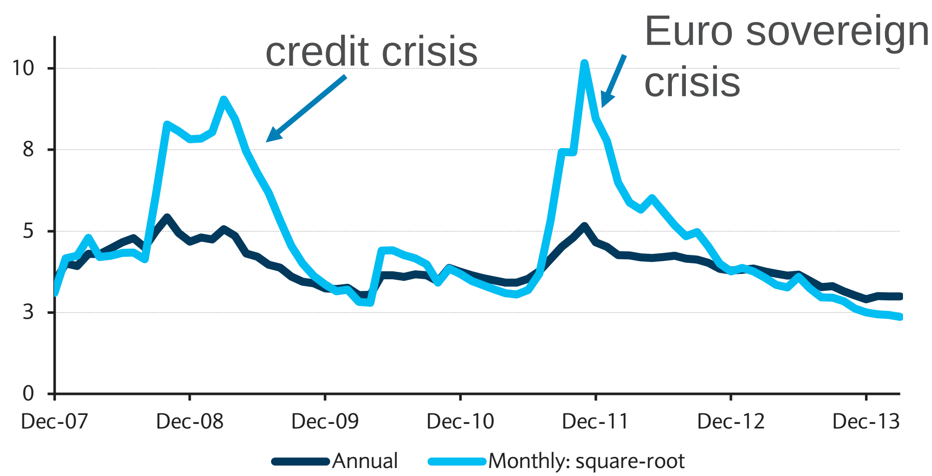
Long-term volatility forecasts should

- be responsive, but **smooth**
- **mean-revert** over the long run
- more **stable** than short-term forecast

Model Features

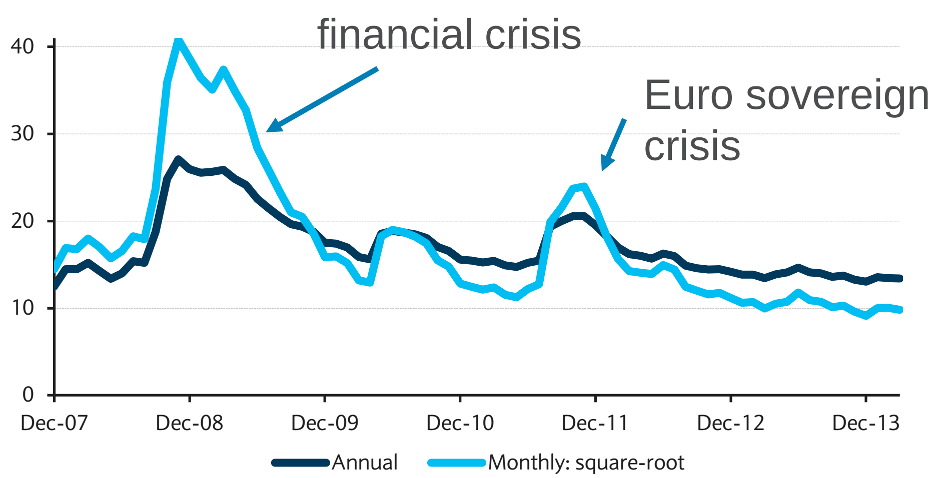
- **Two-factor model**
  - Short-run component moves around a long-run component
- **Mean-reversion** that depends on the deviation between short- and long-run component
- **Long-run correlation model** adjusting for cross-serial correlation

EUR Credit: Annual vs. Scaled Monthly



Source: Barclays Research

S&P500: Annual vs. Scaled Monthly



Source: Barclays Research

Term Structure of Volatility

Term Structure of Volatility

Quantitative Two-factor Volatility Model

$$\hat{\sigma}_{t,t+1y}^{annual} = \hat{\sigma}_{t}^{long-run} \times \left(1 - \theta_{t,t+1y}\right) + \hat{\sigma}_{t}^{short-run} \times \theta_{t,t+1y}$$

Volatility Model

- Two-factor model
  - Short-run component moves around a long-run component
- Relative weights
  - Time varying
  - Capture mean-reversion
  - Calibrated via a simplified Nelson-Siegel term structure model

"Intuitive" Quantitative Model

- Model the term structure of volatility
- Historical data to calibrate the model
- Economic intuitive model that obeys stylized facts

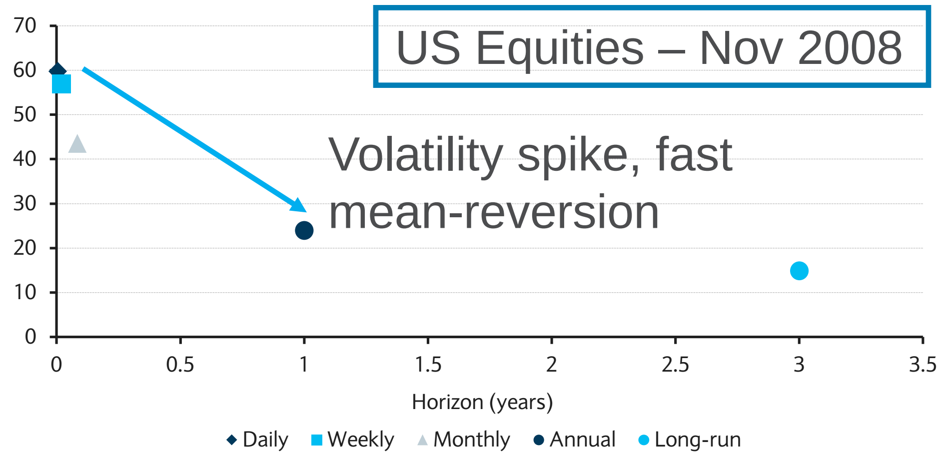
Term Structure of Volatility - Calibration

Term Structure of Volatility

$$\hat{\sigma}_{t,t+1y}^{annual} = \hat{\sigma}_t^{long-run} \times (1 - \theta_{t,t+1y})$$
$$+ \hat{\sigma}_t^{short-run} \times \theta_{t,t+1y}$$

- Mean-reversion determined by $\theta_{t,t+1y}$
  - Speed of mean-reversion depends on short- to long-run deviation

Term Structure – Downward Sloping

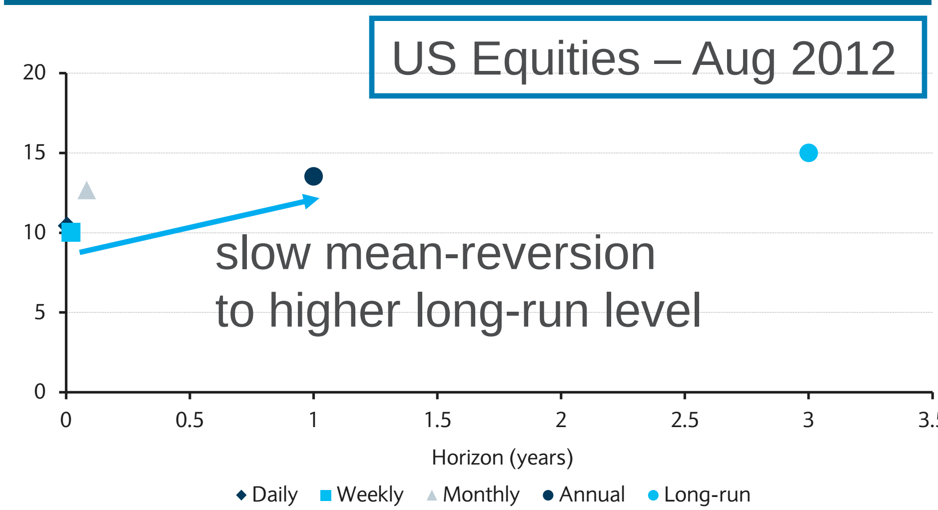


Source: Barclays Research

Empirical Facts

- Volatility spikes mean-revert fast
  - Smooth out volatility spikes
  - Annual forecast is more stable than short-term forecast
- Volatility can remain at very low levels for extended periods of time
- Mean-reversion is state dependent

Term Structure – Upward Sloping



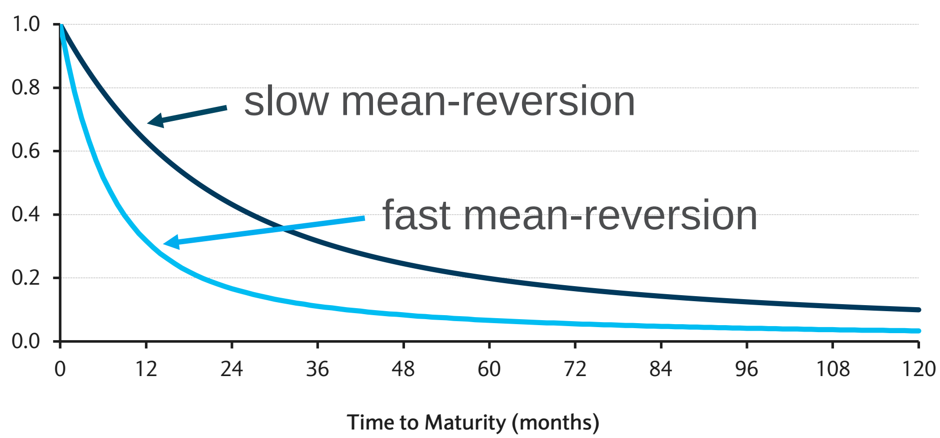
Source: Barclays Research

Term Structure of Volatility – Calibration

Implementation

- Work in annualized space
- Three parameters
  - Short-run volatility: Monthly MXF
  - Long-run volatility: Unconditional
  - Relative weight: $\theta_{t,t+1y}$
    - Determines mean-reversion

Mean-reversion Behavior



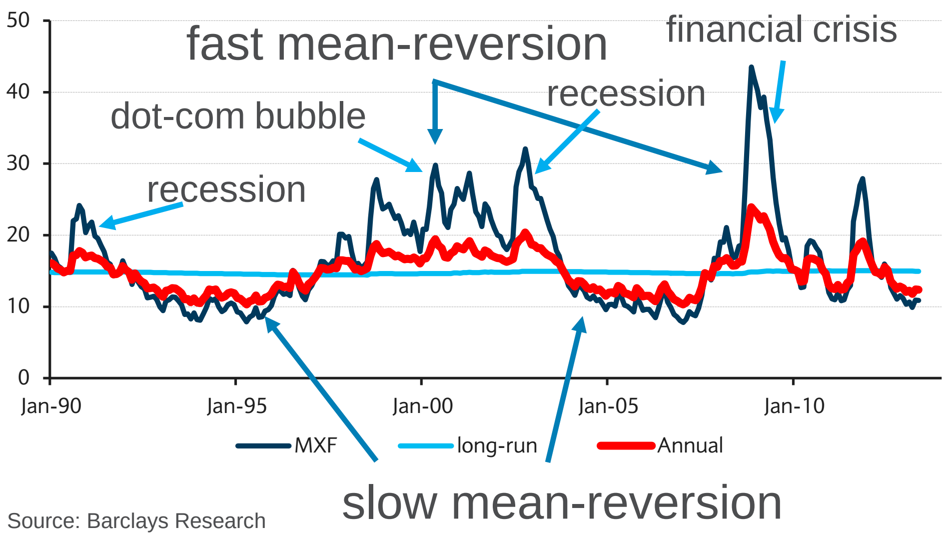
Source: Barclays Research

Mean-reversion

- **Volatility spikes**
  - Short-run is at least 50% higher than long-run
  - Empirically volatility spikes last 5-7 months
  - $\theta_{t,t+1y} \approx ⅓$ weight on short-run
    - Fast mean-reversion: ~6 month HL
- If **short-run below long-run level**
  - $\theta_{t,t+1y} \approx ⅔$ weight on short-run
    - Slow mean-reversion: ~19 month HL
- If short-run deviation b/w 0% and 50%
  - Linearly decrease from $\theta_{t,t+1y} \approx ⅔$ to $\theta_{t,t+1y} \approx ⅓$

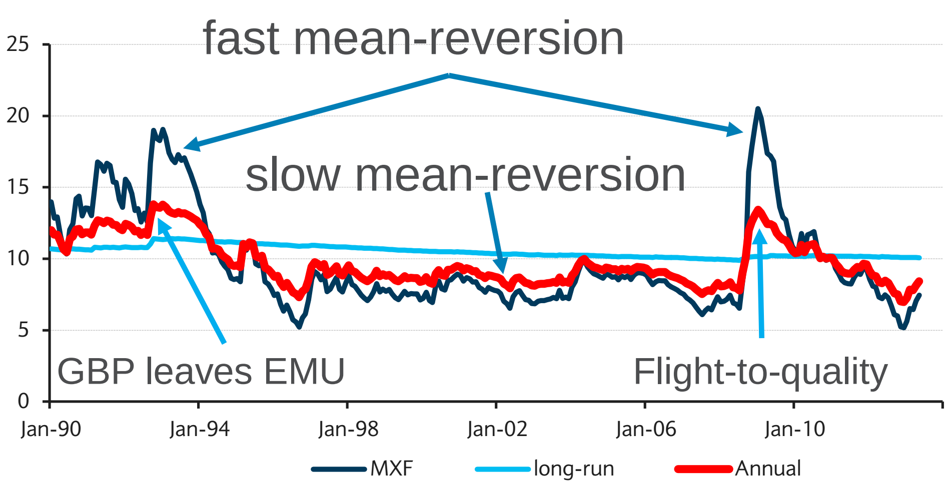
POINT Annual Volatility Model

US Equity



Source: Barclays Research

FX USD-GBP



Source: Barclays Research

- Annual volatility forecast more stable than monthly forecast
  - Volatility spikes are smoothed
  - Fast mean-reversion
- During very low volatility periods, annual forecast mean-reverts slowly to higher levels
- Mean-reversion is state and factor dependent
  - Market wide events:
    - Financial crises
    - Recessions
  - Factor specific events:
    - E.g.: GBP leaving EMU

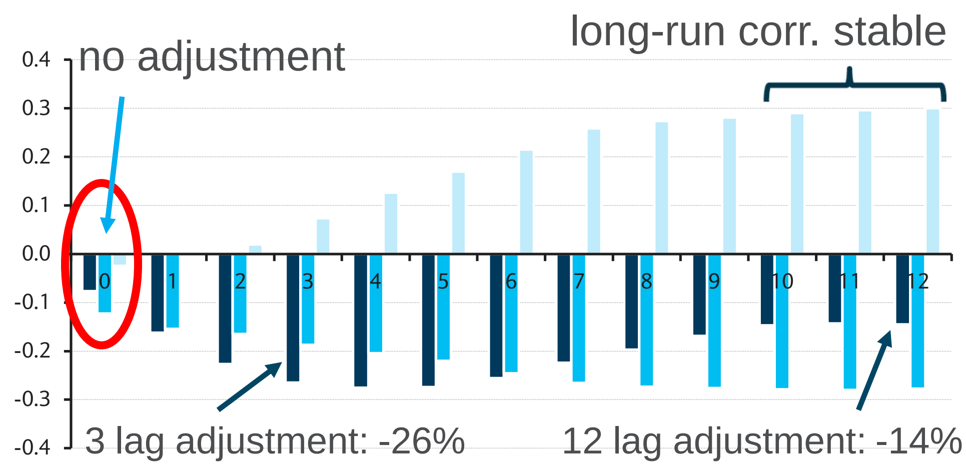
Term Structure of Correlation

Annual Correlation Model

Long-run Correlations

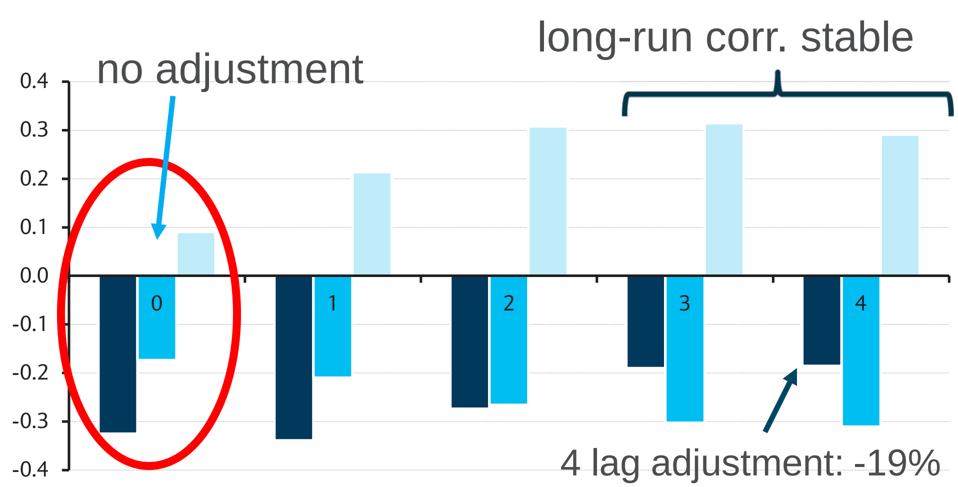
- Correlations depend on observation frequency
- Example: US Equity-US FI 10y
  - Period: 1990-2012
  - Monthly correlation: -8%
  - Quarterly correlation: -33%
- Correct for cross-serial correlation

Long-run Correlations: Monthly Data



Source: Barclays Research

Long-run Correlations: Quarterly Data



Source: Barclays Research

Implementation

- Monthly data
  - EWMA model with 36-month HL
  - Adjust for cross-serial correlation
    - Newey-West method with 12 lags

Loadings

Treatment of Loadings

- Global Risk Model (GRM) is a linear factor model

$$R = L \times F \Rightarrow \sigma_R = L \times \sigma_F$$

- Short-run volatility spikes affect factor volatility
  - Mean reversion for the long run (LR) model allows smoother reaction
  - Discussion so far

$$\sigma_F \longrightarrow \sigma_F^{LR}$$

- However, for some other factors volatility spikes also affect their loadings
  - E.g., loadings that depend on spread levels: BiDS*, DTS
  - Spreads also mean-revert over the long run -> need adjustment too

$$L = L(S) \longrightarrow L^{LR} = L\left(S^{LR}\right)$$

- Let's look to them in more detail

* Gu and Silva, 2014, Enhanced Credit Betas, Barclays presentation

Mean Reverting Loadings

- Global Risk Model (GRM) has two types of spread-based loadings:

DTS: $$L_i = DTS_i = D_i \times S_i$$

BiDS: $$L_i = BiDS_i = \beta_i \times D_B \times S_B$$

- The volatility from these factors is given by:

Short Run $$\sigma_i = BiDS_i \times \sigma_F$$

Long Run $$\sigma_i^{LR} = BiDS_i^{LR} \times \sigma_F^{LR} = \beta_i \times D_B \times S_B^{LR} \times \sigma_F^{LR}$$

NOTE: DTS loading is a special case of BiDS where $\beta_i = DTS_i / DTS_B$

This DTS Ratio represents the current DTS approach used in the GRM

Loadings Affected

- All factor with standard DTS loadings are potentially affected
- Spreads in the loadings are replaced by long-term spreads

  - **Credit Industry DTS factors**
    - Beta = Enhanced Credit Beta (ECB) * when available
      - DTS ratio otherwise

  - **Other DTS Factors**
    - Currently no Enhanced Credit Beta (ECB)
    - Beta = DTS Ratio
      - Euro Treasury factors
      - Euro credit country factors
      - EM external debt factors
      - Muni DTS factors

* Gu and Silva, 2014, Enhanced Credit Betas, Barclays presentation

Long-run Spreads

Long-run Spreads

- Benchmarks closely resemble POINT GRM risk factors
- Spreads mean-revert over the annual horizon to long-run level
- Assume no duration decay in benchmarks

How Fast Do Spreads Mean-revert?

Factor	HL	Period
US Core	6-7 month	Nov 08 – May 09
US Banking	3-4 month	Mar 09 – Jun 09
EUR CRD Spain	8-9 month	Jul 12 – Mar 13
EUR Core - 1	4-5 month	Mar 09 – Jul 09
EUR Core - 2	7-8 month	Nov 11 – Jun 12

Source: Barclays Research

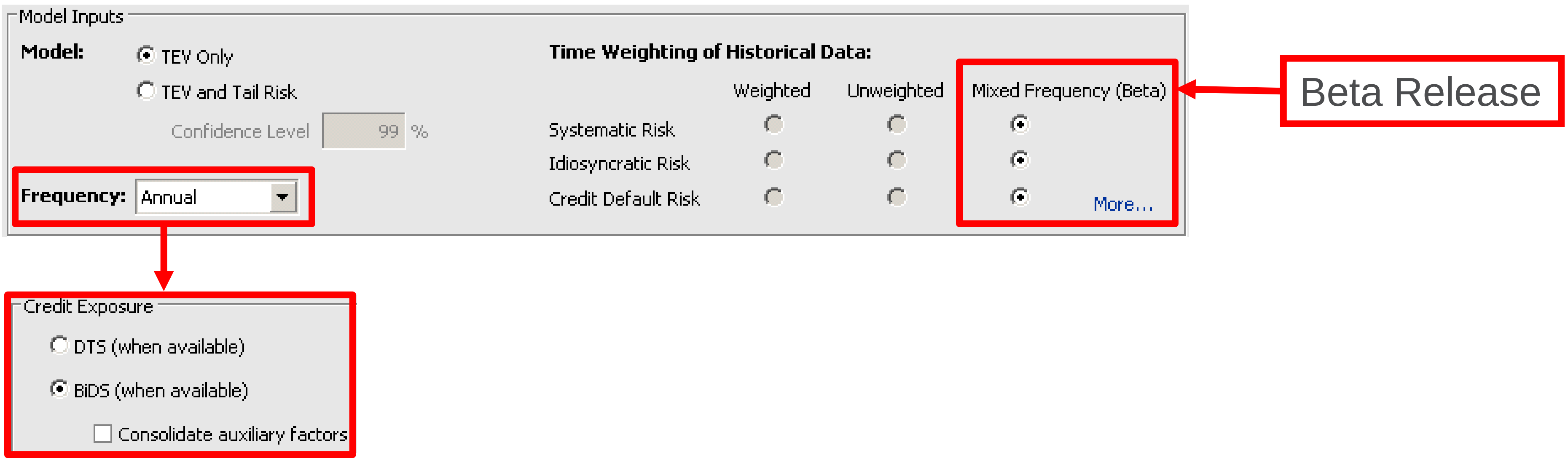
Implementation

- **Long-run** level:
  - 10y rolling median
- **Short-run**:
  - current spread level
- **Mean-reversion**:
  - Empirically average ~6 month HL

Implementation in POINT

May Release

- Annual Model on Beta Release
  - BiDS and mean-reversion are default options



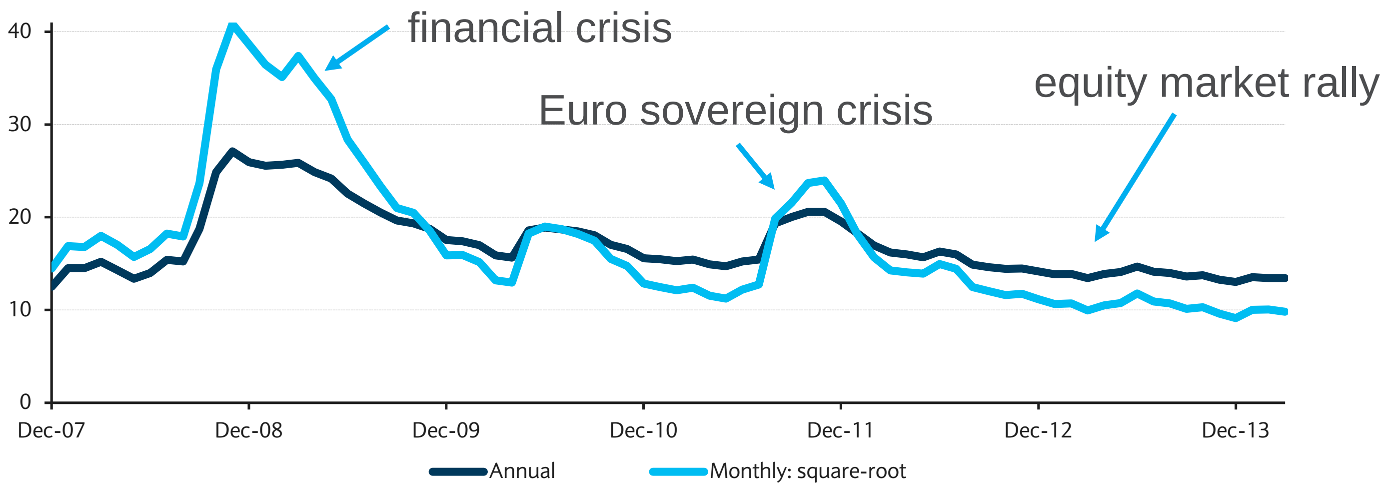
Future Release

- Added flexibility
  - Choice of BiDS or DTS
  - Choice of consolidated BiDS model
  - Choice of mean-reversion of spreads (to be added)

Examples on Specific Indices in POINT

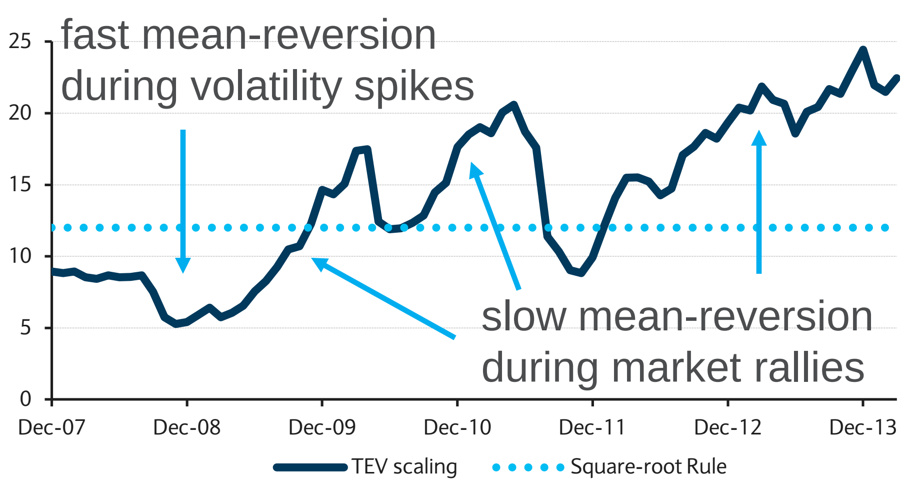
Annual Model: S&P 500

Annual vs. Monthly



Source: Barclays Research

TEV Scaling: Annual vs. Monthly



Source: Barclays Research

Comparison: TEV

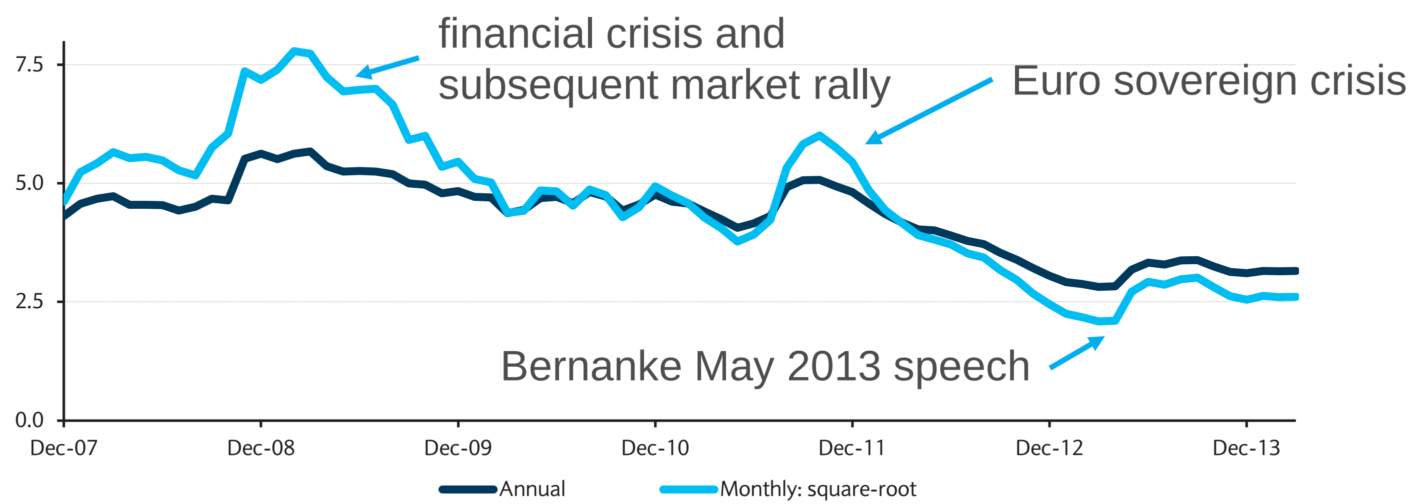
Volatility	Annual	Monthly (scaled)
Min	12.5%	9.1%
Max	27.1%	40.8%
Std.Dev (Vol-of-vol)	3.7%	7.9%

Source: Barclays Research

- Scaling ranges between 5.3 and 24.4
- Average scaling over time 14.1

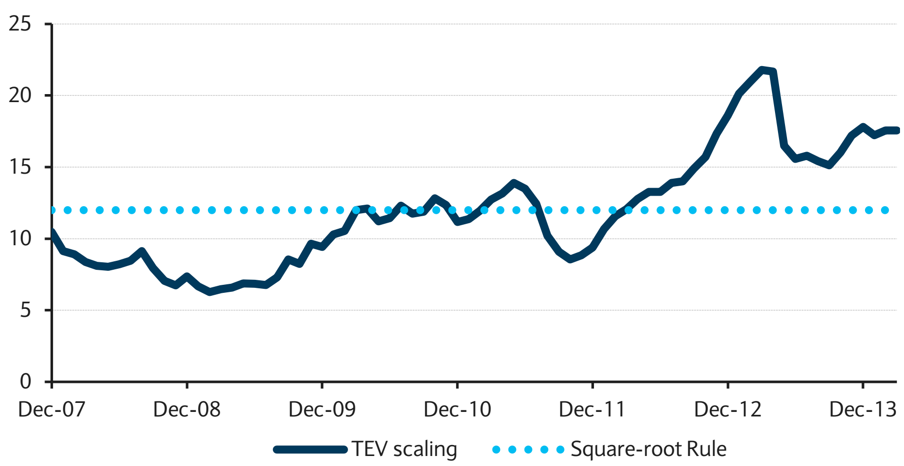
Annual Model: US Treasury

Annual vs. Monthly



Source: Barclays Research

TEV Scaling: Annual vs. Monthly



Source: Barclays Research

Comparison: TEV

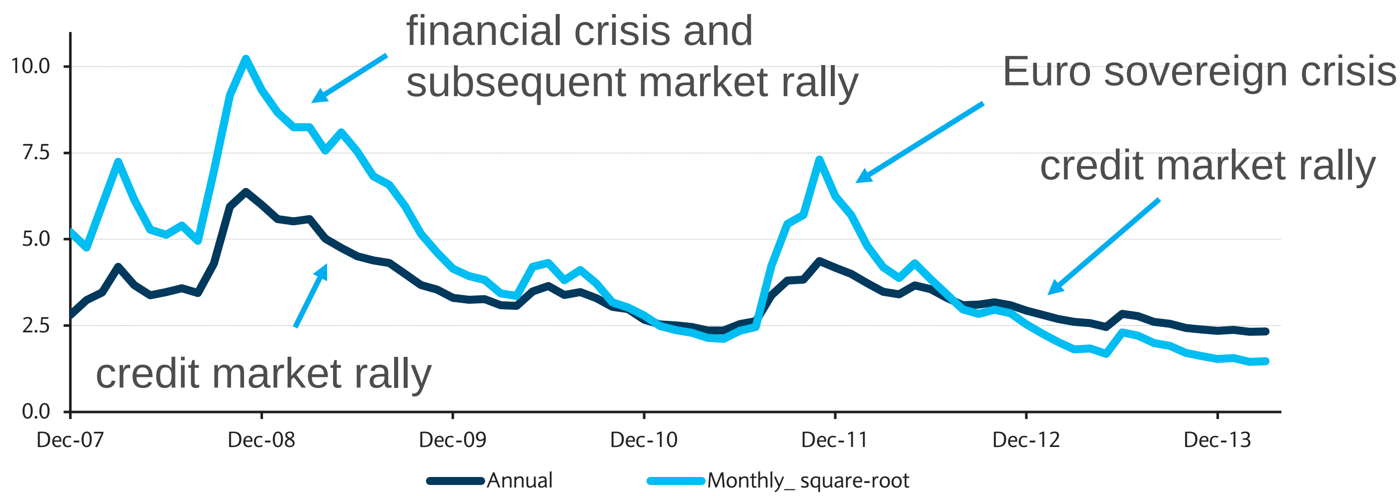
Volatility	Annual	Monthly (scaled)
Min	2.8%	2.1%
Max	5.7%	7.8%
Std.Dev (Vol-of-vol)	78bp	152bp

Source: Barclays Research

- Scaling ranges between 6.3 and 21.8
- Average scaling over time 11.9

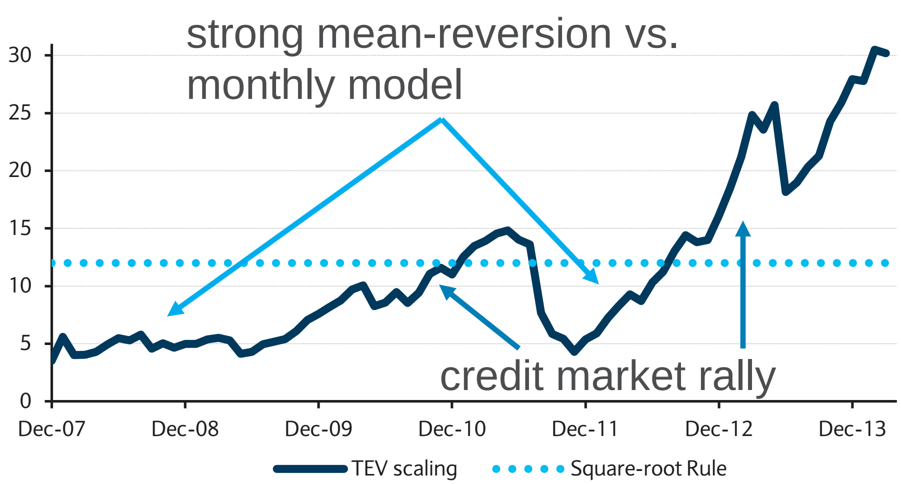
Annual Model: US Credit Corp Yield Curve Hedged

Annual vs. Monthly



Source: Barclays Research

TEV Scaling: Annual vs. Monthly



Source: Barclays Research

Comparison: TEV

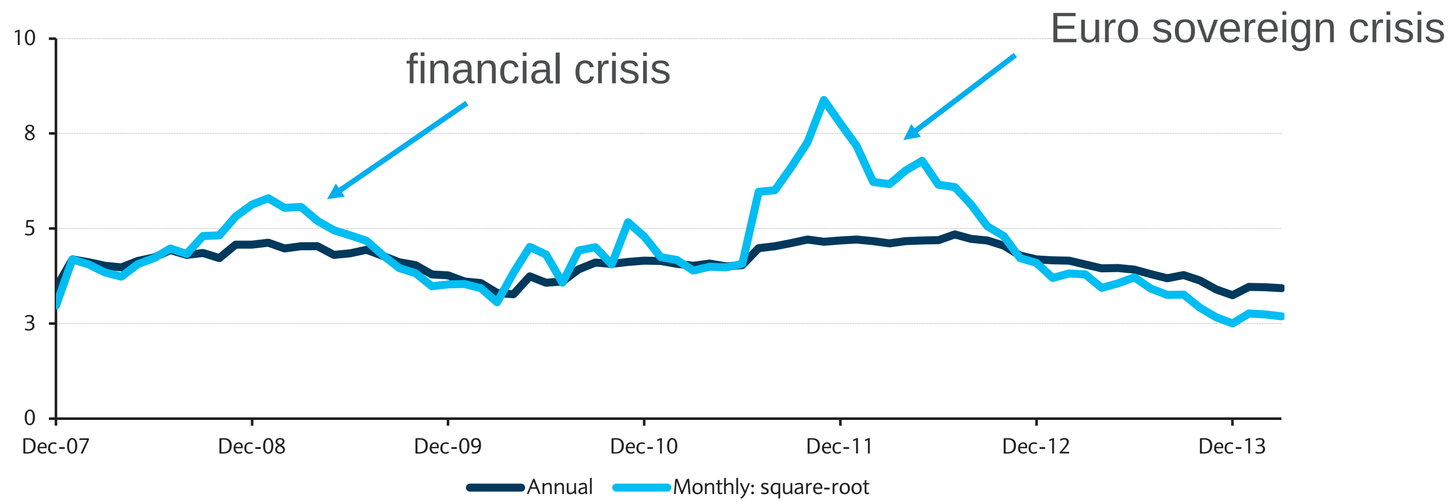
Volatility	Annual	Monthly (scaled)
Min	2.3%	1.5%
Max	6.4%	10.2%
Std.Dev (Vol-of-vol)	95bp	222bp

Source: Barclays Research

- Scaling ranges between 3.5 and 30.5
- Average scaling over time 11.3

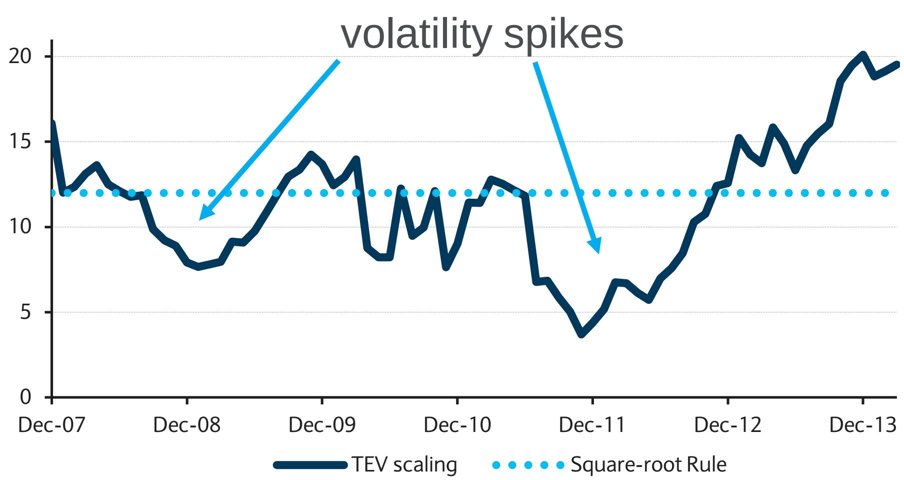
Annual Model: Euro Treasury

Annual vs. Monthly



Source: Barclays Research

TEV Scaling: Annual vs. Monthly



Source: Barclays Research

Comparison: TEV

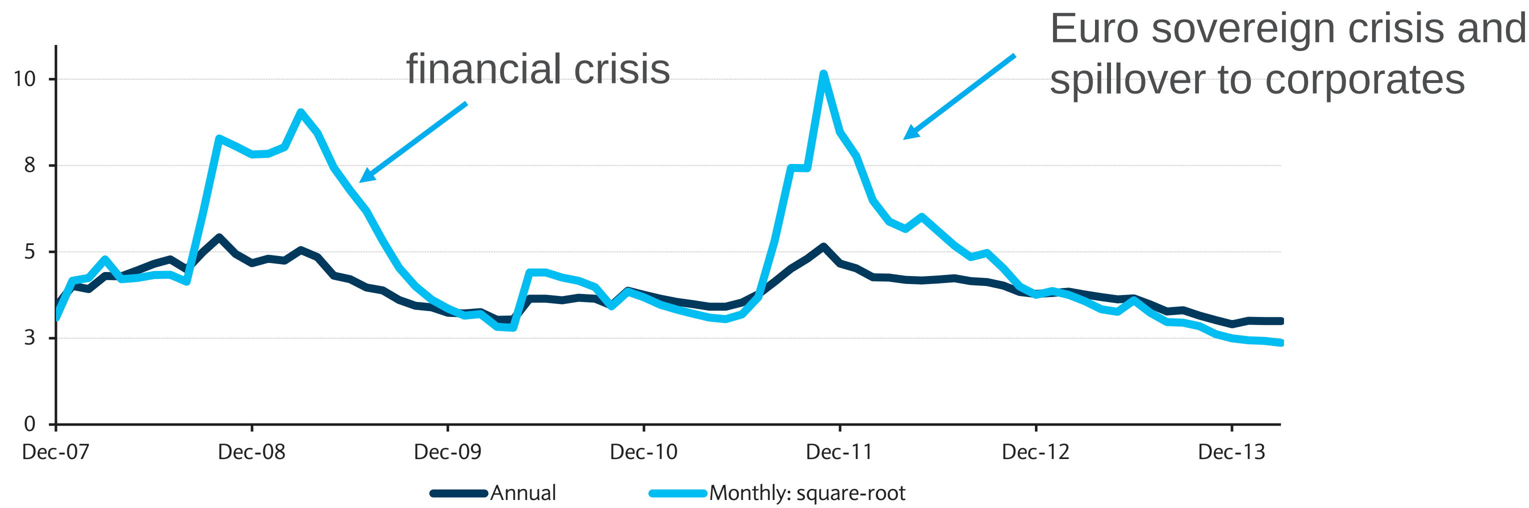
Volatility	Annual	Monthly (scaled)
Min	3.2%	2.5%
Max	4.8%	8.4%
Std.Dev (Vol-of-vol)	41bp	127bp

Source: Barclays Research

- Scaling ranges between 3.7 and 20.1
- Average scaling over time 11.3

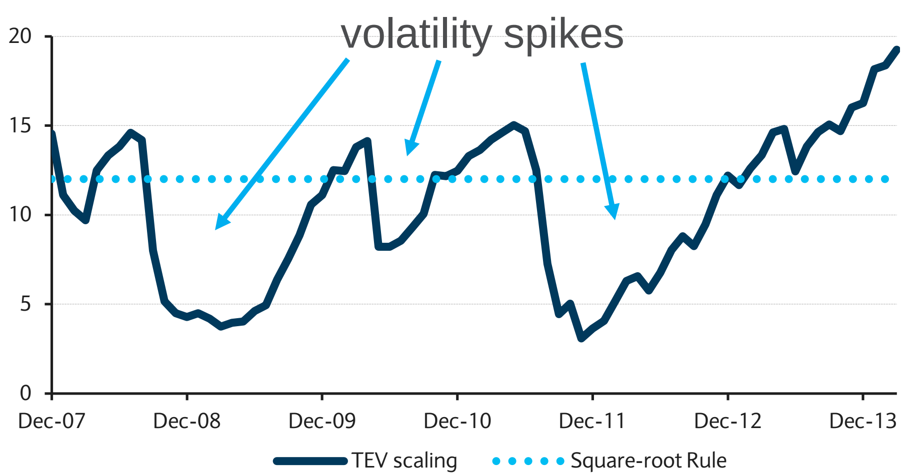
Annual Model: Euro Credit Corp

Annual vs. Monthly



Source: Barclays Research

TEV Scaling: Annual vs. Monthly



Source: Barclays Research

Comparison: TEV

Volatility	Annual	Monthly (scaled)
Min	2.9%	2.4%
Max	5.4%	10.2%
Std.Dev (Vol-of-vol)	60bp	188bp

Source: Barclays Research

- Scaling ranges between 3.1 and 19.2
- Average scaling over time 10.3

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