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A Method of Estimating Operational Risk: Loss Distribution Approach with Piecewise-defined Frequency Dependence

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Abstract

In loss distribution approach (LDA), the most popular approach to operational risk aggregation, modeling the dependence across business lines has been recognized, however, the research of separately modeling dependence of high-frequency low-severity and low-frequency high-severity loss events is scarce so far. In this paper, we present an approach to estimate operational risk by modeling frequency dependence for high-frequency low-severity and low-frequency high-severity loss events separately across business lines in the framework of LDA, named LDA with piecewise-defined frequency dependence (LDA-PFD), and then apply this approach to calculate operational risk capital of the overall Chinese banking based on the largest bank, operational risk data set, the Chinese Operational Loss Database (COLD), which consists of 2132 operational risk records. The empirical results reveal that the operational risk capital calculated by LDA-PFD is significantly less than the loss distribution approach simply considering frequency dependence of the entire data (LDA-FD) and loss distribution approach based on piecewise-defined distribution but not considering dependence (LDA-PD).

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Keywords: Operational risk; piecewise-defined dependence; frequency dependence; copula; Monte Carlo simulation.

1. Introduction

In recent years, the operational risk events have caused more and more harms to banks, and even threaten the survival of banks. In view of the serious losses caused by operational risk, following credit risk and market risk, operational risk has become the third risk covered by Basel Accord II, and Basel Committee on Banking Supervision (hereafter BCBS) asked the financial institutions to allocate the corresponding capital for operational risk to enhance the stability of the bank. Basel Accord II proposes basic indicator approach (BIA), standardized

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approach (SA), and advanced measurement approach (AMA) to calculate operational risk capital. Among the three approaches, AMA is the most sophisticated and much more risk sensitive than the former two approaches, so the BCBS encourages banks to develop and use the AMA within operational risk management [1,2,3]. Many methods have been developed so far, among which LDA is the most widely used [4,5].

Scholars have a more and more deep and specifically research on LDA due to the existence of problems in classical LDA. Many researches reveal that the severity distribution is the most important component in quantitative operational risk models, and the choice of severity distribution usually has a much more severe impact on capital than the choice of frequency distribution [4,6]. Therefore, we need a more accurate method to fit the severity distribution. There is an obvious fat-tail characteristic of the operational risk loss distribution, which is manifested in the fact that the loss is small in most cases, but large in some extreme cases [7], so, the operational risk loss events can be divided into high-frequency low-severity and low-frequency high-severity loss events. Due to the two-dimensional character of operational risk losses, fitting the distribution with a specified distribution is of great difficulty [8]. Naturally, the piecewise-defined severity distribution is used in the framework of LDA. Feng et al. proposed the piecewise-defined severity distribution based on loss distribution approach (PSD-LDA) to calculate the operational risk capital charge, which involves estimating two different severity distributions, one above a certain threshold, and one below it [4]. What's more, the dependence across business lines has been recognized. The BCBS divides the business activities of commercial banks into 8 business lines, and three kinds of dependencies between the business lines might occur and so should be taken seriously, that is, frequency dependence, severity dependence, and loss distribution dependence [2,6,9]. Among the three dependencies, frequency dependence can be quite easily calculated from empirical loss data and adding correlation between frequencies of events is quite an easy task and does not destroy the very nature of the LDA model [2]. Operational losses of different business lines may be subject to the same claim generating mechanism or affected by the changes in the common underlying environment. Consequently, it is reasonable to consider the dependence in the framework of LDA [9]. However, the research of modeling dependence in the framework of LDA is simply based on entire data so far, but the various theoretical researches show that the dependence between the high-frequency low-severity and low-frequency high-severity loss events is also different. Therefore, separately modeling the dependence of two types of data based on the piecewise-defined distribution will further refine the research so that obtain a more precise capital charge.

This paper aims to separately model the frequency dependence of high-frequency low-severity and low-frequency high-severity loss events in the framework of LDA. An approach named LDA with piecewise-defined frequency dependence (LDA-PFD) is proposed and applied to calculating the operational risk capital charge for Chinese banking based on the largest Chinese operational risk data set called COLD. In order to verify the effectiveness of the proposed approach, its empirical result is compared with other approaches that either only consider integrated frequency dependence or piecewise-defined distributions.

The rest of this paper is organized as follows. Firstly, Section 2 introduces the approach LDA-PFD. Then Section 3 employs the approach to calculate the operational risk capital charge of the overall Chinese banking. Section 4 summarizes the conclusions.

2. LDA with piecewise-defined frequency dependence (LDA-PFD)

The core of LDA-PFD is the modeling of piecewise-defined frequency dependence. Firstly, we estimate two different distributions of high-frequency low-severity and low-frequency high-severity separately for both frequency and severity, then, copula function is used for modeling frequency dependence, and finally, simulating VaR using Mont Carlo simulation. There are three assumptions in the proposed LDA-PFD model: (i) frequency and severity is independent; (ii) two different losses in the same class are independently and identically distributed [4]; and (iii) high-frequency low-severity losses and low-frequency high-severity losses are independent. The amount of operational risk is estimated by processes outlined herein below.