Chapter 1
Introduction

1.1 Problem Definition and Objectives of This Work

"Risk concentrations are arguably the single most important cause of major problems in banks".[1] On the one hand, dealing with concentration risk is important for the survival of individual banks; therefore, banks should be interested in a proper management of risk concentrations on their own. On the other hand, the Basel Committee on Banking Supervision (BCBS) has found that nine out of the thirteen analyzed banking crises were affected by risk concentrations,[2] which shows that this issue is important for the stability of the whole banking system. Consequently, risk concentrations are also crucial from a regulatory perspective and should therefore be considered when establishing regulatory capital standards.

Recently, the "International Convergence of Capital Measurement and Capital Standards – A Revised Framework",[3] better known as "Basel II", has replaced the former capital accord "Basel I". The objective of the new framework is to strengthen the soundness and stability of the international banking system, which shall mainly be achieved by capital requirements that are aligned more closely to the underlying risk. Although Basel II has sometimes been subject to criticism,[4] there is widely consensus that Basel II promotes the adoption of stronger risk management practices by the banking industry and leads to more transparency. The Minimum Capital Requirements are formulated in the so-called Pillar 1 of Basel II. The first pillar is accompanied by the Supervisory Review Process (Pillar 2), which refers to a proper assessment of capital adequacy by banks and a review of this assessment by

[1] BCBS (2005a), § 770.

[2] Cf. BCBS (2004b), p. 66 f.

[3] Cf. BCBS (2004c, 2005a).

[4] One occasionally expressed criticism is the procyclicality of Basel II. This means that in recession the default risk of firms increase and at the same time, due to higher capital requirements for risky credits, the banks have to reduce their investment activities; thus, recessions could be amplified. For a discussion of this aspect, cf. Gordy and Howells (2006).

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supervisors. The market discipline (Pillar 3) is a set of disclosure requirements, which allows market participants to assess information on the capital adequacy.

Until now, most of the literature on Basel II has focused on parameter estimation and the theoretical framework of Pillar 1. Consequently, these concepts are widely known in academics and practice by now. But it is important to notice that some crucial types of risk, like concentration risk, interest rate risk, or liquidity risk, are not considered in the quantitative capital requirements of Pillar 1. Instead, concerning these types of risks, the requirements are only qualitatively formulated under Pillar 2. Fitch Ratings expressed this shortcoming as follows: "While all three Pillars are integral to the effectiveness of Basel II as a regulatory capital framework, it is often Pillar 1 that receives the bulk of public attention, given its direct and explicit impact on bank capital ratios. It is important that financial institutions and market participants also focus on the Pillar 2 objective of managing enterprise risk, including concentration risk, rigorously and comprehensively".[5]

The existing literature regarding concentration risk in credit portfolios mainly consists of some documents from banking supervisors, empirical studies on the effect of concentration risk on bank performance, and of some proposed models on the measurement of concentration risk, which range from rather simple and heuristic to sophisticated model-based approaches. However, there is hardly any literature which analyzes the impact of credit concentrations on portfolio risk for different portfolio types or answers the practically relevant question, in which cases the influence of concentration risk is rather small so that it should be unproblematic if a bank does not explicitly measure its concentration risk. Furthermore, it would be valuable to know how good the proposed approaches for the measurement of concentration risk do perform in comparison. Moreover, banks are requested by supervisors "to identify, measure, monitor, and control their credit risk concentrations",[6] but it is not clear how the models on concentration risk can be implemented in a way that they are consistent with the Basel framework. The main objective of this work is to answer these questions. Beyond that, this work tries to integrate economical and regulatory aspects of concentration risk and seeks to provide a systematic way to get familiar with the topic of concentration risk from the basics of credit risk modeling to present research in the measurement and management of credit risk concentrations.

1.2 Course of Investigation

The fundamentals of credit risk measurement and the quantitative framework of Basel II are presented in Chap. 2. At first, the need of banking regulation in general, the development of banking supervision, as well as the concept of Basel II

[5]Hansen et al. (2009).

[6]See BCBS (2005a), § 773.

is presented briefly. In Sect. 2.2, relevant measures of risk in credit portfolios, like the expected loss (EL), the Value at Risk (VaR), and the Expected Shortfall (ES) are introduced. Then, the asset value model of Merton (1974) is described in Sect. 2.3, which builds the basis of the conditional probability of default within the one-factor model of Vasicek (1987) that is derived in Sect. 2.4. Applying this conditional probability, the binomial model of Vasicek (1987) allows determining the loss distribution for homogeneous credit portfolios, which is demonstrated in Sect. 2.5. Next, the Asymptotic Single Risk Factor (ASRF) model of Gordy (2003) is presented in Sect. 2.6. This model allows an easy calculation of the VaR or the ES for heterogeneous portfolios if there is no concentration risk in the portfolio. As a last step, in Sect. 2.7 the conditional probability of default is integrated into the ASRF model, which leads to the core element of the regulatory capital requirement under Pillar 1.

In Chap. 3, risk concentrations in credit portfolios are discussed. Firstly, different types of concentration risk are described. In Sect. 3.2, it is argued that banks often consciously accept concentrations in their portfolios in order to gain higher returns from specialization, but they should have an additional capital buffer to survive economic downturns. The measurement and management of concentration risk, including relevant regulatory requirements and industry best practices, is presented in Sect. 3.3. Then, some simple, heuristic approaches for the measurement of concentration risk are demonstrated and assessed in Sect. 3.4. After that, a review of the literature on model-based approaches for the measurement of concentration risk is presented in Sect. 3.5.

Chap. 4 deals with the measurement of name concentrations. This type of concentration risk occurs if the weight of single credits in the portfolio does not converge to zero; thus, the individual risk component cannot be completely diversified. The main research questions on name concentrations that are considered in this chapter are:

- In which cases are the assumptions of the ASRF framework critical concerning the credit portfolio size?
- In which cases are currently discussed adjustments for the VaR-measurement able to overcome the shortcomings of the ASRF model?

Concerning the first question, it is analyzed how many credits are at least necessary implying the neglect of undiversified individual risk not to be problematic. Since there exist analytical formulas – the so-called granularity adjustment – which approximate these risks, it is further determined in which cases these formulas are able to lead to desired results. Against this background, in Sect. 4.2 the granularity adjustment is presented and in a next step an expansion of the existing formula is derived. Then, the minimum size of a credit portfolio is determined for several parameter combinations, for the case that only the ASRF formula is used and for the case that the granularity adjustment (and its expansion) is applied. The same analyses, which were performed using the risk measure VaR, are carried out for the risk measure ES in Sect. 4.3. The main results of this chapter are subsumed in Sect. 4.4.

After dealing with name concentrations, the focus of Chap. 5 is on sector concentrations. This type of concentration risk can occur if there is more than one systematic risk factor that influences credit defaults. For example, sector concentrations can arise if a relatively high share of a bank's credit exposure is concentrated in a specific industry sector or geographical location. Concerning sector concentrations, the main research questions that are analyzed in this chapter are:

- How can existing approaches for measuring sector concentration risk be modified and adjusted to be consistent with the Basel framework? Is the risk measure Value at Risk problematic when dealing with sector concentration risk?
- Which methods are capable of measuring concentration risk and how good do they perform in comparison? What are the advantages and disadvantages of these methods?

In order to deal with these questions, in Sect. 5.2 it is initially determined how a multi-factor model can be parameterized to obtain a capital requirement, which is consistent with Basel II. Then, the models of Pykhtin (2004), Cespedes et al. (2006), and Düllmann (2006) are presented and modified, which have been developed to approximate the risk in the presence of sector concentrations. In Sect. 5.3, the accuracy of these models concerning their ability to measure sector concentration risk is compared. In addition to the accuracy of the results, the emphasis is also put on the runtime of the models, since even with up-to-date computer hardware the computation can still take a very long time. Moreover, the simulation study chosen for the comparison is well-suited to analyze in a quite realistic setting whether there are relevant differences if either the risk measure VaR or ES is used. This question is of high practical relevance, since the VaR is often criticized concerning some theoretical shortcomings that are often illustrated in contrived portfolio examples. These shortcomings could be very problematic in the presence of concentration risk, but nevertheless, the VaR is very often applied in practice and in the literature. The results of these analyses are subsumed in Sect. 5.4.