A New Methodology to Derive a Bank's Maturity Structure Using Accounting-Based Time Series Information

Oliver Entrop[1], Christoph Memmel[2], Marco Wilkens[1], and Alexander Zeisler[1]

[1] Catholic University of Eichstaett-Ingolstadt, Germany
oliver.entrop@ku-eichstaett.de
marco.wilkens@ku-eichstaett.de
alexander.zeisler@ku-eichstaett.de
[2] Deutsche Bundesbank, Frankfurt, Germany
christoph.memmel@bundesbank.de

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1 Introduction

While over the past few years both banking supervisors and researchers have focussed their attention on banks' credit risk, the spotlight is now being turned again on interest rate risk. One reason for this is its character as a kind of systemic risk: there is evidence that a rise in interest rates affects most banks negatively. An historical example of a banking crisis caused by high interest rates is the 'Savings and Loan Crisis' which occurred in the USA during the 1980s.[3] Between 1980 and 1988, 563 of the approximately 4,000 savings and loan institutions failed, while further failures were prevented by 333 supervisory mergers. The total costs of the crisis are estimated at USD160 billion. Recently, the Basel Committee on Banking Supervision published principles for the management and supervision of interest rate risk that go far beyond current practice.[4] However, few data are available concerning banks' interest rate risk exposure.
Whereas the Deutsche Bundesbank has exclusive information for some sub-samples of banks that is based on bank-internal risk management systems, most methods proposed in literature rely on accounting-based information. Accounting-based information on the banks' maturity structure usually contains information on the amount of positions within certain time bands: the total outstanding amount of a given position is distributed among a number of time bands according to initial maturity and/or remaining time to maturity. Approaches proposed in literature use

[3] See [4] for a detailed analysis.
[4] See [1].

one-point-in-time data, typically the most recent report. In order to derive a cash flow structure and its interest rate sensitivity, a certain distribution within the time bands is assumed.[5] The Economic Value Model (EVM) of the Federal Reserve assumes a concentration in the middle of a time band.[6] A similar approach is applied by [7] who quantify the interest rate risk of the Indian banking system. In contrast, [2] and [8] assume a uniform distribution. The main shortcoming of these approaches is the omission of further information about the distribution within a time band, which can either be taken from time series information or additional data sources.
We present here a methodology to systematically use different accounting-based data sources and time series information to derive the maturity structure of banks' assets and liabilities.[7] In a simulation approach we compare our new methodology with models proposed in literature and show that time series can contain important information for inferring the banks' maturity structure.
The model presented here was developed within a joint research project of the Deutsche Bundesbank and the Catholic University of Eichstaett-Ingolstadt. An extended model was applied to quantify the interest rate risk exposure of all German banks. For further details and applications see [3].

2 Model

Let time be discrete: $t \in T = \mathbb{N}_0$. In each $t_{beg} \in T$ the bank invests the amount $X^{pos,t_{beg},t_{end}}$ in a position pos (such as loans on the asset side or deposits on the liability side) that matures in $t_{end} > t_{beg}$. We will refer to these variables as 'business items'. To keep things simple, we omit possible provisions and premature redemptions here. Under this assumption, the outstanding amount in t that is due in $s > t$ is given by

$$OA(pos, t, s) \sum_{i=0}^{t} X^{pos,i,s}. \tag{1}$$

The knowledge of the outstanding amounts $OA(pos, t, s)$ for each s and pos is the basis for deriving the maturity and cash flow structure of the bank in t. The cash flow structure in turn determines the bank's on-balance-sheet interest rate risk exposure and makes it possible to apply risk measures like duration or value at risk. Unlike the bank itself, external analysts do not have detailed information on the maturity structure. However, at certain dates the bank reveals some information on its maturity structure by reporting the amount of a position broken down into a certain number of time bands. These contain for each pos the sum of all business within specified ranges of initial maturity or remaining time to maturity, respectively. We assume that in each $t_{obs}^{itm} \in T_{obs}^{itm} \subset T$ there are N report items characterized by the business' initial maturity: ITM_t^n with $n \in \{1,...,N\}$ reports the amount of pos^n in t with an initial maturity within the time band $t_{lower}^n < t_{end} - t_{beg} \leq t_{upper}^n$. Analogously, in each $t_{obs}^{rtm} \in T_{obs}^{rtm} \subset T$ there are M items characterized by the business' remaining

[5] See [6] for an advanced approach using detailed information on the banks' assets and liabilities.

[6] See [5] and [9]. For an evaluation of the model see [11], [10] and [9].

[7] Accounting-based data can here include both publicly available and non-publicly available data like confidential reports to the banking supervisors.