CALCURIX: a "tailor-made" RM software

Ismael Fadiga & Jang Schiltz (LSF)

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Financial technologies at the LSF

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- Education programmes
- Outreach to the financial industry

The 3x3 Fintech Lecture Series

The 3x3 lecture series is a joint project between the Luxembourg House of Financial Technology (LHoFT) and the University of Luxembourg.

Over the course of the 2016-2017 academic year, it will feature three Speakers from each of the three disciplines carrying out FinTech research at the University of Luxembourg – information technology, finance and law.

3x3 brings together academics at the forefront of FinTech research and professionals from Luxembourg's business community and financial centre.

It bridges the academic-practice divide and discusses the practical implications of FinTech research for financial services and the potential repercussions for the industry, furthering knowledge transfer and exchange of information and expertise.

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- 1963: Benoit Mandelbrot, (J. Business 36(4), 394-419) concluded that the empirical distribution of financial data does not fit the assumption of normality; data are non-Gaussian, heavy tailed
- 1964: Paul Cootner (MIT-Sloan) added: If Mandelbrot is right, almost all of our statistical tools are obsolete!

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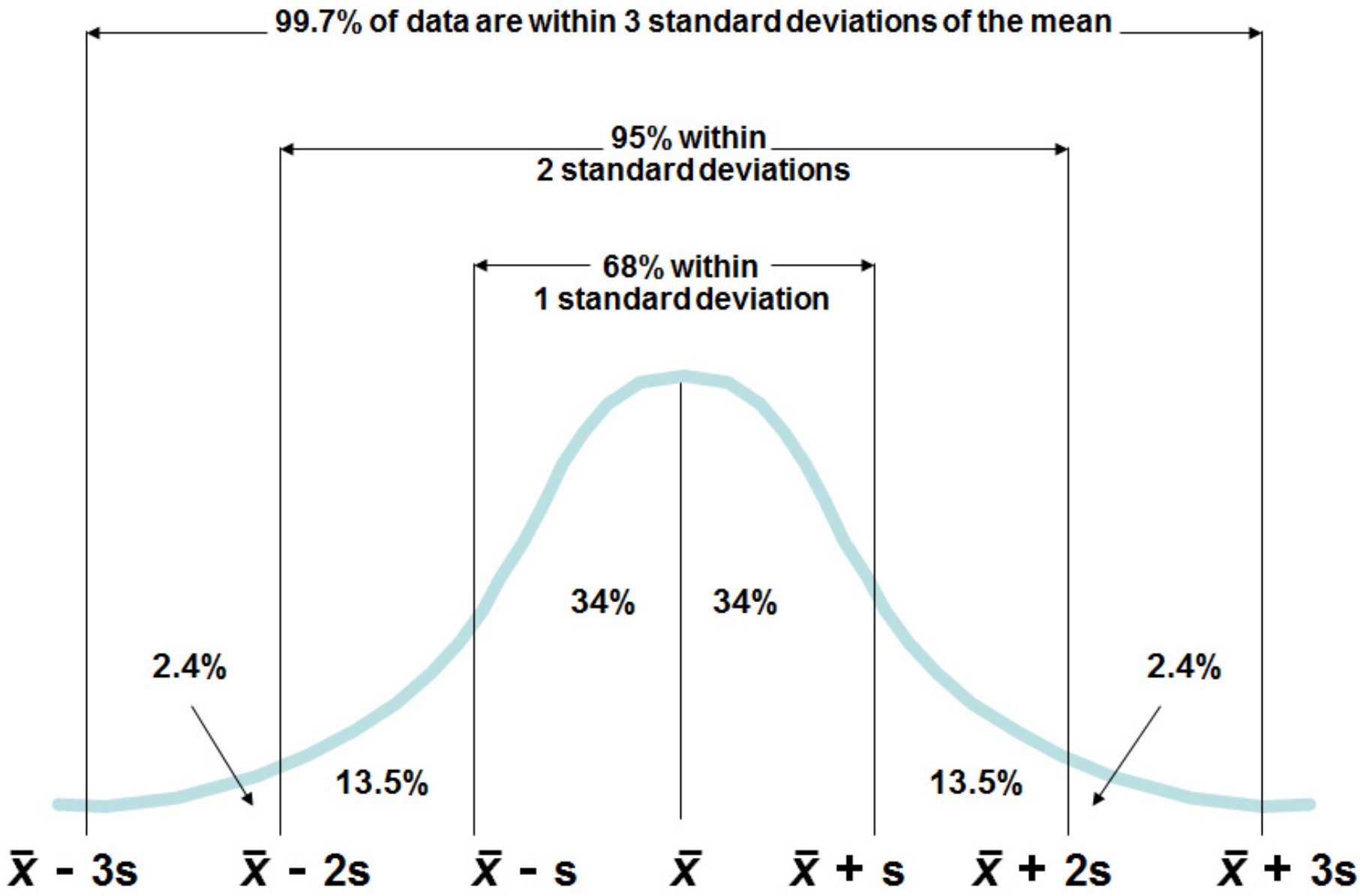
Main feature of Gaussian Distributions



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  - 1988: Basel I: Focus on Credit Risk and risk-weighting of assets
  - 1996: Basel I$\frac{1}{2}$: the birth of Value-at-Risk

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Value-at-Risk (VaR)

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- Mr. Weatherstone requested a simple report be made available to him every day concerning the firms risk exposure.
- VaR summarizes the worst loss over a target horizon that will not be exceeded with a given level of confidence under normal market conditions.

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Problems with Value-at-Risk

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- VaR does not tell you how big the losses can be on bad days.
- From the mathematical point of view, VaR is not a coherent risk measure. In fact, it is not sub-additive.

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- Risk categories: Market (MR), Credit (CR), Operational (OR) for banks
- Philosophy: Internal models: the calculation of Risk Weighted Assets through internal models became widely accepted.
- 2001: The following paper warned early for regulatory weaknesses underlying the Basel II proposals:

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Embrechts, P. et al. (2001): **An academic response to Basel II**
Financial Markets Group, London School of Economics.
(Mailed as an official response to the Basel Committee and published on its website as such) (17 pages)

→ PE website since 2001!

et al. = Jón Daníelsson
Charles Goodhart
Con Keating
Felix Muennich
Olivier Renault
Hyun Song Shin

Main findings of this report:

(1) The **Basel II** regulations fail to consider the fact that **risk is endogenous**, VaR-based regulation can destabilize an economy and induce crashes when they would not otherwise occur.
(2) **Statistical models** used for forecasting risk typically **under-estimate joint downside risk** (joint losses) of multiple assets.
(3) A too **heavy reliance on credit rating agencies** for credit risk models.
(4) These proposals will increase **procyclicality** and hence **systemic risk.**
(5) **Operational Risk** modeling is not possible given current databases.

Conclusion: The Basel II proposals will enhance both the procyclicality and the susceptibility of the financial system to **systemic crises**, thus negating the central purpose of the whole exercise.

Reconsider before it is too late!

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- 2006 Basel II: minimum capital requirements (credit risk, operational risk & market risk), supervisory review and market discipline.
- 2013 Basel III: capital requirements, introduction of a minimum leverage ratio, liquidity requirements.
- Work in progress: Basel IV: higher maximum leverage ratios, simpler or standardised risk models, more disclosure of financial statistics like reserves.

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Abstract

Empirical research on the modeling of financial data has shown that stable Paretian laws are superior to Gaussian distribution in this context. Nevertheless, Student-t distributions are still used by practitioners to capture "fat-tails" regardless of its undesirable theoretical properties. This paper assesses the suitability of non-Gaussian stable distributions in Risk Management by investigating the Alternative UCITS space, in particular Hedge Fund Indices which have undergone the consequences of tightening European regulatory environments since the 2008 crisis.

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- Presented at the World Congress of the Bachelier Finance Society in New York 2016.

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Stochastic distribution

The characteristic function $\phi(t)$ of a stable distribution X can be written as

$$\phi(t) = \exp[it\mu - |ct|^{\alpha}(1 - i\beta \operatorname{sgn}(t)\Phi)],$$

where $\operatorname{sgn}(t)$ denotes the sign of t and

$$\Phi = \tan(\pi\alpha/2), \text{ if } \alpha \neq 1$$

and

$$\Phi = -2\frac{2}{\pi}\log|t|, \text{ if } \alpha = 1.$$

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Statistical estimator

$$f(x-\zeta;\alpha,\beta) = \begin{cases} \frac{\alpha(x-\zeta)^{\frac{1}{\alpha-1}}}{\pi\,|\alpha-1|} \int_{-\theta_0}^{\frac{\pi}{2}} V(\theta;\alpha,\beta)\exp(-(x-\zeta)^{\frac{\alpha}{\alpha-1}}V(\theta;\alpha,\beta))\mathrm{d}\theta & \alpha \neq 1 \text{ and } x > \zeta \\ \frac{\Gamma\left(1+\frac{1}{\alpha}\right)cos(\theta_0)}{\pi\left(1+\zeta^2\right)^{\frac{1}{2\alpha}}} & \alpha \neq 1 \text{ and } x = \zeta \\ f(-x;\alpha,-\beta) & \alpha \neq 1 \text{ and } x < \zeta \\ \frac{1}{|2\beta|}e^{-\frac{\pi x}{2\beta}} \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} V(\theta;\alpha,\beta)\exp(-e^{-\frac{\pi x}{2\beta}}V(\theta;\alpha,\beta))\mathrm{d}\theta & \alpha = 1 \text{ and } \beta \neq 0 \\ \frac{1}{\pi(1+x^2)} & \alpha = 1 \text{ and } \beta = 0, \end{cases}$$

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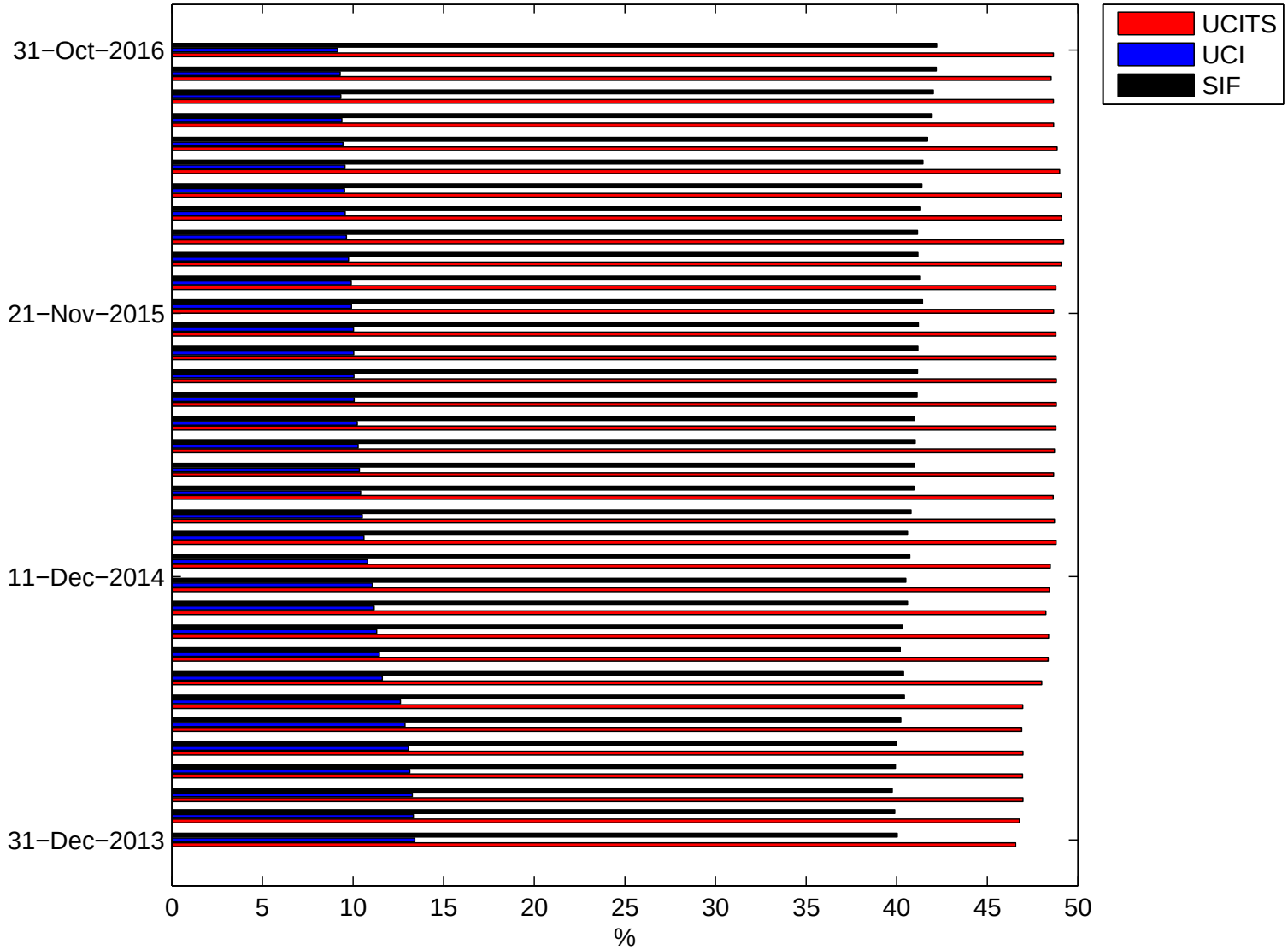
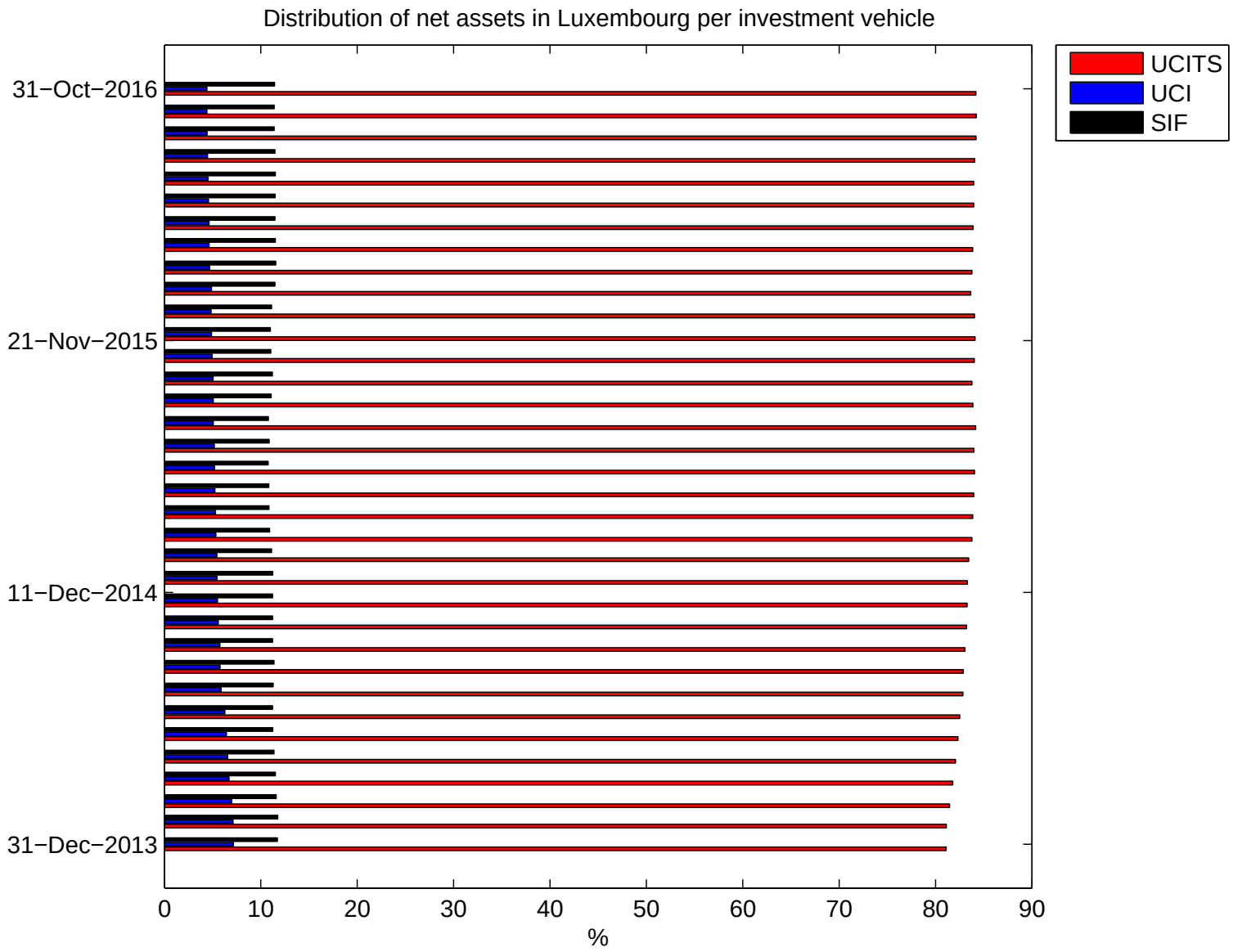
Distribution of Luxembourg investment vehicles according to the Law(s) of 2010 (Part I & II) and 2007 on SIF




Distribution of net assets in Luxembourg per investment vehicle
UCITS
UCI
SIF
31−Oct−2016
21−Nov−2015
11−Dec−2014
31−Dec−2013
0
10
20
30
40
50
60
70
80
90
%

law of 17 December 2010 relating to undertakings for collective investment

CSSF 10-788
Committee of European Securities Regulators on 28th of July 2010

CSSF 10-673
Committee of European Securities Regulators on 1st of July 2010

Market environment for the risk & compliance service providers

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Oligopolistic market

- Concentration within the "Big 5" model providers in Luxembourg.
- Need for more competition in the market.

Main criticism of the market leading engine providers: "Black box!"

- Opacity of the model data feed while resorting to API solutions.
- Inability to provide a P&L per asset following risk-based simulation processes to ascertain an accurate origin of the portfolio losses (i.e VaR, etc.). As a corollary, risk strategies such as "Stop-Losses" could not be captured precisely.
- Difficulty to update the pre-defined engine pricing library in the presence of exotic derivatives with distinct payoff functions (i.e complex certificates, options, or swaps on reference assets such as proprietary indexes with embedded derivatives)...
- Difficulty to account for OTC exposures if margins for the listed derivatives are insured through a deposit guaranteed scheme

A cost-effective and efficient solution

- API connection to good quality data providers other than Bloomberg and Reuters (i.e no data license cost management issues)
- Integration of sound open-source software / libraries used by leading Investment Banks worldwide
- Rationalization of the engine (i.e a single engine performing market risk and compliace calculations) . No costly dependence on external Third Party solutions as a complementary service.

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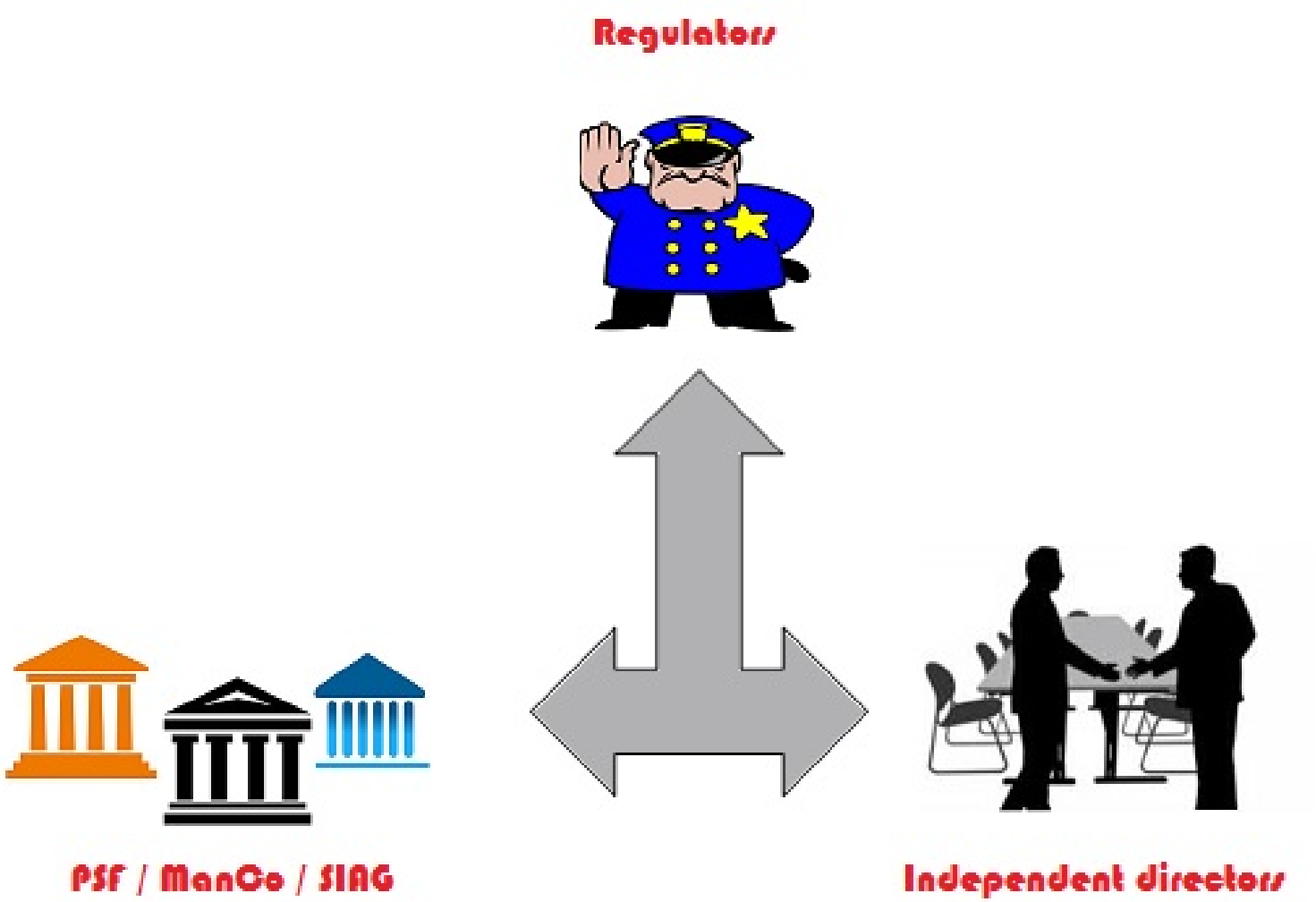
Target users



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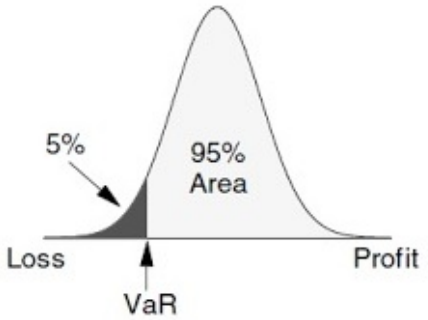
Overview of the software



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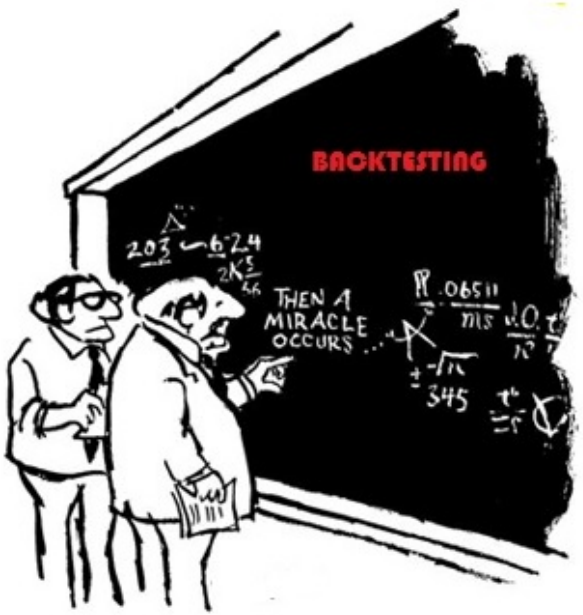
STRESS TEST



CALCURIX

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Value-at-Risk

- Several methods[a]: Historical Simulation, Monte Carlo, Variance Covariance
- Integration with open-source pricing library
- API connection with data vendors
- No black boxes!

[a] Schiltz, J., & Fadiga, I. (2015). Stable Distribution for Alternative UCITS. *Working Paper - Luxembourg School of Finance*, pp. 27

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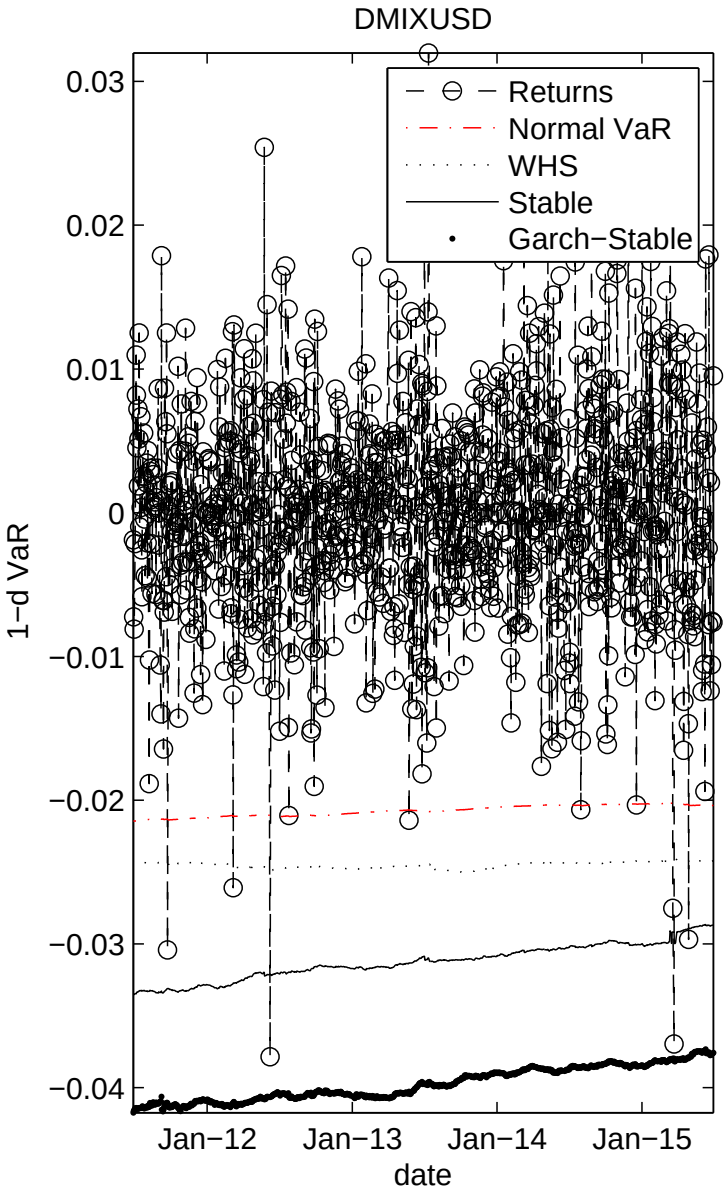
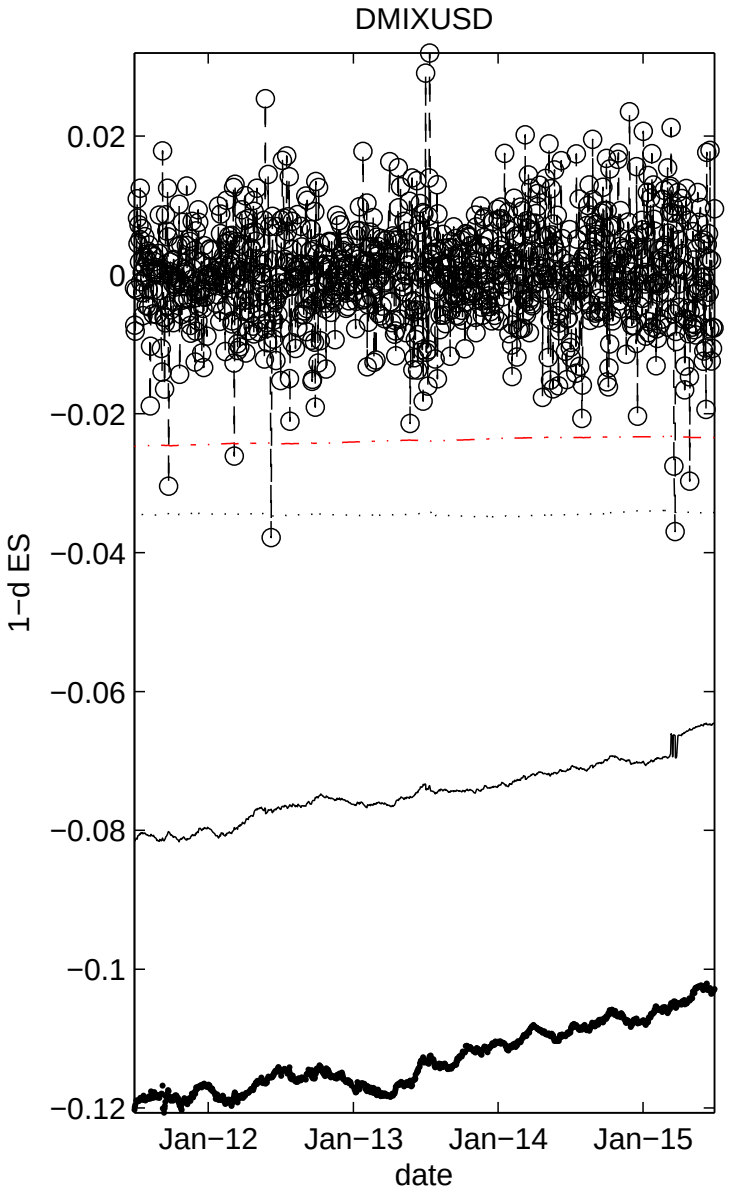
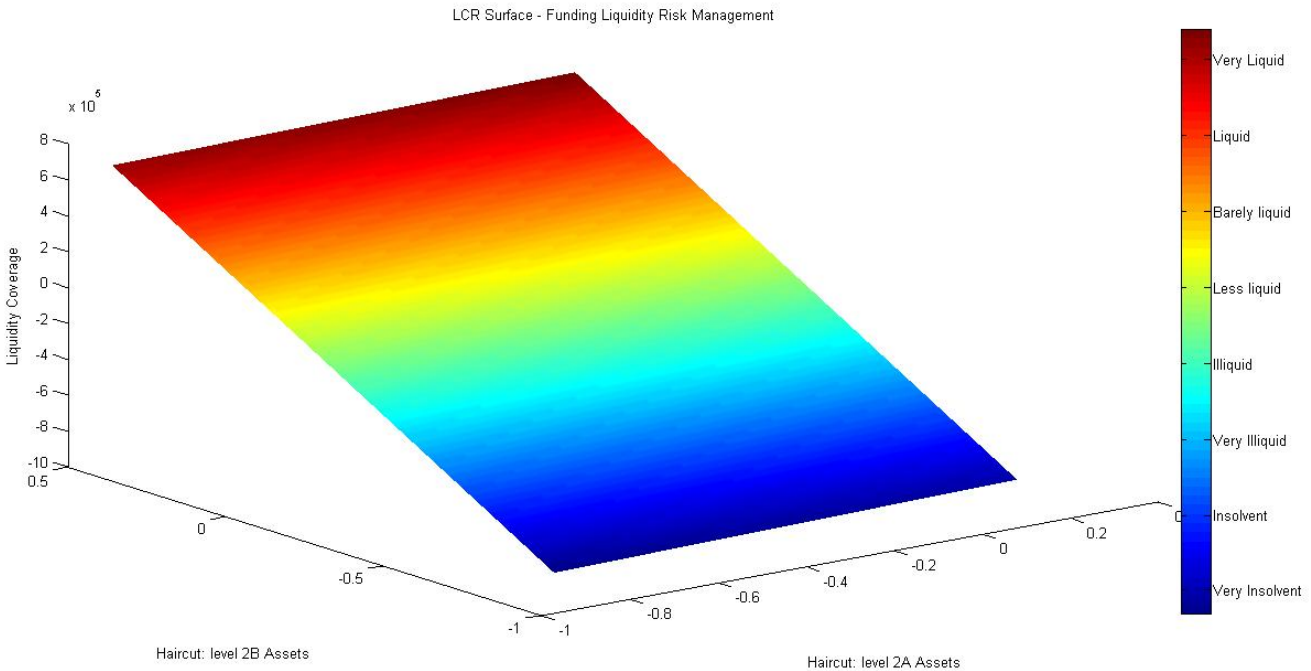
Backtesting





Liquidity risk

- Asset liquidity risk: Time to Liquidation(TTL), LaR
- Funding liquidity risk: Liquidity Coverage Ratio (*under normal & stressed conditions*)



Stress testing

Regulatory-based Univariate Stress tests:

- Stock markets +/- 30%
- IR curves: parallel shift +200 bps
- Credit spreads: proportional shift (-50% & +100%)
- FX: base currency vs other currencies +/- 30%

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Counterparty risk

- Risk exposure to counterparties of the UCITS in OTC derivative transactions
- Netting arrangements with counterparties
- Deposit guaranteed scheme:

$$\max\left[\sum_{k=1}^{n}\frac{(MTM_k - D)}{NAV_t}, 0\right]$$

Investment restrictions (incl. Concentration risk)

OPC Law of December 2010 - Chapter V

- Art. 43: *Transferable securities single issuer Max 10%*
- Art. 43: *Cash and deposits single issuer Max 20%*
- Art. 43: *OTC exposure to a single counterparty Max 5% or 10%*
- Art. 43: *Total non-guaranteed issuer over 5% Max 40%*
- ...

  $\oplus$ Prospectus guidelines
- *Maximum leverage accounts for X% of NAV*
- *Sub-Fund should not invest more than X% of NAV in HY bonds*
- ...

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Synthetic Risk Reward Indicator

Estimation of volatilities

- All type of fund classification : Market, Absolute returns, Total return, Life cycle & Structured funds

Risk Class	Volatility Intervals	
	equal or above	less than
1	0%	0.50%
2	0.50%	2%
3	2%	5%
4	5%	10%
5	10%	15%
6	15%	25%
7	25%	

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CALCURIX in a nutshell!!!