Backtesting Shortfall: A Breakthrough in Risk Management

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Summary

- A new methodology from MSCI ends debate as to whether Expected Shortfall (ES) can be backtested
- MSCI provides a simple backtest framework for ES
  - Easy to implement
  - Easy to audit
- Especially important where asset management is vulnerable to tail risk
Backtesting in a Nutshell

- Backtesting means checking whether realizations were in line with model forecasts
- However, distributions (and statistics) do not materialize
  - Only one scenario at a time does
- Not all risk measures can be backtested
  - Not easy to say which ones can
VaR and Expected Shortfall (ES)

- **VaR**: the best of worst x% losses; \(\rightarrow\) threshold of x% losses
- **ES**: the average of worst x% losses \(\rightarrow\) expected x% loss

**ES multiple advantages**: tail sensitivity, “coherent”

**Last roadblock for ES toward Basel**: backtesting

**As of Oct 13**, no general consensus how to backtest ES
Background

- In 2012, the Basel Committee proposed to change the measurement method for forecasting risk
- ...from the method called Value at Risk
- ...to an alternative known as ‘Expected Shortfall’
- ...which regulators believed would better capture the extreme losses in times of systemic turmoil

“Basel Committee proposes scrapping VaR”
Risk.net, May 2012
But no general backtest method for Expected Shortfall had ever been discovered

Moreover, many financial experts concluded that Expected Shortfall can’t be backtested

Because of this debate, the Basel Committee suggested:

- Adopting Expected Shortfall to measure risk,
- But continuing to use Value at Risk for backtesting
The Breakthrough from MSCI

- MSCI solves this dilemma by demonstrating:
- It is possible to backtest Expected Shortfall,
- The MSCI methodology is more informative – as a test of model performance – than the current VaR backtesting methodology
- And it is relatively simple to implement
Elicitability: A Red Herring

- Due to a 2011 proof that ES lacked a mathematical property called “elicitability”...

- It was believed, incorrectly, that ES could not be backtested
  - But this concern is a red herring

- MSCI proves that elicitability is related to model selection and not to model testing, and is therefore irrelevant for the choice of a regulatory risk standard.
Backtesting Expected Shortfall

- MSCI solves this dilemma by proving that elicitability does not imply backtestability.
- This proof actually shows a simple method to backtest ES.
- MSCI introduces three model-independent, non-parametric back-test methodologies for ES.
- More powerful than today’s standard Basel VaR test.
  - One of them (Test 2), in particular, requires same data storage as a normal VaR backtest.
Why this matters for LDI

- Expected Shortfall is a popular risk measure for LDI strategies
- Regulatory framework in which LDI operates requires tail risk management
- Market movements can have non-linear impacts on funded status
- LDI strategies are very sensitive to inflation and interest rate assumptions and movements
Proposals for Basel

- Our results provide ways to backtest models in the current ES-based framework for internal models in Basel regulation

- The two best candidate solutions would be:
  - Integrating the current VaR backtest on frequency of exceptions with Test 1 on their magnitude
  - Replacing the VaR backtest with just Test 2

- We consider the latter solution most promising:
  - Simpler to implement
  - A single number is always an easier tool for decision making
Conclusions

- It has long been known that Expected Shortfall (ES) is superior to Value at Risk (VaR)
  - But methods to back-test ES remained elusive
- MSCI has just demonstrated that back-testing ES is possible
  - And proposes a simple method for back-testing ES
- This breakthrough will improve risk management for LDI
- And could potentially replace VaR in regulatory reporting and risk management
Technical Appendix
Basel: VaR or ES?

- 1996: Basel Committee internal-based approach to capital adequacy, based on VaR
- 2001: Rockafellar and Uryasev, Acerbi and Tasche, define “Expected Shortfall” (ES, aka CVaR), a coherent measure of risk
- 2000s VaR and ES are widely adopted by financial institutions as complementary tools
- 2013: Basel Committee replaces VaR1% with ES2.5%
  - VaR is maintained for model backtesting
Test 2: No Need for MC Testing

- $Z_2$ displays remarkable stability of the significance thresholds across a wide range of tail index values, which span all financially realistic cases.
- A $Z_2$ traffic-light system can be designed, based on fixed significance thresholds.
- No need to record forecast distributions.

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<th>0.01% location</th>
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Table 1: 5% and 0.01% significance thresholds for $Z_2$ across Student-$t$ distributions with different $\nu$ and location.
Implementing Test 2

- Test 2 can be adopted without storing forecast distributions
  - 95% and 99.99% significance level thresholds are fixed values \( Z_2 = -0.70 \) and \( Z_2 = -1.8 \)
- Every day, it is sufficient to record the quantities
  - \( X_t I_t \): magnitude of exceptions, or zero
  - \( ES_t \): predicted ES
- The graph \( s \mapsto \sum_{t=1}^{s} \frac{X_t I_t}{T \alpha ES_{\alpha,t}} + \frac{s}{T} \)
  - allows us to visualize the time evolution of the contributions to the final \( Z_2 \) and check time independence
Elicitable ≠ Backtestable

- We have shown that ES can be backtested without being elicitable
- Therefore backtestable $\not\Rightarrow$ elicitable
- Or in other words, elicitability is not the only way to backtest

Actually, there is even more...
Elicitability: Model Selection, Not Model Testing

- If a measure is elicitable, we can rank models by their mean score
  - However, this is a relative, not an absolute scale
  - A mean score alone doesn’t tell us anything about the validity of a single model
- A mean score allows to choose the best model among several ones which forecast the same random process
  - Ex: Bank A has three VaR forecast models and runs a contest to select the best one
  - This is Model selection
- Statistical test instead provides a validation with absolute significance
  - Ex: Bank A wants to validate the model
  - Ex: Regulators want to compare models of Banks A, B, C, ...Z against the same scale
  - This is Model testing (a.k.a. validation)
- This key observation has been completely overlooked so far in the public debate
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May 2014