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Leverage Ratios for Different Bank Business Models

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Abstract

The development of the Basel III leverage ratio does not consider the different risk characteristics of bank business models. All banks have to achieve the same requirements even if a high-risk business model is chosen. For that reason, leverage ratios which are adjusted to the risk-profile of retail, wholesale, and trading banks are developed. Based on Value-at-Risk and Expected Shortfall calculations, the left-hand tail of a net return on non-risk-weighted assets distribution of 120 European banks is analyzed. Retail banks are less risky and can withstand financial distress with a smaller amount of capital.

Verschuldungsquoten für unterschiedliche Bank-Geschäftsmodelle

Zusammenfassung

Bei der Entwicklung der Verschuldungsquote nach Basel III wurden die unterschiedlichen Risikomerkmale von Bank-Geschäftsmodellen nicht berücksichtigt. Alle Banken müssen die gleichen Anforderungen erfüllen, auch wenn ein risikoreiches Geschäftsmodell gewählt wird. Aus diesem Grund werden Verschuldungsquoten hergeleitet, die sich an dem Risikoprofil von Retail-, Wholesale- und Trading-Banken orientieren. Auf Basis von Value-at-Risk und Expected-Shortfall Berechnungen wird eine Renditeverteilungskurve, die als Jahresüberschuss nach Steuern im Verhältnis zur nicht-risikogewichteten Aktiva ermittelt wird, von 120 europäischen Banken analysiert. Retail-Banken sind weniger riskant und können finanziellen Stresssituationen mit einer geringeren Kapitaldecke standhalten.

Keywords: Bank Business Models, Bank Capital Requirements, Expected Shortfall, Leverage Ratio, Regulation, Value-At-Risk

JEL Classification: G21, G28, G32

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I. Introduction

Banks choose their business model to meet their strategic objectives and thus display different risk characteristics. However, the different risks of business models, such as the risk-return profile or dependencies of the capital structure, are not considered for the development of the leverage ratio requirement in Pillar 1 of the Basel framework. All banks have to achieve the same leverage ratio no matter whether a bank pursues a low-risk or a high-risk business strategy. A ratio, which accounts for numerous problems and was designed without a reasonable method for the measures of financial risks. Given these problems, *Ayadi* et al. (2011) and *Grossmann/Scholz* (2017) state that bank business models require diverse capital requirements and suggest to adjust the leverage ratio to account for the different risk-profiles of business models. The consideration of bank business models can complete the existing regulatory framework to cover business model risks in Pillar 1. Against this backdrop, the main questions are: how can the leverage ratio requirement be adjusted to consider the riskiness of different bank business models? And, what are the consequences for retail, wholesale, and trading bank business models?

Previous research on business models concentrates on the classification of banks, the profitability and performance, the return and costs, the risk and default, or the impact of higher capital requirements (cf. *Roengpitya* et al. 2014; *Ayadi* et al. 2016; *Koehler* 2015; *Mergaerts/Vander Vennet* 2016*; Grossmann/Scholz* 2017). We expand the field of research on bank business models with the development of different leverage ratio requirements. For this reason, established methods to measure financial risk are chosen to overcome problems of the current development of the leverage ratio. Since the existing method of the Basel Committee on Banking Supervision (BCBS 2010) does not coincide with the characteristics of a coherent risk measure, Value-at-Risk (VaR) and Expected Shortfall (ES)[1] calculations are used to match the requirements of *Artzner* et al. (1999). VaR and ES seem to be appropriate risk measurement methods because they promote sufficient levels of capital for banks to withstand financial distress, are approved by regulators, and are commonly used by banks. First, we find that retail banks account for the lowest risk of the examined business models in the sample. Wholesale and trading banks account for higher potential losses and need higher leverage ratios to withstand financial distress. Based on VaR calculations, the adjusted leverage ratio for retail banks should be between 2.83 % and 3.00 %, and for wholesale banks between 3.28 % and 4.21 % relative to total assets. Trading banks should have an adjusted leverage ratio of 3.76 % to 4.41 % relative to total assets. Second, to capture "tail risks" the ES calculations

[1] The ES can also be called Conditional Value-at-Risk, Expected Tail Loss, or Tail Conditional Expectation.

indicate a leverage ratio including an additional buffer between 3.00 % and 3.76 % for retail, 3.81 % and 4.16 % for wholesale, and 4.78 % and 5.13 % for trading banks. We also report ratios for a combined wholesale and trading bank sample. The main findings, at least for medium and small banks in the sample, illustrate the potential to account for the different risk characteristics of business models. Third, the results support *Grossmann/Scholz* (2017) that a 'one size' approach for the regulation of banks does not fit all. Adjusted leverage ratios can help to keep the existing differences between bank business models and must not lead to a more similar banking system. The impact on banks' balance sheets seems to be acceptable to strengthen both, the individual bank and the financial stability.

The approach to investigate the research questions is based upon two steps. In a first step, 120 banks are separated into retail, wholesale, and trading bank business models. The separation is based on a study by *Roengpitya* et al. (2014) and a procedure defined by *Grossmann/Scholz* (2017) for each bank from 2000 to 2013. In a second step, leverage ratios for three bank business models are developed. In contrast to the BCBS (2010), VaR and ES are applied to adjust the current leverage ratio requirement. Since the leverage ratio focuses on a bank's total exposure, a return distribution of the net return on non-risk-weighted assets is created and the left-hand tail is analyzed. The idea is comparable to the calibration of capital requirements for risk-weighted assets (RWA) but with a focus on non-risk sensitive assets. The use of VaR can be a good estimate of sufficient capital because 'high percentiles of this distribution might be reasonable proxy value for the degree of shock' that a bank is able to withstand (BCBS 2010). As for the method of the ES, we refer to the revised standards for minimum capital requirements for market risk by the BCBS (2016), which introduces a shift from VaR to ES to capture "tail risks" for adequate levels of equity under significant periods of financial stress. Two approaches to adjust the current BCBS leverage ratio are presented. Firstly, the current requirement of 3 % is used as a minimum basis. Supplementary, the differences between low-risk and high-risk bank business models are added as extra capital requirements. Secondly, the highest VaR and ES calculations are added to the highest negative returns for each bank business model over the examined timeframe. In both approaches, the different risk characteristics of business models are considered and sufficient levels of capital are promoted for banks to withstand financial distress without government support.

II. The BCBS Leverage Ratio

Before the focus shifts to the adjustments, the development of the original BCBS leverage ratio, the accompanying problems, and a brief literature review on the leverage ratio are discussed. After the financial crisis, the BCBS proposed

new capital requirements, commonly known as Basel III, to strengthen the financial system. One part of Basel III is the leverage ratio, which is the ratio of a bank's Tier 1 equity to its on- and off-balance sheet exposure and is a non-risk-weighted capital requirement (BCBS 2011 and 2014). The leverage ratio requirement is invented to reduce the creation of leverage within the financial system, which the RWA approach was not intended for. Hence, the leverage ratio serves as a backstop supplementary to the RWA approach. Moreover, it serves as a safety net and prevents a possible over-reduction of capital requirements due to the use of internal risk models (BCBS 2013). The BCBS (2010) establishes a conceptual framework for a top-down approach to determine capital requirements for a bank's risk sensitive as well as non-risk sensitive exposure. The top-down approach is used as one of the inputs for the Basel III framework.[2] For the development of the RWA requirements, the BCBS (2010) examines the left-hand tail of the historical net return on risk-weighted assets (RORWA) distribution, which is conceptually comparable to the VaR to measure potential losses. In contrast to the RWA approach, the BCBS (2010) uses historical losses to calibrate the current leverage ratio requirement. The survey focuses on Tier 1 capital to on-balance sheet assets and identifies a critical value at 3 %–5 % between severely stressed and non-severely stressed banks. Severely stressed banks are defined as banks that failed, are acquired under stress, or receive government assistance (BCBS 2010).

The problems with the development of the BCBS leverage ratio are manifold. First, when the BCBS calibrates the leverage ratio, it is simply based on historical leverage ratios and a critical value between severely and non-severely stressed banks. The BCBS admits that it is not a direct approach to set capital requirements, but it is 'at least a rough indication' (BCBS 2010). By contrast, *Jarrow* (2013) calls the proposed leverage ratio of Basel III a 'standard with no economic reasoning provided'. In addition, the BCBS approach does not consider the characteristics of a coherent risk measure. Second, the BCBS is inconsistent regarding the methodology to develop capital requirements. Third, the dataset: the calibration of the leverage ratio is based on severely stressed banks, but only 12.5 % of the first sample and only 17 % of the broader second sample were stressed banks. For the first working group, a sample of 88 banks (11 of them were stressed) is observed over a period from the mid-1990s to 2006. Additionally, 117 large banks are observed for a broader second sample (BCBS 2010). However, the data is calculated at the end of 2006, one year before the financial crisis started. Significantly stressed banks during the crisis are not considered. Fourth, the current leverage ratio of 3 % seems to be too low. *Miles* et al. (2012) find an optimal ratio between 7–10 % and *Admati* et al. (2013) suggest an equity

[2] The other inputs for Basel III are the Long-Term Economic Impact (LEI) group and the "bottom up" Quantitative Impact Study (QIS). For more details see BCBS (2010).

ratio of even 20–30 % of a bank's total unweighted assets. Fifth, the new supervisory review and evaluation process (SREP) of the EBA in Pillar 2 does not consider the leverage ratio for additional capital requirements (Pillar 2 Requirements, P2R) for risky banks (cf. *EBA* 2014). Sixth, the diversification of the banking sector is not sufficiently considered (*Ayadi* et al.; 2011 and 2016 *Grossmann/Scholz* 2017).

Most scientific research in this field of activity relates to the disadvantages and advantages of a leverage ratio requirement. To name a few: the leverage ratio is criticized for that it could reduce the amount of lending (*Frenkel/Rudolf* 2010), will have a negative impact on the business policy of banks due to higher funding costs (*Hartmann-Wendels* 2016), seduce banks to shift towards riskier assets (IMF 2014), and lead to a more similar banking sector that may undermine the financial stability (*Kiema/Jokivuolle* 2013). In contrast, the leverage ratio is praised to induce truthful risk reporting, to increase the ability to sanction banks (*Blum* 2008), and to reduce the probability of bank runs because it puts a floor on the risk-weighted capital requirements (*Dermine* 2015). Overall, the necessity of a leverage ratio is not discussed because it can serve as a sound and robust safety net (cf. EBA 2016). The primary goal is to consider the riskiness of different bank business models for the adjustment of the leverage ratio. Besides the above-described method of the BCBS (2010), other approaches to design a leverage ratio exist. On the one hand, *Fender/Lewrick* (2015) calibrate a leverage ratio based on the link between the historical leverage ratio and the historical Tier 1 risk-weighted capital requirement. The calibration considers the ratio of RWA to on- and off-balance sheet exposure and assumes that the leverage ratio requirement is cyclical to the RWA approach. On the other hand, *Jarrow* (2013) designs a maximum leverage ratio (calculated as debt over equity) based on the probability of insolvency over a given timeframe. The maximum leverage ratio ensures that a bank's equity exceeds it's debts. Otherwise, a bank needs to be restructured, e. g. through haircuts.

In contrast, we focus on existing risk measurement methods that are detached from an interaction with the RWA and neglect a possible dependence between different regulatory concepts. Thereby, the leverage ratio can serve as an independent backstop supplementary to the RWA requirements and other non-risk-weighted assets. Furthermore, we do not focus on haircuts or on severely stressed banks. The definition of stressed banks (cf. BCBS 2010) intervenes too late, e. g. banks that failed. The consideration of negative earnings seems to be a more appropriate method for an earlier detection of expected bank failure because non-stressed banks can turn into stressed banks after negative earnings adjoin or exceed banks' capital, e. g. losses over several quarters or years. The development of the BCBS leverage ratio does not consider the larger losses of wholesale and trading banks during the financial crisis. Therefore, our approach considers the experienced losses to set higher levels of capital requirements for

riskier business models. Overall, both the maximum leverage ratio and VaR control for the same insolvency risks and can be seen as equivalent instruments (*Jarrow* 2013). In addition, a combination of VaR and ES can be a good risk-adjusted performance measurement tool (*Frey/McNeil* 2002).

III. Dataset

The final sample consists of 89 banks with a banking license in Germany and additional 31 banks with a banking license in Europe. The bank sample is based on *Grossmann/Scholz* (2017) who analyze the return on Tier 1 capital for a European bank sample. The composition of the sample consists of large, medium, and small European banks. The large banks belong to the biggest banks in Europe, based on their balance sheet volume at the end of 2013 or the last known. The majority of medium and small banks are selected from Germany for two reasons. One, the German banking sector is chosen as an example because it is one of the largest in Europe based on the number of credit institutions and the ratio of assets to GDP (ECB 2015). Two, information about regulatory Tier 1 capital, especially for medium and small banks, which are based on disclosure reports according to § 26a of the German Banking Act, are available for the investigated timeframe. We like to mention that the largest banks in Germany could also be categorized to the group of large European banks. Appendix V shows the list of banks. Nevertheless, it should be considered that the results of the analysis are influenced by the majority of German banks. Banks operating in Germany that are a subsidiary of a European bank holding company in the sample are not considered to avoid duplications. The data is collected for the timeframe of 2000 to 2013 from the bankscope-database Bureau van Dijk Electronic Publishing (2015). The dataset does not contain data for all banks for every year from 2000 to 2013, but the available observations are kept because the banks represent the financial system. The predominant share of data exists for the years 2006–2013 with more than one hundred yearly observations as Appendix I shows. The observed timeframe allows us to split the sample into two subsamples: "Pre-Crisis" for the years 2000 to 2006 and "Post-Crisis" for the years 2007 to 2013. The data sample is checked for banks with no observations for the examined data, i. e. yearly earnings and total assets. Furthermore, data errors such as incorrect units and banks that are overtaken by competitors are deleted from the final sample. If a competitor in the sample overtakes 50 percent of the shares of another bank in the sample, the examined bank is dropped for the observed year. The observations before the merger are taken into account in order to avoid a selection bias. The observations of the overtaken bank for the years following the merger are deleted because they would otherwise be considered twice. Each bank and possible merger are examined for every year. Hence, the sample considers banks that might be acquired after the investigated timeframe.

Due to disclosure requirements of medium and small banks, only yearly data is available for every bank in the sample. About half the banks in the sample do not disclose semi-annual and quarterly reports. We decide not to mix annual, semi-annual, and quarterly data to avoid a possible distortion of observations towards banks with higher publishing requirements. The unbalanced panel dataset includes a total of 1,265 observations.

The dataset is used to analyze losses of the past to calibrate capital requirements for future distress. However, it should be considered that the use of historical data might not be a good predictor of future distress. More sophisticated simulation methods could be used instead, but would rely on several assumptions and require internal bank data e. g. the interest margin, new business volume, or the future cost structure. As far as we know, the development of most regulatory ratios is based on historical data.

IV. Bank Business Models

In the current regulatory framework, the business model of a bank is considered in Pillar 2 as one out of four parts in the European SREP. The goal is to cover individual risks that are not considered by Pillar 1 (EBA 2014). However, several problems with the current supervisory review process exist, which motivate the consideration of bank business models in Pillar 1. One, the SREP of the EBA is primarily for significant European institutes (SI). Less significant institutes (LSI) are supervised by national authorities that may use adapted Pillar 2 concepts. Two, in practice, the composition of additional P2R for SI is nontransparent and not comparable with P2R for LSI.[3] Three, the business model analysis is primary for European banks. Other regulatory jurisdictions can have different Pillar 2 concepts that do not analyze the business model. The described disadvantages could lead to competitive national and international disadvantages for banks (cf. *Grossmann/Scholz* 2017). A possible solution could be standardized Pillar 1 requirements for business models (P1R-BM), which would be applied by all SI and LSI within and outside Europe to ensure a certain level of capital. P1R-BM are irrespective of risk estimates, which focus on single risk-weighted assets, and could cover general risks that affect all banks within one business model e. g. dependencies of the capital structure or certain business activities. Changes in the P1R-BM, due to a revised risk assessment by the supervisory board, would affect all banks of one business category at the same time, in contrast to a delayed individual consideration within the next SREP. Irrespective of this, additional P2R could still be applied if individual bank risks are found under the SREP.

[3] See for example the EBA SREP Guideline vs. the LSI-SREP of the BaFin and Deutsche Bundesbank.

The allocation of the banking sample into business models follows *Roengpitya* et al. (2014). The allocation is based on the business activities, the compositions of the asset side, and the funding structures of the individual banks. *Grossmann/Scholz* (2017) define a procedure based on three key ratios and five supportive ratios identified by *Roengpitya* et al. (2014) as well as two additional supportive ratios to split the banking sample into retail, wholesale, and trading banks. In step one, the allocation procedure focuses on the funding structure. In step two, the focus is on banks' business activities. The allocation of banks to business models is made for each bank and for every year from 2000 to 2013. Changes of business models over time are possible and are taken into account for the calculations. The results of the allocation for the banking sample are presented in table 1.

Banks choose balance sheet structures that suit their strategic goals best. The aim of a retail bank is to collect deposits from private and small corporate customers to deal in credits. Hence, a retail bank has a high share of gross loans which is refinanced via customer deposits and has low shares of wholesale debt or interbank borrowing. A bank is therefore classified as a retail bank if the gross loans are above 50 % with customer deposits above 50 %, or if gross loans are above 35 % with customer deposits exceeding wholesale debt and interbank borrowing, and investment activities (i. e. derivative exposure and trade liabilities) below 20 % of the balance sheet total net of derivatives. The aim of a wholesale bank is to provide banking services to financial institutions and larger corporate customers. Thus, a wholesale bank also has a high share of gross loans, but differs in the funding mix. Wholesale banks depend less on customer deposits and use more banking and non-current liabilities. A bank is therefore classified as a wholesale bank if the gross loans are above 50 % with interbank borrowing and wholesale debt exceeding customer deposits, or if gross loans are above 35 % with wholesale debt and interbank borrowing exceeding customer deposits, and investment activities below 20 %. By contrast, the aim of trading banks is to consult on corporate finance decisions, provide brokerage services, and to assist customers in raising equity and debt. Trading banks have a smaller share of gross loans and a higher share of loans to banks. Moreover, they have a high share of investment activities such as derivative or trading exposure and use a market-based funding strategy (see also *Hull* 2015 and *Roengpitya* et al. 2014). *Roengpitya* et al. (2014) discover that the share of interbank related assets and investment activities is about 20 % of the balance sheet total for trading banks. A bank is therefore classified as a trading bank if investment activities are above 20 %, or if interbank lending (e. g. loans and advances to banks) and investment activities exceeds gross loans. In total, the sample provides 685 retail bank observations, 350 wholesale bank observations, and 230 trading bank observations.

The described procedure to split the banking sample into business models illustrates one possible approach. Other approaches that use different databases

Table 1

The Allocation of Banks

Variables	*All Banks*	*Retail*	*Wholesale*	*Trading*
Gross Loans	53 % (58 %)	*62 %* (62 %)	*52 %* (65 %)	29 % (26 %)
Interbank Borrowing	22 % (11 %)	18 % (8 %)	29 % (14 %)	23 % (19 %)
Wholesale Debt	19 % (19 %)	8 % (11 %)	*38 %* (37 %)	24 % (18 %)
Interbank Lending	15 % (11 %)	9 % (9 %)	20 % (8 %)	*26 %* (22 %)
Customer Deposits	47 % (54 %)	*64 %* (67 %)	24 % (36 %)	29 % (38 %)
Stable Funding	63 % (67 %)	71 % (74 %)	59 % (63 %)	46 % (49 %)
Derivative Exposure	5 % (n/a)	0.9 % (n/a)	3 % (n/a)	*18 %* (n/a)
Trading Exposure	3 % (n/a)	0.5 % (n/a)	1 % (n/a)	*11 %* (n/a)

Notes: Gross Loans show the share of loans relative to total assets. Interbank Borrowing describes the share of deposits from banks relative to total assets. The share of other deposits plus short-term borrowing plus long-term funding relative to total assets is shown by Wholesale Debt. Interbank Lending displays the share of loans and advances to banks in relation to total assets. Customer Deposits are calculated by the share of customer deposits relative to total assets. The Stable Funding is displayed by the share of total customer deposits plus long-term funding relative to total assets. The share of derivatives relative to total assets is presented by Derivative Exposure. Trading Exposure is the share of trading liabilities in relation to total assets. The total assets are net of derivatives. The results in parentheses are from *Roengpitya* et al. (2014).

with other variables, such as *Ayadi* et al. (2016) who offer five business models, exist. A more granular classification of business models, which considers more differences between banks could increase the practicability of the analysis, but would require additional internal and external data. In practice, the yearly allocation of a bank to a business model could be made by the supervisory authority. In the case of borderline-decisions or differences between business models across countries, competent supervisory authorities could use additional data regarding e. g. strategic plans, internal reporting, recovery and resolution plans, business development and specialized mortgage loans, or domestic characteristics of banks to allocate banks. Nevertheless, we believe that the chosen business models offer a first approach to consider the different risk characteristics of banks more appropriate than a single leverage ratio for all banks. In a next step, a more detailed allocation of banks could build upon our analysis.

In addition, we find that ownership structure, as another possibility to separate a banking sample, does not allow to distinguish between international banks because of the differences between two and three-pillar banking systems. Moreover, ownership structures are not a robust measure to distinguish between the riskiness of different banks. For example, both cooperative and savings banks claim to collect deposits at a local level to deal in credits to their customers or owners. However, based on the balance sheet structure, which can reflect the chosen business strategy, some cooperative and savings banks in the sample

feature characteristics of wholesale or trading banking. Hence, it is important to analyze each bank in every year and to consider possible changes over time.

Overall, the applied procedure to separate the banking sector offers an objective approach based on financial statements with realized business activities and funding structures. The focus on business models allows differentiating capital requirements for the regulation of unequal banks.

V. Characteristics for a Coherent Risk Measure

We aim to find rules of capital regulation that are based on an 'economic reasoning' method, can be seen as a coherent measurement of risk, and consider the differences of business models. In particular, the focus is on financial risks for the European bank sample. Financial risks can include various categories of risk, e. g. market, credit, and operational risk. The focus on financial risks as a whole provides a unified risk perspective that considers possible correlations among various risk categories. In this respect, the definition of characteristics for a coherent risk measure by *Artzner* et al. (1999) is chosen. A coherent risk measure considers the aspects monotonicity, translation invariance, positive homogeneity, and subadditivity. The characteristics are chosen because they enable to deliver a judgment about sufficient capital to cover financial risks and are indirectly considered by the BCBS (2016) for minimum requirements to capture "tail risk" in periods of significant financial market stress.

Following *Artzner* et al. (1999), 'these measures of risk can be used as (extra) capital requirements to regulate the risk […]'. This means for our approach: certain bank business models that are riskier than other business models should have higher capital buffers (monotonicity). The additional equity, e. g. cash out of retained earnings, will make riskier bank business models less risky (translation invariance). If the relative trading activities and funding structure of a bank and the related classification to a bank business model are unchanged, even if the size of the bank increases, the relative capital requirement should stay the same. If a bank changes its business strategy and the related trading activities and funding structure, the capital requirement should be adjusted (positive homogeneity). We look at the sample as a portfolio of positions of a diversified banking sector. If two banks of the same bank business model merge, the risk measure should not increase (subadditivity). If two banks of different bank business models merge, the future risk measure should consider the new bank business model. The new business model should again be classified based on the funding structure and trading activities. However, our approach does not consider size dependencies and the related systemic importance of banks, but additional capital buffers for global systemically import banks (G-SIB) could be added.

VI. Methodical Approach

The practical implementation of the characteristics for a coherent risk measure can be accomplished by using two existing risk measurement methods: VaR and ES. The VaR approach satisfies the first three proposition of *Artzner* et al. (1999) and is used to adjust the leverage ratio requirement. Though, VaR is not a coherent risk measure because it lacks the subadditivity proposition. However, VaR is used because it requires a smaller sample size than ES for the same level of accuracy (*Yamai/Yoshiba* 2002). The ES is considered because it complies with all four propositions of *Artzner* et al. (1999) and is used to calculate additional leverage ratio buffers for periods of significant financial stress. Overall, VaR and ES have the advantage of an underlying economic methodology, can capture financial risks, have been approved by regulatory and supervisory authorities, are used in practice by banks, and can be used to differentiate between business models.

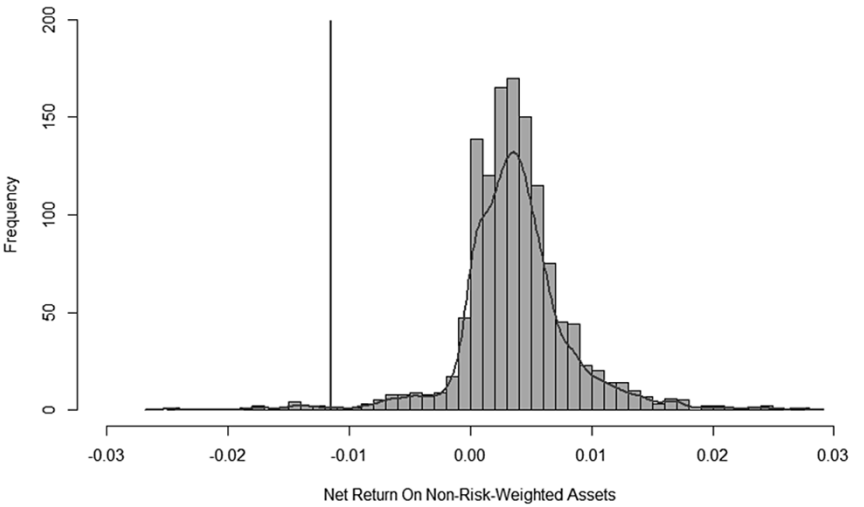
The VaR is a method to measure the risk exposure of a potential change in value of a single asset or a portfolio for a predefined timeframe with a given probability (*Morgan/Reuters* 1996). Depending on the aim of the research and the number of observations, different values for α can be used to calculate the VaR, with the most common $\alpha = 0.95$ and $\alpha = 0.99$. Theoretically, a 99.9 % confidence level can be used as well, but requires sufficient data (*Embrechts* et al. 2003). The VaR can be used for investment, hedging, or general portfolio management decisions (*Dowd* 1999). In contrast to traditional methods that are based on risk-return analysis or the Capital Asset Pricing Model, the VaR approach concentrates on the downside of return distributions to measure financial risk (*Lu* et al. 2008). Moreover, the VaR can create an incentive for banks to adjust their leverage. *Adrian/Shin* (2014) find in a contracting model of leverage and balance sheet size that the VaR at a given confidence level determines a bank's leverage. The financial risks involved will be managed to the extent that the VaR will not exceed banks' equity capital. The methods to calculate the VaR can be divided into the local valuation method, which presumes a normal distribution of returns, and the full valuation method, which presumes nonlinear and non-normal distributions of returns (cf. *Jorion* 2007). Three different VaR calculations are used to analyze the bank sample. One, the gaussian VaR that assumes a normal distribution of returns. Two, the historical VaR that is based on historical returns. According to *Jorion* (2007) the historical method does not have underlying assumptions for the return distribution. Though, historical data cannot predict future results, trends in the data, the occurrence of new risks, or unpredictable market movements (*Damodaran* 2007). Third, the modified VaR (mVaR) calculates the potential loss in value based on the Cornish-Fisher expansion to correct the percentiles of the return distribution for skewness and kurtosis (cf. *Zangari* 1996 and *Boudt* et al. 2008). However, the mVaR approach does not work under market stress because it underestimates the likelihood of

extreme values and "tail risks" of the return distribution (*Yamai/Yoshiba* 2002b). Furthermore, mVaR might disregard the diversification of a portfolio and does not declare the potential size of a loss (cf. *Embrechts* et al. 2003).

The ES is the average expected loss at a given confidence beyond the calculated VaR level and is a coherent risk measure (*Yamai/Yoshiba* 2002). For example, if the $ES_{\alpha\,0.99}$ is 5 %, the average loss in the worst 1 % of returns will be 5 % within the predefined timeframe. The ES can be applied to different categories of risk (*Acerbi/Tasche* 2001) and can supplement the VaR because it provides information about the size of a loss (cf. *Embrechts* et al. 2003). In both methods, "tail risks" are more significant under periods of market stress than under normal market conditions (*Yamai/Yoshiba* 2002b). However, *Yamai/Yoshiba* (2002) find that ES, other than VaR, can easily be optimized, but requires a larger sample size. In order to compare the results of the ES with the VaR estimates, three different ES calculations are used. First, the gaussian ES that assumes a normal distribution of returns, but disregards that empirical time series are often skewed and can have fat tails. Second, the historical ES that is based on historical returns with no distributional assumptions, but with larger observations of outliers. Third, the modified ES (mES) which is based on the Cornish-Fisher and Edgeworth approximations to address skewness and kurtosis of the return distribution. Compared to the gaussian method, *Boudt* et al. (2008) state that the modified method seems to be the better estimator for VaR and ES. The mES is consistent with the mVaR. In contrast, *Martin/Arora* (2015) find that mVaR and mES are inefficient risk estimators because the standard errors are larger than for comparable VaR and ES estimations. However, we do not try to compare or model different methods of risk estimators, but use all three calculation methods to test the differences in the riskiness of bank business models for the adjustment of capital requirements.

VII. Statistics and Results

The adjustment of the leverage ratio to consider different bank business models is based on the examination of return distributions using VaR and ES. The focus is on the left-hand, negative net income tail of the distribution because it contains the largest losses (cf. *Hull* 2015). The return distributions for all three bank business models are based on yearly earnings and losses, i. e. negative earnings. More precisely, the positive or negative net return (numerator) relative to total non-risk-weighted assets (denominator). The denominator considers total asset rather than the exposure measure of the leverage ratio formula due to incomplete data of the sample regarding off-balance sheet exposure, derivate exposure, and securities financing transaction exposure. The use of total assets is in line with the BCBS (2010), who focus on-balance sheet assets for the development of the BCBS leverage ratio. Future research could examine the net re-

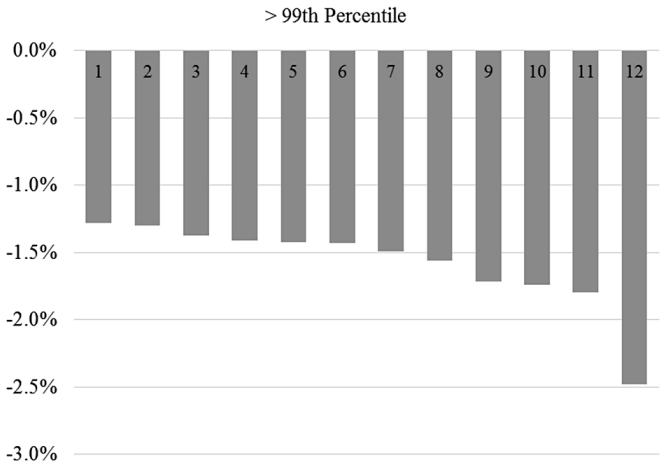


Notes: The figure shows the distribution of the net return on non-risk-weighted assets for all banks. The assets are based on on-balance sheet exposure. The vertical line marks the 99th percentile of the distribution.

Figure 1: Distribution of the Net Return on Non-risk-weighted Assets for All Banks

turn relative to on- and off-balance sheet assets if sufficient data is available. The return distribution for all banks in the sample can be seen in figure 1 with a mark for the 99th percentile.

The descriptive statistics, as presented in Appendix II, show that retail banks (0.472 %) on average have the highest net return on non-risk-weighted assets for the observed timeframe compared to wholesale banks (0.264 %) and trading banks (0.246 %). One reason is that from the ten percent of the highest returns, the majority of observations with approximately 60 % belong to retail banks. Another reason is that retail banks in the sample report the fewest observations with yearly losses. About 97 % of all retail bank observations are positive compared to 83 % of wholesale bank observations and 77 % of positive trading bank returns. At the same time, trading banks (–2.478 %) account for the highest loss compared to retail banks (–1.797 %) and wholesale banks (–1.741 %). For clarification, if a bank generates a loss of –2.478 % of the total assets it nearly breaches the potential leverage ratio requirement of 3 %. As a result, the mentioned trading bank had to be rescued by its liability system. Overall, a total of 118 bank observations generated negative returns between the years 2000 and 2013 with a high share of about 62 % during the financial crisis between the years 2007 and 2011. Figure 2 shows the results for the 99th percentile of the return distribution for all banks in the sample. The 99th percentile results range from –1.28 % to –2.48 % with a mean of –1.58 %.



Notes: The figure shows the results for the 99th percentile of the net return on non-risk-weighted assets distribution for twelve banks.

Figure 2: Net Return on Non-risk-weighted Assets – 99th Percentile Results

As mentioned above, three different VaR and ES methods, as well as two subsamples, are considered. The chosen timeframe for the calculations can have an influence on the estimation of VaR and ES. In order to estimate comparable results with the BCBS (2010) and to address the circumstance that only annual data is available for the sample, a timeframe of one year is chosen as well. We choose confidence levels of 99 % for the VaR and 97.5 % for the ES. Both are in line with the BCBS (2016) guidelines for the calculation of market risk. Confidence levels of 99.9 % (i. e. one in a thousand) are not considered because the number of sample observations are too low for each business model sample. The return distributions of the samples are tested for normal distribution to see if the gaussian methods can be used. For this, a Jarque-Bera-test that is based on skewness and kurtosis of the distribution is used. The test shows that all samples are non-normal distributions as the null hypothesis, which indicates a normal distribution, can be rejected (p-value 0.000). As seen in Appendix II, the skewness of retail banks and wholesale banks are right skewed (> 0) and the trading bank sample is left-skewed (< 0). The kurtosis is above 0 for all samples. As a result, the gaussian methods are not used for the remainder of this paper.[4]

The historical VaR and ES methods can be used to address non-normal return distributions. Therefore, a time series of returns is created by using actual historical data of positive and negative earnings (cf. *Damodaran* 2007). Table 2

[4] An overview of the results for the gaussian models is displayed in Appendix III.

Table 2

Value-at-Risk and Expected Shortfall for Non-Normal Distribution

Historical	*Method*	*All Banks*	*Retail*	*Wholesale*	*Trading*	*W+T*
Total	VaR 99 %	–1.152 %	–0.256 %	–1.461 %	–1.056 %	–1.422 %
	ES 97.5 %	–1.085 %	–0.398 %	–1.472 %	–1.247 %	–1.404 %
	Obs.	1265	685	350	230	580
Pre–Crisis < 2007	VaR 99 %	–0.515 %	*n/a*	–1.494 %	–0.180 %	–1.201 %
	ES 97.5 %	–0.623 %	*n/a*	–1.348 %	–0.520 %	–1.093 %
	Obs.	524	292	152	80	232
Post–Crisis ≥ 2007	VaR 99 %	–1.292 %	–0.485 %	–1.422 %	–1.248 %	–1.415 %
	ES 97.5 %	–1.233 %	–0.650 %	–1.468 %	–1.468 %	–1.502 %
	Obs.	741	393	198	150	348

Notes: Historical Value-at-Risk (VaR) and Expected Shortfall (ES) calculations for retail, wholesale, and trading bank business models. A combined subsample of wholesale and trading banks (W+T) is added. The methods are used for the distribution of historical data of the net return on non-risk-weighted assets. The timeframe for the examination of the returns is one year. The confidence levels are based on BCBS guidelines of 99 % for the VaR and 97.5 % for the ES. The subsamples account for different periods of time. The VaR and ES calculations for retail banks for the pre-crisis subsample produce unreliable results because negative returns do not occur between 2000 and 2006.

shows the results of the historical methods for the three bank business models and subsamples. Since retail banks have the highest number of observations, a combined wholesale and trading bank sample (W+T) is added to increase the comparability.

Overall, the calculations with the chosen confidence levels for VaR and ES seem to produce comparable results. The results support the indented shift from VaR to ES of the BCBS (2016). The VaR result of the full sample illustrates that the potential loss of a bank over a period of one year with a given probability of 99 % is not more than –1.152 %. In other words, one out of one hundred banks could lose 1.152 % or more of its total assets within one year. The ES result for all banks shows the average expected loss at a given confidence level of 97.5 %, which is –1.085 %. In other words, the average loss in the worst 2.5 % of returns would be 1.085 % within the predefined timeframe. The combined W+T sample displays the highest VaR and ES results. Retail banks, with the lowest estimates, seem to be less risky. The subsamples before and after 2007 show extensive variations as the results for VaR and ES for the all banks sample double. Obviously, the financial crisis had a huge impact on the return distribution of the investigated banks. As for trading banks, the financial crisis increased the potential

Table 3

Modified Value-at-Risk and Modified Expected Shortfall Calculations

Modified	*Method*	*All Banks*	*Retail*	*Wholesale*	*Trading*	*W+T*
Total	VaR 99 %	–1.297 %	–0.669 %	–1.437 %	–1.686 %	–1.524 %
	ES 97.5 %	–2.059 %	–0.732 %	–1.886 %	–2.516 %	–2.198 %
	Obs.	1265	685	350	230	580
Pre-Crisis < 2007	VaR 99 %	–0.788 %	*n/a*	–1.306 %	–0.092 %	–1.087 %
	ES 97.5 %	–0.883 %	*n/a*	–1.712 %	–1.042 %	–1.274 %
	Obs.	524	292	152	80	232
Post-Crisis ≥ 2007	VaR 99 %	–1.523 %	–1.035 %	–1.537 %	–1.932 %	–1.734 %
	ES 97.5 %	–2.338 %	–1.959 %	–2.067 %	–2.653 %	–2.502 %
	Obs.	741	393	198	150	348

Notes: Modified Value-at-Risk (mVaR) and Expected Shortfall (mES) calculations for retail, wholesale, and trading bank business models as well as a combined wholesale and trading bank sample. The methods are based on Cornish-Fisher expansions to correct the percentiles of the distribution of the net return on non-risk-weighted assets for skewness and kurtosis. The time period for the examination of the returns is one year. The confidence levels are 99 % for the mVaR and 97.5 % for the mES. The subsamples account for different observed timeframes. The mVaR calculation for retail banks for the pre-crisis subsample produces unreliable results due to missing negative returns.

losses up to six times and almost tripled the average expected losses. Though, it should be considered that the trading bank sample has the fewest observations. Surprisingly, wholesale banks produce consistent VaR and ES outcomes throughout the different subsamples. The riskiness does not seem to have changed. A possible explanation could be the business activities and balance sheet structure with less trading exposure e. g. asset-backed securities than comparable trading banks.

The last methods to calculate VaR and ES are the modified methods that consider skewness and kurtosis of the gaussian return distributions. The modified methods correct the gaussian distributions for non-normal returns. The results can be seen in table 3.

Overall, the mVaR and mES results are not as comparable as for the historical VaR and ES. The spreads between the mVaR and mES vary from 0.095 to 0.950. Whereas the spreads for the historical methods vary merely from 0.012 to 0.165. Compared to the historical methods, the mVaR and mES account for higher results for the all banks sample. For the subsample "Post-Crisis", the mES are highest in each bank sample for both methodological approaches. The differ-

ences in the ES calculations between the historical and modified approach vary from 0.181 to 1.309, which means that the average expected loss at a given confidence level of 97.5 % can exceed the historical results up to 1.309 % of the total assets of a bank. Again, retail banks display the lowest estimates of the three business models. Trading banks, with the fewest observations, display the highest results for the total timeframe and for the years after the crisis. Both, the results of the historical and modified methods, provide estimates that display the differences in the riskiness of bank business models for the underlying sample.

The underlying banking sample is dominated by German banks. Therefore, separate results for German banks and for all other European banks in the sample are offered. The results for historical calculations are shown in Appendix IV. The tendencies of the results for the German subsample, due to a large number of observations, are comparable to the whole banking sample. The European subsample shows different results and seems to have been affected differently by the financial crisis. Like the total banking sample, the majority of losses occurred after 2006. However, the overall VaR and ES calculations for the investigated timeframe are lower for the total sample, wholesale bank sample, and the trading banks. In contrast, European retail banks in the sample have significantly higher results due to higher losses during and after the financial crisis. The VaR and ES calculations for European retail banks are almost as high as for comparable European wholesale banks and are even higher than for European trading banks in the sample. However, it should be considered that the European subsample has significantly fewer observations and therefore does not allow a comparison. Nevertheless, the results of the subsamples indicate that separate calculations for large, international banks are necessary in order to account for the different risk characteristics of business models in relation to the size of a bank. A combination of bank business models and the relevance of banks to the financial system as suggested by Grossmann (2016) gives room for future research and might help to increase the financial stability. Overall, the analyses for the German and European bank subsamples show that the findings for the whole banking sample may be limited to medium and small banks, but illustrate the potential to build upon the findings.

VIII. Adjusting the Leverage Ratio

The results of the VaR and ES calculations indicate that the BCBS leverage ratio of 3 % seems to be adequate for a minimal capital level. If a bank's equity at least equals or is greater than the VaR and ES exposure then capital is sufficient and a bank's assets need not be restructured (cf. *Jarrow* 2013). If banks would have had an equity ratio of at least 3 % relative to total assets before the crisis, they might have surpassed financial distress during the crisis with less support from liability systems or governmental assistance. However, the highest losses

would have been covered, but the continuation of the operational business would not have been ensured. Furthermore, a uniform leverage ratio does not account for the riskiness of different bank business models. The results show that the potential losses of wholesale and trading banks for the historical and modified methods at a confidence level of 99 % is twice as high as for retail banks for the examined timeframe from 2000 to 2013.

The absolute differences between retail banks compared to wholesale banks, trading banks, and the combined wholesale and trading bank samples are shown in table 4. For each subsample and method, retail banks have lower values for VaR and ES than comparable wholesale or trading banks.[5] The absolute differences in the VaR for both methods range from –0.502 to –1.205. The range for the historical ES is –0.818 to –1.074 and for the modified ES –0.108 to –1.784. Noteworthy, the historical ES of wholesale and trading banks during the crisis is up to five times as high as for retail banks. Retail banks would have needed the smallest amount of capital to withstand financial distress. Consequently, wholesale and trading bank business models need higher equity ratios than retail banks. Following *Grossmann/Scholz* (2017), different leverage ratios can account for the diversification of the banking sector.

Table 4

The Lower Riskiness of Retail Banks

		Δ Value-at-Risk			*Δ Expected Shortfall*		
	Samples	*R vs. W*	*R vs. T*	*R vs. WT*	*R vs. W*	*R vs. T*	*R vs. WT*
Hist.	*Total*	*–1.205*	–0.800	*–1.166*	–1.074	–0.848	–1.006
	Post-Crisis	–0.937	*–0.763*	–0.931	–0.818	–0.818	–0.852
Mod.	*Total*	–0.767	*–1.016*	–0.854	*–1.155*	*–1.784*	*–1.466*
	Post-Crisis	*–0.502*	–0.897	*–0.700*	–0.108	–0.693	–0.543

Notes: The results show the absolute differences of retail banks compared to wholesale banks (R vs. W), retail banks compared to trading banks (R vs. T), and retail banks compared to wholesale and trading banks (R vs. WT) based on Value-at-Risk (VaR) and Expected Shortfall (ES) calculations. The VaR and ES calculations are based on the historical methods (see table 2) and modified methods (see table 3). For example, the differences of the historical VaR for "R vs. W" for the subsample "Total" is calculated by the VaR (–1.461) of wholesale banks minus the VaR (–0.256) of retail banks (see table 2). The subsample "Pre-Crisis" is not shown due to missing results for retail banks.

[5] Retail banks also show the lowest values for VaR and ES, i. e. are less risky, compared to wholesale and trading bank business models if the gaussian calculations from Appendix III are used.

Two approaches to design adjusted leverage ratio are presented. One, if the current BCBS leverage ratio of 3 % is used as a minimum basis, in our case for lower-risk retail banks, the absolute differences between retail vs. wholesale banks and retail vs. trading banks are added. Thereby, sufficient capital will remain available if the potential loss of a bank exceeds existing leverage ratio requirements. Both, the historical and modified VaR calculations produce sound estimates. To avoid a decision for one over the other method, for which no theoretical consensus prevails, the lowest and the highest absolute differences are chosen. Based on the VaR calculations, the adjusted leverage ratio for wholesale banks should be between 3.50 % (+0.502) and 4.21 % (+1.205). For trading banks, the leverage ratios should be between 3.76 % (+0.763) and 4.02 % (+1.016). A combined wholesale and trading bank ratio should account for 3.70 % (+0.700) to 4.17 % (+1.166). For additional leverage ratio buffers for periods of significant financial stress, the highest negative values of the ES calculations are chosen to ensure that the likelihood of extreme values and "tail risks" are captured. Therefore, the leverage ratios including the additional buffers should be 4.16 % (+1.155) for wholesale banks, 4.78 % (+1.784) for trading banks, and 4.47 % (+1.466) for a combined wholesale and trading bank ratio. For wholesale banks, the upper range of the adjusted leverage ratio is 5 basis points over the current leverage ratio plus the additional buffer. For trading banks, the additional buffer would increase the adjusted leverage ratio by 76 basis points (4.78 – 4.02).

Two, as an alternative approach, the highest negative return for each bank business model for the examined timeframe is used as a starting point. On this basis, the highest VaR and ES calculations (historical or modified method of table 2 or 3) of the individual business model are added. Thereby, the highest historical losses are covered and a security buffer based on VaR or ES ensures that in the event of financial distress a bank can continue to operate without government support. In this case, the adjusted leverage ratio, based on VaR, for retail banks would account for 2.83 % (1.797 % + 1.035 %), for wholesale banks 3.28 % (1.741 % + 1.537 %), for trading banks 4.41 % (2.478 % + 1.932 %), or for the combined W+T sample 4.21 % (2.478 % + 1.734 %). The additional leverage buffer, based on ES, for retail banks would account for 3.76 % (1.797 % + 1.959 %), for wholesale banks 3.81 % (1.741 % + 2.067 %), for trading banks 5.13 % (2.478 % + 2.653 %), or for the combined W+T sample 4.98 % (2.478 % + 2.502 %). In both approaches, sufficient levels of capital will be based on the risk-profile of the individual bank business model. The adjusted leverage ratios may be limited to medium and small banks due to the number of underlying observations, but consider the highest losses of all German and other European banks in the sample. Therefore, the adjusted leverage ratios seem to offer an appropriate starting point to account for the different risk characteristics of bank business models.

An increase of the leverage ratio requirement means that riskier bank business models either have to raise their levels of Tier 1 capital or reduce their on- and off-balance sheet exposure. For wholesale and trading banks in the sample, an increase of the leverage ratio by 50 basis points would mean additional levels of Tier 1 capital of approximately 860 million euro.[6] To reduce the impact on the operational business of the bank and the real economy, a gradual introduction of higher leverage ratios should take several years with sufficient lead time for the retention of earnings. Despite a long implementation period, higher leverage ratios will strengthen the financial system.

IX. Conclusion

The development of the current BCBS leverage ratio focuses mainly on severely stressed banks but sets requirements for all banks no matter of the chosen business model. Regardless of the size, banks with lower business model risks are treated the same way as banks with higher business models risk. Against this backdrop, established risk measurement methods that consider the characteristics of a coherent risk measure are used as estimators for sufficient capital for banks to withstand financial distress. VaR and ES calculations illustrate the differences between business models. The negative tails of a return distribution are smaller for retail banks than for wholesale and trading banks. These differences are used to adjust the leverage ratio requirement and will help cover business model risk. The adjustments tighten the safety net, e. g. the floor to the risk-weighted capital requirements, for riskier bank business models in normal times as well as in periods of financial stress. The adjusted leverage ratios and the additional buffers will most likely have an impact on the balance sheets of riskier business models, but higher capital requirements can strengthen the individual bank and the financial stability at the same time. To reduce the impact on the real economy, a sufficiently long transition period for the implementation is desirable. Future research could concentrate on the impact of different business model requirements on the real economy and could also consider size dependencies for G-SIB to increase the applicability of the analysis. Overall, we conclude that the focus on bank business models allows differentiating capital requirements for an internationally harmonized Pillar 1 capital framework.

[6] The calculation is based on 385 wholesale and trading banks that disclose data for Tier 1 capital. Based on data for equity (i. e. CET1, AT1 and T2) for all 580 wholesale and trading banks in the sample, an increase of 50 basis points would mean additional levels of equity of approximately 959 million euro.

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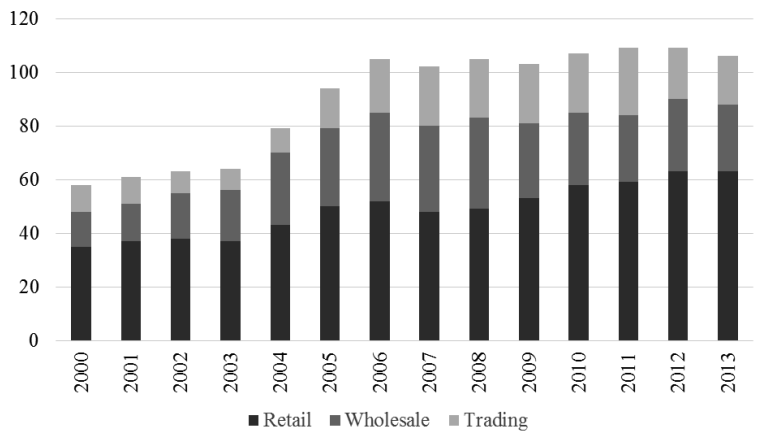
Appendix

Appendix I

Yearly Observations



Appendix II

Descriptive Statistics

Net Return on Non-Risk-Weighted Assets

Sample	*All Banks*	*Retail*	*Wholesale*	*Trading*	*W+T*
No. Observations	1265	685	350	230	580
Mean	0.374 %	0.472 %	0.264 %	0.246 %	0.257 %
Minimum	–2.478 %	–1.797 %	–1.741 %	–2.478 %	–2.478 %
Maximum	2.711 %	2.504 %	2.711 %	2.119 %	2.711 %
Median	0.352 %	0.423 %	0.212 %	0.248 %	0.226 %
Std. Deviation	0.462 %	0.374 %	0.554 %	0.481 %	0.526 %
Skewness	–0.055	0.749	0.074	–0.417	–0.067
Kurtosis	8.348	9.381	6.456	9.225	7.348

Appendix III

Value-at-Risk and Expected Shortfall for Normal Distribution

Gaussian	*Method*	*All Banks*	*Retail*	*Wholesale*	*Trading*	*W+T*
Total	VaR 99 %	–0.702 %	–0.397 %	–1.023 %	–0.870 %	–0.966 %
	ES 97.5 %	–0.707 %	–0.401 %	–1.030 %	–0.875 %	–0.972 %
	Obs.	1265	685	350	230	580
Pre-Crisis < 2007	VaR 99 %	–0.557 %	–0.295 %	–0.920 %	–0.592 %	–0.816 %
	ES 97.5 %	–0.562 %	–0.299 %	–0.927 %	–0.597 %	–0.822 %
	Obs.	524	292	152	80	232
Post-Crisis ≥ 2007	VaR 99 %	–0.780 %	–0.460 %	–1.073 %	–0.961 %	–1.028 %
	ES 97.5 %	–0.785 %	–0.464 %	–1.080 %	–0.967 %	–1.033 %
	Obs.	741	393	198	150	348

Notes: Value-at-Risk (VaR) and Expected Shortfall (ES) calculations for retail, wholesale, and trading bank business models. The methods are based on normal distributions of the net return on non-risk-weighted assets. The timeframe for the examination of the returns is one year. The confidence levels are based on current BCBS guidelines of 99 % for the VaR and 97.5 % for the ES. The subsamples account for different periods of time.

Appendix IV

Value-at-Risk and Expected Shortfall for GER and EU Banks

German Banks

Historical	*Method*	*All Banks*	*Retail*	*Wholesale*	*Trading*	*W+T*
Total	VaR 99 %	–1.214 %	–0.087 %	–1.460 %	–1.315 %	–1.430 %
	ES 97.5 %	–1.113 %	–0.236 %	–1.507 %	–1.468 %	–1.521 %
	Obs.	995	594	278	123	401
Pre–Crisis < 2007	VaR 99 %	–0.588 %	*n/a*	–1.525 %	–0.301 %	–1.457 %
	ES 97.5 %	–0.712 %	*n/a*	–1.348 %	–0.520 %	–1.208 %
	Obs.	449	269	128	52	180
Post–Crisis ≥ 2007	VaR 99 %	–1.291 %	–0.316 %	–1.415 %	–1.703 %	–1.418 %
	ES 97.5 %	–1.276 %	–0.439 %	–1.463 %	–1.925 %	–1.617 %
	Obs.	546	325	150	71	221

Other European Banks

Historical	*Method*	*All Banks*	*Retail*	*Wholesale*	*Trading*	*W+T*
Total	VaR 99 %	–0.770 %	–0.873 %	–0.979 %	–0.659 %	–0.739 %
	ES 97.5 %	–0.981 %	–0.983 %	–1.130 %	–0.680 %	–0.860 %
	Obs.	270	91	72	107	179
Pre–Crisis < 2007	VaR 99 %	–0.063 %	*n/a*	*n/a*	–0.067 %	–0.065 %
	ES 97.5 %	–0.065 %	*n/a*	*n/a*	–0.070 %	–0.065 %
	Obs.	75	23	24	28	52
Post–Crisis ≥ 2007	VaR 99 %	–0.813 %	–1.110 %	–1.152 %	–0.675 %	–0.760 %
	ES 97.5 %	–1.112 %	–1.285 %	–1.130 %	–0.695 %	–0.913 %
	Obs.	195	68	48	79	127

Notes: Value–at–Risk (VaR) and Expected Shortfall (ES) calculations for retail, wholesale, and trading bank business models for German banks and all other European banks in the sample. The methods are based on the distribution of historical data of the net return on non–risk–weighted assets. The timeframe for the examination of the returns is one year. The confidence levels are based on current BCBS guidelines of 99 % for the VaR and 97.5 % for the ES. The subsamples account for different periods of time.

Appendix V

List of Banks

Bank	*Location*	*Years of Observation*
HSBC Holdings Plc	GB	2004–2013
BNP Paribas SA	FR	2005–2013
Crédit Agricole	FR	2004–2013
Deutsche Bank AG	GER	2006–2013
Barclays Bank Plc	GB	2004–2013
Société Générale SA	FR	2005–2013
The Royal Bank of Scotland	GB	2004–2013
BPCE Group	FR	2008–2013
Banco Santander SA	ES	2004–2013
ING Groep NV	NL	2005–2013
Lloyds Banking Group Plc	GB	2005–2013
UniCredit SpA	IT	2005–2013
Rabobank	NL	2004–2013
Credit Mutuel	FR	2005–2013
Groupe Caisse d'Epargne	FR	2005–2008
Nordea Bank AB	SE	2005–2013
Intesa Sanpaolo	IT	2006–2013
Goldman Sachs International	GB	2000–2013
Banco Bilbao Vizcaya Argentaria SA	ES	2004–2013
Commerzbank AG	GER	2000–2013
Natixis SA	FR	2005–2013
Standard Chartered Plc	GB	2005–2013
HypoVereinsbank	GER	2000–2004
KfW Bankengruppe	GER	2007–2013
Danske Bank A/S	DK	2004–2013
Dresdner Bank AG	GER	2000–2008
Groupe Banques Populaires SAS	FR	2005–2008
DZ Bank AG	GER	2006–2013
ABN AMRO	NL	2009–2013
Credit Suisse International	GB	2005–2013
CaixaBank	ES	2004–2013
Nomura International Plc	GB	2009–2013
Merrill Lynch International Bank Limited	IE	2005–2013
SANPAOLO IMI	IT	2005–2006

Bank	*Location*	*Years of Observation*
SEB AB	SE	2005–2013
Svenska Handelsbanken	SE	2005–2013
Landesbank Baden-Wuerttemberg	GER	2006–2013
JP Morgan Securities Plc	GB	2000–2013
Bayerische Landesbank	GER	2006–2013
Hypothekenbank Frankfurt AG	GER	2003–2004
Deutsche Postbank AG	GER	2000–2009
Norddeutsche Landesbank	GER	2006–2013
Landesbank Hessen-Thueringen	GER	2006–2013
NRW.BANK	GER	2002–2013
Hypo Real Estate Holding AG	GER	2003–2013
DekaBank Deutsche Girozentrale AG	GER	2004–2013
HSH Nordbank AG	GER	2006–2013
Landesbank Berlin Holding AG	GER	2004–2013
Portigon AG	GER	2005–2013
Volkswagen Financial Services AG	GER	2001–2013
WGZ-Bank AG	GER	2006–2013
Landwirtschaftliche Rentenbank	GER	2006–2013
Landeskreditbank BW	GER	2000–2013
Sachsen Bank	GER	2000–2006
Aareal Bank AG	GER	2001–2013
HASPA Finanzholding	GER	2001–2012
Dexia Kommunalbank Deutschland AG	GER	2000–2013
Münchener Hypothekenbank eG	GER	2000–2013
Deutsche Apotheker- und Aerztebank eG	GER	2000–2013
Sparkasse KölnBonn	GER	2005–2013
IKB Deutsche Industriebank AG	GER	2000–2013
Kreissparkasse Köln	GER	2010–2013
LFA Förderbank Bayern	GER	2006–2013
BMW Bank GmbH	GER	2000–2013
Investitionsbank Berlin	GER	2008–2013
Sal. Oppenheim Jr. & Cie. AG & Co. KGAA	GER	2004–2008
Mercedes-Benz Bank AG	GER	2000–2013
Landesbank Saar-SaarLB	GER	2006–2013
Stadtsparkasse München	GER	2000–2013

(Continue next page)

(Appendix V: Continued)

Bank	*Location*	*Years of Observation*
State Street Bank GmbH	GER	2000–2013
Oldenburgische Landesbank – OLB	GER	2004–2013
Frankfurter Sparkasse	GER	2000–2004
Citigroup Global Markets Deutschland AG	GER	2000–2013
Mittelbrandenburgische Sparkasse in Potsdam	GER	2010–2013
Duesseldorfer Hypothekenbank AG	GER	2000–2013
Stadtsparkasse Düsseldorf	GER	2004–2013
HSBC Trinkaus & Burkhardt AG	GER	2000–2003
Die Sparkasse Bremen	GER	2000–2013
Nassauische Sparkasse	GER	2000–2013
Berliner Volksbank eG	GER	2010–2013
Sparkasse Nürnberg	GER	2000–2013
Kreissparkasse Muenchen Starnberg Ebersberg	GER	2000–2013
Santander Consumer Bank AG	GER	2000–2003
Sparkasse Aachen	GER	2000–2013
Kreissparkasse Ludwigsburg	GER	2000–2013
Investitions- und Strukturbank Rheinland-Pfalz	GER	2004–2012
Sparkasse Münsterland Ost	GER	2000–2013
Bank für Sozialwirtschaft Aktiengesellschaft	GER	2000–2013
Landessparkasse zu Oldenburg	GER	2000–2013
Kreissparkasse Esslingen Nuertingen	GER	2000–2013
Sparkasse Krefeld	GER	2000–2013
Saechsische AufbauBank Forderbank	GER	2000–2013
Sparkasse Dortmund	GER	2000–2013
Stadtsparkasse Essen	GER	2000–2013
BBBank eG	GER	2000–2013
Kreissparkasse Boeblingen	GER	2000–2013
Kreissparkasse Waiblingen	GER	2000–2013
Sparkasse Mainfranken Würzburg	GER	2000–2013
M.M. Warburg & CO Gruppe KGaA	GER	2002–2013
Stadtsparkasse Wuppertal	GER	2000–2013
Sparkasse Heidelberg	GER	2000–2013
Volksbank Mittelhessen eG	GER	2000–2013
Sparkasse Paderborn-Detmold	GER	2000–2013
Sparkasse Saarbrücken	GER	2000–2013

Bank	*Location*	*Years of Observation*
Sparkasse Westmünsterland	GER	2002–2013
Foerde Sparkasse	GER	2000–2013
Sparkasse Neuss	GER	2000–2013
Kreissparkasse Biberach	GER	2000–2013
Nord-Ostsee Sparkasse	GER	2000–2013
Sparkasse Vorderpfalz	GER	2000–2013
COREALCREDIT BANK AG	GER	2000–2013
ProCredit Holding AG & Co. KGaA	GER	2004–2013
Dortmunder Volksbank eG	GER	2000–2013
Sparkasse Osnabrück	GER	2000–2013
Sparkasse Bochum	GER	2000–2013
Sparkasse Vest Recklinghausen	GER	2000–2013
Degussa Bank Ag	GER	2010–2012
Sparkasse Bielefeld	GER	2000–2013
Siemens Bank GmbH	GER	2011–2013
Sparkasse Freiburg-Nordlicher Breisgau	GER	2000–2013
Sparkasse Duisburg	GER	2000–2013

Notes: The sample selection is based on the bankscope-database. The listing is based on the balance sheet volume at the end of 2013 or the last known. The last given name of the bank is considered.