Available online at www.sciencedirect.com
ScienceDirect
Computational Statistics & Data Analysis 52 (2008) 3107–3127
COMPUTATIONAL STATISTICS & DATA ANALYSIS
www.elsevier.com/locate/csda

A Bayesian approach to estimate the marginal loss distributions in operational risk management

L. Dalla Valle[a,*], P. Giudici[b]

[a] *Department of Business Research "R. Argenziano", Faculty of Economics, University of Pavia, via S. Felice 7, Pavia 27100, Italy*
[b] *Department of Statistics and Applied Economics "L. Lenti", Faculty of Political Science, University of Pavia, Pavia 27100, Italy*

Available online 2 October 2007

Abstract

One of the main problems in operational risk management is the lack of loss data, which affects the parameter estimates of the marginal distributions of the losses. The principal reason is that financial institutions only started to collect operational loss data a few years ago, due to the relatively recent definition of this type of risk. Considering this drawback, the employment of Bayesian methods and simulation tools could be a natural solution to the problem. The use of Bayesian methods allows us to integrate the scarce and, sometimes, inaccurate quantitative data collected by the bank with prior information provided by experts. An original proposal is a Bayesian approach for modelling operational risk and for calculating the capital required to cover the estimated risks. Besides this methodological innovation a computational scheme, based on Markov chain Monte Carlo simulations, is required. In particular, the application of the MCMC method to estimate the parameters of the marginals shows advantages in terms of a reduction of capital charge according to different choices of the marginal loss distributions.

Keywords: Expected shortfall; Loss distribution approach; Marginal loss distribution; Markov chain Monte Carlo; Operational risk; Value at risk

1. Introduction

Recent years have seen a rapid and widespread development of operational risk models. This is due not only to regulatory compliance, but also to the recognition of the fact that system complexity and sophistication need a complete and composite evaluation regarding this type of risk, in order to increase the soundness of business procedures. However, the main reason that pushes risk managers towards the application of good operational risk practices is represented by financial regulators (www.bis.org).

Considering the different methodologies for operational risk management, we focus our attention on the advanced measurement approach (AMA) (in particular, on the loss distribution approach, LDA). This method shows great improvements compared to the traditional approaches, in that it takes into account the particular characteristics of a bank and calculates the capital charge on the basis of the division business line/event type (BL/ET). Managing operational risk at this level means an advantage in terms of reduction of the capital requirements. However, the AMA does have some limitations. The main problem is the inaccuracy and scarcity of data, that is basically due to the relatively recent definition and management of operational risk. This makes the process of data recovery generally more difficult,

* Corresponding author. Tel.: +39 382 986418; fax: +39 382 986228.
E-mail address: luciana.dallavalle@unipv.it (L. Dalla Valle).

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doi:10.1016/j.csda.2007.09.025

since financial institutions only started to collect operational loss data a few years ago. In this context, the employment of Bayesian and simulation methods appears to be a natural solution to the problem. In fact, they allow us to combine the use of quantitative information (coming from the time series of losses collected by the bank) and qualitative data (coming from experts' opinions), taking the form of prior information. Besides, simulation methods represent a widely used statistical tool that overcome computational problems. The combination of the described methodologies leads to the Markov chain Monte Carlo (MCMC) methods, which includes the main advantages of both Bayesian and simulation methods. The idea behind the present work is to estimate the parameters of the marginal distributions of the losses not only with the classical, but also with the Bayesian approach and, in particular, with the MCMC method. Our final objective is to obtain the total loss distribution via simulation and, finally, to calculate a global risk measure.

The paper is organized as follows. Section 2 introduces and explains the motivation behind our research, providing a definition of operational risk and reviewing the approaches available to quantify and manage this type of risk. Section 3 illustrates in detail the methodology we use, with particular focus on the description of simulation methods. Section 4 outlines the application of our model to a real database (conducted with the R software, RDCT, 2006), showing the results of parameter estimates. In Section 5, a comparison between classical and Bayesian outcomes is illustrated in terms of estimates and risk measures, underlining the advantages and disadvantages of the two techniques. Finally, remarks and conclusions are given in Section 6.

2. Background

2.1. Operational risk: definition

The Bank of International Settlements (BIS) is the world's oldest financial institution, whose main purpose is to encourage and facilitate cooperation among central banks (for more details see BIS, 2002). In particular, BIS established the Basel Committee on Banking Supervision (BCBS), in order to formulate broad supervisory standards, guidelines and statements of best practice. The ultimate purpose of the Committee is the prescription of capital adequacy standards for all internationally active banks. In 1988 the BCBS issued one of the most significant international regulations impacting on the financial decision of banks: the Basel Accord (BCBS, 1988). Subsequently, the BCBS worked on a revision, called the New Accord on Capital Adequacy, or Basel II (BCBS, 2001a, 2003). This new framework, developed by the Committee in 2002 to ensure the stability and soundness of financial systems, was based on three 'pillars': minimum capital requirements, supervisory review and market discipline. For more details, see BCBS (2001a–c) and Nash (2003). The crucial novelty of the new agreement was the identification of operational risk as a new category separated from the others. In fact, it was only with the new agreement that the Risk Management Group (RMG) of the Basel Committee proposed the current definition of operational risk:

> Operational risk is the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events (Risk Management Group, 2003).

The RMG also provided a standardized classification of operational losses into eight BLs and seven ETs.

2.2. Statistical models for operational risk management

Statistical models for operational risk are grouped into two main categories: 'top-down' and 'bottom-up' methods. In the former, risk estimation is based on macrodata without identifying the individual events or the causes of losses. Therefore, operational risks are measured and covered at a central level, so local business units are not involved in the measurement and allocation process. 'Top-down' methods include the basic indicator approach (see, for example, Yasuda, 2003; Pezier, 2002) and the Standardized Approach (see Cornalba and Giudici, 2004; Pezier, 2002 for more details), where risk is computed as a certain percentage of the variation of some variable, as, for example, gross income, considered as a proxy for firm performance. This first approach is suitable for small banks, which prefer a cheap, easy to implement methodology (Netter and Poulsen, 2003). 'Bottom-up' techniques use individual events instead to determine the source and amount of operational risk. Operational losses have been divided into levels corresponding to BLs and ETs and risks are measured at each level and then aggregated. These techniques are particularly appropriate for large sized banks and those operating at the international level, since they can afford the implementation of sophisticated methods, sensitive to the bank's risk profile. Methods belonging to this class are grouped into the AMAs (BCBS,