Economic Capital as an Optimal Hedge against Bank Distress: Case of the Zimbabwean Banking Sector

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Outline

- Introduction
- Motivation
- Methods
- Data
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- Conclusions

Introduction

Definitions

- Banks' distress
- Credit risk management
- Basel Committee on Banking Supervision (1974):
  - Basel I (1988) - minimum capital requirements;
  - Basel II (1997) - quantitative models,
  - Basel III (2013) - strengthen the global capital standard.
- Credit risk modelling according to the Basel accord;
- CAMELS Ratings (1-Outperforming, ... , 5-Failure).

Motivation

- Financial crisis-led bank failures.
- Use of predictive analytics in internal risk modelling,
- Creation of early warning systems to curb bank failure.

The aim of this study was to:

Investigate financial risk inherent within Zimbabwean banks and model the economic capital as an optimal hedge against bank distress.

Methods - Bayesian Networks

1. Qualitative component

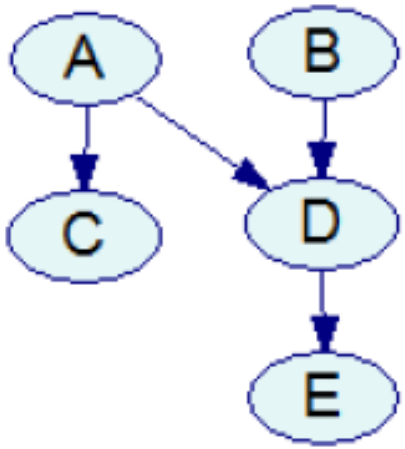

Figure: A representative Bayesian Network: Source- Varuttamaseni (2011)

2. Quantitative component

$$p(X_1, ..., X_n) = \prod_{i=1}^{n} p(X_i|pa(X_i)).$$

Methods - Estimating Economic Capital using VaR

- Value at risk (*VaR*)

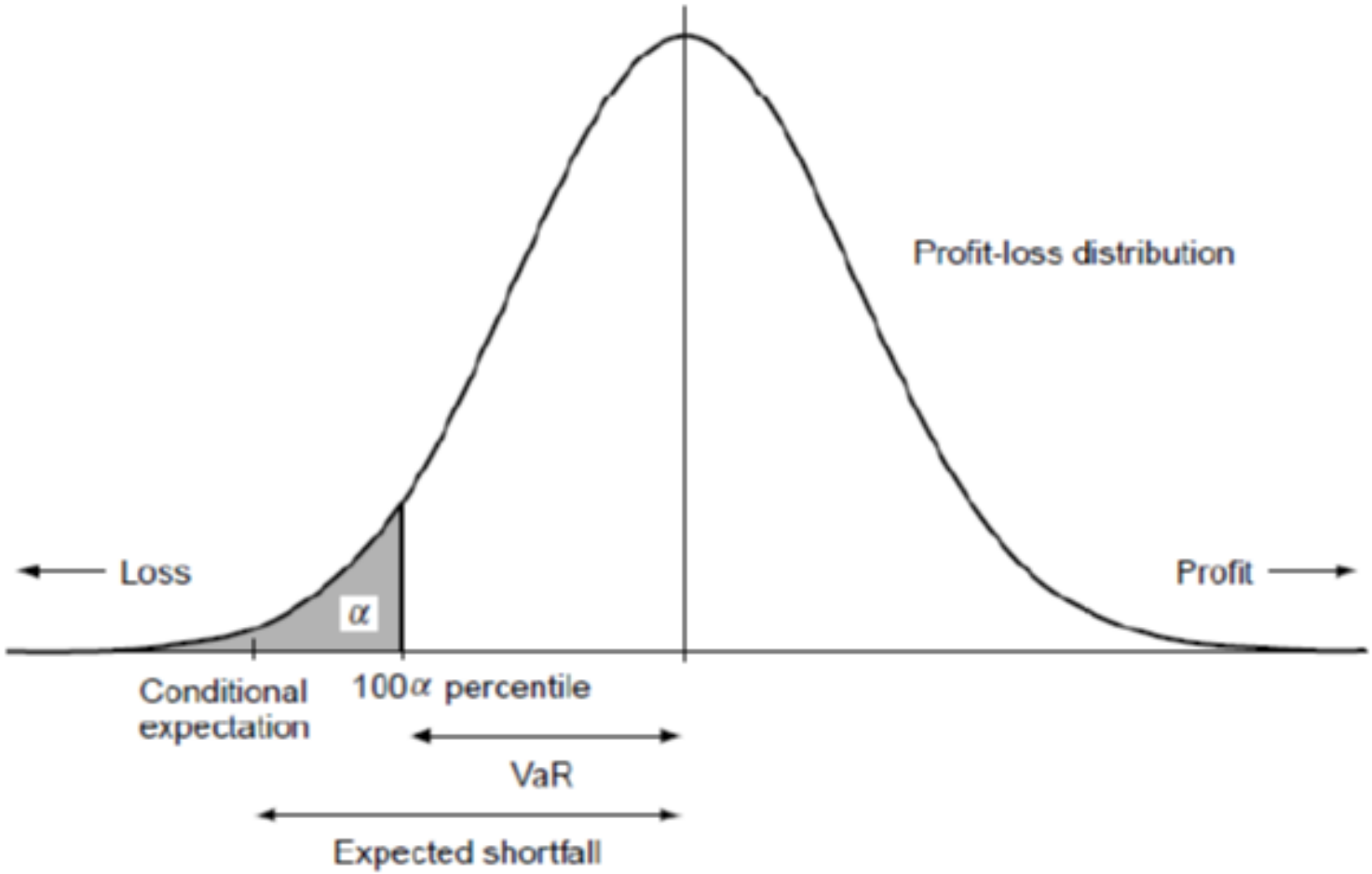

Figure: Profit and Loss distribution: Source – Yamai and Yoshiba (2002a)

Methods - Estimating Economic Capital using VaR *Cont'd.*

- Conditional Value at Risk (*VAR*)

$$CVaR_p(p) = \frac{\int_{-F^{-1}(1-p)}^{\infty} l \cdot f(l) dl}{p}.$$

- Economic Capital (*EC*) as $EC = UL - EL$, where

$$UL = q_\alpha^N \cdot \sigma, \tag{1}$$

q_α^N = quantile of N(0, 1) distribution and $EL = CVaR$.

- Returns on Risk Adjusted Capital(RAROC)

$$RORAC = \frac{\text{Net Income}}{\text{Economic Capital}}$$

Data

- Financial ratios (Moyo et al., 2019)
  - Performance: ROA, ROE, NIM
  - Capital: MS, Conc, SR, BO
  - Growth: CS, Tax, Reserve, RBS, Crisis
  - Credit risk: CR1, CR2
  - Cost Management Efficiency: CE1, CE2, Efficiency, IMI
  - Business mix: Divers, BM1, BM2
  - Liquidity: Liq1, Liq2, LAR
  - Loan funding structure
  - Foreign exchange risk management efficiency
  - Ownership: Government vs Private

Results - Descriptive Statistics

Microeconomic factor	Min	Max	Mean	Std Dev
MS	15.514	21.266	18.86	1.131
Conc	240.677	452.258	356.954	42.213
ROA	-0.29	0.233	0.048	0.056
ROE	-6.164	0.771	0.133	0.634
NIM	-0.016	0.211	0.077	0.033
CS	16.219	21.38	18.942	1.009
CR	-0.207	0.246	0.015	0.036
CE	0.061	0.64	0.218	0.119
Divers	-0.081	0.855	0.466	0.189
Liq1	0.163	1.894	0.961	0.272
Liq2	0.155	0.978	0.8	0.142
CR2	0.144	0.93	0.665	0.159
LFS	0.189	2.349	0.773	0.337
Efficiency	0.111	3.715	0.85	0.461
IMI	15.332	18.719	17.283	0.754
D1	0	1	0.169	0.376
Reserve	-0.009	0.341	0.117	0.076
Crisis	-0.42	42.731	7.583	5.608
BO	1.386	4.174	2.904	0.703
RBS	0.194	30.931	5.882	6.238

Table: Descriptive Statistics, Source: Moyo I.L. *et. al,* 2019

Results - Bayesian Network

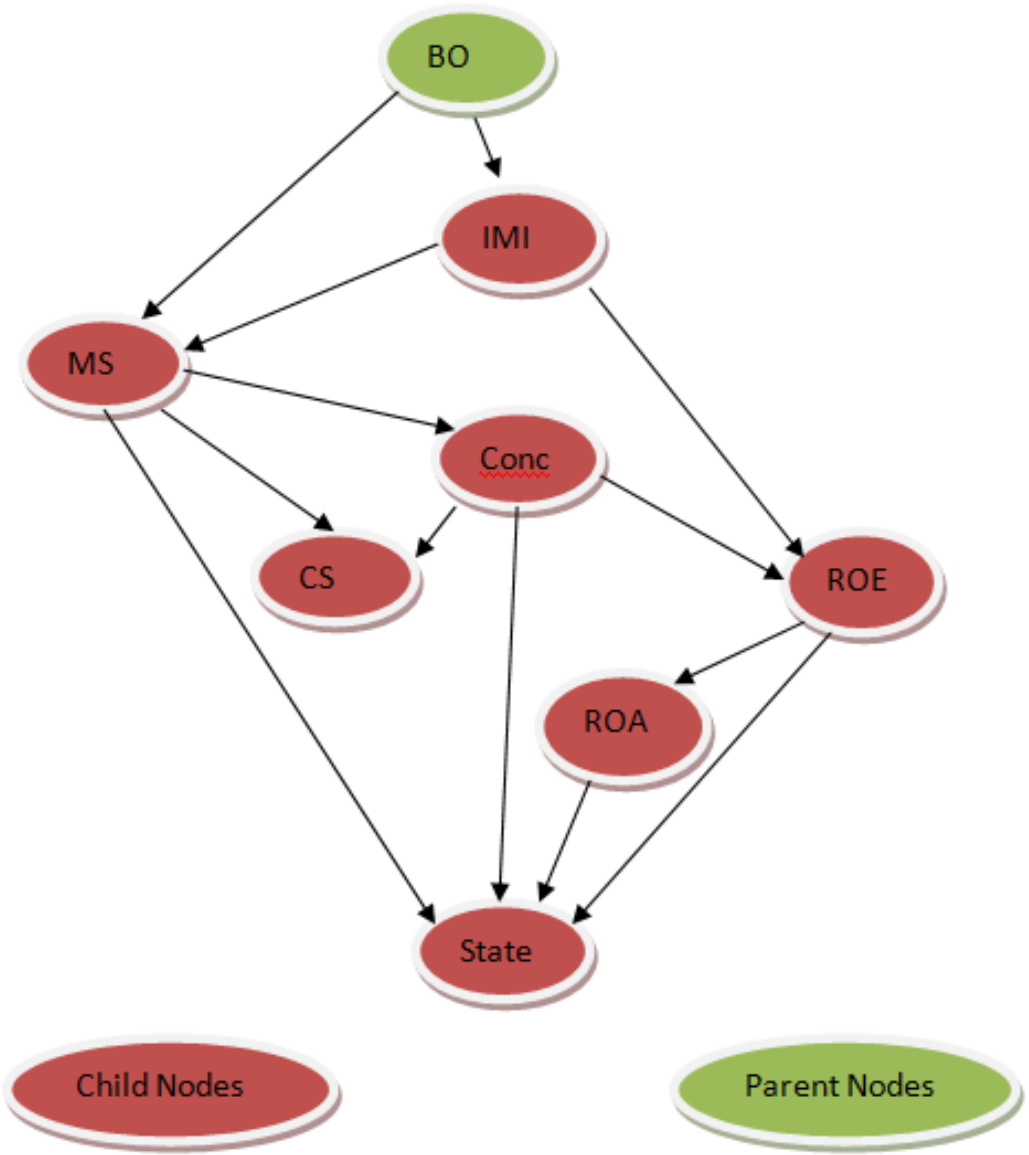

Figure: Bayesian Network found by the learning algorithm. Source: Author

Results - Conditional Probabilities

State	**1**	**2**	**3**	**4**
P(State)	0.156	0.54	0.228	0.076

Table: P(State)

BO	$-\infty$, **2.8618**	**2.8618,** ∞
P(BO)	0.383	0.617

Table: P(BO)

Risk factor	**Value**	**IMI in** $-\infty$, **17.9375**	**IMI in 17.9375,** ∞
BO	$-\infty$, 2.8618	0.991	0.009
	2.8618, ∞	0.712	0.288

Table: $P(IMI|BO)$

Risk factor	Value	Conc in $-\infty$, 380.3446	Conc in 380.3446, ∞
MS	19.5024, ∞	0.995	0.05
	19.5024, ∞	0.012	0.988

Table: $P(Conc|MS)$

Risk factor	Value	ROA in $-\infty$, 0.0236	ROA in 0.0236, ∞
ROE	0.1643, ∞	0.402	0.598
	0.1643, 0.4849	0.024	0.976
	0.4849, ∞	0.031	0.969

Table: $P(ROA|ROE)$

BO	IMI	MS in $-\infty$, 19.5024	MS in 19.5024, ∞
$-\infty$, 2.8618	$-\infty$, 17.9375	0.896	0.104
$-\infty$, 2.8618	17.9375, ∞	0.5	0.5
2.8618, ∞	$-\infty$, 17.9375	0.762	0.238
2.8618, ∞	17.9375, ∞	0.1	0.9

Table: $P(MS|BO, IMI)$

Validation of the Bayesian Networks

Evaluation Metrics	Measure
Accuracy	67.6471
Kappa	0.4899
MAE	0.1999
RMSE	0.3399
Coverage Rate	97.0588%
Precision	0.681
Recall	0.676
TP Rate	0.676
FP Rate	0.178
ROC Area	0.838
PRC Area	0.724
LogScore Bayes	-596.267
LogScore BDeu	-707.660
LogScore MDL	-713.822
LogScore Entropy	-583.632
LogScore AIC	-636.636

Loss Distribution

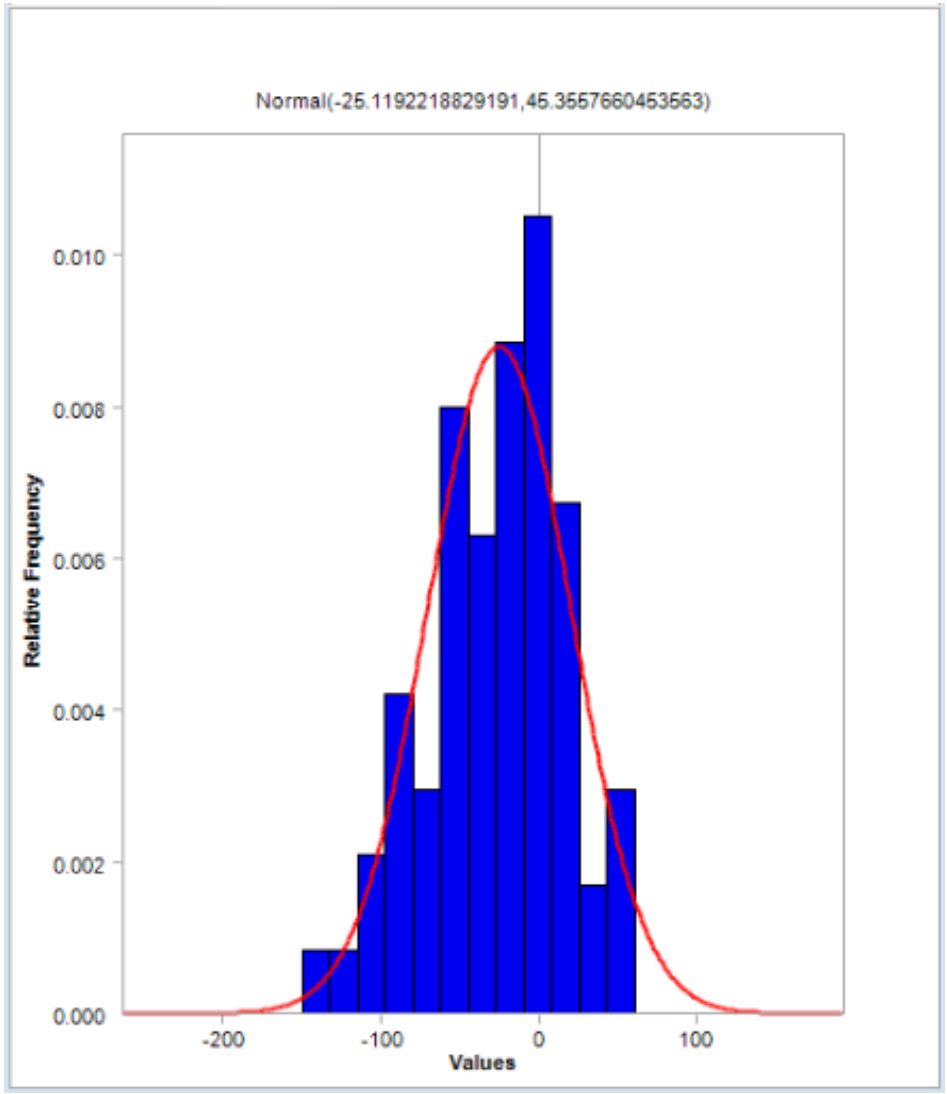

Figure: Loss Distribution Fit: Source – Author

Probability of downgrade by factor

Risk Factor	1-2	2-3	2-4	3-4
MS	0.837	0.52	0.353	0.384
Conc	0.511	0.501	0.496	0.497
ROA	0	0.748	0.001	0
ROE	0.864	0.954	0.008	0.04
CS	0.914	0.467	0.313	0.343
IMI	0.837	0.694	0.146	0.547
BO	0.921	0.579	0.331	0.414
Standard Deviation	0.33783	0.17350	0.18777	0.21490
Total Standard Deviation				0.91400

Table: Probabilities of default given downgrade rating transitions and risk factors: Source – Author

Economic Capital Estimation

	99%	**99.90%**
EL	-23.322	-25.119
UL	2.12628	2.82447
EC	**25.44828**	**27.94347**

Table: EC Estimates

RORAC Estimation

Bank	2018 Net Income (USD)	RORAC 99%	RORAC 99.9%	Z-score 2018	Zone
Agribank	12 701 185.47	0.499098	0.454528	1.071	Distress
BancABC	9 837 685.92	0.386576	0.352054	1.123	Grey
Barclays	25 271364.00	0.993048	0.904367	1.149	Grey
Cabs	44 061 869.98	1.731428	1.576809	1.192	Grey
CBZ	50 481 472.58	1.983689	1.806542	1.215	Grey
Ecobank	39 465 809.73	1.550824	1.412333	1.282	Grey
FBC.BS	11 243 195.68	0.441806	0.402352	1.210	Grey
FBC	25 642 922.01	1.007648	0.917664	1.251	Grey
MBCA/Nedbank	15 391 788.57	0.604826	0.550814	1.206	Grey
Metropolitan	23 701 751.32	0.931369	0.848197	0.703	Distress
NMB	10 631 379.80	0.417764	0.380457	1.195	Grey
POSB	16 854 812.20	0.662316	0.603170	1.056	Distress
Stanbic	39 157 720.52	1.538718	1.401308	1.172	Grey
Stanchart	18 394 050.32	0.722801	0.658254	1.170	Grey
Steward	31 633 219.83	1.243039	1.132034	1.258	Grey
ZB.BS	-131 646.75	-0.005173	-0.004711	0.664	Distress
ZB	14 005 261.04	0.550342	0.501196	1.184	Grey
NBS	1 342 864.42	0.052768	0.048056	0.936	Distress

Table: Liquidity Position of Banks 2018: Source – Author

Conclusions

- RORAC measures inconsistent with Z-scores for some banks - same risk level (EC) used for all banks.
- The same capital requirements (regulatory or economic) cannot be imposed to all banks.
- If EC is controlled then probability of default can also be controlled and hence the rating of a bank.
- Future work should aim at unifying methodological tools from diverse disciplines to develop models that optimally allocate the EC and automated financial systems using these models to ease the computation of EC for end users.

"The future of banking is not just about technology, it's about combining it with human intelligence and expertise to offer clients a better experience" - Brian Moynihan, CEO of Bank of America"

THANK YOU!!!!!!!!!!