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POT model for operational risk: Experience with the analysis of the data collected from Chinese commercial banks☆

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ABSTRACT

This paper takes 533 operational risk loss events publicly announced by Chinese commercial banks in the period of 1995-2012 as the sample, using Peaks over Threshold (POT) model to quantify the operational risk. The statistical data classification indicates the internal fraud is the main type of operational risk in Chinese commercial banks. This paper explains its causes from the perspective of behavioral finance. The results are as follows: first, Chinese commercial banks' operational risk loss events show an upward trend, then downward trend beginning in 2003 and currently an upward trend again; second, through the empirical analysis, this paper simulates the extreme value distribution function, finds the optimal threshold, and calculates the VaR and ES of the operational risk of Chinese commercial banks and compare them at different confidence levels; and third, in view of behavioral finance theory, overconfidence and loss aversion contribute to high internal fraud incidence.

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1. Introduction

Although operational risk is far from a new concept among the risks of the commercial bank, it is after Barings Bank (London) declared bankruptcy in 1995 when this kind of risk was officially regarded as a major bank risk by Basel Committee. In recent years, with the rapid development of Chinese commercial banking, operational risk has been increasingly severe. The measurement of such risk in Chinese commercial banks has also become increasingly important. Three approaches were described by the Basel accord for the measurement of operational risk: the Basic Indicator Approach, the standardized approach and the Advanced Measurement Approach (AMA). As the Chinese banking sector lacks good information disclosure, and many banks fear that the disclosure of operational risk loss events is detrimental to their image, they even try to hide their losses. The available operational risk loss data are often incomplete and insufficient. Moreover, operational risk loss events also have the characteristic of low frequency, high severity and thick tail distribution. To study such kind of loss data, extreme value theory (EVT) which is one of the AMAs, is more appropriate. So this paper focuses on this theory.

EVT is the theory of modeling and measuring events which occur with very low probability. EVT was first developed by Fisher and Tippett (1928) and formalized by Gnedenko (1943). Gumbel (1958) codified this theory in his 1958 book "Statistics of Extremes", including the Gumbel distributions that bear his name. EVT has traditionally been applied to predict the probability distribution of extreme floods, tsunamis, earthquakes and other natural disasters. Embrechts, Resnick and Samorodnitsky (1998) used EVT in the financial risk analysis. McNeil (1999) used the POT model for estimating measures

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of tail risk. E.A. Medova et al. (2001) applied extreme value theory for the purpose of calculating the economic capital requirement against unexpected operational losses. In recent years, EVT has been widely used in finance, insurance, hydrology and meteorology. Hela, Georges, and Daniel (2010) use POT model to analyze the 52 documented loss data from a very large US bank and find that no marked trend exists in the frequency of such losses. It also shows that there is very low correlation between the value of each loss and the bank's assets in the year that the loss occurred and calculates the maximum potential loss (VaR). Petr, Vidya, and Radovan (2010) utilized two main approaches, namely the Loss Distribution Approach (LDA) and EVT to model economic capital for operational risk of a Central European Bank. They find that when using the AMA rather than the Basic Indicator Approach (BIA) used in Basel II, the researched bank might save approx. 67% of its capital requirement on operational risk. Compared with other countries, operational risk quantification of Chinese banks has a late start. Xia (2002) compares POT model with other traditional methods in the empirical VaR calculation. Fengzhen (2006) discusses the EVT in risk management. Zhong, Aiyuan, and Xuezhen (2006) study the EVT in the risk measurement of the financial market. Mingsheng (2007) analyzes the application of EVT in the operational risk modeling and its improvements of financial institutions. Yuanrui and Rui (2007) do an empirical analysis of internal fraud risk of Chinese commercial banks. Zhou Minjuan and Su Xin (2011) discussed the mean excess function plot method and Hill Plot method when doing the threshold selection. Longteng and Lisheng (2012) through empirical research find that POT model is more suitable than the BMM model to measure the operational risk of Chinese commercial banks.

In this paper, using publicly 533 operational risk loss event data announced by China's commercial banks in the period of 1995–2012, we quantify the operational risk of Chinese commercial banks. The second section is an introduction of the POT model. The third section studies the characteristics and causes of the operational risk of Chinese commercial banks. The fourth section uses POT model to measure the operational risk of Chinese commercial banks. The last section is the conclusions and suggestions.

2. Peak over threshold (POT) model

Over the recent years, EVT has been well recognized as a useful set of probabilistic and statistical tools for the modeling of rare events, especially the statistical data that departure from normality. It estimates the probability of severe shocks that are more extreme and focuses on the tail behavior of a distribution and has great significance for the low-frequency, high-severity operational loss events of commercial banks. Block-Maxima Models (BMMs) are traditional analysis approach models of EVT. These models consider the largest observations got from successive periods and choose an appropriate length of time as the blocks. They are mainly for handling extreme value data. When using BMM model, because only one maxima can be selected from the data in each block, it cannot sufficiently use of the data information. However we can assume a very large threshold, and the values which exceed the threshold value can be considered as the extremes, thus the above data waste can be avoided. POT model is such a model that you can take advantage of these data information for statistical modeling.

2.1. POT model overview

Consider the independent identically distributed (iid) variables $X_1, \ldots, Xn$, and x^* is the endpoint of the distribution function $F(x)$. Select a high enough value as the threshold μ, and the exceedances of this threshold μ value are called Peaks Over Threshold, referred as POT.

$$F_U(x) = \Pr(X-u \le x | X>u) = \frac{F(x+u)-F(u)}{1-F(u)}, \qquad x \ge 0. \tag{1}$$

We call $F(x)$ the distribution function of the exceedances (exceeds the threshold) of the idd random variable X. The corresponding density function is:

$$f_u(x) = \frac{f(x+u)}{\overline{F}(u)}, \qquad x \ge 0$$

$$F_{[u]}(x) = \Pr(X \le x | X>u) = \frac{F(x)-F(u)}{1-F(u)}, \qquad x \ge u,$$

is called the distribution function of the Peaks Over Threshold of the independent identically distributed random variable X. The corresponding density function is:

$$f_{[u]}(x) = \frac{f(x)}{\overline{F}(u)}, \qquad x \ge u.$$

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