Modeling Operational Risk Incorporating Reputation Risk: An Integrated Analysis for Financial Firms

Christian Eckert, Nadine Gatzert

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Modeling Operational Risk Incorporating Reputation Risk: An Integrated Analysis for Financial Firms

ASTIN, AFIR/ERM and IACA Colloquia – Innovation & Invention
Sydney, August 24, 2015
Christian Eckert, Nadine Gatzert
Friedrich-Alexander University Erlangen-Nürnberg (FAU)
Introduction: Motivation

• Operational risk: Definition Solvency II
  – “The risk of loss arising from inadequate or failed internal processes, personnel or systems, or from external events.”
  – Operational risk […] shall include legal risks, and exclude risks arising from strategic decisions, as well as reputation risks.”

• Operational risk can be categorized in 7 event types:
  1. Internal fraud
  2. External fraud
  3. Employment practices & workplace safety
  4. Clients, products & business practices
  5. Damage to physical assets
  6. Business disruption & system failures
  7. Execution delivery & process management
Introduction: Motivation

• Can substantially impact a firm’s risk situation, e.g.
  – Société Générale 2008 - €4.9 billion loss due to unauthorized trading
  – UBS rogue trader scandal 2011 - $2.3 billion loss due to unauthorized trading

➢ Adequate measurement and management of op. risk is vital (also required in Basel II/III, Solvency II)

• However: Losses not restricted to pure operational loss!
  – Empirical literature shows: Op. loss events can lead to sign. reputational losses
    (e.g. Gillet et al., 2010: loss in market capitalization; financial firms)
  – Reputational losses especially pronounced for internal and external fraud (e.g. Fiordelisi et al., 2014)
Introduction: Aim

• Previous work on quantifying operational risks typically does not consider reputational losses

• Aim of this paper:
  – Provide a model to quantify operational risk incorporating reputation risk
  – Extend the classical loss distribution approach (LDA) by taking into account reputational losses using the results in the empirical literature (impact on market capitalization)
  – Calibrate the model based on empirical data from the banking industry

➤ Gain a better (holistic) understanding of the consequences of operational risk and the impact of reputation risk
Model framework: Operational risk

• Total loss $S^L$ resulting from op. risk (LDA)

\[ S^L = \sum_{i=1}^{I} S^L_i = \sum_{i=1}^{I} \sum_{k=1}^{N^L_i} X^L_{i,k} \]

  - $S^L_i$: Op. loss of firm $L$ resulting from event type $i$
  - $N^L_i$: Number of losses due to event type $i$
  - $X^L_{i,k}$: Severity of the $k$-th loss of event type $i$

• Assumptions (see, e.g., Angela et al., 2008):
  - Independence between $X^L_{i,k}$ (for all $i$ and $k$)
  - Independence between $X^L_{i,k}$ and $N^L_i$ (for all $i$ and $k$)
  - $N^L_i$ follows a Poisson process with intensity $\lambda^L_i$
  - $X^L_{i,k}$ follows a truncated lognormal distribution
Model framework: Reputation risk

• Integrating reputational losses:
  - Follow empirical literature with focus on the banking industry (e.g. Cummins et al., 2006; Fiordelisi et al., 2014; Perry and De Fontnouvelle, 2005)
  - Rep. loss = Market value loss that exceeds announced op. loss
  - Use cumulative abnormal returns (CAR) for a given event window ($\tau_1$ days before and $\tau_2$ days after announcement date)

  Rep. loss $Y_{i,k}^L$ of firm $L$ following an op. loss $X_{i,k}^L$

\[
Y_{i,k}^L = -M_{0,i,k}^L \cdot CAR_{i,k}^L (\tau_1, \tau_2) \cdot 1\{X_{i,k}^L \geq H_i^R\}
\]

- $M_{0,i,k}^L$: Market capitalization of firm $L$ at announcement date ("day zero") of the $k$-th op. loss of event type $i$
- $H_i^R$: Threshold above which reputational losses occur
Model framework: Reputation risk

➢ Total reputational loss of firm $L$ in the considered period

$$R^L = \sum_{i=1}^{I} \sum_{k=1}^{N_i^L} Y_{i,k}^L = \sum_{i=1}^{I} \sum_{k=1}^{N_i^L} -M_{0,i,k}^L \cdot CAR_{i,k}^L (\tau_1, \tau_2) \cdot 1_{\{X_{i,k}^L \geq H_i^R\}}$$

• Challenges when calibrating the model:
  
  – Estimating the distribution of the CAR based on empirical data
  
  – Only very little research according to severity distributions of reputational losses
Model framework: Reputation risk

• Approach 1:
  
  - Deterministically integrate the reputational loss by using the average CAR (per event type $i$)

  $$Y_{i,k}^L = -M_{0,i,k}^L \cdot \overline{CAR}_i \left( \tau_1, \tau_2 \right) \cdot 1_{\{X_{i,k}^L \geq H_i^R\}}$$

  ➢ First insight regarding the expected operational and reputational loss depending on the event type
Model framework: Reputation risk

• Approach 2:
  - Assuming a probability distribution for the CAR
  - Estimation based on empirical data (if available)
  - Until now only Cannas et al. (2009) using a small sample
    - Logistic distribution for internal fraud events
  - Assumptions (see Cannas et al., 2009):
    - $CAR_{i,k}^L (\tau_1, \tau_2)$ follows a logistic distribution
    - Independence between the $CAR_{i,k}^L (\tau_1, \tau_2)$ (for all $i$ and $k$)
    - Independence between $CAR_{i,k}^L (\tau_1, \tau_2)$ and $X_{i,k}^L$ (for all $i$ and $k$)
    - Independence between $CAR_{i,k}^L (\tau_1, \tau_2)$ and $N_i^L$ (for all $i$ and $k$)
Model framework: Reputation risk

• Approach 3:
  - Extending the second approach
  - Explicitly taking into account the probability with which reputational losses occur
  - Allows taking into consideration:
    • Firm characteristics
    • Ability for crisis management and crisis communication after a reputation risk event
  ➢ First insight regarding the effects of reducing the probability of reputational losses and the potential of preventive measures
Numerical analysis: Calibration

• Calibration of the model based on external data
  - Necessary to adjust external data to characteristics of considered firm $L$
  - Using a scaling model proposed in Dahen and Dionne (2010)

• Results derived based on closed-form expressions whenever possible (otherwise Monte Carlo simulation)

• Input parameter for firm $L$ (Dahen and Dionne, 2010):

<table>
<thead>
<tr>
<th>Type</th>
<th>Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>USA</td>
</tr>
<tr>
<td>Market capitalization $ML$</td>
<td>$9,000$ million</td>
</tr>
<tr>
<td>Total assets $AL$</td>
<td>$100,000$ million</td>
</tr>
<tr>
<td>Bank capitalization $BL$</td>
<td>0.1</td>
</tr>
<tr>
<td>Mean salary $SL$</td>
<td>$50,000$</td>
</tr>
<tr>
<td>Real GDP growth $GL$</td>
<td>3.7</td>
</tr>
<tr>
<td>Considered period</td>
<td>1 year</td>
</tr>
</tbody>
</table>
Numerical analysis: First approach

- Mean annual operational & reputational loss of firm $L$ in $\$ million

<table>
<thead>
<tr>
<th>Event type</th>
<th>Op. loss</th>
<th>Rep. loss</th>
<th>Total loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>in %</td>
<td>Mean</td>
</tr>
<tr>
<td>Internal fraud</td>
<td>0.25</td>
<td>7.6%</td>
<td>6.39</td>
</tr>
<tr>
<td>External fraud</td>
<td>0.62</td>
<td>19.2%</td>
<td>7.11</td>
</tr>
<tr>
<td>Employment practices &amp; workplace safety</td>
<td>0.08</td>
<td>2.4%</td>
<td>1.05</td>
</tr>
<tr>
<td>Clients, products &amp; business practices</td>
<td>2.17</td>
<td>67.2%</td>
<td>5.48</td>
</tr>
<tr>
<td>Execution delivery &amp; process management</td>
<td>0.12</td>
<td>3.7%</td>
<td>0.42</td>
</tr>
<tr>
<td>Sum</td>
<td>3.23</td>
<td>100%</td>
<td>20.45</td>
</tr>
</tbody>
</table>
Numerical analysis: Event window

- Impact of the choice of the event window

![Event Window Diagram]

- Rep. loss - Execution delivery & process management
- Rep. loss - Clients, products & business practices
- Rep. loss - Employment practices & workplace safety
- Rep. loss - External fraud
- Rep. loss - Internal fraud

Op. loss

in $ million

(-3;3)  (-5;5)  (-10;10)  (-20;20)

event window
Numerical analysis: Firm size

- Impact of the firm size (market capitalization; total assets)

![Chart showing the impact of firm size on mean annual operational and reputation losses. The x-axis represents market capitalization in $ billion, and the y-axis represents losses in $ million. Bars indicate mean annual operational losses and mean annual reputation losses for different levels of market capitalization.]
### Numerical analysis: First approach

- Value at risk at the confidence level 99.5%

<table>
<thead>
<tr>
<th>Event type</th>
<th>Op. loss (VaR 99.5%)</th>
<th>Rep. loss (VaR 99.5%)</th>
<th>Total loss (VaR 99.5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal fraud</td>
<td>13.1</td>
<td>290.0</td>
<td>303.4</td>
</tr>
<tr>
<td>External fraud</td>
<td>31.4</td>
<td>226.7</td>
<td>259.6</td>
</tr>
<tr>
<td>Employment practices &amp; workplace safety</td>
<td>3.1</td>
<td>145.5</td>
<td>148.6</td>
</tr>
<tr>
<td>Clients, products &amp; business practices</td>
<td>95.6</td>
<td>94.3</td>
<td>206.7</td>
</tr>
<tr>
<td>Execution delivery &amp; process management</td>
<td>6.1</td>
<td>58.7</td>
<td>64.7</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td><strong>149.3</strong></td>
<td><strong>815.2</strong></td>
<td><strong>983.0</strong></td>
</tr>
<tr>
<td><strong>VaR of the sum (Ind.)</strong></td>
<td><strong>111.7</strong></td>
<td><strong>290.0</strong></td>
<td><strong>373.8</strong></td>
</tr>
</tbody>
</table>
Summary

• Extend current approaches to quantify operational risk by including reputation risk
  ➢ Comprehensively assess consequences of operational risk

• Calibrate model based on empirical literature

• Findings emphasize that neglecting potential reputational losses may lead to
  ➢ An underestimation of operational risk in general and specific event types in particular (e.g. internal fraud, external fraud)
  ➢ Potential underestimation of relevance of preventive measures regarding operational risk
  ➢ A possible inadequate allocation of resources in ERM

➢ Further research is necessary (empirical and theoretical)
Thank you for your attention.

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