Proceedings of the Second International Conference on Credit Analysis and Risk Management

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Edited by

Pascal Gantenbein, Simone Westerfeld
and Beatrix Wullschleger

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PREFACE

Following the Second International Conference on Credit Analysis and Risk Management, which was organized in Basel in September 2013, we decided to publish a book with the respective conference proceedings. However, given the high relevance of this topic, we have invited several additional authors from the field to submit papers throughout the collection phase of the articles. We are now delighted to present the outcome of this process in the form of this book. The current volume comprises a spectrum of articles by both the keynote speakers and the academic presenters of the conference as well as additional inputs from academia and credit risk practice.

Credit risk is an important element in most financial transactions in some form and therefore plays a crucial role in different layers of economic activity. Three key elements can be distinguished, namely (1) the lender-borrower relationship which is at the core of the entire discussion, (2) the pricing of credit risk in financial markets, and (3) the relevance of financial stability and regulation related to the occurrence of credit risk. In this book, we strive to capture these areas in a comprehensive way although within these topics it will, of course, only be possible to highlight some of the current issues and questions related to them.

The first layer, the lender-borrower relationship and the intermediation function which banks assume in providing loans to the private and public sector is always dominated by two questions: First, which factors are important in determining credit volume, credit prices, and conditions to a client on an individual loan basis? In other words, how should credit-linked assets be rated, priced, monitored, and organized along their lives? And, second, how can a bank optimally structure its entire credit portfolio and which impact does the portfolio composition have on credit decisions and hedging?

Several features that are important in this respect will be discussed in the book, such as the ability to forecast distress (in the special case of SMEs), the relevance of soft information versus financial information about potential clients, the (eventually limited) role of the default history for enabling better credit decisions, and the effects of internal control in the credit assessment process. Regarding credit portfolio management, it is of utmost importance to understand the dominant risk factors for the entire portfolio, to be aware of potential contagion effects and correlated defaults across loan segments, and to control the optimal provision of economic capital. All these aspects will be addressed subsequently in the papers of tracks 1, 4, and 5.

A second layer which can be located in the pricing of credit risk in financial markets becomes important as soon as claims arising from bilateral lending get securitized and traded. First of all, it is apparent that pricing of credit risk is highly dependent on the economic environment. While in the wake of the subprime crisis, prices for assets of lower credit quality collapsed, hence leading to skyrocketing credit risk premiums in fall 2008, only a few years later, credit risk premiums dropped again to pre-crisis levels or even below. This shows that credit risk premiums obtained from financial markets, inter alia, are a function of both market fear and scarcity of investment alternatives.

However, especially in situations like the one described above, it is not trivial to keep credit risk and liquidity risk apart. Just remember that many investors buying so called toxic assets from banks and institutional investors during the financial crisis of 2008 meanwhile made a fortune with these positions. In other words, plenty of these assets were not as toxic as many investors thought in terms of credit risk, at least not in hindsight, but pricing undoubtedly was heavily influenced by illiquidity, as well. This again had to do with the forced sell-offs of these positions by many banks into a falling market. Hence, time constraints (due to economic, legal, or accounting related restrictions) may play an important role in explaining the pricing of credit risk in financial markets.

Some related topics covered in this book include the analysis of credit default swap (CDS) spread changes, the attribution of CDS spreads on both default premiums and liquidity premiums, the discussion of the often observed market segmentation in fixed-income securities, the changing risk perception for corporate bonds together with higher risk factor correlations throughout crises, and the ability to extract distance-to-default data for private firms from public markets. These issues will be mainly covered in papers of streams 1 and 3.

Probably the most relevant field in recent years, at least in public perception and measured by regulatory activity, has been the third layer mentioned above which is the discussion of systemic risk and financial market stability. In economies with a strong banking sector, credit crises may well have caused severe shocks in the banking industry, but these were traditionally contained within the respective national boundaries. However, both internationalization of banking activities and large-scale securitizations of loan and bond portfolios not only have contributed to better diversification opportunities for investors but likewise to an international dissemination of credit risk. Alongside this development, financial markets have seen a tremendous generation and distribution of credit derivatives such as CDS and index products. As a result, the risk of contagion has significantly increased given these multiple connections between international financial markets and institutions.

Obviously, several questions and objectives arise from this observation. First, given the sheer size of some banks as well as the interconnectedness in the sector, it is important to take a closer look into the prerequisites of financial stability. Key topics presented in papers of stream 2 include the analysis of default probabilities in the banking sector, the link between internal rating based (IRB) approaches and risk-weighted capital, and the relevance of liquidity risk in the financial system. Furthermore, the years since 2008 have advanced a new and highly interesting stream of research on the connection between credit crises and real estate crises which in turn typically have a strong impact on the entire economy.

All these topic areas will be reflected in papers of the streams Ratings (1), Regulation (2), CDS & Bond Pricing (3), Relationship Banking (4), and Credit Portfolio Models (5) as well as in the several further articles about the role and challenges of microfinance, recent considerations as to the capital structure decision, and the link between credit and real estate cycles.

With this book, we hope to provide you with many interesting and useful inputs for your academic and professional work in the field of credit risk. We are looking forward to an ongoing discussion of credit topics on the occasion of the 3rd International Conference on Credit Analysis and Risk Management to be held in Michigan (USA) on August 28/29th 2014 as well as the next Basel Conference in August 2015.

— Pascal Gantenbein, Simone Westerfeld and Beatrix Wullschleger
Basel 2014

INTRODUCTION[1]

A SUMMARY OF THE SECOND INTERNATIONAL CONFERENCE ON CREDIT ANALYSIS AND RISK MANAGEMENT: BASEL WORKSHOP ON CREDIT RISK 2013

SIMONE WESTERFELD[2]

In September 2013, the Second International Conference on Credit Analysis and Risk Management, the Basel Workshop on Credit Risk, was hosted in Basel, Switzerland. Jointly organized by the University of Applied Sciences Northwestern Switzerland and the Universities of Basel, Hohenheim, Oakland, Regensburg, and St. Gallen, the conference was the second in this set-up after the first event was organized in 2011 by the Oakland University, USA. The conference series is intended to establish a discussion platform on credit analysis and related topics for both academia and banking practice alike. In the course of the program, more than 70 international academics and practitioners gathered in Basel for two days to discuss keynotes and latest academic research categorized in the streams Ratings, Regulation, Credit Default Swap & Bond Pricing, Relationship Banking, and Credit Portfolio Models.

Various keynote speakers from different backgrounds started the conference and opened the floor for debate by providing hands-on insights from practitioner's and regulators perspectives: Armin Landerer, Head of Corporate Banking at Basel Cantonal Bank, opened the conference and elaborated on developments and trends in Credit Risk Management from a Commercial Bank's point of view in the Swiss banking environment.

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[1] This article has been published with the title "Second International Conference on Credit Analysis and Risk Management 2013 in Basel - Challenging the Establishment" in 'Credit and Capital Markets', 2/2014, p. 367-375.

[2] Prof. Dr. Simone Westerfeld is from the Institute for Finance, School of Business, University of Applied Sciences Northwestern Switzerland in Basel.

Imène Rahmouni-Rousseau, representing the Financial Stability Board gave an overview on the FSB work agenda and its link to credit risk followed by a lively discussion with the audience. The speech of Markus Heusler, CEO of RSN Risk Solution Network AG, contributed to the topic by a presentation on rating model development for SME from an outsourcing company's perspective, including pitfalls and lessons learned over the last ten years.

Klaus Duellmann from European Central Bank (ECB) elaborated in his speech on the impact of Basel III on the International Banking System and perfectly rounded off the picture in adding a supervisor's perspective to the before stated FSB and banks' points of view. Finally, Jens Kuttig, Partner at zeb/rolfes.schierenbeck.associates, ended the keynote roundtable with the presentation of innovative trends in credit risk transfer and possible answers to the question where the secondary markets for credit risk might head to.

In the course of the academic program, 15 selected authors had the chance to present their latest research papers, each followed by a lively discussion with the audience. Based on the submitted abstracts of the presented academic papers, the subsequent section provides a brief overview on the topics covered during the two conference days:

The first stream covered predominantly rating-related topics and featured three contributions. In their paper "Forecasting Distress in European SME Portfolios" *Dimitra Michala, Theoharry Grammatikos* and *Sara Ferreira Filipe* (all from University of Luxembourg) develop distress prediction models for non-financial small and medium enterprises (SMEs) using a dataset from eight European countries over the period 2000-2009. The authors examine idiosyncratic and systematic covariates and find that macro conditions and bankruptcy codes add predictive power to their models. Moreover, industry effects usually demonstrate significance but provide only small improvements. The paper contributes to the literature in several ways: First, using a sample with many micro companies, it offers unique insights into European small businesses. Second, it explores distress in a multi-country setting, allowing for regional- and country-level comparisons. Third, the models can capture changes in overall distress rates and co-movements during economic cycles.

Sebastian Löhr (University of Hannover) and his co-authors *Arndt Claussen* (University of Hannover), *Daniel Rösch* (University of Regensburg) and *Harald Scheule* (University of Technology, Sydney) analyze in their paper "Valuation of Systematic Risk in the Cross-section of Credit Default Swap Spreads" the pricing of systematic risk factors in credit default swap contracts in a two-stage empirical framework. In the first pass, they estimate contract-specific sensitivities to several systematic risk factors by time-series regressions, using quoted credit default swap (CDS) spreads of 339 U.S. entities from 2004 to 2010. They find that the credit market climate, the cross-market correlation and the market volatility serve to explain CDS spread changes. In the second pass, they examine by cross-section regressions whether the contract-specific sensitivities to these systematic risk factors are priced in the cross-section of swap contracts, hereby controlling for individual risk factors such as credit ratings, liquidity and leverage. The authors find that their basic risk factors explain about 83% of the CDS spreads prior to the crisis and about 90% during the crisis.

In "An Empirical Analysis of Priced Systematic Risk on Bonds and Market Segmentation" *Terry Benzschawel* (Citi Bank), *Liang Fu* and *Austin Murphy* (both from Oakland University, Rochester) investigate the existence of segmentation in the market for fixed-income securities. Evidence is found of lower risk-adjusted returns being required for bonds making larger contributions to the risk of pure debt portfolios over the 2003-2011 interval. Significant abnormal returns existed for diversified investors taking short (long) positions on bonds with higher (lower) pure bond betas.

In the stream Regulation, three authors focused on regulatory aspects of credit risk. *Edward Altman* (New York University), *Francesca Campolongo* (European Commission), *Janko Cizel* (presenting author) and *Herbert Rijken* (both from University of Amsterdam) presented their article titled "Estimating the Probability of Default of the Western European Banks". In this paper the authors propose the novel methodology to produce long-term probabilities of default (PD) for the European listed and non-listed banks. The methodology relies on the observation that during times of financial turmoil, market valuation of banks to a large extent reflects the credit quality fundamentals. The authors estimate the distressed market-to-book model for the listed European banks, and apply the model to the non-listed banks to produce the implied distressed market-to-book ratios. Finally, they use the linking function constructed from about 1'500 bank failures in the U.S. to produce the expected default frequency for the entire spectrum of European banks.

Mike Mariathasan (University of Oxford) and *Ouarda Merrouche* (The Graduate Institute, Geneva, and CEPR) presented their paper "The manipulation of Basel Riskweights" as a contribution to the session on regulation. In their paper, the authors examine the relationship between banks' approval for the internal ratings-based (IRB) approaches of Basel II and the ratio of risk weighted assets over total assets. Analyzing a panel of 115 banks from 21 OECD countries that were eventually approved for applying the IRB to their credit portfolio, they find that the risk-weight density is lower once regulatory approval is granted. The effect persists when controlled for different loan categories, and the authors provide evidence showing that it cannot be explained by flawed modeling, or improved risk-measurement alone. Consistent with theories of risk-weight manipulation, they find the decline in risk-weights to be particularly prevalent among weakly capitalized banks, when the legal framework for supervision is weak, and in countries where supervisors are overseeing many IRB banks. The authors conclude that part of the decline in reported riskiness under IRB results from banks' strategic risk-modeling.

Ren-Raw Chen (Fordham University) and his co-authors *William Filonuk* (Bank of New York), *Dilip K. Patro* (Office of the Comptroller of the Currency) and *An Yan* (Fordham University) also analyze regulatory impacts in the credit context and presented their paper "Valuing Financial Assets with Liquidity Discount: An Implication to Basel III": The unprecedented financial crisis in 2007-8 and the largest bankruptcy in U.S. history prompted the expedited regulation in the financial industry. A new Basel Accord has been proposed to further regulate the main risk that caused the crisis – liquidity risk. In a recent paper, Chen (2012)[3] presents a liquidity discount model where financial securities can be evaluated with substantial discounts at the presence of a liquidity squeeze in the market place. In the presented paper, the authors adopt this model to evaluate a selection of 23 largest U.S. financial institutions (assets over $100 billion) to investigate the liquidity impact during the crisis period. The authors calibrate the model to market information such as market capitalization and volatility. They find that the model can provide significant predictive power of a firm's liquidity healthiness.

In the stream CDS & Bond Pricing, the following works caught participants' attention. "Liquidity premium in CDS market" is the title of the paper presented by *Kuate Kamga* (Goethe University Frankfurt) and his co-author *Christian Wilde* (Goethe University Frankfurt). The authors develop a state-space model to decompose bid and ask quotes of CDS into two components, fair default premium and liquidity premium. This approach gives a better estimate of the default premium than mid quotes, and it allows to disentangle and compare the liquidity premium earned by the protection buyer and the protection seller. In contrast to other studies, the model is sparse while still allowing for correlation between liquidity and default premia, which is supported by empirical evidence. The model is implemented and applied to a large data set of 118 CDS for a period ranging from 2004 to 2010. The authors find evidence that 1) the liquidity premium widens for the protection seller and the protection buyer in absolute terms during the crisis, 2) the protection buyer receives a larger liquidity premium than the protection seller, 3) during the crisis, the share of the liquidity premium earned by the protection seller increases, in particular for non-financials, 4) this is at the cost of the protection buyer, since the relative liquidity premium of the protection buyer decreases strongly after the beginning of the financial downturn, while that of the protection seller hardly changes, and 5) protection sellers generally require a lower liquidity premium for financial names than non-financial names. To the knowledge of the authors, this is the first paper that attempts to explain the liquidity premium of the protection seller relative to the liquidity premium of the bidder during the financial crisis.

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[3] Chen, R.-R., 2012, "Valuing a Liquidity Discount," *Journal of Fixed Income*, 1 Winter 2012.

In their paper "Default Probabilities and Interest Expenses of Privately Held Firms", *Jin-Chuan Duan* (National University of Singapore), *Baeho Kim* (Korea University Business School), *Changki Kim* (Korea University), *Woojin Kim* (Seoul National University) and *Donghwa Shin* (Princeton University) estimate term structures of default probabilities for private firms using Korean data comprising 1,440 default events from 29,894 firms between 1999 and 2011. They then study whether the reported interest expenses are reflective of the estimated default term structure. Each private firm's default likelihood is characterized by a forward intensity model employing both macro risk factors and firm-specific attributes derived from financial statements. Although private firms have no traded stock prices, the authors devise a way of obtaining a public-firm equivalent distance-to-default by projection, which references the distance-to-defaults of public firms with comparable firm attributes. Statistical tests indicate that the fitted model provides accurate multi-period forecasts of defaults for both financial and non-financial private firms. The used methodology can be directly applied by commercial lenders in charging appropriate interest rates upon lending decisions for different future periods.

The paper "The Correlation Puzzle: The Interaction of Bond and Risk Correlation" presented by *Sebastian Bethke* and co-authored by *Alexander Kempf* and *Monika Trapp* (all from University of Cologne) deals with diversification benefits, which depend on the correlation between assets, and the fact that asset correlation increases when it is most needed. The authors examine bond correlation using a broad sample of U.S. corporate bonds and find bond correlation to be higher during the financial crisis in 2008. Increased bond correlation results from higher correlation between corporate bond risk factors. Risk factor correlation in turn increases when investor sentiment worsens. This suggests that corporate bond investors change their perception of risk factors, which results in higher risk factor correlation and finally higher bond correlation.

The fourth stream displays latest research on Relationship Lending, exploring aspects of information asymmetries in the lending process. The paper "Hidden Gems and Borrowers with Dirty Little Secrets: Investment in Soft Information, Borrower Self-selection and Competition" was presented and written by *Reint Gropp* (Goethe University Frankfurt), *Christian Gruendl* (EBS Business School) and *Andre Guettler* (Ulm University). This paper empirically examines the role of soft information in the competitive interaction between relationship and transaction banks. Soft information can be interpreted as a private signal about the quality of a firm that is observable to a relationship bank, but not to a transaction bank. The authors show that borrowers self-select to relationship banks depending on whether their privately observed soft information is positive or negative. Competition affects the investment in learning the private signal from firms by relationship banks and transaction banks asymmetrically. Relationship banks invest more; transaction banks invest less in soft information, exacerbating the selection effect. Finally, the authors show that firms where soft information was important in the lending decision were no more likely to default compared to firms where only financial information was used.

The paper "Should Defaults Be Forgotten? Evidence from quasi-experimental variation in removal of negative consumer credit information" by *Marieke Bos* (Stockholm University) and *Leonard Nakamura* (Federal Reserve Bank of Philadelphia) deals with the fact that around the globe, credit bureaus restrict the length of time during which negative credit information can be retained. By exploiting a quasi-experimental variation in retention times of negative credit information, the authors find that a prolonged retention time increases the need for and access to credit and reduces the likelihood to default. In both regimes, less than 27 percent of individuals default again within two years after removal, suggesting that only a minority is inherently high risk or, alternatively, removal of credit arrears induce borrowers to exert greater effort. Either interpretation raises the possibility that forgetting defaults is welfare enhancing.

In "The Hidden Costs of Control – Evidence from Small Business Lending" the authors *Martin Brown* (University of St. Gallen), *Matthias Schaller* (University of St. Gallen), *Simone Westerfeld* (University of Applied Sciences FHNW) and *Markus Heusler* (RSN Risk Solution AG) use proprietary data on 3,360 credit assessments by 340 loan-officers at six banks and analyze how internal control affects the credit rating process. They document a positivity bias of control: Loan officers propose better ratings for their clients when they know that the rating is subject to internal approval. The evidence suggests that this positivity bias is driven by strategic behavior: Loan officers inflate proposed ratings in reaction to past downward corrections by their current approver. Moreover, experienced loan officers inflate those parameters of a credit rating which are least likely to be corrected by approvers. Overall, the authors find that internal control does not improve the informational efficiency of the credit assessment process.

Finally, the stream Credit Portfolio Models completes the academic program with a series of papers aiming to break new soil in modeling credit portfolio risk. *Xin Zhang* (VU University Amsterdam), *Bernd Schwaab* (European Central Bank) and *André Lucas* (Duisenberg School of Finance) presented a paper titled "Conditional Probabilities and Contagion Measures for Euro Area Sovereign Default Risk". The authors propose a novel empirical framework to assess the likelihood of joint and conditional failure for Euro area sovereigns. Their model is based on a dynamic skewed-t copula which captures all the salient features of the data, including skewed and heavy-tailed changes in the price of CDS protection against sovereign default, as well as dynamic volatilities and correlations to ensure that failure dependence can increase in times of stress. The authors apply the framework to Euro area sovereign CDS spreads from 2008 to mid-2011. The results reveal significant time-variation in risk dependence and considerable spill-over effects in the likelihood of sovereign failures. They also investigate distress dependence around a key policy announcement by Euro area heads of state on May 9, 2010, and demonstrate the importance of capturing higher-order time-varying moments during times of crisis for the correct assessment of interacting risks.

In the paper "Specification Risk and Calibration Effects of a Multifactor Credit Portfolio Model" by *Gregor Dorfleitner* (University of Regensburg), *Matthias Fischer* (University of Erlangen-Nürnberg) and *Marco Geidosch* (University of Regensburg) the authors point out a crucial source of specification risk when calibrating a typical industry-type, Merton-based credit portfolio model. In addition to equity prices and asset values, which are the classical choices, the authors consider credit default swap (CDS) spreads and Expected Default Frequencies (EDF, from Moody's KMV) as alternatives. Based on 40 large European companies from different industries, they calibrate a macroeconomic factor model with an OLS regression analysis for each specification and calculate the corresponding economic capital. The findings are: 1) on average 2 to 3 risk factors are needed to adequately model creditworthiness on the obligor level, 2) stock market variables are the most important risk factors, 3) model-implied credit correlation is extremely sensitive to the choice of the proxy for creditworthiness and 4) only the EDF specification leads to less economic capital as compared to regulatory capital according to Basel II while it is exceeded substantially by all other specifications. In particular, credit correlation in the CDS specification by far exceeds any estimate mentioned in the literature. Most importantly, the authors show that the economic capital of their sample portfolio can be reduced by 78%, depending on which variable to choose as proxy for creditworthiness.

The paper "Concentration risk in SME credit portfolios: the role of banks' portfolio composition policy and risk appetite" presented by *Michel Dietsch* (Université de Strasbourg) and co-authored by *Henri Fraisse* (Banque de France) and *Joël Petey* (Université de Strasbourg) focuses on particular aspects of SME financing in Europe and the appropriateness of current risk weights for SME lending. Knowing that risk weights depend strongly on asset correlations, the object of this paper is to estimate the potential for credit risk concentration arising from correlated defaults of small firms. The measurement of concentration risk needs to take into account borrowers' heterogeneity. One way to proceed is to extend the standard asymptotic single factor framework by introducing additional factors of systematic risk varying between groups of borrowers. Using a generalized linear mixed model, the paper extends the standard single-factor credit risk model to a multi-factor framework taking into account size and industry effects. The paper uses the French Credit Register and the rating histories of more than 400.000 French SMEs, covering the period from 2003 to 2011. Provided by the Banque de France ratings system, the sample allows considering the real portfolios of the five major banking groups in France. This paper shows that despite comparable portfolios in terms of size and industry distributions, there are sizeable differences in terms of economic capital across banking groups. The authors investigate whether such differences could be attributed to concentration of credit risk on specific size segments or industries or, on the contrary, are the result of different risk appetite levels across banks at the portfolio level.

Without exception, all of these recent works provide significant contributions to the understanding of credit analysis and risk management, and clearly demonstrate the need for ongoing research in this area. Given the fast-paced environment of today's global financial network, sophisticated but practicable models and effective regulation, alongside with well-wrought incentive schemes are more important than ever in order to address the currently imminent challenges. There was broad consent among all the participants that the recent and ongoing global financial crisis has exposed a weakness in credit analysis in the financial system. By encouraging the exchange of knowledge from multiple perspectives, the conference contributed to addressing these weaknesses and raising awareness for future challenges in the field of credit analysis and affiliated areas. We are looking forward to the next Basel Workshop on Credit Risk!

CHAPTER ONE

SETTING UP CREDIT RISK STRESS TESTS WITHIN A CANTONAL BANK

MICHAEL ACKERKNECHT
AND STEFAN BENVEGNÙ[1]

I. Introduction

Within the last years, the mortgage sector in Switzerland experienced a strong dynamical development. A high immigration rate and continuously low interest rate levels led to an increased demand for residential property. Also firms used the favorable environment for refinancing and investments. As a consequence, retail banks strongly increased their loan volume – partially also to compensate the low interest margins. The Swiss National Bank and FINMA, the Swiss regulator, were both worried about this situation since they felt the banks could increase their risk exposure on their books. They started to take preventive measures such as the revision of the capital adequacy ordinance (Schweizerische Eidgenossenschaft 2013), the introduction of a self-regulation for mortgage lending by the Swiss bankers association (SwissBanking 2012) and the activation of the anti-cyclical capital buffer, which was increased again this year (SNB 2014b).

Facing the current market status, Thurgauer Kantonalbank (TKB) is well aware of its responsibility regarding both society and its owners. For a future-proof credit risk steering and controlling mechanism, it was decided to strengthen the credit risk control sector and to further broaden the already well seized toolset for analyzing credit risk. One of these measures is the introduction of credit risk stress testing.

---

[1] Michael Ackerknecht (michael.ackerknecht@tkb.ch) and Dr. Stefan Benvegnù (stefan.benvegnu@tkb.ch) are from Thurgauer Kantonalbank TKB.

In this article, we will show one way of setting up credit risk stress analytics for a mid-sized Cantonal bank. We will show in detail the applied methodology, the calculations and which effects the applied stress will have. As a proof of concept we built a tool prototype within a standard office toolset which we applied to the sub-portfolio of self-used residential mortgages.

II. Credit risk stress analytics at TKB

1. Description of the approach

The description and implementation of the stress scenarios focuses on the portfolio of self-used residential mortgages. Nevertheless, we try to keep the analyses and descriptions as general as possible to support the application also to other types of sub-portfolios.

The stress tests are specified by the following steps:

1. Definition of those portfolios to be subject to the particular stress test (Chapter II.2)
2. Definition of the key figures for measuring the results (Chapter II.3)
3. Derivation of the relevant risk factors – w.r.t the chosen portfolio (Chapter II.4)
4. Description of the used methodology and the applied assumptions (Chapter II.5)
5. Description of the effects of the risk factors using sensitivity analyses (Chapter II.6)
6. Derivation and description of a particular stress scenario (Chapter II.7)
7. Presentation of the stress testing results (Chapter II.8)
8. Challenges and improvements (Chapter II.9)
9. Conclusion (Chapter III.)

2. Selection of the portfolio

The TKB credit portfolio can be divided according to quite different criteria depending on requirement or usage of the portfolio. A partition that is frequently done is to separate credits to mortgages and to credits that are not mortgage backed.

For the purpose of stress analyses we can divide the portfolio according to the following criteria:

- Counterparty type: private household or company
- Collateral: mortgages and non-mortgage type
- Usage: if mortgage: type of usage (self-used, income-producing)

A generic subdivision of the mortgage portfolio is shown in the next figure.

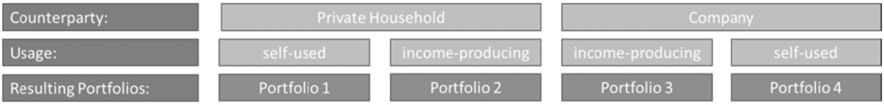
Counterparty:
Private Household
Company
Usage:
self-used
income-producing
income-producing
self-used
Resulting Portfolios:
Portfolio 1
Portfolio 2
Portfolio 3
Portfolio 4

Figure 1-1: Subdivision of the mortgage portfolio (own representation).

The different counterparties belonging to the sub-portfolios can be represented according to the simplified object model shown in figure 1-2. The understanding of the model and the identification of the interdependencies within the model is one of the challenges to effectively calculate the stress tests.

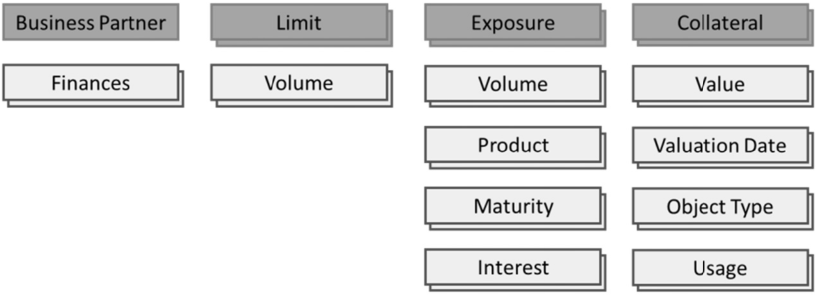
Business Partner
Finances
Limit
Volume
Exposure
Volume
Product
Maturity
Interest
Collateral
Value
Valuation Date
Object Type
Usage

Figure 1-2: Object model (own representation)

3. Key figures for measuring the stress test results

Basically, every available credit risk measure can be used as a potential result figure for stress tests. The following criteria are important within the selection process: On the one hand the figure needs to be calculated in an effective and efficient manner by the financial institute. On the other hand, the cost/benefit ratio is essential, which may depend on seize and business model of the respective bank. Shown in figure 1-3, we give a generic overview about how such reasoning for a mid-sized Cantonal bank may look like.

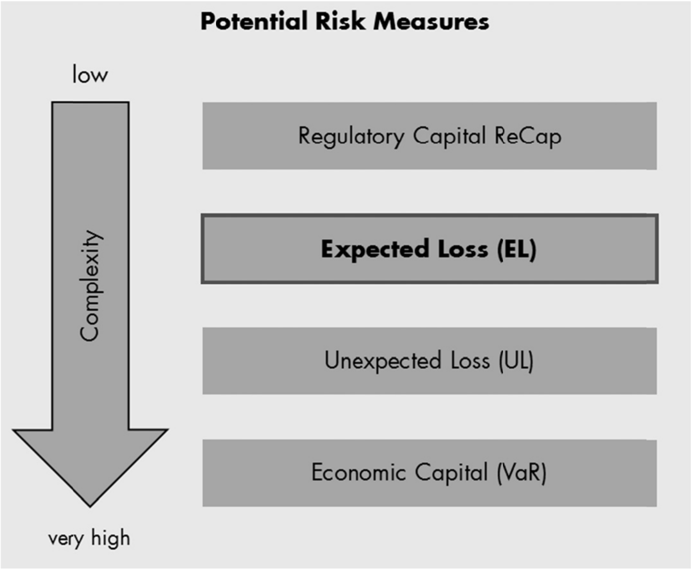
Potential Risk Measures
low
Complexity
very high
Regulatory Capital ReCap
Expected Loss (EL)
Unexpected Loss (UL)
Economic Capital (VaR)

Figure 1-3: Possible Risk Measures (own representation)

TKB for example is not calculating Value-at-Risk (VaR) for the credit risk and costs for unexpected losses are charged according to regulatory requirements. As we believe that for stress testing purposes VaR figures are of limited value regarding the understanding of stress effects, those figures are not part of this study.

Furthermore, the regulatory requirement for TKB in form of regulatory capital according to the standard approach – without usage of ratings – makes Regulatory Capital a very insensitive stress testing quantity for meaningful and significant stress analyses.

Hence, the expected loss (EL) is the last remaining comprehensive risk figure that could be used as stress measure. In fact, this measure combines many important advantages without being too simple: it is a linear measure – it can be calculated on counterparty level and subsequently aggregated to portfolio level in any combination. And its inherent model uncertainty (model risk) is low compared to e.g. a VaR measure.

4. Risk factors

Basically every driver that leads to an economic effect can be regarded as a potential risk factor. Only few of them will have significant influence on the credit portfolio though. The identification of the relevant risk factors is therefore a central element in an economic stress calculation. One commonly used tool for this purpose is regression analysis in univariate or multivariate form. It will give an idea about how strong the effect of the chosen risk driver was on the portfolio given a certain historical time period of parameters – for example by looking at the effect on counterparty default rates. Yet, such a regression analysis is no proof for a cause-effect relation. It just shows dependencies between the analyzed parameters and can give a hint about a potential deterministic connection amongst them. Moreover, the realization of such a regression can only be made with an available respective loss database which is a veritable hurdle for many mid-sized banks even in these days.

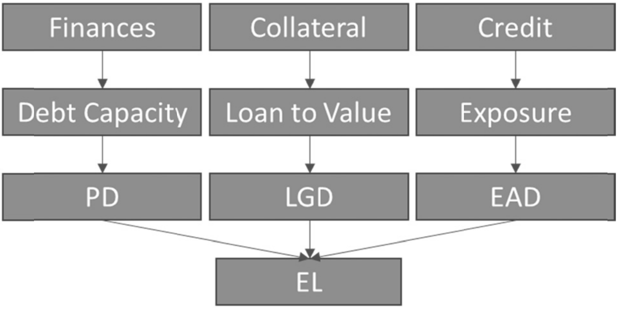

Figure 1-4: Calculation of the EL (own representation)

Leaving regression aside we are looking for macroeconomic drivers for which we can construct a direct functional chain using assumptions between these factors and our defined risk measure, the expected loss EL. For illustration purposes we will use an example portfolio of mortgages for self-used property throughout the article. As can be seen in figure 1-4, the expected loss is calculated via PD (probability of default), LGD (loss given default) and EAD (exposure at default) using the debt capacity (DC), the loan-to-value ratio (LTV) and the exposure (EXP). To find relevant risk factors we can start looking for drivers that potentially affect these figures. For this article we choose the following macroeconomic factors as risk drivers affecting the EL via PD: unemployment rate UR, gross domestic product GDP, and interest rates IR. Furthermore, we choose the real estate price as risk driver affecting the EL via the LGD and we assume the exposure to be constant – and hence the EAD.

5. Methodology and Assumptions

5.1 Approach

Generally, stress testing can be done either in a "top-down" or a "bottom-up" approach. We think of the top-down type as calculation of stress-effects to specific aggregated portfolio volumes such as e.g. the exposure of counterparties that have a certain financial capability. Under a stressed economic environment, let's say an increased interest rate, the financial capability to pay the mortgage will deteriorate and the exposure volume of counterparties corresponding to that financial capability will change. The bottom-up type instead will look at each single exposure in the portfolio and the stress will be applied to each counterparty and its associated exposure value. Lastly, there will be aggregations of figures to show the effect to the portfolio.

Yet, this effect is an aggregation of single effects whereas the top-down approach is the effect to aggregated volumes as was developed for example by RSN (RSN 2012). In the following we will describe a bottom-up stress analysis approach.

The effects of the stress scenarios are to be measured with the EL, in particular we are interested in its absolute level as well as the difference to the original value. The risk factors chosen in chapter II.4 are affecting PD and LGD in the following way:

- Increasing unemployment rate:
  Counterparty defaults as a consequence of the individual unemployment and therefore increasing PD
- Increasing interest rates:
  Increasing interest rate costs for the actual credit relation yields a worsened DC and hence an increasing PD
- Declining real estate prices:
  An unchanged credit exposure yields a higher LTV and thus a higher LGD for the respective credit relation

The stress effect will be calculated at counterparty level. Using the linearity of the EL the effect at the whole portfolio is easily obtained by summing the individual figures.

5.2 Stress factor effects

We assume that in the sensitivity analyses the chosen risk factors act in an isolated manner – i.e. all other factors are kept constant (ceteris-paribus approach). Though it will usually not happen in reality, the assumption has the advantage to show the pure impact without distortion.

5.3 Assumptions and models

For the determination of each of the three parameters PD, LGD and EAD constituting the EL, substantial model assumptions are necessary. For instance, the PD determination – which can be done in various ways – needs to be specified. Furthermore, we need to define how the spoken credit limits should be split up according to the underlying collateral types and how the segregation of the portfolio to private or commercial clients is made. These are in fact cumbersome but important details that need to be clarified thoroughly before a sound analysis of stress effects can be performed.

In this chapter we present the assumptions and model adjustments before we start with the details of the EL calculation in the subsequent chapter.

- Portfolio
  The portfolio is assumed to be static – i.e. positions will remain untouched even though the number of counterparties should decrease over time according to defaults. This is conservative on one hand and makes calculations easier on the other.

- Collateral value
  The valuation date of the residential property used as collateral could be several years old. Since the real estate price levels were constantly rising in the last years this has a substantial effect that needs to be corrected by a respective scaling, if desired.

- Spoken or contractual limits
  Since we are considering mortgages of private counterparties with self-used property we only take into consideration limits that relate to collateral that is self-used. Income-producing real estate is therefore not included and we leave out as well those limits that are collateralized simultaneously with both self-used and non-self-used property. In the example that is shown in figure 1-5 limit L1.1 for

counterparty 1 (BP 1) is included to the calculation whereas L1.2 will be discarded due to its underlying income-producing real estate. Looking at Counterparty 2 we discard it entirely since the respective limit isn't completely self-used.

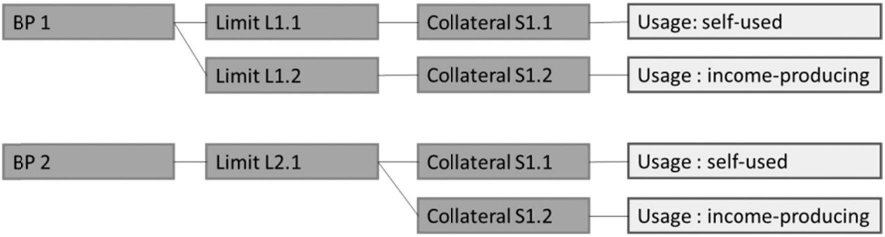
BP 1
Limit L1.1
Collateral S1.1
Usage: self-used
Limit L1.2
Collateral S1.2
Usage : income-producing
BP 2
Limit L2.1
Collateral S1.1
Usage : self-used
Collateral S1.2
Usage : income-producing

Figure 1-5: Limit example (own representation)

- LTV
  The LTV is calculated according to a gross figure in the following sense: as relation between the limit and the collateral value at counterparty level. A correction by potential pledges, other collateral types, liquidation priority or stakes of other lenders could be included but for the sake of simplicity is not considered for this article. We quote the LTV as a percentage value in the following way:

$$LTV = \frac{Limit_{BP}}{Value\ of\ the\ Collateral_{old} \times Change\ in\ Real\ Estate\ Prices_{since\ Valuation\ Date}}$$

- LGD mapping
  The LGD will be determined by a mapping according to the LTV – for details see next chapter II.5.4: calculation of the EL.

- Income
  For the stress scenarios in this article the income is essentially the salary of the private mortgage clients – we used the main salary plus potential additional income, if available. While technically not difficult, the salary is not stressed in our example. The reason is that for our risk drivers we chose mechanisms that are not connected to the salary component (see chapter II.6).

- Expenses regarding the residential real estate
  The maintenance costs for an owner of a residential real estate constitute of:

Interest expenses

Regarding interest costs we differentiate two types of expenses: effective and imputed. The imputed interest expense relates to the current interest level but with an additional security margin. Especially during the present lowest-level interest rate phase the imputed interest is of high importance. With most banks in Switzerland the imputed interest is around 5%. The imputed interest expense is therefore calculated with the imputed interest and the volume of the respective credit position.

Real estate maintenance

The expenses relating to the maintenance costs of the respective real estate property are approximated with 1% of the collateral value of the property. This is the usual long-term renovation cost assumption.

Amortizations

An LTV higher than 2/3 often implies amortization obligations. For example the self-regulation rules of the Swiss Bankers Association (SwissBanking 2014) that became mandatory (Schweizerische Eidgenossenschaft 2014) specifies that a new or increased mortgage has to be amortized to 2/3 of the collateral value within 15 years at most.

- Debt capacity

  The differentiation of effective and imputed interest expenses lead to analogously defined debt capacity (DC) values:

Imputed debt capacity

The imputed debt capacity (DC_{imp}) is calculated as the ratio of the imputed interest expenses (currently 5%) and the income:

$$DC_{imp} = \frac{Imputed\ Interest \times Limit + (1\% + x\%) \times Collateral\ Value}{Income}$$

Here, depending on the LTV, x will vary usually around a level of 1%.

Effective debt capacity

The effective debt capacity (DC_{eff}) is calculated as the ratio of the effective interest expense and the income:

$$DC_{eff} = \frac{Effective\ Interest \times Exposure + (1\% + x\%) \times Collateral\ Value}{Income}$$

Again, depending on the LTV, x will vary around a level of 1%.

- Mapping DC to PD

As described above the PD is a function of the DC – which will be realized via a mapping table. Generally, the imputed DC is used for the mapping, since this is the applied criteria for granting a loan. Should the effective DC exceed the imputed DC during the stress period, this will change and the effective DC will be used for the determination of the PD. Practically this corresponds to a PD flooring in times without strong interest rate stress.

- Time horizon

We calculate the stress scenarios over a period of 5 years. The current EL without stress is denominated by EL_{curr} , the current EL under stressed conditions is EL_1 (which is in other words the EL in the first year after a stress took place starting at time t = 0), the stressed EL in year 2 is called EL_2 and so on (see figure 1-6).

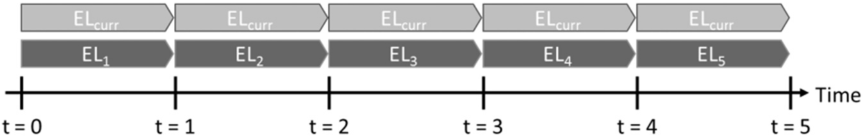

Figure 1-6: Time horizon (own representation)

- Extension assumptions of maturing mortgages

Since the stress period will last for several years, we need to make assumptions regarding the pricing conditions of (tranches of) mortgages reaching their maturity. For example:

- The mortgage will be extended.
- The new loan interest rate corresponds to the assumed stressed interest rate.
- The new maturity will be placed beyond the stress horizon – i.e. only one adjustment will be made for each loan.
- There will be no amortization made by the client.

These are all conservative assumptions – the client will not improve its conditions regarding product, term and interest rate.

- EAD

The EAD is identified with the Limit mainly to avoid the usage of the drawdown factor. For private mortgages this is feasible since the usage is usually identical with the limit anyway.

In the following we use exemplary values for illustration and for calculation purposes.

5.4 Calculation of the EL

The calculation of the EL as a product of PD, LGD and EAD is shown again as a schematic in figure 1-7:

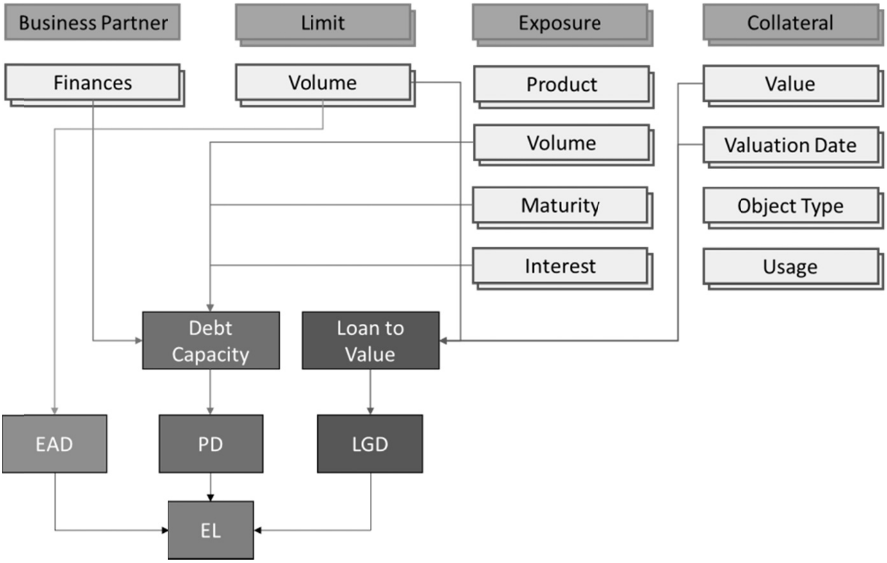
Business Partner
Limit
Exposure
Collateral
Finances
Volume
Product
Value
Volume
Valuation Date
Maturity
Object Type
Interest
Usage
Debt Capacity
Loan to Value
EAD
PD
LGD
EL

Figure 1-7: EL calculation overview (own representation)

In the stress scenarios the EL is calculated as follows:

PD

With the PD calculated as a function of the DC of the client, this represents basically a stylized rating model. As such, the relationship will be supplied by an external or internal rating provider. Since we use a mapping table we need to put the clients to DC classes with associated PDs. For simplicity, our model doesn't include rating migrations during the quite long stress period.