

Essays on Economic Capital and Credit Risk Pooling

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Vorwort

Diese Dissertation entstand während meiner Zeit als wissenschaftlicher Mitarbeiter am Lehrstuhl für Finanzwirtschaft von Herrn Prof. Dr. Peter Nippel. Ich möchte Herrn Prof. Dr. Peter Nippel danken für die Betreuung meiner Arbeit. Hieraus haben sich viele anregende Diskussionen zu Themen der Finanzwirtschaft und darüber hinaus ergeben. Die stets freundliche und produktive Atmosphäre am Lehrstuhl wird mir in sehr guter Erinnerung bleiben. Herrn Prof. Dr. Alexander Klos danke ich herzlich für die Übernahme des Zweitgutachtens.

Immer wenn während meiner Arbeit am Lehrstuhl etwas zu organisieren war, konnte ich mich auf die tatkräftige und hilfsbereite Unterstützung von Frau Barbara Geisler verlassen. Hierfür und für viele nette Gespräche möchte ich ihr danken.

Weiterhin möchte ich meinen Kollegen Dr. Paul Plewa und Abdulali Hadizada danken. Mit ihnen konnte ich während unserer gemeinsamen Zeit am Lehrstuhl stets gut zusammenarbeiten.

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Introduction

Overview of the papers

I wrote this thesis while working at the Chair of Corporate Finance of Prof. Dr. Peter Nippel at the University of Kiel. The following table shows the titles and the authors of the three different papers contained in this thesis.

Title	Author
Unexpected Loss, Expected Profit, and Economic Capital: A Note on Economic Capital for Credit Risk Incorporating Interest Income, Expenses, Losses, and ROE Target	Martin Krebs and Peter Nippel
Pro rata Credit Risk Pooling between Regional Banks: Economic Capital and Portfolio Granularity	Martin Krebs
Credit Risk Pooling as a Tool to optimize Deadweight Costs of Regional Banks	Martin Krebs

Table 1: Papers in this thesis

The different papers treat different influences on a bank's economic capital for credit risk. The first of these papers analyzes the influence of profits and losses other than losses from credit defaults on a bank's economic capital. The other two papers are concerned with changes in a bank's economic capital if this bank participates in a credit risk transfer transaction called credit risk pooling. Hence, the last two papers are more closely connected with each other than either of these is connected with the first paper. All papers will be described in more detail now.

Unexpected Loss, Expected Profit, and Economic Capital: A Note on Economic Capital for Credit Risk Incorporating Interest Income, Expenses, Losses, and ROE Target

Banking supervisors require every bank to hold equity at least equal to its economic capital to cover unexpected losses from borrower defaults in its credit business. This standard economic capital for the credit business does not take into account potential profits or losses from other sources than defaults but still connected to the bank's credit business. This includes the potential interest payments from borrowers and the bank's

commitment to pay interest on its own liabilities. If economic capital calculations took these other profit and loss sources into account, we would arrive at what we call profit based economic capital for the credit business. Standard economic capital and profit based economic capital will differ, in general.

The goal of the banking supervisors in setting rules for the provision of economic capital is to ensure the stability of the banking system as a whole. If banks can cover unexpected losses in a sufficient number of cases, they are less likely to default and thus less likely to impair other banks' solvency by their default. But since standard economic capital that is defined by banking supervisors only takes losses from borrower defaults into account and ignores potential losses from other sources as well as potential profits, the question arises whether obliging banks to hold standard economic capital instead of profit based economic capital is compatible with the supervisors' goal of stability in the banking system.

The first paper in this thesis compares standard economic capital and profit based economic capital. It includes the demand of a bank's shareholders for a sufficient return on equity (target *ROE*). We are able to show as the main result of the paper that under weak conditions regarding the shareholders' target *ROE* and the bank's standard economic capital, the standard economic capital is larger than the profit based economic capital.

From the point of view of the banking supervisors, this is good news. It implies that when banks are obliged to hold equity to the amount of the standard economic capital, they default less frequently than they would if equity were held equal to the profit based economic capital. Obliging banks to hold standard economic capital thus leads to a more stable banking system even though major sources of a bank's profits and losses from its credit business are not taken into account.

The main result of the paper is derived via the comparison of two minimum interest rates in the credit business: r_A^{EC} and r_A^{\min} . The first rate is obtained by comparing standard economic capital and profit based economic capital. We find that if the interest rates that the bank charges in its credit business exceed the rate r_A^{EC} , then standard economic capital is greater than profit based economic capital. For the second minimum interest rate r_A^{\min} , we find that if a bank charges an interest rate that is at least equal to r_A^{\min} , then the shareholders will achieve their target *ROE*.

The main result then obtains by showing that the interest rate r_A^{\min} is larger than the interest rate r_A^{EC} under the following two conditions. Firstly, the bank's equity needs to be larger than the standard economic capital. Secondly, its shareholders' target *ROE* needs to be high enough. It follows that if the bank charges an interest rate in the credit business that leads to the shareholders' demand for their target *ROE* being met, i.e. $r_A \geq r_A^{\min}$, then this will also lead to the standard economic capital being larger than the profit based economic capital because $r_A \geq r_A^{\min} \geq r_A^{EC}$ under the two conditions. Thus,

the shareholders' demand for their target ROE drives the bank to set interest rates in the credit business to a level such that its risk is lower than if only the risk of unexpected losses was considered.

The two sufficient conditions for the main result are relatively weak. The first one of these, namely that the bank's equity exceeds its standard economic capital, should be fulfilled since it simply means that a bank complies with its supervisor's rules regarding the minimum amount of its equity. The second condition is shown to be equivalent to the target ROE being higher than the minimum interest rate r_A^{\min} . But since it is natural to expect the bank's shareholders to ask for a higher return than the bank's average return because of the bank's leverage, we can also expect that the target ROE is indeed higher than r_A^{\min} .

The main result is illustrated by simulating a one-factor credit portfolio model. In this example, the minimum interest rates r_A^{EC} and r_A^{\min} are calculated. It is shown that the difference between the standard economic capital and the profit based economic capital is significant given a sufficiently (but not unreasonably) high target ROE .

Pro rata Credit Risk Pooling between Regional Banks: Economic Capital and Portfolio Granularity

Regional banks like German savings and cooperative banks operate in small geographic areas. Therefore, their credit portfolios are concentrated on fewer borrowers than the portfolios of larger banks that operate nationwide or even internationally. This name concentration or, synonymously, coarse granularity can increase the risk of regional banks' credit portfolios.

In order to reduce name concentration in their portfolios, regional banks may use a transaction for synthetic risk transfer called credit risk pooling. A credit risk pooling transaction consists of two phases. In a first phase, banks pick risks to sell to a central institution called the pool. In the second phase, banks buy a share in the portfolio that this pool holds. This portfolio is also called the pool for brevity. The share in the pool will have banks participate proportionally in losses from defaults on the credit risks in the pool.

In this paper, we concentrate on a reduction of economic capital as a bank's motivation for participating in credit risk pooling. If a bank has fixed equity, then a reduction in economic capital makes it less likely that the bank faces financial distress as a result of high unexpected losses. This lowers the present value of financial distress costs and thus increases firm value.

We will demonstrate that a bank can reduce its economic capital via credit risk pooling without changing its portfolio exposure (in the sense of the total loan amount). In order to do so, we consider a special form of credit risk pooling called pro rata credit risk pooling.

In pro rata credit risk pooling, a bank may not choose its share in the pool independently of its sale decision. Instead, its share in the pool is set equal to its proportion in the exposure of credit risks sold to the pool. The paper shows that in pro rata pooling, a bank's portfolio exposure indeed remains constant.

The paper investigates two questions. The first question is under which circumstances pro rata pooling can lead to finer granularity in a bank's portfolio. The second question is how a bank's economic capital is affected by a bank's participating in pro rata pooling to different degrees. The answers to these two questions also show how changes in a bank's economic capital may be linked to alterations in its portfolio granularity.

In order to answer the first question, changes in a portfolio's granularity are described using general properties of concentration measures. This presents a novelty to the literature of name concentration in credit portfolios. Elsewhere in the literature, name concentration is described under more restrictive assumptions by either using a specific concentration measure or by employing so-called granularity adjustments. Our results are more general compared to the first approach of using specific concentration measures because the properties of concentration measures we use to describe granularity changes are shared by many different concentration measures including the Herfindahl-Hirschman index. If we used granularity adjustments instead, we would have to specify a credit portfolio model. But our results hold regardless of any credit portfolio model one might be using to calculate economic capital.

The use of general properties of concentration measures allows us to identify the following conditions under which a bank's portfolio granularity will become coarser or finer, respectively, by participating in pro rata pooling. Given other banks' choices of the credit risks they sell, a bank can achieve finer portfolio granularity if it sells more credit risks with relatively large exposures. If it sells more credit risks with relatively small exposures and its share in the pool is already large, then its portfolio granularity becomes coarser. If a bank sells credit risks for which the exposure is in between these two cases of small and large risks, respectively, then the assessment of the change in its portfolio granularity depends on the particular concentration measure that is used to describe it. Given its own choice of credit risks to sell, a bank's portfolio granularity becomes finer if another bank sells more credit risks with relatively small exposures.

The second question regarding a bank's changes in economic capital after pooling is discussed using the simulation results of a one-factor credit portfolio model with varying degrees of participation of two banks in pro rata pooling. Two different risk measures are used to calculate economic capital: Value-at-Risk and Expected Shortfall. In all cases we describe, Expected Shortfall decreases as a bank's portfolio granularity becomes finer. Contrarily, Value-at-Risk may also increase despite finer portfolio granularity.

A second observation from the simulation results is that if the risks that banks pool have heterogeneous exposures, the bank selling the risks with smaller exposures may see

its economic capital increasing with increasing participation. This happens if the bank already holds a large share in the pool and even if Expected Shortfall is used as a risk measure.

We thus find two reasons why banks may choose to limit their participation in pro rata credit risk pooling: Either they use Value-at-Risk as a risk measure and this signals an increase in risk despite finer portfolio granularity. Or the risks banks pool have heterogeneous exposures and the bank with relatively small exposures holds a large share in the pool.

Credit Risk Pooling as a Tool to optimize Deadweight Costs of Regional Banks

The third paper analyzes an explanation for credit risk pooling between regional banks that is complementary to the one provided in the second paper. This alternative explanation is connected to regional banks' limited access to capital markets. If this access is limited, then the banks will not be able to adjust their capital structure in the short run. Given a credit portfolio, a bank's fixed equity might deviate from its economic capital in a way that leads to lower firm value for the bank.

If a regional bank's economic capital is high relative to its fixed equity, then the bank's insolvency risk is high, too, *ceteris paribus*. The present value of the bank's insolvency costs is thus relatively high resulting in a loss of firm value compared to the firm value with the optimal proportion between equity and economic capital. High economic capital thus leads to a loss in firm value that constitutes deadweight costs for a regional bank.

If a regional bank lacks lending opportunities with a positive net present value in its region, it might hold a large part of its assets in safe assets leading to low economic capital. The free cash flow might be wasted by inefficient management on projects with a negative net present value. As a result, a bank's firm value might be lower as a consequence of the free cash flow problem compared to a situation with less free cash flow. Therefore, low economic capital may also lead to deadweight costs in the form of lower firm value for a regional bank.

The third paper motivates regional banks' participation in credit risk pooling by minimizing deadweight costs from economic capital being too high or too low. Contrary to the second paper, a bank may not only seek to reduce its economic capital by pooling but it may also have a motivation to increase its economic capital by buying additional credit risks and thus increasing its portfolio exposure. Accordingly, the third paper does not restrict itself to pro rata pooling. Instead, banks may decide on their share in the pool independently of the set of credit risks they choose to sell to the pool. Portfolio diversification which is the underlying effect of the reductions in economic capital in the second paper is ruled out in the third paper by an assumption in order to facilitate the analysis.

The paper develops a theoretical model that yields results with respect to the welfare increases regional banks realize by pooling, the prices paid for the credit risks and also the banks' optimal decisions. Banks that participate in pooling never suffer a loss in welfare and in many cases, they realize a welfare increase.

In the solutions regarding the prices paid and the decisions made by the banks, a factor called risk overhang becomes important. By a bank's risk overhang we denote the difference between a bank's actual economic capital and the economic capital at which its deadweight costs would be minimized.

The prices for credit risks contain a premium (discount) relative to the value of the credit risks in a frictionless market if the banks that buy a share in the pool have a negative (positive) risk overhang after pooling. In the first case of banks having a negative risk overhang after pooling, the banks' economic capital after pooling is lower than the economic capital that would minimize deadweight costs. Therefore, banks cannot take on as many credit risks as they would like to maximize their firm value. Credit risks are thus "scarce" and consequently trade at a premium. Conversely, in the situation where banks have a positive risk overhang after pooling, we may consider credit risks as being in "excess supply" and hence they trade at a discount.

In analyzing the decisions banks make with respect to the credit risks they sell and the share they buy in the pool, we can distinguish two groups of banks. One group is characterized by having a relatively low risk overhang on average before pooling and the other by having a relatively large risk overhang on average before pooling. Banks of the first group are net buyers in the pooling in the sense that the share they buy in the pool is larger than their share in the credit risks sold to the pool. Contrarily, banks of the second group are net sellers of credit risks.

After pooling, the risk overhangs of the banks in the two different groups align more closely than before. However, perfectly identical risk overhangs across all banks after pooling are only accomplished in one equilibrium out of many different possible equilibria. Therefore, credit risk pooling may be welfare-increasing by redistributing credit risks among regional banks in order to make more efficient use of the banks' fixed equity. This will result in higher firm values of participating banks. However, since even after pooling the distribution of risk overhangs may be uneven, the banks' increase in firm values may be smaller than in more desirable equilibria.

Unexpected Loss, Expected Profit, and Economic Capital: A Note on Economic Capital for Credit Risk Incorporating Interest Income, Expenses, Losses, and ROE Target

Martin Krebs and Peter Nippel

Published in Finance Research Letters, Vol. 38, January 2021

Link: <https://doi.org/10.1016/j.frl.2020.101481>

Abstract

We compare the traditional calculation of economic capital for credit default losses with a more comprehensive one based on the bank's (net) profit from credit business as accounted for in the bank's P&L statement. In this comparison, we integrate shareholders' perspective into the bank's calculation of economic capital. Shareholders' *ROE* target affects credit pricing in terms of interest rates to be charged in the lending business and hence affects the profit distribution. We show that economic capital needed to buffer losses as of the P&L statement is strictly less than the unexpected loss in *EaD* from defaults.

Keywords: Credit Risk, Economic Capital, *ROE*

JEL Classification: G21, G28

Pro rata Credit Risk Pooling between Regional Banks: Economic Capital and Portfolio Granularity

Martin Krebs

Published on SSRN

Link: <http://dx.doi.org/10.2139/ssrn.3900446>

Abstract

This paper describes the effect of pro rata credit risk pooling transactions - a special type of synthetic credit risk transfer - on the granularity and the economic capital of regional bank credit portfolios. The change in granularity is described analytically using general properties of concentration measures. Given other banks' choices of which credit risks to sell, a regional bank can achieve finer portfolio granularity if it sells more credit risks with relatively large exposures. If it sells more credit risks with relatively small exposures and its share in the pool is large, then its portfolio granularity becomes coarser. Given its own choice of credit risks to sell, a regional bank's portfolio granularity becomes finer if another bank sells more relatively small credit risks. The changes in economic capital following pro rata pooling are analyzed by simulating a credit portfolio model. The simulations show two reasons why regional banks may choose to limit their participation in pooling. Firstly, Value-at-Risk will not always decrease despite a portfolio's granularity becoming finer. Secondly, a bank's economic capital may increase if it sells risks with relatively small exposures and the risks that banks pool have heterogeneous exposures.

Keywords: Credit risk transfer, Credit risk pooling, Economic capital, Portfolio granularity, Value-at-Risk, Expected Shortfall

JEL Classification: G11, G21, G32

Credit Risk Pooling as a Tool to optimize Deadweight Costs of Regional Banks

Martin Krebs

Published on SSRN

Link: <http://dx.doi.org/10.2139/ssrn.4629229>

Abstract

This article analyzes a credit risk transfer transaction used by German regional banks: credit risk pooling. A credit risk pooling transaction entails two decisions for participating banks. The first is which credit risks they sell to the pool and the second is which share they buy in the credit risks in the pool. A theoretical model is developed which motivates the participation of regional banks in credit risk pooling with deadweight costs of having either too little or too much economic capital in the spirit of the tradeoff theory of the capital structure. The deadweight costs are given via a variable we call *risk overhang*. The banks' optimal participation in the pooling and the prices at which credit risks trade are derived. After pooling, banks are never worse off and in many cases pooling increases their welfare. Further, credit risk pooling leads to a more even distribution of risk overhang across banks. However, a completely even distribution is not always achieved.

Keywords: Economic capital, Credit risk transfer, Credit risk pooling, Deadweight costs

JEL Classification: G11, G21, G32

Authors' Contribution Statements

Paper 1

Martin Krebs and Peter Nippel are co-authors of the first paper. They contributed equally to the conceptualization, the writing and the mathematical analysis.

Date 30.11.2023 Signature 

Date 30.11.2023 Signature 

Papers 2 and 3

Martin Krebs is the sole author of the papers 2 and 3. He gratefully acknowledges comments by Peter Nippel and an anonymous referee to have been very helpful for improving the papers.

Erklärung zum selbständigen Verfassen der Arbeit

Ich erkläre hiermit, dass ich meine Doktorarbeit „Essays on Economic Capital and Credit Risk Pooling“ selbständig und ohne fremde Hilfe angefertigt habe und dass ich als Koautor maßgeblich zu den weiteren Fachartikeln beigetragen habe. Alle von anderen Autoren wörtlich übernommenen Stellen, wie auch die sich an die Gedanken anderer Autoren eng anlehrenden Ausführungen der aufgeführten Beiträge wurden besonders gekennzeichnet und die Quellen nach den mir angegebenen Richtlinien zitiert.

Datum 30.11.2023

Unterschrift 