UNIGESTION

Risk-Based Investing but What Risk(s)?

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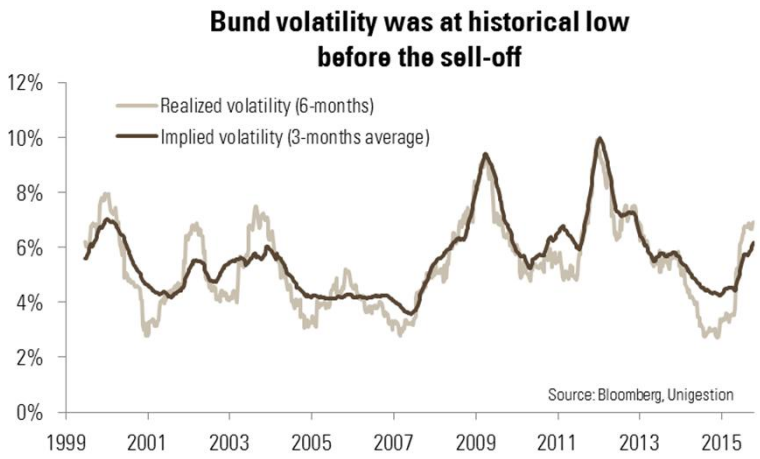
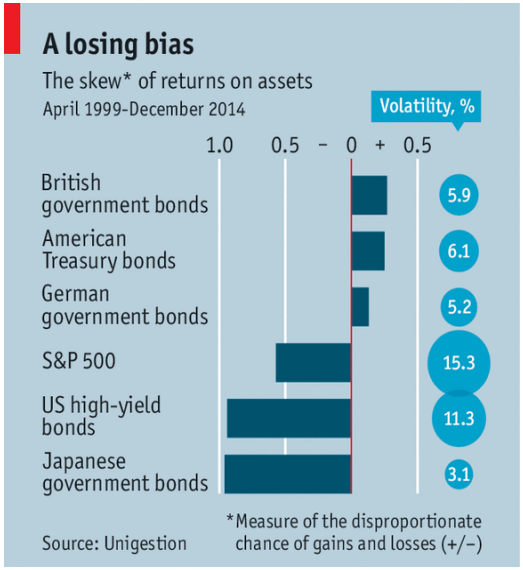
When volatility turns out to be a bad indicator: The Bund tantrum

- Worst historical returns for the Bund while volatilities were at historical low levels
- Low bond yields generate negative asymmetry…
- …a risk not captured by volatility





Our proposal: A generalised risk-based framework

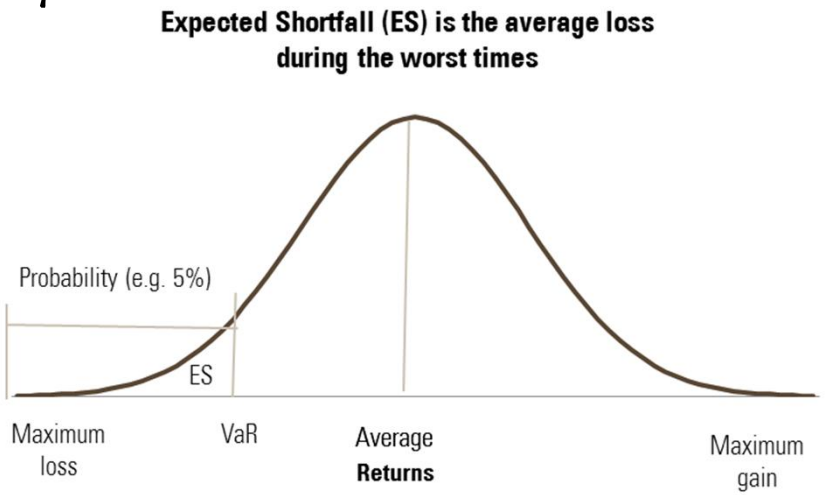
- Variations around Expected Shortfall (ES) risk measure:
  - Concentrates on extreme risk, contrary to volatility
  - Better properties than VaR
  - Allows us to incorporate a larger variety of risks:
    - Volatility
    - Valuation
    - Tail
    - Correlation
    - Asymmetry
    - Illiquidity

Expected Shortfall: Overview

- ES : average return for worst α periods. Computed as:

$$ES = -\mu + \lambda_\alpha \times \sigma$$

- ES is higher (risk is higher):
  - For more extreme events, i.e. smaller α
  - For smaller expected returns μ
  - For higher volatility σ



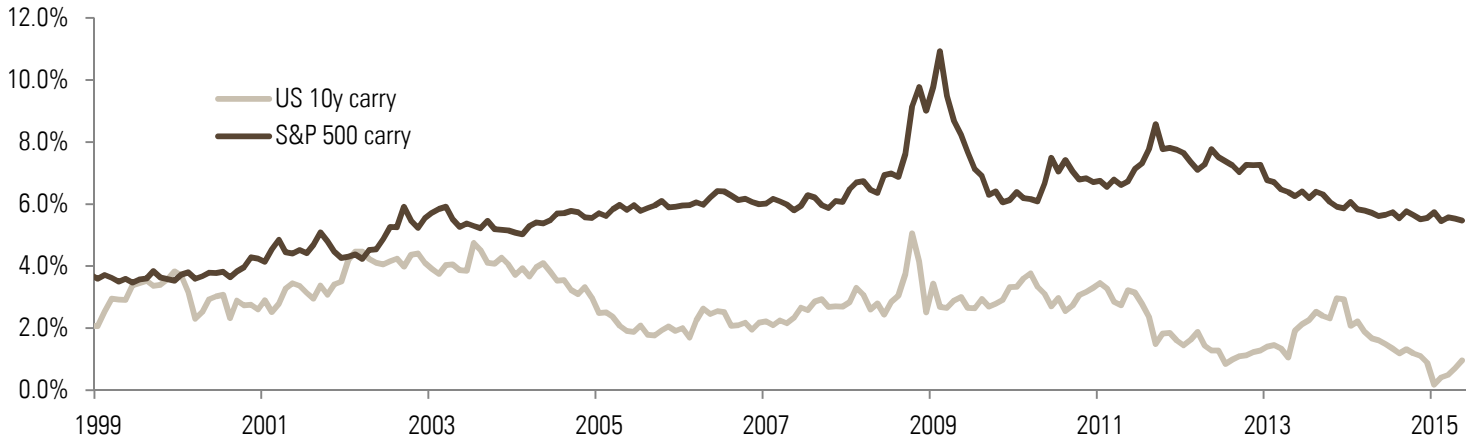
Expected Shortfall: Gaussian vs non-Gaussian distribution

- Higher λ_α means higher ES
- Gaussian case: λ_α scalar that only depends on α ; e.g. $\lambda_{0.05} = 2.06$
- More general distributions: λ_α function of higher moments
- Cornish-Fisher expansion around the quantile of a standard normal random variable
- Higher ES if negative skewness or high kurtosis

Valuation risk

- Expensive (cheap) assets have negative (positive) expected return ([5]).
- Carry = expected return of an asset if its price does not move in the future ([6])
- Consistent with risk-based approach

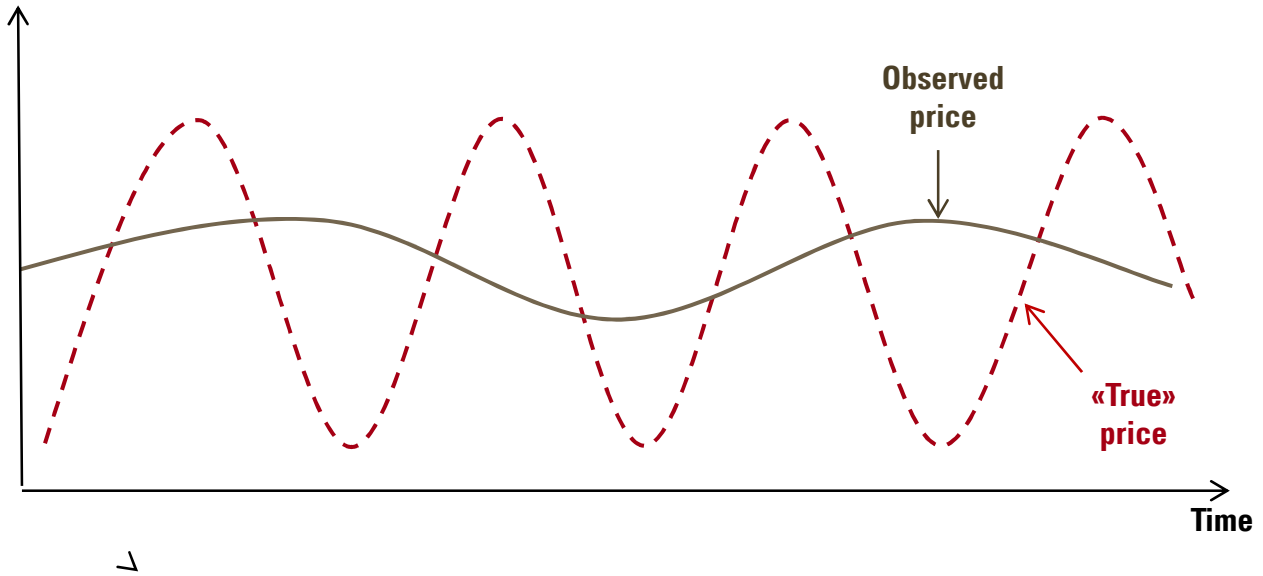
Bonds and Equities carry for US assets



Sources: Bloomberg, author's calculations. For illustrative purposes only.

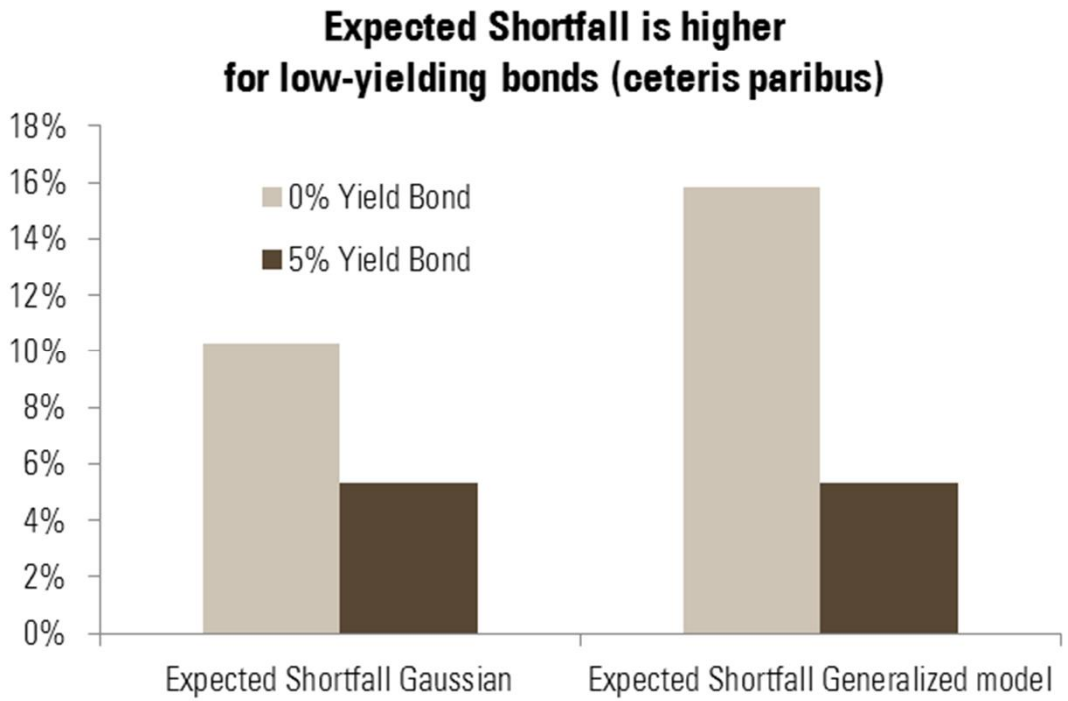
Illiquidity risk

- Illiquidity = stale pricing and artificially smoothed returns
- MA models to correct for co-moment matrices of order 2 to 4 ([7], [8])



Expected Shortfall: The Bund tantrum redux

- Same volatility but different yield and different models leads to significant differences between ES estimates



Empirical application: Universe

- Eight traditional and alternative asset classes
- Period: 1990Q1- 2013Q3

Code	Asset class (index)	Source	Carry definition
EQ	Equities Large Cap (S&P 500)	Bloomberg	Earning yield plus inflation expect
SC	Equities Small Cap (Russell 2000)	Bloomberg	Earning yield plus inflation expect
IG	U.S. Investment Grade (Barclays)	Barclays' Website	Yield to worst plus roll-down
HY	U.S. Corp. High Yield (Barclays)	Barclays' Website	Yield to worst plus roll-down
CO	Commodities (basket of 14 comm.)	Bloomberg	1-year roll-yield
HF	Hedge Funds (HFR)	Bloomberg	Regression-based implied carry
PE	Private Equity (Cambridge)	Cambridge's Website	Regression-based implied carry
RE	Real Estate (NCREIF)	NCREIF's Website	Rental income returns

Descriptive statistics

- Sharpe ratios: higher for some alternative assets…but abnormal distributions
- Carry can represent a significant portion of returns for some assets
- Most diversifying assets: high-grade bonds, commodities and real estate

	EQ	SC	IG	HY	CO	HF	PE	RE
Average return	2.53%	2.90%	1.80%	2.30%	2.49%	1.84%	3.61%	1.83%
Volatility	8.15%	10.61%	2.73%	5.24%	9.22%	3.63%	5.14%	2.44%
Sharpe ratio	0.19	0.18	0.29	0.25	0.16	0.23	0.51	0.34
Skewness	-0.55**	-0.43**	-0.11	0.29	0.03	-0.76***	-0.50**	-1.94***
Excess Kurtosis	0.48	0.62	1.45**	5.34***	3.48***	3.07***	2.00***	4.95***
Jarque–Bera	5.70	4.45	8.53**	114.08***	47.90***	46.48**	19.77***	156.82***

EQ	SC	IG	HY	CO	HF	PE	RE
Panel A: average carry (per quarter)							
2.11%	1.49%	1.66%	2.59%	0.10%	0.36%	1.81%	2.00%
Panel B: average correlation							
0.47	0.44	0.08	0.39	0.15	0.41	0.44	0.07

Illiquidity characteristics

- MA methodology correctly identifies the less liquid assets
- Moments are unchanged for most assets and scaled up for HY, PE and a lot for RE

	EQ	SC	IG	HY	CO	HF	PE	RE
	Panel A: BIC criterion for MA(k)							
$k=0$	**-207.76**	**-157.59**	**-415.86**	-291.85	**-184.29**	-361.57	-295.29	-436.73
$k=1$	-203.47	-153.99	-412.13	**-301.97**	-180.19	**-362.98**	-301.13	-480.00
$k=2$	-199.04	-150.54	-409.60	-301.49	-175.81	-359.01	**-302.40**	-519.48
$k=3$	-194.49	-146.91	-405.07	-297.04	-172.92	-354.91	-298.55	-515.39
$k=4$	-190.05	-143.03	-404.37	-293.65	-168.66	-350.58	-295.47	**-533.61**
	Panel B: smoothing coefficients							
$\theta_{i,0}$	1.000	1.000	1.000	0.658	1.000	0.808	0.650	0.305
$\theta_{i,1}$	0.000	0.000	0.000	0.342	0.000	0.192	0.205	0.204
$\theta_{i,2}$	0.000	0.000	0.000	0.000	0.000	0.000	0.145	0.203
$\theta_{i,3}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.131
$\theta_{i,4}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.157
	Panel C: implied scaling coefficients for moments							
Volatility	1.000	1.000	1.000	1.348	1.000	1.204	1.435	2.143
Skewness	1.000	1.000	1.000	1.255	1.000	1.072	1.182	1.976
Kurtosis	1.000	1.000	1.000	1.502	1.000	1.113	1.304	3.641

Comparison of risk-adjusted performance measures

- Sharpe ratios (SR): biased when abnormal or illiquid
- Conditional SR: ratio between excess returns and ES; allows to correct for biaises
- Real Estate: 2nd highest SR but worst Conditional SR

	Corrections		Assets							
Measure	Skew-Kurt	Illiquidity	EQ	SC	IG	HY	CO	HF	PE	RE
SR (Sharpe ratio)	No	No	0.19	0.18	0.29	0.25	0.16	0.23	0.51	0.34
SR	No	Yes	0.19	0.18	0.29	0.18	0.16	0.19	0.35	0.16
Conditional SR	No	No	0.18	0.15	0.47	0.27	0.15	0.33	0.52	0.57
Conditional SR	Yes	No	0.15	0.13	0.39	0.20	0.12	0.21	0.36	0.24
Conditional SR	Yes	Yes	0.15	0.13	0.39	0.11	0.12	0.16	0.20	0.05

Risk-based allocation based on Generalised Expected Shortfall

- ES decomposition by asset ([9]):

$$ES_{ptf} = \sum_{i=1}^{n} CES_i$$

- ES decomposition by risk dimension (see also [10]):

$$CES_i = CMEAN_i + CVOL_i + CSKEW_i + CKURT_i + ILLIQUID_i$$

Valuation | Volatility | Asymmetry | Tail risk | Illiquidity

- Risk-based allocation program: risk proportions $\%CES$ match risk-budgets b

$$w^* = \underset{w_i}{\operatorname{argmin}} \sum_{i=1}^{n} (\%CES_i - b_i)^2$$

$$\text{s.t. } \sum_{i=1}^{n} b_i = 1,\ \sum_{i=1}^{n} w_i = 1\ , b_i, w_i \geq 0$$

$$\%CES_i = \frac{CES_i}{ES}$$

Equal Risk Contribution Allocation based on Expected Shortfall

- Comparison of five Equal Risk Contribution ([11]) portfolios: $b_i = \frac{1}{n}$

Name	Acronym	Risk measure	Correlation	Valuation	Skew / Kurt	Illiquidity
Naïve Risk Parity	NRP	Volatility	No	No	No	No
Risk Parity	RP	Volatility	Yes	No	No	No
Gaussian Expected Shortfall	GES	Expected Shortfall	Yes	Yes	No	No
Modified Expected Shortfall	MES	Expected Shortfall	Yes	Yes	Yes	No
Liquidity-Adjusted Modified Expected Shortfall	LAMES	Expected Shortfall	Yes	Yes	Yes	Yes

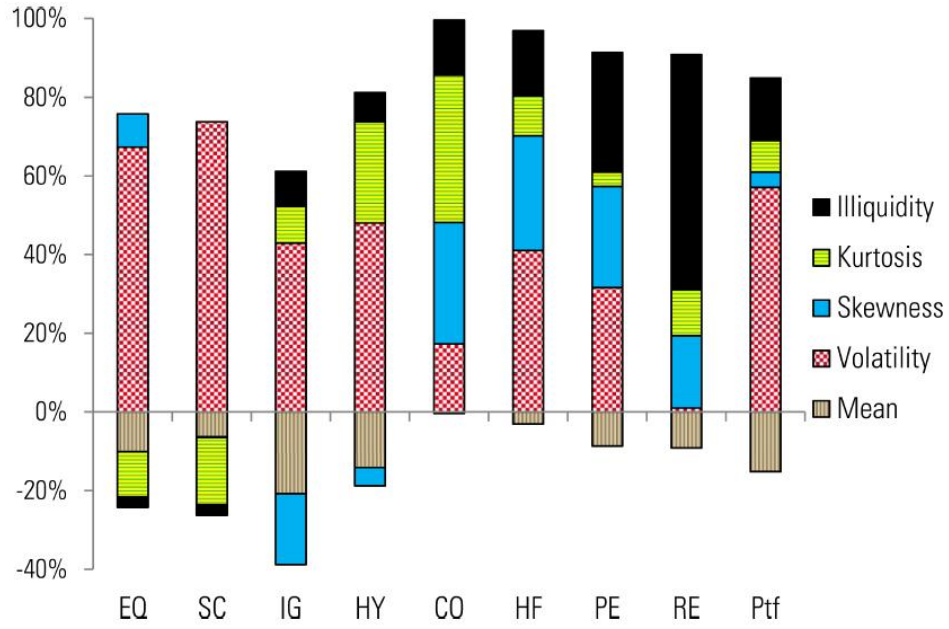
Equal Risk Contribution Portfolio: Differences across Models

- Substantial differences in portfolio weights and metrics across models

	NRP	RP	GES	MES	LAMES
	Panel A: portfolio weights				
EQ	6.96%	4.55%	2.87%	7.02%	8.67%
SC	5.34%	3.80%	2.29%	7.19%	8.36%
IG	20.81%	27.85%	31.47%	52.10%	52.01%
HY	10.83%	7.89%	6.54%	7.22%	8.13%
CO	6.15%	6.76%	3.85%	3.21%	3.88%
HF	15.64%	11.05%	6.66%	7.58%	8.33%
PE	11.03%	7.44%	5.02%	6.32%	5.39%
RE	23.23%	30.66%	41.30%	9.38%	5.23%
	Panel B: portfolio metrics				
Average carry	1.58%	1.61%	1.73%	1.64%	1.62%
Volatility	3.61%	3.09%	2.88%	3.03%	3.26%
Skewness	-2.64	-3.52	-4.19	-1.00	-0.62
Excess Kurtosis	12.15	17.74	18.69	3.92	2.91
Gaussian expected shortfall	5.87%	4.77%	4.17%	4.61%	5.11%
Modified expected shortfall	16.99%	18.15%	17.97%	7.83%	7.46%

Decomposing the Expected Shortfall for LAMES portfolio

- For each asset, the contributors vary substantially, e.g.
  - Equities are mostly contributing through volatility
  - Commodities are mainly contributing through asymmetry and tail risks
  - Real estate is mainly contributing through illiquidity



Concluding remarks

"If the investor, instead, fears price volatility, erroneously viewing it as a measure of risk, he may, ironically, end up doing some very risky things"

Warren Buffet (2014)

- Our framework:
  - Large spectrum of risks;
  - Closed-form analytical formulas
  - Straightforward to implement and useful in different asset allocation problems

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For a more detailed set of references, see JURCZENKO E., TEILETCHE J., « Risk-Based Investing but What Risk(s)?", Chapter 6 in *Risk-Based and Factor investing* Emmanuel Jurczenko (ed), ISTE Press-Elsevier, 2015.

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