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Functional correlation approach to operational risk in banking organizations☆

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Abstract

A Value-at-Risk-based model is proposed to compute the adequate equity capital necessary to cover potential losses due to operational risks, such as human and system process failures, in banking organizations. Exploring the analogy to a lattice gas model from physics, correlations between sequential failures are modeled by as functionally defined, heterogeneous couplings between mutually supportive processes. In contrast to traditional risk models for market and credit risk, where correlations are described as equal-time-correlations by a covariance matrix, the dynamics of the model shows collective phenomena such as bursts and avalanches of process failures.

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1. Introduction

Risk management has become increasingly important in financial institutions over the last decade. Since the publication of JP Morgan's RiskMetrics™ [1] in the nineties, Risk Management and Risk Control departments in banks have grown significantly in size and importance. The task is to fulfill regulatory requirements, to add transparency

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about a bank's risk profile by a quantitative assessment of risks, to develop the necessary IT solutions which allow to process the huge amount of data of a bank, and, finally, to integrate this information in a risk-return (RoRAC = Return on Risk-Adjusted Capital)-based steering process of the bank. Ultimately, a proper risk management and risk control process is recognized by rating agencies and investors so that shareholder value is added to the bank.

Banks first focused on controlling potential losses due to market fluctuation, such as changes in the S&P 500 stock index, changes in interest and currency exchange rates, which is termed market risk. Internal market risk models are nowadays rather matured and accepted by regulators for the calculation of the required capital to be held as buffer against such losses. In contrast to these elaborated statistical models for market risks, credit risks (i.e., risks due to obligors' default) have to be covered by simply 8% capital of the bank's risk-weighted assets. Implicitly, this charge also includes other risks such as operational risks (ORs). Since the New Basel Accord on Capital Adequacy issued by the Basel Committee on Banking Supervision in February and September 2001 [2–4], known as Basel II, it is clear that regulators will demand banks to hold equity capital against ORs explicitly.

A common industry definition of OR is the risk of direct or indirect losses resulting from inadequate or failed internal processes, people and systems or from external events [5]. See Ref. [6] for a practice-oriented introduction to the issue. Possible OR-risk categories are [6]: (i) human processing errors, e.g., mishandling of software applications, reports containing incomplete information, or payments made to incorrect parties without recovery, (ii) human decision errors, e.g., unnecessary rejection of a profitable trade or wrong trading strategy due to incomplete information, (iii) (software or hardware) system errors, e.g., data delivery or data import is not executed and the software system performs calculations and generates reports based on incomplete data, (iv) process design error, e.g., workflows with ambiguously defined process steps, (v) fraud and theft, e.g., unauthorized actions or credit card fraud, and (vi) external damages, e.g., fire or earthquake.

Thinking of theses categories as "OR processes" it is clear that there are *functionally defined dependencies* between individual processes, which all together bring a big organization to work. Consider the following example for illustration: a system error leads to an incomplete data import into a risk calculation engine, resulting in a wrong calculation of risk figures, and eventually to a human decision error by the trader, who closes a possibly profitable position unnecessarily to reduce a risk which in fact does not exist.

In the end misleading or lagging information, or system and workflow failures will always result in financial loss for a bank. Indeed, practitioners have recognized these dependencies in OR events and mandated units like the internal audit and risk control departments to control processes for the bank, and generated functions like a Chief Operating Officer to optimize them. OR error trees between the above categories have been formalized in Ref. [6] in more detail.

Since the mid-nineties, financial markets have also attracted physicists in academia. One of the main reason is that financial time series exhibit several statistical peculiarities, many of them being common to a wide variety of different markets and