TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Diplomarbeit

Segment Risk – based Capital Allocation Systems in Financial Institutions: Conceptualization & Empirical Investigations

ausgeführt zum Zwecke der Erlangung des akademischen Grades eines

Diplom-Ingenieurs

unter der Leitung von

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eingereicht an der Technischen Universität Wien

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Wien, im November 2013

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Acknowledgements

This master's thesis would not have been possible without the provision of many persons who contributed in various manner.

Most of all, I want to reveal my cordially thanks to my supervisor Professor Walter Schwaiger for his academic guidance and his unweary patience with me. Only his support and supervision throughout the entire research process made this master's thesis happen. Furthermore, I want to express my appreciativeness to Professor Aussenegg for being my academic co-advisor as well as Bernhard Kronfellner for being the reference person of my supporting company, The Boston Consulting Group. I would have never been able to get all data needed for my research without the broadminded support of BCG and the courageous dedication of Bernhard.

What would life be without a supporting family and trustworthy friends. I could describe myself as one of few consecrated people who always get support from them. Nonetheless, nobody has been more important to me than my parents. Since the year one they gave me the termless support in my life and made my progress and success possible.

To all of you, I owe you a lot and I ween to get prospect to accomplish.

Christian Zaussinger

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Overview

Years after the start of the financial crisis in 2007, the banking industry is still in a very fragile condition.
The importance of the banking sector and the impact on the whole economy have been leading to new regulations and to a new market environment.

On the one hand side latest regulations such as the

(i) Third Basel Accord (Basel III), focus on common equity and require new levels of liquidity as well as new monitoring.

(ii) MaRisk, the fourth novel concerning the basic requirements for the Risk Management issued by the "Bundesanstalt für Finanzdienstleistungsaufsicht" (BaFin) in Germany, has commencing date of January 1st, 2013 and near-future impact on other countries, such as Austria.

(iii) Furthermore, new regulations concerning financial stability (Liikanen Report in the EU, Vickers Report in the U.K., Volcker Rule in the U.S.), consumer protection (Credit CARD Act in the U.S.) and counterparty risks (Central Counterparty Clearing CCC) have been set up.

On the other side a new market environment, including

(i) shrinking earnings and slow growth rates in Europe, an inconsistent global economy

(ii) enhanced risks for states and banks as well as new market dynamics (volatile exchange rates, high credit spreads, low interest rate levels, policies of central banks, illiquid markets)

(iii) changing customer and investor behavior (low interest rates and high volatility, loss in trust) and

(iv) new competitors (internet and other IT corporations enter the classical banking business, insurance companies penetrate the market)

forces financial institutions to react.

As a result the creation of sustainable value needs new ways of thinking. Therefore structural changes and challenges are inevitably for the management in this transition phase. Banks have to focus on yield protection as well as on bank's profitability. Consequently, the accurate management of the major resource capital represents a strategic chance.

Abstract

Problem: The strained situation after the financial crisis 2007-2011 leads to falling levels of net income in banks' business segments. This is because new regulations and the new market environment leave its marks in their balance sheets. Consequently, the accurate management of tightening resources such as capital states a main pillar to remain competitive in the post-crisis environment. Because capital is essential to cover the risks being faced by a bank an accurate capital management is mandatory. In more detail, a sophisticated capital steering system leads to amended decision making and to an enhanced overall performance. *Objective:* This master's thesis is dedicated to improve performance of financial institutions in times after the crisis by (i) setting up a bank segment study concerning the cost of equity capital as well as the economic return, (ii) by conceptualizing a new method to distribute capital within banks and (iii) by illustrating the optimization of the Bank-RORAC via risk capital allocation. *Method:* (i) Based on a set of investigated banks I estimate the cost of equity capital as well as the economic return. By defining and analyzing major market segments concerning the universal bank market I can calculate the cost of equity capital by setting up index models. In more detail, through the generation of market segment indices based on historical stock market data as well as the direct mapping of the individual bank business segments to a certain market segment, the systemic risk coefficient relative to a certain market segment index can be found via regression analysis. Consequently, the cost of equity capital can be estimated. These activities result in a *bank study on market segment level.* (ii) Based on these calculations I set up a *new method for risk-based capital steering* and (iii) I illustrate the *optimization of the Bank-RORAC via risk capital allocation* founded on latest quantitative finance research perception. Additionally, extensions due to economic reasons, the incorporation of multiple business segments as well as implementation requirements in practice are set up. *Results and Application:* These considerations state an integral part of success in a very volatile environment. Subsequently, the new concept of considering business segment risks even more precisely within the internal funding can help financial institutions to sustainably improve their performance and the accuracy of risk-based capital management. Thus, the additional risk-based capital allocation approach (ii) is meant to be included in a new capital allocation system in practice. The illustration of (iii) the RORAC-optimization for banks by appropriate segment capital allocation demonstrates an even more advanced step in sustainable and performance-oriented capital management, but may require more pervasive adaptations in the organization.

Kurzfassung

Problem: Die angespannte Situation nach der Finanzkrise von 2007-2011 führt zu Ergebniseinbrüchen in den Geschäftssegmenten der Banken. Das ist einerseits durch neue Regularien als auch durch die neue Marktumgebung begründet und widerspiegelt sich in den Bilanzen der Finanzinstitute. Das akkurate Management der knappen Ressourcen, wie etwa Kapital, stellt folglich einen Eckpfeiler dar, um in Zeiten nach der Krise konkurrenzfähig zu bleiben. Da Kapital essentiell für die Deckung der Risiken ist, denen die Banken ausgesetzt sind, ist ein akkurates Kapitalmanagement unabdingbar. Ein fortschrittliches Kapitalsteuerungssystem führt dabei zu besseren Entscheidungen und zu einer verbesserten Performance. *Ziel:* Diese Diplomarbeit ist der Steigerung der Performance von Finanzinstituten in der Zeit nach der letzten Finanzkrise gewidmet. Dazu wird (i) eine Banksegmentstudie bezüglich der Eigenkapitalkosten und der Geschäftswertbeitragsrenditen aufgesetzt, (ii) eine neue Methode zur Kapitalallokation entwickelt und (iii) die Bank-RORAC-Optimierung mittels Risikokapitalallokation illustriert. *Methode:* (i) Basierend auf einem Satz an Banken berechne ich die Eigenkapitalkosten als auch die Geschäftswertbeitragsrenditen auf Segmentebene. Durch die Definition und Analyse von Marktsegmenten bezüglich des Universalbankmarktes werden die Eigenkapitalkosten durch die Modellierung von Indexmodellen ermittelt. Das heißt, durch die Generierung von Marktsegmentindizes, basierend auf historischen Aktienmarktdaten, sowie das direkte Mapping der individuellen Geschäftssegmente der Banken auf ein bestimmtes Marktsegment, können die systemischen Risikokoeffizienten relativ zu einem bestimmten Marktsegmentindex mittels Regressionsanalyse gefunden werden. Damit werden die Eigenkapitalkosten je Geschäftssegment abgeschätzt. Diese Aktivitäten resultieren in einer *Marktsegmentstudie*. (ii) Basierend auf diesen Berechnungen wird eine neue Methode zur risikobasierten Kapitalallokation entwickelt und (iii) die *Optimierung des Gesamtbank-RORAC mittels Risikokapitalallokation* illustriert, welche auf neuesten quantitativen Forschungsergebnissen basiert. Darüber hinaus werden Erweiterungen bezüglich ökonomischer Gesichtspunkte vorgenommen, die Einbindung von mehreren Geschäftssegmenten illustriert sowie die Voraussetzungen für eine Umsetzung in der Praxis beleuchtet. *Ergebnisse und Anwendung:* Dieser Ansatz ist ein integraler Bestandteil für Erfolg in einer hochvolatilen Marktumgebung. Das neue Konzept zur Berücksichtigung der aggregierten Geschäftssegmentrisiken im internen Allokationssystem hilft Finanzinstituten, ihre Performance und ihre Sorgfalt beim Kapitalmanagement zu verbessern. Der additionale, risikobasierte Kapitalallokations-Ansatz (ii) ist ausgelegt, um in einem neuen Kapitalallokationssystem in einer Universalbank implementiert zu werden. Die Illustration der (iii) Optimierung des Gesamtbank-RORAC mittels quantitativer Kapitalallokation stellt einen noch fortschrittlicheren Ansatz im nachhaltigen und Performance-orientierten Kapitalmanagement dar, benötigt jedoch umfangreichere Adaptierungen in der Organisation.

Content

1 Introduction

1.1 The Financial Industry

OECD defines the financial sector as follows:

Definition:

"The financial sector is the set of institutions, instruments, and the regulatory framework that permit transactions to be made by incurring and settling debts; that is, by extending credit."[1]

Context:

"The financial system makes possible the separation of the ownership of wealth from the control of physical capital. As an economy develops, the financial sector deepens, strengthens and widens: terms that refer to the increase in the nature and number of financial instruments, the interrelationship and sophistication of financial institutions, and the geographical penetration and extent of financial markets (for short, financial sector development)."[2]

European Financial Industry over time:

Before subprime-crisis 2007:

Until the financial crisis, the banking industry represented 20% (2007) of the market capitalization of the Stoxx Europe 600[3]:

The time after crisis:

After the crisis the banking sector stated a market cap of approximately 11.5 percent (2012 ongoing), 4.6 percent below the long term average (2001-2013) and illustrates the effects of the US mortgage market collapse in 2007 imposingly.

[1] Alexander, P., Baden, S. (2000), p. 13, Glossary on macroeconomics from a gender perspective, Institute of Development Studies, University of Sussex (found at http://www.bridge.ids.ac.uk/reports/re48c.pdf (03-24-2013))
[2] Alexander, P., Baden, S. (2000), p. 13
[3] Stoxx Europe 600 covers following countries of the European region: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom

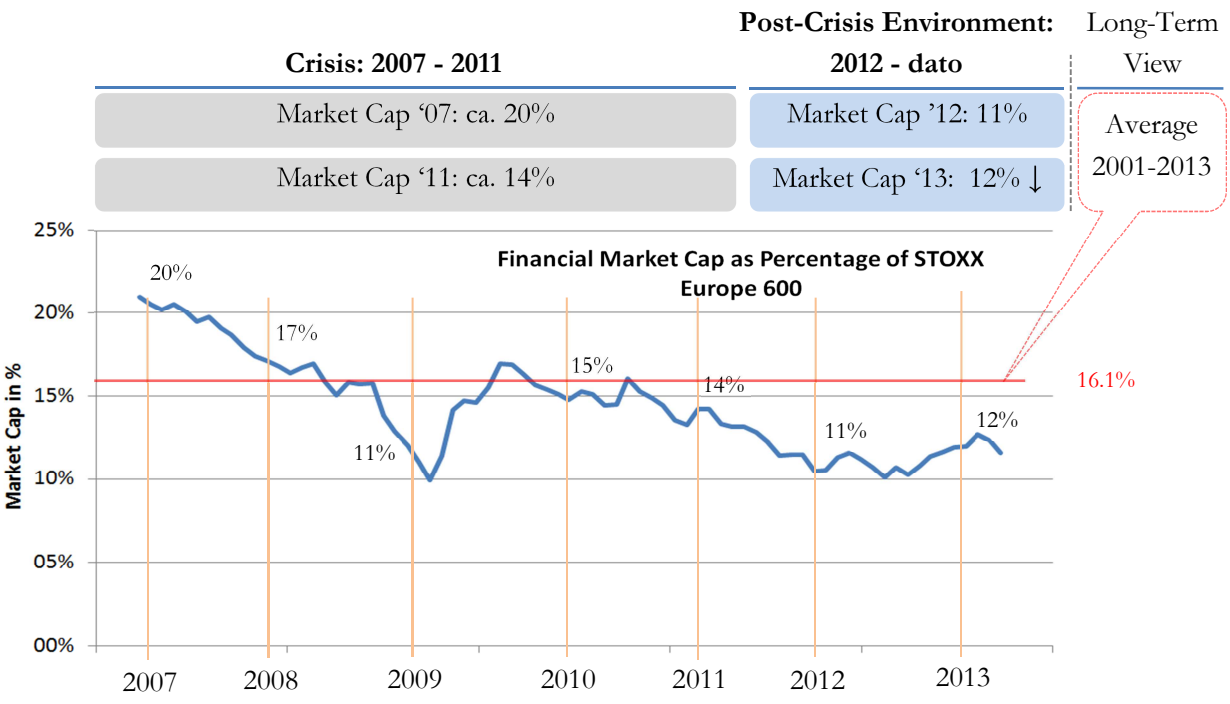


Figure 1: European Financial Market Cap as Percentage of Stoxx Europe 600[4]

1.1.1 Important Economic Functions of Banks

Lot size transformation:

Aligning capital demand of debtors to saving interests of depositors by bundling small amounts of savings to big ones and vice versa.

Term transformation:

"Maturity transformation, also called maturity mismatching or gapping, describes how a bank receives a deposit for one maturity period and lends the same amount for a different maturity period."[5]

Risk transformation:

Aligning different risk appetites of debtors to depositors via risk diversification, credit management, equity capital accountability, etc..

[4] Stoxx 600 Banks (SX7P Index) over Stoxx Europe 600 (SXXP Index), data by Bloomberg: www.bloomberg.com
[5] ct. http://morganstanleycontent.intuition.com/lms/glossary/a_to_z_definition.asp?187338 (03-24-2013)

1.2 Capital versus Liquidity

1.2.1 Capital

There can be found many definitions of capital differing from the point of view:

- Snapshot from various angles (RC, BVC, FVC, MC) versus capital needed to cover current risks (EC) -

Regulatory capital (RC): the set of capital instruments that can be computed for regulatory purpose. It is composed primarily of two categories, *core capital* and *supplementary capital* (according to Basel II and Basel III).
For further reading please refer to chapter 2.2.3.1.1.

Book-value capital (BVC): BVC is based on the accounting standards used for financial reporting purposes and is equivalent to the *difference between the bank's assets and liabilities* as they appear on the balance sheet. To some extent, this is *similar to Tier 1 capital* for regulatory purposes. Indeed, it does not include items such as subordinated debt, which are a part of Tier 2 and Tier 3 capital (Basel II) as they imply fixed interest payments and/or redemption upon maturity.

Fair-value capital (FVC): represents the *fair value of the bank's assets minus the fair value of its liabilities.* This *differs from book-value capital* in that the assets and liabilities are taken at a *value in line with current market conditions* (and not at the value at which they were entered into the bank's books - may be the historic cost).
The fair value of assets and liabilities is equal to the present value of the cash flows that they will generate in the future. It includes intangible assets, such as trademarks, patents, and goodwill, which, despite being intangible, have the capacity for generating greater future revenues. This, then, represents a further difference from book-value capital, which normally only includes goodwill if it has been recognized on the balance sheet as a result of extraordinary transactions (typically acquisitions).

Market capitalization (MC): also called *market value of an individual stock* multiplied by the *number of shares outstanding* (including any preference shares, etc.). It can only be calculated for banks that are publicly listed.
It corresponds to the present value of the cash flows that shareholders will receive in the future (dividends and any value received upon divestment), discounted at an appropriate risk-adjusted rate.
If the
- market is efficient,
- the information available is complete

- investors are rational, this value will coincide with fair-market capital.
However, it is not uncommon for the market not to have all information needed in order to value a bank's assets, liabilities and net worth.
Furthermore, investors' valuations are often affected by overall upward and downward trends in the market as a whole (e.g. buying at a high price on the belief that the stock will rise even further). For this reason, market capitalization does not normally coincide with fair-value capital, but rather with the perceived fair value as seen by equity investors in a given market context.

Economic capital (EC): the *amount of capital needed to* "reasonably" *cover the risks being faced by a bank*. This is also known as capital at risk (CaR), and can be measured using the concept of value at risk (VaR), i.e. as the maximum loss to be expected, within a sufficiently wide confidence interval, over a given period of time. In other words, EC represents the best estimation of mandatory capital that financial institutions use internally to manage their own risk.

In order to differentiate EC from previous capital definitions, *economic capital measures the capital needed* or desirable *given the current risks* while the other definitions of capital above provide a *snapshot*, from various angles, of the amount of capital actually available to a bank (i.e. available capital, or AC).[6]

1.2.2 Liquidity

Liquidity states the *amount of capital accessible for spending/investment*. Because big banks and other financial institutions use far more credit instead of cash for investment, credit dominates the total amount of capital.

Corporate point of view:
Assets and liabilities can be classified according to decreasing liquidity. Therefore, liquidity indicates the *speed with which an item can be converted to cash*:

> Assets – top line: cash, accounts receivable, marketable securities, etc.
> Assets – bottom line: land, plant, equipment, etc.
>
> Liabilities – top line: short-term loans, accounts receivable, etc.
> Liabilities – bottom line: shareholder's equity

Bank/Insurance point of view:
There is an interlink between capital and liquidity, even though they fulfill different functions.

> *Banks* have a much more unstable liquidity position compared to insurance companies: This is because banks have *very liquid liabilities* that can easily be withdrawn. On the other side they have *very illiquid assets*, which means that a bank is *prone to liquidity shocks*.

[6] ct. Resti et al. (2007), p.658ff.

Hence, the risk of a fragile capital position for banks is not so much the capital position itself, but the fact that it can trigger a liquidity shock (e.g. large customer withdrawals). Therefore, for banks, a good capital position is mainly in support of a stable liquidity position.

Insurance companies have a *favorable liquidity position,* the exact opposite situation to banks. This is inherent to the business that insurance companies conduct. Hence, *insurance companies can use their favorable liquidity position to take more risks with respect to their capital position*. In other words, the liquidity position can actually support the capital position.[7]

1.3 Estimating the Cost of Capital in the Banking Industry

In academic literature one can find three main methods to estimate the cost of capital in the banking sector:

- The *Dividend Discount Model*

This method is based on the Dividend Valuation Model (DVM) by Gordon et al. (1959)[8].
If the market is efficient, the market value (market capitalization) of a stock is equal to the current share price. Assuming a constant dividends growth rate g one can rearrange the DVM what leads to

$$COC_{Bank}(\%) = g + \frac{dividend_0 * (1+g)}{share\ price_0} \tag{1.1}$$

COC_{Bank} … cost of capital
$dividend_0$ … current dividend level
g … dividends growth rate g
$share\ price_0$ … share price at time 0

The major downside of the Dividend Discount Model is that it requires forecasted dividend values or even an assumed constant growth rate.

[7] ct. Frans de Weert (2011), p.39
[8] Gordon et al. (1959) assume that the future dividends as well as the cost of capital are known and calculate the equilibrium value of the enterprise (share value) as $Value_{Bank} = \sum_{t=1}^{\infty} \frac{dividend_t}{(1+COC(\%))^t}$. Consequently they describe the value of an enterprise as the present value (PV) of its future dividends, discounted by the cost of capital in percent (includes risk). If one assumes a constant dividends growth rate g forever the previous equation becomes $Value_{Bank} = \frac{dividend_0 * (1+g)}{(COC(\%) - g)}$ with the current dividend value $dividend_0$.

- The *Earnings/Price Ratio*
This principle is given by the ratio between the earnings per share and bank's net income [9].

$$COC_{Bank} = \frac{net\ income\ per\ share_{Bank}}{share\ price_{Bank}} \quad (1.2)$$

It estimates bank's fair cost of capital because in case of stable earnings per share it signifies the fraction of net income that is gained by a share and the price to be paid in order to own one. In other words it represents the fair return for investing in the bank and therefore the COC[10].
The main drawback of this measure is that it assumes fixed net income per share, more precisely while the recent share price (denominator) is used the consolidated net income (nominator) refers to the "average" data for the last financial year. To overcome this problem one can use analyst's expected earnings for the current financial year or compute a long-term Earnings/Price ratio.[11]

- *Capital Asset Pricing Model (CAPM)*

Please refer to chapter 1.3.1.

[9] net income divided by the number of shares outstanding (issued shares minus treasury stock)
[10] return investors expect to earn from investing into the business
[11] ct. Resti et al. (2007), p. 739f

1.3.1 CAPM

The Capital Asset Pricing Model (CAPM) determines the expected return $E(r_i)$ (equilibrium return) of an individual security. In other words, it calculates the equilibrium price of a risky asset based on an appropriately *diversified* portfolio (elimination of *unsystematic risk* related to the individual asset-specific factors – *first risk component*) and proceeds from the *Modern Portfolio Theory (MPT)*[12].
In order to incorporate the *second risk component*, the non-diversifiable *systemic (market) risk*, the CAPM comprises the *beta coefficient* β_i, originally developed by Sharpe (1963). The factor-specific betas are found via a linear regression of historical security returns and a market index. The benchmark/market index is represented by the market portfolio, measured by a market index. Consequently, the Capital Asset Pricing Model incorporates a riskless asset, represented by the risk-free rate, and an appropriately diversified portfolio with a market risk premium as the premium for taking the systemic risk in combination with β_i (the systemic risk of security i relative to the market). Under further assumptions, this results in the best expected return compared to the risk taken.
The Capital Asset Pricing Model was developed independently by Sharpe (1964), Lintner (1965) and Moissin (1966) and represents a *single factor (asset) model.*

$$E(r_i) = r_f + \beta_i[E(r_m) - r_f] \tag{1.3}$$

$E(r_i)$ … expected return on security i
$E(r_m)$ … expected market return
r_f … risk-free rate
β_i … beta factor of security i
$[E(r_m) - r_f]$ … market risk premium
$\beta_i[E(r_m) - r_f]$ … risk premium of security i

CAPM-Assumptions:

1) The CAPM adopts the same hypotheses as the portfolio theory by Markowitz:

- rational investors (e.g. investors only invest in the portfolio with the best expected return – risk profile)
- perfect markets (e.g. perfect competition, including:

  - perfect market information,
  - no government intervention,
  - no market power of participants (to set prices without losing customers)
  - profit maximization

[12] see Markowitz (1952)

- no externalities (e.g. no cost or benefit for uninvolved party resulting from an activity or transaction, ct. Buchanan et al. (1962))
- no barriers for market-exit or –entry
- no supply shortfall concerning factors of production

If there exists perfect competition, the market can reach an equilibrium of asset's supply and demand at the current price level.

- normal distribution of securities' returns (law of large numbers)

If all three assumptions are true, every financial asset should offer an expected return which is consistent with its degree of systemic risk.

2) Concluding Assumptions/Restrictions:
For that reason, the CAPM is an equilibrium model, assuming:

- According to MPT:

  - perfect and highly liquid capital market
  - rational and well informed investors (investors are efficient and have same expectations, time horizon)
  - no taxes and transaction costs

- Additional/CAPM-specific:

  - bank's estimated beta is based on historical data and may not fully represent the degree of future systemic risk

  - the market risk premium $E(r_m) - r_f$ also results out of past data

  - CAPM measures via the volatility of returns (vs. VaR in economic capital approach)

  - CAPM does not include unsystematic risk (vs. EC includes the impact of a certain business segment to the bank's overall risk and not the contribution to the market portfolio)

1.3.1.1 Multi-Factor Models - Introduction

Fama and French (1993) overawed the Capital Asset Pricing Model by showing that not only β influences significantly the return of financial time series but also (at least) two other indicators. In the Three-Factor Model of Fama and French for instance the two other indicators are the market capitalization (calculated as small minus big (SMB) market capitalization) and book-to-market-ratio (calculated as high minus low (HML) book-to-market-ratio).
In the bank segment context this means that not only the correlation factor β significantly contributes to the cost of capital but also the difference of market capitalization of the bank segments as well as the fraction of book value/market capitalization of equity capital have major impact on bank's cost of capital (therefore the bank is seen as a portfolio of business segments). More precisely, Fama and French implicitly constitute that small business segments (and therefore small segment market caps) reduce COC. Additionally, big differences of book value relative to its real market value drive the cost of capital.
Thus, many scientists integrated more indicators to describe share returns and other asset classes even more substantial (with the focus on sophisticated stochastics). This field of research is named Arbitrage Pricing Theory (APT).[13]

[13] See Fama and French (1993) and Kronfellner B. (2011), p. 4

2 Literature Study – Introduction into Overall Bank Performance Management

2.1 Operating Segments by IFRS 8 and SFAS 131

Introduction

IFRS 8 supports the identification and reporting of operating segments with internal management reporting. This standard replaced IAS 14 after 1 January 2009. More precise, segment reporting should highlight the information and measures from a management perspective with the focus on key decision making. It should also provide a better link between the financial statements and the information reported in management commentaries such as the Operating and Financial Review or Management Discussion and Analysis. The standard converges IFRS with US Accounting Standard SFAS 131 'Disclosure about Segments of an Enterprise and Related Information'.[14]

IFRS 8 introduces Management Approach

IFRS 8 introduced a '*management approach*' to identifying and measuring the financial performance of an entity's operating segments.
Reported *segment information is based on the information used internally by management*. This means:
- the way entities identify segments and measure and present segment information could change;
- there is more diversity in reported segment information;
- if segment information is not measured in accordance with IFRS – entities are required to reconcile segment financial information to the consolidated financial statements; and
- entities no longer need to prepare two sets of information for internal and external reporting.[15]

"Operating Segments"

IFRS 8.5 defines „operating segment" as a sub-part of an entity:

Business activities that may earn revenues or incur expenses, whose operating results are regularly reviewed by the chief operating decision maker and for which discrete financial information is available.[16]

[14] ct. http://www.pwc.com/en_GX/gx/ifrs-reporting/pdf/segment-reporting.pdf, p.5 and http://www.journalofaccountancy.com/Issues/2009/Apr/20081008.htm (10-16-2013)
[15] ct. http://www.pwc.com/en_GX/gx/ifrs-reporting/pdf/segment-reporting.pdf, p.5 (10-14-2013)
[16] ct. http://www.pwc.com/en_GX/gx/ifrs-reporting/pdf/segment-reporting.pdf, p.6 (10-16-2013)

2.2 Overall Bank Management from a Regulatory Perspective (Basel III)

In this section the focus lies on bank's capital.

2.2.1 Basel I - Overview

In 1988, the Basel Committee on Banking Supervision[17] (BCBS), a committee established by central banks of the "Group of Ten" countries in 1974 issued a set of minimum capital requirements for the banking system, the Basel Accord (focus on credit risk).

2.2.2 Basel II - Overview

The framework of capital requirements Basel II, since 2007 in force in EU, introduced new regulatory standards to ensure the solvency of banks and the stability of the banking system.

Its key objectives were:

- Enhance the international banking supervision
- Increase the sensitivity of institutions concerning risk
- Stabilize the financial system

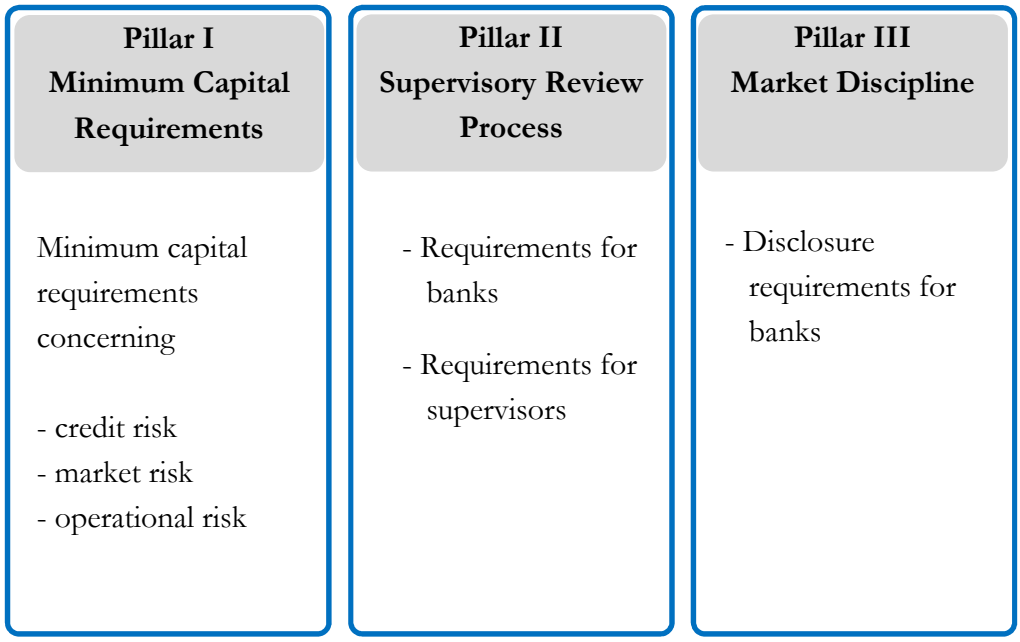


Figure 2: Basel II Accord[18]

[17] The committee includes experts from several countries and its secretariat is settled at the Bank for International Settlements (BIS) in Basel (CH).
[18] ct. BCBS (2006), p. 6f.

2.2.3 Basel III

The new Basel III regulation affects requirements regarding *capital*, *liquidity* and *leverage*. These reforms deliver on the core of the global financial reform agenda and had to be translated into national laws before 1 January 2013 in order to become legally binding.
The new regulations of the Basel III-Accord are intended to raise the *quality*, *consistency* and *transparency* of the capital base and enhance the risk coverage of the capital framework.[19]

[19] ct. BCBS (2011-capital), p.2, section 7

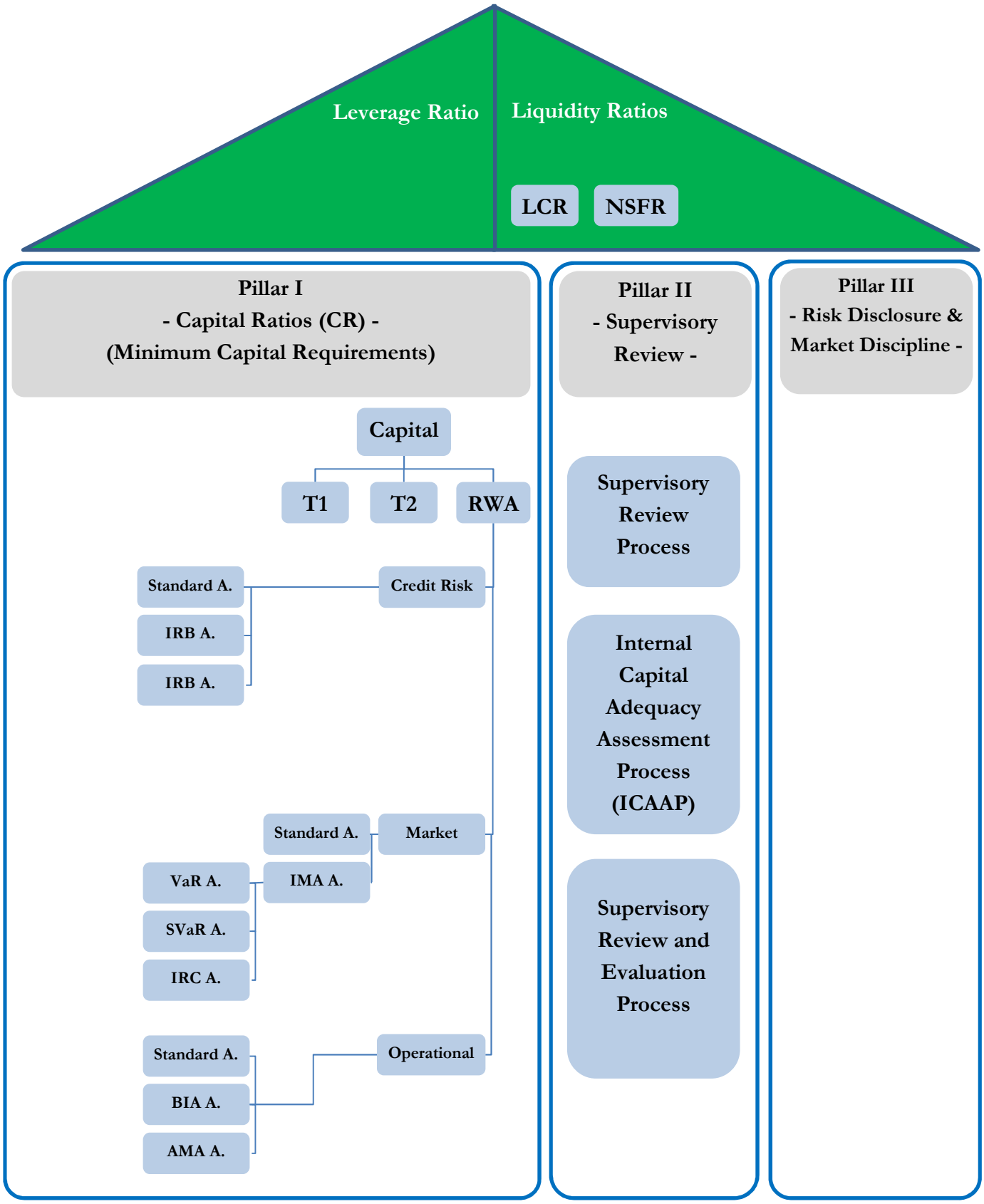


Figure 3: Basel III - Big Picture[20]

[20] ct. BCBS (2006), p. 6ff. as well as BCBS (2011-capital), p. 1ff. and BCBS (2013-liquidity), p. 1ff.

2.2.3.1 Pillar I – Capital and Liquidity Requirements

2.2.3.1.1 Capital (Tier I and Tier II)

Tier 1 Capital (T1, going concern capital[21], core capital):

Tier 1 Capital (T1) - ensuring capital adequacy

a) Common/Core Equity Tier 1(CT1)[22]: predominantly includes

- *Common shares* issued by the bank[23]
- *Stock surplus* (share premium) resulting from the issue of instruments included Common Equity Tier 1
- *Retained earnings*
- *Accumulated other comprehensive income* and *other disclosed reserves*
- etc.

Borderline to Basel II:

- Basel III drops innovative *hybrid capital*[24]

b) Additional Tier 1 (AT1)[25]:

- *Instruments issued by the bank* that are not included in Common Equity Tier 1.[26]
- *Stock surplus* (share premium) resulting from the issue of instruments included in Additional Tier 1 capital.
- etc.

[21] Assuming ongoing business in the future
[22] ct. BCBS (2011-capital), p. 13f., for further information see section 53.
[23] Criteria for classification as common shares for regulatory capital purposes can be found in BCBS (2011-capital), p. 14
[24] Hybrid capital includes *capital instruments which can neither clearly be defined as equity capital nor as debt capital* (can for instance sustain losses but on the other side can be resigned). Consequently they combine several types of securities, such as bonds in combination with an insurance contract. Hybrid capital represents a relatively young invention (innovative instrument) in the financial industry. In Basel II it was accepted as Tier 1 capital with a limit of 15%. See BCBS (2006), Annex 1, p. 243
[25] ct. BCBS (2011-capital), p. 15f.
[26] Criteria to fulfill can be found in ct. BCBS (2011-capital), section 55, p. 15f.

Tier 2 Capital (T2, gone-concern capital[27], supplementary capital):

Tier 2 Capital - loss absorption on a gone-concern basis

Tier 2 capital predominantly includes
- Instruments issued by the bank not covered by T1[28]
- *Stock surplus* (share premium) resulting from the issue of instruments included in Additional Tier 2 capital.
- etc.

Borderline to Basel II:

- International Standards (Basel III-launch phase) replace national regulations (Basel II initiation phase)
- Tier 3 Capital, as part of the *supplementary capital is abolished completely*. Tier 3 capital composed of short-term subordinated debt was considered exclusively for the purposes of market risk capital requirements.[29]

Total (regulatory) Capital (TC):

$$Total\ (regulatory)\ Capital = \ Tier\ 1\ Capital\ (T1) + Tier\ 2\ Capital\ (T2)$$

2.2.3.1.2 Risk Weighted Assets (RWA)

Risk weighted assets (RWA) as regulatory representation of asset's risks
- the sum of all assets (and off-balance sheet items) multiplied with its risk weights

The Basel I Accord from 1988 requires banks to have regulatory capital amounting to at least 8% (consolidated level) of total risk-weighted assets:

$$CR = \frac{RC}{\sum_i A_i * w_i} \geq 8\% \qquad (2.1)$$

with

$$RWA = \sum_i A_i * w_i$$

Where:

[27] Assuming stopped business in the future
[28] Criteria to fulfill can be found in BCBS (2011-capital), section 58, p. 18f.
[29] ct. BCBS (2006), section 49(xiii), p. 16f.

CR = capital ratio
RC = regulatory capital
A_i = i-th asset
w_i = risk weight of the i-th asset

Risk weighted assets (RWA) represent the sum of all assets (and off-balance sheet items) multiplied with its risk weights. The risk weights depend on the probability of default and the loss given default, consequently different asset classes characterize different risk classes.
Cash and cash equivalents, for instance, have zero risk weight.[30]

Main driver of RWA:

- *Economic downturn* leads to an increase of RWA (higher credit costs lead to decreased net earnings and effect ratings, changing ratings result in higher risk weights for unchanged assets) – and promotes the procyclical impact of Basel's capital requirements.

There exist different **approaches for risk weighting**[31]:
Standardized Approach (for credit risk):
This approach introduced by Basel II is based on ratings from external credit rating agencies (in order to compute required capital for credit risk) as well as predefined risk weights per asset class and rating.
e.g. w_i=0% for claims on sovereigns and their central banks with credit assessment of AAA, 20% for A+rating and 100% for unrated sovereigns; Standardized Approach)[32]
The rules consider credit risk, operational risk and market risk of the assets (e.g. loans to consumers, governments and other banks).

Internal Ratings-Based Approach (IRB) (for credit risk):
If banks meet certain minimum conditions, disclosure requirements and approval from their national supervisor they are permitted to estimate the risk parameters to calculate regulatory capital (RWA). In this case the IRB Approach allows banks to set up their own assessment of their counterparties and exposures to compute capital requirements concerning credit risk.
Therefore banks have to
- *categorize* bank's exposures *into asset classes*, which are predefined by the Basel Accord
- risk parameter estimation – PD (probability of default), LGD (loss given default), EAD (exposure at default), M (maturity) as contributions to risk-weight functions; designed for each asset class to arrive at the total risk weighted assets(RWA).[33]

[30] Resti et al. (2007), p.549ff.
[31] For graphically overview ct. BCBS (2006), p.6
[32] ct. BCBS (2006), p.19, section 53
[33] ct. http://www.bis.org/publ/bcbsca05.pdf, 06-28-2013

Why to set up the IRB Approach:

- *Minimization of regulatory capital*, but accompanied by advanced risk management to control credit risk
- IRB estimates are *more risk sensitive* concerning credit risk

Market Risk: please refer to BCBS (2006), p. 157ff., section 638(i)ff.

Operational Risk: please refer to BCBS (2006), p. 144ff., section 644ff.

2.2.3.1.3 Capital Ratios

Key Capital Ratios reflect new regulatory requirements

Principle of Capital Ratios:

According to the Basel III Accord **the minimum capital requirements** have been **increasing** gradually and considerably since 2011 and burden economic profit.

This is characterized by
- higher minimum contingent/*increasing capital ratios* (Core Tier 1 Ratio, Tier 1 Ratio, introduction of Conservation and Countercyclical Buffer)
- stricter rules concerning qualified capital (*thightened capital definitions*)
- enhanced capital requirements (some asset classes require *increased levels of RWA*)

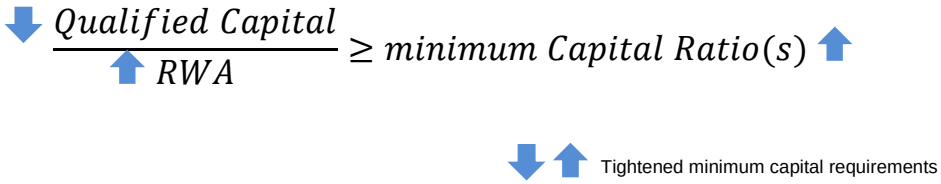


Figure 4: Tightened Minimum Capital Requirements in Basel III[34]

[34] ct. BCBS (2011-capital), Annex 1 and p.67

Core Tier-1 Ratio (Common Capital Ratio):

CT1 as prevailing measure of capital adequacy

$$\frac{CT1}{RWA} \geq 3.5\%_{2013}$$

$CT1$ … Core/Common Tier 1 Capital
RWA … Risk Weighted Assets

The Core Tier-1 Capital ratio represents the prevailing measure of capital adequacy (e.g. hybrids and silent participations excluded, see chapter 2.3.1.2.). Common Tier 1 (Equity) Capital increases from 2% in 2011 to 4.5% in 2015.[35]

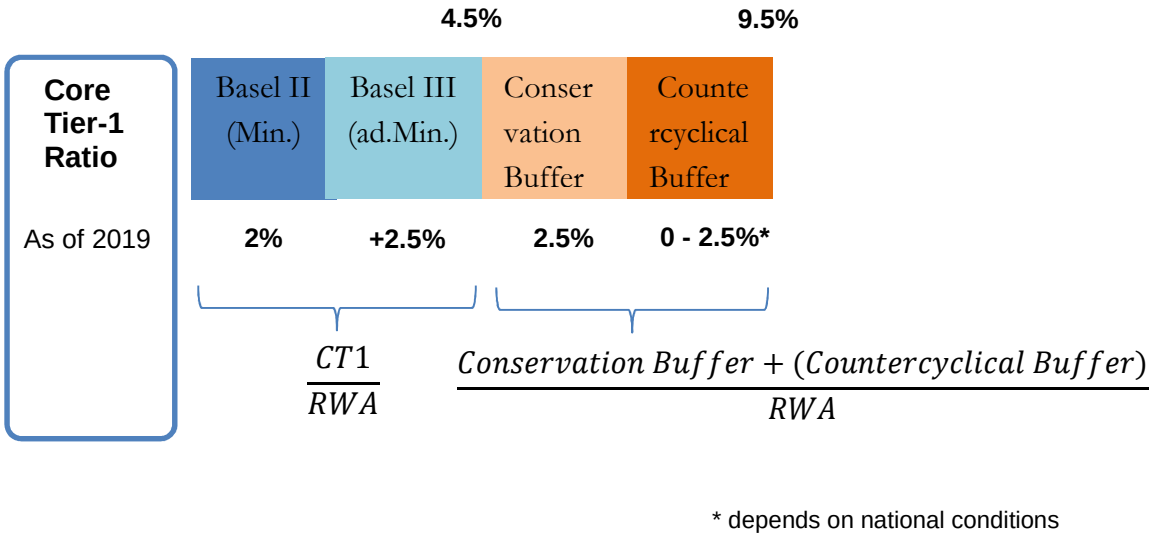


Figure 5: Core/Common Tier 1 Capital[36]

[35] ct. BCBS (2011-capital), Annex 1
[36] ct. http://www.bis.org/bcbs/basel3/basel3_phase_in_arrangements.pdf (06-04-2013)

Tier 1-Ratio

$$\frac{T1}{RWA} \geq 4.5\%_{2013}$$

$T1$ … Tier 1 Capital
RWA … Risk Weighted Assets

Basel III increases CT1 from 4% to 6% between 2011 and 2015. The 4.5% requirement is effective since January 1st, 2013 ongoing, 5.5% from January 2014 and 6% from January 2015.[37]
Common Equity Capital will now reach 82.3% of T1, including the capital conservation buffer.[38]

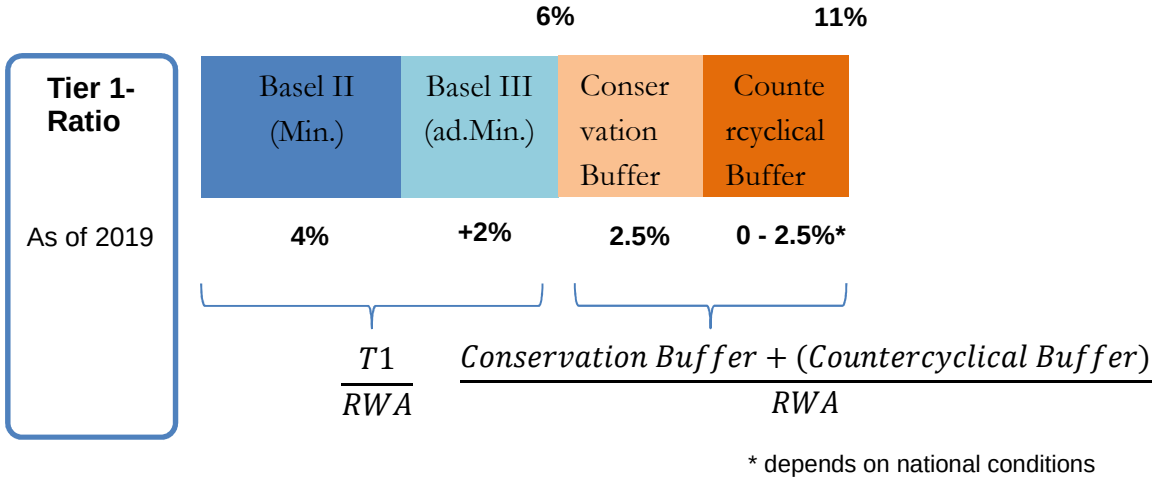


Figure 6: Tier 1-Ratio[39]

[37] ct. BCBS (2011-capital), section 123ff., p. 55ff.
[38] ct. BCBS (2011-capital), Annex 4
[39] ct. http://www.bis.org/bcbs/basel3/basel3_phase_in_arrangements.pdf (06-04-2013)

Total Capital Ratio (Capital Adequacy Ratio CAR[40]):

Total Capital Ratio to ensure reasonable loss absorption by equity capital

$$\frac{T1 + T2}{RWA} \geq 8.0\%$$

$T1$ … Tier 1 Capital
$T2$ … Tier 2 Capital
RWA … Risk Weighted Assets

The Total Capital Ratio represents the ratio of a bank's capital related to its risk. It *confirms that banks do not over expand their commercial activity without adequate capitalization.* In other words it determines reasonable loss absorption by equity capital and goes in hand with latest regulatory capital requests.

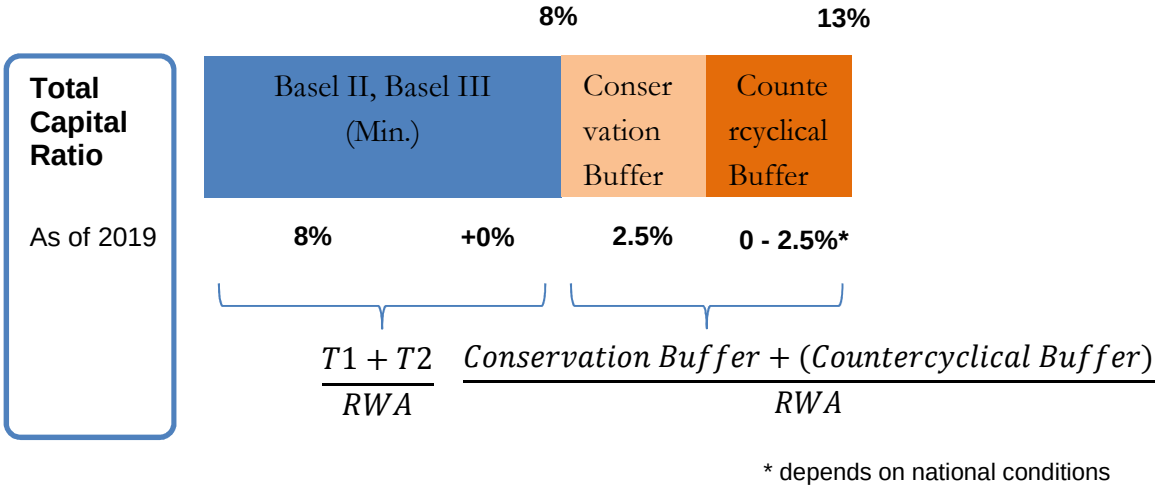


Figure 7: Total Capital Ratio[41]

[40] Sometimes the synonym CRAR (Capital to Risk Assets Ratio) is used for CAR. See BCBS (1988-Basel I)
[41] ct. http://www.bis.org/bcbs/basel3/basel3_phase_in_arrangements.pdf (06-04-2013)

2.2.3.1.4 Capital Conservation Buffer[42] and Countercyclical Capital Buffer:

Capital Conservation Buffer introduced to absorb losses during periods of financial and economic distress - Countercyclical Capital Buffer extends it for times of excessive credit growth

$$\frac{Conservation\ Buffer + (Countercyclical\ Buffer)}{RWA} \geq 2.5\% - 5.0\% \qquad (2.2)$$

Conservation buffer … in upswing of 2.5% (0.625% at start in 2016, 2.5% as of 1 January 2019)
Countercyclical Buffer … in times of excessive credit growth of up to 2.5% (0-2.5%)[43]
Fully Effective: January 2019

The Capital Conservation Buffer has been introduced with Basel III and will be gradually effective with starting point in 2016, starting at a level of 0.625% and will reach 2.50% as of 2019.[44]
It is used to absorb losses throughout periods of financial and economic distress and *must be met entirely with Common/Core Equity Tier 1 (CT1).* As of 2019 banks will be required to hold a capital conservation buffer of 2.5% to withstand future periods of stress. Together with the common equity requirement of 4.5% it will reach a total common equity requirement of 7%[45].

The Countercyclical Capital Buffer is installed for times of excessive credit growth. When in effect, this buffer represents an extension to the conservation buffer.
It will be implemented depending on national conditions (counterparty countries) and its range lies between 0% - 2.5% of common equity or other entirely loss absorbing capital.[46]

[42] ct. BCBS (2011-capital), p. 54ff.
[43] For detailed Countercyclical Buffer requirements ct. BCBS (2011-capital), pp.59, 60, especially footnote 53
[44] ct. BCBS (2011-capital), Annex 4 and p. 57, section 133
[45] ct. BCBS (2011-capital), p. 57, section 134
[46] ct. BCBS (2011-capital), p. 59ff., section 146ff.

2.2.3.2 Pillar II – Supervisory Review Process for Overall Risk Management and Capital Planning

2.2.3.2.1 Overview (ICAAP)

ICAAP as the major topic of Pillar II

Pillar II sets up requirements for banks as well as for supervisors (Supervisory Review Process, ICAAP, Supervisory Review and Evaluation Process).[47]

A major approach based on the ideas of Pillar II in the Basel II Accord is represented by the *Internal Capital Adequacy Assessment Process* (*ICAAP*), an assessment requirement for financial institutions covering the following:
- *adequate risk management* (identifying, measuring, aggregation and monitoring of risk) and *risk understanding by the management board*
- *minimum capital requirements* (ct. Pillar I ratios)
- the *extent of capital coverage required* to meet institutions' strategy and maintain adequate capital requirements *according to* the *risk factors identified*[48]

The ICAAP is established individually for each bank in order to take particular information and risks into consideration:

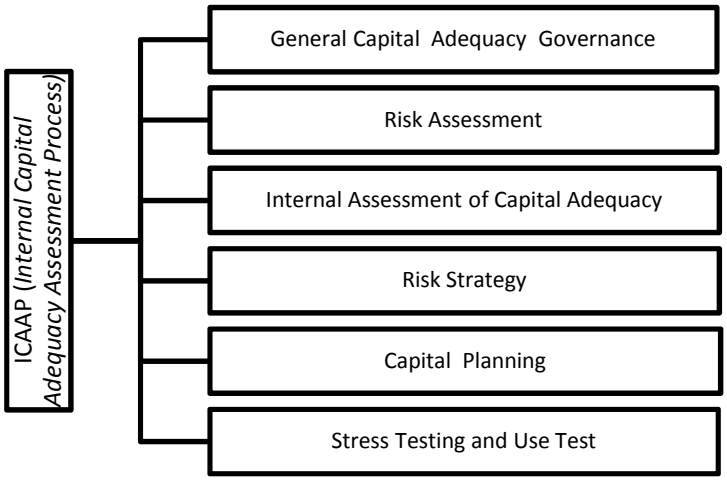


Figure 8: ICAAP – Principle[49]

The Basel III Accord additionally introduces (enhanced) requirements concerning

[47] Pillar II and III were established with Basel II
[48] ct. BCBS (2006), p. 205ff., section 725ff.
[49] ct. BCBS (2006), p.204ff, section 719ff.

- Stress testing
- Governance
- Concentration risk[50]

As well as a

- Leverage Ratio

2.2.3.2.2 Leverage Ratio[51]

Leverage Ratio as "backstop measure" to amplify risk based requirements and forcing the deleveraging process

Basel III also introduces a leverage ratio of 3% in January 2018, taking into account total assets including off-balance sheet items in order to deal with following **objectives**:

- constrain the build-up of leverage in the banking industry / forcing the deleveraging process.
- amplify the (risk based) requirements with a non-risk based measure ("backstop measure")

$$\frac{T1}{Total\ Assets^1 + 10\% * OBS^2} \geq 3.0\%^* \qquad (2.3)$$

$T1$ … Tier 1 Capital

$Total\ Assets^1$ … Total Assets to be reduced by deductions that are applied to Tier 1 capital

OBS^2 … Off-Balance Sheet Items (e.g. undrawn credit, written CDS); Assumption: CCF (Credit Conversion Factor[52]) of 10% referring to all OBS

* … The leverage ratio limit of 3.0% will be adapted after an observation phase in H1/2017 (parallel run between 1 January 2013 – 2017 and fully implemented into Pillar I in 2018

Fully Effective: January 2018

2.2.3.3 Pillar III - Risk Disclosure & Market Discipline

In addition to pillar I (Minimum Capital Requirements) and II (Supervisory Review Process), pillar III sets up a portfolio of risk *disclosure requirements* concerning capital adequacy and market

[50] ct. BCBS (2011-capital), p.43ff,
[51] ct. BCBS (2011-capital), p. 61ff., section 151ff.
[52] ct. BCBS (2011-capital), p. 63, section 163f.; CCF is used to estimate EAD (Exposure at Default) of off-balance sheet exposures (excluding derivatives) which should be treated as on balance sheet in order to have additional capital on the balance sheet to compensate default. For an (statistically analyzed) CCF of 10% for instance, 10% of contingent off-balance sheet exposures are assumed to move to the balance sheet prior to default. Therefore additional capital of CCF*OBS is allocated to the balance sheet. See BCBS (2006), p.326, section 24ff.

discipline (sharing adequate information for coherent assessment of financial institutions by externals: rating agencies, analysts and investors, etc.).[53]

The Basel III Accord implements additional disclosure requirements.

2.2.3.4 Basel III - Summary

Summa summarum Basel III affects / introduces requirements regarding capital, leverage and liquidity

The new Basel III regulation affects three (five) main topics concerning **capital**:

- Concerning **Risk coverage** higher RWAs due to stricter requirements regarding market risk (since January 2012), (re-)securitization (since January 2012), counterparty risk (since January 2013) and financial institutions exposure (since January 2013) are set up.

- **Capital base:** Introduction of higher quality core tier 1 capital consisting of common equity and retained earnings less regulatory deductions and without hybrids. The minimum core tier 1 ratio is at 4.5% of RWAs by January 2013.

- **Procyclicality:** On top of minimum requirements introduction of a *capital conservation buffer* of 2.5% to be met with core tier 1 capital until 2019 and a *countercyclical buffer* of 0% - 2.5% in times of excessive credit growth.

- **Implementation:** Transition agreements allow for a gradual implementation

- **Systemically important banks:** Additional requirements regarding loss absorbing capacity are still under discussion. Global Systemic Important Banks (G-SIBs, annually nominated by the Financial Stability Board FSB, a board of all major G-20 economies, European Commission, central bankers, etc.; settled in Basel, CH) will be recommended to hold higher core tier 1 (CT1) capital. In 2012 there were more than 25 G-SIBs listed, for instance Deutsche Bank, Citigroup, etc..

The Basel III accord introduces new requirements concerning **leverage:**

- Limitation of leverage ratio to 3% in January 2018 (Tier 1 capital versus gross/book balance sheet including consideration of off-balance items with a credit conversion factor of 10%[54])

Concerning **liquidity** Basel III regulation introduces three main topics:

[53] ct. BCBS (2006), p.226ff., section 808ff.
[54] Assumption: CCF of 10% referring to all OBS

- Introduction of **short-term** liquidity coverage ratio **LCR** (<30 days) under stressed market conditions in January 2015
- Introduction of monitoring tools: **new data/reporting requirements** on liquidity
- Introduction of long-term net stable funding ratio (**NSFR**)[55]

For detailed Basel III **phase-in arrangements** of each point please refer to http://www.bis.org/bcbs/basel3/basel3_phase_in_arrangements.pdf (06-04-2013)

[55] ct. http://www.bis.org/bcbs/basel3.htm, 06-19-2013, http://www.bis.org/bcbs/implementation.htm, 06-19-2013 and BCBS (2011-capital) as well as BCBS (2011-liquidity)

2.3 Performance Measures

"*Are things done right*".

Performance Measures in the business context *indicate how efficient goals are being met*, in other words they measure the proportion of the de facto output related to its input. Therefore performance measures answer the question "*Are things done right*".[56]

One can distinguish between

- Performance-Related Yield Ratios/Return on Capital Invested (profitability) such as Return on Equity (ROE, German: "Eigenkapitalrendite"), Return on Assets (ROA, German: "Gesamtkapitalrendite")[57]

  Pros: Easy to use

  Cons: Do not take risk into consideration, e.g. higher return is not compared to the risk undertaken. For example two investments have the same rate of return but have different risk. If one would compare these investments via ROE, they would be regarded as equal. Obviously this is not true because businesses (which are run by human beings) are usually observed being risk-averse. Hence, people would require a higher return, a premium for higher risk exposure.

- Risk Adjusted Performance Measures (RAPM) such as Return on Risk Adjusted Capital (RORAC) and Risk Adjusted Return on Capital (RAROC) state reliable risk-based profitability measures for financial performance analysis across businesses/business segments. They are used for ex ante (prediction) or ex post (historical) performance measurement.[58]

[56] see Pride, et al. (2011), p. 518
[57] see Pride, et al. (2011), p. 518
[58] see Nickel (2006), p. 87 and Steiner and Rathgeber (2006), p. 482

The Effects of Crisis (2001, 2007) have evolved bank measures from a pure performance view to a risk-adjusted view

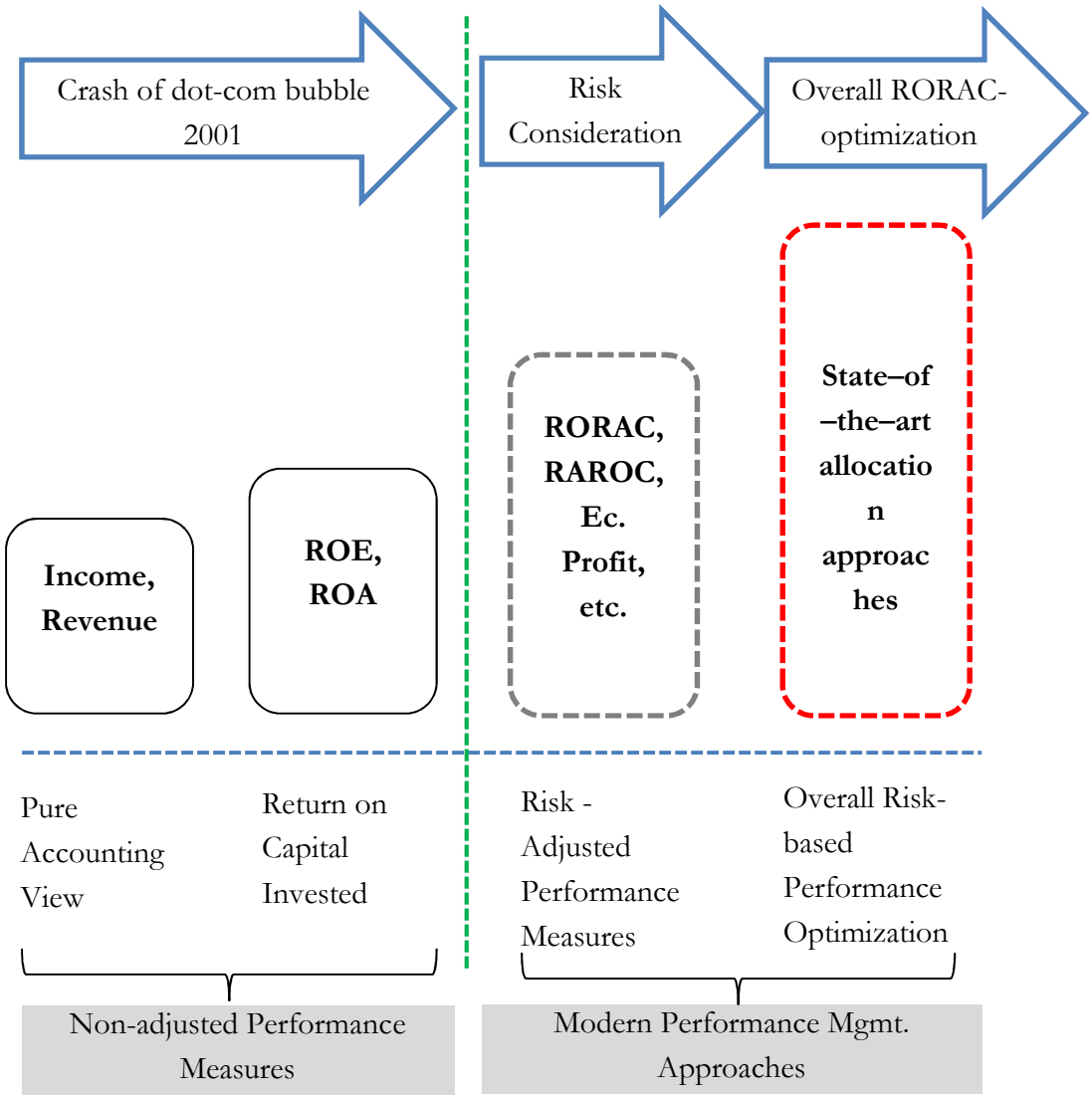


Figure 9: Performance Measures over Time[59]

2.4 Performance Management

"Are the right things done" & "Are things done right"

Performance Management covers all activities *ensuring that objectives are met in an effective and efficient way*. Hence, they cover the questions "Are the right things done" as well as "Are things done right".[60]

[59] see Pride, et al. (2011), p. 518, Nickel, (2006), p. 87 and Buch et al. (2011)
[60] see Pride, et al. (2011), p. 518

2.5 Basic Risk Measures in Overall Bank Management

In Overall Bank Management one can categorize three main "tracks" for risk consideration:

Effective Overall Bank Steering requires the transition from a pure regulatory view towards an evolved economic point of view

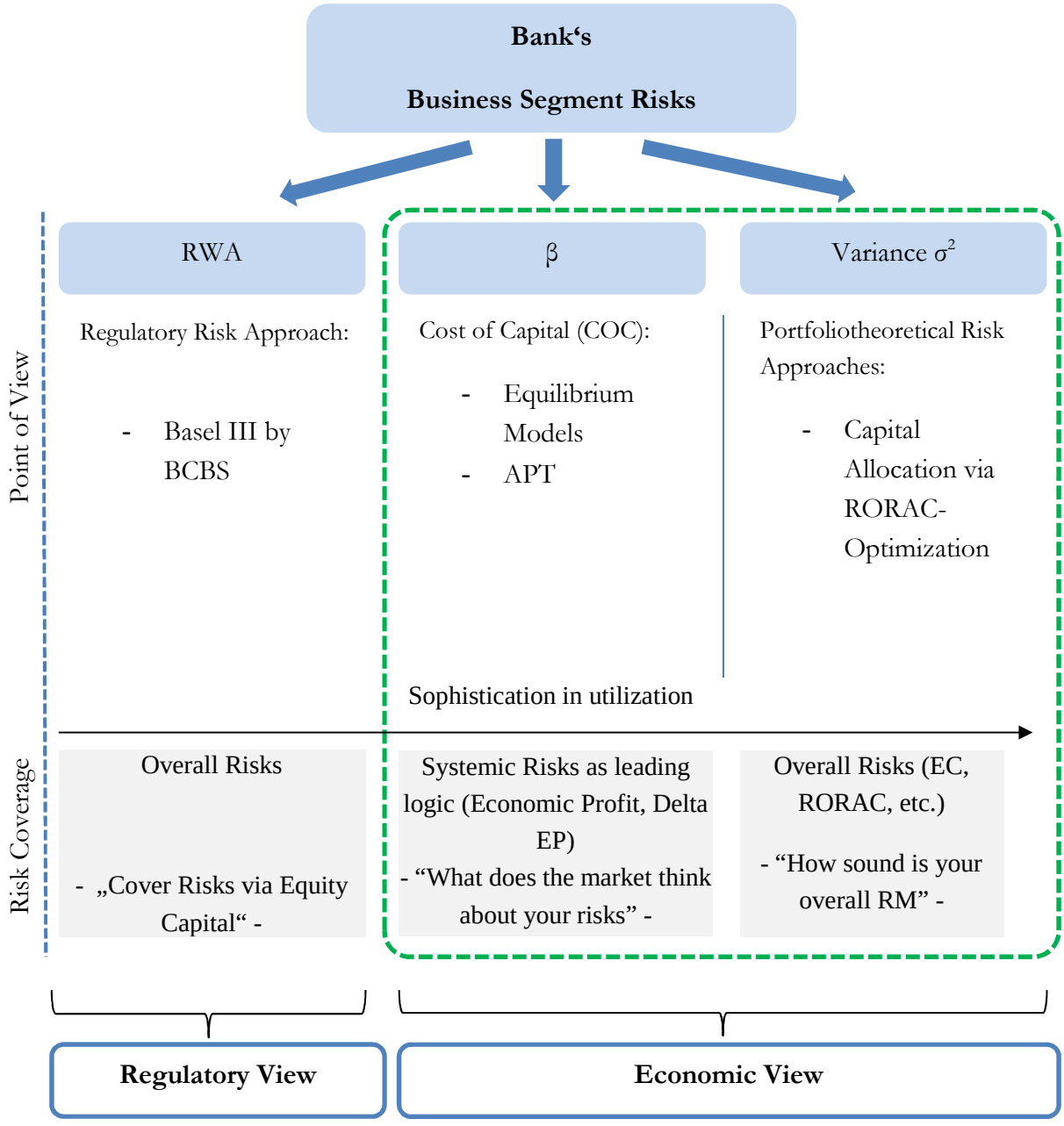


Figure 10: Aggregated Segment-Risk-Approaches[61]

[61] ct. chapter 2.2, 1.3 and Buch et al. (2011)

Attributes:

RWA - track: This track is set up to represent regulatory requirements, but ROE as core profitability measure found in most annual reports is not state-of-the-art.

β - track: The second track denotes the steering possibility via economic profit, a drawback is the difficile COC-estimation on segment level ("What does the market think about your risks" might not properly cover the real bank-internal risk situation; ct. chapter 3.3.1.3)

Variance σ^2 - track: The third track is less restrictve concerning post-crisis inefficient markets, RORAC/RAROC-approaches merge profitability-, overall risks and its interlinkage into one single key performance measure.

2.5.1 Economic Capital

Economic Capital (EC) is the amount of money which is needed to protect the business against shocks, in other words it states a shield against economic distress. It should capture all types of risk and is regularly denoted by Value at Risk

Economic capital (EC): the *amount of capital needed to* "reasonably" *cover the risks being faced by a bank*. This is also known as capital at risk (CaR), and can be measured using the concept of value at risk (VaR), i.e. as the maximum loss to be expected, within a sufficiently wide confidence interval, over a given period of time. Furthermore, EC represents the best estimation of mandatory capital that financial institutions use internally to manage their own risk.[62]

In academic literature the term risk capital is often used synonymously for economic capital as the estimate of the amount of equity capital a company needs to cover potential losses generated by running its business.

Economic Capital versus Regulatory Capital:

In contrast to regulatory capital, whereby the risk adjustment of Equity Capital is based on the capital adequacy guidelines as defined by the Basel Committee, currently Basel III, EC denotes an internal estimate of financial institution's risks.

Since Basel II there is consonance to the greatest possible extend between regulatory and economic equity capital. Nevertheless, because of the required universality of regulations to cover a wide variety of financial institutions they do not have to be too restrictive. In contrast economic equity capital requirements are far more tailored to the individual institutions and business segments.[63]
Moreover, one of the biggest differences states the focus on creditor protection and consequently the reduction of bankruptcy risk as leading logic in the regulatory capital approach. Hence,

[62] See Resti et al. (2007), p. 658ff
[63] See Deutsche Bundesbank (2002), p.48

diversification effects are not considered. Thus, EC-based approaches are recommended for capital allocation purposes dependent on risk.[64]

2.6 Risk Adjusted Performance Measures (RAPM)

2.6.1 RORAC

2.6.1.1 Definition

Practical Approach:

Core Idea: More risky businesses/business segments will gain higher profit on the long term but require more "safety capital"

The Return on Risk Adjusted Capital (RORAC) denotes a modern performance measure for risk-adjusted, value based management (German: "risikoadjustierte, wertorientierte Erfolgssteuerung"), where the net income is related to the risk capital. Consequently, this approach states the risk-adjustment of the net income. In most cases the risk capital required is calculated on basis of Value at Risk (VaR)[65]. The core idea behind it is that more risky businesses/business segments will gain higher profit on the long term but require more "safety capital".

$$RORAC = \frac{Net\ Income}{Risk\ Capital} \tag{2.4}$$

$$RORAC = \frac{Net\ Income}{VaR}$$

Value is created if

$$RORAC > Hurdle\ Rate\ (HR)$$[66]

[64] See Dresel (2003), p. 69
[65] See Steiner and Rathgeber (2006), p. 482
[66] See Steiner and Rathgeber (2006), p. 485f

Scientific Approach:

Tasche (2008) defines RORAC in a portfolio context as follows:
Let $\mu_i = E[X_i]$. Then

- the total *portfolio* Return on Risk Adjusted Capital[67] is defined by

$$RORAC(X) = \frac{E[X]}{\rho(X)} = \frac{\sum_{i=1}^{m} \mu_i}{\rho(X)},$$

$\rho(X)$ … *risk contribution of Xi to* $\rho(X)$ *by* $\rho(Xi \mid X)$
$X_1, \ldots, X_n$ are given that stand for the profits and losses with the assets (or some sub-portfolios) in a portfolio.

The economic capital (EC) required by the portfolio (i.e. capital as a buffer against high losses caused by the portfolio) is determined with a risk measure ϱ, i.e.
$EC = \rho(X)$

- the *portfolio-related* RORAC *of the i-th* asset is defined by

$$RORAC(X_i \mid X) = \frac{E[X_i]}{\rho(X_i \mid X)} = \frac{\mu_i}{\rho(X_i \mid X)}.$$

Based on the notion of RORAC as introduced above (total portfolio RORAC), two properties of risk contributions can be stated that are desirable from an economic point of view.[68]

Pros:

- This ratio permits the incorporation of market, credit, operational risk, etc within a single comprehensive performance measure
- perfect for optimization via risk capital allocation[69]
- quite easy to implement in overall bank management structure because of existing VaR-Model Know-How

Cons:

- no COC included directly

[67] Note that performance measurement by RORAC can be motivated by Markowitz-type risk-return optimization for general risk measures that are homogeneous of any degree τ (see Tasche (1999), Section 6).
[68] ct. Tasche (2008), p.3
[69] Because Euler Contributions satisfy the properties of RORAC compatibility and add up to portfolio-wide risk (ct. chapter 3.4.2.2)

2.6.2 RAROC

2.6.2.1 Definition

Many definitions of Risk-adjusted Return on Capital (RAROC) exist in academic literature. It was originally introduced by Bankers Trust (today: part of Deutsche Bank) in the 1970s as the fraction of risk-adjusted return divided by equity capital.[70]

$$RAROC = \frac{Risk\text{-}adjusted\ income}{Equity\ Capital} = \frac{Net\ Income - Expected\ Loss\ (EL)}{Equity\ Capital} \quad (2.5)$$

Because no economic capital is used the validity of this measure is limited.[71]

2.6.3 RARORAC

2.6.3.1 Definition

RARORAC combines the core ideas of both previous mentioned RAPM. Accordingly, the nominator as well as the denominator is adjusted for risk. More precisely, the nominator is reduced by the expected loss (often called standard risk costs), the denominator covers the unexpected loss. Regularly the term RAROC is used synonymously.[72]

$$RARORAC = \frac{Risk\text{-}adjusted\ income}{Economic\ Capital\ (EC)} \quad (2.6)$$

$$RARORAC = \frac{Net\ Income - Expected\ Loss\ (EL)}{VaR}$$

$Risk - adjusted\ income$ … Net Income – Expected Loss
EC … Economic Capital, Risk Capital
EL … Expected Loss
VaR … Value at Risk

Value is created if

$$RARORAC - \left(Risk\ Capital * Hurdle\ Rate\ (HR)\right) > 0 \quad [73]$$

HR … a certain, demanded "hurdle rate" for risk capital

[70] See Herring, R. et al. (2010), p. 347
[71] Please note that in practice the term RAROC is often used instead of RARORAC (ct. chapter 2.6.3)
[72] See Paul (2005), p. 282ff
[73] See Gehmann and Kaufmann (2006), p. 333ff

Pros:

- This ratio permits the incorporation of market, credit, operational risk, etc within a single comprehensive performance measure
- perfect for optimization via risk capital allocation[74] (see later)
- quite easy to implement in overall bank management structure because of existing VaR-Model Know-How
- nominator as well as denominator are risk-adjusted (expected as well as unexpected loss exposure considered)

Cons:

- no COC included directly

RARORAC calculation via RORAC-measures:

RARORAC can be also calculated as the difference between attained RORAC and target RORAC[75]:

$$RARORAC = RORAC_{actual} - RORAC_{target}$$

With:

$$RORAC = \frac{Net\ Income}{Risk\ Capital}$$

[74] Because Euler Contributions satisfy the properties of RORAC compatibility and add up to portfolio-wide risk (ct. chapter 3.4.2.2)
[75] See Nickel (2006), p. 89

2.6.4 Economic Profit

2.6.4.1 Definition

Main question: "Are the cost of capital exceeded by net income"

The economic profit or EVA (German: „Geschäftswertbeitrag"; EVA trademarked by Stern Stewart & Co) is an estimation of the value-based residual income of a business/business segment. If the economic profit (EP) has a positive value, the business created value. On the other hand, if the EP measurement turns out to be negative, this means the business is destroying value.

Coenenberg and Salfeld (2003) define the residual income as follows:[76]

$$Economic\ Profit\ = Net\ Income - [Cost\ of\ Capital\ * invested\ Capital] \\ = (ROE - WACC) * invested\ Capital \quad (2.7)$$

$Economic\ Profit$ … Economic Profit in €
$Net\ Income$ … Net Income in €
$Cost\ of\ Capital$ … Cost of Capital in %
$invested\ Capital$ … invested Capital in €

In the Economic Profit performance measure the cost of capital should reflect the business risks of the financial institution as well as its leverage. Hence, EP represents the annual contribution to shareholder value. [77]

Pros:

- EP has the advantage that it includes the cost of capital. Different business segments of the bank have different systematic exposures to the market. Hence, they might have different cost of capital. This is the advantage of using EP instead of RAROC
- EP represents economic performance of the business from a shareholder perspective
- First choice from a balance sheet analysis point of view

Cons:

- Not suitable for optimization via risk capital allocation

[76] ct. Coenenberg and Salfeld (2003), p. 264f; COC can be calculated via WACC: WACC stands for "Weighted Average Cost of Capital", which represents the average required rate of return investors expect to earn from investing (debt and equity capital) into the business
[77] See Stoughton et al. (2006), p. 7ff

3 Segment Risk-based Capital Allocation Systems and Improved Overall Performance in the Post-Crisis Environment

3.1 Challenges of Bank Management in the Post-Crisis Environment

During the financial crisis 2007-2011 banks have started to optimize their balance sheets (more core capital, reducing RWA as well as leverage, diminishing short term refinancing, optimizing liquidity, etc.), but still do not earn their costs of capital by far. Therefore financial institutions are advised to focus on three main pillars in order to sustainably strengthen their profitability and their future market position.[78]

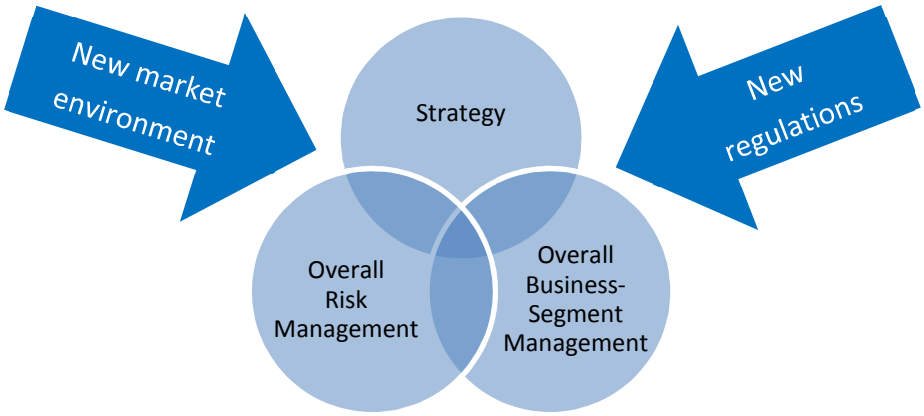


Figure 11: Main topics for Bank Management in the Challenging Post-Crisis Environment[79]

In more detail, these main pillars include the following from a capital allocation point of view:

Strategy: - realignment of business model (equity structure, legal structure, etc.)
- adaptation concerning changing market conditions and regulatory developments
- enhancing overall bank management (capital / earnings, liquidity, risk, infrastructure, human resource, etc.)

Overall Risk Management: - strengthen holistic as well as business segment specific view

Overall Business Segment Management: - sustainable capital allocation, etc.

[78] ct. Annual Reports 2011, set of banks according to chapter 3.3.1.1
[79] ct. "Overview" at the beginning

3.2 Predominant Status Quo in Capital Steering in the Banking Industry

Regulatory capital as leading logic

In universal banks capital states a central control parameter predominantly managed in a functional controlling structure and committees for reviews and decision making (ct. chapter 3.4.1). Therefore regulatory capital on business segment level is used as leading logic, but not the real cost of capital as the "price for capital" or approaches concerning the Bank-RORAC-optimization by adequate capital allocation.
Typically, each segment is allocated an amount of capital the management believes the business would require, incorporating Tier 1 common capital requirements by the Basel III Accord.[80]

3.3 Risk / Prosperity Measurement & Aggregation

3.3.1 Business Segment Performance Analysis – Study concerning Universal Bank Market Situation (On Business Segment Level)

In this chapter I will investigate the current banking industry concerning their cost of capital (ct. chapter 1.3) and their economic return (ct. chapter 2.6.4). The focus thereby lies on the universal bank market in Europe and the US. This study is set up on business segment level and covers 11 investigated financial institutions with 47 business segments as well as 25 reference banks.

For setting up this analysis of the banking industry the case study methodology is used. Therefore I incorporate the interpretive/qualitative method for qualitative annual report analysis and market segment generation. With the quantitative method I will estimate the cost of capital and from a correlational point of view I will compare the different market segments concerning their cost of capital and their economic return.
Interval of investigation: 2008-2012
ROE: annual results 2012
Data: Annual Reports of set of banks established in 3.3.1.1

The results will be used as integral part in chapter 3.4.2, especially in 3.4.2.1.

Remark:
- In this chapter I use the abbreviation CoC for the estimated cost of capital. For further details please refer to 3.3.1.3.1.

[80] ct. Annual Reports 2011, set of banks used in 3.3.1.1; for Basel III capital requirements refer to 2.2.3.1

3.3.1.1 Set of Banks

In order to cover the universal bank market in Europe as well as in the U.S., I select major, active traded financial institutions via annual report analysis. Trading status and ticker are checked via www.bloomberg.com.

Following banks are part of the investigation:

Country	Financial Institution	Bloomberg Ticker	Trading Status
Austria	UniCredit	UCG IM Equity	Active
	Erste Group	EBS AV Equity	Active
	ÖVAG	VBPS AV Equity	Active
Germany	Deutsche Bank	DBK GY Equity	Active
	Commerzbank	CBK GY Equity	Active
Switzerland	UBS	UBSN VX Equity	Active
	Credit Suisse	CSGN VX Equity	Active
Great Britain	HSBC	HSBA LN Equity	Active
US	JP Morgan Chase	JPM US Equity	Active
	Citigroup	C US Equity	Active
	Wells Fargo	WFC US Equity	Active

Figure 12: Investigated Universal Banks[81]

[81] Annual Report 2011 analysis (qualitative), trading status and ticker checked via www.bloomberg.com (04-03-2013)

3.3.1.2 Market Segment Definition and Business Segment Mapping

3.3.1.2.1 Market Segment Definition

The investigated banks have to set up their operating segment identification and reporting according to IFRS 8 (if listed on a stock exchange in the EU) or SFAS 131 (if listed on an U.S. stock exchange). Therefore, reported segment information has to be based on the information used internally by management. [82]
In the following these IFRS/FAS-conform operating segments are called *business segments (BS)*.

In order to define market segments representing major universal bank businesses, a qualitative matrix analysis is set up. Therefore I analyze the Annual Reports 2011 (of the set of banks mentioned in 3.3.1.1) by business and by customers resulting into major *market segments (MS)*.

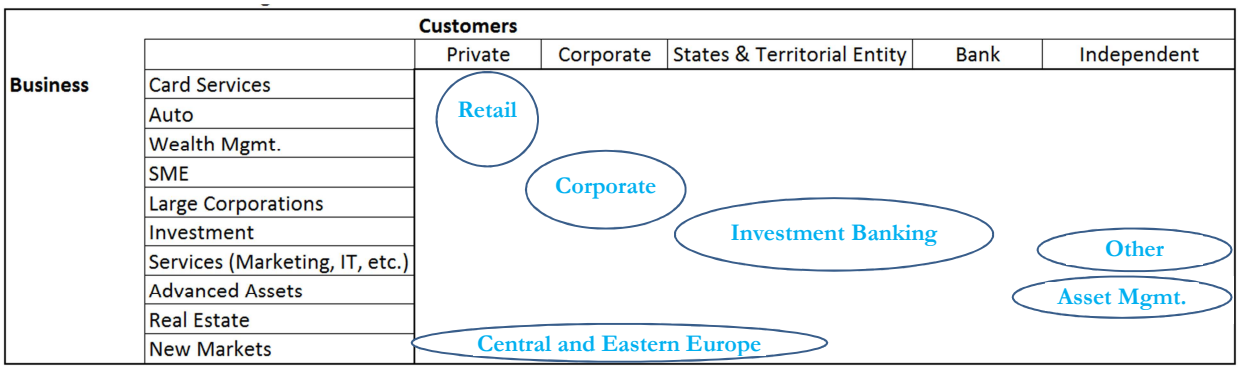


Figure 13: Definition of Market Segments[83]

In more detail, the defined market segments include the following:[84]

	including
Retail	Card Services, Auto, SME (small and medium sized companies), Wealth Management, Commercial Banking, etc.
Investment Banking	Global Transaction Banking, M&A, Brokerage, Credit Investment, etc.
Corporate	Large Corporate Customers, Institutional Clients, etc.
Asset Management	Portfolio mgmt., mutual funds, Real Estate, infrastructure, hedge fund, etc.
Central and Eastern Europe	Sub-part of Retail Segment (especially interesting for Austria/Germany), etc.
Other	Corporate Center, Services in Marketing, Organisation, IT, Strategy, Insurance, Export and Project Finance, etc.

[82] For further reading please refer to 2.1, ct. http://www.pwc.com/en_GX/gx/ifrs-reporting/pdf/segment-reporting.pdf, p.5 (10-14-2013)
[83] Annual Report 2011 analysis, set of banks as defined in 3.3.1.1
[84] Annual Report 2011 analysis, set of banks as defined in 3.3.1.1

3.3.1.2.2 Mapping of Business Segments to Market Segments

To interlink the business segments (BS) of individual banks with the market segments defined in 3.3.1.2.1 with available segment information, the business segments are mapped to the market segments according to their predominant business activity. Therefore, the annual reports of 2011 are analyzed qualitatively on business segment level. (set of banks as defined in 3.3.1.1)

Country	Bank	Business Segment (major)	Retail	Investment Banking	Corporate	Asset Mgmt.	CEE	Other
Austria	UniCredit	Private Banking	x					
		Corporate & Investment Banking			x			
		Central & Eastern Europe					x	
Austria	Erste Group	Retail & SME					x	
		Group Corporate and Investment Banking			x			
		Group Markets						x
Austria	ÖVAG	Non-core Corporate			x			
		Non-core Retail					x	
		Non-core Real Estate				x		
		Financial Markets/Investment Book		x				
		Non-core Investment Book/Other Operations		x				
Germany	Deutsche Bank	Corporate Banking & Securities			x			
		Global Transaction Banking		x				
		Asset and Wealth Management	x					
		Private & Business Clients	x					
Germany	Commerzbank	Private Customers	x					
		Mittelstandsbank			x			
		Central&Eastern Europe					x	
		Corporates & Markets		x				
		Asset Based Finance				x		
Switzerland	UBS	Wealth Management	x					
		Wealth Management Americas	x					
		Investment Bank		x				
		Global Asset Management				x		
		Retail & Corporate	x					
Switzerland	Credit Suisse	Private Banking & Wealth Management	x					
		Investment Banking		x				
		Corporate Center						x
		Noncontrolling interests without SEI						x
United Kingdom	HSBC	UK Retail	x					
		Continental Europe Retail	x					
		Global Banking and Markets		x				
		Global Private Banking	x					
		Other						x
United States of America	JPMC	Consumer & Community Banking	x					
		Corporate & Investment Bank		x				
		Commercial Banking	x					
		Asset Management				x		
		Corporate/Private Equity			x			
United States of America	Citigroup	Global Consumer Banking (GCB)	x					
		Institutional Clients Group (ICG)				x		
		Citi Holdings				x		
		Corporate/Other						x
United States of America	Wells Fargo	Community Banking	x					
		Wholesale Banking			x			
		Wealth Brokerage and Retirement	x					
		Other						x

Figure 14: Business Segment and Market Segment Interrelationship[85]

[85] Annual Reports of 2011 are analyzed qualitatively on business segment level. (set of banks as defined in 3.3.1.1)

3.3.1.3 Cost of Capital and Economic Return Estimation

Following notation is used in the thesis regarding the cost of capital:

Cost of Capital	*generic*[1]	COC in %
	index model-based cost of equity capital[2]	CoE in %
	for regulatory capital[3]	CRC in €

Figure 15: Cost of Capital Notation[86]

In the following model the historical cost of capital are calculated.

3.3.1.3.1 Construction

For the estimation of the cost of capital on bank (segment) level a (segment) index model is created. This model is based on the ideas of the capital asset pricing model introduced in 1.3.1. In this model, the expected return of an individual security represents the required rate of return shareholders expect to earn from investing equity capital into the bank business. From a bank (segment) perspective this is denoted as the cost of equity capital (CoE). While the Capital Asset Pricing Model incorporates the market portfolio as systemic risk benchmark, I will construct market segment indices in order to estimate the market segment β per individual bank and the cost of equity capital on segment level as defined in 3.3.1.2. Additionally, the cost of equity capital on overall bank level are estimated with a market index incorporating the data from the market segment indices. (see later)
The integration of the ideas of Fama and French (1993), ct. chapter 1.3.1.1, are scrapped due to lack of segment data.

On the business segment level the cost of equity capital are estimated as follows:

$$CoE_k = r_f + \beta_k * MRP = r_f + \beta_k\left[E(r_m) - r_f\right] \quad (3.1)$$

CoE_k … estimated cost of equity capital of business segment k in %
$E(r_m)$ … expected market return in %
r_f … risk-free rate in%
β_k … beta coefficient of business segment k
$MRP = \left[E(r_m) - r_f\right]$ … market risk premium in %

[86] 1: for estimation methods in the banking industry refer to 1.3; 2: for further details concerning the cost of capital estimation ct. 1.3.1 and 3.3.1.3.1; 3: ct. 1.2.1 and 2.2

On overall bank level following model is used:

$$CoE_B = r_f + \beta_B * MRP = r_f + \beta_B[E(r_m) - r_f]$$

CoE_B … estimated cost of equity capital of bank B in %
$E(r_m)$ … expected market return in %
r_f … risk-free rate in %
β_B … beta factor of bank B
$MRP = [E(r_m) - r_f]$ … market risk premium in %

3.3.1.3.1.1 Economic Return

In order to calculate the economic return, the residual return of a business/business segment (ct. chapter 2.6.4) with available data from annual reports, I use following approach:

The economic return on business segment level is calculated the following:

$$ER_k = ROE_k - CoE_k = ROE_k - r_f - \beta_k * MRP \quad (3.2)$$

ER_k … economic return of business segment k in %
ROE_k … return on equity of business segment k in %

The economic return on overall bank level is computed the following:

$$ER_B = ROE_B - CoE_B = ROE_B - r_f - \beta_B * MRP$$

ER_B … economic return in %
ROE_B … return on equity in %

3.3.1.3.1.2 Beta Coefficient - Construction

3.3.1.3.1.2.1 Market Segment Index Generation

Definition of reference banks per market segment via industry screening

In order to generate a stock price index per market segment a set of reference banks, which represents the market segments at the best possible rate, is set up via industry screening (major business activities according to market segments as defined in 3.3.1.2.1):

Market Segment	Country	Financial Institution	Bloomberg Ticker	Trading Status
Retail	Switzerland	Bank Coop	BC SW Equity	Active
	Austria	Erste Bank	EBS AV Equity	Active
	Germany	Deutsche Postbank AG	DPB GY Equity	Active
Investment Banking	US	JPMorgan	JPM US Equity	Active
	US	Goldman Sachs	GS US Equity	Active
	US	Morgan Stanly	MS US Equity	Active
	US	Bank of America/Merill Lynch	BAC US Equity	Active
	Japan	Nomurra	8604 JP Equity	Active
	Germany	Deutsche Bank	DBK GY Equity	Active
Corporate	Switzerland	Julius Bär	BAER VX Equity	Active
(Wholesale Banking, Institutional Customers)	Switzerland	Vontobel	VONN SW Equity	Active
	Great Britain	RBS Markets & International Banking (M&IB)	RBS LN Equity	Active
	Germany	IKB Deutsche Industriebank AG	IKB GR Equity	Active
Asset Management	Switzerland	UBS Global Asset Management	UBSFACI FP Equity	Active
	Germany	Albrech & Cie Vermögensverwaltung AG	ADOPTIP LX Equity	Active
	France	BNP Paribas Asset Management	BNPPSCC FP Equity	Active
Central and Eastern Europe	Austria	RBI	RBI AV Equity	Active
	Austria	Erste Group	EBS AV Equity	Active
	Tukey	Denizbank	DENIZ TI Equity	Active
	Czech Republic	Komerční banka	KOMB CP Equity	Active
	Poland	PKO Bank Polski	PKO PW Equity	Active
	Poland	Bank Pekao SA	PEO PW Equity	Active
	Hungary	OTP Bank	OTP HB Equity	Active
	Romania	BRD - Groupe Société Générale	BRD RO Equity	Active
	Romania	Banca Transilvania S.A.	TLV RO Equity	Active

Figure 16: Set of Reference Banks[87]

Market segment index (MSI) and overall bank index (OBI) generation

The market segment index is modeled by weighted aggregation of weekly close prices of the set of reference banks via market cap (ct. 1.2.1 and 1.1). Therefore, time series with a time horizon 04-2011 to 06-2013 are used. [88]

In more detail, the ideas of the Laspeyres index[89] are adapted for modeling the market segment indices. The price index model can be explained as the ratio of the number of shares outstanding at time point 0 when valued at the close prices of time points t and 0, correspondingly.
In other words, the index represents the *weighted arithmetic average of the ratios of the individual close prices at time points t and 0* using the number of shares outstanding at time point 0 as weights.

[87] Evaluation via industry screening and www.bloomberg.com (07-07-2013)
[88] Data by Bloomberg, ct. www.bloomberg.com
[89] ct. International Monetary Fund (2004), p. 7f.

In the model only the number of shares outstanding (=weights) / the market cap of the basis time point is required. Another advantage signifies the good comparability of the market segment indices, which are created with the same basis time point.

Therefore, the market segment index is modeled as follows:

$$MSI_i(t) = \frac{\sum_j PX_{LAST\,j,i}(t) * NSO_{j,i}(0)}{\sum_j PX_{LAST\,j,i}(0) * NSO_{j,i}(0)} = \frac{\sum_j \frac{PX_{LAST\,j,i}(t)}{PX_{LAST\,j,i}(0)} * CUR\_MKT\_CAP_{j,i}(0)}{\sum_j CUR\_MKT\_CAP_{j,i}(0)} \quad (3.3)$$

with

$$CUR\_MKT\_CAP_{j,i}(t) = PX_{LAST\,j,i}(t) * NSO_{j,i}(t)$$

$MSI_i(t)$	… market segment index of market segment i at time t
$CUR\_MKT\_CAP_{j,i}(t)$	… market cap of reference bank j as part of market segment i at time t in €
$NSO_{j,i}(t)$	… number of shares outst. of ref. bank j as part of market segm. i at time t
$PX_{LAST\,j,i}(t)$	… close price of reference bank j as part of market segment i at time t in €

The overall index (OBI) is computed with the complete data set of all reference banks defined in 3.3.1.3.1.2.1, figure 16:

$$OBI(t) = \frac{\sum_j PX_{LAST\,j}(t) * NSO_j(0)}{\sum_j PX_{LAST\,j}(0) * NSO_j(0)} = \frac{\sum_j \frac{PX_{LAST\,j}(t)}{PX_{LAST\,j}(0)} * CUR\_MKT\_CAP_j(0)}{\sum_j CUR\_MKT\_CAP_j(0)}$$

with

$$CUR\_MKT\_CAP_j(t) = PX_{LAST\,j}(t) * NSO_j(t)$$

$OBI(t)$	… overall (bank) index estimation at time t, including all reference banks j[90]
$CUR\_MKT\_CAP_j(t)$	… market cap of reference bank j at time t in €
$NSO_j(t)$	… number of shares outstanding of bank j at time t
$PX_{LAST\,j}(t)$	… close price of reference bank j at time t in €

Following figures show the market segment "Investment Banking" and the results per market index.

[90] Reference banks j represent the market segments i according to 3.3.1.3.1.2.1 and cover all market segments: Retail, Investment Banking, Corporate, Asset Management, CEE

Investment Banking

JPM US Equity

Date	PX_LAST	CUR_MKT_CAP	...
01.04.2011	32.6087	129897.0535	...
08.04.2011	32.47816	129377.0693	...
15.04.2011	31.0851	123827.8166	...
...	...	...	...
21.06.2013	39.53736	149438.4179	...
28.06.2013	40.59208	153424.9087	...

DBK GY Equity **Index Investment Banking**

...	PX_LAST	CUR_MKT_CAP	Index Investment Banking
...	42.75	39573.4492	
...	42.92	39791.8828	0.993
...	41.075	38295.3867	0.954
...	...	...	...
...	33.2	34051.2891	1.084
...	32.155	32959.4023	1.097

Figure 17: Weighted Market Index Generation[91]

Bloomberg Abr. Bank Stock Exchange: **Trade Date**	Index Retail **Index**	Index Investment B. **Index**	Index Corporate **Index**
01.04.11			
08.04.11	0.987	0.993	1.024
15.04.11	0.987	0.954	1.003
...	...	...	...
21.06.13	0.826	1.084	0.725
28.06.13	0.797	1.097	0.707

Index Asset Mgmt. **Index**	Index CEE **Index**	**Overall Index** **Index**
1.024	1.017	1.002
0.975	1.011	0.969
...	...	...
0.762	0.685	0.957
0.785	0.693	0.966

Figure 18: Overview Market Segment Indices (MSI)

[91] Illustration regarding market segment „Investment Banking"

3.3.1.3.1.2.2 Share price return and Index return

The share price returns or index returns of the time series are calculated as follows. All time series used are on weekly basis with the time horizon 04-2011 to 06-2013.

$$r_s = \frac{PX_{LAST,s}(t) - PX_{LAST,s}(t-1)}{PX_{LAST,s}(t-1)}$$

$$r_j = \frac{PX_{LAST,j}(t) - PX_{LAST,j}(t-1)}{PX_{LAST,j}(t-1)}$$

$$R_{MSI,i} = \frac{MSI_i(t) - MSI_i(t-1)}{MSI_i(t-1)}$$

$$R_{OBI} = \frac{OBI(t) - OBI(t-1)}{OBI(t-1)}$$

r_s	… share price return of an individual bank share at time t
r_j	… share price return of reference bank j at time t
$R_{MSI,i}$	… market segment index return of market segment i at time t
R_{OBI}	… overall (bank) index return at time t
$PX_{LAST,s}(t)$	… close price of individual bank share at time t
$PX_{LAST,s}(t-1)$	… close price of individual bank share at time t-1

3.3.1.3.2 Calibration

3.3.1.3.2.1 Risk-Free Rate r_f

For the estimation of the risk-free rate I use local government bond returns. In order to deal with a high credit-worthiness I incorporate (long term) local ten-year government bond returns.[92]

$$r_f = r_{government\ bond,local,10y}$$

3.3.1.3.2.2 Market Risk Premium MRP

In my approach I use the results of Fernandez et al. (2012), p. 3, to cursory estimate the Market Risk Premium $MRP_{country}$. The results of this paper are based on 6,308 specific MRP used by analysts, managers of companies and universities by June 2012.

$$MRP = MRP_{country}$$

[92] ct. http://de.investing.com/rates-bonds/(07-03-2013)

3.3.1.3.2.3 Beta Coefficient – Calibration

β-coefficient estimation

For the determination of the β-coefficient described in 1.3.1 I use the software package MS Excel 2010 and the regression analysis capabilities as follows:

e.g.: β_i =RGP(U7:U123;$AL7:$AL123;1;1)

Remark: German version
U7:U123 … return time series of bank segment k
$AL7:$AL123 … return time series of reference index

This RGP function estimates a (linear) regression of the form

$$r_s = \beta_s * R_{OBI} + const.$$

β_s … beta coefficient of an individual bank at time t

For instance the regression line of a major German Bank reads as follows:

$$r_{Commerzbank} = \beta_{Commerzbank} * R_{OBI} + const.$$
$$r_{Commerzbank} = 1.27 * R_{OBI} - 0.011$$

The coefficient of determination R^2 (German: "Bestimmtheitsmaß") of the β-estimate describes the explanatory power increasing from 0 to 1. It therefore describes that 48 percent of the movements in the Commerzbank return series are explained by the overall index returns.

On segment level the regression line is estimated the following:

$$r_{Commerzbank,Retail} = \beta_{Commerzbank,Retail} * R_{MSI,Retail} + const.$$
$$r_{Commerzbank,Retail} = 1.33 * R_{MSI,Retail} - 0.009$$

Bank Correlation (exemplary):

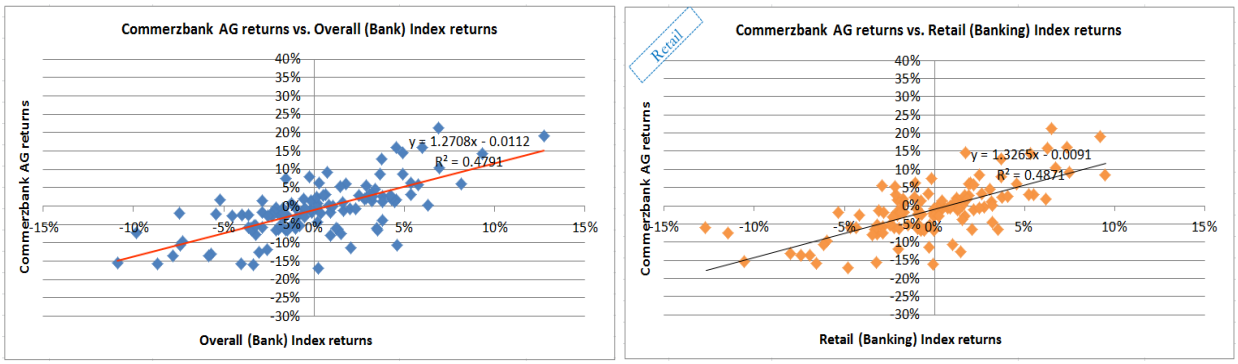


Figure 19: Beta Coefficient Estimation via Regression Analysis[93]

[93] Regression analysis with the software package MS Excel 2010

β-Estimation via Regression Analysis – Results

Bank Stock Exchange: **Trade Date**	**Return** UniCredit (EUR)	**Return** Erste Group (EUR)	**Return** ÖVAG (EUR)	**Return** Deutsche Bank (EUR)	**Return** Commerzbank (EUR)
01.04.11					
08.04.11	0.027	-0.018	0.005	0.004	-0.039
15.04.11	-0.048	-0.002	0.000	-0.043	-0.160
…	…	…	…	…	…
21.06.13	-0.072	-0.078	0.059	-0.040	-0.025
28.06.13	-0.013	-0.066	-0.055	-0.031	-0.079
βB	1.25	1.23	-0.12	1.21	1.27
βB,retail	1.34	1.68	-0.18	1.06	1.33
βB,invest	0.98	1.04	-0.12	1.09	1.09
βB,corp	0.79	0.75	0.03	0.73	0.84
βB,asset	0.99	0.79	-0.08	0.81	0.84
βB,cee	1.43	1.39	-0.25	1.12	1.29
σB (share price return)	8.18%	6.70%	13.92%	6.10%	7.35%
μB (share price return)	-0.665%	-0.252%	-1.025%	-0.068%	-1.057%

Return UBS (EUR)	**Return** Credit Suisse (EUR)	**Return** HSBC (EUR)	**Return** JP Morgan Chase (EUR)	**Return** Citigroup (EUR)	**Return** Wells Fargo (EUR)
0.017	0.033	0.015	-0.004	0.010	-0.028
-0.011	-0.027	-0.020	-0.043	-0.032	-0.056
…	…	…	…	…	…
-0.040	-0.048	-0.030	-0.009	-0.035	0.034
0.015	-0.001	0.025	0.027	0.034	0.018
0.82	1.02	0.57	0.84	1.16	0.54
0.72	0.80	0.40	0.52	0.68	0.27
0.72	0.93	0.54	0.89	1.20	0.56
0.57	0.68	0.36	0.42	0.61	0.29
0.52	0.62	0.31	0.37	0.56	0.25
0.77	0.93	0.49	0.59	0.90	0.37
4.57%	5.33%	3.01%	3.81%	5.47%	3.14%
0.112%	-0.202%	0.093%	0.264%	0.280%	0.368%

Bank Stock Exchange: **Trade Date**	**Return** Index Retail	**Return** Index Investment B.	**Return** Index Corporate	**Return** Index Asset Mgmt.	**Return** Index CEE	**Return** **Overall Index**
01.04.11						
08.04.11						
15.04.11	0.000	-0.040	-0.021	-0.048	-0.006	-0.034
…	…	…	…	…	…	…
21.06.13	-0.041	-0.020	-0.096	-0.059	-0.090	-0.036
28.06.13	-0.034	0.012	-0.024	0.031	0.011	0.009
βB	0.69	0.97	1.17	1.34	0.80	-
σB (index return)	3.87%	3.99%	5.73%	6.33%	3.90%	4.00%
μB (index return)	-0.11%	0.16%	-0.15%	-0.03%	-0.25%	0.05%

Figure 20: Beta coefficients regarding investigated banks – results

3.3.2 Analyzing Historical Segment Profit and Volatility

3.3.2.1 Historical Segment Profit and Volatility – Construction and Calibration

3.3.2.1.1 Construction

In the following the historical (segment) return on equity volatility is calculated on annual time-frame basis:

Return on Equity Volatility

$$\mu_{ROE(k)} = avg(ROE_{k,}(y-1,y)) = (\Sigma ROE_k(y-1,y))/T$$

$$SSD_a = \Sigma(ROE_k(y-1,y) - avg[ROE_k(y-1,y)])^2$$

$$\sigma_{ROE(k)} = (SSD_a / (T-1))\text{^}1/2 \quad (3.4)$$

$\mu_{ROE\ (k)}$ … return on equity mean of bank B on annual basis in %
$ROE_k\ (y-1,y)$ … return on equity of business segm. k (bank B) and time frame (y-1, y) in %
SSD_a … Sum Squared Deviations on annual basis
$\sigma_{ROE(k)}$ … return on equity volatility of business segment k on annual basis in %
T … number of financial periods investigated

y or y-1 represent the investigated and its previous financial period.

On overall bank level equation (3.4) is adapted by $ROE_B(y-1,y)$ representing the return on equity on overall bank level.

3.3.2.1.2 Calibration

Due to lack of segment data the return on equity volatility is estimated by the net income volatility.

Return on Equity Volatility - Estimation

$$\mu_{ROE(k)} = avg(ROE_k(y-1,y)) = (\Sigma ROE_k(y-1,y))/T$$

$$SSD_a = \Sigma(ROE_k(y-1,y) - avg[ROE_k(y-1,y)])^2$$

$$\sigma_{ROE(k)} = (SSD_a / (T-1))\text{^}1/2 \quad (3.5)$$

with

$$ROE_k(y-1,y) \overset{!}{=} r_{ni(k)}\ (y-1,y) =$$

$$= (ni_k(y) - ni_k(y-1)) / ni_k(y-1)$$

$r_{ni(k)}\ (y-1,y)$ … net income return of business segm. k (bank B) and time frame (y-1, y) in %
$ni_k(y)$ … net income business segment k (bank B) of financial year y in €

On overall bank level equation (3.5) is adapted by $ni_B(y)$ representing the net income on overall bank level.

3.3.2.2 Bank- and Business Segment Analysis (excerpt)

CoE-Estimation - Overall Bank Level as well as Segment Level (exemplary):

Commerzbank (coba) — Quantitative Cross-Section analysis

B … bank
k … business segment
i … market segment

B: Overall Bank € 1,000

	Model		Remark
$ni_B(08)$	$ni_B(Y)$	59,000	Net Income Bank 2008
$ni_B(09)$		-4,633,000	Net Income Bank 2009
$ni_B(10)$		1,489,000	Net Income Bank 2010
$ni_B(11)$		747,000	Net Income Bank 2011
$ni_B(12)$		69,000	Net Income Bank 2012
$r_{ni(B)}(08,09) = (ni_B(09)-ni_B(08)) / ni_B(08)$	$r_{ni(B)}(LY,Y)$	-7952.54%	Net Income Return 2008/2009
$r_{ni(B)}(09,10)$		-132.14%	Net Income Return 2009/2010
$r_{ni(B)}(10,11)$		-49.83%	Net Income Return 2010/2011
$r_{ni(B)}(11,12)$		-90.76%	Net Income Return 2011/2012
$\mu r_{ni(B)}=avg(r_{ni(B)}(y-1,y)) =sum(r_{ni(B)}(Y))/T$		-2056.32%	Net Income Return Mean
$SSD_a = \Sigma(r_{ni(B)} - avg[r_{ni(B)}])^2$		463573.19%	Sum Squared Deviations
$\sigma_{ROE(B)} != \sigma r_{ni(B)} = (SSD_a / (T-1))^{1/2}$	$\sigma_{ROE(B)} != \sigma r_{ni(B)}$	3930.96%	Return on Equity Volatility Estimation
$ROE_B(12)$	ROE_B	0.00%	Return on Equity Bank 2012 (after-tax)
r_f != MRPcountry	rf	1.24%	Risk Free Rate
MRP != $MRP_{country}$	MRP	5.50%	Market Risk Premium
$E[rm]=MRP+r_f$	E[rm]	6.74%	Expected Market Return
β_B	β_B	1.271	Bank Beta (regression analysis)

$CoE_B=rf+\beta_B*MRP$	CoE_B	8.233%	Cost of Equity Capital overall Bank
$ER_B(12)=ROE_B(12)-CoE_B$	ER_B	-8.233%	Economic Return 2012

T 4 Periods

k: Private Customers (market segment i: Retail) € 1,000

	Model		Remark
$ni_k(08)$	$ni_k(Y)$	569,000	Net Income 2008
$ni_k(09)$		-196,000	Net Income 2009
$ni_k(10)$		47,000	Net Income 2010
$ni_k(11)$		476,000	Net Income 2011
$ni_k(12)$		245,000	Net Income 2012
$r_{ni(k)}(08,09) = (ni_k(09)-ni_k(08)) / ni_k(08)$	$r_{ni(k)}(LY,Y)$	-134.45%	Net Income Return k 2008/2009
$r_{ni(k)}(09,10)$		-123.98%	Net Income Return k 2009/2010
$r_{ni(k)}(10,11)$		912.77%	Net Income Return k 2010/2011
$r_{ni(k)}(11,12)$		-48.53%	Net Income Return k 2011/2012
$\mu r_{ni(k)}=avg(r_{ni(k)}(y-1,y)) =sum(r_{ni(k)}(Y))/T$		151.45%	Net Income Return Mean Segment k
$SSD_a = \Sigma(r_{ni(k)} - avg[r_{ni(k)}])^2$		7771.92%	Sum Squared Deviations
$\sigma_{ROE(k)} != \sigma r_{ni(k)} = (SSD_a / (T-1))^{1/2}$	$\sigma_{ROE(k)} != \sigma r_{ni(k)}$	508.98%	Return on Equity Volatility Estimation
$ROE_k(12)$	ROE_k	6.30%	Return on Equity Segment k 2012 (after-tax)

β_k	β_k	1.327	Segment k beta (regression analysis)

$CoE_k=r_f+\beta_k*MRP$	CoE_k	8.54%	Cost of Equity Capital Segment k
$ER_k(12)=ROE_k(12)-CoE_k$	ER_k	-2.24%	Economic Return Segment k 2012

k: Mittelstandsbank (market segment i: Corporate) € 1,000

	Model		Remark
$ni_k(08)$	$ni_k(Y)$	719,000	Net Income 2008
$ni_k(09)$		528,000	Net Income 2009
$ni_k(10)$		1,598,000	Net Income 2010
$ni_k(11)$		1,588,000	Net Income 2011
$ni_k(12)$		1,649,000	Net Income 2012
$r_{ni(k)}(08,09) = (ni_k(09)-ni_k(08)) / ni_k(08)$	$r_{ni(k)}(LY,Y)$	-26.56%	Net Income Return k 2008/2009
$r_{ni(k)}(09,10)$		202.65%	Net Income Return k 2009/2010
$r_{ni(k)}(10,11)$		-0.63%	Net Income Return k 2010/2011
$r_{ni(k)}(11,12)$		3.84%	Net Income Return k 2011/2012
$\mu r_{ni(k)}=avg(r_{ni(k)}(y-1,y)) =sum(r_{ni(k)}(Y))/T$		44.83%	Net Income Return Mean Segment k
$SSD_a = \Sigma(r_{ni(k)} - avg[r_{ni(k)}])^2$		337.51%	Sum Squared Deviations
$\sigma_{ROE(k)} != \sigma r_{ni(k)} = (SSD_a / (T-1))^{1/2}$	$\sigma_{ROE(k)} != \sigma r_{ni(k)}$	106.07%	Return on Equity Volatility Estimation
$ROE_k(12)$	ROE_k	28.60%	Return on Equity Segment k 2012 (after-tax)

β_k	β_k	0.843	Segment k beta (regression analysis)

$CoE_k=r_f+\beta_k*MRP$	CoE_k	5.88%	Cost of Equity Capital Segment k
$ER_k(12)=ROE_k(12)-CoE_k$	ER_k	22.72%	Economic Return Segment k 2012

k: Central&Eastern Europe (market segment i: CEE) € 1,000

	Model		Remark
$ni_k(08)$	$ni_k(Y)$	313,000	Net Income 2008
$ni_k(09)$		-398,000	Net Income 2009
$ni_k(10)$		53,000	Net Income 2010
$ni_k(11)$		427,000	Net Income 2011
$ni_k(12)$		-28,000	Net Income 2012
$r_{ni(k)}(08,09) = (ni_k(09)-ni_k(08)) / ni_k(08)$	$r_{ni(k)}(LY,Y)$	-227.16%	Net Income Return k 2008/2009
$r_{ni(k)}(09,10)$		-113.32%	Net Income Return k 2009/2010
$r_{ni(k)}(10,11)$		705.66%	Net Income Return k 2010/2011
$r_{ni(k)}(11,12)$		-106.56%	Net Income Return k 2011/2012
$\mu r_{ni(k)}=avg(r_{ni(k)}(y-1,y)) = sum(r_{ni(k)}(Y))/T$		64.66%	Net Income Return Mean Segment k
$SSD_a = \Sigma(r_{ni(k)} - avg[r_{ni(k)}])^2$		5570.29%	Sum Squared Deviations
$\sigma_{ROE(k)} != \sigma r_{ni(k)} = (SSD_a / (T-1))^{1/2}$	$\sigma_{ROE(k)} != \sigma r_{ni(k)}$	430.90%	Return on Equity Volatility Estimation
$ROE_k(12)$	ROE_k	13.60%	Return on Equity Segment k 2012 (after-tax)
β_k	β_k	1.289	Segment k beta (regression analysis)
$CoE_k=r_f+\beta_k*MRP$	CoE_k	8.33%	Cost of Equity Capital Segment k
$ER_k(12)=ROE_k(12)-CoE_k$	ER_k	5.27%	Economic Return Segment k 2012

k: Corporates & Markets (market segment i: Inv. Banking) € 1,000

	Model		Remark
$ni_k(08)$	$ni_k(Y)$	-63,000	Net Income 2008
$ni_k(09)$		-571,000	Net Income 2009
$ni_k(10)$		786,000	Net Income 2010
$ni_k(11)$		583,000	Net Income 2011
$ni_k(12)$		197,000	Net Income 2012
$r_{ni(k)}(08,09) = (ni_k(09)-ni_k(08)) / ni_k(08)$	$r_{ni(k)}(LY,Y)$	806.35%	Net Income Return k 2008/2009
$r_{ni(k)}(09,10)$		-237.65%	Net Income Return k 2009/2010
$r_{ni(k)}(10,11)$		-25.83%	Net Income Return k 2010/2011
$r_{ni(k)}(11,12)$		-66.21%	Net Income Return k 2011/2012
$\mu r_{ni(k)}=avg(r_{ni(k)}(y-1,y)) = sum(r_{ni(k)}(Y))/T$		119.16%	Net Income Return Mean Segment k
$SSD_a = \Sigma(r_{ni(k)} - avg[r_{ni(k)}])^2$		6549.28%	Sum Squared Deviations
$\sigma_{ROE(k)} != \sigma r_{ni(k)} = (SSD_a / (T-1))^{1/2}$	$\sigma_{ROE(k)} != \sigma r_{ni(k)}$	467.24%	Return on Equity Volatility Estimation
$ROE_k(12)$	ROE_k	6.10%	Return on Equity Segment k 2012 (after-tax)
β_k	β_k	1.092	Segment k beta (regression analysis)
$CoE_k=r_f+\beta_k*MRP$	CoE_k	7.25%	Cost of Equity Capital Segment k
$ER_k(12)=ROE_k(12)-CoE_k$	ER_k	-1.15%	Economic Return Segment k 2012

k: Asset Based Finance (market segment i: Asset Management)

	Model		Remark
$ni_k(08)$	$ni_k(Y)$	-973,000	Net Income 2008
$ni_k(09)$		-1,625,000	Net Income 2009
$ni_k(10)$		-1,301,000	Net Income 2010
$ni_k(11)$		-4,018,000	Net Income 2011
$ni_k(12)$		-1,568,000	Net Income 2012
$r_{ni(k)}(08,09) = (ni_k(09)-ni_k(08)) / ni_k(08)$	$r_{ni(k)}(LY,Y)$	67.01%	Net Income Return k 2008/2009
$r_{ni(k)}(09,10)$		-19.94%	Net Income Return k 2009/2010
$r_{ni(k)}(10,11)$		208.84%	Net Income Return k 2010/2011
$r_{ni(k)}(11,12)$		-60.98%	Net Income Return k 2011/2012
$\mu r_{ni(k)}=avg(r_{ni(k)}(y-1,y)) = sum(r_{ni(k)}(Y))/T$		48.73%	Net Income Return Mean Segment k
$SSD_a = \Sigma(r_{ni(k)} - avg[r_{ni(k)}])^2$		427.20%	Sum Squared Deviations
$\sigma_{ROE(k)} != \sigma r_{ni(k)} = (SSD_a / (T-1))^{1/2}$	$\sigma_{ROE(k)} != \sigma r_{ni(k)}$	119.33%	Return on Equity Volatility Estimation
$ROE_k(12)$	ROE_k	-15.20%	Return on Equity Segment k 2012 (after-tax)
β_k	β_k	0.843	Segment k beta (regression analysis)
$CoE_k=r_f+\beta_k*MRP$	CoE_k	5.88%	Cost of Equity Capital Segment k
$ER_k(12)=ROE_k(12)-CoE_k$	ER_k	-21.08%	Economic Return Segment k 2012

3.3.3 Results - Aggregated Bank-, Business Segment- and Market Segment Data

Overall Bank Level:

Country	Overall Bank	ROE (%)	σ_{ROE}*(%) [2008-2012]	CoE (%)	Economic Return (%)
Austria	UniCredit	2.40%	61.99%	9.46%	-7.06%
Austria	Erste Group	3.80%	20.57%	9.35%	-5.55%
Austria	ÖVAG	-79.40%	1264.00%	9.46%	-88.86%
Germany	Deutsche Bank	0.40%	12.90%	7.92%	-7.52%
Germany	Commerzbank	0.00%	3930.96%	8.23%	-8.23%
Switzerland	UBS	-5.20%	95.70%	5.53%	-10.73%
Switzerland	Credit Suisse	3.90%	70.23%	6.63%	-2.73%
United Kingdom	HSBC	8.40%	15.13%	4.18%	4.22%
United States of America	JPMC	11.00%	120.34%	7.37%	3.63%
United States of America	Citigroup	4.10%	766.64%	9.15%	-5.05%
United States of America	Wells Fargo	12.95%	10.40%	5.71%	7.24%
		4.64%*	**130.43%**	**7.26%***	**-2.62%***

Figure 21: Aggregated Results and Average – Overall Bank Level[94]

Segment Level:

Market Segment (prevailing)	Country	Bank	Segment (major)	σ_{ROE} (%) [2008-2012]	CoE (%)	ROE (%)	Economic Return (%)
Retail	Austria	UniCredit	Private Banking	13.49%	10.00%	8.27%	-1.73%
	Germany	Deutsche Bank	Private & Business Clients	90.35%	7.08%	4.22%	-2.86%
			Asset and Wealth Management	67.28%	6.76%	0.97%	-5.78%
		Commerzbank	Private Customers	508.98%	8.54%	6.30%	-2.24%
	Switzerland	UBS	Wealth Management	16.62%	4.97%	5.60%	0.63%
			Wealth Management Americas	290.58%	4.97%	1.90%	-3.07%
			Retail & Corporate	10.94%	4.72%	4.25%	-0.47%
	United Kingdom	HSBC	UK Retail	46.83%	3.26%	2.79%	-0.47%
			Continental Europe Retail	56.13%	3.26%	1.30%	-1.96%
			Global Private Banking	5.35%	3.26%	1.66%	-1.60%
	United States of America	JPMC	Consumer & Community Banking	25.18%	5.59%	25.00%	19.41%
			Commercial Banking	1.27%	5.59%	28.00%	22.41%
		Citigroup	Global Consumer Banking (GCB)	32.23%	6.48%	4.40%	-2.07%
		Wells Fargo	Community Banking	9.11%	4.21%	7.19%	2.98%
			Wealth Brokerage and Retirement	11.61%	4.21%	5.33%	1.12%
			Average	**79.06%**	**5.53%**	**7.15%**	**1.62%**
Asset Mgmt.	Austria	ÖVAG	Non-core Real Estate	313.00%	1.90%	6.56%	4.66%
	Germany	Commerzbank	Asset Based Finance	119.33%	5.88%	-15.20%	-21.08%
	Switzerland	UBS	Global Asset Management	18.07%	3.91%	1.33%	-2.58%
	United States of America	JPMC	Asset Management	9.81%	4.79%	24.00%	19.21%
		Citigroup	Institutional Clients Group (ICG)	32.23%	6.48%	4.40%	-2.07%
			Citi Holdings	45.58%	5.85%	-3.57%	-9.42%
			Average	**89.67%**	**4.80%**	**2.92%**	**-1.88%**
CEE	Austria	UniCredit	Central & Eastern Europe	41.95%	10.53%	5.61%	-4.92%
		ÖVAG	Non-core Retail	1369.42%	1.02%	-31.14%	-32.15%
		Erste Group	Retail & SME	32.47%	11.21%	11.00%	-0.21%
	Germany	Commerzbank	Central&Eastern Europe	430.90%	8.33%	13.60%	5.27%
			Average*	**168.44%**	**10.02%**	**10.07%**	**0.05%**
Corporate	Austria	UniCredit	Corporate & Investment Banking	197.50%	6.89%	8.27%	1.38%
		ÖVAG	Non-core Corporate	248.61%	2.52%	6.37%	3.85%
		Erste Group	Group Corporate and Investment Banking	66.02%	6.97%	-2.70%	-9.67%
	Germany	Commerzbank	Mittelstandsbank	106.07%	5.88%	28.60%	22.72%
		Deutsche Bank	Corporate Banking & Securities	78.11%	5.85%	5.19%	-0.66%
	United States of America	JPMC	Corporate/Private Equity	224.51%	5.12%	-1.08%	-6.20%
		Wells Fargo	Wholesale Banking	6.72%	4.31%	5.33%	1.02%
			Average	**132.51%**	**5.36%**	**7.14%**	**1.78%**
Investment B.	Austria	ÖVAG	Financial Markets/Investment Book	210.21%	1.67%	3.54%	1.87%
			Non-core Investment Book/Other Operations	296.94%	1.67%	-11.96%	-13.63%
	Germany	Deutsche Bank	Global Transaction Banking	22.21%	7.24%	7.14%	-0.10%
		Commerzbank	Corporates & Markets	467.24%	7.25%	6.10%	-1.15%
	Switzerland	UBS	Investment Bank	196.17%	5.00%	-6.36%	-11.36%
		Credit Suisse	Investment Banking	176.44%	6.13%	4.63%	-1.49%
	United Kingdom	HSBC	Global Banking and Markets	1090.25%	3.76%	2.22%	-1.55%
	United States of America	JPMC	Corporate & Investment Bank	1.13%	6.99%	18.00%	11.01%
			Average*	**195.76%**	**5.13%**	**3.01%**	**-2.12%**
Other	Austria	Erste Group	Group Markets	74.47%	8.30%	65.00%	56.70%
	Switzerland	Credit Suisse	Corporate Center	511.49%	6.63%	-9.02%	-15.66%
			Noncontrolling interests without SEI	112.01%	6.63%	0.70%	-5.93%
	United Kingdom	HSBC	Other	329.48%	4.18%	-4.50%	-8.69%
	United States of America	Citigroup	Corporate/Other	410.78%	9.15%	-1.01%	-10.16%
		Wells Fargo	Other	78.85%	5.71%	5.33%	-0.38%
			Average	**252.85%**	**6.77%**	**9.42%**	**2.65%**
			Overall Segment A	**153.05%**	**6.27%**	**6.62%**	**0.35%**

* outlier with volatility greater than 550% excluded
** σ_{ROE} (%) estimated via net income volatility

Figure 22: Aggregated Results – Business Segment Level[95]

[94] Analysis based on consolidated enterprise data; interval of investigation: 2008-2012; after-tax ROE: 2012, σ_{ROE}: estimated via net income return volatility, *ÖVAG and Commerzbank excluded due to big structural changes (ÖVAG: nationalization in Nov. 2008 as well as rehabilitation process, 2011: loss in CEE-market, bad deal at sale of ÖVAG-Int. in 2012 to Sberbank; Coba: humpy fusion process with Dresdner Bank

3.3.4 Result Analysis and Interpretation

Cumulative Segment Data:

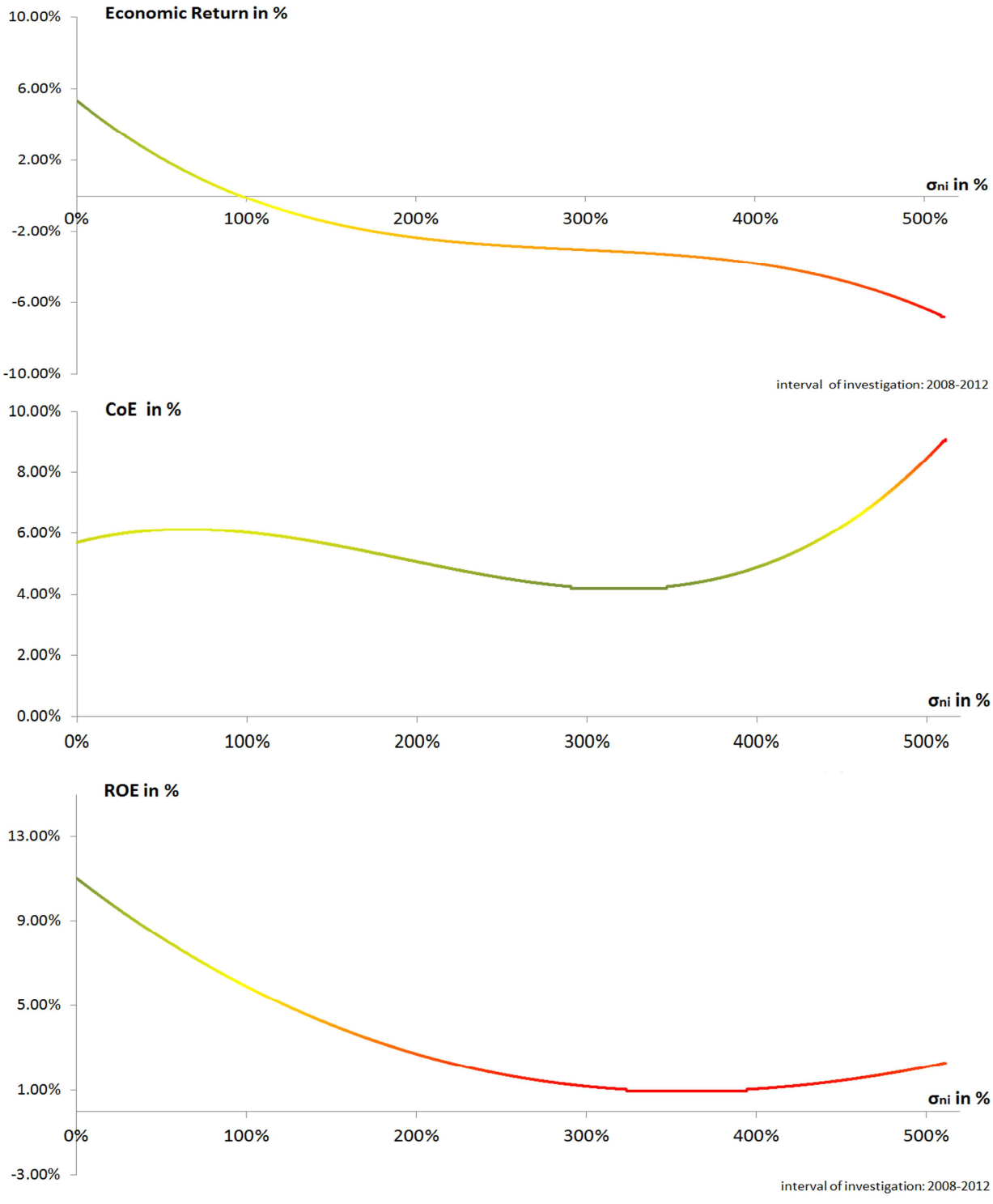


Figure 23: Cumulative Business Segment Data[96]

[95] Analysis based on business segment data; results sorted by financial institution can be found in the appendix (6.1); outlier with volatility greater than 550% excluded

[96] Cumulation of data presented in figure 31 (6.1); set of banks as defined in (3.3.1); outlier with volatility greater than 550% excluded; polynomic trendline function in MS Excel 2010; after-tax ROE: 2012; Economic Return estimation according to financial year 2012

Business Segment Distribution according to Value Creation:

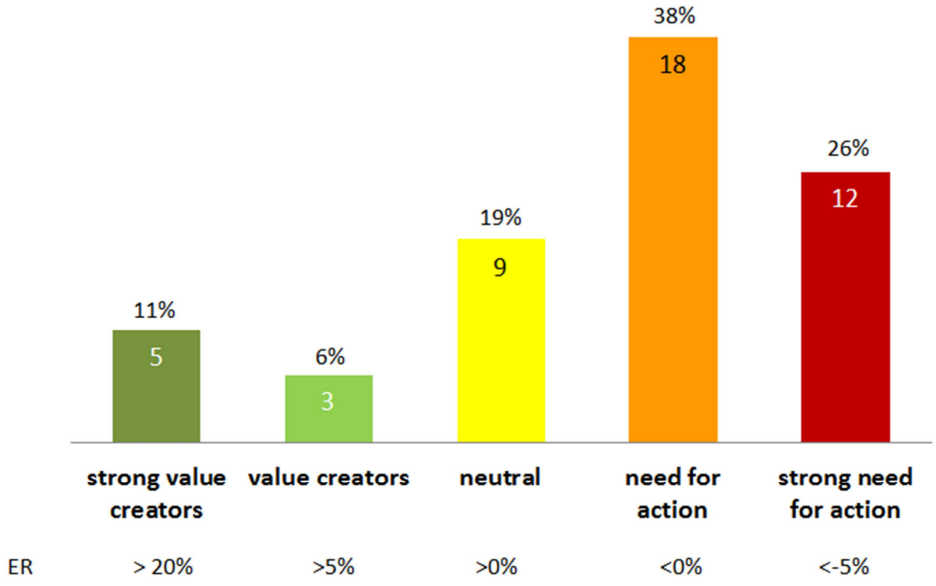


Figure 24: Business Segment Distribution according to Value Creation[97]

Résumé: More than a fourth of the investigated business segments have strong need for action, featuring 1% to -31% after-tax ROE, 67% to more than 500% volatility concerning segment profitability in the post-crisis era and contribute 82% of business segments with negative economic return in 2012.

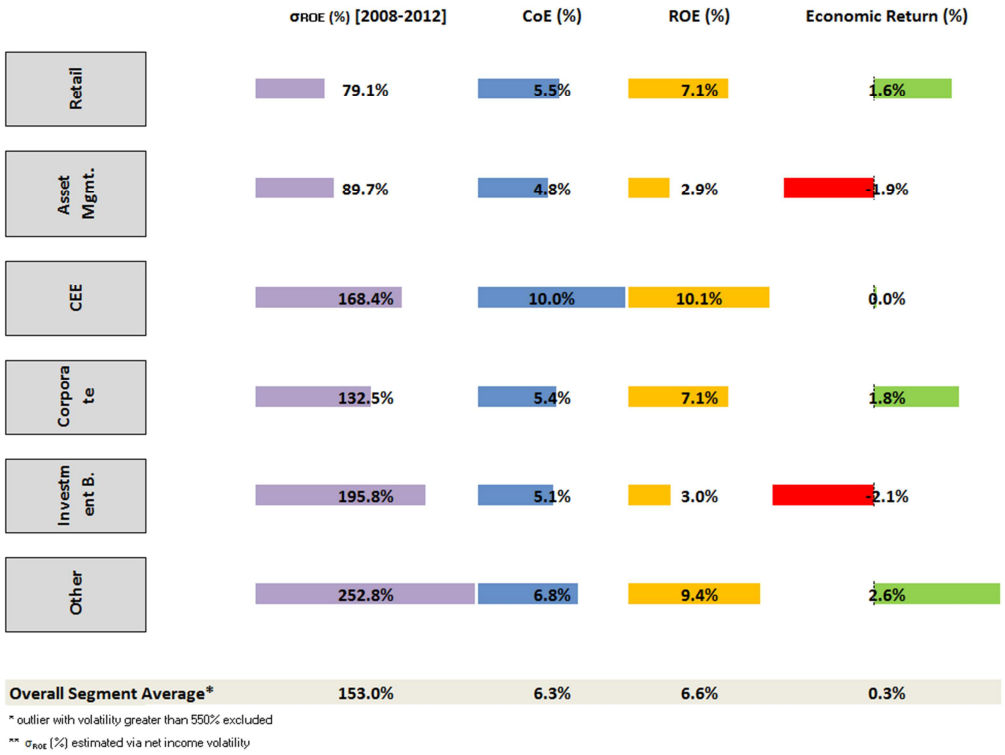


Figure 25: Market Segment Performance[98]

[97] Cumulation of data presented in figure 31 (6.1), set of banks defined in (3.3.1), Economic Return estimation according to financial year 2012; outlier with volatility greater than 550% excluded

Retail:

Shrinking Yield Rates in Retail Banking

The condition in the Retail Banking segment gets even worth. The market condition is characterized by a high cost pressure due to tough competition, increased risk costs, low interest levels and not forgetting the phase-in of higher minimum contingent, tightened capital definitions and increase of RWA by regulators (Basel III). Thus, these aspects impinge on the consolidated profit-and-loss-statements of universal banks. Shrinking yield rates and a slump in profitability due to increased operating costs are underpinned by this study with an average economic return of 1.6 percent in 2012. Consequently, banks are advised to get more innovative with more cost-efficient solutions, for instance by better meeting consumer's needs with the incorporation of new technologies.

CEE:

Tightened capital definitions by regulators enforce the medium-term cut back of the CEE-business

Western universal banks are exposed to a devastating situation in its CEE-business segments. A highly volatile profitability situation with 169% in the post-crisis era, high cost of equity capital of 10.0% and an average economic return of 0.0% in 2012 perfectly illustrate the situation in CEE-banking. This is completely contrary to the former anticipated glory of this new market.

Bank's risk appetite has decreased substantially because of mistakes made in the past (e.g. foreign currency loans) and the effects of financial crisis. As a consequence the resolution of July 2013 to implement Basel III in the EU arrived. The phase-in-period of this new set of regulations lies between 2014 and 2019. Moreover, the challenging market conditions are accelerating the execution of reforms on overall bank level as well as on business segment level, such as the CEE-segment. In order to persist in the CEE-market, a sophisticated capital management system is required in order to deal with the even more scarce resource 'capital'.

Asset Management:

Asset management business segments in the ascendant

Compared to the situation at the beginning of the investigation-interval in 2008, the Asset Management segment is in the ascendant. Particularly in virtue of positive developments of the stock- and bond markets a moderate earnings volatility of 89.7%, an average ROE of 2.9% in 2012 marks the lane in the asset management divisions of universal banks. Strong differences in performance of the investigated business segments result in a negative economic profit of minus 1.9% on average. The study also shows that the US vendors are far on top of the performance ranking.

[98] Analysis based on business segment data; interval of investigation: 2008-2012; after-tax ROE: 2012, Economic Profit estimation regarding to financial year 2012; , σ_{ROE}: estimated via net income return volatility

Corporate:

Corporate-banking business segments unexpectedly good outlasted financial crisis

The crisis unexpectedly did not affect the corporate-banking business as much as others. Despite client's financial distress, affecting wholesale banking predominantly via losses from corporate loans, as well as mostly weak economic growth rates result in an earnings volatility of 132.5%. The business therewith lies in the midfield of all investigated market segments in the post-crisis environment. Profitability represented by a ROE of 7.1% in 2012 resulted in a positive economic return of 1.8% on average. Nonetheless, tightened regulatory definitions, fallouts from the crisis, ongoing globalization and shifting industry structures interlinked with technological evolution will impinge the mid-term future of corporate-banking.

Investment Banking:

Evident strategy essential in investment-banking

Fantastic return on equity levels of up to 20 percent are inconceivable in the post-crisis-era. A weak market environment as well as increasing international competition has led to a highly volatile earnings history of 196% and resulted in an average economic return of minus 2.1% in 2012. In order to crack the ten percent level in the future an evident strategy and clear decisions are inevitably.

3.4 Segment Risk - based Capital Allocation Systems in Financial Institutions

3.4.1 Overall Bank Management and Overall Business Segment Management

Universal Bank Status Quo:

Each core topic represents a committee

Bank's main decisions and reviews are made by committees, typically separated according to following core topics[99]:

1) GMB (General Management Board):

The GMB discusses topics with the need of decision making at the executive level. Therefore the top management as well as experts meet weekly or ad-hoc.
On the one hand side its focus lies on overall bank management issues, but on the other side a wide range of people is consulted related to each topic.

2) RICO (Firm's Risk Committee):

Firm's Risk Committee takes responsibility for the overall risk report, current risk situation of the institution (RWAs, VaR, etc.), the amount of the risk cap as well as bank's rating. Participants of this board are the Chief Risk Officer (CRO), the CFO, other executive and risk controlling staff. At the monthly meetings the focus lies on pure risk issues excluding governance and allocation decisions.

3) ALCO (Firm's Asset-Liability Committee):

ALCOS's topics are interconnected with governance as well as current capital, liquidity and profitability situation. On the personnel side the CFO, CRO, Treasury, RICO-members, FICO (Financial Committee), etc. are part of the council.

4) BS-Dialog (Business Segment Dialog Committee):

This committee treats with main questions concerning operative results, segment earnings and costs, central control parameters as well as value drivers. Therefore operative segment management, CRO/CFO, and other segment executives meet bi-annually. It includes following sub-councils:

a) Cost Committee (CoCO):

This committee covers the cost topic.

[99] ct. Annual Reports 2011, set of banks according to chapter 3.3, industry screening

b) Business Segment Committee (BSCO):

The focus of this committee lies on the earnings view per segment. Consequently each business segment has installed such a council.

Appraisal for Future Business (Segment) Management:

Unburden ALCO by implementing a separate Capital Committee (CAPCO) on the medium-term

In order to deal with the post-crisis market environment as well as tightening regulations capital should be of special interest. One way to focus on this scarce resource at overall bank management level states the medium-term implementation of a CAPCO (Firm's Capital Committee) in order to relieve the Asset-Liability-Committee in capital issues, but it would drive complexity.

Relief Corporate Development by installing a Regulatory and Project Committee (RPCO)

The RPCO is responsible for the integration of new regulations, etc., especially by the use of projects.

3.4.2 Capital Allocation Methods

3.4.2.1 Capital Allocation Approach 1 – Cost of Capital

This approach is based on the segment specific cost of capital (for determination on segment level please refer to chapter 3.3) representing the segment risks. This complementary improvement to the prevailing allocation method mentioned in 3.2 is necessary to bank management because volatilities differ heavily from segment to segment and therefore have big impact on accurate capital steering.

Core Idea:

The Cost of Equity are calculated as follows:

$$CE_k = E_k * COE_k \tag{3.6}$$

In order to incorporate the regulatory view (Basel III) the equity capital is replaced by the regulatory capital. Accordingly, the multiplication of the regulatory capital of business segment k with the cost of capital fraction of the same segment leads to the cost of regulatory capital in currency units.

$$CRC_k = RC_k * COC_k \tag{3.7}$$
$$with$$
$$RC_k = RWA_k * CR$$

CE_k … cost of equity capital of business segment k in €
E_k … equity capital of business segment k in €
COE_k … cost of equity capital of business segment k in %
CRC_k … cost of regulatory capital of business segment k in €
RC_k … regulatory capital of business segment k in € (ct. chapter 2.2.3)
COC_k … cost of capital fraction of business segment k in %
RWA_k … risk weighted assets of business segment k in € (ct. chapter 2.2.3)
CR … capital ratio in %; remark: in this concept a constant capital ratio CR is assumed.

With this approach not only regulatory capital RC_k on business segment level is used as leading logic for capital steering, but the real cost of capital as the "price for the capital".

Remark:
- this approach is shown from a regulatory perspective, but can also be applied with economic capital (ct. chapter 2.5.1 for further information regarding EC).

3.4.2.1.1 Construction - The Charging of Cost of Capital to the Segments

The charging of cost of capital to the business segments can have different bases of calculation. Therefore, three versions are investigated.

Version 1:

This version uses the actual amount of RWA of the current period as calculation base.

In this case the cost of regulatory capital (CRC) of a business segment are calculated as follows:

$$CRC_k = RWA_k * CR * COC_k$$
$$with$$
$$RWA_k = RWA_{k,actual}$$

CRC_k … cost of regulatory capital of business segment k in €
RWA_k … risk weighted assets of business segment k in €
$RWA_{k,actual}$ … actual risk weighted assets of business segment k in €
COC_k … cost of capital fraction of business segment k in %
CR … capital ratio in %; remark: in this concept a constant capital ratio CR is assumed. Regulatory capital RC=RWA*CR. For further information please refer to 2.2.3.1.2.

Version 1 is characterized that it generates no incentive for accurate planning on business segment level. Thus, the non-source-specific charging of CRC_k leads to potential inefficiencies in allocation and capital expenditure.

Version 2:

This version uses the maximum out of actual- and plan-RWA as calculation base.

In this case the CRC per business segment are calculated as follows:

$$CRC_k = RWA_k * CR * COC_k$$
$$with$$
$$RWA_k = max(RWA_{k,actual}; RWA_{k,plan})$$

$RWA_{k,plan}$ … previously planned risk weighted assets of business segment k in €

Version 2 has a low degree of complexity and the penalization of an underutilization increases the incentive for planning accuracy. As the major drawback the non-source-specific charging of CRC_k has to be mentioned.

Version 3:

This version uses the maximum out of actual- and plan RWA and additionally a penalty payment in the case of a plan-exceedance as calculation base.

In this case the CRC_k are calculated as follows:

$$CRC_k = RWA_k * CR * COC_k + PP_k \tag{3.8}$$

$$with$$

$$RWA_k = max\left(RWA_{k,actual}; RWA_{k,plan}\right)$$

$$PP_k = max\left(RWA_{k,actual} - RWA_{k,plan}; 0\right) * CR * PF_k$$

PF_k … penalty fraction of business segment k in %

PP_k … penalty payment of business segment k in €

Version 3 generates incentive for accurate planning as well as source-specific charging of CRC_k, but a complex charging logic is inherent.

Because of the source-specific charging mechanism version 3 is recommended for practical usage and will be used in the following steps.

3.4.2.1.2 Calibration - The Disclosure of Business Segment-specific Cost of Capital Fractions

The cost of capital fractions per business segment consist of
a) a *COC-Socket Fraction*, represented by the COC of the market segment i[100] and the actual COC of the business segment k
as well as
b) an additional *Penalty Fraction*, which is valid in the case of a market segment-level exceedance

The Disclosure of Business Segment-specific Cost of Capital Fractions depends on the Market Condition

a) COC-Socket Fraction COC_k

Option 1 has its orientation on business segments:

$$COC_{k,option\,1} = COC_{k,actual} \tag{3.9}$$

$COC_{k,actual}$ … actual cost of capital of business segment k in %[101]

Option 2 is set up with the market as reference:

$$COC_{k,option\,2} = min(COC_{i,actual}; COC_{k,actual}) \tag{3.10}$$

$COC_{i,actual}$ … actual cost of capital of market segment i in %

While option 1 uses the real cost of capital and is easy to calculate, option 2 ensures competitive power against the market and generates the incentive to hold the business segment cost of capital below the market level. The decision which option to choose has to be made in the *Capital Committee (CAPCO)* defined in 3.4.1.

[100] The market segment i is represented by: Retail, Corporate, Investment Banking, CEE, Asset Management and Other as defined in 3.3.1.2; the numbers can be found in 3.3.3
[101] Cost of Capital-fractions on segment level of banks used in the study in 3.3 can be found in the appendix (6.1), figure 31

In the following option 1 is used:

$$COC_k = COC_{k,option\,1} \quad (3.11)$$
$$with$$
$$COC_{k,option\,1} = COC_{k,actual}$$

b) Penalty Fraction$_k$

This penalty is valid in the case of a market segment-level exceedance

$$PF_k = max(\,COC_{k,actual} - \,COC_{i,actual}; 0) \quad (3.12)$$

3.4.2.1.3 Overview employment of Capital and Earnings Situation after Cost of Capital in the Business Segments

In order to illustrate the capital as well as the earnings situation after CRC I set up an illustrative example for a major German bank. This example is an excerpt out of the study in 3.3.1.

business segment k	Private Customers	Mittelstandsbank	Central&Eastern Europe	Corporates & Markets	Asset Based Finance	
$COC_{k,actual}$ (in %)	8.5	5.9	8.3	7.2	5.9	
$COC_{i,actual}$ (in %)	5.5	5.4	10.0	5.1	4.8	
$RWA_{k,actual}$ (in € bn.)	27,2	53,2	16,0	26,5	64,6	
$RWA_{k,plan}$ (in € bn.)	29,4	54,3	15,8	23,4	65,1	Dummy-Figures
Pre-tax earnings (in € MM)	245	1.649	-28	197	-1.568	
PF_k (in %)	0	0	**0**	**2,1**	0	
CRC (in € MM)	126	151	45	89	173	
PP_k (in € MM)	0	0	0	3	0	
Pre-tax Earnings. after CRC (in MM €)	119	1.498	-73	108	-1.741	

No further PP, if $COC_{k,actual} < COC_{i,actual}$

Figure 26: Illustrative Example[102]

[102] data source: market segment COC_i out of market study in 3.3.4, figure 25 (Retail: 5.5%; Corporate: 5.4%; CEE: 10%; Inv. Banking: 5.1%; Asset Mgmt.: 4.8%; Segment COC_k out of 6.1, figure 31; remaining: Annual Report 2012, Commerzbank

An illustration for the business segment k=Corporates & Markets:

COC-Penalty in % of business segment k:

$$PF_k = max.(\ COC_{k,actual} - \ COC_{i,actual}; 0) = max(7.2\% - \ 5.1\%; 0) = 2.1\%$$

COC-Socket Fraction COC_k (Option 1):

$$COC_k = COC_{k,actual} = 7.2\%$$

CRC in € MM of business segment k:

Assumptions:
- constant CR= 9% (For further information concerning the capital ratio please refer to 2.2.3.1.2.)
- average bounded RWA not taken into account; therefore a fraction of 0.5 is used for illustration

$$CRC_k = \left[max\left(RWA_{k,actual}; RWA_{k,plan}\right) * CR * COC_k \ + max\left(RWA_{k,actual} - RWA_{k,plan}; 0\right) * CR * \ PF_k\right] * 0.5 = [max(26.5 * 10^3€MM; 23.4 * 10^3€MM) * 9\% * 7.2\% + (26.5 * 10^3€MM - 23.4 * 10^3€MM) * 9\% * 2.1\%] * 0.5 =$$88.79 €MM

Penalty Payment in € MM of business segment k:

$$PP_k = max\left(RWA_{k,actual} - RWA_{k,plan}; 0\right) * CR * \ PF_k = [(26.5 * 10^3€MM - 23.4 * 10^3€MM) * 9\% * 2.1\%] * 0.5 = 2.93$$ €MM

3.4.2.2 Capital Allocation Approach 2 – RORAC-Optimization

Concept 2 deals with the implementation of the overall bank RORAC optimization approach by Buch et al. (2011) in practice (refer to chapter 3.2 for predominant status quo). From an organizational point of view chapter 3.4.1 is assumed to be in the implementation phase.

3.4.2.2.1 The quantitative approach in brief

The overall bank-RORAC is optimized by determination of optimal segment investments. A further property is that this capital allocation ensures central planning and the pure regulatory view is replaced by the economic view (ct. chapter 2.5). Thus, the allocation approach involves diversification effects. From an organizational point of view Business Segment Controlling uses information and experience on location in the business segments.

For further details as well as the implementation with the software package R please refer to chapter 3.4.2.2.3.

3.4.2.2.2 How to implement in existing bank structure

Optimal capital allocation requires besides the economic risk view a central as well as decimated, decentralized capital management.

This implementation has the advantage that it enables optimal capital allocation with regard to the overall bank. Furthermore, segment risks from an economic view are integral part of the optimization. The approach allows gaining the optimum out of a central and decentralized capital management structure. Additionally, calculated BS-investment size fractions represent an excellent basis for discussion entailing the relief of the committees introduced in chapter 3.4.1. Moreover, the strong reduction of the decentralized localization of capital management functions eases target-oriented steering significantly.
This approach requires a bank-wide establishment of economic capital and risk-adjusted performance measures. Additionally, significant effort concerning organizational and human resource topics are required and an extremely wide job profile and qualification level is mandatory, especially in the central capital management unit (profound organizational, mathematical as well as IT-skills).

3.4.2.2.3 Quantitative Implementation - Overall Bank RORAC Optimization and the Problem of Decentralization

In this section the capital allocation approach by Buch et al. (2011) as well as the stochastic planning and control framework by Schwaiger (2012) is used. This chapter is intended to illustrate the ideas of Buch et al. (2011) in an applicable software code. Moreover, extensions due to economic and multi segment reasons are set up and are implemented.

3.4.2.2.3.1 Introduction to Quantitative Capital Allocation

If the sum of overall Economic Capital of several business segments is higher than its total equity, one has to decide in which business segment to invest. In this case, *diversification effects* play a major role. Therefore, risk-adjusted performance measures are not only predestinated to compare business segments with each other, they are also a prevailing tool for coherent capital allocation and optimization.

Why Risk Capital Allocation:

Typically, it is stated that the allocation is necessary to control risks ex ante by assigning limits to individual business segments and its necessity for performance measurement is emphasized. On the other hand, risk capital allocation is also subject to criticism, but the question emerges concerning why the optimum amounts of every line of business are not more adequately directly optimized by the headquarters.[103]

Target Audience for the core-approach:

Buch et al. (2011) address financial firms[104] with different business segments, for which the managerial decision concerns whether to expand or reduce rather than to create newly or abandon completely. A Gaussian distribution is assumed as leading logic.

- Bank specific view:

In banks the economic capital to be allocated could cover market, credit and operational risk (Alessandri and Drehmann (2010); Breuer et al. (2010); Embrechts et al. (2003)) or classically credit risk in a portfolio context (Rosen and Saunders (2010))

- Insurance company perspective:

Companies' risk capital could be allocated for different lines of insurance contracts (Urban et al. (2004))[105].

[103] ct. Buch et al. (2011), p.3

[104] The core approach is not restricted to certain specific risk measures or distributional assumptions and therefore addresses banks as well as insurance companies the same way.

[105] ct. Buch et al. (2011), p.3f.

3.4.2.2.3.2 Stochastic Preparation in the Context of Decentralized Organizations

Stochastic Enterprise Control Framework

Buch et al. (2011) implicitly suppose that decentralized financial institutions are composed out of different business segments. The *segments* are managed by segment managers and therefore act as *infimal decision units*. The superior bank management acts as *supremal decision unit*[106].

The *stochastic performance* Y(u) is modeled as a *function* of the control input u and is decomposed into the *deterministic mean performance function M(u)* and the *stochastic fluctuation function X(u)*.

$$\widetilde{Y}(u) = M(u) + \widetilde{X}(u)$$

This bank performance function Y(u) is segmented into segment performance functions $Y_k(u_k)$.

$$\begin{aligned}\widetilde{Y}(u) &= \sum_k \widetilde{Y}_k(u_k) \\ &= \underbrace{\sum_k M_k(u_k)}_{M(u)} + \underbrace{\sum_k \widetilde{X}_k(u_k)}_{\widetilde{X}(u)}\end{aligned}$$

The stochastic segment fluctuation function $X_k(u_k)$ is assumed to be Gaussian (normal) distributed with mean M_k and variance $\sigma^2_{X(k)}$[107].

$$\begin{aligned}&\widetilde{X}_k(u_k) \sim N(0, \sigma^2_{X(k)}(u_k)) \\ &\textit{such that} \\ &\widetilde{Y}_k(u_k) \sim N(M_k(u_k), \sigma^2_{X(k)}(u_k)) \\ &\textit{and} \\ &\widetilde{Y}(u) \sim N(M(u), \sigma^2_X(u))\end{aligned}$$

Risk Aggregation

The *Bank Volatility Function: $\sigma_X(u)$* is the quadratic aggregation of the segment volatilities $\sigma_{X(i)}(u_i)$ so that the correlation terms $\varrho_{X(i),X(j)}$ are incorporated.[108]

$$\sigma_X(u) = \sqrt{\sum_i \sum_j \sigma_{X(i)}(u_i) \cdot \rho_{X(i),X(j)} \cdot \sigma_{X(j)}(u_j)}$$

[106] For further reading according to "Theory of Hierarchical, Multilevel, Systems" see Mesarovic et al. (1970)

[107] Due to the linear decomposition and segmentation the Gaussian distribution stochastics of the segment fluctuation functions $X_k(u_k)$ carry over to the bank performance function Y(u) which is accordingly also Gaussian distributed.

[108] Because the segment fluctuation functions represent themselves aggregated VaR functions such that the bank volatility function is based at least on a 2-step aggregation.

Bank VaR and Segment VaR

The *Fluctuation Value at Risk* Function: $VaR_X^{1-\alpha}(u)$ (on enterprise as well on segment level) is modeled as the (1-α)-percentile of the standard normal distribution times the enterprise volatility function.

$$VaR_X^{1-\alpha}(u) = z^{1-\alpha} \cdot \sigma_X(u)$$
$$and$$
$$VaR_{X(k)}^{1-\alpha}(u_k) = z^{1-\alpha} \cdot \sigma_{X(k)}(u_k)$$

Enterprise Performance VaR Function[109]: $VaR_Y^{1-\alpha}(u)$ is the fluctuation Value at Risk function $VaR_X^{1-\alpha}(u)$ minus the mean performance function M(u)

$$VaR_Y^{1-\alpha}(u) = VaR_X^{1-\alpha}(u) - M(u)$$

The same way *Segment Performance VaR* Function: $VaR_{Y(k)}^{1-\alpha}(u_k)$ is related to the segment specific fluctuation Value at Risk and mean performance functions

$$VaR_{Y(k)}^{1-\alpha}(u) = VaR_{X(k)}^{1-\alpha}(u) - M(u)$$

Bank RORAC and Segment RORAC

Bank (Segment) RORAC Function: RORAC(u) is modeled as the ratio out of the bank (segment) mean performance function and the bank (segment) performance Value at Risk function

$$RORAC^{1-\alpha}(u) = \frac{M(u)}{VaR_Y^{1-\alpha}(u)} = \frac{M(u)}{VaR_X^{1-\alpha}(u) - M(u)}$$

and on segment level among

$$RORAC_k^{1-\alpha}(u_k) = \frac{M_k(u_k)}{VaR_{Y(k)}^{1-\alpha}(u_k)} = \frac{M_k(u_k)}{VaR_{X(k)}^{1-\alpha}(u_k) - M_k(u_k)}$$

[109] According to Buch et al. (2011) $VaR_Y^{1-\alpha}(u)$ implies that at the headquarters level, only the risk of the profit fluctuations is distributed among the segments. That is, the segments receive their per-unit risk contribution related to their fraction of the profit fluctuation represented by $VaR_X^{1-\alpha}(u)$. Once these contributions are calculated, the actual required and allocated economic capital is determined by subtracting each segment's expected profit.

Marginal Volatility and Euler Theorem

Marginal Segment Volatility Function: $mVola_{X(k)}(u)$ remains out of the partial derivative of the enterprise volatility function $\sigma_X(u)$ with respect to the control variable u_k

$$mVola_{X(k)}(u) = \frac{\partial \sigma_X(u)}{\partial u_k}$$

Euler Theorem: The marginal segment volatility functions $mVola_{X(k)(u)}$ multiplied with the current control inputs u_k and summed up correspond to the bank volatility function $\sigma_X(u)$. By the Euler theorem the *diversification effects are split to the segments.*[110]

$$\sum_k mVola_{X(k)}(u) \cdot u_k = \sigma_X(u)$$

Marginal Mean and Marginal VaR

The *Marginal Segment Mean Contribution* Function: $mM_k(u_k)$ is calculated as the derivative of the segment mean performance function $M_k(u_k)$ with respect to the control variable u_k.

$$mM_k(u_k) = \frac{\partial M_k(u_k)}{\partial u_k}$$

And the *Marginal Segment Risk Contribution* Function: $mVaR_{X(k)}^{1-\alpha}(u)$ equals to the partial derivative of the enterprise performance Value at Risk function $VaR_X^{1-\alpha}(u)$ with respect to the control variable u_k.

$$mVaR_{X(k)}^{1-\alpha}(u) = \frac{\partial VaR_X^{1-\alpha}(u)}{\partial u_k}$$

Marginal RORAC

The *Marginal Segment RORAC* Function $mRORAC_k(u)$ is equal to the ratio of the marginal segment mean contribution function $mM_k(u_k)$ divided by the *marginal segment performance VaR* function $mVaR_{Y(k)}^{1-\alpha}(u)$ (marginal segment risk contribution function $mVaR_{X(k)}^{1-\alpha}(u)$ minus the marginal segment mean contribution function $mM_k(u_k)$)

$$mVaR_{Y(k)}^{1-\alpha}(u) = mVaR_{X(k)}^{1-\alpha}(u) - mM_k(u_k)$$

[110] ct. Tasche (2008), p. 4

$$mRORAC_k^{1-\alpha}(u) = \frac{mM_k(u_k)}{mVaR_{Y(k)}^{1-\alpha}(u)} = \frac{mM_k(u_k)}{mVaR_{X(k)}^{1-\alpha}(u) - mM_k(u_k)}$$

Euler Allocation Principle in the context of Marginal VaR

According to the *Euler Theorem*[111] the marginal segment risk contribution functions $mVaR_{X(k)}{}^{1-\alpha}(u)$ multiplied with the current control inputs u_k and summed up correspond to the bank fluctuation Value at Risk function $VaR_X{}^{1-\alpha}(u)$.[112]

$$\sum_k mVaR_{X(k)}^{1-\alpha}(u) \cdot u_k = VaR_X^{1-\alpha}(u)$$

$$\sum_k \underbrace{mVaR_{X(k)}^{1-\alpha}(u)}_{a_{X(k)}^{1-\alpha}(u)} \cdot u_k$$

such that

$$\sum_k \underbrace{a_{X(k)}^{1-\alpha}(u) \cdot u_k}_{A_k^{1-\alpha}(u)} = VaR_X^{1-\alpha}(u)$$

$$\sum_k A_k^{1-\alpha}(u) = VaR_X^{1-\alpha}(u)$$

[111] ct. Tasche (2008)

[112] Buch et al.(2011) use $a_{X(k)}{}^{1-\alpha}(u)$ instead of $mVaR_{X(k)}{}^{1-\alpha}(u)$ as the *Per Unit Segment Risk Contributions*. Remark: As Tasche (2002) for instance mentions, VaR is not a coherent risk measure due to missing sub-additivity property., Nevertheless, with the restriction of Gaussian distributions it is indeed sub-additive, as Artzner et al. (1999) describe.

3.4.2.2.3.3 R-Implementation of the core RORAC-Optimization Approach

3.4.2.2.3.3.1 Core Ideas

Problem:

For demonstration of the Risk-adjusted Bank Performance Management with regard to the ideas of Buch et al. (2011) the stochastic enterprise control framework is applied to a decision problem within a decentralized organization represented by a bank with two risky segments.[113]

Expected Result and Methods used:

In order to **find** an **optimal overall bank-RORAC** (for one period) following steps are set up:

a) Iterative optimization with n steps

The decision to expand or reduce the investment (represented by a positive or negative $\varepsilon_k^{x(i)}$) is selected by comparing the marginal segment RORAC $mRORAC_k^{1-\alpha}$ with the enterprise RORAC (including Euler Allocation Principle).

b) Selection of optimal segment investment sizes

By using approximated marginal segment RORAC function (2nd order function) the tangible adjustments for the two segment investments are determined. (ct. 3.4.2.2.3.4.2.1)[114]

$$iRORAC_k^{1-\alpha,(i)}(\varepsilon_{k,opt}^{x,(i)}) = \frac{M_k(u_k^{(i)} + \varepsilon_{k,opt}^{x,(i)}) - M_k(u_k^{(i)})}{\varepsilon_{k,opt}^{x,(i)} \cdot a_k^{1-\alpha}(u^{(i)}) + 0.5 \cdot (\varepsilon_{k,opt}^{x,(i)})^2 \cdot \Lambda - (M_k(u_k^{(i)} + \varepsilon_{k,opt}^{x,(i)}) - M_k(u_k^{(i)}))} \qquad (3.13)$$

Λ represents the upper bound for the largest eigenvalue of the Hessian of the risk measure.[115] The second order approximation (denominator) ensures convergence to the optimal enterprise RORAC.[116] In more detail, the quadratic term in the denominator represents the quadratic approximation of the risk, including the largest eigenvalue of the Hessian Matrix of the risk measure. (Remark: The risk measure has volatilities, and the second derivatives are in the Hessian Matrix. The largest eigenvalue of that matrix is used to limit the risk so that the contributions cannot get in a negative direction. In other words the lender term ensures a clear way to appropriately increase the investments.)

---

[113] Remark: this example illustrates the model and does not want to satisfy a deep economic sense.

[114] While $mRORAC_k^{1-\alpha}$ derives the mean and volatility function (VaR) with respect to the control variable u_k, $iRORAC_k^{1-\alpha}$ evaluates the mean function at different points (different levels of the control variable u_k).

[115] ct. Buch et al. (2011), p.9 concerning the definition and p.15 for calculation. The Hessian $H(u) = \left[\frac{\partial^2 \rho_X(u)}{\partial u_i \partial u_j}\right]$ of the risk measure ρ_X(u) ensures much better optimization (max. of $iRORAC_k^{1-\alpha,(i)}(\varepsilon_{k,opt}^{x(i)})$) because it denotes the coefficient of the quadratic term of the Taylor expansion of the function.

[116] $(\varepsilon_{k,opt}^{x(i)})^2$ in the denominator increases the marginal RORAC, represented by $iRORAC_k^{1-\alpha,(i)}(\varepsilon_{k,opt}^{x(i)})$, in the case of a big value of ε_k (i.e. big size of expansion) and vanishes for small values. Consequently a very good approximation can be achieved.

3.4.2.2.3.3.2 Construction and Calibration

3.4.2.2.3.3.2.1 Primary Note

For construction and calibration the ideas and assumptions of Buch et al. (2011), p. 12 (numerical example) are used.

Therefore a bank with two risky business segments is set up with the control input

$$u_1 = 1.5;\ u_2 = 1.7$$

The VaR significance level is assumed to be 99.97%.
As deterministic segment mean performance function a fictive, differentiable function is used

$$M_k(u_k) = ln(u_k + 0.5)$$

as well as following segment volatility function (including u_k)

$$\sigma_k(u_k) = u_k$$

This function is just established for illustration and does not want to satisfy any economic sense.

The segment correlation $\varrho_{X(1),X(2)}$ is assumed to be 0.5[117] and Λ is supposed to be 0.99016.

$delta_{uk}=0.5*\varepsilon_k$ states a rought estimation for the optimal selected investment size $\varepsilon_{k,opt}$ changing the control input u_k per iterative step so that

$$u_k^{(i+1)} = u_k^{(i)} + \varepsilon_{k,opt}^{(i+1)}$$

For the numerical calculations the software package R is used[118]:

[117] $\varrho_{X(1),X(2)}$ will be represented by ABcorr in the following R-code
[118] http://www.r-project.org

3.4.2.2.3.3.2.2 R-Code

```
#-------------------------------------------------------------------------------------------------------------------------------

#Risk capital allocation for RORAC optimization (core-approach implementation)


library(rootSolve)

ABcorr <- c(0.5)                                    #segment correlation (A & B)
VaRsign_level <- 0.9997                             #1-alpha
z_value <- qnorm(VaRsign_level, mean=0, sd=1)       #quantile, z-value;
lambda <- 0.99016                                   #lambda is upper bound for the largest eigenvalue of the
                                                    #Hessian of the risk measure
n <- 20                                             #Number of Iterations


u1 <- 1.5000                                        #control input segment 1
u2 <- 1.7000

mu1 <- log(u1+0.5)                                  #segment mean perf. function
mu2 <- log(u2+0.5)
mu1_prime <- 1/(u1+0.5)                             #first derivative of mu1
mu2_prime <- 1/(u2+0.5)

PF <- mu1+mu2                                       #deterministic mean performance function

sigmaPF <- sqrt(u1^2+u2^2+2*ABcorr*u1*u2)           #quadratic aggregation includes diversif. eff.
VaR <- sigmaPF*z_value                              #enterprise performance VaR(VaRY)
mVaR_u1 <- z_value*(u1+ABcorr*u2)/sigmaPF           #a1;
mVaR_u2 <- z_value*(u2+ABcorr*u1)/sigmaPF

RORAC <- PF/(VaR-PF)
RORAC

mRORAC1 <- mu1_prime/(mVaR_u1-mu1_prime)
mRORAC1

mRORAC2 <- mu2_prime/(mVaR_u2-mu2_prime)
mRORAC2

#------------------

j <- 1
while(j <= n) {

#----

iRORAC1 <- function(eps1) {

M_upluseps_minus_M_u_1 <- log(u1+eps1+0.5)-log(u1+0.5)
ret <- M_upluseps_minus_M_u_1/(eps1*mVaR_u1+0.5*lambda*eps1^2-M_upluseps_minus_M_u_1)
return(ret)

}

#----

iRORAC2 <- function(eps2) {

M_upluseps_minus_M_u_2 <- log(u2+eps2+0.5)-log(u2+0.5)
ret <- M_upluseps_minus_M_u_2/(eps2*mVaR_u2+0.5*lambda*eps2^2-M_upluseps_minus_M_u_2)
return(ret)

}
```

```
#----

eps1_start <- -1
eps2_start <- -1

f <- function(params){

  eps1 <- params[1]
  eps2 <- params[2]
  irorac1 <- iRORAC1(eps1)
  irorac2 <- iRORAC2(eps2)
  return(c(irorac1-RORAC,irorac2-RORAC))

}

sol <- multiroot(f,c(eps1_start,eps2_start))

eps1 <- sol$root[1]
eps2 <- sol$root[2]

cat("\n\n")
cat("estimated eps1-value:",eps1,"\n\n")
cat("estimated eps2-value:",eps2,"\n\n")

delta_u1 <- 0.5*eps1
delta_u2 <- 0.5*eps2
u1 <- u1+delta_u1
u2 <- u2+delta_u2
mu1 <- log(u1+0.5)                              #segment mean perf. function
mu2 <- log(u2+0.5)
mu1_prime <- 1/(u1+0.5)                         #first derivative of mu1
mu2_prime <- 1/(u2+0.5)
PF <- mu1+mu2                                   #deterministic mean performance function

sigmaPF <- sqrt(u1^2+u2^2+2*ABcorr*u1*u2)       #quadratic aggregation includes diversif. eff.
VaR <- sigmaPF*z_value                          #enterprise performance VaR(VaRY)
mVaR_u1 <- z_value*(u1+ABcorr*u2)/sigmaPF       #a1;
mVaR_u2 <- z_value*(u2+ABcorr*u1)/sigmaPF

RORAC <- PF/(VaR-PF)
j<-j+1

}

#------------------
cat("\n\n")
cat("optimal enterprise RORAC:",100*RORAC,"%\n")

u1_fraction_opt <- u1/(u1+u2)                   #optimal allocation fraction segment 1
u2_fraction_opt <- u2/(u1+u2)

cat("\n\n")
cat("Enterprise-RORAC-optimal capital allocation for SEGMENT 1:",100*u1_fraction_opt,"%\n")
cat("Enterprise-RORAC-optimal capital allocation for SEGMENT 2:",100*u2_fraction_opt,"%\n")
#-----------------------------------------------------------------------------------------------------------------------------------------------------------
```

3.4.2.2.3.3.3 Results

1)
n=20 iterations:
u1= 1.5
u2=1.7
no risk capital limit (therefore the control inputs u_k at the end of the optimization process are the same)

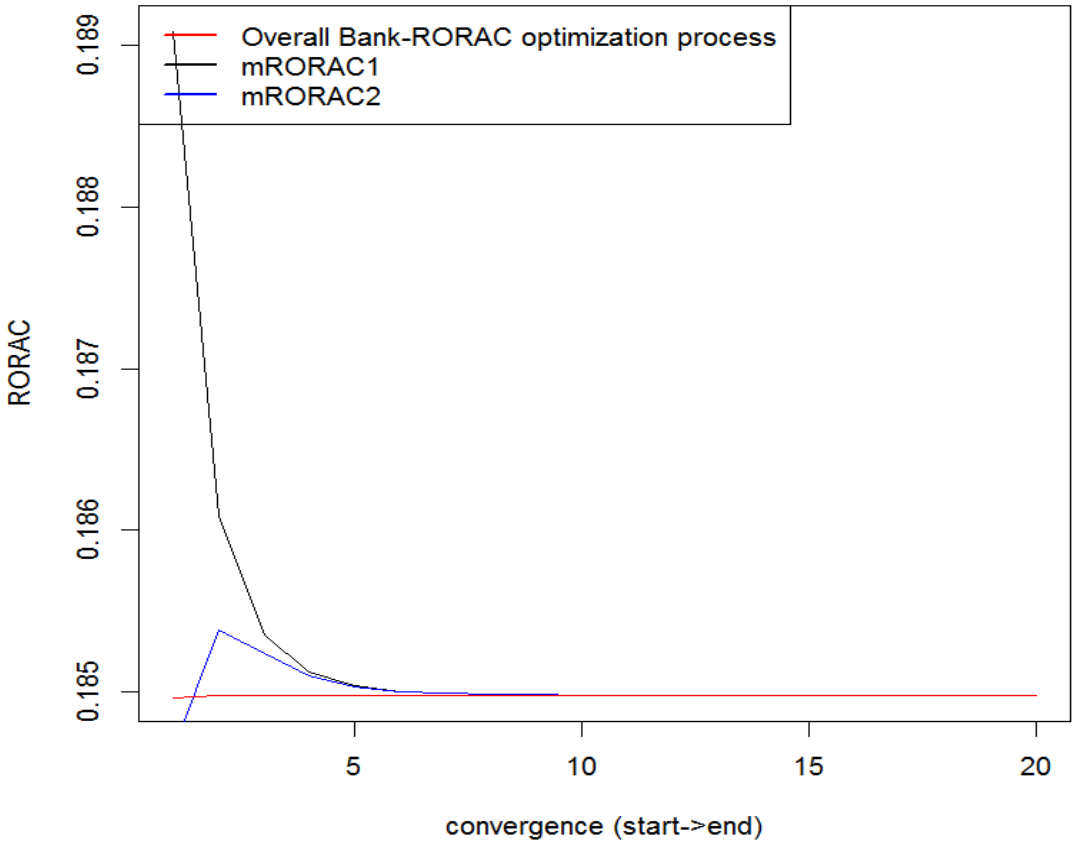


Figure 27: RORAC Optimization 1

optimal enterprise RORAC: 18.4981 %

2)
n=20 iterations:
u1= 2.5
u2= 1.7
no risk capital limit (therefore the control inputs u_k at the end of the optimization process are the same)

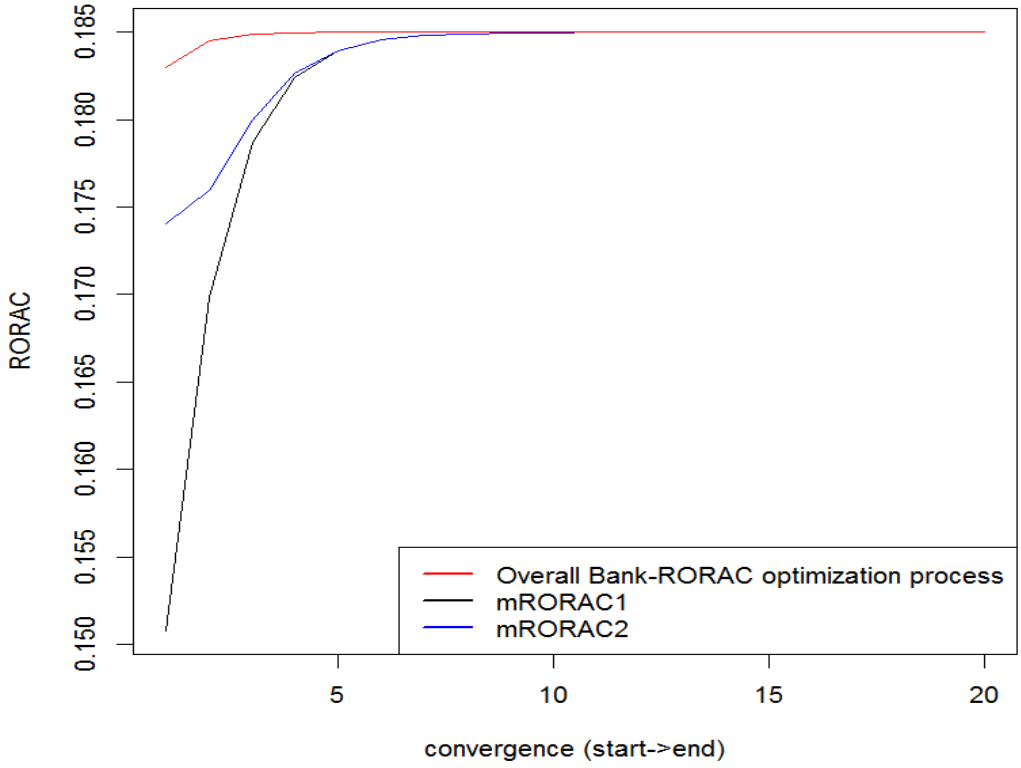


Figure 28: RORAC Optimization 2

optimal enterprise RORAC: 18.4981 %

3.4.2.2.3.4 Extension due to Multi-Segment Institutions and Economic Reasons in the Context of Decentralized Enterprises

3.4.2.2.3.4.1 Core Ideas

In order to use the core ideas by Buch et al. (2011) more realistic extensions due to economic reasons have to be made. Furthermore, following R-Implementation shows the way of how to handle multiple risky bank business segments in the context of the *stochastic bank planning and control framework* by Schwaiger W. (2012)[119].

3.4.2.2.3.4.2 Construction and Calibration

3.4.2.2.3.4.2.1 Construction

Control Inputs

Therefore a bank with three risky business segments is set up with the *control inputs* u_k symbolizing the amount of business of the business segment k. (the sum of the segment control inputs equals to the overall investment u)

Mean Performance Function

As *deterministic segment mean performance function* following differentiable function is used

$$M_k(u_k) = u_k * \mu_{ROA\,(k)} = u_k * avg(ROA_k(y-1,y)) = u_k * (\Sigma ROA_k(y-1,y))/T \quad (3.14)$$

$\mu_{ROA\,(k)}$ … historical return on assets mean of business segment k in %

$ROA_k\,(y-1,y)$ … return on assets of business segm. k (bank B) and time frame (y-1, y) in %

T … number of financial periods investigated

(Segment) Volatility Function

as well as following *segment volatility function* (including u_k)

$$\sigma_{X(k)}(u_k) = u_k * \sigma_{ROA\,(k)} = u_k * [\Sigma(ROA_k(y-1,y) - avg[ROA_k(y-1,y)])^2 / (T-1)]\text{^}1/2 \quad (3.15)$$

$\sigma_{ROA\,(k)}$ … historical return on assets volatility of business segment k in %

y or y-1 represent the investigated and its previous financial period.

[119] Schwaiger W. (2012) therefore extends the cybernetic planning and control framework introduced by Anthony (1965) and incorporates ideas of Mesarovic et al. (1970)

This function is established in order to link the return on assets volatility with the control input. The segment correlation $\varrho_{X(1),X(2)}$ is directly calculated with the software R[120].

Optimal Investment Size

Based on the ideas of 3.4.2.2.3.3.1 following clarifications are set up:

Λ is computed via the R-package 'numDeriv'.
$delta_{uk}=\varepsilon_{k,opt}$ is set up for the optimal selected investment size $\varepsilon_{k,opt}$ changing the control input u_k per iterative step so that

$$u_k^{(i+1)} = u_k^{(i)} + \varepsilon_{k,opt}^{(i+1)}$$

The optimal selected investment size $\varepsilon_{k,opt}$ is computed regarding the core ideas mentioned in 3.4.2.2.3.3.1. Therefore $RORAC_k^{1-\alpha}(u_k) = \frac{M_k(u_k)}{VaR_{Y(k)}^{1-\alpha}(u_k)}$ is differentiated and set to 0 and $mRORAC_k^{1-\alpha}(u_k)$ is replaced by $iRORAC_k^{1-\alpha}(\varepsilon_k)$.

Accordingly, $\varepsilon_{k,opt}$ is calculated out of

$$iRORAC_k^{1-\alpha}(\varepsilon_k) - RORAC := 0$$

The result of the calculation can be found in the R-code (eps1, etc.) in 3.4.2.2.3.4.2.4.

3.4.2.2.3.4.2.2 Calibration

Control Inputs

The *control inputs* of the bank business segments are calibrated with the segment total assets

$$u_k \overset{!}{=} ta_k(y-1)$$

$ta_k(y-1)$ … total assets of business segment k of financial year 2012 in €

symbolizing the amount of business of these business segments k.

The VaR significance level is assumed to be 99.97%.

[120] $\varrho_{X(1),X(2)}$ will be represented by ABcorr in the following R-code

Mean Performance Function

As *deterministic segment mean performance function* following calibration with available data is used

$$M_k(u_k) = u_k \ * \ \mu_{ROA\,(k)} = u_k \ * avg(ROA_k(y-1,y)) = u_k \ * (\Sigma ROA_k(y-1,y))/T$$

with

$$ROA_k \overset{!}{=} ni_k/ta_k$$

$\mu_{ROA\,(k)}$ … historical return on assets mean of business segment k (2008-2012) in %[121]

$ROA_k\ (y-1,y)$ … after-tax return on assets of business segm. k (bank B) and time frame (y-1, y) in %

Segment Volatility Function

as well as following *segment volatility function* (including u_k)

$$\sigma_{X(k)}(u_k) = \ u_k \ * \ \sigma_{ROA\,(k)}$$
$$= u_k \ * [\Sigma(ROA_k(y-1,y) - \ avg[ROA_k(y-1,y)])^2 \ / \ (T-1)]\text{^}1/2$$

with

$$ROA_k \overset{!}{=} ni_k/ta_k$$

$\sigma_{ROA\,(k)}$ … historical after-tax return on assets volatility of business segment k (2008-2012) in %[122]

Bank RORAC

Because the control inputs u_k are modeled with the total assets per business segment, the nominator of the Bank-RORAC (net income related to economic capital) has to be calibrated accordingly.

$$\widetilde{RORAC}^{1-\alpha}(u) \overset{!}{=} \tilde{x} * \ RORAC^{1-\alpha} = \frac{\tilde{x} * \ M(u)}{VaR_X^{1-\alpha}(u) - M(u)}$$

with

$$\tilde{x} = \underbrace{\frac{ni(y-1)}{ta(y-1)}}_{\widetilde{ROA(y-1)}} * \frac{ROE(y-1)}{ROA(y-1)} = ROE(y-1)$$

[121] for real bank data used in the following refer to 3.3.2.2 and Annual Reports
[122] for real bank data used in the following refer to 3.3.2.2 and Annual Reports

$ROA\ (y-1)$ … after-tax return on assets of bank B, previous financial year 2012 in %
$ROE\ (y-1)$ … after-tax return on equity of bank B, previous financial year 2012 in %
$\tilde{x}$ … bank RORAC (nominator) calibration factor

Marginal RORAC and Incremental RORAC

Because the control inputs u_k are modeled with the total assets per business segment, the nominator of the marginal (incremental) business segment RORAC has to be calibrated appropriately.

$$m\widetilde{RORAC}_k^{1-\alpha}(u) \stackrel{!}{=} \widetilde{y_k} * mRORAC_k^{1-\alpha}(u) = \frac{\widetilde{y_k} * mM_k(u_k)}{mVaR_{X(k)}^{1-\alpha}(u) - mM_k(u_k)}$$

and

$$i\widetilde{RORAC}_k^{1-\alpha}(\varepsilon_k) \stackrel{!}{=} \widetilde{y_k} * iRORAC_k^{1-\alpha}(\varepsilon_k)$$

with

$$\widetilde{y_k} = \frac{ROE_k(y-1)}{ROA_k(y-1)}$$

$ROA_k\ (y-1)$ … after-tax return on assets of business segment k, previous financial year 2012 in %
$ROE_k\ (y-1)$ … after-tax return on equity of business segment k, previous financial year 2012 in %
$\widetilde{y_k}$ … mRORAC (nominator) calibration factor of business segment k

3.4.2.2.3.4.2.3 Remarks on Economic (Risk) Capital

In the style of Buch et al. (2011) $VaR_Y^{1-\alpha}(u)$ implies that at the headquarters level, the risk of the return on assets fluctuations is distributed among the segments. That is, the segments receive their per-unit risk contribution $mVaR_{X(k)}^{1-\alpha}(u)$ related to their fraction of the return on assets fluctuation represented by $VaR_X^{1-\alpha}(u)$. Once these contributions are calculated, the actual required and allocated economic capital is determined by subtracting each segment's expected return on assets (historically calibrated). [123]

[123] ct. Buch et al. (2011) and 3.4.2.2.3.2

3.4.2.2.3.4.2.4 R-Code

```
#-----------------------------------------------------------------------------------------------------------------------------
#Risk capital allocation for RORAC optimization (multi segment extension, econ. reasons)
#goal: code to be easily comprehensible

library(rootSolve)

RORAC_last100 <- 0
mRORAC1_last100 <- 0
mRORAC2_last100 <- 0
mRORAC3_last100 <- 0

ni_B <- c(59000000, -4633000000, 1489000000, 747000000, 69000000)      #ni [euro]
ni_1 <- c(569000000, -196000000, 47000000, 476000000, 245000000)       #private customers: c(2008...2012)
ni_2 <- c(719000000, 528000000, 1598000000, 1588000000, 1649000000)    #mittelstandsbank
ni_3 <- c(-63000000, -571000000, 786000000, 583000000, 197000000)      #corporates and markets

periods<-dim(ni_B)[,1]

#total assets [euro]
ta_1 <- c(38596000000, 69220000000, 60565000000, 68293000000, 65511000000)
ta_2 <- c(74675000000, 85235000000, 83877000000, 88406000000, 80747000000)
ta_3 <- c(138159000000, 300211000000, 243336000000, 204921000000, 213781000000)

#after tax return on assets [1]
ROA_1 <- c(ni_1[1]/ta_1[1], ni_1[2]/ta_1[2], ni_1[3]/ta_1[3], ni_1[4]/ta_1[4], ni_1[5]/ta_1[5])
ROA_2 <- c(ni_2[1]/ta_2[1], ni_2[2]/ta_2[2], ni_2[3]/ta_2[3], ni_2[4]/ta_2[4], ni_2[5]/ta_2[5])
ROA_3 <- c(ni_3[1]/ta_3[1], ni_3[2]/ta_3[2], ni_3[3]/ta_3[3], ni_3[4]/ta_3[4], ni_3[5]/ta_3[5])

ROE_B <- c(0, 0, 0, 0, 0.060)          #after tax return on equity [B] for RORAC,mRORAC,(iRORAC) -Calibration
                                       #assumption: ROE_B 2012 = 6%
ROE_1 <- c(0, 0, 0, 0, 0.063)          #after tax return on equity [1] for RORAC,mRORAC,(iRORAC) –Calibration
ROE_2 <- c(0, 0, 0, 0, 0.286)
ROE_3 <- c(0, 0, 0, 0, 0.061)

ABcorr <- cor(ta_1, ta_2)              #segment correlation (A & B)
ABcorr
BCcorr <- cor(ta_2, ta_3)              #segment correlation (B & C)
BCcorr
ACcorr <- cor(ta_1, ta_3)              #segment correlation (A & C)
ACcorr

VaRsign_level <- 0.9997                #1-alpha
z_value <- qnorm(VaRsign_level, mean=0, sd=1)      #quantile, z-value;

n <- 50                                #number of iterations

u1 <- ta_1[5]                          #control input segment 1
u2 <- ta_2[5]
u3 <- ta_3[5]
u <- c(u1, u2, u3)                     #u vector (u: overall investment)

mu1 <- u1*mean(ROA_1)                  #segment mean perf. function
mu2 <- u2*mean(ROA_2)
mu3 <- u3*mean(ROA_3)
mu1_prime <- mean(ROA_1)               #first derivative of mu1
mu2_prime <- mean(ROA_2)
mu3_prime <- mean(ROA_3)
PF <- mu1+mu2+mu3                      #deterministic mean performance function
PF

sigma1 <- u1*sd(ROA_1)                 #uk*sd of rates of return
sigma2 <- u2*sd(ROA_2)
sigma3 <- u3*sd(ROA_3)
```

```
sigmaA <- sd(ROA_1)                    #sd of rates of return
sigmaB <- sd(ROA_2)
sigmaC <- sd(ROA_3)

sigmaPF <-
sqrt(sigma1^2+sigma2^2+sigma3^2+2*ABcorr*sigma1*sigma2+2*BCcorr*sigma2*sigma3+2*ACcorr*sigma1*sigma
3)                                     #quadratic aggregation includes diversif. eff.

VaR <- sigmaPF*z_value                 #enterprise performance VaR(VaRY)

#VaR_func <- function(u)
z_value*sqrt(sigma1^2+sigma2^2+sigma3^2+2*ABcorr*sigma1*sigma2+2*BCcorr*sigma2*sigma3+2*ACcorr*sigm
a1*sigma3)

VaR_func <- function(u)
z_value*sqrt(sigmaA^2*u[1]^2+sigmaB^2*u[2]+sigmaC^2*u[3]+2*ABcorr*sigmaA*u[1]*sigmaB*u[2]+2*BCcorr*sigm
aB*u[2]*sigmaC*u[3]+2*ACcorr*sigmaA*u[1]*sigmaC*u[3])
VaR_func

mVaR_u1 <- z_value*(u1*sigmaA^2+ABcorr*sigmaA*u2*sigmaB+ACcorr*u3*sigmaC*sigmaA)/sigmaPF      #a1
mVaR_u2 <- z_value*(u2*sigmaB^2+ABcorr*sigmaA*u1*sigmaB+BCcorr*u3*sigmaC*sigmaB)/sigmaPF
mVaR_u3 <- z_value*(u3*sigmaC^2+ACcorr*sigmaA*u1*sigmaC+BCcorr*u2*sigmaB*sigmaC)/sigmaPF

#install and load Package numDeriv in R to compute lambda

h <- c(100000,100000,100000)   #Hessian matrix assessed at (100000|100000|100000) due to large input numbers
eigen_hess <- eigen(hessian(VaR_func,h))     #evaluate eigenvalues and eigenvectors
eigen_hess
lambda <- max(eigen_hess$values)             #choose largest eigenvalue of the hessian matrix of the risk measure
                                             #(VaR:VaRY...enterpr. perf. VaR)
lambda

#check (Euler Allocation)
VaR == mVaR_u1*u1+mVaR_u2*u2+mVaR_u3*u3

x <- ROE_B[5]                          #calibration of the nominator of RORAC function
y1 <- ROE_1[5]/ROA_1[5]                #calibration of the nominator of mRORAC [1] function
y2 <- ROE_2[5]/ROA_2[5]
y3 <- ROE_3[5]/ROA_3[5]

RORAC <- (x*PF)/(VaR-PF)
RORAC

j <- 1
RORAC_last100[j]<- RORAC
RORAC_last100[j]<- RORAC
mRORAC1 <- (y1*mu1_prime)/(mVaR_u1-mu1_prime)
mRORAC1
mRORAC1_last100[j] <- mRORAC1
mRORAC2 <- (y2*mu2_prime)/(mVaR_u2-mu2_prime)
mRORAC2
mRORAC2_last100[j] <- mRORAC2
mRORAC3 <- (y3*mu3_prime)/(mVaR_u3-mu3_prime)
mRORAC3
mRORAC3_last100[j] <- mRORAC3
j <- j+1

#------------------

while(j <= n) {

eps1 <- (2*(y1*mean(ROA_1)-x*RORAC*mVaR_u1+x*mean(ROA_1)*RORAC))/(x*RORAC*lambda)   #eps1_opt
eps1
eps2 <- (2*(y2*mean(ROA_2)-x*RORAC*mVaR_u2+x*mean(ROA_2)*RORAC))/(x*RORAC*lambda)
eps2
```

```
eps3 <- (2*(y3*mean(ROA_3)-x*RORAC*mVaR_u3+x*mean(ROA_3)*RORAC))/(x*RORAC*lambda)
eps3
cat("\n\n")
cat("estimated eps1-value:",eps1,"\n\n")
cat("estimated eps2-value:",eps2,"\n\n")
cat("estimated eps3-value:",eps3,"\n\n")

delta_u1 <- eps1                        #eps1_opt
delta_u2 <- eps2
delta_u3 <- eps3
u1 <- u1+delta_u1
u2 <- u2+delta_u2
u3 <- u3+delta_u3

mu1 <- u1*mean(ROA_1)                   #segment mean perf. function
mu2 <- u2*mean(ROA_2)
mu3 <- u3*mean(ROA_3)
mu1_prime <- mean(ROA_1)                #first derivative of mu1
mu2_prime <- mean(ROA_2)
mu3_prime <- mean(ROA_3)
PF <- mu1+mu2+mu3                       #deterministic mean performance function

sigma1 <- u1*sd(ROA_1)                  #sd of rates of return
sigma2 <- u2*sd(ROA_2)
sigma3 <- u3*sd(ROA_3)
sigmaPF <-
sqrt(sigma1^2+sigma2^2+sigma3^2+2*ABcorr*sigma1*sigma2+2*BCcorr*sigma2*sigma3+2*ACcorr*sigma1*sigma
3)                                      #quadratic aggregation includes diversif. eff.
VaR <- sigmaPF*z_value                  #enterprise performance VaR(VaRY)
VaR_func <- function(u)
z_value*sqrt(sigmaA^2*u[1]^2+sigmaB^2*u[2]+sigmaC^2*u[3]+2*ABcorr*sigmaA*u[1]*sigmaB*u[2]+2*BCcorr*sigm
aB*u[2]*sigmaC*u[3]+2*ACcorr*sigmaA*u[1]*sigmaC*u[3])

mVaR_u1 <- z_value*(u1*sigmaA^2+ABcorr*sigmaA*u2*sigmaB+ACcorr*u3*sigmaC*sigmaA)/sigmaPF      #a1;
mVaR_u2 <- z_value*(u2*sigmaB^2+ABcorr*sigmaA*u1*sigmaB+BCcorr*u3*sigmaC*sigmaB)/sigmaPF
mVaR_u3 <- z_value*(u3*sigmaC^2+ACcorr*sigmaA*u1*sigmaC+BCcorr*u2*sigmaB*sigmaC)/sigmaPF

h <- c(100000,100000,100000)   #Hessian matrix assessed at (100000|100000|100000) due to large input numbers
eigen_hess <- eigen(hessian(VaR_func,h))    #evaluate eigenvalues and eigenvectors
eigen_hess
lambda <- max(eigen_hess$values)            #choose largest eigenvalue of the hessian matrix of the risk measure
(VaR:VaRY...enterpr. perf. VaR)

RORAC <- (x*PF)/(VaR-PF)
RORAC_last100[j]<- RORAC
cat("RORAC:",RORAC,"\n\n")

mRORAC1 <- (y1*mu1_prime)/(mVaR_u1-mu1_prime)
cat("mRORAC1:",mRORAC1,"\n\n")
mRORAC1_last100[j] <- mRORAC1
mRORAC2 <- (y2*mu2_prime)/(mVaR_u2-mu2_prime)
cat("mRORAC2:",mRORAC2,"\n\n")
mRORAC2_last100[j] <- mRORAC2
mRORAC3 <- (y3*mu3_prime)/(mVaR_u3-mu3_prime)
cat("mRORAC3:",mRORAC3,"\n\n")
mRORAC3_last100[j] <- mRORAC3

j<-j+1

}

#------------------

#RORAC optimization process, RORAC1, RORAC2
```

```
plot(RORAC_last100, xlab="convergence (start->end)", ylab="RORAC", type="l", col="black")
legend("topleft", c("Overall Bank-RORAC optimization process" , "mRORAC1" , "mRORAC2" , "mRORAC3"),
lty=c(1, 1, 1, 1) , lwd=c(2, 2, 2, 2) , col=c("black" , "red" , "blue" , "green"))

lines(mRORAC1_last100, col="red")
lines(mRORAC2_last100, col="blue")
lines(mRORAC3_last100, col="green")

#deltaRORAC - eps1, deltaRORAC - eps2

cat("\n\n")
cat("optimal enterprise RORAC:",100*RORAC,"%\n")

u1_fraction_opt <- u1/(u1+u2+u3)                #optimal control input u1 in percent
u2_fraction_opt <- u2/(u1+u2+u3)
u3_fraction_opt <- u3/(u1+u2+u3)
cat("\n\n")
cat("Enterprise-RORAC-optimal capital allocation for SEGMENT 1:",100*u1_fraction_opt,"%\n")
cat("Enterprise-RORAC-optimal capital allocation for SEGMENT 2:",100*u2_fraction_opt,"%\n")
cat("Enterprise-RORAC-optimal capital allocation for SEGMENT 3:",100*u3_fraction_opt,"%\n")

#-------------------------------------------------------------------------------------------------------------
```

3.4.2.2.3.4.3 Results

n=50 iterations:
optimal enterprise RORAC: 3.721394 %
Enterprise-RORAC-optimal capital allocation for SEGMENT 1: 18.29593 %
Enterprise-RORAC-optimal capital allocation for SEGMENT 2:. 23.23147 %
Enterprise-RORAC-optimal capital allocation for SEGMENT 3: 58.4726 %

3.4.2.2.3.5 Interpretation

Decentralized banks are composed out of different segments, also called business segments. In order to manage these segments according to an optimal overall performance (represented by the Overall Bank RORAC), the risk-adjusted performance management is a sophisticated and state-of-the-art approach.

In 3.4.2.2.3.3 a fictive segment mean performance function $M_k(u_k)$ as well as an extremely simplified segment volatility $\sigma_{X(k)}(u_k)$, represented by the control input u_k, are used. This is approximately true for small values of the control input u_k and does not hamper to show the principle of the optimization approach. For a more realistic bank-case (3.4.2.2.3.4) it has to be adopted by appropriately implementing for instance the expected/historic segment return on assets (deterministic mean performance function) and the standard deviation (stochastic fluctuation function) with functional interaction of the control inputs, representing business segment's assets. Additionally, the R-Implementation in 3.4.2.2.3.4.2.4 shows the way of how to handle multiple risky bank business segments.

3.4.2.2.3.6 Outlook

- Extension due to even more realistic distribution functions (here: Gaussian Distribution)
- Advanced RORAC function (dock bank's existing VaR-models for economic capital estimation; more sophisticated net income function (nominator))

4 Summary

Bringing regime to complexity

This thesis does not only intend to improve overall performance in the post-crisis environment. Furthermore, its aim is to sustainably and significantly drive (i) simplicity, (ii) clarity and (iii) efficiency on an organizational-/business segment management-, risk management- and strategic level in order to reduce complexity on the segment- to the enterprise level.

The enhanced business focus of overall bank management via consistence of organizational- and controlling structure is not only an interesting aspect regarding capital management but is of great importance to drive *simplicity*, especially in times after financial crisis.

Further on, the combination of cost of capital as the "cost for capital" and the business segment-specific cost of capital fractions or segment investments defined by quantitative algorithms for optimal risk-related bank performance are bringing capital steering to a whole new "*clarity*"- level.

Last but not least efficiency states a commanding topic in the post-crisis environment. This segment risk concept deals with it by the establishment of a central unit for capital management with advantage for efficient capital steering, lifelong learning in the organization as well as pragmatic penalty payments as incentive for accurate planning. Furthermore, the inclusion of economic profit or RORAC in bank's compensation structure empowers risk management, inspires to decision making on the long term, and dampens the pure profit and loss view. Not quantitative capital management alone ensures the optimal RORAC on overall bank level, employees represent the "potential of capital". Therefore a hybrid of central and decentralized hierarchical integration of business segment controlling is recommended to establish. All these aspects lead to enhanced *efficiency* in capital steering.

This Master's Thesis underlines the aspiration of modern risk management as a sustainable value-creating activity and an essential component of strategy in order to create competitive advantage.

5 Concluding Remarks and Recommendations

5.1 Organizational View regarding Capital Allocation

According to a trend analysis by BCG on the longer-term the controlling focus will shift from the overall view to a segment specific view. How this could look like in practice, especially with the focus on capital management, is part of the following.

5.1.1.1 Accurate Capital Allocation represents a Strategic Chance

Appraisal:

Accurate central capital management along with focus on business segments

In order to prevent future scarcity of the more and more tightening resource capital banks are recommended to set up an accurate capital management on the longer-term via know-how transfer along with a central unit for capital management with the focus on business segments, gaining following benefits:

- Increase in efficiency by central coordination (reduction of interface problems, one contact for business segments as well as the top management)
- Enhanced accountability for capital as well as more sophisticated, risk-based resource allocation processes
- Risk-based capital allocation ("price for capital" depends on segment risks, accurate capital allocation via RORAC-optimization, etc.)

5.1.1.2 Advice regarding Changes in the Controlling Structure

From functional controlling to business segment controlling (BSC) in order to significantly reduce complexity

Changing conditions entail changes in organizational structure to disentangle increasing complexity. This complexity will lead to an *enhanced business focus* in overall bank management through consistence of organizational- and controlling-structure. The additional implementation of a comprehensive business segment controlling for instance, including RICO, ALCO, CAPCO, etc. on a business segment basis, represents such an execution.
This BSC drives forth interlinked planning and control as well as the birds-eye-view, but requires the empowerment of controlling staff along with a wider job profile.

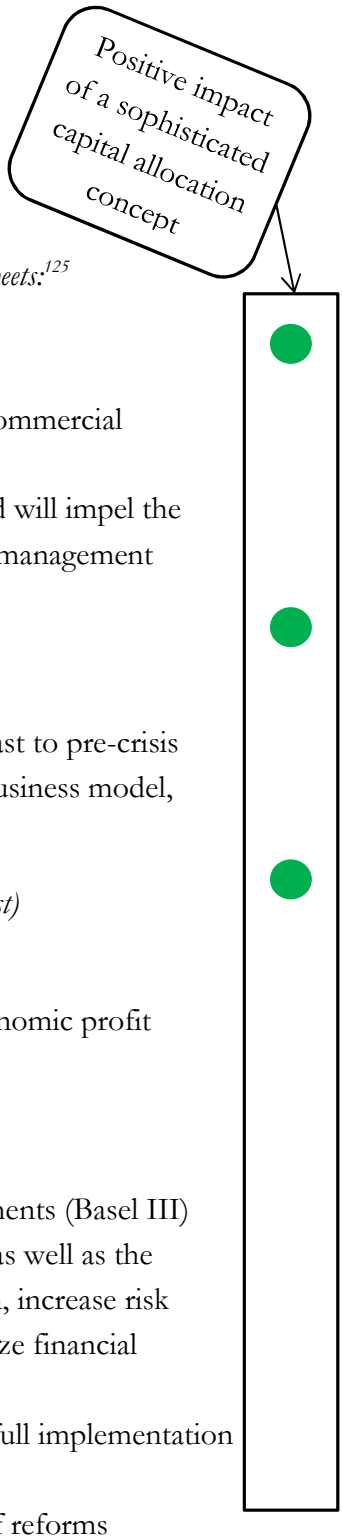
5.1.1.3 Hierarchical Integration of Business Segment Controlling

Comprehensive hierarchical integration of BSC considerably diminishes interdependences

From an organizational perspective one can distinguish between two extreme cornerstones, the central and the decentralized form of organization. In order to gain the benefits of both approaches it is highly recommended to implement a hybrid. Thus, BSCs are located at the segment site, but co-ordinate themselves via BSC-meetings. The main benefits of this concept are the close *proximity to the segment business* (accompanied with deep and up-to-date insight into the business – benefit of decentralized approach) as well as the *fine coordination possibilities* (*due to modern IT-infrastructure* – advantage of centralized coordination principle)[124].

[124] This implementation also *reduces interdependencies* (see Frese (1993), p. 296ff) and leads to an optimal tradeoff between *autonomy costs* (costs according to the lack of reconciliation between departments/controllers) as well as *coordination costs* (costs due to exchange of information, in other words costs according to the establishment of appropriate information as well as communication mechanisms)

5.2 Impacts of changing Market Environment on the Organization



New Regulations and the New Market Environment leave its marks in Bank's Balance Sheets:[125]

Equity Capital Perception: High Cost of Equity Capital

- Cost of Equity increased from a stable level of 9% to 12%/16% (commercial banks/investment banks)[126] during financial crisis 2007-2011[127]
- High CoE levels perhaps remain or might even increase slightly and will impel the need for enhanced business segment consideration in overall bank management

Debt Capital Perception: High Funding Costs and restricted Market Embarrassment

- Higher costs for unsecured funding
- Restricted market embarrassment and sources for funding in contrast to pre-crisis environment require developments in overall bank management (business model, steering)

Yield Perception: Aggravated Value Creation (tough Yield Protection and Profitability Boost)

- Falling levels of net income
- Increased refinancing costs
- Tightened operating cost levels

} humbly or even negative economic profit

Regulatory Impact

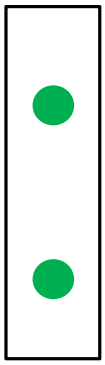
- Enhanced regulations, such as a new framework of capital requirements (Basel III) proposed by BCBS (BIS) to ensure stability of the banking system as well as the solvency (key objectives: improve international banking supervision, increase risk sensitivity of the banking system, set new liquidity standards, stabilize financial markets)[128]
- New requirements are phased-in within the next years and require full implementation as per January 2019[129]
- The challenging market conditions are accelerating the execution of reforms

[125] Annual Report 2011 analysis (qualitative): set of banks according to chapter 3.3
[126] Classification according to the Glass-Stealgall Act of 1933 (two US federal laws as a result of the Great Depression in the 1930s; relaxed by the Financial Services Modernization Act of 1999)
[127] Aggregated data according to BCG Analysis (represents the whole banking industry)
[128] ct. BCBS (2010)
[129] ct. http://www.bis.org/bcbs/basel3/basel3_phase_in_arrangements.pdf, 05-30-2013

5.3 Overall Strategy in the fragile Post-Crisis Environment

Challenging (structural) Market Changes require Changes in Strategy[130]

- The need for positive economic profit makes changes of the operating and business models mandatory (from the product-, the segment- to the enterprise level)
- Need for centralized transformation at all organizational stages and across the whole institution (reduction of leverage, deglobalization, cost decrease, consolidation)
- Challenges to fulfill the minimum capital ratios (increase of total capital) and capital allocation efficiency



5.4 Core Challenges for Overall Bank Risk Management

Overall Bank View

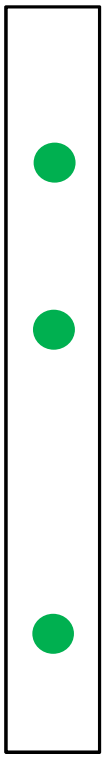
- Overall risk view – Contagion/Stresstesting
- Risk appetite and resource allocation as strategic objective
- Economic view: combining risk & profit and loss, balance sheet and market view

Bank Governance and Culture

- Sustainable growth and profitability as a goal
- Independence of CRO and influence on all chief-officer's topics

Organization & IT

- Organization: industrializing/optimizing processes and changes in structure
- Staff empowerment along with wider job profile, increase in qualification
- Reduction of hierarchy levels, consistence of organizational and controlling structure
- Unification of reports and even more advanced central control parameters
- Improvements in IT-consistence (data quality/consistence, flexibility, data models)



[130] Annual Report 2011 analysis (qualitative): set of banks according to chapter 3.3.1.1

6 Appendix

6.1 Additional Data and Results of Banking Industry - Study in 3.3

Bank Segment Data:

Market Segment*	Country	Bank	Business Segment (major)	σROE (%) [2008-201	CoE	Economic Return	Remark
Retail	Austria	UniCredit	Private Banking	13.49%	10.00%	-1.73%	-
Corporate			Corporate & Investment Banking	197.50%	6.89%	1.38%	-
CEE			Central & Eastern Europe	41.95%	10.53%	-4.92%	-
57% Retail, 43% CEE	Austria	Erste Group	Retail & SME	32.47%	11.21%	-0.21%	-
20% Inv. Banking, 70% Corporate, 10% Asset Mgmt.			Group Corporate and Investment Banking	66.02%	6.97%	-9.67%	-
Other			Group Markets	74.47%	8.30%	56.70%	-
Corporate	Austria	ÖVAG	Non-core Corporate	248.61%	2.52%	3.85%	-
23% Retail, 77% CEE			Non-core Retail	1369.42%	1.02%	-32.15%	-
Asset Management			Non-core Real Estate	313.00%	1.90%	4.66%	-
Investment Banking			Financial Markets/Investment Book	210.21%	1.67%	1.87%	-
Investment Banking			Non-core Investment Book/Other Operatio	296.94%	1.67%	-13.63%	-
28% Inv.B, 73%Corpora	Germany	Deutsche Bank	Corporate Banking & Securities	78.11%	5.85%	-0.66%	-
Investment Banking			Global Transaction Banking	22.21%	7.24%	-0.10%	-
69%Retail, 31%AssetMgmt.			Asset and Wealth Management	67.28%	6.76%	-5.78%	-
Retail			Private & Business Clients	90.35%	7.08%	-2.86%	-
Retail	Germany	Commerzbank	Private Customers	508.98%	8.54%	-2.24%	-
Corporate			Mittelstandsbank	106.07%	5.88%	22.72%	-
CEE			Central&Eastern Europe	430.90%	8.33%	5.27%	-
Investment Banking			Corporates & Markets	467.24%	7.25%	-1.15%	-
Asset Management			Asset Based Finance	119.33%	5.88%	-21.08%	-
Retail	Switzerland	UBS	Wealth Management	16.62%	4.97%	0.63%	-
Retail			Wealth Management Americas	290.58%	4.97%	-3.07%	-
Investment Banking			Investment Bank	196.17%	5.00%	-11.36%	-
Asset Management			Global Asset Management	18.07%	3.91%	-2.58%	-
70% Retail, 30% Corporate			Retail & Corporate	10.94%	4.72%	-0.47%	-
76% Retail, 24%Corpor	Switzerland	Credit Suisse	Private Banking & Wealth Management	0.00%	5.25%	3.49%	poor data
Investment Banking			Investment Banking	176.44%	6.13%	-1.49%	-
Other			Corporate Center	511.49%	6.63%	-15.66%	-
Other			Noncontrolling interests without SEI	112.01%	6.63%	-5.93%	-
Retail	United Kingdom	HSBC	UK Retail	46.83%	3.26%	-0.47%	-
Retail			Continental Europe Retail	56.13%	3.26%	-1.96%	-
75% Inv.B., 20% Corp., 5%AssetMgmt.			Global Banking and Markets	1098.25%	3.78%	-1.55%	-
Retail			Global Private Banking	5.35%	3.26%	-1.60%	-
Other			Other	329.48%	4.18%	-8.69%	-
Retail	United States of America	JPMC	Consumer & Community Banking	25.18%	5.59%	19.41%	-
75%Inv.B., 25%Corp.			Corporate & Investment Bank	1.13%	6.99%	11.01%	-
Retail			Commercial Banking	1.27%	5.59%	22.41%	-
Asset Management			Asset Management	9.81%	4.79%	19.21%	-
10%Retail, 90% Corporate			Corporate/Private Equity	224.51%	5.12%	-6.20%	-
Retail	United States of America	Citigroup	Global Consumer Banking (GCB)	32.23%	6.48%	-2.07%	-
Asset Management			Institutional Clients Group (ICG)	32.23%	6.48%	-2.07%	-
Asset Management			Citi Holdings	45.58%	5.85%	-9.42%	-
Other			Corporate/Other	410.78%	9.15%	-10.16%	-
Retail	United States of America	Wells Fargo	Community Banking	9.11%	4.21%	2.98%	-
85%Corporate, 15% Asset Mgmt.			Wholesale Banking	6.72%	4.31%	1.02%	-
Retail			Wealth Brokerage and Retirement	11.61%	4.21%	1.12%	-
Other			Other	78.85%	5.71%	-0.38%	-

Remark: σROE estimated via net income volatility; * Annual Report 2011 Analysis;

Figure 29: Banking Industry - Study – Results by Institution[131]

[131] Market segment definition according to chapter 3.3.1.2 and Annual Report Analysis 2011; Market segments represent the prevailing business activity of the individual bank business segments (basis for qualitative analysis: Annual Reports 2011) ; Economic Return estimation according to annual data of financial year 2012 (ct. chapter 3.3.1.3.1)

Cumulative Performance Functions (Total Set of Business Segments):

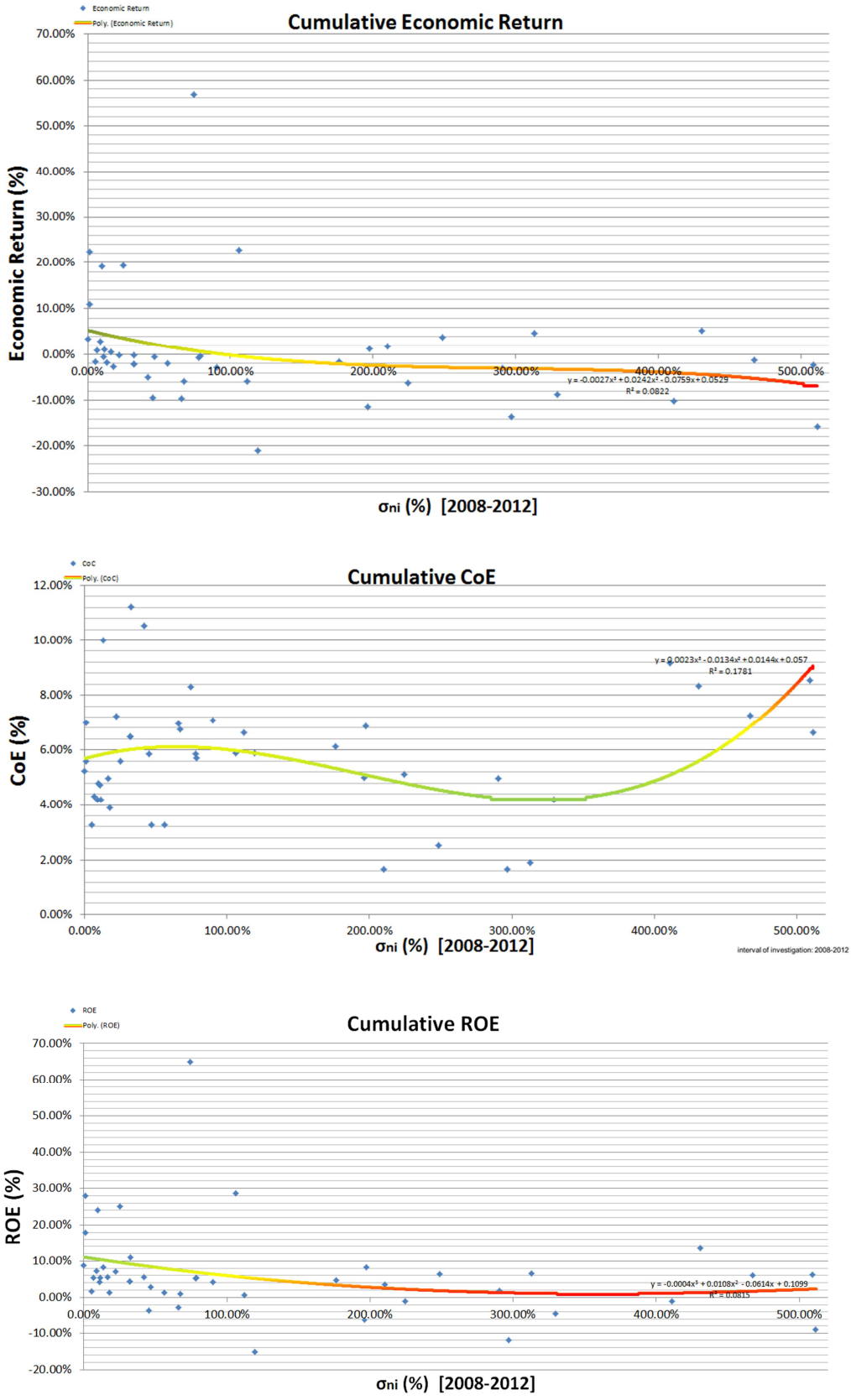


Figure 30: Cumulative Performance Functions[132]

[132] Cumulation of data presented in figure 44 (6.1); set of banks defined in (3.3.1); outlier with volatility greater than 550% excluded; polynomic trendline function in MS Excel 2010; after-tax ROE: 2012, economic profit estimation for financial year 2012

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8 List of figures

9 Abbreviations

APT	Arbitrage Pricing Theory
BCBS	Basel Committee on Banking Supervision
BS	Business Segment
BSC	Business Segment Controlling
CAPM	Capital Asset Pricing Model
COC	Cost of Capital
CoE	Cost of Equity Capital
CRC	Cost of Regulatory Capital
c.t.	compare to
EC	Economic Capital
EP	Economic Profit
ER	Economic Return
LCR	Liquidity Coverage Ratio
MPT	Modern Portfolio Theory
MRP	Market Risk Premium
MS	Market Segment
NSFR	Net Stable Funding Ratio
OBM	Overall Bank Management
UML	Unified Modelling Language
ROE	Return on Equity
ROA	Return on Assets
RAROC	Risk-adjusted Return on Capital
RORAC	Return on Risk-adjusted Capital
RARORAC	Risk-adjusted Return on Risk-adjusted Capital
RWA	Risk Weighted Assets
VaR	Value at Risk