Operational Risk Revisited

Paul Embrechts

Department of Mathematics

RiskLab and Risk Center, ETH Zurich

www.math.ethz.ch/~embrechts

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"Operational Risk"

Risk Components (Basel II)

(now Basel III even Basel 3.5 or IV ...)

(also Solvency II (2019), SST (2011), FSA, BoE, ...)

- Credit Risk
- Market Risk
- Operational Risk
- Business Risk ...

Operational Risk: The risk of loss resulting from inadequate or failed internal processes, people and systems or from external events. Including legal risk, but excluding strategic and reputational risk.

Where does my OpRisk interest originate?

- (1) Board member of a bank & Basel II (1997+)
- (2) An Academic Response to Basel II (2001): Jón Daníelsson, Paul Embrechts, Charles Goodhart, Con Keating, Felix Muennich, Olivier Renault and Hyun Song Shin (BCBS)
- (3) Nešlehová, J., Embrechts, P., Chavez - Demoulin, V. (2006): Infinite mean models and the LDA for operational risk, Journal of Operational Risk 1(1), 3-25
- (4) A course given at the Boston Fed in 2005

From (2):

Detailed quantitative Operational Risk modelling is not possible given current (i.e. 2001) databases … **data availability and type!**

The situation in 2019 is not that much better, however … **this talk!**

From (3):

- This paper very much lies at the basis of the so-called **non-diversification fallacy** based on the super-additivity of VaR:

$$\text{VaR}(X + Y) > \text{VaR}(X) + \text{VaR}(Y)$$

"**>**" holds in the case of **(1)** very heavy-tailed dfs, **(2)** special dependence structure, and **(3)** very skewed dfs all present in OpRisk Data

This is also very much related to the **discussion** on:

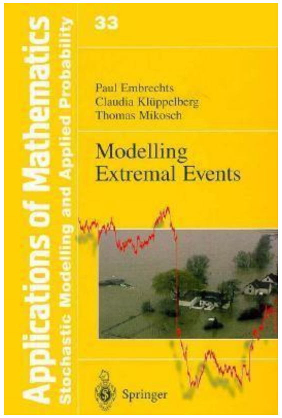
- "The Dismal Theorem" of **Martin L. Weitzman** in (2008) "On Modeling and Interpreting the Economics of Catastrophic Climate Change"
- Very much driven by **William Nordhaus** as in (2009) "An Analysis of the Dismal Theorem"
- And several later papers like R. McKitrick …
- " … society has an indefinitely large expected loss from high-consequence, low-probability events so that standard economic analysis cannot be applied." (<-- certain conditions!)

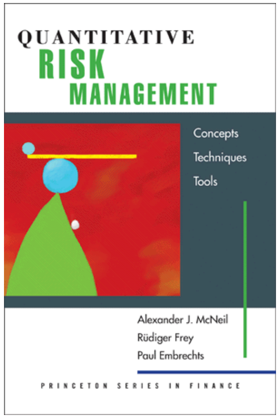
For an interesting OpRisk relevant discussion, see:

- M.L. Weitzman (2009): “Reactions to the Nordhaus Critique”, Discussion Paper 09-11, The Harvard Environmental Economics Program (e.g. critique on standard CC-CBA)
- Especially related to: “There is a natural tendency to sneer at economic models that yield **infinite outcomes**.” on p. 11 and further
- Climate Change --> e.g. **Cyber Risk**

About (4):

Two books and a Federal Reserve Bank of Boston course on "EVT & relevance for OpRisk" (2005)





From the Basel Committee's March 2016 Consultative Document on OpRisk:

"The Committee has determined that the withdrawal of internal modelling approaches for operational risk regulatory capital from the Basel Framework is warranted. "

As a consequence AMA is replaced by a standardized BI-based approach!

Planned under Basel "IV"

- A single non-model based method using as components BIC, LC and ILM (= Internal Loss Multiplier) = f(BIC,LC) (see (*))
- OpRisk Capital = ILM x BIC
- 10 years of loss data as basis for LC and hence ILM
- Hence drop Basel II BIA, SA and AMA Pillar 1 Ansatz
- Move more towards Pillar 2
- Business Indicator Component (BIC) via bucket weights
- Start: January 1, 2022
- **BCBS**' aim: improve comparability and reduce complexity (e.g. LDA)

(*) ILM

$f(x, y)$ = log (exp(1) -1 + $(\frac{15y}{x})^{0.8}$)

x = BIC

y = LC = "average annual OpRisk loss
over last 10 years" (...)
(corresponds to risk sensitivity)

0.541 (y= 0) $\leq f(x, y) \leq$ 1 ($15y = x$)

Some reactions (KPMG, February 2018)

- “The scope for national discretion and the use of opaque Pillar 2 capital requirements will make it difficult to compare banks, while the new SA is less simple for banks that currently use the less advanced approaches to OpRisk because of the ten year loss data capture requirement. “

- “There is also a risk that the new SA will reduce the incentives for robust risk management within the business due to the lack of risk sensitivity in the new approach.”

However:

- “It is critical that banks maintain high quality OpRisk teams, continue key processes such as scenario analysis and modelling risks to assist with business decision making, and embed operational risk management mindsets into the business.”
- “Consider advanced non - financial risk analytics such as causal and machine learning models (e.g. Neural Networks or Bayesian Networks).”

Quotes from "Bank Capital for Operational Risk: A Tale of Fragility and Instability", M. Ames, T. Schuermann, H.S. Scott, February 10, 2014:

- On May 16, 2012, Thomas Curry, the Comptroller of the Currency (head of the OCC), said in a speech that bank supervisors are seeing "operational risk eclipse credit risk as a safety and soundness challenge." This represents a real departure from the past when concern was primarily focused on credit and market risk. A major component of operational risk is legal liability, and the recent financial crisis, a credit crisis par excellence, has been followed by wave after wave of legal settlements from incidents related to the crisis.
- To again quote Curry (2012), "The risk of operational failure is embedded in every activity and product of an institution."

Coming out of the Financial Crisis:

- From The Economist, 13/8/2016, OpRisk losses since 2009 as % of market capitalisation (+/-):

(1) Bank of America: 50% (70 billion USD)

(2) Deutsche Bank: 30%

(3) JP Morgan: 18%

(4) Credit Suisse: 16%

(5) Morgan Stanley: 15%

(6) BNP Paribas: 13%

(7) Citigroup: 12%

(8) Barclays: (11%)

(9) UBS: 10%

(10) Goldman Sachs: 10%, ...

So far 188 settlements for a total of 219 Bi USD, about 278 possible cases more in the pipeline ...

Top 10 OpRisks for 2018 (Risk.net, 22/2/2018)

#1: IT disruption (0)

#2: Data compromise (0)

#3: Regulatory risk (-)

#4: Theft and fraud (++)

#1, 2 and 4 are akin to **Cyber Risk**

#5: Outsourcing (-)

#6: Mis-selling (-)

#7: Talent risk (new)

#8: Organisational change (-)

#9: Unauthorised trading (-)

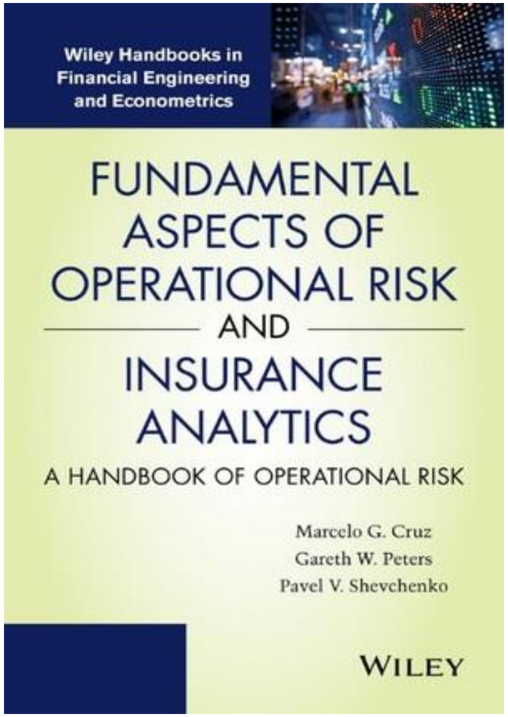
#10: Model risk (++)

(2017)

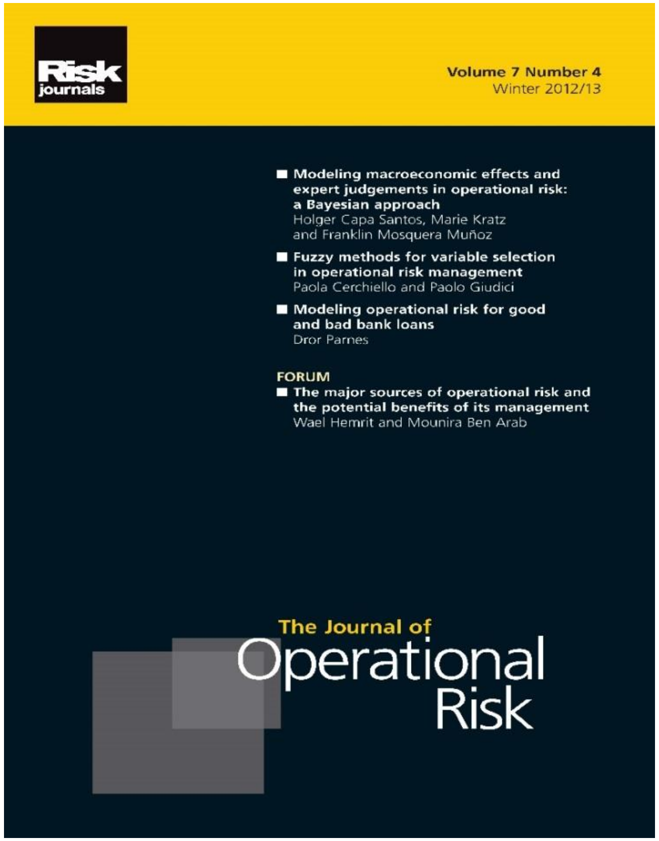
Whereas I do agree with the overall assessment by the Basel Committee on the AMA for Operational Risk, and indeed in the past (already in 2001 (*))) have voiced my concerns about the possibility of the AMA/LDA on the basis of available and quality of statistical OpRisk data, I still strongly feel that, at least for bank-internal purposes, **more detailed statistical modeling is useful!** Some ideas for the latter are sketched below.

(*) P. Embrechts et al. (2001) An academic response to Basel II, LSE-FMG & BCBS

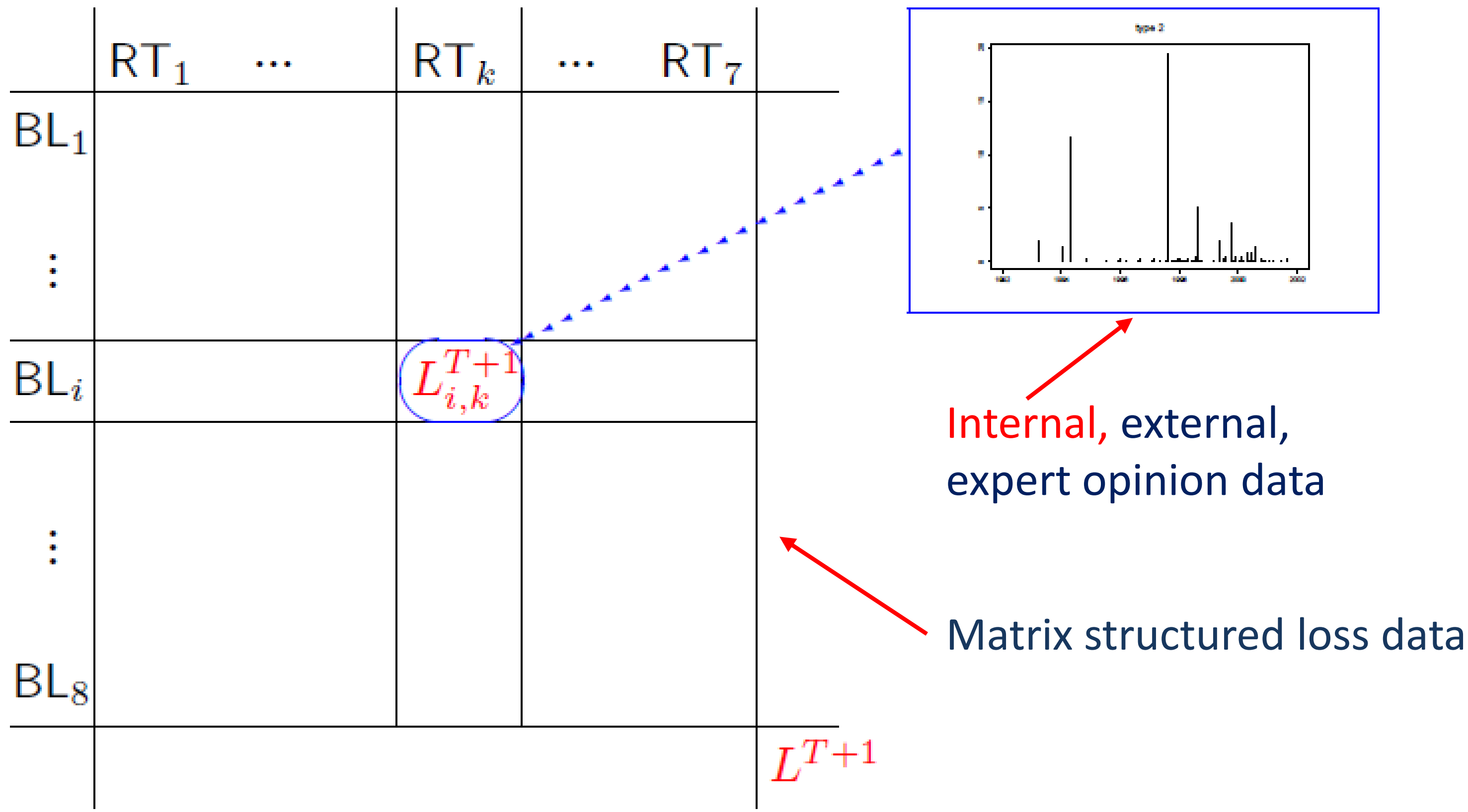
A **lot** has been written on the topic (e.g.):



2015, 900 pages!



Loss Distribution Approach (LDA) within AMA-Framework



A complicated stochastic structure

"Insurance Analytics"

$$L^{T+1} = \sum_{i=1}^{8} \sum_{k=1}^{7} L_{i,k}^{T+1}$$

$$L_{i,k}^{T+1} = \sum_{\ell=1}^{N_{i,k}^{T+1}} X_{i,k}^{\ell}$$

$X_{i,k}^{\ell}$: loss severities

$N_{i,k}^{T+1}$: loss frequencies

together with left-censoring, inter-dependencies, reporting delays (IBNR-like), non-stationarity, insurance cover, extreme heavy-tailedness …

A modelling approach:

For the **statistical estimation** of P($L^{T+1} > x$) as a function of several covariates, see :

[1] Chavez-Demoulin, V., Embrechts, P., Hofert, M. (2016): An extreme value approach for modeling Operational Risk losses depending on covariates. Journal of Risk and Insurance 83(3), 735-776

[2] Embrechts, P., Mizgier, K.J., Chen, X. (2018): Modeling Operational Risk Depending on Covariates. An Empirical Investigation. Journal of Operational Risk 13(3), 17-46 **(Best Paper Award J. OpRisk (2018))**

Extra? … Model uncertainty!

Conclusion

- Operational Risk is highly relevant as a risk class to be well-understood by industry
- Goes well beyond banking and insurance
- Important intersection with Cyber Risk
- Interesting (non-trivial) mathematical and statistical questions (AI, NN, …)
- Mathematical questions very much related to model uncertainty

Operational Risk indeed:

À votre santé chère Nicole!

Extra

A general fundamental problem in Quantitative Risk Management (relevant for OpRisk modelling):

- Risk factors: $\mathbf{X} = (X_1, \ldots, X_d)$
- Model assumption: $X_i \sim F_i$, F_i known, $i = 1, \ldots, d$
- A financial position $\Psi(\mathbf{X})$
- A risk measure/pricing function: $\rho(\Psi(\mathbf{X}))$

Calculate $\rho(\Psi(\mathbf{X}))$

also denoted by S_d

Example:

- $\Psi(\mathbf{X}) = \sum_{i=1}^{d} X_i$
- $\rho = \mathrm{VaR}_p$ or $\rho = \mathrm{ES}_p$

Challenge:

- We need a *joint* model for the random vector $\mathbf{X}$
- Joint models are hard to get by

We will focus on the above special choices of Ψ and ρ.

For a given risk measure ρ denote

$$\overline{\rho}\,(S_d) = \sup\{\rho(\textstyle\sum_{i=1}^{d} X_i): X_i \sim F_i,\ i = 1, \dots, d\}$$

and similarly

$$\underline{\rho}\,(S_d) = \inf\{\rho(\textstyle\sum_{i=1}^{d} X_i): X_i \sim F_i,\ i = 1, \dots, d\}$$

where sup/inf are taken over all joint distribution models for the random vector $(X_1, \dots, X_d)$ with given marginal dfs $(F_1, \dots, F_d)$, or equivalently over all d-dimensional copulas.

We will consider as special cases the construction of the ranges:

$$(\underline{\mathrm{VaR}}, \overline{\mathrm{VaR}}) \text{ and } (\underline{\mathrm{ES}}, \overline{\mathrm{ES}})$$

unknown

known: comonotonic case

referred to as dependence-uncertainty ranges.

Summary of existing results:

$d = 2$:

- fully solved analytically

$d \geq 3$:

- Homogeneous model $(F_1 = \cdots = F_d)$
  - $\underline{\mathrm{ES}}_p(S_d)$ solved analytically for decreasing densities, e.g. Pareto, Exponential
  - $\overline{\mathrm{VaR}}_p(S_d)$ solved analytically for tail-decreasing densities, e.g. Pareto, Gamma, Log-normal
- Inhomogeneous model
  - Few analytical results: current research
- Numerical methods available: Rearrangement Algorithm

See www.math.ethz.ch/~embrechts for references