Study Guide for Casualty Actuarial Exam 7 on "Operational Risk in Perspective"

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This is an open-source study guide and may be revised pursuant to suggestions.

Source: Alexander J. McNeil, Rüdiger Frey, and Paul Embrechts. *Quantitative Risk Management: Concepts, Techniques, and Tools.* Chapter 10. Operational Risk and Insurance Analytics. Section 10.1. Operational Risk in Perspective. pp. 499-507.

Problem S7-ORP-1.

(a) Provide the Basel II definition of "operational risk".
(b) Give four examples of kinds of operational losses.
(c) Give an example of a kind of loss that is *not* included under "operational risk" (McNeil et al., p. 500).

Solution S7-ORP-1.
(a) Basel II definition: Operational risk is the risk of loss resulting from inadequate or failed internal processes, people, or systems or from external events. This definition includes legal risk, but excludes strategic and reputational risk.
(b) Examples of kinds of operational losses (any four will suffice):
1. Internal fraud
2. External fraud
3. Losses due to IT failures
4. Losses due to errors in settlements of transactions
5. Litigation losses
6. Losses due to external events (flooding, fire, earthquake, terrorism, etc.)
(c) Losses due to unfortunate management decisions (e.g., failed mergers) are not included under operational risk.

Problem S7-ORP-2.
(a) What, according to McNeil et al., is an essential difference between operational risk and other types of risk, such as market risk or credit risk?
(b) How has this fact motivated the Basel Committee to treat operational risk for banks?
(McNeil et al., p. 500)

Solution S7-ORP-2.
(a) Unlike market risk or credit risk, operational risk has no upside for the company.
(b) The Basel Committee has recommended that banks set aside risk capital for operational risk under Pillar I of the three-pillar Basel II system. Also, the Basel II accord provides for Pillar II supervisory review and for Pillar III market discipline with respect to public disclosure to exist in regard to operational risk.

Problem S7-ORP-3.
(a) What, according to McNeil et al., is a major issue with regard to considering operational risk?
(b) How has the insurance industry responded when it faced a similar issue in the underwriting of catastrophe insurance? (McNeil et al., p. 500)

Solution S7-ORP-3.
(a) A major issue is the lack of operational-loss data currently and in the foreseeable future.
(b) The insurance industry's answer has been data-pooling across industry participants. The same solution could be useful for obtaining data on operational losses.

Problem S7-ORP-4.
(a) Qualitatively describe the two elementary approaches to operational risk management.
(b) Provide formulas for risk capital under each of these two elementary approaches. Define all terms used. (McNeil et al., p. 501)

Solution S7-ORP-4.
(a) Basic indicator (BI) approach: Banks must hold capital for operational risk equal to the average over the previous three years of a fixed percentage (α) of positive annual gross income (GI). Figures for any year in which annual gross income is negative or zero should be excluded from both the numerator and the denominator when calculating the average.
Standardized (S) approach: Banks' activities are divided into eight business lines: corporate finance, trading and sales, retail banking, commercial banking, payment and settlement, agency services, asset management, and retail brokerage. Within each business line, gross income (GI) is a broad indicator that serves as a proxy for the scale of business operations and the likely scale of operational risk exposure. The capital charge for each business line is calculated by multiplying gross income by a factor (β) assigned to that business line. The total capital charge is calculated as a three-year average over positive GIs.
(b) <u>Formula for BI approach</u>:
$$\mathbf{RC_{BI}^{t}(OR) = (1/Z_t)*\sum_{i=1}^{3}[\alpha*\max(GI^{t-i},0)]}$$
<u>Definitions of terms</u>:
$RC_{BI}^{t}(OR)$ = risk capital, under the BI approach, for year t, for operational risk.
GI = gross income
GI^{t-i} = gross income in year (t-i)
α = fixed percentage of positive annual gross income
$Z_t = \sum_{i=1}^{3}[I_{\{GI^{(t-i)} > 0\}}]$ (i.e., the sum of income for all three previous years where gross income exceeds 0.
<u>Formula for S approach</u>:
$$\mathbf{RC_S^{t}(OR) = (1/3)*\sum_{i=1}^{3}[\max(\sum_{j=1}^{8}[\beta_j*GI_j^{t-i}], 0)].}$$
<u>Definitions of terms</u>:
$RC_S^{t}(OR)$ = risk capital, under the S approach, for year t, for operational risk.
j = indicator variable, ranging from 1 to 8, denoting each of the eight business lines considered.
β_j = factor assigned to a line of business (indexed by j), by which gross income is multiplied to calculate the capital charge for that business line.
GI_j = gross income for a line of business (indexed by j).

GI_j^{t-i} = gross income in year (t-i) for a line of business (indexed by j).

Problem S7-ORP-5. What, according to McNeil et al., is a built-in incentive for banks to switch from the basic indicator (BI) approach to the standardized (S) approach? (McNeil et al., p. 502)

Solution S7-ORP-5. Since the S approach considers each of eight business lines separately, in any given year, negative capital charges (from negative gross income) in some lines might be used to offset positive capital charges in other business lines. No such "netting" is possible under the BI approach, and banks might be incentivized to move to the S approach to take advantage of this netting.

Problem S7-ORP-6. For the advanced measurement (AM) approach to measuring operational risk, the Basel II committee did not provide detailed prescriptions, but rather set forth general guidelines. Describe two of these general guidelines as they pertain to banks. (McNeil et al., p. 503)

Solution S7-ORP-6. General guidelines: **1.** A bank must be able to demonstrate that its approach captures potentially severe "tail" loss events.
2. A bank must demonstrate that its operational-risk measure meets a soundness standard comparable to that of the internal ratings-based approach for credit risk (i.e., comparable to a one-year holding period and the 99.9% confidence interval).

Problem S7-ORP-7. What are the two ways in which, according to McNeil et al., operational losses should be categorized in an AM approach for banks? (McNeil et al., p. 503)

Solution S7-ORP-7. In an AM approach for banks, operational losses should be categorized according to (i) eight business lines and (ii) seven loss-event types:
(1) internal fraud;
(2) external fraud;
(3) employment practices and workplace safety;
(4) clients, products, and business practices;
(5) damage to physical assets;
(6) business disruption, & system failures; and
(7) execution, delivery, and process management.

Problem S7-ORP-8. Fill in the blanks (McNeil et al., p. 503): In an AM approach, banks are expected to gather _____ data on _____, _____ losses, as well as relevant _____ data on _____, _____ losses. Moreover, they must add stress scenarios both at the level of _____ and _____. In the absence of detailed joint models for different loss types, risk measures for the aggregate loss should be calculated by _____. In general, both _____ and _____ losses should be taken into account.

Solution S7-ORP-8. In an AM approach, banks are expected to gather **internal** data on **repetitive**, **high-frequency** losses, as well as relevant **external** data on **non-repetitive**, **low-frequency** losses. Moreover, they must add stress scenarios both at the level of **loss severity** and **correlation between loss types**. In the absence of detailed joint models for different loss types, risk measures for the aggregate loss should be calculated by **summing across the different loss categories**. In general, both **expected** and **unexpected** losses should be taken into account.

Problem S7-ORP-9. For the AM approach described by McNeil et al., describe how the total loss amount for a given year is calculated. (McNeil et al., p. 503)

Solution S7-ORP-9.
Step 1: First, add up all the losses of the same loss type and line of business.
Step 2: Then, keeping each line of business the same, add all the losses of the same loss type within that line of business.
Step 3: Combine the totals from Step 2 from each of the eight lines of business.

Problem S7-ORP-10. Give **(a)** a general formula and **(b)** a special instance of that formula for arriving at the risk capital under the AM approach. Define all terms used. (McNeil et al., p. 504)

Solution S7-ORP-10.
(a) <u>General formula</u>:
$\mathbf{RC_{AM}^{t}(OR) = \varrho_{\alpha}(L^{t})}$
<u>Definitions of terms</u>:
$RC_{AM}^{t}(OR)$ = risk capital, under the BI approach, for year t, for operational risk.
L^{t} = The total loss amount for year t.
ϱ_{α} = The risk measure of choice, at confidence level α.

(b) <u>Special instance of general formula</u> (Many answers are possible.)**:**
$\mathbf{RC_{AM}^{t}(OR) = VaR_{0.999}[\sum_{k=1}^{N}(X_k)]}$
<u>Definitions of terms</u>:
$VaR_{0.999}$ = Value at Risk at the 0.999 percentile. This is the ϱ_{α} being used.
X_k = A sequence of loss severity.
N = A random variable describing the frequency with which operational losses occur.

Problem S7-ORP-11. What three "stylized facts" did McNeil et al. extract from the very limited operational-risk data available? (McNeil et al., p. 505)

Solution S7-ORP-11.
1. Loss severities have a heavy-tailed distribution.
2. Losses occur randomly in time.
3. Loss frequency may vary substantially over time.

Problem S7-ORP-12. What are two possible causes of the non-homogeneity of loss frequency? (McNeil et al., p. 506)

Solution S7-ORP-12.
1. There may be reporting bias in that fewer operational-risk losses were reported from earlier periods (when operational risk was not as much of a subject of study) than were reported from later periods.
2. There may be a considerable cyclical component to some kinds of losses (e.g., dependency of errors on volume of business and relationship of fraud levels with the stage of the business cycle).

Problem S7-ORP-13. In view of the heavy-tailedness of loss data and the necessity of calculating capital charges corresponding to high quantiles, what methodology do McNeil et al. recommend and consider "natural"? (McNeil et al., p. 507)

Solution S7-ORP-13. Extreme value theory (EVT)