Moody's ANALYTICS

Market Risk Stress Testing Models

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Modelling Interest Rates and Market Factors

Leading Examples

(1) Swaps and Sovereign Curves (term structure models for interest rates)
Principle component approach

(2) Stock Market Returns, Historical and Implied Volatilities
Time series model with conditional heteroskedasticity and Global Equity Factor (GEF) related to global economic conditions

(3) Mortgage-backed Securities: Agency and Non-agency
Term structure models with GEF and prepayment factor

(4) Corporate CDS and Corporate Bond Spreads by Sector and Rating Category
Time series model with Global Credit Factors, combined with principal component analysis

(5) Sovereign CDS by Country and Maturity
Time series model with long memory, combined with principal component analysis

(6) Credit Migration
Transition matrices for credit portfolios, two-stage approach: (i) discrete-choice model combined with (ii) quantile and time-series analysis

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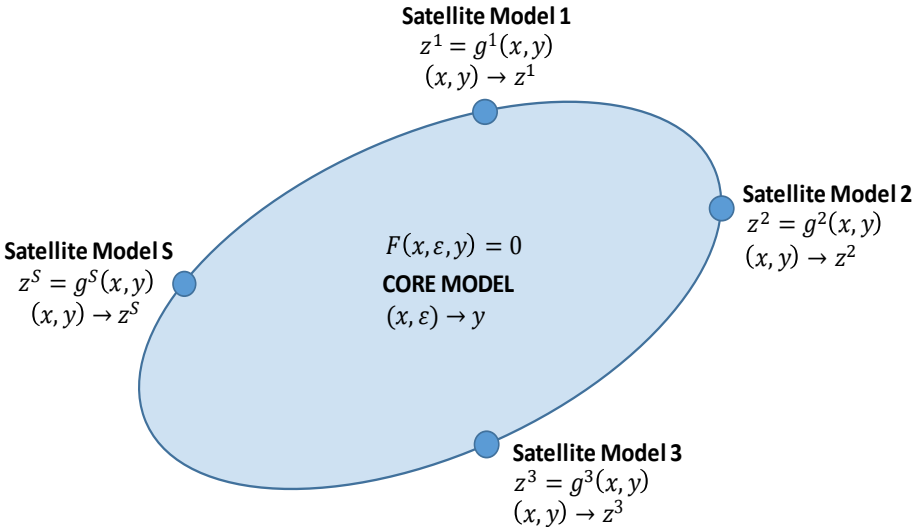
Overall Modelling Approach

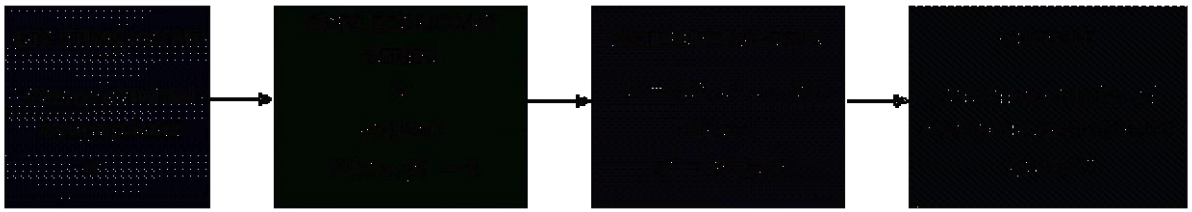
Market Risk Stress Testing Models

- Map alternative scenarios assumptions to market risk variables in multivariate, parametric and semi-structural framework.
- Satellite models allow for explicit and transparent connection to core drivers; no feedback between satellite variables *z* and core drivers *(x,y)*.
- Model selection is based on a combination of economic theory, regulatory assumptions, and the statistical properties of estimated model.
- Models have reasonable in-sample fit; produce consistent, sensible forecasts and stressed scenarios out of sample.



Model Selection Procedure

- Potential core drivers identified based on macroeconomic intuition and consistency with regulatory assumptions.
- The potential drivers undergo the ***exhaustive search process*** to obtain the most robust and predictive model available from the tested variables.
- Typical exhaustive search criteria include:
  - All possible combinations of potential drivers (including lags)
  - A max number of macro drivers selected
  - No strong correlation between drivers
  - Coefficient estimates must be statistically significant
  - Expected signs and magnitude of the estimates
  - Maximization of a target index (e.g. Adjusted R^2 /RMSE, Log-likelihood, AIC, MAE, etc.)



Typical Model Validation

- **Post-estimation analysis**

Diagnostic methods to verify regression model assumptions and detect. Residual & outlier analysis, in-sample goodness of fit.

- **Beta elasticities**

Quantifies the response of the dependent variable to a 1 standard-deviation shock on each driver.

- **Impulse-response analysis**

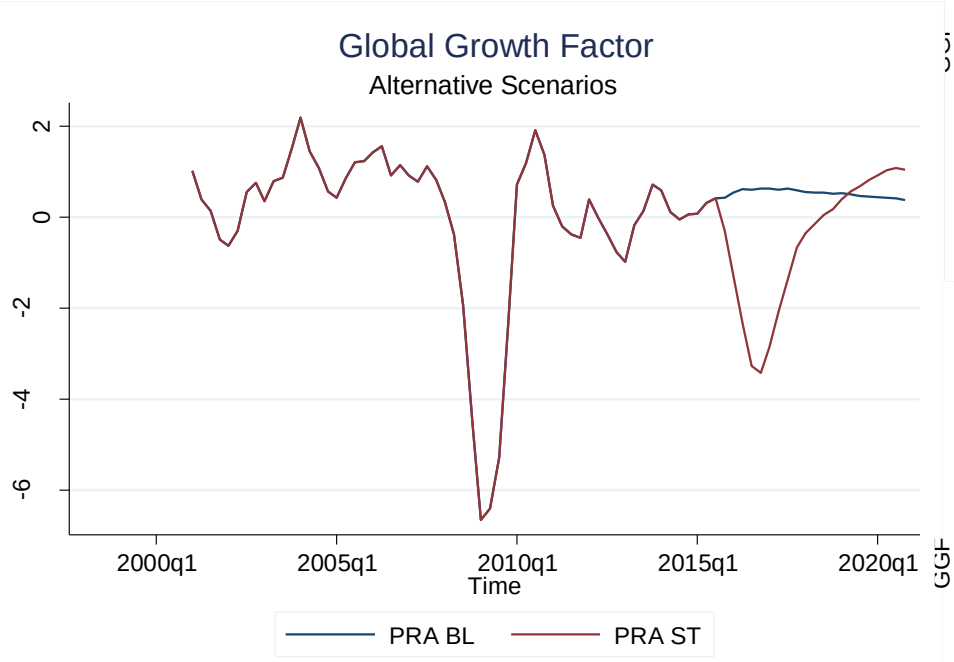
Time-series analysis of the effect of a permanent and/or temporary shock (e.g. 1 standard-deviation) applied to any given driver. The output is the **response** function (over time) of our endogenous variable to an **impulse** on any of the drivers.

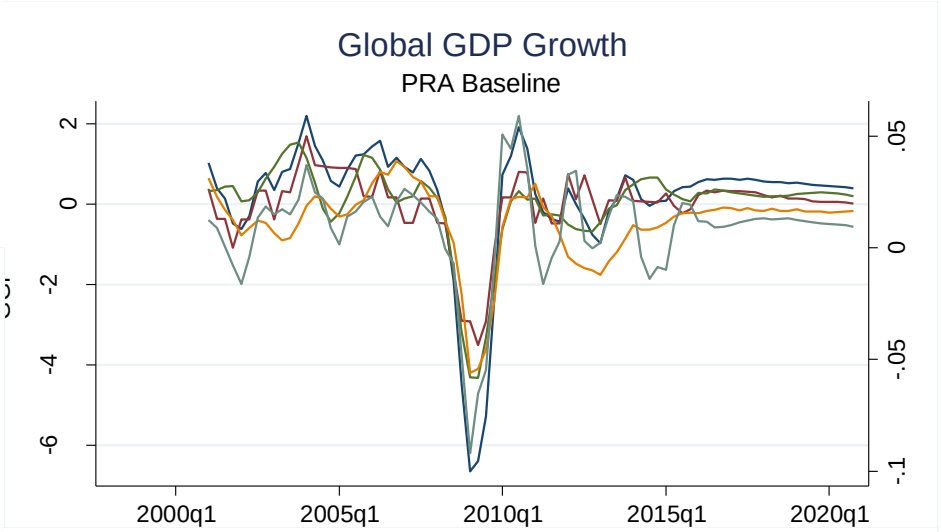
- **Backtesting**

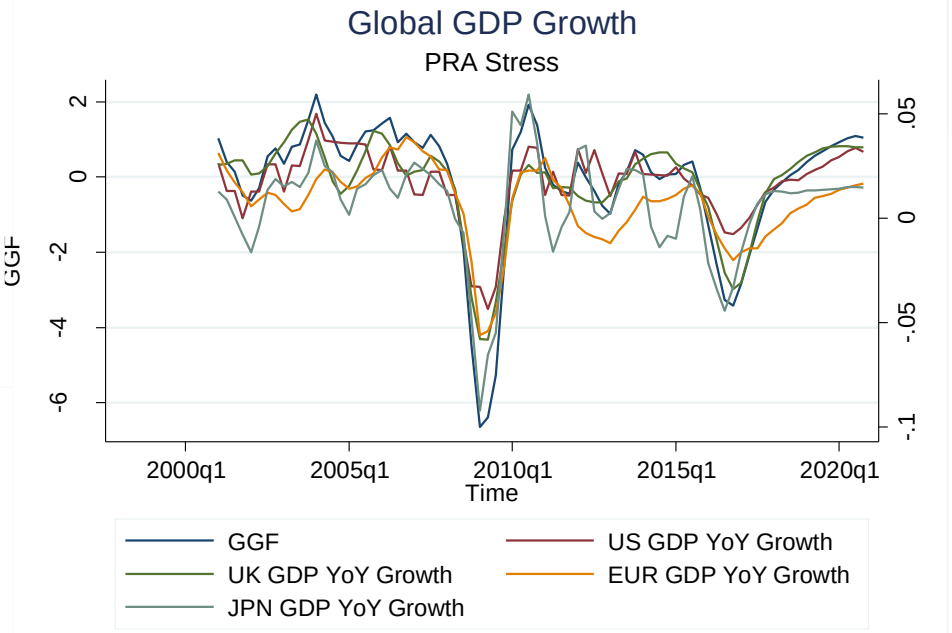
Remove parts of the sample data from the model estimation and use the model to generate forecasts for the resulting holdout sample to assess model accuracy.

Model Drivers

Global Growth Factor (GGF)

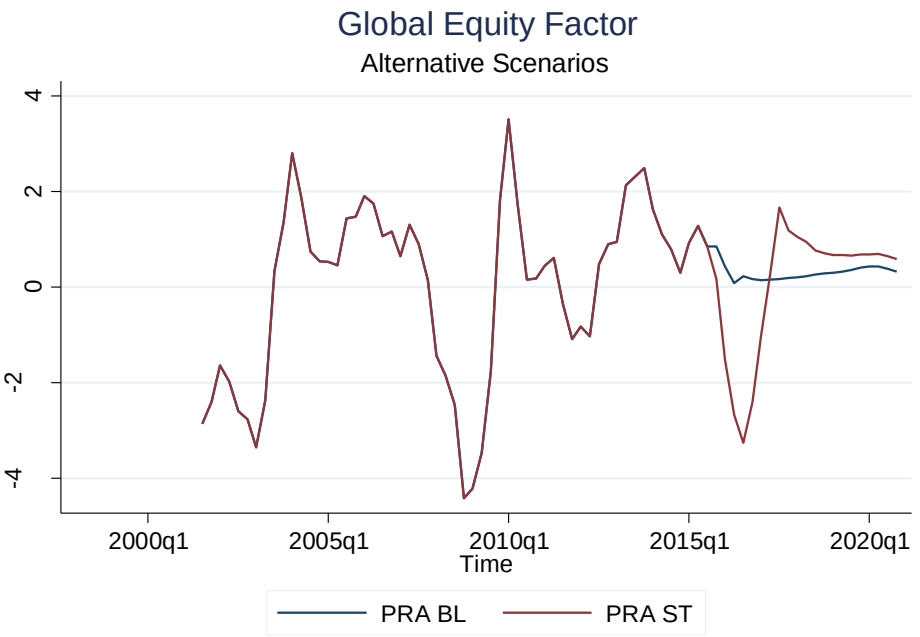


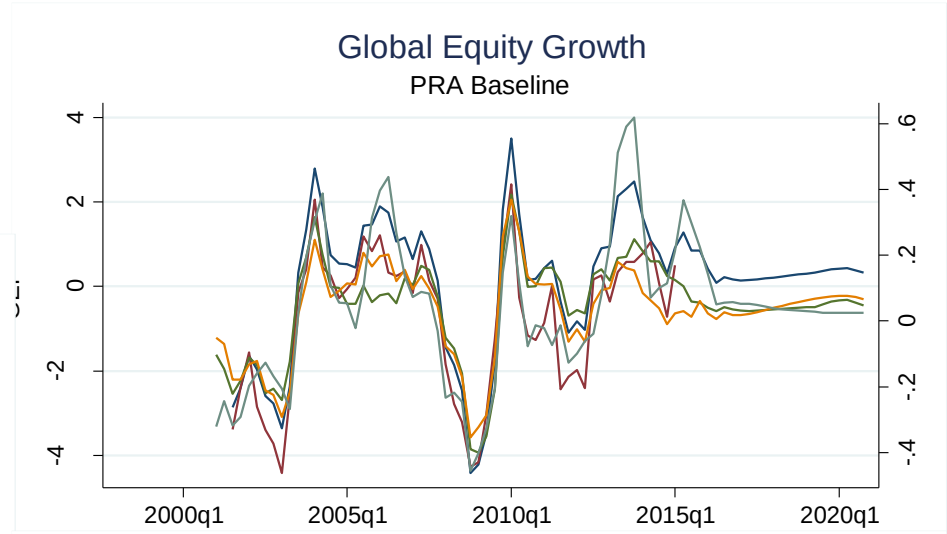


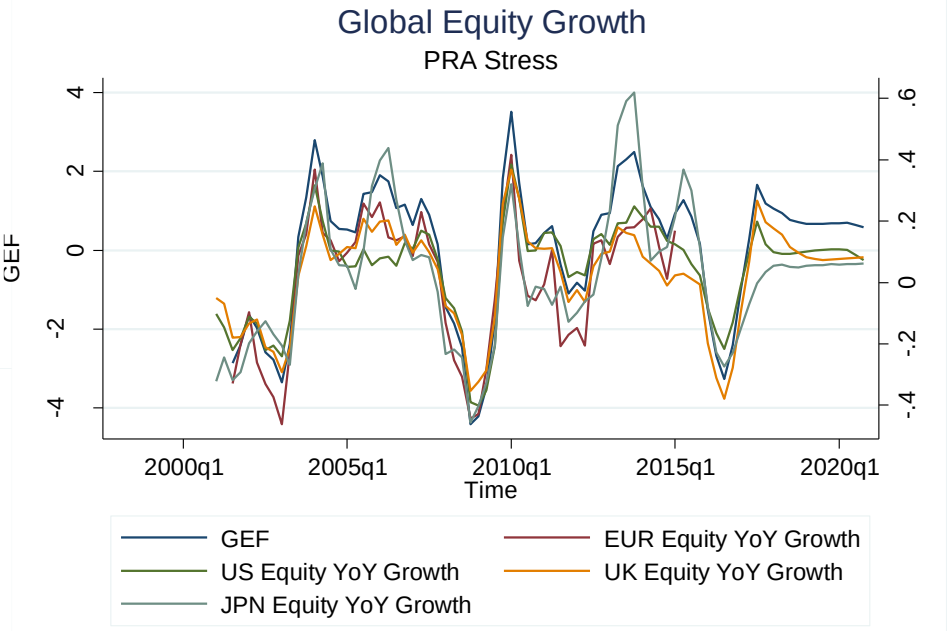


Model Drivers (cont.)

Global Equity Factor (GEF)

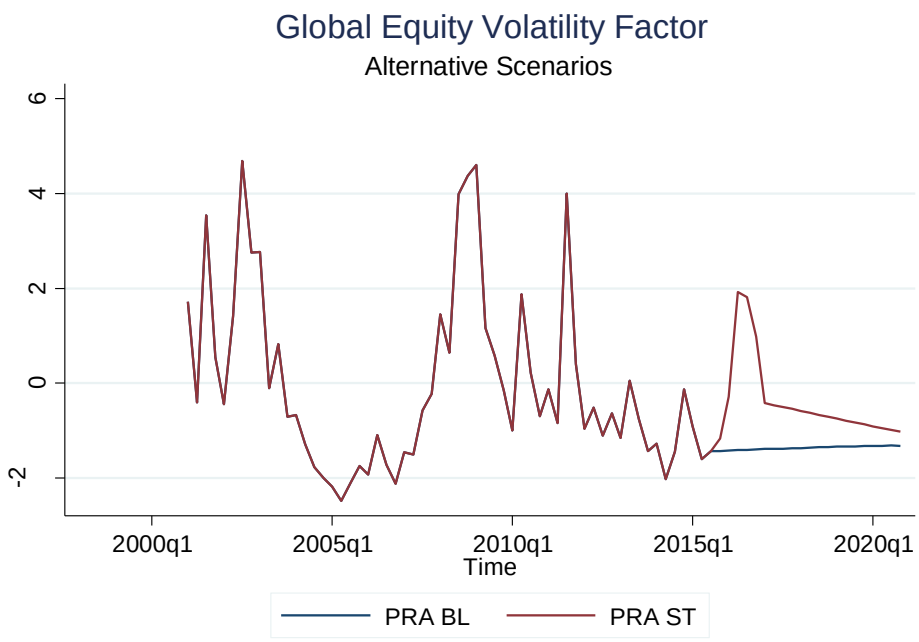


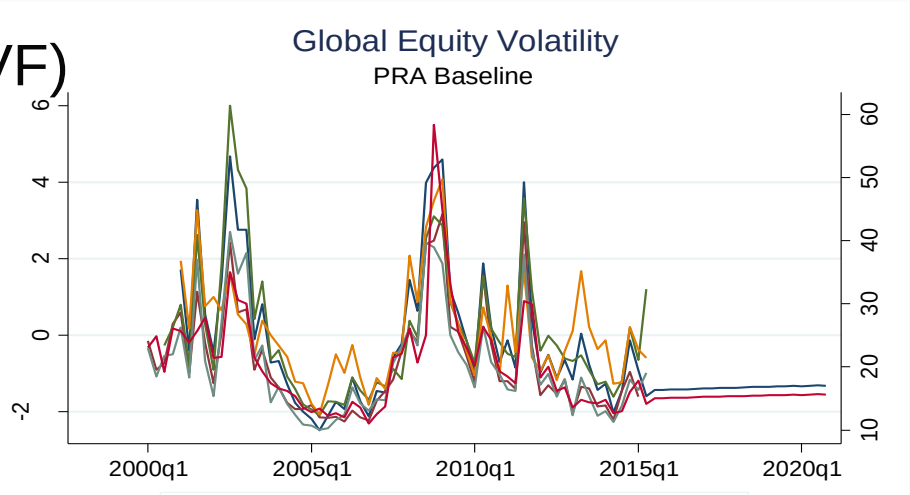


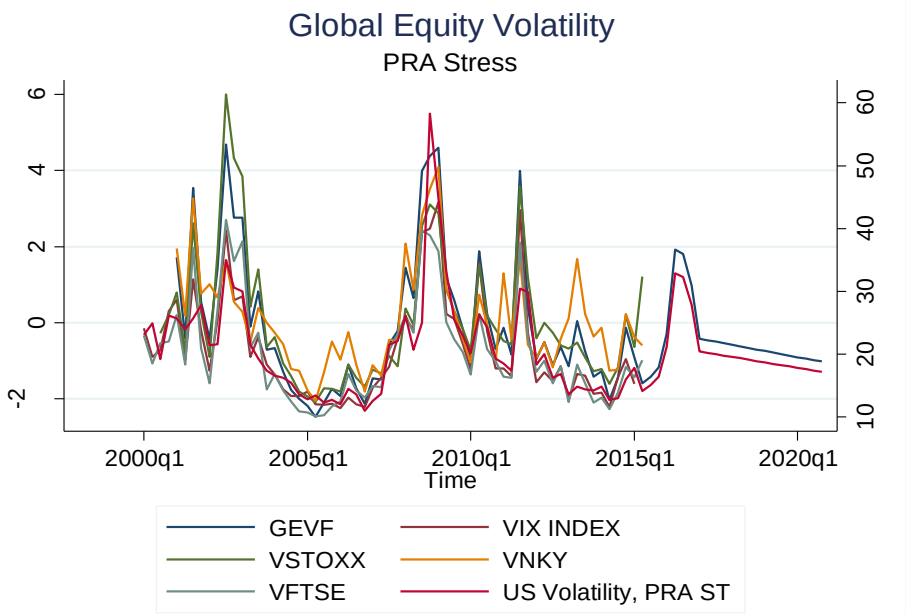


Model Drivers (cont.)

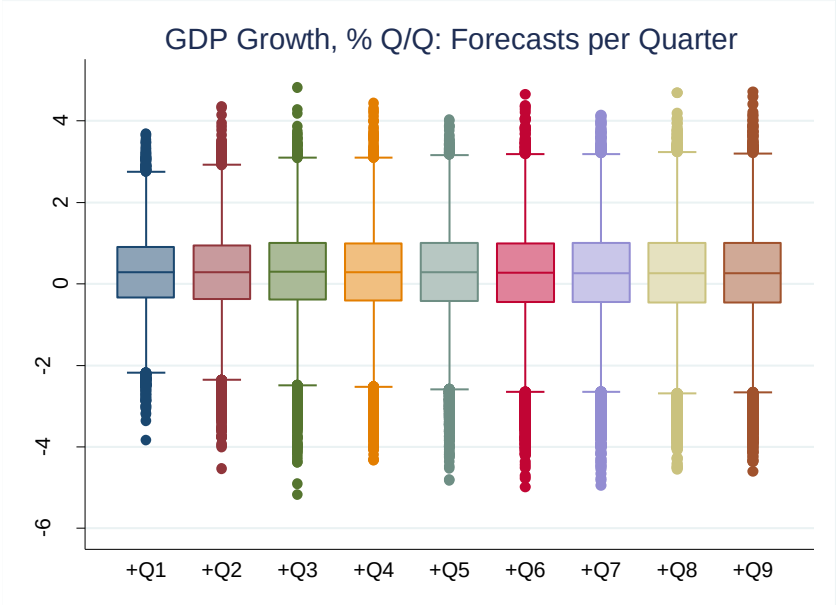
Global Equity Volatility Factor (GEVF)

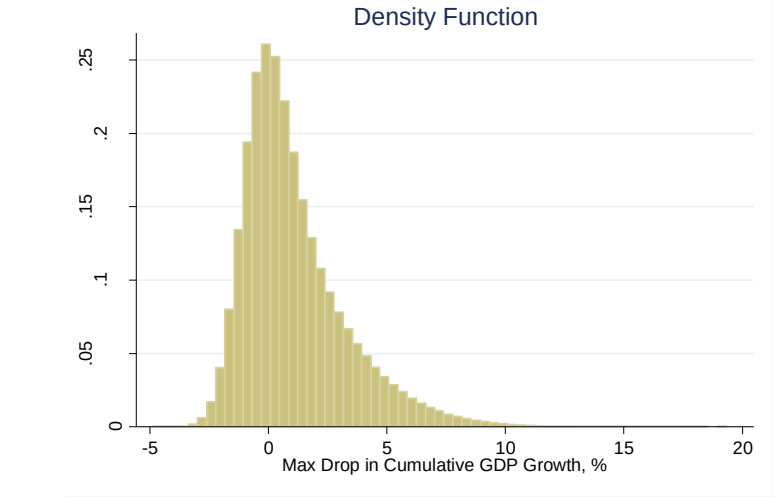




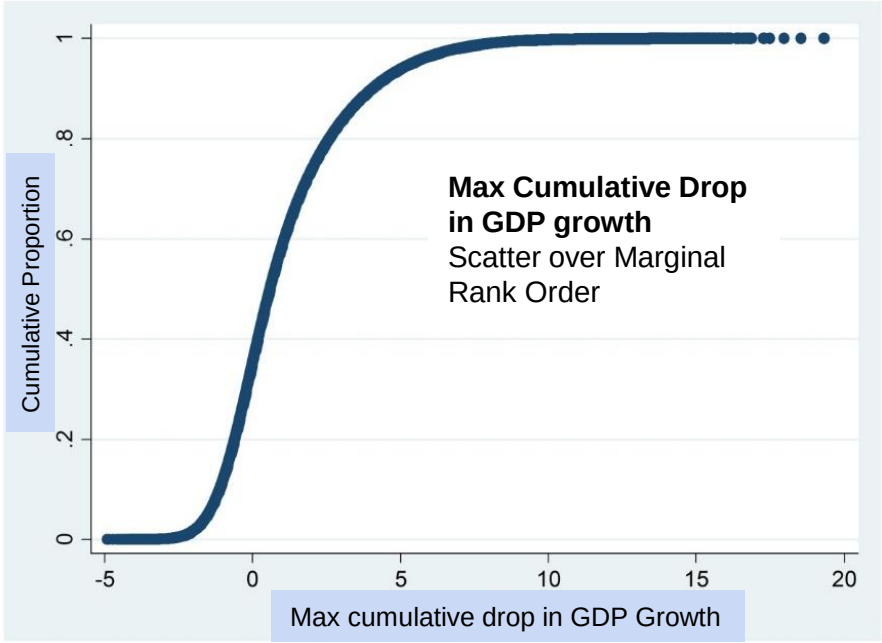


Macroeconomic Scenario Simulations

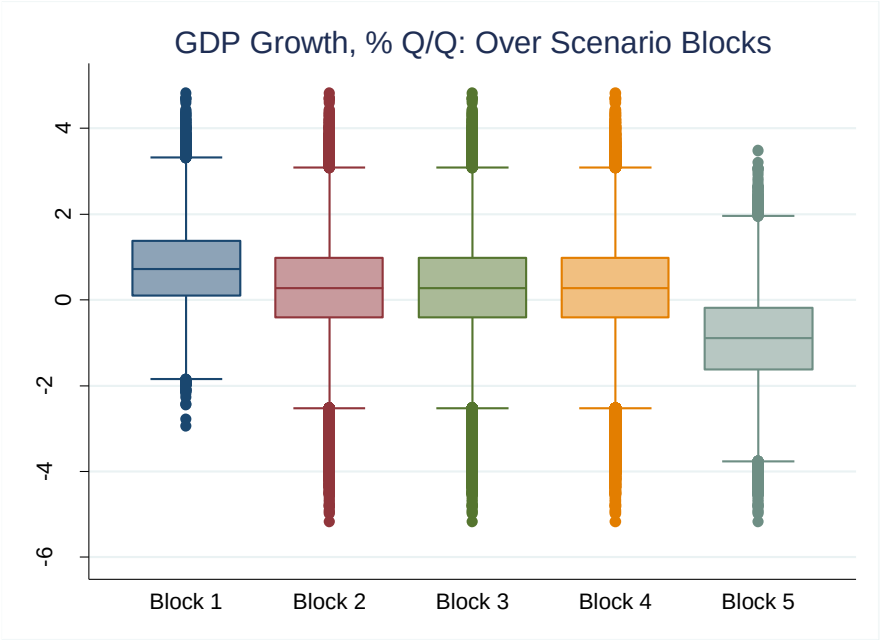


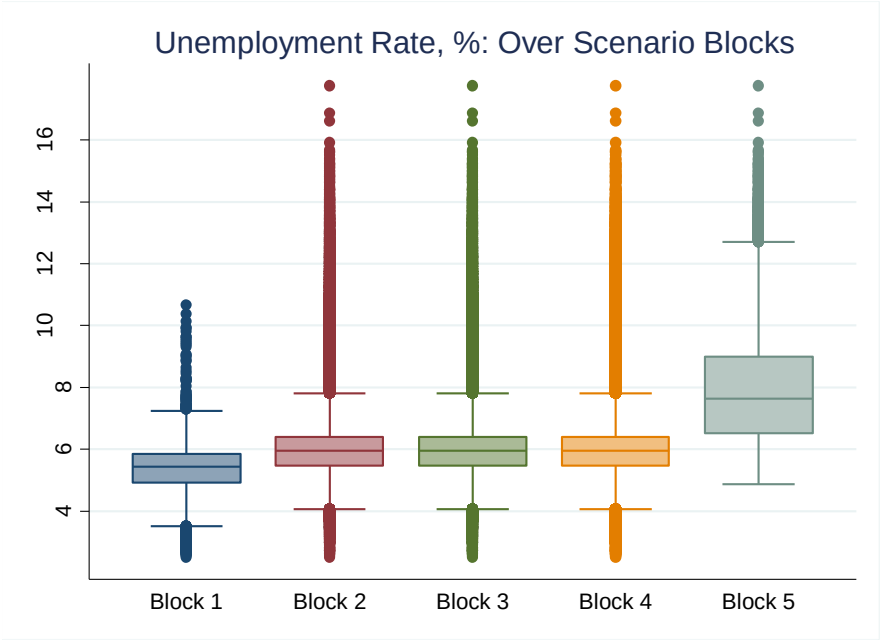


Example of a Marginal Loading into Overall Scenario Rank-Ordering Algorithm



Macroeconomic Scenario Simulations (cont.)





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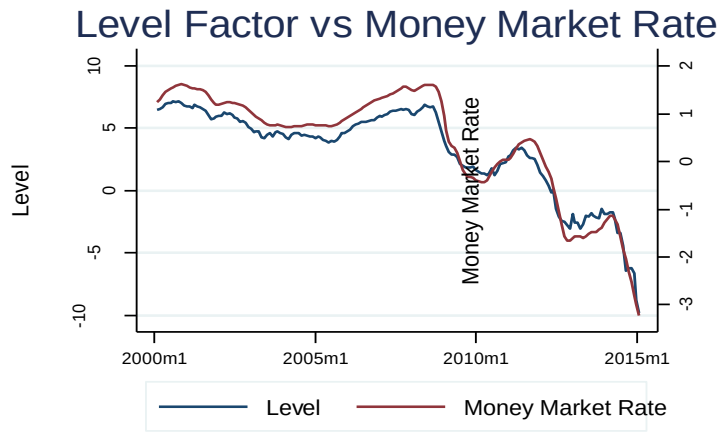
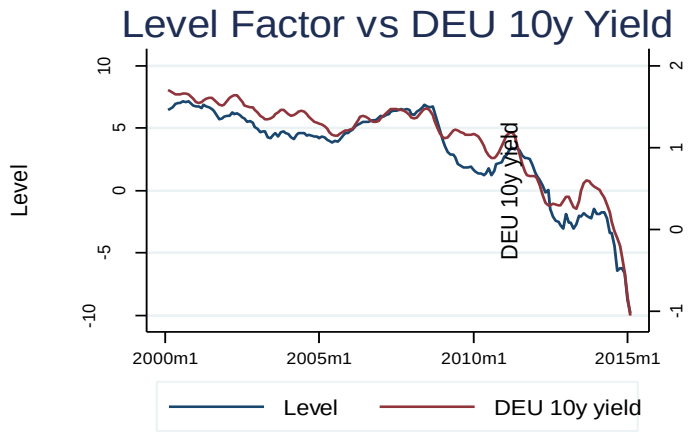
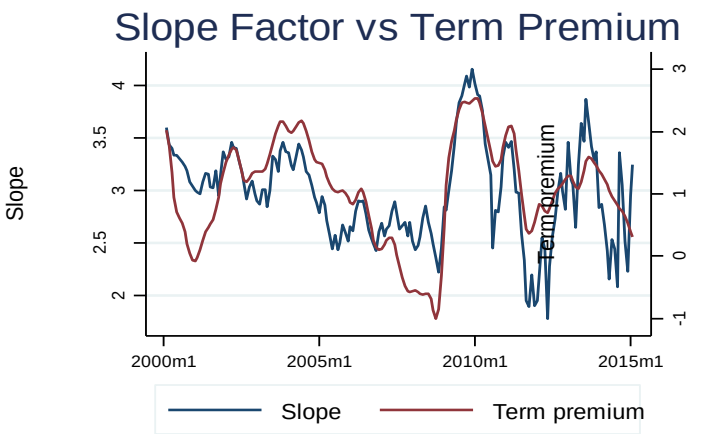
Examples of Market Risk Models:
Swap Rates, Bond Yields & Libor Rates
Equity Returns & Volatilities
Corporate Credit Spreads

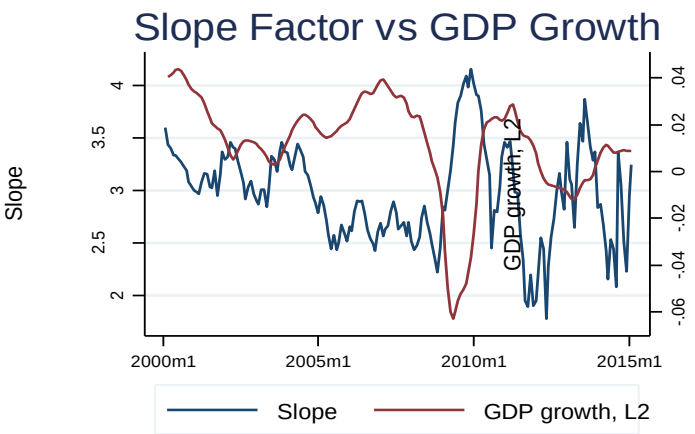
Swap Rates

Euro curve level and slope factors with core drivers



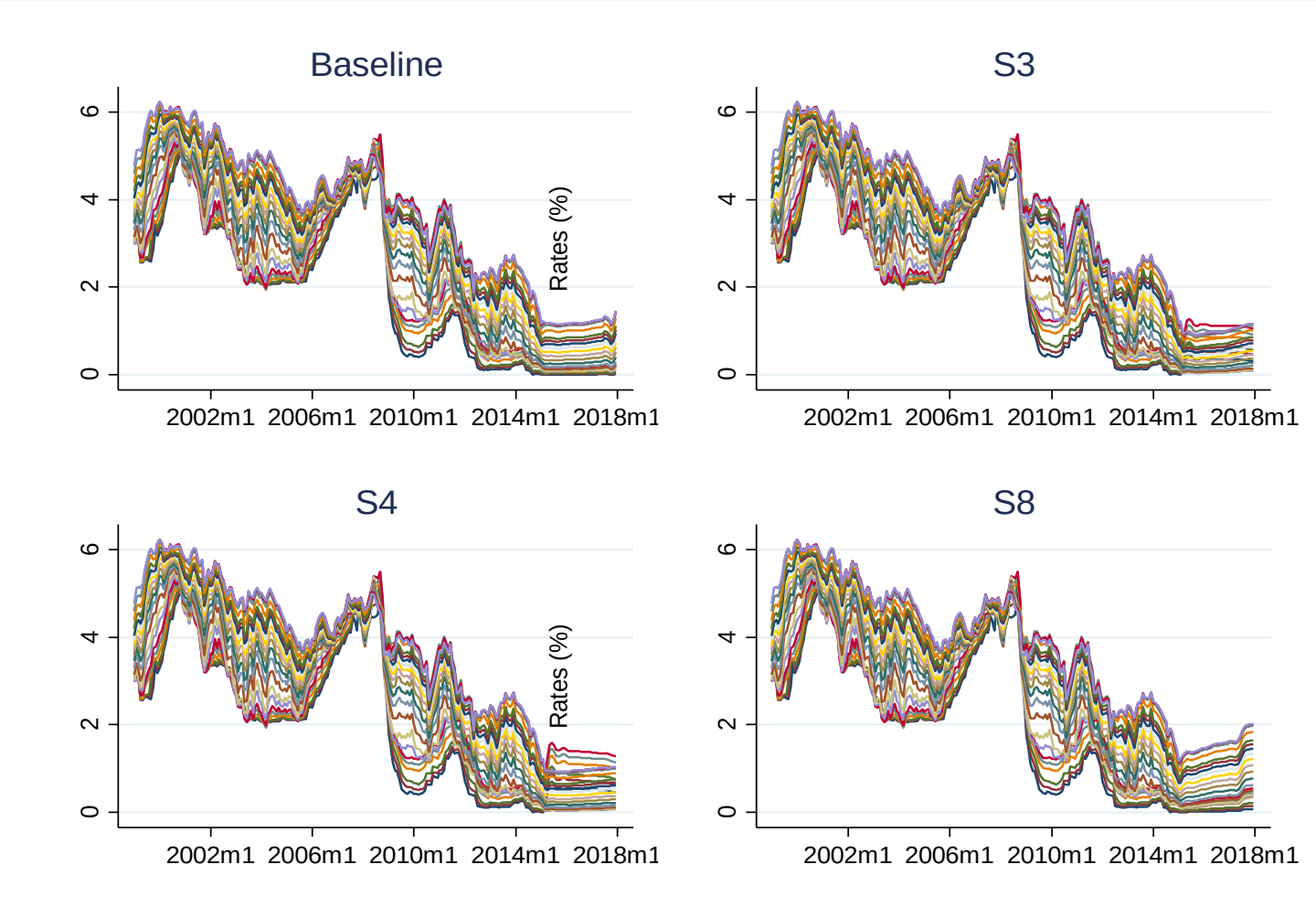






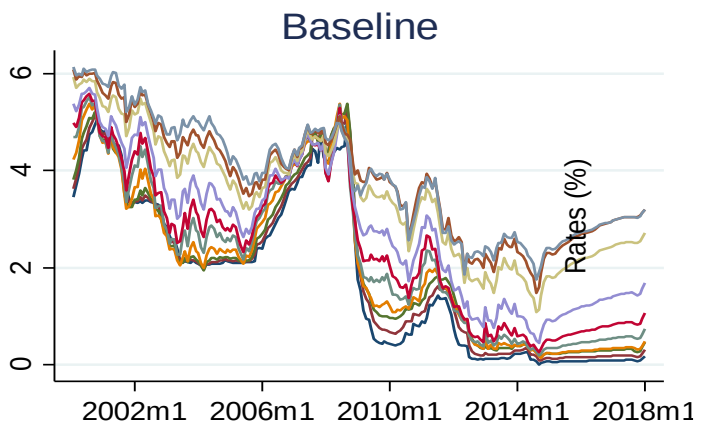
Swap Rates (cont.)

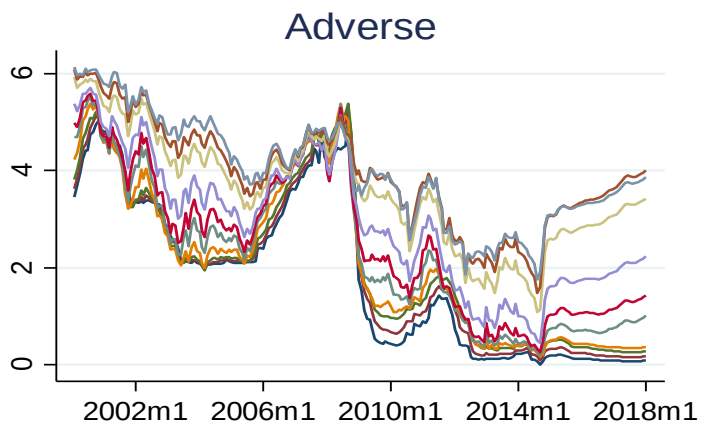
Euro term structure history and forecasts, ECCA scenarios

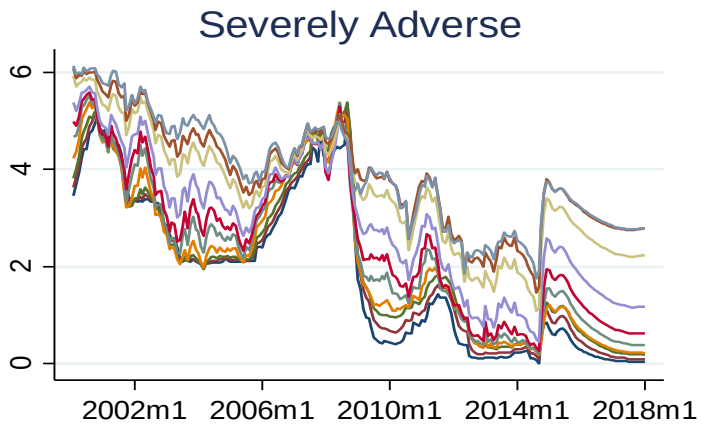


Swap Rates (cont.)

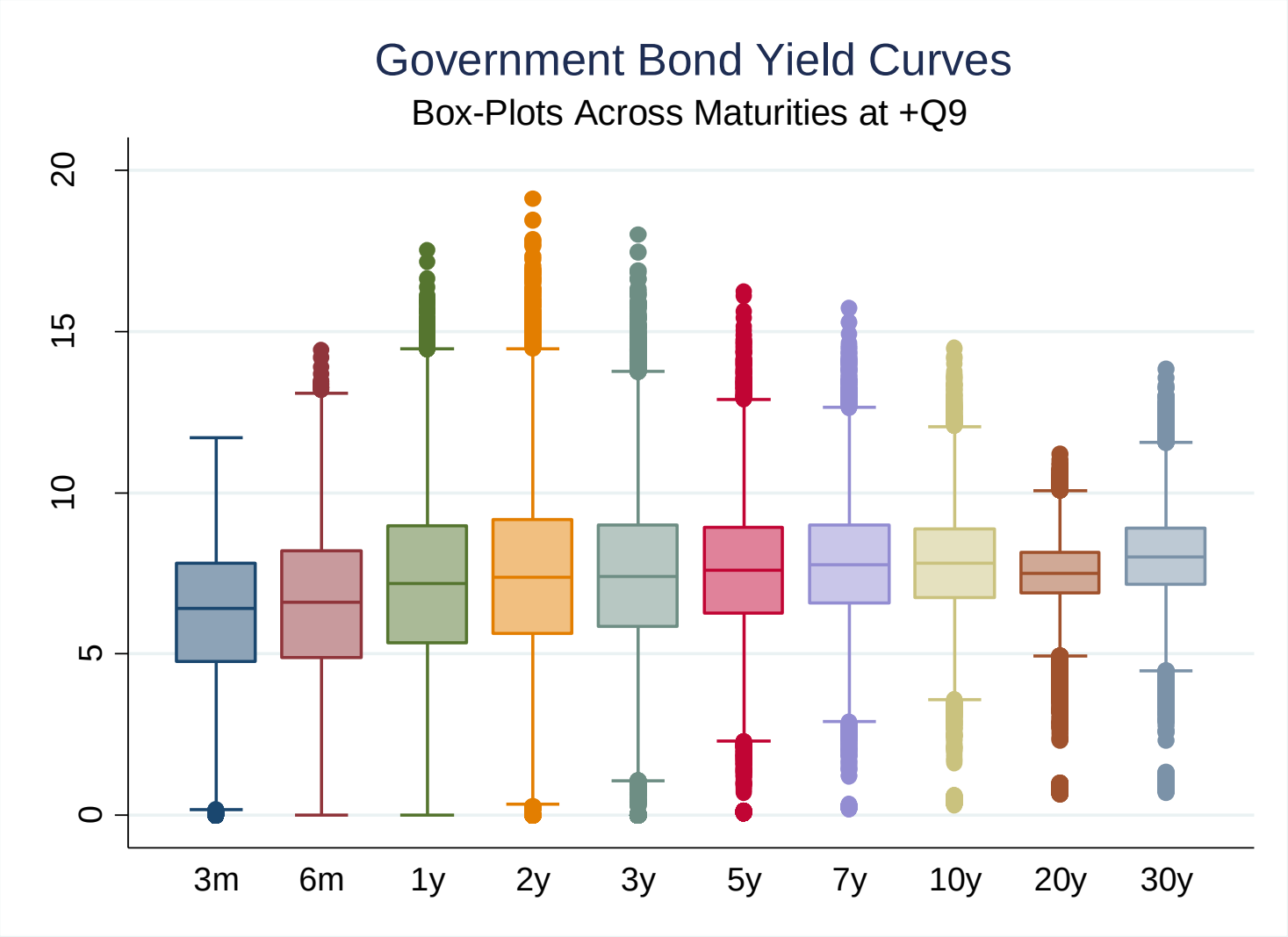
Euro term structure history and forecasts, CCAR scenarios



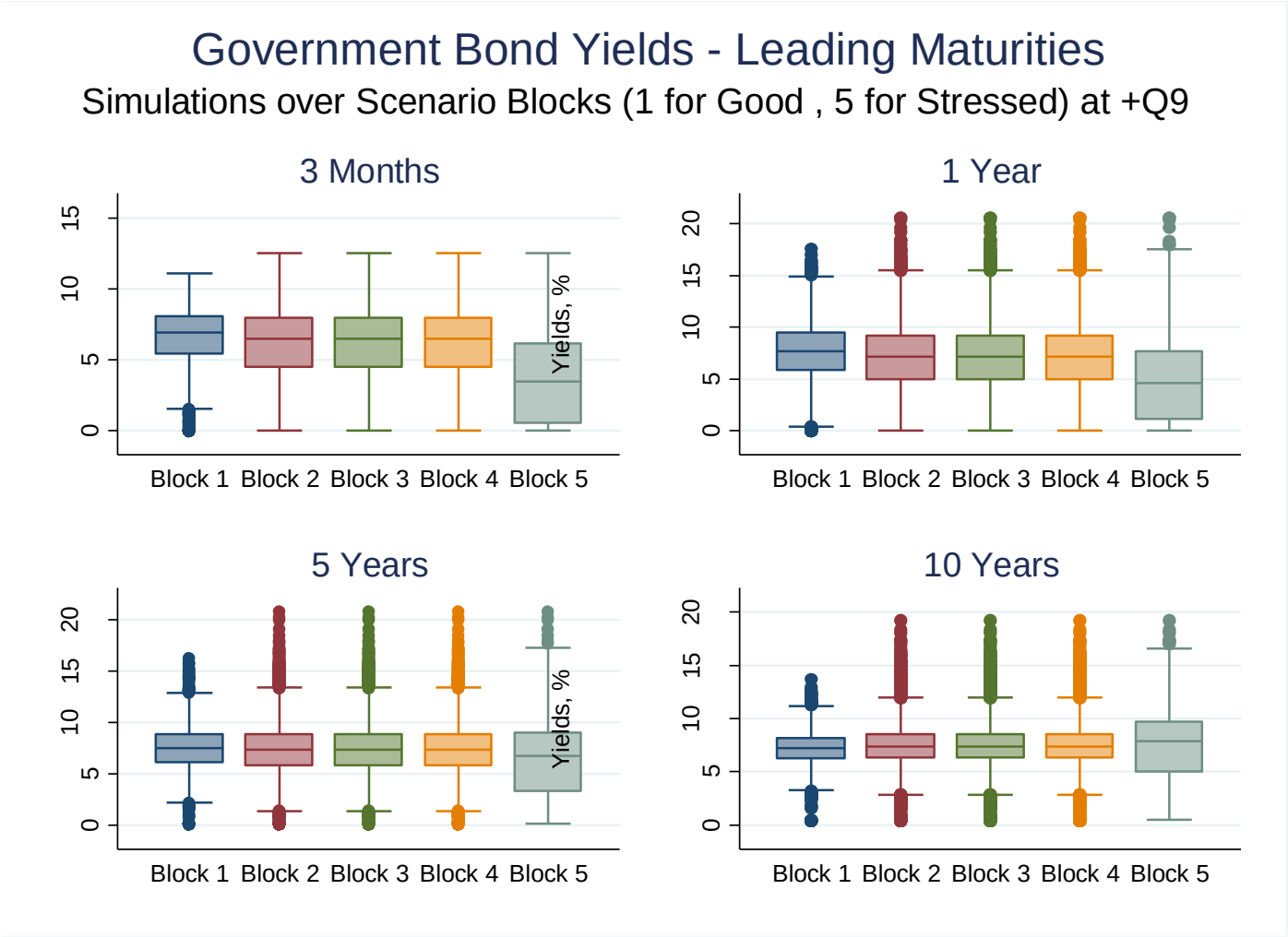




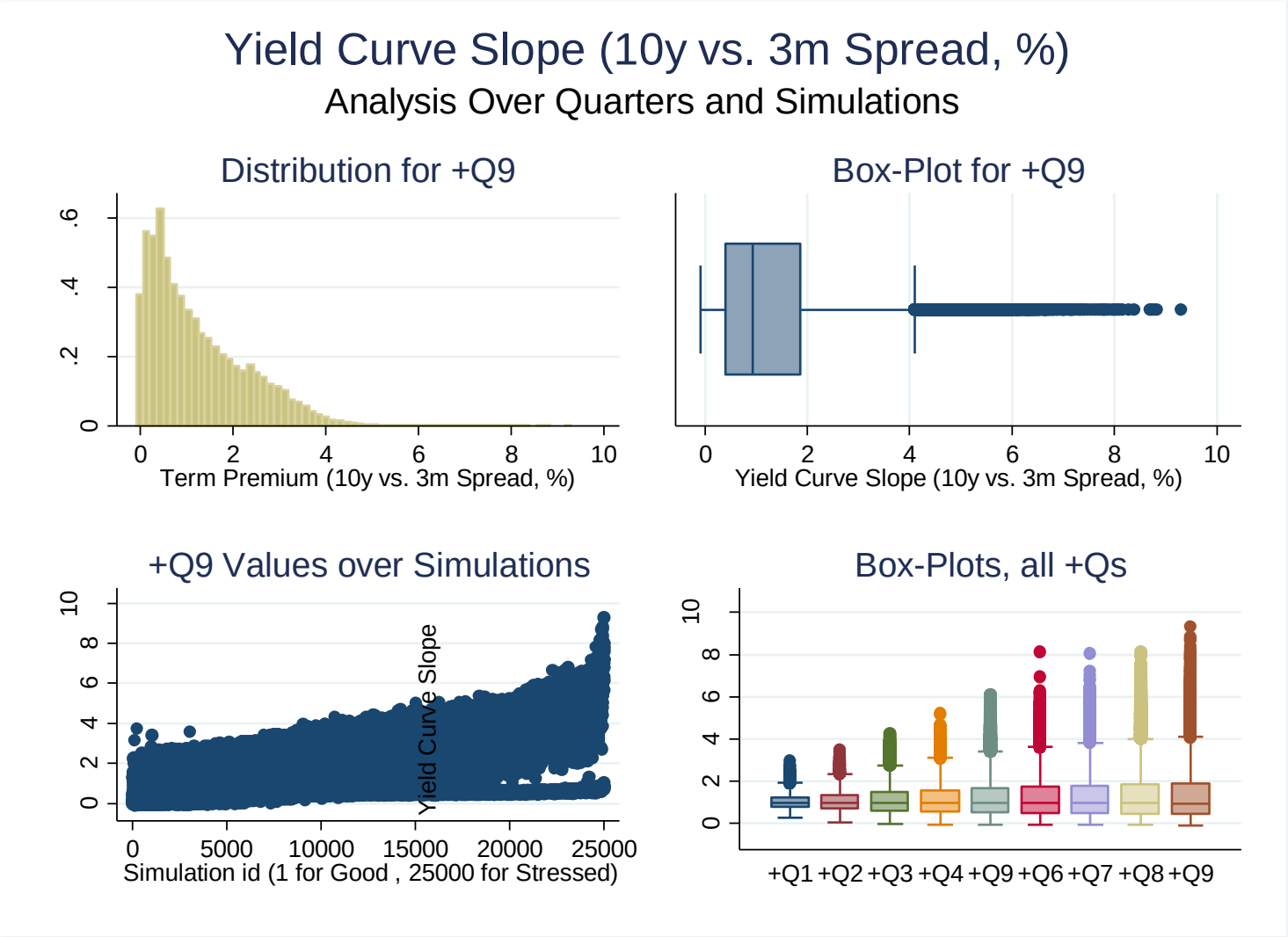
Government Bond Yields



Government Bond Yields (cont.)

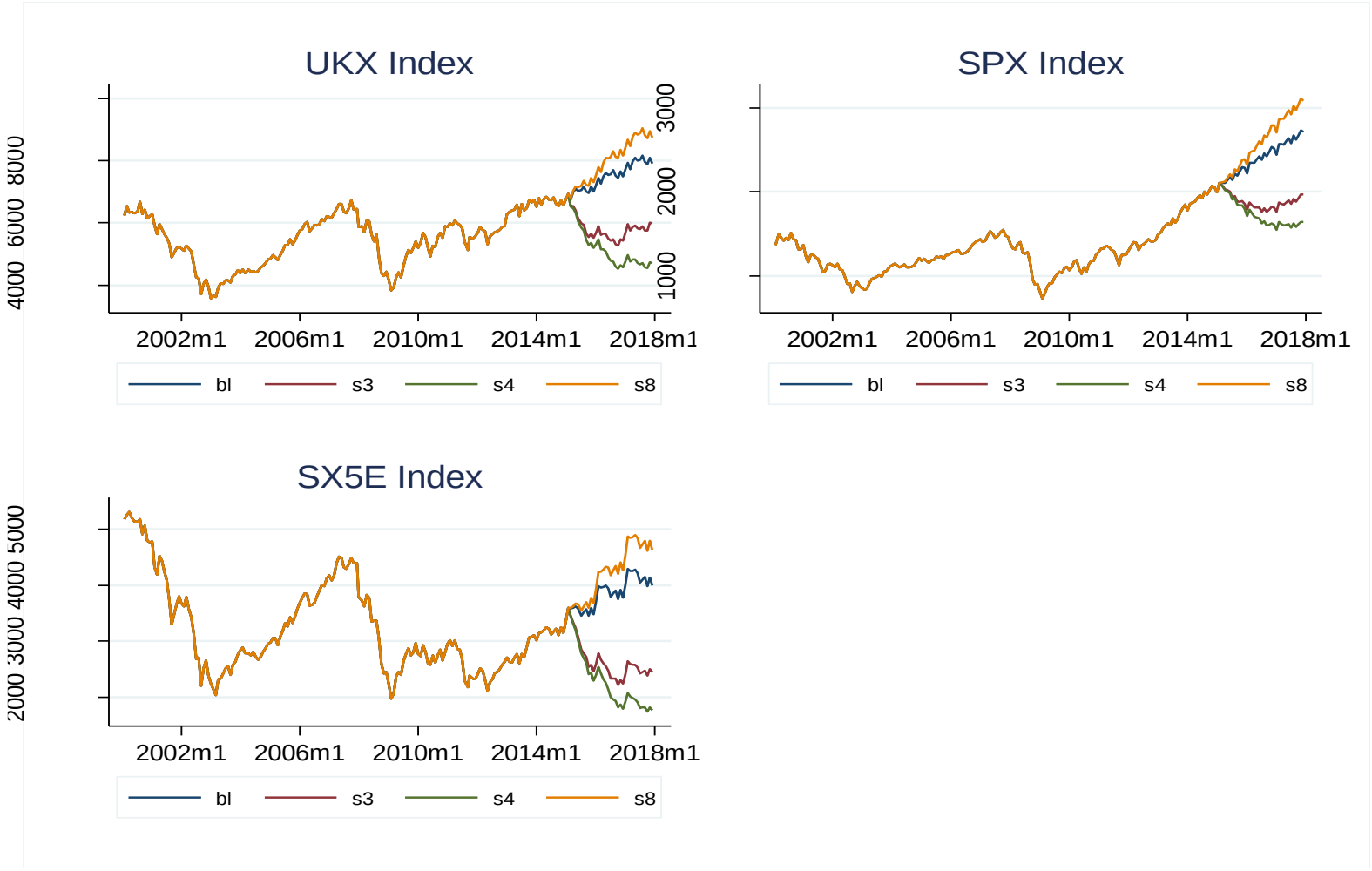


Government Bond Yields (cont.)



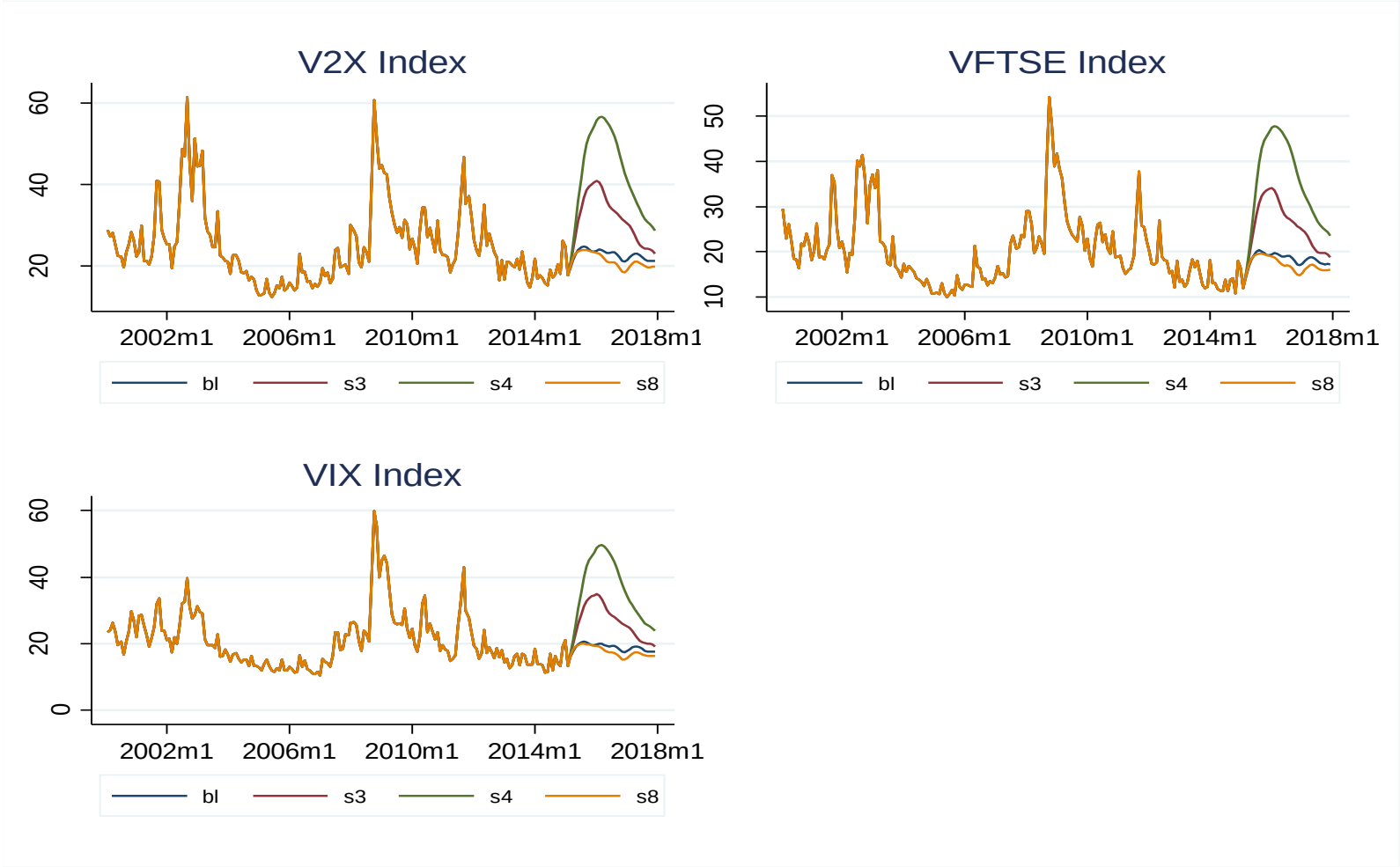
Equity Returns and Volatilities

Stock indexes history and forecasts, ECCA scenarios



Equity Returns and Volatilities (cont.)

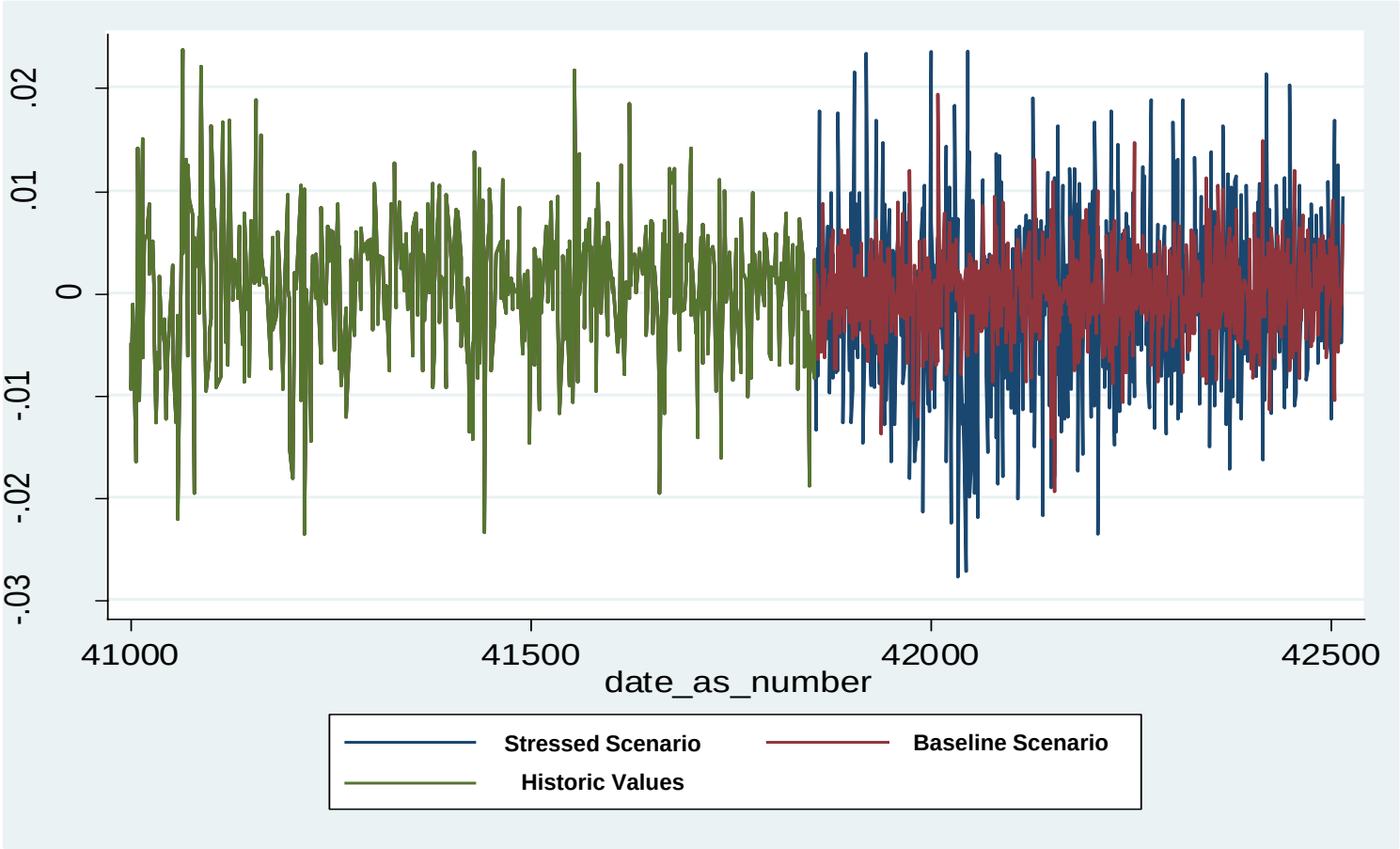
Implied 30-day volatility history and forecasts, ECCA scenarios



Equity Returns and Volatilities (cont.)

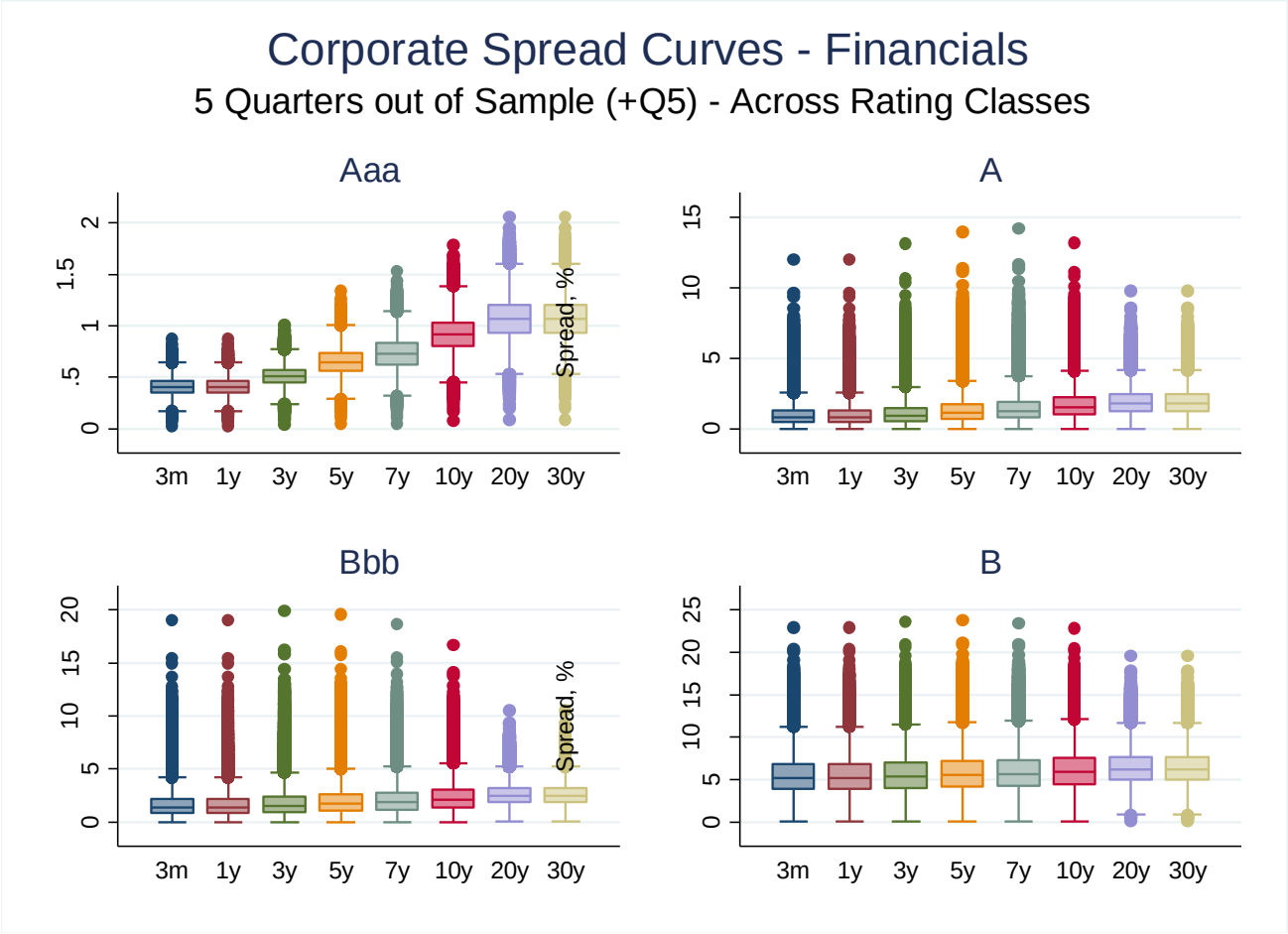
Example of daily forecasts – Dow Jones Industrial Average

Forecast daily returns over time – consistent with Baseline & Severe Scenarios



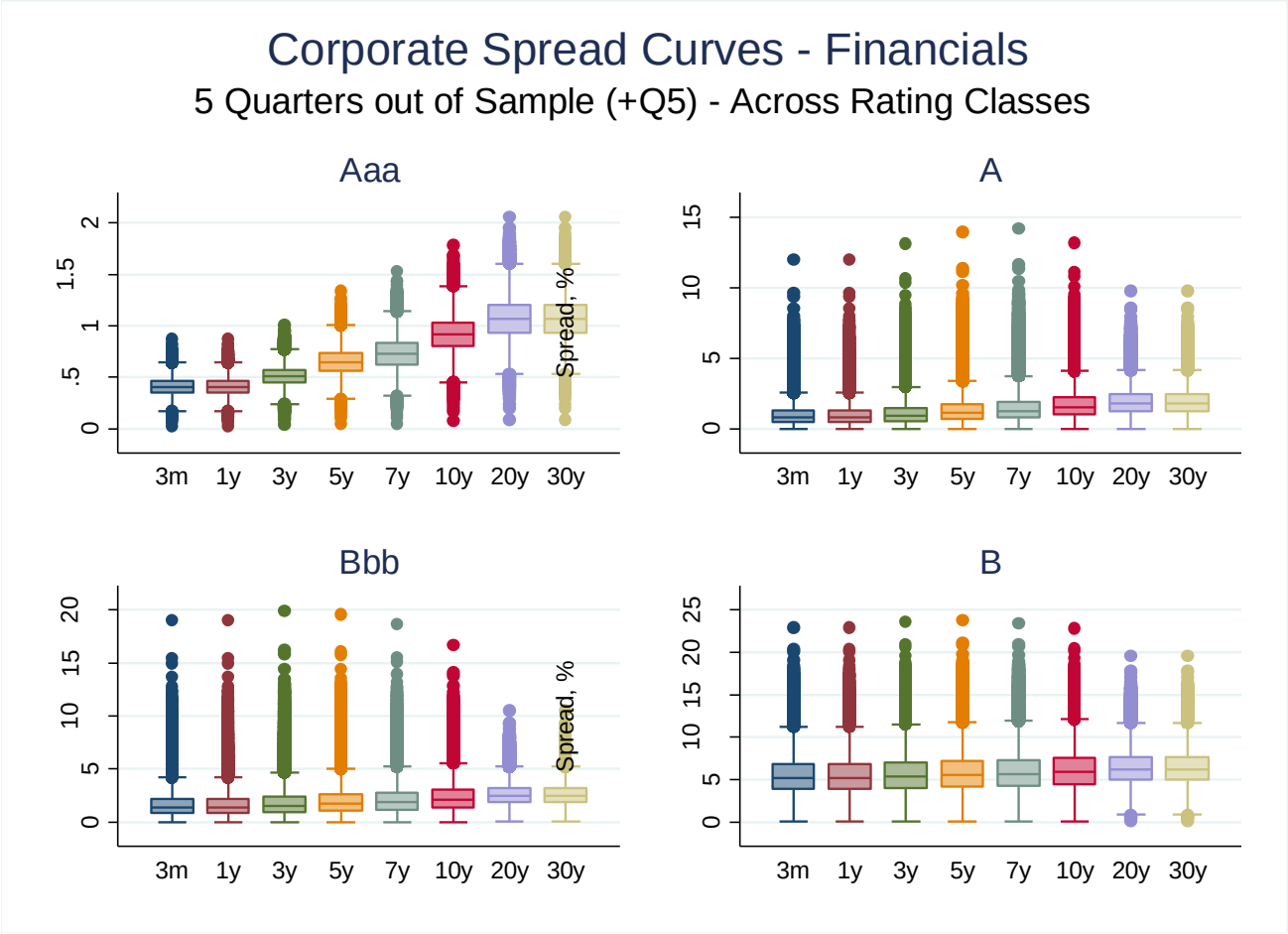
Corporate Credit Spreads

Financials - over maturities and rating classes



Corporate Credit Spreads (cont.)

5Y Credit Spreads for Financials - over quarters and ratings



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Concluding Remarks

- Model set-up
- Scenario-driven and simulated projections
- Leverage credit risk stress testing models to achieve consistent outcomes

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