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

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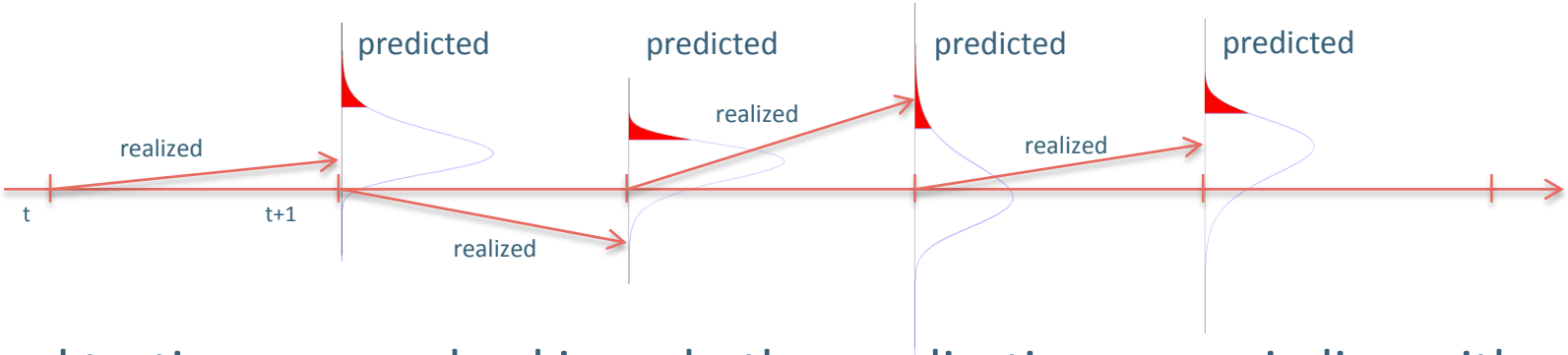
Backtesting in a Nutshell



- 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

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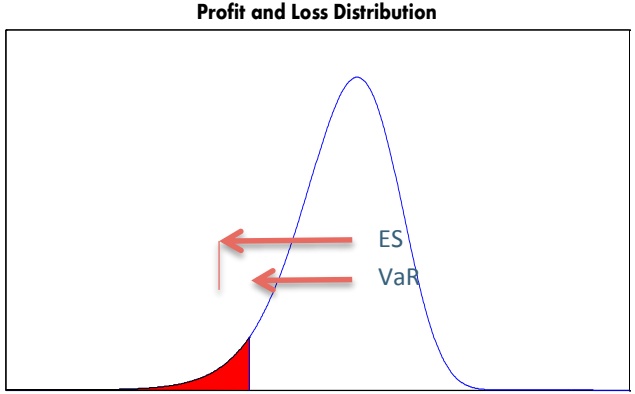
VaR and Expected Shortfall (ES)

- VaR: the best of worst x% losses; → threshold of x% losses
- ES: the average of worst x% losses → 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

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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

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Background (cont.)

- 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

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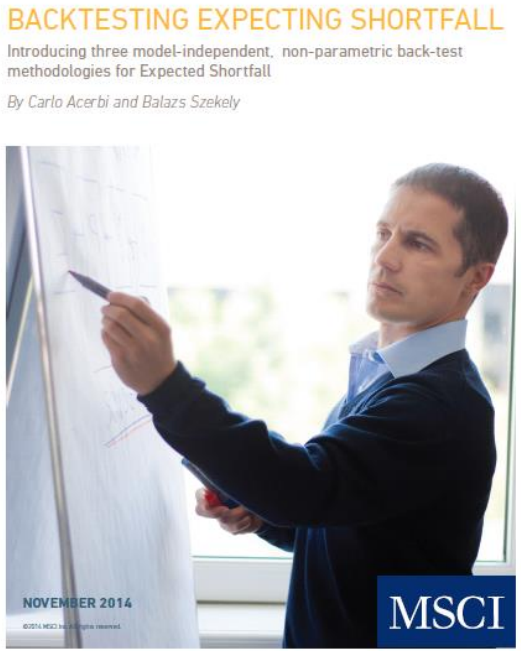
The Breakthrough from MSCI

- 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



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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.

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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.

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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

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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

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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

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Technical Appendix

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Basel: VaR or ES?

- 1994: RiskMetrics Technical Document popularizes “Value at Risk” (VaR)
- 1996: Basel Committee internal-based approach to capital adequacy, based on VaR
- 1997: Artzner et al. “Coherent Measures of Risk”: axioms for sensible risk measures. VaR criticized for not complying
- 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

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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

	Significance					
	5%			0.01%		
	location			location		
ν	-1	0	1	-1	0	1
3	-0.78	-0.82	-0.88	-3.9	-4.4	-5.5
5	-0.72	-0.74	-0.78	-1.9	-2.0	-2.3
10	-0.70	-0.71	-0.74	-1.8	-1.9	-1.9
100	-0.70	-0.70	-0.72	-1.8	-1.8	-1.9
Gaussian	-0.70	-0.70	-0.72	-1.8	-1.8	-1.9

Table 1: 5% and 0.01% significance thresholds for Z_2 across Student-t distributions with different ν and location

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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

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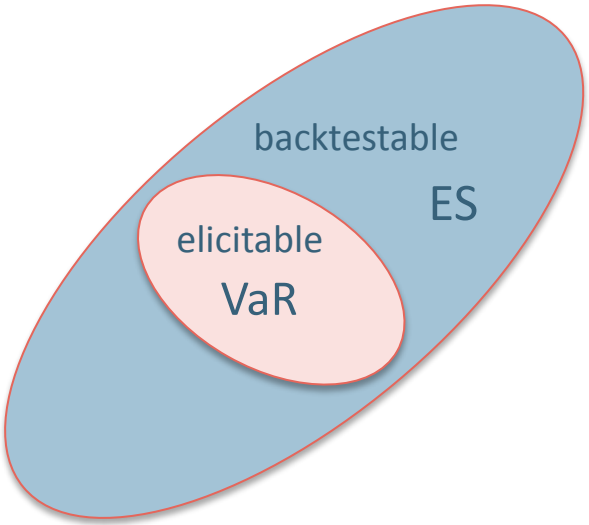
Elicitable ≠ Backtestable

- 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…

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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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