

**Copenhagen Business School**

# **Bank capital regulation**

**How the implementation of CRD IV affects  
Danish financial institutions' capital structures**

**Ane Kamstrup Karkov**

14 January 2016

cand.merc.aef

Master's Thesis

Supervisor: Poul Kjær

Number of pages: 75

Number of characters including spaces: 168.488

## Abstract

This thesis finds that three capital requirements are especially important for banks and that breaches of these have different but all severe consequences. These requirements are the MDA requirement, the Pillar 2 requirement and the minimum capital requirement. These requirements make the bank's capital structure decision especially challenging compared to corporate firms.

The thesis uses a model by Harding, Liang and Ross (2009) that estimates the optimal capital structure of banks by taking into account deposit insurance, capital requirements, bankruptcy costs and tax-advantaged debt. The model assumes that banks face bankruptcy if they fail to comply with their capital requirement but that some of this cost is balanced by the government's deposit insurance. When applied to the cases of Danske Bank, Sydbank and Jyske Bank, however, it dramatically overshoots the optimal capital ratio compared with the observed capital ratios and the banks' own proclaimed target capital ratios. The shortcomings of the model are the riskless interest rate's dramatic influence on results as well as the fact that it fails to take into account risk-weighted assets. The extended model includes a second capital requirement, which is modeled as the combined capital requirement. This model overshoots the optimal capital structure marginally more than the base model.

A new model is developed specifically to take into account the new regulatory framework in Denmark, where systemically important banks are not allowed to be liquidated but where shareholders and owners of banks' AT1 capital face the risk of loss even though the bank is not liquidated. The predicted capital ratios of this model for Danske Bank, Sydbank and Jyske Bank are more realistic but still much higher than the banks' own capital ratio targets. The shortcoming of the model stems from the current extremely low riskless rate's large influence on the result. The riskless interest rate is negatively correlated with the optimal capital ratio and the asset volatility and the combined capital requirement are positively correlated with the optimal capital ratio. The combined capital requirement only has a marginal impact, which implies that the phase-in of higher capital requirements until 2019 will have little impact on Danish banks' optimal capital ratio. The main factor in the optimal capital structure decision is the risk of expropriation and the risk that tax benefits are lost in the process.

The results further imply that bank managers, investors and regulators should be careful not to forget to focus on the capital ratio in terms of total assets. It is tempting just to look at the capital ratio in terms of risk-weighted assets, as this is the ratio that is monitored in relation to capital requirements. However, the average risk weight can differ substantially between banks without an apparent difference in the riskiness of the banks' assets. Therefore, a bank with a very low average risk weight but an asset volatility that is comparable to banks with higher average risk weights, should target a higher capital buffer in terms of risk-weighted assets. The potential introduction of a leverage requirement can help on this issue.

The implementation of CRD IV is predicted to increase Danish financial institutions' optimal capital structures marginally. It is also found that SIFIs' optimal capital structures will not be significantly different from non-SIFIs.

## Table of Contents

<b>1 INTRODUCTION</b>	<b>4</b>
1.1 MOTIVATION	4
1.2 RESEARCH QUESTIONS	4
1.3 LIMITATIONS	5
1.4 METHODOLOGY	5
1.5 STRUCTURE OF THE THESIS	6
<b>2 BANK CAPITAL REGULATION</b>	<b>8</b>
2.1 HISTORY OF THE BASEL ACCORDS	8
2.1.1 <i>Basel I</i>	9
2.1.2 <i>Basel II</i>	10
2.1.3 <i>Basel III and the Capital Requirement Directive IV (CRD IV)</i>	13
2.3 BANK PACKAGES IN DENMARK	13
2.3.1 <i>Bank Packages 1 - 2</i>	14
2.3.2 <i>Bank Packages 3 - 4</i>	14
2.3.3 <i>Bank Package 5 - 6</i>	15
2.3.4 <i>The Supervisory Diamond</i>	15
2.4 DANISH BANKS' CAPITAL REQUIREMENTS TODAY	16
2.4.1 <i>Minimum Capital Requirement</i>	16
2.4.2 <i>Pillar 2 Requirements</i>	18
2.4.3 <i>Buffers</i>	18
2.4.4 <i>MDA</i>	19
2.4.5 <i>MREL and TLAC</i>	20
2.4.6 <i>Rating Requirements</i>	21
2.4.7 <i>Liquidity and Funding Requirements</i>	21
2.5 CASES OF NON-COMPLIANCE	21
2.5.1 <i>Roskilde Bank</i>	21
2.5.2 <i>JAK Cooperative Bank</i>	26
2.6 REFLECTION ON DANISH CAPITAL REGULATION	27
<b>3 THEORIES OF BANK CAPITAL STRUCTURE</b>	<b>29</b>
3.1 THEORIES FROM CORPORATE FINANCE	29
3.1.1 <i>The classic Modigliani &amp; Miller theorem</i>	29
3.1.2 <i>The Modigliani &amp; Miller theorem with taxes</i>	29
3.1.3 <i>Static tradeoff theory</i>	30
3.1.4 <i>Asymmetric information and pecking order theory</i>	30
3.1.5 <i>Merton's model of firm capital structure</i>	31
3.2 OPTIMAL BANK CAPITAL STRUCTURE IN THE LITERATURE	31

3.2.1	<i>Special features of banks</i>	31
3.2.2	<i>The HLR-model</i>	32
3.2.3	<i>The HLR-model with warning threshold</i>	36
3.2.4	<i>Do banks adjust capital towards an optimal?</i>	37
3.3	A MODEL OF ZERO LIQUIDATIONS AND EQUITY EXPROPRIATION	37
3.3.1	<i>Assumptions and theoretical foundation</i>	38
3.3.2	<i>Costs of expropriation</i>	40
3.3.3	<i>Tax benefits</i>	41
3.3.4	<i>Costs of regulatory non-compliance</i>	42
3.3.5	<i>Optimal capital structure</i>	43
3.4	BRIEF SUMMATION OF THEORIES OF BANK CAPITAL STRUCTURE	44
<b>4</b>	<b>CASE 1: DANSKE BANK</b>	<b>45</b>
4.1	CAPITAL POLICY	45
4.2	MODEL PARAMETERS	46
4.2.1	<i>Value of assets</i>	46
4.2.2	<i>Volatility of asset returns</i>	46
4.2.3	<i>Marginal corporate tax rate</i>	47
4.2.4	<i>Capital requirements</i>	47
4.2.5	<i>Marginal regulatory non-compliance cost rate</i>	50
4.2.6	<i>Risk free rate</i>	50
4.3	OPTIMAL CAPITAL STRUCTURE IN THE HLR-MODEL	51
4.4	OPTIMAL CAPITAL STRUCTURE IN THE HLR-MODEL WITH WARNING THRESHOLD	52
4.5	OPTIMAL CAPITAL STRUCTURE IN THE K-MODEL	52
4.6	BRIEF SUMMATION OF THE CASE	54
<b>5</b>	<b>CASE 2: SYDBANK</b>	<b>56</b>
5.1	CAPITAL POLICY	56
5.2	MODEL PARAMETERS	56
5.2.1	<i>Value of assets</i>	56
5.2.2	<i>Volatility of asset returns</i>	57
5.2.3	<i>Effective corporate tax rate</i>	57
5.2.4	<i>Capital requirements</i>	58
5.2.5	<i>Marginal regulatory non-compliance cost rate</i>	60
5.2.6	<i>Risk free rate</i>	60
5.3	OPTIMAL CAPITAL STRUCTURE IN THE HLR-MODEL	60
5.4	OPTIMAL CAPITAL STRUCTURE IN THE HLR-MODEL WITH WARNING THRESHOLD	61
5.5	OPTIMAL CAPITAL STRUCTURE IN THE K-MODEL	62
5.6	BRIEF SUMMATION OF THE CASE	64
<b>6</b>	<b>CASE 3: JYSKE BANK</b>	<b>65</b>
6.1	CAPITAL POLICY	65

6.2 MODEL PARAMETERS .....	65
6.2.1 Value of assets .....	65
6.2.2 Volatility of asset returns.....	66
6.2.3 Effective corporate tax rate .....	67
6.2.4 Capital requirements .....	67
6.2.5 Marginal regulatory non-compliance cost rate.....	69
6.2.6 Risk free rate.....	69
6.3 OPTIMAL CAPITAL STRUCTURE IN THE HLR-MODEL .....	69
6.4 OPTIMAL CAPITAL STRUCTURE IN THE HLR-MODEL WITH WARNING THRESHOLD .....	70
6.5 OPTIMAL CAPITAL STRUCTURE IN THE K-MODEL .....	71
6.6 BRIEF SUMMATION OF THE CASE.....	72
<b>7 SUMMARY AND CONCLUDING REMARKS.....</b>	<b>73</b>
7.1 CONCLUSION .....	73
7.2 OTHER PERSPECTIVES .....	75
<b>8 BIBLIOGRAPHY .....</b>	<b>76</b>
8.1 LITERATURE .....	76
<i>Berk, Jonathan, et al., 'Capital Structure in a Perfect Market', Second Edition, Pearson Education, 2011.....</i>	<i>76</i>
8.2 JOURNALS.....	76
8.3 WEBSITES .....	77
8.4 COMPANY INFORMATION .....	78
8.5 NEWS PAPER ARTICLES.....	79
8.6 SUBMISSIONS.....	79
8.7 DOCUMENTARY .....	82
8.8 STOCK EXCHANGE ANNOUNCEMENTS.....	82
<b>NORWEGIAN MINISTRY OF FINANCE, 'COUNTERCYCLICAL BUFFER INCREASES NEXT YEAR', 18 JUNE 2015.....</b>	<b>82</b>
<b>9 APPENDICES .....</b>	<b>83</b>
9.1 APPENDIX 1: VBA CODE FOR THE K-MODEL .....	83
9.2 APPENDIX 2: DANSKE BANK.....	86
9.3 APPENDIX 3: SYDBANK .....	90
9.4 APPENDIX 4: JYSKE BANK.....	94

## 1 Introduction

In the following, an account of the motivation behind the thesis' focus and the research questions are given. The limitations that have been found necessary in order to stay inside the thesis' scope are described and the methodology that has been chosen in order to answer the research questions is motivated. Lastly, an overview of the structure of the thesis and the abbreviations that are used throughout the thesis is presented.

### 1.1 Motivation

Banks perform a value-adding role in society by providing long-term financing through short-term capital, which is an important prerequisite for growth and value creation in the society as a whole. Their capital structure decisions impacts the riskiness of the banks and consequently the riskiness of the economy.

The financial crisis, which commenced in 2007, threatened the global financial stability.<sup>1</sup> The crisis demonstrated that banks were highly vulnerable to market fluctuations and that their financial reserves were not adequate. In the wake of the crisis, analysts have tried to come up with explanations for and reasons behind what caused the crisis in order to establish measures to prevent the occurrence of a new crisis. At this point, these efforts have been translated into requirements and regulatory guidelines, of which the implementation process is well under way both at a global and local level.

The new regulatory framework has its roots in the Third Basel Accord, also referred to as the Basel III Framework. It has had profound impacts on financial systems all over the world and is now being implemented in Europe via the Capital Requirements Regulation (CRR) and Capital Requirements Directive IV (CRD IV).<sup>2</sup> These changes are resulting in stricter regulation for banks and even stricter regulation for large-scale, systemically important banks.

The CRD IV/CRR is changing the rules of the game when it comes to the way banks capitalize themselves. It is important to understand the consequences for banks as they face several pressures from regulatory authorities, shareholders, debtholders, customers, and other stakeholders. The composition of the capital structure influences the riskiness as well as the value of the bank. This thesis investigates the effects of the new regulatory framework in Denmark on Danish banks' optimal capital structures.

### 1.2 Research questions

The overall research question of the thesis is:

---

<sup>1</sup> Baldvinsson, 2011, p. 66

<sup>2</sup> European Banking Authority, 'CRD IV – CRR / Basel III monitoring exercise', 2015, p. 7 and Finanstilsynet, 'Markedsudvikling 2013', 2014, p. 4

- How does the implementation of CRD IV affect the Danish financial institutions' capital structure?

Additional research questions that will assist in answering the overall question are:

- How is regulation concerning banks' capital structures changing in Denmark?
- Which factors influence a bank's optimal capital structure?
- How will the implementation of CRD IV in Denmark affect Danske Bank's, Sydbank's and Jyske Bank's capital structures?

### 1.3 Limitations

Selecting the clarified issue of the thesis naturally leads to delimitations along the way. Bank regulation is complex, and the possible areas of investigation are plentiful. For the sake of simplicity and focus of this thesis, the following deselections have been made: The focus of the thesis is on capital requirements, not other requirements such as transparency or corporate governance. Furthermore, the focus is on which factors determine the optimal capital structure of banks and not the societal or economic consequences of a potential change in banks' optimal capital structures. Also, the banks' policies regarding return on equity and the choice between dividend payments and share buybacks are not touched upon.

The focus of the thesis is on banking business, not mortgage institutions, life assurance companies, pension funds, etc.

### 1.4 Methodology

In order to address the research question 'how does the implementation of CRD IV affect the Danish financial institutions' capital structure', universal quantitative methods are employed. A qualitative assessment of the research question could involve bank managers' opinion on the issue, a more thorough account of jurisdiction surrounding bank capital regulation or a study of industry responses to the newly implemented capital requirements. However, it is assessed that the question in hand is best elucidated through quantitative methods, which will yield results that are more applicable.

The research question is sought answered through a deployment of relevant models from the literature as well as the development of an updated theoretical model, which is applied to real cases. The models may explain some underlying factors in the optimal capital structure decision for Danish banks but cannot be expected to fully explain the observed capital structure of Danish banks. The models are used as a starting point in order to elaborate on the consequences of the new regulatory framework for Danish banks' capital structures. The observed deviations between theoretical predictions and observed capital ratios will be elaborated on with an outset in the theory.

In order to clarify how CRD IV affects the Danish financial institutions' capital structure, different methods of collecting information are used. These methods include data

extraction from Bloomberg, and financial and risk management reports. In addition to this, academic articles are analyzed, discussed, and used as an inspiration for the new model. Different Danish banks are used as cases throughout the thesis.

The three banks that are used to apply the selected models and the newly developed model are Danske Bank, Sydbank and Jyske Bank. These banks are chosen because they are the largest Danish banks when Nordea is not considered. Nordea has been omitted as a case since it has a larger presence in markets outside of Denmark and therefore is more influenced by foreign regulation, which is outside this thesis' scope. The three banks have differing levels of systemic importance and size and therefore provide a good starting point for the discussion of the new regulatory framework's implications for different banks in Denmark. The largest Danish banks have been chosen because they are considered the types of banks that are mostly influenced by the new regulatory framework, for example through the SIFI buffer. The new model is applied to the banks through VBA code.

## 1.5 Structure of the thesis

The thesis is divided into seven chapters. Chapter 1 is an introductory chapter, which outlines the focus of the thesis and the methodology that will be used to clarify the issue. The thesis will proceed with two theoretical chapters that lay the foundation for subsequent more practical chapters exhibited in three cases. Chapter 2 describes the capital requirements imposed on Danish banks to the present day, and chapter 3 looks at theories of optimal capital structure in general and more specifically for banks. Hereafter, selected theories from chapter 3 are applied to three Danish banks in chapter 4 through 6. The thesis is rounded off with Chapter 7, which provides a conclusion on the research question and the study as a whole.

Chapter 2: This chapter introduces bank capital regulation in a historical setting. In order to understand the CRD IV framework, the Basel I, II and III frameworks are examined in this chapter. In addition to addressing the CRD IV, the chapter also studies local initiatives in Denmark, such as the bank packages, as well as cases where Danish banks have succumbed to the requirements. The chapter concludes with a reflectance on the Danish issues.

Chapter 3: This chapter begins with an account of theories from corporate finance regarding capital structure in general. It provides a foundation for the subsequent treatment of theories regarding the optimal bank capital structure. Thereafter, theories that take into account the special nature of banking when it comes to optimal capital structure are elaborated on. The concluding section develops a model that explains how a value-optimizing bank should capitalize itself in the current regulatory framework.

Chapter 4-6: These chapters apply the selected theories from chapter 3 as well as the new model to three Danish banks: Danske Bank, Sydbank and Jyske Bank, which are analyzed separately, in order to see how their capital structure policies match the theories of optimal bank capital structure.

Chapter 7: This final chapter concludes with an account of implications of the thesis as well as suggestions to further research.



## 1.6 List of abbreviations

The following list of abbreviations is used in the thesis:

<b>Term</b>	<b>Abbreviation</b>
Additional Tier 1 capital	AT1
Additional Loss Absorbing Capacity	ALAC
Advanced measurement approach	AMA
Bank for International Settlements	BIS
Capital Requirements Directive IV	CRD IV
Capital Requirement Regulation	CRR
European Union	EU
Financial Stability <sup>3</sup>	FS
Global systemically important banks	G-SIBs
Internal ratings-based	IRB
Liquidity coverage ratio	LCR
Minimum requirement for own funds and eligible liabilities	MREL
Net Stable Funding Ratio	NSFR
Point of No Viability	PONV
Systemically Important Financial Institution <sup>4</sup>	SIFI
The Agricultural Financial Institution <sup>5</sup>	AFI
The Danish Financial Services Authority <sup>6</sup>	FSA
The Danish Financial Business Act <sup>7</sup>	FIL
The Danish National Bank <sup>8</sup>	NB
The Deposit Guarantee Fund <sup>9</sup>	DGF
The Financial Stability Act <sup>10</sup>	FS Act
The irrelevance theorem by Modigliani & Miller (1958)	MM
The Private Contingency Association <sup>11</sup>	PCA
The Supervisory Diamond <sup>12</sup>	SD
The Systemic Risk Council <sup>13</sup>	SRC
Total Loss Absorbing Capital	TLAC

---

<sup>3</sup> In Danish: Finansiell Stabilitet A/S

<sup>4</sup> In Danish: Systemisk vigtige finansielle institutter

<sup>5</sup> In Danish: Landbrugsfinansieringsinstitut

<sup>6</sup> In Danish: Finanstilsynet

<sup>7</sup> In Danish: Lov om finansiell virksomhed

<sup>8</sup> In Danish: Nationalbanken

<sup>9</sup> In Danish: Indskydergarantifonden

<sup>10</sup> In Danish: Lov om Finansiell Stabilitet

<sup>11</sup> In Danish: Det Private Beredskab

<sup>12</sup> In Danish: Tilsynsdiamanten

<sup>13</sup> In Danish: Det systemiske risikoråd

## 2 Bank Capital Regulation

In the following sections, the three Basel accords, the CRD IV and the bank packages in Denmark are introduced with a focus on capital adequacy requirements. The relevant bank regulation has a direct impact on banks' overall costs, and in order to understand the cost relation, it is important to understand the regulation itself.

Sections 2.1-2.3 will introduce the motivation and history of current bank regulation in order to clarify the motivation for the structure of the current regulation. Section 2.4 will specify the most important regulatory pressures that banks face today. Section 2.5 looks into cases of regulatory non-compliance in order to estimate the actual costs banks risk to incur if they fail to comply with regulation.

### 2.1 History of the Basel Accords

After the financial market turmoil that followed the collapse of the Bretton Woods system of managed exchange rates in 1973 and the resulting large foreign currency losses of banks worldwide, the bank supervisory authorities in the G-10 countries (Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, UK and USA) created the Basel committee on Banking Supervision (henceforth the Basel Committee) in 1974. The committee has since expanded its membership and now includes 28 jurisdictions. The secretariat meets regularly, three or four times a year, and is located at the Bank for International Settlements (BIS) in Basel, which is an international organization formed in 1930 that functions as the central bank of central banks<sup>14</sup>.

The initial role of the Basel Committee was to close gaps in international supervisory coverage so that no foreign bank branch would escape supervision. This resulted in the issuance of the 'concordats' that, among others, aimed at enhancing the exchange of information between member supervisors. The Basel Committee's main aim has since changed to ensure convergence of national capital requirements in order to strengthen the stability of the international banking system and to decrease the incentive to lower national capital requirements in order to gain a comparative competitive advantage<sup>15</sup>. This resulted in the issuance of the Basel accords. The first capital accord was Basel I, which was released in 1988, and since then both Basel II and III have been released. The Basel accords have been incorporated into the national regulation of, among others, countries of the European Union (EU).

The guidelines of the Basel Committee are in principle only recommendations, although they are given substantial weight in the legislation among the participating countries. In fact, the guidelines of the Basel Committee are continuously implemented by the EU-

---

<sup>14</sup> [www.bis.org](http://www.bis.org) -> *about BIS*

<sup>15</sup> BIS, 'A brief history of the Basel Committee', 2015, p. 1-2

commission into EU-directives, which is binding for all credit institutions in EU, including Denmark<sup>16</sup>.

### 2.1.1 Basel I

The main aim of the Basel I proposals was to secure international convergence of supervisory regulations governing the capital adequacy of international banks<sup>17</sup>. The framework introduced a minimum ratio of capital to risk-weighted assets of 8% that had to be implemented by the end of 1992.<sup>18</sup> The Basel I accord has been implemented not only in member countries but also in most other countries with active international banks<sup>19</sup>. The then new concepts were risk-weighted assets and Tiers of capital, which will be elaborated upon below.

#### 2.1.1.1 Risk-Weighted Assets

The focus of the Basel I accord in terms of risk was *credit risk or the risk of counterparty failure*. The Basel I accord defined five risk weights for different categories of credit risk, which were 0, 10, 20, 50 and 100%. Riskier categories were assigned a higher risk weight. The total risk-weighted assets of a bank were the sum of the product of risk weights and their corresponding assets.

Assets that could be assigned a 0% risk weight included cash and claims on OECD central banks. The 10, 20 and 50% risk weights could be applied to, among others, claims on domestic public-sector entities, claims on banks incorporated in the OECD, cash items in the process of collection and loans fully secured by mortgage on residential property. The 100% risk weight applied to claims on the private sector as well as fixed assets.

#### 2.1.1.2 Tiers of capital

The Basel Committee defined two Tiers of capital – Tier 1 and Tier 2 capital.<sup>20</sup> This approach was motivated by the fact that different types of capital were more or less suited to absorb unexpected losses. The committee considered the key element of capital to be equity capital (less goodwill and other deductions) and published reserves from post-tax retained earnings. This was dubbed 'Tier 1' and was the capital of highest quality, i.e. it had the highest degree of loss-absorbing capacity ('Tier 1' was later changed to 'Common Equity Tier 1' or 'CET1', when junior subordinated debt or 'Additional Tier 1' was included in the definition of Tier

---

<sup>16</sup> Baldvinsson, 2011, p. 56

<sup>17</sup> BIS, 'International Convergence of Capital Measurement and Capital Standard', 2006, p. 1

<sup>18</sup> Baldvinsson, 2011, p. 404

<sup>19</sup> BIS, 'A brief history of the Basel Committee', 2015, p. 2

<sup>20</sup> Baldvinsson, 2011, p. 250 and 266

1)<sup>21</sup>. Other elements of capital (supplementary capital) were admitted into Tier 2. Tier 1 and Tier 2 capital constituted the bank's total capital base. The capital ratio was defined as the base capital to weighted risk assets:<sup>22</sup>

$$\text{Capital ratio} = \text{Base capital/RWA} \quad (2.1)$$

Where RWA is risk-weighted assets. The Basel Committee required 50% of the minimum requirement to consist of core capital elements (Tier 1), hence banks were required to hold Tier 1 capital corresponding to 4% of risk-weighted assets. This was a minimum target, and national authorities were free to adopt arrangements that set higher levels<sup>23</sup>.

### *2.1.1.3 Reflection on Basel I*

Basel I was a novel step towards harmonization of the rules of the game in the international banking market. It was without a doubt a step in the right direction. However, the framework with only five risk weights was very simple and allowed banks considerable room to maneuver. Different assets in the same asset category could vary considerably in credit quality, which made it possible to favor high-risk borrowers in order to enhance profit in the short term. Furthermore, the framework only considered credit risk (although, in 1996, the committee refined the framework to also address market risk). The major advantage of Basel I was the change to more comparable international capital ratios, a feature later (in Basel II) weakened when different approaches to determining risk weights were introduced.

### **2.1.2 Basel II**

In response to the criticism of Basel I, the Basel Committee issued a proposal for a new capital adequacy framework in 1999 to replace the 1988 accord.<sup>24</sup> The Basel Committee then consulted banking sector representatives, supervisory agents, central banks and outside observers in order to develop more risk-sensitive capital requirements until it published the framework in 2004 as the *Revised Capital Framework*. In 2005, the Basel Committee published a proposal governing the treatment of banks' trading books under the new framework. This document was integrated with the framework from 2004 in a comprehensive document released in 2006. This document also included the elements of the 1988 Accord that had not been revised and the 1996 Amendment to the Capital Accord to Incorporate Market Risks. The revised framework was called Basel II and sought to align regulatory

---

<sup>21</sup> European Banking Authority, 'CRD IV – CRR / Basel III monitoring exercise', 2015, p. 7 and BIS, 'Basel III: Monitoring Report', 2015, p. 2 and BIS, 'Basel III: A global regulatory framework for more resilient banks and banking systems', 2010, p. 40 and Baldvinsson, 2011, p. 253

<sup>22</sup> European Banking Authority, 'CRD IV – CRR / Basel III monitoring exercise', 2015, p. 15

<sup>23</sup> BIS, 'International Convergence of Capital Measurement and Capital Standard', 2006, p. 13

<sup>24</sup> Baldvinsson, 2011, p. 56

capital requirements with the underlying risks of banks<sup>25</sup>. The framework comprised three mutually reinforcing 'Pillars' and was available for implementation in 2007.<sup>26</sup>

### *2.1.2.1 The Pillars*

Basel II was an extension of the Basel I framework. It introduced three different approaches to evaluate credit risk, where Basel I had only one calculation approach. Aside from this extension, the calculation of risk-weighted assets further had to include market risk (through the 1996 amendment) and operational risk. The calculation of risk-weighted assets had thus been made more advanced, which further motivated banks to develop more advanced methods to evaluate credit-, market- and operational risk. In addition to the more advanced consideration of risks when calculating risk-weighted assets, the Basel II accord added two new features to the framework: the supervisory review process (Pillar 2) and market discipline (Pillar 3). The calculation of risk-weighted assets and minimum capital requirements was then dubbed 'Pillar 1'.<sup>27</sup>

The framework permitted banks a choice between two broad methodologies for calculating their capital requirements for credit risk. Banks were able to determine required capital to cover credit risk either through the standardized approach or through the internal ratings-based (IRB) approach.<sup>28</sup> The standardized approach was similar to Basel I, as the risk weights were defined by the regulator. This approach was, however, supported by external credit assessments. The alternative, the IRB approach, allowed banks to use their own internal rating systems for credit risk. Banks, however, needed supervisory approval to use the IRB approach. The bank would estimate risk components in order to determine the capital requirement for a given exposure. The risk components included measures of the probability of default, loss given default, exposure at default, and effective maturity. Banks using the IRB approach used a risk-weight function stated by the regulator to transform risk components into risk-weighted assets and thereby capital requirements.

Banks could choose between three methods for calculating required capital to cover operational risk. Operational risk was defined as the risk of losses resulting from inadequate or failed internal processes, people and systems or from external events. The methods included the basic indicator approach, the standardized approach and the advanced measurement approach (AMA).<sup>29</sup> Banks had to qualify in order to use the AMA approach.

Total risk-weighted assets were determined by multiplying the capital requirements for market risk and operational risk by 12.5 and adding the resulting figures to the sum of risk-weighted assets for credit risk. In order to motivate banks to choose the more advanced

---

<sup>25</sup> European Banking Authority, 'A brief history of the Basel Committee', 2015, p. 3

<sup>26</sup> BIS, 'International Convergence of Capital Measurement and Capital Standard', 2006

<sup>27</sup> BIS, 'Basel III leverage ratio framework and disclosure requirements', 2014, p. 1

<sup>28</sup> Baldvinsson, 2011, p. 278

<sup>29</sup> Baldvinsson, 2011, p. 286

methods for credit and/or operational risk, the Basel Committee applied a scaling factor to the total risk-weighted assets. The scaling factor would, by full implementation in 2009, be 80%. This feature was also meant to ease the transition to the new framework, as it would broadly maintain the aggregate level of minimum capital requirements<sup>30</sup>.

Pillar 2 addressed the supervisory review process of the framework. Supervisors were expected to evaluate how well banks assessed their capital needs relative to their risks; mainly risks that were not fully captured by the Pillar 1 process and external risks. Also, supervisors had to ensure that banks that used the more advanced (IRB and AMA) methods for measuring credit and operational risk complied with the minimum standards and disclosure requirements. Pillar 2 requirements were capital requirements beyond the core minimum requirements.

Pillar 3 addressed market discipline and its purpose was to complement the minimum capital requirements of Pillar 1 and the supervisory review process of Pillar 2 by providing a set of disclosure requirements<sup>31</sup>. Such disclosure requirements were particularly relevant under the Basel II framework as the new internal methodologies gave banks more discretion in assessing capital requirements.

### *2.1.2.3 Reflection on Basel II*

During the financial crisis, it was clear that capital requirements under Basel II were not adequate as several states had to bail out banks.

Basel II is often criticized for the potentially pro-cyclical influence on economic activity. The IRB practice entails that a bank's capital requirements are an increasing function of its estimated probability of default and losses given default of their loans and other assets. These estimates are expected to be higher in periods of economic decline, and, on the other hand, lower during periods of economic rise. As a consequence of this practice, banks will face higher minimum requirements in times of economic decline, which may cause them to tighten the supply of credit. The opposite is true in times of an economic rise, where a fall in the bank's capital requirements can lead to an expansion of the supply of credit, which can amplify a credit-led economic bubble due to an increase in loan-driven activity<sup>32</sup>.

Furthermore, banks were able to lower their capital requirements simply by switching from the standardized approach to the IRB approach. This built-in incentive was meant to motivate capable banks to improve their risk management practices but it also created the risk of a significant fall in the accumulated level of regulatory capital. Sounder market discipline and supervision were stressed as factors that would counter this effect. Nevertheless, capital

---

<sup>30</sup> BIS, 'International Convergence of Capital Measurement and Capital Standard', 2006, p. 13

<sup>31</sup> Baldvinsson, 2011, p. 274 and 287

<sup>32</sup> Andersen, 2009, p. 2

requirements for larger banks fell during the transition from Basel I to Basel II due to lower average risk weights<sup>33</sup>.

Basel II was put to the test during the financial crisis in 2007-2008 and was soon revealed as insufficient in bolstering banks to withstand a severe financial crisis. One of the weaknesses in the method under Basel II was that it did not sufficiently anticipate the underlying risks, which had led to a market collapse and a liquidity standstill. Furthermore, the crisis demonstrated the need for addressing certain risks, such as risks that correlate across banks and sectors and cyclical risks. In light of the experience gained, the Basel Committee formulated new recommendations regarding stricter capital requirements regulations in 2010<sup>34</sup>.

### **2.1.3 Basel III and the Capital Requirement Directive IV (CRD IV)**

The Basel Committee released Basel III in 2010 and introduced far stricter requirements to capital and liquidity for banks. In Europe, the Basel III standard is reflected in CRD IV and Capital Requirement Regulation (CRR).<sup>35</sup> The main difference between CRR and CRD IV is the fact that CRR is effective in all member states in the same way national legislation is. CRD IV has to be implemented into national legislation to have a direct affect. The financial institutions in Denmark are regulated by the Danish Financial Business Act (FIL). The CRD IV has been implemented in FIL by the Danish Financial Services Authority (FSA). The new regulation is expected to be fully phased in by 2019 and introduces new capital requirements, stricter requirements of Tier 1 and Tier 2 capital and liquidity requirements. Furthermore, the framework introduces additional capital buffers that banks are required to hold on top of the minimum capital and Pillar 2 requirements. The framework is not yet complete and certain aspects, such as the specifics of the minimum requirement for own funds and eligible liabilities (MREL), are still under development.

In general, the goal of the new regulation is to enhance the banks' loss-absorbing capacity so that banks will be able to absorb unanticipated losses, such as those they experienced during the financial crisis. This goal has resulted in stricter requirements across all Pillars. The implications for Danish banks will be outlined in section 2.4.

## **2.3 Bank Packages in Denmark**

Basel III was released after the burst of the financial crisis and had yet to be implemented at the height of the crisis; therefore, six bank packages were implemented in Denmark from 2008-2013 as an attempt of crisis intervention to stabilize the Danish economy.<sup>36</sup>

The first bank package was passed in October 2008, after which a new bank package followed every year, the last being passed in October 2013. The bank packages contained

---

<sup>33</sup> Syvertsen, 2012, p. 3-4

<sup>34</sup> BIS, 'A brief history of the Basel Committee', 2015, p. 4-5

<sup>35</sup> Danmarks Nationalbank, 'Finansiell Stabilitet 1. halvår', 2015, p. 40

<sup>36</sup> Baldvinsson, 2011, p. 77

various initiatives, but they all shared the objective to help Danish banks withstand the financial crisis and prevent a big downturn.

To get an overview of the bank packages and the timeframe, a small illustration is sketched below:

Table 2.1: Bank Packages

2008	Bank Package I	"The Bank Package"
2009	Bank Package II	"The Credit Package"
2010	Bank Package III	"The Exit Package"
2011	Bank Package IV	"The Consolidating Package"
2012	Bank Package V	"The Development Package"
2013	Bank Package VI	"The Settlement Scheme Since October 2010" or the "SIFI-deal"

Source: Own adaptation with inspiration from [www.finansielstabilitet.dk](http://www.finansielstabilitet.dk) -> *Bankpakkerne i Danmark* and Baldvinsson, 2011, p. 77, 79, 80, 83 and 460

### 2.3.1 Bank Packages 1 - 2

The Financial Stability Act (FS Act), also known as Bank Package 1, was meant to establish better cooperation between the financial sector and the regulatory authorities. The financial sector became organized through the Private Contingency Association (PCA), a voluntary association which most banks joined by paying a fee. The aim of the bank package was to sustain a safety net so that all depositors obtained certainty for their receivables in Danish banks, and to stabilize the economy with a 2-year state guarantee for deposits. The guarantee was also applicable to depositors in Danish branches of foreign banks, and covered more than the Deposit Guarantee Fund (DGF). The DGF covers up to EUR 100.000. The additional guarantee given in Bank Package 1 was applicable until September 2010<sup>37</sup>.

Another outcome of Bank Package 1 was the establishment of the state-owned company 'Finansiel Stabilitet A/S' (FS), which was put into place to maintain financial stability and to dismantle banks threatened by bankruptcy.

Bank Package 2 was passed in October 2009, a year after Bank Package 1. It focused on banks' and other credit institutions' ability to continue to be able to offer borrowing opportunities to healthy companies as well as households, henceforth the name "The Credit Package". The government achieved this by providing DKK 75 billion to banks and DKK 25 billion to the Danish mortgage credit institutions.

### 2.3.2 Bank Packages 3 - 4

The 2-year state guarantee for deposits given in Bank Package 1 expired in 2010. In continuation of this, a new bank package was established with the objective to prepare the banks to operate without state interference. In practice, this meant that the state did not

---

<sup>37</sup> Baldvinsson, 2011, p. 77-78



guarantee the depositor beyond what was already covered in the DGF, which was also the case before the introduction of Bank Package 1.

Furthermore, Bank Package 3 encompassed new instructions to FS, which, among others, included that FS could not force a distressed bank to be liquidated. However, they could still take over and run distressed banks, as long as the request came from the bank itself.<sup>38</sup>

The motivation of Bank Package 4, the consolidating package, was to give healthy banks an incentive to take over distressed banks. This was launched by offering the healthy banks a compensation scheme, which was provided to the DGF. The idea was that taxpayers should no longer pay for distressed banks, and this was achieved by letting the DGF pay, because the fund was sponsored by the financial sector and thus poses no cost to the state.

### **2.3.3 Bank Package 5 - 6**

The focus of Bank Package 5 from 2012 was to develop small and medium-sized companies by facilitating their financing options. This bank package further established the Agricultural Financial Institution (AFI), which should fund new facilities in the agricultural sector. However, the agricultural sector should still use the normal banks to finance their regular operations as well as normal mortgage companies to finance their properties.

The last bank package, Bank Package 6, was passed in 2013 and contained three main elements. The first element included new capital requirements aimed at making SIFIs<sup>39</sup> more robust against shocks and less prone to take excessive risks. SIFIs are so big that a possible bankruptcy of a SIFI would result in fatal consequences for the economy. As a result, the capital requirements for SIFIs are more demanding than for other banks. The second element of Bank Package 6 was that the requirements on capital and liquidity in general to all Danish banks should be tightened in order for them to better be able to withstand a crisis in the future. The last element of this bank package was to strengthen the FSA through the creation of a board of supervisory activities of the FSA.

### **2.3.4 The Supervisory Diamond**

The Supervisory Diamond (SD) with five thresholds is set by the FSA in Denmark in order to prevent excessive risks. It was introduced in 2010 based on the experiences with the bank crisis of 2007-2008.<sup>40</sup> When a threshold in the SD is trespassed, it serves as a red flag and marks that the bank has a higher risk than recommended.<sup>41</sup> The five areas of interest include each corner of the diamond:

---

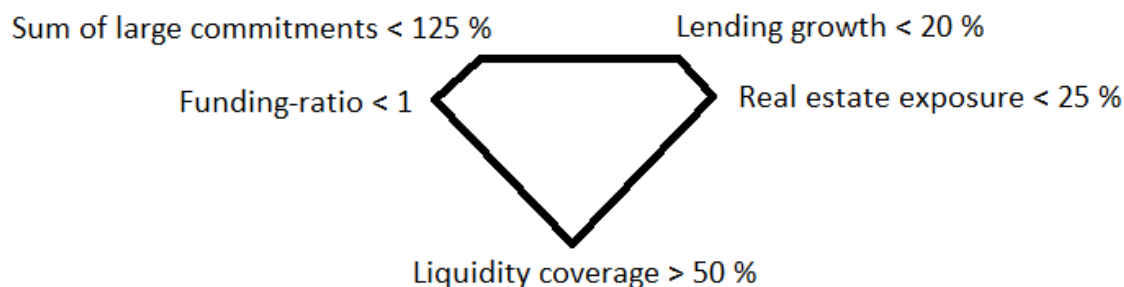
<sup>38</sup> [www.finansielstabilitet.dk](http://www.finansielstabilitet.dk) -> Exitpakken

<sup>39</sup> Systemically Important Financial Institutions, which are Danske Bank, Nykredit, Nordea Bank Danmark, Jyske Bank, BFR Kredit, Sydbank, and DLR-Kredit and Baldvinsson, 2011, p. 269

<sup>40</sup> Abildgren, 2011, p. 134

<sup>41</sup> Finanstilsynet, 'Vejledning om tilsynsdiamanten for pengeinstitutter', 2015

Figure 2.1: The Supervisory Diamond



Source: [www.finanstilsynet.dk](http://www.finanstilsynet.dk) -> Tilsynsdiamanten for pengeinstitutter and Baldvinsson, 2011, p. 400 and 439

From 2018 a new SD applies, which has a *sum of large commitments* < 175%, which is less strict than the current SD.<sup>42</sup>

## 2.4 Danish Banks' Capital Requirements Today

In the previous sections, the legislation that has been put into place in Denmark and elsewhere has been elaborated upon chronologically, beginning when the Basel Committee was formed. In the following, the most imposing requirements that Danish banks face today as well as possible future developments will be outlined.

### 2.4.1 Minimum Capital Requirement

The 8% rule has been in place since Basel I in 1992 and is the requirement that has the most severe consequences if breached.<sup>43</sup> It is also called the Pillar 1 rule. General banking risks are assumed to be covered by the 8% rule and additional risks of the individual banks are reflected in the Pillar 2 requirements. The 8% rule has remained constant through the changing regulatory framework for capital but both the denominator and the nominator have changed and are still changing. The rule states that a bank must hold capital corresponding to at least 8% of risk-weighted assets.<sup>44</sup> If a bank's capital falls below this point, it will face resolution. Pillar 1 requirements were tightened in the CRD IV framework in the form of a required minimum Tier 1 ratio of 6% of risk-weighted assets (up from 4%) as well as a required minimum CET1 ratio of 4.5% of risk-weighted assets (up from 2%).<sup>45</sup> The percentages are for full Basel III implementation in 2019, and the rules will be implemented gradually (see figure 2.2).

---

<sup>42</sup> Finanstilsynet, 'Vejledning om tilsynsdiamanten for pengeinstitutter', 2015, p. 3

<sup>43</sup> Baldvinsson, 2011, p. 272

<sup>44</sup> Danmarks Nationalbank, 'Finansiel Stabilitet 1. Halvår', 2015, p. 40

<sup>45</sup> European Banking Authority, 'Basel III: Monitoring Report', 2015, p. 8

Figure 2.2: Pillar 1 capital requirements in Europe until 2019



Source: Own adaptation Bank of England, 'Strengthening capital standards: implementing CRD IV', 2013, p. 12

In addition, Tier 1 capital must live up to certain requirements. These requirements changed when Basel III was implemented, which made 'old' Tier 1 capital incapable of being used for the minimum requirement. Old Tier 1 instruments were outphased in order for banks to have time to issue new compliant Tier 1 capital. Tier 1 capital that comply with the requirements of Basel III is called Additional Tier 1 capital (AT1)<sup>46</sup>. AT1 capital will be converted into equity or be written down if the bank's CET1 ratio falls below the trigger level. AT1 capital further has a Point of No Viability (PONV) trigger, voluntary coupon deferral and forced coupon deferral. The PONV trigger gives the regulatory authorities power to force a write-down or conversion to equity. Lastly, AT1 capital is non-cumulative and is non-dated.

The trigger level of AT1 instruments is generally either 5.125% or 7% (low versus high trigger). If the bank uses subordinated capital to cover 3.5% points of the 8% minimum requirement, a CET1 ratio of 5.125% means that the capital ratio is 8.625%, which is very close to the minimum requirement. This low trigger level is called a gone-concern trigger and allows the bank to absorb losses in a resolution from AT1 capital. The high trigger is called a going-concern trigger and allows the bank to be recapitalized before the bank is in a state

<sup>46</sup> BIS, 'Basel III: A global regulatory framework for more resilient banks and banking systems', 2010, p. 15 and 40

where resolution may be the only option. A breach of the high trigger (7%) means that the bank's capital ratio (assuming it has 3.5% subordinated capital) would be 10.5%, which is still a viable level. Some AT1 bonds are allowed to be written up again if the bank succeeds in regaining enough capital to comply with additional capital requirements.

In addition to the minimum requirements, banks will possibly also have to comply with a new leverage requirement in the future. The details regarding this requirement have not been finished but The Basel Committee suggests a requirement that a bank's leverage ratio (Tier 1 capital as a percentage of exposure measure<sup>47</sup>) should be no less than 3%<sup>48</sup>.

### 2.4.2 Pillar 2 Requirements

The Pillar 2 requirements are additional capital requirements that are assessed for the individual bank. These depend on which risks the bank is exposed to. The bank is expected to assess these risks itself, and the financial authority will check if the bank's methods are reliable. The Pillar 2 requirement is the highest of the requirement calculated using the 8+ method or the bank's internal method. The Pillar 2 requirement should consist of CET1 capital, but up to 44% of the requirement can be covered by AT1 capital or Tier 2 capital where Tier 2 capital is limited to 25% of the Pillar 2 requirement<sup>49</sup>. The Pillar 2 requirements are published in the bank's financial reports alongside the Pillar 1 requirements. If a bank breaks the Pillar 2 requirements, it will face multiple restrictions in order for it to comply with the requirement again, as well as heavy involvement by the FSA.

### 2.4.3 Buffers

The CRD IV framework includes several types of capital buffers. Firstly, a capital conservation buffer is being implemented. It should consist of CET1 capital and amount to 2.5% of risk-weighted assets. The capital conservation buffer serves as a permanent add-on and is, as the name suggests, intended to conserve capital.<sup>50</sup> The capital conservation buffer requirement is being implemented across Europe in line with the implementation plan that is depicted in figure 2.2.

In addition, SIFIs are required to comply with a SIFI buffer. This buffer must consist of CET1 capital. Currently, four Danish banks are subject to SIFI buffer requirements as depicted in figure 2. The SIFI buffers were enforced in 2015 with a 20% cap. Every year until 2019, an additional 20% of the SIFI buffer will be enforced. By 2019, it will therefore be fully phased-in.

---

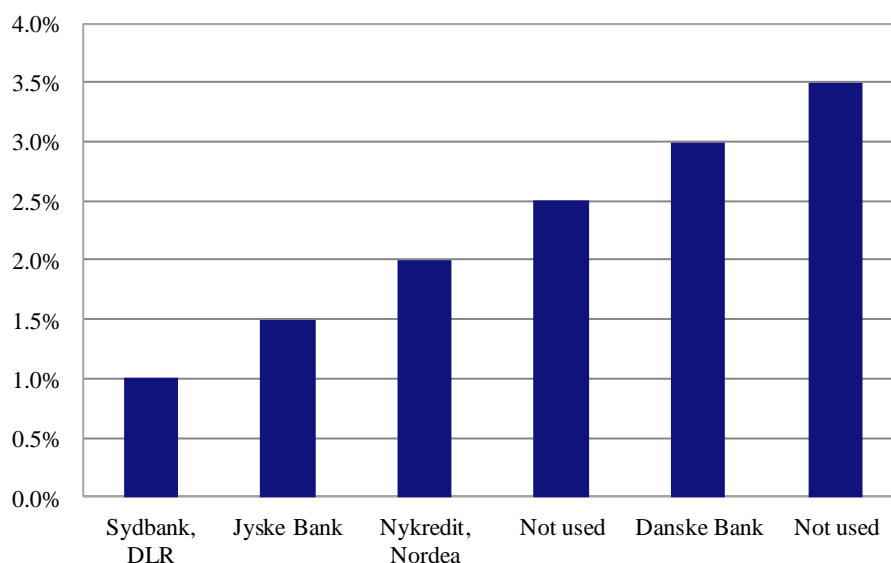
<sup>47</sup> A bank's total exposure measure is the sum of the following exposures: (a) on-balance sheet exposures; (b) derivative exposures; (c) securities financing transaction exposures; and (d) off balance sheet items

<sup>48</sup> BIS, 'Basel III leverage ratio framework and disclosure requirements', January 2014, p. 1

<sup>49</sup> Erhvervs- og Vækstministeriet, 'Bekendtgørelse om kapital til opfyldelse af det individuelle solvenstillæg for pengeinstitutter og realkreditinstitutter', 2015

<sup>50</sup> BIS, "Basel III: A global regulatory framework for more resilient banks and banking systems", 2010, p. 54

Figure 2.3: Danish banks' SIFI buffer requirements 2016



Source: [www.evm.dk](http://www.evm.dk) -> SIFI-krav

Furthermore, the CRD IV framework includes a country specific systemic risk or countercyclical capital buffer, also consisting of CET1 capital. This buffer is meant to reinforce the banks' resilience in times of economic recession, as well as to counter the pro-cyclical effects of the banks' credit supply. The buffer is between 0% and 2.5% of the banks' risk-weighted asset and will be time-varying. In Denmark, the Systemic Risk Council (SRC) assesses the level of the countercyclical buffer on an ongoing basis<sup>51</sup> and makes recommendations to the Danish Business and Growth Ministry, which determines the level of the countercyclical buffer. The countercyclical buffer is 0% in Denmark<sup>52</sup> and a change has to be announced at least 12 months before it is effective. Norway and Sweden have implemented a systematic risk buffer of 1%, which will increase to 1.5% in July 2016<sup>53</sup>. Danish banks that have exposures to Norway and/or Sweden are therefore impacted by this requirement.

#### 2.4.4 MDA

If a bank does not meet the combined capital buffer requirements, it will be subject to constraints regarding dividends and coupons on subordinated debt, as well as to restrictions on share buy-backs. The bank will face restrictions on the Maximum Distributable Amount (MDA) if its capital ratio falls below the minimum requirement plus the combined buffer ratio. However, in December 2015 the EBA published its opinion on the matter, stating that

---

<sup>51</sup> [www.risikoraad.dk](http://www.risikoraad.dk) -> the countercyclical capital buffer

<sup>52</sup> Erhvervs- og Vækstministeriet, 'Fastsættelse af den kontracykliske buffersats', 2015

<sup>53</sup> Norwegian Ministry of Finance, 'Countercyclical buffer increases next year', 2015 and Swedish Financial Services Authority, 'Decision regarding the countercyclical buffer rate', 2015

the MDA should apply already if a bank's capital ratio falls below the minimum requirement plus the combined buffer ratio and the Pillar 2 requirement<sup>54</sup>. The EBA announced at the same time their opinion that a breach of the MDA should be communicated to the public. The EBA's opinion is not legally binding but it has an impact on the general trends in European and national legislation on the matter. The MDA will increase in steps as the capital breach increases.

A breach of the MDA can be costly for the bank, as it can cause mistrust among equity holders and subordinated debt holders as well as mistrust around whether the bank will be able to honor its obligations. If a breach of the MDA forces a bank to cancel coupons on its AT1 capital, it may be very costly to issue additional AT1 capital in the future. Of course, the same rule applies to future equity issues.

#### **2.4.5 MREL and TLAC**

The MREL is meant to ensure that the bank will be able to survive a stressed scenario by inflicting losses on debtholders, if necessary, or that the bank has adequate liabilities suitable for absorbing losses in a liquidation situation. This requirement is made in order to avoid the situation where the government would have to bail out a bank. The MREL requirements are not yet outlined in detail. There are, however, proposals that the MREL criterion should have two elements: loss absorption and recapitalization.

If a bank is deemed credible, then the bank's MREL requirement should only be a loss absorption requirement. This requirement's purpose is to ensure that all losses are absorbed in the case of liquidation so that the government will not be required to cover losses. However, if a liquidation is not feasible, then the bank's MREL requirement will be a loss absorption requirement as well as a recapitalization requirement. The recapitalization requirement would depend on the bank's resolution plan. If, for example, the preferred resolution strategy is to transfer critical assets and liabilities to a bridge bank and liquidate the rest, then the MREL should be large enough to provide loss absorption for the liquidated part of the bank and provide recapitalization for the continued bank.<sup>55</sup>

The discussion about MREL has spurred speculation in a new kind of capital, so far named Tier 3 capital, or 'junior-senior' capital, which has the same rank as unsecured senior capital but which can be used for bail-in<sup>56</sup>.

Global systemically important banks (G-SIB)<sup>57</sup> also have to comply with Total Loss Absorbing Capital (TLAC) requirements, which are very similar to MREL<sup>58</sup>.

---

<sup>54</sup> European Banking Authority, 'Opinion of the European Banking Authority on the interaction of Pillar 1, Pillar 2 and combined buffer requirements and restrictions on distributions', 2015

<sup>55</sup> European Banking Authority, 'EBA FINAL Draft Regulatory Technical Standards on criteria for determining the minimum requirement for own funds and eligible liabilities under Directive 2014/59/EU', 2015

<sup>56</sup> Moody's, 'Change in French Banks' Hierarchy of Claims Increases Clarity of Bank Resolution', 2015

### 2.4.6 Rating Requirements

In addition to the regulatory requirements, many banks are dependent on obtaining a high rating in order to access the capital markets. This is especially true for banks that base their lending on market funds, which is typically the case for large banks. S&P requires banks to have Additional Loss Absorbing Capacity (ALAC).

### 2.4.7 Liquidity and Funding Requirements

Banks are also required to have capital set aside in order to comply with capital requirements in the event of a period with limited liquidity in the market. This requirement is expressed as the liquidity coverage ratio (LCR), which is required to be above 100%<sup>59</sup>. LCR is the holding over 30 days of high-quality liquid assets as a percentage of total net cash flow amount<sup>60</sup>. The LCR requirement will be phased in between 2015 and 2018.

Banks are also required to have sufficient liquidity on the liability side. This requirement is expressed with the Net Stable Funding Ratio (NSFR). The NSFR is the amount of available stable funding as a percentage of the required amount of stable funding and is required to be above 100%<sup>61</sup>.

## 2.5 Cases of non-compliance

Capital requirements affect banks' capital structure choices because banks want to optimize their value by reducing the risk of non-compliance. However, the size of this risk depends on the costs associated with regulatory non-compliance. These costs are obviously difficult to measure since they are only incurred when banks actually breach the requirements. The following sections look into cases of regulatory non-compliance in order to determine the size and kinds of costs banks incur when they fail to comply with the regulations.

### 2.5.1 Roskilde Bank

Roskilde Bank was founded in 1884 and had therefore been a bank with a long history before its collapse in 2008<sup>62</sup>. In the beginning of 2008, Roskilde Bank was the 10<sup>th</sup> largest bank in

---

<sup>57</sup> Financial Stability Board, '2014 update of list of global systemically important banks (G-SIBs)', 2014, p. 1 and BIS, 'Global systemically important banks: updated assessment methodology and the higher loss absorbency requirement', 2013, p. 4

<sup>58</sup> Standard & Poor's, 'Advance Notice Of Proposed Criteria Change: Ratings Uplift Due To Additional Loss-Absorbing Capacity', 2014

<sup>59</sup> BIS, 'CRD IV – CRR / Basel III monitoring exercise', 2015, p. 33 and Finanstilsynet, 'Markedsudvikling 2013', 2014, p. 5 and Danmarks Nationalbank, 'Finansiel Stabilitet 1. Halvår', 2015, p. 5 and BIS, 'Basel III: Monitoring Report', 2015, p. 3 and BIS, 'Basel III: The liquidity Coverage Ratio and liquidity risk monitoring tools', 2013, p. 6 and Baldvinsson, 2011, p. 405

<sup>60</sup> BIS, 'Results of the comprehensive quantitative impact study', 2010, p. 17

<sup>61</sup> BIS, 'Basel III: The Net Stable Funding Ratio', 2014, p. 1 and 3 and European Banking Authority, 'CRD IV – CRR / Basel III monitoring exercise', 2015, p. 42 and BIS, 'Basel III: Monitoring Report', 2015, p. 4

<sup>62</sup> Jeppesen, 2009, p. 7

Denmark with a working capital at around DKK 30 billion.<sup>63</sup>. In the years prior to the collapse, the bank had positive results. However, it had in particular a high lending growth, especially targeted towards the real estate sector<sup>64</sup>.

Roskilde Bank was the city pride of Roskilde. It had been around since the 1800s and was an important company because of its close contact with the local business and culture, not only in the city of Roskilde but also in other cities in the Zealand region. Over the years it had grown from being a small local bank, to becoming a major bank in the Copenhagen metropolitan area. The bank's Chief Executive Officer, Niels Valentin Hansen, resigned in 2007 after 28 years of service. Just prior to that in 2003, the five executives of Roskilde Bank had been awarded the biggest stock options programs in total amount in Danish history<sup>65</sup>.

#### *2.5.1.1 The time course*

In August 2008, it was announced that Roskilde bank did not comply with its solvency requirements. In order to restrict harmful effects on Danish society, the assets and liabilities of the bank were acquired by the NB and the PCA. No other banks showed interest in an acquisition of the destitute bank<sup>66</sup>. When the Danish National Bank took over Roskilde Bank, the state provided a deposit guarantee.

In September 2008, buyers for the branch offices were successfully found, such that three other banks altogether bought 21 branch offices<sup>67</sup>. Since it was not possible to sell all parts of Roskilde Bank, the remaining parts of the Bank went to a new company for resolution. Thus, the bank's old activities continued in a new company, and in August 2009 this company was handed over for resolution to FS<sup>68</sup>. The state guarantee, granted in August 2008 to The Danish National Bank, was handed over to FS.

#### *2.5.1.2 Problem analysis*

In this section, the specifics of the Roskilde Bank collapse regarding capital and risk management will be outlined in order to form an opinion on the causes and consequences of the regulatory non-compliance case.

Firstly, the loans of Roskilde Bank were in July 2008 subject to large impairments considerably greater than previously acknowledged according to the management of the bank. This is the reason the management, in the first instance, sought help from the FSA with whom they tried to find a solution to the problem either by carrying out capital injections or by

---

<sup>63</sup> Finanstilsynet, 'Pengeinstitutternes størrelsesgruppering 2015', 2015

<sup>64</sup> Baldvinsson, 2011, p. 76-77

<sup>65</sup> Jeppesen, 2009, p. 90-108

<sup>66</sup> Danmarks Nationalbank, 'Roskilde Bank', 2008, p. 41-42

<sup>67</sup> Nymark, 2008 and Jeppesen, 2009, p. 194-195

<sup>68</sup> Finansrådet, 'Overdragelse af Roskilde Bank A/S til Finansiell Stabilitet A/S', 2009



merging with another bank.<sup>69</sup> The sudden large impairments had a severe effect on the capital adequacy of the bank.

As seen in the graph below, the solvency of Roskilde Bank was not below 8% of the risk-weighted assets in any of the official reports, annual or quarterly, up until Q1 2008. However, in the first three quarters of 2006, the solvency descended from 9.8% in Q1 to 8.9% in Q3. In December 2006, the FSA raised the individual solvency requirement for Roskilde Bank from 8% to 10.75%<sup>70</sup>, which meant that Roskilde Bank's management had to take drastic actions in order to comply. Therefore, Roskilde Bank started selling its own treasury shares in 2006, which improved its solvency ratio immediately<sup>71</sup>. The annual report of 2006 showed an initial stock of 614,258 shares<sup>72</sup>, but at the end of the year the amount was at 1.235, which reflected the sale of treasury shares. This resulted in a solvency ratio of 13%, which was compliant with the increased individual solvency requirement.

In 2007, Roskilde Bank further improved its equity by issuing new shares. This helped, among others, to increase the bank's solvency ratio from 11.9% to 13.2% between Q1 and Q2 2007. At the same time, the FSA lowered the individual solvency requirement marginally to 10.5%.

Table 2.2: Roskilde Bank's solvency

Development in Roskilde Bank in %	2005	2006				2007				2008	
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Core capital *	8.3%	7.2%	6.3%	6.7%	8.0%	7.3%	7.8%	7.8%	7.0%	7.4%	Neg.
Solvency **	11.5%	9.8%	9.1%	8.9%	13.0%	11.9%	13.2%	13.2%	11.9%	12.2%	Neg.

Source: Own adaptation, numbers from released annual and quarterly reports

\* Core capital after deductions as a percentage of total weighted items

\*\* Solvency calculated in accordance with FIL § 124 par. 1

As seen in table 2.1, the core capital was between 6.3% and 8.3% of risk-weighted assets in the period between Q4 2005 and Q1 2008, which indicated there was a comparatively high amount of proven reserves to meet any potential losses in that period. The escalation happened in the second quarter of 2008, because the bank's result was negative by more than DKK 5 billion. The deficit was deducted from the bank's equity, which as a result fell to minus DKK 2.5 billion.

<sup>69</sup> Økonomi- og Erhvervsministeriet, 'Redegørelse vedrørende Roskilde Bank', 2008

<sup>70</sup> DR Documentary: Bankerot

<sup>71</sup> Jeppesen, 2009, p. 120

<sup>72</sup> Roskilde Bank annual report 2006, p. 36

Table 2.3: Roskilde Bank's capital

Development in Roskilde Bank (in DKK million)	2005	2006				2007				2008	
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Equity	1,705	1,686	1,583	1,829	2,494	2,467	2,656	2,684	2,633	2,732	-2,525
Hybrid core capital	250	350	274	317	350	350	468	473	449	473	473

Source: Own adaptation, numbers from released annual and quarterly reports

As seen in the above graph, the value of Roskilde Bank's equity grew by 72% from Q2 2006 to Q1 2008, so the collapse could hardly have been predicted from the financial reports. The sudden change in the bank's results came mainly from two different sources, which both affected the financial result negatively<sup>73</sup>:

(1) Big impairments on the lending of the bank, i.e. the accounting item: *Impairment losses on loans and receivables etc.*, which amounted to DKK 3,578 million in Q2 2008 and reflected the deteriorating quality of the bank's loans.

(2) The accounting item: *Losses on disposal of bank activity*, which amounted to DKK 1,915 million in Q2 2008. This item was a result of the agreement with The Danish National Bank and the PCA to acquire Roskilde Bank's assets and liabilities at *transfer values*, which were considerably lower than the book value.

The supplementary capital of Roskilde Bank increased from DKK 749 million in 2005 to DKK 1,953 million in 2008, a total intensification of around 260%. The trend was increasing rapidly except for a few small bumps along the way.

Table 2.4: Roskilde Bank's supplementary capital

Development in Roskilde Bank (DKK million)	2005	2006				2007				2008	
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Supplementary capital	749	680	809	722	1,752	1,749	2,158	2,164	1,954	2,087	1,953

Source: Own adaptation, numbers from released annual and quarterly reports

As mentioned earlier, Roskilde Bank was challenged by the increased solvency requirement in the fourth quarter of 2006. In order to comply with the higher requirement, Roskilde bank issued around DKK 1 billion during Q4 2006. Roskilde Bank raised several loans in that period: One of the loans, the biggest in nominal size, is from December 2006, a loan of EUR 80 million or DKK 596 million.<sup>74</sup> The issuance of capital in a time of distress is especially expensive because investors expect to be compensated for taking on the risk. Had

<sup>73</sup> Roskilde Bank half-yearly report 2008, p. 10

<sup>74</sup> Roskilde Bank Stock Exchange Announcement, 1 December 2006, and Roskilde Bank Annual Report, 2006

the bank not been in such an urgent need for capital, it would have been able to raise capital at better terms when or if the crisis ended.

Table 2.5: Roskilde Bank's total assets

Development in Roskilde Bank	2005	2006				2007				2008	
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Total Assets (DKK million)	18,621	20,153	22,884	25,735	30,052	33,765	42,632	41,58	41,983	42,935	37,330

Source: Own adaptation, numbers from released annual and quarterly reports

As a last comment, the bank's total assets expanded dramatically from 2005 to 2007, which is associated with additional risk. This was associated with a corresponding growth in lending that exceeded 20% per annum in the years up to 2008.<sup>75</sup> Today, the SD limits banks' deposit growth to 20% per annum.

### 2.5.1.3 Key points

The management carried out various actions to cushion the solvency of Roskilde Bank, especially in the last months of 2006. These were sales of own treasury shares, issues of new shares and issues of supplementary capital. There are obvious costs of issuing capital in a stressed situation because the bank will have to pay a premium to investors for taking on the risk. The actual costs are hard to estimate as they depend on the bank's standing in financial markets and its market timing.

Also, the case of Roskilde Bank shows the importance of truthful financial reporting and timely impairment tests. The case is a good example of the need for better disclosure, which was one of the concerns that were addressed in Basel III. Furthermore, the case demonstrates that the true value of a bank's assets is not always observable and that the reported figure has a huge impact on the effective capital requirement. Furthermore, the observed jump in the value of assets stresses the difficulties in estimating the asset volatility. The volatility of assets is especially tricky when the bank is expanding its business rapidly. Today there is focus on this dilemma through the SD, which was introduced in 2010 to deal with the lessons learned from the financial crisis.

Roskilde Bank is a case of a large bank that was allowed to collapse in a time of economic recession when many governments would save their countries' distressed banks with no or low costs to bondholders. The current regulatory framework encourages the use of bail-in as in the case of Roskilde Bank but on the other hand has introduced very strict requirements for systemically important banks, which will not be allowed to collapse. The

---

<sup>75</sup> Roskilde Bank Annual Reports

case of Roskilde Bank may be relevant for smaller, less systemically important banks but in the case of SIFIs, a similar situation will most likely be tackled very differently in today's regulatory framework.

### 2.5.2 JAK Cooperative Bank

J.A.K. Slagelse is the first Danish bank that has been taken over by FS since the implementation of CRD IV in January 2015. It is therefore the most relevant case to look at when estimating the current costs of regulatory non-compliance in Denmark.

JAK Cooperative Bank<sup>76</sup> began its operations in 1931 after the Great Depression in the late 1920s. The bank works for an interest-free society, where money serves the community. It differs from other banks because of this business concept. It offers interest-free deposits, allowing for interest-free lending, and its income only accounts for the essential administration.<sup>77</sup> JAK Cooperative bank is organized in independent financial institutions. JAK stands for land, labor and capital in Danish<sup>78</sup>.

JAK Cooperative Bank has been subject to a number of mergers and acquisitions and consists of several different banks.<sup>79</sup> In this context, it is pertinent to mention, that only one of the principal banks in the cooperative, Andelskassen J.A.K. Slagelse, has critical issues regarding capital and solvency. Henceforth, this bank is analyzed in the following.

#### 2.5.2.1 The time course

By the end of 2012, Andelskassen J.A.K. Slagelse was criticized for having trespassed a corner of the SD, since it exceeded the limit regarding the sum of large commitments.<sup>80</sup> The FSA made an inspection of Andelskassen J.A.K. Slagelse in December 2014 and in January 2015, and submitted a statement with injunctions over future measures to be taken.<sup>81</sup> Among others, it was highlighted that the supplementary capital consisted of more than half of the total capital, and in addition, that the individual solvency requirement was not met. The actual solvency was 17.3%, which was 4% lower than the individual solvency requirement.

In September 2015, the FSA dismissed the chief executive officer of the bank because the bank did not comply with the money laundering rules, which was reported to the police.<sup>82</sup>

In October 2015, it was announced that J.A.K. Slagelse was taken over by FS<sup>83</sup>. This announcement was followed up a couple of days later by a statement saying that restructuring

---

<sup>76</sup> In Danish: JAK Andelskasse

<sup>77</sup> [www.jak.dk](http://www.jak.dk) -> JAK historie

<sup>78</sup> JAK in Danish: Jord, arbejde og kapital

<sup>79</sup> Abildgren, 2010, p. 143-149

<sup>80</sup> Finanstilsynet, 'Redegørelse om risikoplysning til Andelskassen J.A.K. Slagelse - overskridelse af tilsynsdiamantens pejlemærke for store engagementer', 2013

<sup>81</sup> Finanstilsynet, 'Redegørelse om inspektion i Andelskassen J.A.K. Slagelse', 2015

<sup>82</sup> Finanstilsynet, 'Anmodning om politimæssig efterforskning af Andelskassen J.A.K. Slagelse', 2015

<sup>83</sup> Finansiell Stabilitet, 'Finansiell Stabilitet overtager kontrollen med Andelskassen J.A.K. Slagelse', 2015

and a resolution of the bank was ongoing. In December 2015 there were discussions on whether Andelskassen J.A.K. Slagelse should be sold partially or fully and who potential buyers might be.<sup>84</sup> There are indications that the sales process will take place in 2016. However, those assumptions are of course indeterminate in nature.

### 2.5.2.2 Problem analysis

Table 2.6: Andelskassen J.A.K Slagelse's solvency

Andelskassen J.A.K. Slagelse				
	2011	2012	2013	2014
Solvency	14.2%	13.7%	11.3%	15.8%
Individual solvency requirement	13.1%	13.1%	18.3%	21.3%

Source: Own adaptation, numbers from released annual reports

As seen in the graph above, the solvency of Andelskassen J.A.K. Slagelse was from 2013 below the individual solvency requirement. By December 2013, Andelskassen J.A.K. Slagelse did not meet the solvency requirements. Therefore, in January 2014, the bank signed subordinated capital for DKK 12 million from, among others, the cooperative members in order to meet the solvency and to cover up for the impairments for lending.<sup>85</sup> This pushed the solvency above the requirements for a time. At the time of writing this thesis, an initiative named "Red Sparekassen JAK" has been formed in order to seek support among the former cooperative members for capital injections<sup>86</sup>.

### 2.5.2.3 Key points

JAK Slagelse is a very small Danish bank, so the case is relevant to similar banks but less so to SIFIs that face different requirements and terms. However, the case shows that banks can be allowed to operate for longer periods without complying with the individual solvency requirement. Even though it is difficult to determine the exact value of costs associated with trying to obtain the necessary capital, one must assume that a lot of costly effort has been put into complying with the requirement.

## 2.6 Reflection on Danish capital regulation

The development of Danish bank regulation has broadly reflected European bank regulation. In contrast to other European countries, the Danish government has treated bondholders less favorably by allowing bail-in on unsecured senior debt as in the case of Roskilde Bank. As a

---

<sup>84</sup> Lund-Hansen, 2015

<sup>85</sup> Andelskassen J.A.K. Slagelse Annual Report 2013, p. 6, 10 and 13

<sup>86</sup> Mandrup, 2015

general note, breaching capital requirements is costly in terms of man hours required to develop capital plans, premium costs related to external funding and in form of limitations on growth. Also, cases of regulatory non-compliance suggests that corporate governance and disclosure requirements have a big impact on the riskiness of the bank. However, these issues are outside the scope of this thesis.

The first occurrence of outside intervention regarding capital requirements is when the bank's capital ratio falls below the MDA limit, which will result in limited ability to pay dividends and possibly also a limited ability to pay coupons on AT1 capital depending on the severity of the breach. This restriction is potentially very costly for the bank depending on the bank's need for efficient access to capital markets. Whether or not the MDA buffer should be interpreted as lying "on top" of the Pillar 2 requirements is not clear at this point. However, since the EBA's opinion is that it should, this will be the assumption throughout the thesis. Whether or not a breach of the MDA limit will be required to be communicated to the public is also not clear. Depending on this, costs could include losses in brand value and creditworthiness.

The second occurrence of outside intervention regarding capital requirements is when the bank's capital ratio falls below the Pillar 2 requirement. The bank will be required to draft a capital conservation plan and the financial authorities would step in with specific requirements to help bring the capital ratio back to a compliant level. The costs of this occurrence are both direct in form of additional amounts of work as well as indirect if for example the bank is forced to issue additional capital at a disadvantageous point in time or if the bank is forced to lower its risk-weighted assets by selling off assets below fair value. Of course, the bank would also lose creditworthiness and would probably have to pay a premium on its debt and equity for a prolonged period.

Lastly, if the bank breaches its minimum requirement, it will be liquidated or sold off. Equityholders' claim on the bank will be lost and so will owners of the bank's AT1 capital's claim through write-downs or conversions to equity. The financial authorities may decide that the bank is non-viable before it breaches its minimum capital requirement but since this decision is subjective and difficult to predict, it will be assumed that the minimum requirement constitutes the non-viable threshold in the following.

### **3 Theories of bank capital structure**

In section 3.1, relevant theories from corporate finance regarding capital structure in general are presented. These provide a theoretical foundation for the subsequent treatment of theories regarding optimal bank capital structure, which are elaborated on in section 3.2. In section 3.3, a model of optimal capital structure in the current regulatory framework is developed. Section 3.4 concludes the chapter.

#### **3.1 Theories from corporate finance**

In the following, classical theories from corporate finance are presented. These theories relate to the issue of optimal capital ratio and whether or not firms do have an optimal capital structure in the first place. The section starts with an account of the classic Modigliani & Miller theorem and its extensions that include the assumption of taxes and financial distress costs. This leads to the static tradeoff theory, which predicts an optimal capital ratio that balances tax benefits and financial distress costs. Next, the issue of asymmetric information is touched upon. The assumption of asymmetric information in a world where tax benefits and financial distress costs are second-order leads to a conclusion that there is no universal formula for the optimal capital structure. Rather, firms' capital structures are a result of their opportunities for cheap finance. Lastly, the more sophisticated theories, which build on Black and Scholes' option theory, are introduced.

##### **3.1.1 The classic Modigliani & Miller theorem**

The irrelevance theorem (MM) by Modigliani & Miller (1958) is an important contribution to concepts of capital structure. Simply, it states that the total value of a firm is independent of its composition of its liability side. Correspondingly, this indicates that the total funding costs of a firm is independent of its equity ratio.

One important takeaway of MM is that the required return on equity is determined by the equity ratio. The higher the equity ratio is, the lower the volatility of equity is. This means that the required return on equity decreases, as rational pricing suggests a less-risky financial claim and a lower risk premium. Correspondingly, debt becomes safer as there will be more equity relative to debt, which in return requires a lower return. MM's result shows that the effect of a lower risk premium is enough to resemble the higher weight on equity, which is more expensive.

However, the theory of MM depends on a list of conditions being symmetric information as well as the nonexistence of transaction costs, taxes and financial distress costs. When these conditions are not satisfied, the value of the firm may depend on its capital structure.

##### **3.1.2 The Modigliani & Miller theorem with taxes**

The tax treatment of debt affects the prediction of the MM theorem. Interest paid by the corporation is generally tax-deductible, while dividend payments on equity are not. This

decreases the costs of debt compared with equity. Therefore, total funding costs can be lowered by issuing debt. In fact, the MM theorem with taxes predicts that the optimal capital structure is one with no equity<sup>87</sup>.

### **3.1.3 Static tradeoff theory**

The static tradeoff theory is a result of the MM proposition's practical implications. If there is an optimal capital structure, the static tradeoff theory predicts that it should reflect tax savings from debt and the accompanying costs of financial distress. The theory avoids corner solutions and rationalizes moderate borrowing. Also, it predicts that firms with valuable intangible assets and growth opportunities will favor equity and more mature firms with a tangible asset base will favor debt. The most comprehensive evidence against the static tradeoff theory is the strong inverse correlation between profitability and financial leverage, which is observed among many firms<sup>88</sup>.

### **3.1.4 Asymmetric information and pecking order theory**

One of the assumptions in the MM theorem is symmetric information. In general, this assumption does not hold as the management of the firm typically have access to more information than market participants. The occurrence of asymmetric information can have an impact on decisions made by the parties. Market participants will observe the actions of management and look for signals about the real value of the firm. If management seeks to optimize current shareholders' value, they will only issue new equity when they believe the share price is higher than the fair value of the firm and they will only buy back equity when they believe the share price is lower than the fair value. Hence, the market perceives an equity issue as a sign that the stock is overvalued. The issuance of debt is also perceived as a sign that the stock is overvalued, however, it is a weaker signal than an equity issuance.

The pecking order theory assumes that the firm prefers internal financing to external financing due to costs associated with asymmetric information. It further assumes that dividend policies are rarely deviated from as the market perceives a change in dividend level as a strong signal and commitment. Hence, managers will issue the least risky securities when funding existing projects. The theory can explain the negative association between profitability and leverage, which is often observed<sup>89</sup>, as profitable firms have access to retained earnings, which is a source of internal financing, and unprofitable firms do not. The pecking order theory does not predict an optimal capital structure but can explain the differences in capital structure between different types of firms.

---

<sup>87</sup> Berk & DeMarzo, 2011

<sup>88</sup> Long, 1985

<sup>89</sup> Shyam-Sunder, 1998



### 3.1.5 Merton's model of firm capital structure

Using the seminal options pricing paper, Black & Scholes (1973), Merton (1974) developed a model of firm capital structure by realizing that debt holders, in addition to their debt claim, are short a put option and by put-call parity, equity holders are long a call option. Hence, Merton's model can explain the spread between risky debt and an otherwise identical risk-free debt, as it is equal to the value of the put option. Merton's framework lay down the analytical machinery to derive the optimal capital structure given a few more introductions, like taxes and bankruptcy costs.

Black & Cox (1976) derived the endogenous default boundary in Merton's model and in 1994, Leland developed a model that derived both the endogenous default boundary as well as the optimal capital structure<sup>90</sup>.

## 3.2 Optimal bank capital structure in the literature

There are obviously many different theories that aim to explain the observed cross-sectional variation in corporate capital structure. However, many of them result either in corner-solutions or are too simple to apply to real cases. Even fewer theories have been developed when it comes to banks' capital structure specifically. Moral hazard theory predicts that banks with insured deposits, which they pay no premium for, should set capital ratios to the lowest level permitted by capital regulations. However, there is a widespread tendency for banks to set their capital ratios well above the required minimum<sup>91</sup>.

One model that finds an interior optimal capital ratio in banks is the model developed by Harding, Liang and Ross (henceforth, the HLR-model)<sup>92</sup> that balances deposit insurance, capital requirements, bankruptcy costs and tax-advantaged debt. In the following, the special features of banks that influence the capital structure decision, are elaborated on, in order to have a starting point for the subsequent introduction of theories that aim to explain the optimal capital structure for banks specifically. Firstly, the model developed by Harding, Liang and Ross (2009) is outlined, followed up by their extension with multiple bankruptcy thresholds. This extended model fits the current regulatory framework better as banks are required to comply with the minimum requirement as well as Pillar 2 and buffer requirements. Lastly, the issue whether banks actively adjust their capital towards an optimal is examined.

### 3.2.1 Special features of banks

Banks are special in several ways, which makes it difficult to use the theories of corporate finance on banks. Banks provide a societal service by providing liquidity transformation through short-term deposits and long-term loans. This role of banking emphasizes the deposit

---

<sup>90</sup> Sundaresan, 2013, p. 2

<sup>91</sup> Tarullo, 2008, p. 142

<sup>92</sup> Harding, 2009

side of banking business. However, banks also provide an important service in the other aspect of classical banking; lending. In lending contracts, the bank serves as a cost-saving monitor. Also, a bank can reduce the riskiness of investment when viewed as a coalition of borrowers who share their risk. The risk for the independent investor is larger than the risk for a large group of individual investors when their investment projects are not perfectly correlated. A bank adds value to society when it allows investors to share their individual risk<sup>93</sup>.

Due to banks' important societal role, they face capital requirements that corporate firms do not. This additional cost obviously affects the optimal capital structure of banks. Also, besides the capital requirement, there are implicit costs of the regulatory burden, which generally increase with leverage. The increased costs serve to offset the bank's incentive for higher leverage<sup>94</sup>.

Banks differ from other firms by the implicit and explicit guarantee of the banks' debt, which means that it is not necessary for the owners of the bank to provide total compensation for the risk of the bank's debt. This affects the banks' access to fairly cheap debt funding and, as a result, can decrease banks' funding costs.

The objective of an explicit guarantee is to protect depositors partially or completely from losses. The Danish government guarantees deposits in all banks with a head office in Denmark with up to a total amount of EUR 100.000 per depositor<sup>95</sup>. This equals approximately DKK 750.000. The implicit guarantee originates from the government's propensity to save a bank in distress rather than letting it fail due to the negative societal and economic impact a bank failure would have.

One can view the guarantee as a subsidy to bank owners, as long as the bank pays a zero or flat premium for the guarantee. The value of the subsidy can be expressed by a put option<sup>96</sup>. This view implies that the value of the guarantee is positively correlated with the amount of guaranteed debt and the volatility of the assets. Therefore, if a bank pays a zero or a flat premium, larger amounts of guaranteed debt increases the value of this subsidy. However, this reasoning assumes that a bank's funding only consists of deposits. However, most banks issue other kinds of debt, as it can be a challenge to grow the business only with deposits.

### 3.2.2 The HLR-model

Harding, Liang & Ross (2009) follow the derivation of Leland (1994) in developing a model for optimal capital structure of banks that takes into account deposit insurance, capital requirements, bankruptcy costs and tax-advantaged debt. In addition to the assumptions

---

<sup>93</sup> Keiding, 2015

<sup>94</sup> Harding, 2009, p. 2

<sup>95</sup> [www.gii.dk](http://www.gii.dk) -> Om garantiformuen

<sup>96</sup> Merton, 1977

inherent in Leland's model, they assume that banks only have one form of debt – fully insured deposits – and that the face value of deposits is static over time. Also, the insured deposits are deemed riskless and banks do not pay an insurance premium for deposit insurance. Hence, banks pay the riskless rate,  $r$ , on all deposits. The bank will be bankrupt when the value of its assets falls under the regulatory threshold. As in Leland (1994), values evolve continuously and the bank's capital structure decision is summarized by its choice of a promised continuous payment  $C$ .

In the context of corporate debt, the assumption  $F_t=0$  can be justified by considering only long maturity debt or debt that is continuously rolled over at a fixed rate or a fixed spread to a benchmark rate<sup>97</sup>. Harding, Liang and Ross (2009) argue that, even though most bank deposits technically have short maturities, as long as the bank is solvent and maintains competitive pricing, it can rollover deposits at the riskless rate, and therefore, the justification is also applicable to banks.

Using the same general solution as Leland (1994), Harding, Liang and Ross (2009) obtain an expression for the major claims that influence the market value of a firm and the market value of the equity claim held by the owners of the firm. It is argued that, when a bank issues debt, it raises the possibility of forced liquidation in the event of insolvency. The event of insolvency is defined by the market value of assets hitting the threshold  $V_B$ , which is an observable constant. The deadweight costs associated with liquidation in the event of insolvency reduce firm value by the current market value of those bankruptcy costs. The firm value is increased by the tax benefits as well as the deposit insurance benefits associated with debt financing. These three costs are viewed as contingent claims on the bank's portfolio of assets,  $V$ , and the market value of the bank is defined as

$$v = V - BC(V) + TB(V) + IB(V) \quad (3.1)$$

The contingent claims are valued using the general solution as in Leland (1994) and boundary conditions. It is assumed that when liquidation occurs, the bank will receive a fraction of the current market value of assets,  $(1-\alpha)V_B$ , where  $0 < \alpha < 1$ . The inability to realize full market value can be attributed to the need for large bulk sales in a short time and problems of asymmetric information associated with the sale of loans. These bankruptcy costs are large when the bank is close to liquidation and small when it is well-capitalized and therefore far from liquidation. Therefore, the bankruptcy costs are expressed as

$$BC(V) = \alpha V_B \left( \frac{V}{V_B} \right)^{-X}, \text{ where } X = \frac{2r}{\sigma^2} \quad (3.2)$$

The market value of bankruptcy costs can be viewed as the expected present value of the deadweight costs associated with liquidation,  $\alpha V_B$ .

Interest payments are generally deductible from corporate earnings when computing a firm's corporate income tax. Thus, each notional amount of interest paid results in a savings

---

<sup>97</sup> Leland, 1994

in taxes for a taxpaying firm equal to its marginal tax rate times the interest paid. As in Leland, it is assumed that tax benefits for a solvent firm are proportional to the interest payment on its debt and are terminated at the insolvency threshold,  $V_B$ . When  $V$  increases relative to  $V_B$ , the likelihood of insolvency declines and the risk of losing the tax benefits becomes remote. In that case, the tax benefits have a market value equal to the present value of a continuously paid perpetuity of  $\tau C$ , where  $\tau$  represents the marginal tax rate and  $C$  denotes the continuously interest on the debt. Therefore, the tax benefits are expressed as

$$TB(V) = \frac{\tau C}{r} \left( 1 - \left( \frac{V}{V_B} \right)^{-X} \right) \quad (3.3)$$

Deposit insurance covers the gap between the face value of deposits and the realizable value if a bank must be liquidated. The face value of deposits is equal to the present value of the continuously paid perpetuity of  $C$ ,  $C/r$ . Therefore, the insurance benefits are expressed as

$$IB(V) = \left( \left( \frac{C}{r} \right) - (1 - \alpha)V_B \right) \left( \frac{V}{V_B} \right)^{-X} \quad (3.4)$$

Substituting equations (2), (3) and (4) into the expression for the market value of the bank gives the following:

$$v(V) = V + \left( \left( (1 - \tau) \frac{C}{r} \right) - V_B \right) \left( \frac{V}{V_B} \right)^{-X} + \frac{\tau C}{r} \quad (3.5)$$

As can be seen, the deadweight cost factor,  $\alpha$ , is cancelled out. This is due to the fact that deposit insurance has the effect of transferring the burden of bankruptcy costs from the bank to the insurer.

Since  $v(V)$  must equal the sum of the market values of debt and equity and the assumption that the value of the bank's debt is  $C/r$ , the market value of equity is simply the market value of the firm less  $C/r$ . Thus,

$$E(V) = V + \left( \left( (1 - \tau) \frac{C}{r} \right) - V_B \right) \left( \frac{V}{V_B} \right)^{-X} - (1 - \tau) \frac{C}{r} \quad (3.6)$$

Although Harding, Liang and Ross (2009) acknowledge the increasingly complex capital requirements and the classification of Tier 1 and Tier 2 capital as well as the risk-weighted classification of assets, they consider a simplified version of regulations where a bank is required to maintain the market value of assets,  $V$ , above some threshold that is related to the face value of its deposits. This simplified regulation structure is equivalent to considering a bank that only has Tier 1 capital and a low risk portfolio for which the book capital ratio is the binding constraint. Hence, the bank is required to maintain  $V > \beta(C/r)$ , where the parameter  $\beta$  measures the stringency of the capital requirement. Once the bank chooses  $C/r$ ,  $\beta(C/r)$  can be viewed as the insolvency threshold<sup>98</sup>. Hence,  $V_B = \beta(C/r)$ . In

---

<sup>98</sup> Note that  $\beta=1$  is equivalent to Leland's (1994) case of protected debt when  $C/r$  is  $D$

addition,  $\beta$  is assumed to be less than  $1/(1-\alpha)$  since if it is not, the value of insurance benefits will be zero.

The model can be expressed in the more traditional language of minimum requirements using the basic accounting identity that  $V=D+Eq$ , where  $D$  is debt and  $Eq$  denotes the book value of equity not the market value of equity,  $E(V)$ . A requirement to maintain a minimum level of capital can be thought of as requiring  $(Eq/V)$  to remain above the specified threshold  $\underline{c}$ . Using this accounting entity, a maximum leverage of  $D/V < 1-\underline{c}$  can be established. Since  $V > \beta D$ , it can be shown that  $\beta = 1/(1-\underline{c})$ .

Substituting  $V_B = \beta(C/r)$  into equation (3.5) yields a general expression for the market value of a bank facing this form of insolvency threshold. The market value of the bank over time is:

$$v(V) = V + \left( \tau - k \left( \frac{C}{V} \right)^X \right) \left( \frac{C}{r} \right), \text{ where } k = (\tau + \beta - 1) \left( \frac{\beta}{r} \right)^X \quad (3.7)$$

To find the optimal value of  $C$  (and hence the optimal level of leverage), the first two derivatives  $v$  with respect to  $C$  are calculated. The second derivative is negative for  $k > 0$  so the market value of the bank is a strictly concave function of  $C$  as long as  $k > 0$ . By setting the first derivative equal to zero yields the optimal  $C$ ,  $C_{opt}$ :

$$C_{opt} = gV(0), \text{ where } g = \left( \frac{\tau}{k(1+X)} \right)^{\frac{1}{X}} \quad (3.8)$$

The interior optimum exists because at low levels of leverage, adding additional debt increases the value of the bank by increasing the tax benefits while adding little to the net expected bankruptcy costs and insurance benefits since insolvency is remote. However, as leverage increase, the incremental tax benefits are outweighed by the risk to future tax benefits with the possibility of insolvency.

Finally, substituting  $C_{opt}$  into equations (3.5) and (3.6) yields the market value of the bank and the market value of equity given an optimal choice of leverage.

$$v_{opt}(V) = V + \left( \frac{X}{1+X} \right) \left( \frac{\tau g V}{r} \right) \quad (3.9)$$

$$E_{opt}(V) = V + \left( \tau - 1 - k \left( \frac{C}{V} \right)^X \right) \left( \frac{C}{r} \right) = V - (k g^X + 1 - \tau) g \left( \frac{V}{r} \right) \quad (3.10)$$

One of the shortcomings of the model developed by Harding, Liang and Ross (2009) is the assumption that the bank will be liquidated as soon as the value of assets hits the insolvency threshold. In reality, it is hard to monitor the value of banks' assets continuously and a disclosure of the estimated value of assets is typically disclosed only every quarter. Also, governance problems may result in distorted accounts, which will have a chance of being discovered in the connection with a visit of the financial authorities. However, such a visit may not happen before the problems occur.

The disadvantages of the model are the obvious inaccuracy in predicting optimal capital ratios for banks. When the study was made, they assumed a riskless rate of 6%, which gave some reasonably realistic capital ratios (though they were a bit greater than what was observed in real life). In the current economic environment with the riskless rate in the area of 0%, the model predicts capital ratios close to 100%, which is very unrealistic.

Another disadvantage is the fact that the model uses total assets as the denominator in the capital requirements and not risk-weighted assets. The optimal capital ratio is between 0-100% when calculated in relation to the value of total assets, however, when calculated in relation to risk-weighted assets, there is no upper boundary for the optimal capital ratio, which may result in capital ratios well above 100%.

When applying the model to real-life cases, the minimum capital ratio in terms of total assets can be expressed as  $\underline{c}\rho$  where  $\rho$  is the average risk weight of assets. Hence, the minimum requirement takes into account the average risk-weight on assets. This application requires the additional assumption that the average risk weight of assets is constant.

### 3.2.3 The HLR-model with warning threshold

The model by Harding, Liang and Ross (2009) can be extended to include multiple bankruptcy thresholds. In this setup, the model includes two fixed thresholds: a “warning” threshold,  $V_C$ , and an “insolvency” threshold,  $V_R$ , where  $V_C > V_R$ . The warning threshold can be expressed in the same manner as the original insolvency threshold, i.e.  $V_C = \gamma \left(\frac{C}{r}\right)$ . If the value of the bank's assets,  $V$ , falls to this level, the bank incurs additional regulatory costs but is able to continue to operate. In this regard, the warning threshold could be calculated using the individual solvency requirement and possibly also the combined capital buffer as it could be assumed that the bank incurs costs when breaching these requirements. The model assumes that the regulatory costs are proportional to the warning threshold (i.e.  $=\delta V_C$ ). The insolvency threshold,  $V_R$ , is modeled as in the original model:  $V_R = \beta(C/r)$  ( $\beta < \gamma$ ). The extra regulatory costs are expressed as:

$$ERC = \frac{\delta\gamma C}{r} \left(\frac{V}{V_C}\right)^{-X} \quad (3.11)$$

The total value of the bank in this extended model is  $v = IB - BC + TB - ERC$ , which can be reduced to:

$$v = V + \left(\tau - n \left(\frac{C}{V}\right)^X\right) \frac{C}{r}, \text{ where } n = k + \delta\gamma^{1+X}r^{-X} > k \quad (3.12)$$

Taking the first order derivative of the total value of the bank,  $v$ , with respect to  $C$  yields the optimal debt service  $C$ ,  $C_{opt}$ :

$$C_{opt} = qV, \text{ where } q = \left( \frac{\tau}{n(1+X)} \right)^{\frac{1}{X}} \quad (3.13)$$

The optimal debt service will be lower in the model with multiple bankruptcy thresholds compared to the original model due to the added extra regulatory costs associated with debt. Therefore, the optimal capital ratio in this model will be higher than in the original model. Also, the total value of the bank is reduced in this model compared to the original model.

### 3.2.4 Do banks adjust capital towards an optimal?

Theory about capital structure suggests that there does exist an optimal mix of equity and debt for the individual bank. However, even if an optimal target capital ratio exists, banks may choose to deviate from their targets due to costs of adjusting their capital ratios. Berger et al. (2008)<sup>99</sup> explore how publicly traded U.S. bank holding companies adjusted their capital from 1992-2006 and find that they actively managed their capital ratios, set target levels substantially above regulatory minima and made rapid adjustments toward their targets. Hence, they find evidence against the pecking order theory that predicts that profitable banks use retained earnings to build up their capital so that profitable banks are excessively well-capitalized and non-profitable banks are less capitalized. The study also suggests that adjusting costs are small or at least small enough to facilitate high adjustment speeds.

### 3.3 A model of zero liquidations and equity expropriation

In the following, a model (henceforth, K-model<sup>100</sup>) that uses the current regulatory framework as inspiration is developed. The model draws on assumptions made in the HLR-model and uses Black and Scholes' option theory to value the assumed contingent claims on the value of the bank. The model shows the optimal capital structure for a bank that is funded with equity and deposits at time  $t=0$ , where it will be subject to both the minimum requirement as well as the Pillar 2 and buffer requirements. The bank will be taken over by the government if it fails to comply with the minimum requirement and will be subject to regulatory costs if it fails to comply with its Pillar 2 and buffer requirements. The bank will operate until time  $t=1$ , which is a quarter of a year later, where it will be subject to the same capital requirements. It is assumed that the bank will be sold off at  $t=1$ . It is further assumed that the costs of adjusting the capital ratio each quarter are small enough for adjusting to be profitable. If for example the value of assets fall by DKK 100 billion, then the bank may want to issue DKK 20 million equity to pay back depositors in order to achieve the desired capital ratio. This change increases the value of the bank with, say, DKK 5 million, so the cost of the action should be less than DKK 5 million for it to be profitable. The model assumes that no bank will be

---

<sup>99</sup> Berger, 2008

<sup>100</sup> K-model for Karkov-model

allowed to be liquidated, therefore it is mostly applicable to larger, systemically important banks. This assumption also implies that there are no bankruptcy costs. The value of equity corresponds to the difference between the value of assets and the value of debt. This value will be written down in the case where the bank breaches its minimum requirement. As in the HLR-model, the bank is subject to tax benefits.

### 3.3.1 Assumptions and theoretical foundation

In developing the model of capital structures of banks, inspiration will be found in Harding, Liang and Ross (2009) but other assumptions regarding the consequences of breaching capital requirements will be made and the model will use option valuation instead of the standard partial differential equation with boundary conditions that Harding, Liang and Ross (2009) uses. It is assumed that the firm's assets are financed with a combination of debt and equity.

Uncertainty enters the model because the firm's assets are assumed to evolve stochastically. To assure that the stochastic process for the assets is unaffected by the capital structure choices of the firm, debt service payments are made by selling additional equity. This implies that after the bank's initial choice of optimal debt, the face value of deposits is constant/static over time. In applying this framework to banks, we assume that banks have only one form of debt – fully insured deposits and that these deposits are deemed by investors to be riskless.

It is further assumed that banks do not pay an insurance premium for deposit insurance. Under these assumptions, banks pay the riskless rate on all deposits. It is assumed that values evolve continuously and that the firm's capital structure decision is summarized by its choice of a promised continuous quarterly payment  $C$ . Also, the bank's book equity is assumed to consist of CET1, AT1 and Tier 2 capital, since these forms of capital all feature in the bank's capital requirements. It is a reasonable assumption that AT1 and Tier 2 capital can be written down in a restructuring situation considering the inherent write-down or conversion triggers in AT1 capital and the discussion about MREL that seems to favor that Tier 2 and even unsecured senior debt could be suspect to bail-in. It is assumed that the bank's issuance of AT1 and Tier 2 is given. If the bank has more AT1 and Tier 2 capital than what can be used to comply with capital requirements, the additional capital will not be calculated towards the capital ratio.

It is further assumed that the bank's portfolio of assets,  $V$ , composes continuously traded financial securities, the market value of which follows a standard geometric Brownian motion process:

$$dV = \mu V dt + \sigma V dW \quad (3.14)$$

Harding, Liang and Ross (2009)'s assumption that the contingent claims are continuous payments creates some limitations that can be overcome by using option valuation. It will be assumed that the bank makes its capital structure decision at  $t=0$  and is dissolved at  $t=1$  where it will pay or receive all contingent claims. The time horizon will be a quarter of a year, as it is assumed that the regulator tests the bank's compliance with capital



requirements in connection with the publication of quarterly results. The Black-Scholes option pricing model will be used, specifically the following formulas, where  $S$  is the spot price of the underlying,  $K$  is the exercise price,  $r$  is the risk free interest rate,  $\sigma$  is the standard deviation of the underlying,  $t$  is the life to expiration of the option,  $N(\cdot)$  is the standard normal cumulative distribution function and  $Q$  is the payoff of the binary option:

$$\text{Value of a call} = SN(d_1) - Ke^{-rt}N(d_2) \quad (3.15)$$

$$\text{Value of a put} = Ke^{-rt}N(-d_2) - SN(-d_1) \quad (3.16)$$

$$\text{Value of a binary call} = Qe^{-rt}N(d_2) \quad (3.17)$$

$$\text{Value of a binary put} = Qe^{-rt}N(-d_2) \quad (3.18)$$

$$d_1 = \frac{\ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \quad (3.19)$$

$$d_2 = d_1 - \sigma\sqrt{t} \quad (3.20)$$

The current bank capital regulation is meant to prevent banks from failing. In fact, systemically important banks will not be allowed to fail. Therefore, the bankruptcy costs that Harding, Liang and Ross (2009) consider will not figure in this model as it is assumed that all banks will be deemed too important to fail. Hence, when a bank breaches its minimum capital requirement, it will be assumed that the remaining book equity value will be written down and the bank will be restructured and formed as a new bank.

The minimum capital requirement is expressed in terms of *book value of equity* over risk-weighted capital. *The book value of equity* is assumed to be equal to  $V - C/(r^*t)$ , the value of assets less the value of debt. The value of the expropriation can be interpreted as belonging to the government since depositors will only be paid the riskless rate and that ultimately, the government is responsible for the deposit insurance. Even though no liquidation will ever take place, banks still benefit from the value of the insurance provided by the government. This is due to the fact that shareholders' claim cannot fall below zero but that debtholders, that normally suffer losses when the value of assets falls below the value of debt, are protected by the government's deposit insurance.

Since no bank will be allowed to go bankrupt, hence banks will always be able to issue new debt if a large amount of depositors wants to cash in. There will be no loss from liquidation and therefore no insurance benefit except for the fact that deposits are deemed riskless due to the government as lender of last resort. In addition, the bank will be assumed to face costs related to regulatory non-compliance if it breaches its combined capital requirement. The combined capital requirement is the minimum capital requirement plus the Pillar 2 requirement and the combined buffer requirement. Lastly, if the bank is subject to taxation and interest payments on debt are tax deductible expenses, then bank value is increased by the tax benefits associated with debt financing. These costs can be viewed as a contingent claim on  $V$  and valued using equations (3.15)-(3.20), and we can define the market value of the bank at  $t=0$ ,  $v_{t=0}$ , as:

$$v_{t=0} = V_{t=0} - \text{EXP}(V_{t=0}) - \text{RN}(V_{t=0}) + \text{TB}(V_{t=0}) \quad (3.21)$$

Where  $V$  is the value of the bank's assets,  $\text{EXP}(V)$  is the value of expropriation costs due to a breach of the minimum capital requirements,  $\text{IB}(V)$  is the value of insurance benefits,  $\text{RN}(V)$  is the value of regulatory costs of non-compliance with the combined capital requirement and  $\text{TB}(V)$  is the value of tax benefits. It will be assumed that the bank makes a capital structure decision, summarized by its choice of  $C$ , by maximizing  $v$ .

The expropriation costs and the regulatory non-compliance costs depend on the *expropriation threshold* and the *non-compliance threshold*, which are points when  $V$  falls to some specified levels. These levels depend on the capital requirements of the bank. The expropriation threshold and the non-compliance threshold are expressed as levels  $V^{\text{MinCap}}$  and  $V^{\text{ComCap}}$ , which are the value of assets when the bank's capital ratio equals the minimum capital requirement and the value of assets when the bank's capital ratio equals the combined capital requirement, respectively. If the bank breaches  $V^{\text{ComCap}}$ , the bank incurs costs related to regulatory non-compliance and if the bank breaches  $V^{\text{MinCap}}$ , the equityholders' claim will be expropriated/written down in order to form a new bank. The minimum capital requirement is 8% and can be expressed as:

$$\text{Minimum capital requirement} = 8\% = \frac{V^{\text{MinCap}} - \frac{C}{r * t}}{\rho * V^{\text{MinCap}}}$$

Where  $\rho$  is the average risk weight so that risk-weighted assets,  $\text{RWA} = \rho * V$ . It is assumed that  $\rho$  is static over time. By solving for  $V^{\text{MinCap}}$ ,  $V^{\text{MinCap}}$  can be expressed as:

$$V^{\text{MinCap}} = \frac{-C}{(8\% * \rho - 1)r * t}$$

The combined capital requirement is individual for each bank and is defined by CCR. It can be expressed as:

$$\text{Combined capital requirement} = \text{CCR} = \frac{V^{\text{ComCap}} - \frac{C}{r * t}}{\rho * V^{\text{ComCap}}}$$

By solving for  $V^{\text{ComCap}}$ ,  $V^{\text{ComCap}}$  can be expressed as:

$$V^{\text{ComCap}} = \frac{-C}{(\text{CCR} * \rho - 1)r * t}$$

It applies that  $V^{\text{ComCap}} \geq V^{\text{MinCap}}$  as the breach of the combined capital requirement will happen before or at the same time as the breach of the minimum capital requirement.

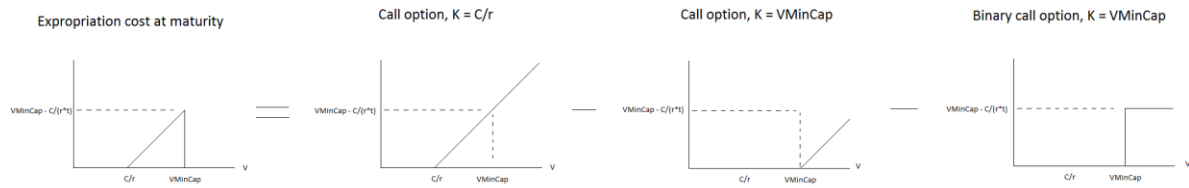
### 3.3.2 Costs of expropriation

Expropriation of the equityholders' claim on assets will happen if the value of assets falls below  $V^{\text{MinCap}}$ , since the equity claim will be written down and the bank will be restructured. Thus, when  $V \geq V^{\text{MinCap}}$ , there will be no expropriation and the costs hereof are zero.

However, when  $V$  drops below  $V^{\text{MinCap}}$ , expropriation of  $V - \frac{C}{r}$  will happen. Therefore, the costs of expropriation at maturity are the payoff of a call option on the value of the banks' assets,  $V_{t=1}$ , if  $V_{t=1} < V^{\text{MinCap}}$  and zero otherwise:

$$\begin{aligned} \text{When } V_{t=1} \geq V^{\text{MinCap}}, \quad \text{EXP}(V_{t=1}) &= 0 \\ \text{When } V_{t=1} < V^{\text{MinCap}}, \quad \text{EXP}(V_{t=1}) &= \text{Max}\left(\left(V_{t=1} - \frac{C}{r}\right), 0\right) \end{aligned}$$

The payoff structure of the expropriation cost at maturity is illustrated below and can be constructed by a call option with exercise price  $C/r$ , a call option with exercise price  $V^{\text{MinCap}}$  and a binary call option with exercise price  $V^{\text{MinCap}}$  and payoff  $V^{\text{MinCap}} - \left(\frac{C}{r}\right)$ .



Using equations (3.15)-(3.20) for option pricing, the market value of the expropriation cost claim is:

$$\begin{aligned} \text{EXP}(V_{t=0}) &= V * N(d_3) - \left(\frac{C}{r * t}\right) e^{-rt} N(d_4) \\ &\quad - \left(V * N(d_5) - V^{\text{MinCap}} e^{-rt} N(d_6)\right) \\ &\quad - \left(\left(V^{\text{MinCap}} - \left(\frac{C}{r * t}\right)\right) e^{-rt} N(d_6)\right) \end{aligned} \tag{3.22}$$

$$d_3 = \frac{\ln\left(\frac{V}{\left(\frac{C}{r * t}\right)}\right) + \left(r + \frac{\sigma^2}{2}\right) t}{\sigma \sqrt{t}}$$

$$d_4 = d_3 - \sigma \sqrt{t}$$

$$d_5 = \frac{\ln\left(\frac{V}{V^{\text{MinCap}}}\right) + \left(r + \frac{\sigma^2}{2}\right) t}{\sigma \sqrt{t}}$$

$$d_6 = d_5 - \sigma \sqrt{t}$$

### 3.3.3 Tax benefits

According to the Danish tax code, interest payments are deductible from corporate earnings when computing a firm's corporate income tax. Thus, each krone of interest paid results in a savings in taxes for a taxpaying firm equal to its marginal tax rate times the interest paid. Following Leland (1994), it is assumed that tax benefits are proportional to the interest

payment on its debt and are terminated at the expropriation threshold,  $V^{\text{MinCap}}$  (indsæt note). Thus, the payoff at maturity of tax benefits can be presented by a binary call option with exercise price  $V^{\text{MinCap}}$  payoff  $\tau C$ , where  $\tau$  represents the marginal tax rate. Using equations (3.17)-(3.20), the market value of the tax benefits is:

$$TB(V_{t=0}) = \tau C e^{-rt} N(d_6) \quad (3.23)$$

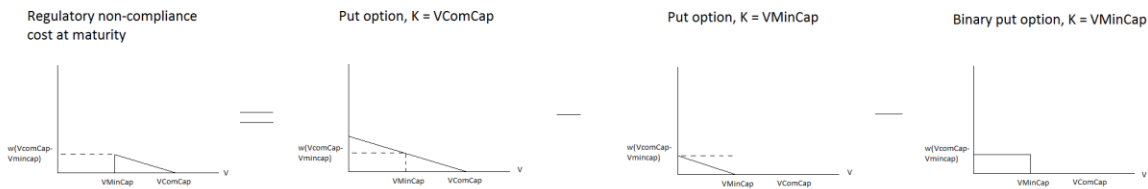
### 3.3.4 Costs of regulatory non-compliance

The costs of regulatory non-compliance are assumed to be proportionate with the size of the breach of the combined capital requirement. It can be interpreted as the costs related to untimely issuance of capital, costs related to constraints on management or costs related to developing a capital plan. Regulatory non-compliance costs are triggered if the value of the bank's assets at maturity,  $V_{t=1} < V^{\text{ComCap}}$ . The size of the costs is expressed by  $\omega$ , the marginal regulatory non-compliance cost rate. The bank will only incur the costs as long as  $V_{t=1} \geq V^{\text{MinCap}}$ , since no costs will be incurred if the bank is restructured. Hence, the costs of regulatory non-compliance at maturity are the payoff of a put option with exercise price  $V^{\text{ComCap}}$  if  $V_{t=1} \geq V^{\text{MinCap}}$  and zero otherwise:

$$\text{When } V_{t=1} \geq V^{\text{MinCap}}, \quad \text{Payoff} = \omega * \text{Max}(V^{\text{ComCap}} - V_{t=1}, 0)$$

$$\text{When } V_{t=1} < V^{\text{MinCap}}, \quad \text{Payoff} = 0$$

The payoff structure is illustrated below and can be constructed by a put option with exercise price  $V^{\text{ComCap}}$ , a put option with exercise price  $V^{\text{MinCap}}$  and a binary put option with exercise price  $V^{\text{MinCap}}$ .



Using these conditions with equations (3.15)-(3.20) results in the following expression for the market value of regulatory non-compliance costs:

$$\begin{aligned} RN(V_{t=0}) &= \omega * \left( V^{\text{ComCap}} * e^{-rt} N(-d_8) - V * N(-d_7) \right) - \omega \\ & * \left( V^{\text{MinCap}} * e^{-rt} N(-d_6) - V * N(-d_5) \right) - \omega * (V^{\text{ComCap}} \\ & - V^{\text{MinCap}}) e^{-rt} N(-d_6) \end{aligned} \quad (3.24)$$

$$d_7 = \frac{\ln\left(\frac{V}{V^{\text{ComCap}}}\right) + \left(r + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$

$$d_8 = d_7 - \sigma\sqrt{t}$$

### 3.3.5 Optimal capital structure

Using equation (3.21)-(3.24), the value of the bank at  $t=0$  is:

$$\begin{aligned} v = & V - V * N(d_3) - \left(\frac{C}{r * t}\right) e^{-rt} N(d_4) \\ & - \left(V * N(d_5) - V^{\text{MinCap}} e^{-rt} N(d_6)\right) \\ & - \left(\left(V^{\text{MinCap}} - \left(\frac{C}{r * t}\right)\right) e^{-rt} N(d_6)\right) - \omega \\ & * \left(V^{\text{ComCap}} * e^{-rt} N(-d_8) - V * N(-d_7)\right) - \omega \\ & * \left(V^{\text{MinCap}} * e^{-rt} N(-d_6) - V * N(-d_5)\right) - \omega * \left(V^{\text{ComCap}} \right. \\ & \left. - V^{\text{MinCap}}\right) e^{-rt} N(-d_6) + \tau C t e^{-rt} N(d_6) \end{aligned} \quad (3.25)$$

Where:

$$d_3 = \frac{\ln\left(\frac{V}{\left(\frac{C}{r * t}\right)}\right) + \left(r + \frac{\sigma^2}{2}\right) t}{\sigma\sqrt{t}} \quad (3.26)$$

$$d_4 = d_3 - \sigma\sqrt{t} \quad (3.27)$$

$$d_5 = \frac{\ln\left(\frac{V}{V^{\text{MinCap}}}\right) + \left(r + \frac{\sigma^2}{2}\right) t}{\sigma\sqrt{t}} \quad (3.28)$$

$$d_6 = d_5 - \sigma\sqrt{t} \quad (3.29)$$

$$d_7 = \frac{\ln\left(\frac{V}{V^{\text{ComCap}}}\right) + \left(r + \frac{\sigma^2}{2}\right) t}{\sigma\sqrt{t}} \quad (3.30)$$

$$d_8 = d_7 - \sigma\sqrt{t} \quad (3.31)$$

$$V^{\text{MinCap}} = \frac{-C}{(8\% * \rho - 1)r * t} \quad (3.32)$$

$$V^{\text{ComCap}} = \frac{-C}{(CCR * \rho - 1)r * t} \quad (3.33)$$

The bank will maximize  $v$  in (3.25) with respect to  $C$ . Please note that the cumulative standard normal distribution has no finite solution. Therefore, the maximization problem in (3.25) will be solved numerically for a range of  $C$  in VBA code (see appendix 1). The values of  $C$  that will be explored are  $0 \leq C \leq rtV$ , since it is assumed that the bank can have a

minimum value of debt equal to zero and a maximum value of debt equal to the value of assets,  $\frac{c}{rt} = V$ .

### **3.4 Brief summation of theories of bank capital structure**

The chapter introduced the classic theories of firm capital structure starting with the MM proposition with and without taxes, which naturally led to the discussion of the static tradeoff theory versus the pecking order theory. More advanced models as Merton's model of optimal capital structure and the later models by Black & Cox and Leland were also touched upon. These theories provided a foundation for the subsequent discussion of theories that looks at optimal capital structure specifically for banks.

Firstly, the HLR-model for optimal capital structure of banks that takes into account deposit insurance, capital requirements, bankruptcy costs and tax-advantaged debt was elaborated on. The extension that includes multiple bankruptcy thresholds was then discussed. Lastly, the K-model, that assumes that no bank is allowed to bankrupt and that equityholders will be expropriated if the bank fails to comply with its minimum requirement, was developed.

In the following three sections, the HLR-model with and without a warning threshold and the K-model will be applied to Danske Bank, Sydbank and Jyske Bank. It will be explored how well the models fit the data and whether the features of the models reflect the issues that the management of the bank considers when choosing their capital policy.

## 4 Case 1: Danske Bank

Danske Bank is the biggest bank in Denmark and is classified as a group 1 bank, because the bank's working capital is above DKK 65 billion.<sup>101</sup> It was founded in the beginning of 1990 as a consequence of a merger between Den Danske Bank, Handelsbanken and Provinsbanken. During that period, a list of comprehensive mergers took place in the Danish financial sector, and Danske Bank thus followed this trend.<sup>102</sup> The bank's actual beginning took place in 1871, since it is traceable to Landmandsbanken.<sup>103</sup>

Danske Bank is mostly present in the countries of Northern Europe, including Scandinavia and the Baltics, and main business areas include *personal banking, business banking, and corporate & institutions*.<sup>104</sup> The volume and importance of its business has resulted in Danske Bank becoming a SIFI Bank.<sup>105</sup> Due to its size, Danske Bank is very active with bond issuance and other debt instruments. The bank has a good standing in the capital markets with stable issuer ratings of A2, A and A with Moody's, S&P and Fitch, respectively.

### 4.1 Capital policy

Danske Bank's funding plan is to fund 54% of its assets with deposits, 1% certificates of deposit and commercial paper, 6% unsecured debt, 12% covered bonds, 2% subordinated debt, 16% repos and 9% equity<sup>106</sup>. The funding plan seeks to provide a funding platform that is diversified across investors, products and currencies. In terms of capital management, the bank's objective is to maintain a level of capital that is sufficient to support its business strategy and to meet the regulatory capital requirements at all times and have a capital level that rating agencies and investors consider robust. The bank considers a CET1 capital ratio of around 14% and a total capital ratio well above 17% as appropriate levels. However, the bank's current capital targets are a CET1 capital ratio of "at least 13%" and a total capital ratio of "at least 17%". This translates into a capital buffer of 5.4% for the 3<sup>rd</sup> quarter of 2015 but will be lower in the coming years due to the phase-in of the CRDIV. The bank will revise its capital policy at least once a year<sup>107</sup>.

As can be expected by a large bank, Danske Bank is often active in adjusting its capital to appropriate levels. Most recently, the bank optimized its capital structure in 2014 with the issuance of a total of DKK 9.3 billion AT1 and Tier 2 capital and its redemption of the hybrid capital from the Danish state.

---

<sup>101</sup> Finanstilsynet, 'Pengeinstitutternes størrelsesgruppering', 2015

<sup>102</sup> Baldvinsson, 2011, p. 22 - 23

<sup>103</sup> [www.danskebank.com](http://www.danskebank.com) -> *Historie* and Baldvinsson, 2011, p. 21

<sup>104</sup> Danske Bank Annual Report 2014

<sup>105</sup> Baldvinsson, 2011, p. 23 and 'Finansiell Stabilitet 1. halvår', 2015, p. 58

<sup>106</sup> Funding Plan, Danske Bank, 2015

<sup>107</sup> Danske Bank's Risk Management Report 2014

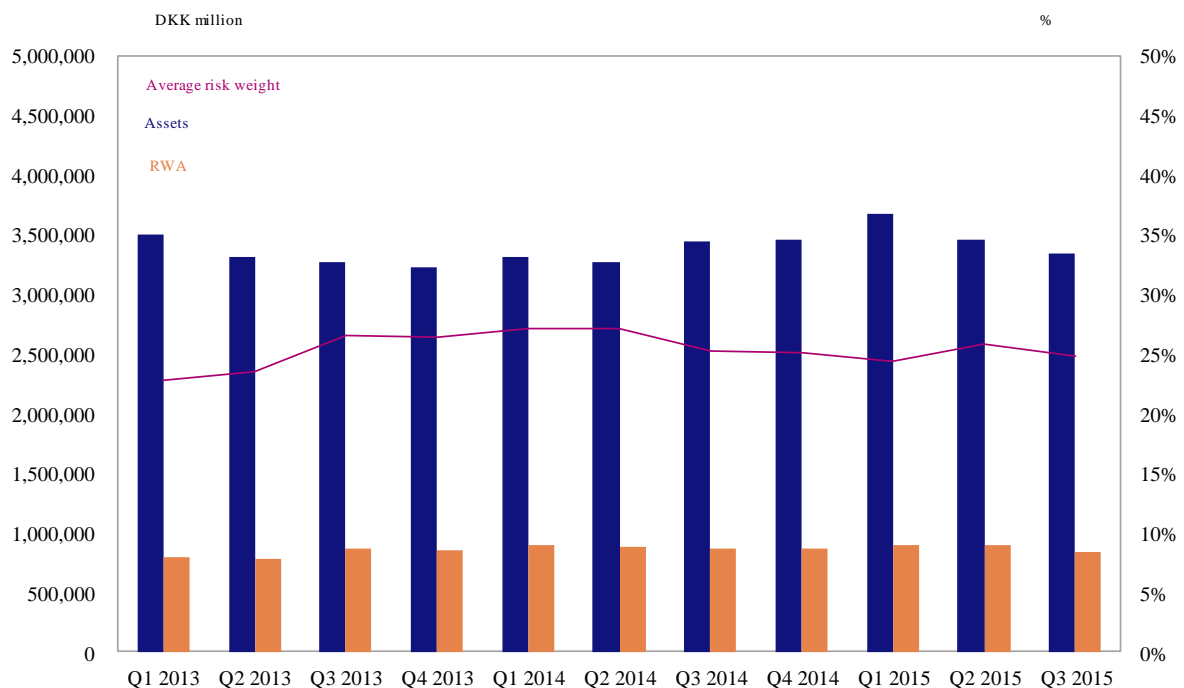
## 4.2 Model parameters

In this section, the model parameters used to estimate the optimal capital structure for Danske Bank are presented. The model parameters are obtained through Danske Bank's Quarterly Financial Reports, Danske Bank's yearly Risk and Capital Management Reports and Bloomberg. Additional assumptions and estimations will be explained accordingly.

### 4.2.1 Value of assets

At the end of the third quarter of 2015, the total value of Danske Bank's assets was DKK 3,348,051 million. At the same time, the total value of Danske Bank's risk-weighted assets was DKK 832,074 million. This results in an average risk weight ( $\rho$ ) of 24.9%. The risk weight has fluctuated around 25% with a maximum of 27.1% and a minimum of 22.8% (see figure 4.1) since the first quarter of 2013. In order to be most forward-looking, the most current value of total assets and the average risk weight are chosen as model parameters. Hence, a value of total assets of DKK 3,348,051 million and an average risk weight ( $\rho$ ) of 24.9% are used as parameters in the models.

Figure 4.1: Danske Bank's total and risk-weighted assets



Source: Danske Bank's quarterly Financial Reports 2013-2015

### 4.2.2 Volatility of asset returns

The time period in which data on asset returns will be estimated will be limited to the period from the first quarter of 2013 to the most recent published financial report, the third quarter report of 2015. This choice naturally limits the number of observations to 11 and the number of returns data to 10. However, a too long period could potentially result in a biased estimate



as the riskiness of assets typically change over time. The estimated volatility of asset returns for this period is 4.1% on a quarterly basis, which translates into 8.1% on a yearly basis. The standard error for the yearly estimation is 1.8%, therefore values of 6.3% and 9.9% for the volatility of asset returns will also be used in calculations. These values will be used in the base calculations 5-6. See appendix 2 for an overview of the data.

### 4.2.3 Marginal corporate tax rate

The corporate tax rate in Denmark over the past ten years has been in decline:

Table 4.1: Development in tax rates in Denmark

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Corporate tax rate (in %)	28.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	24.5	23.5	22.0

Source: Skatteministeriet, 'Selskabsskattesatser i EU-landene 1995-2015', 2015

Most European countries have followed this downward sloping tendency during the same period of time. In return, the corporate tax base has been broadened, which means that a wider range of revenues are taxed compared to other countries. Previously, it was opposite; the corporate tax rate was higher, but the corporate taxes were, by contrast, characterized by a narrow tax base, as there were more kinds of revenues, that were not taxed.<sup>108</sup>

The marginal corporate tax rate that will be used in the baseline calculation is the marginal corporate tax rate in 2016, 22%. However, a calculation with a marginal corporate tax rate of 28% will also be made in order to see the effect of the decline in the tax rate since 2006.

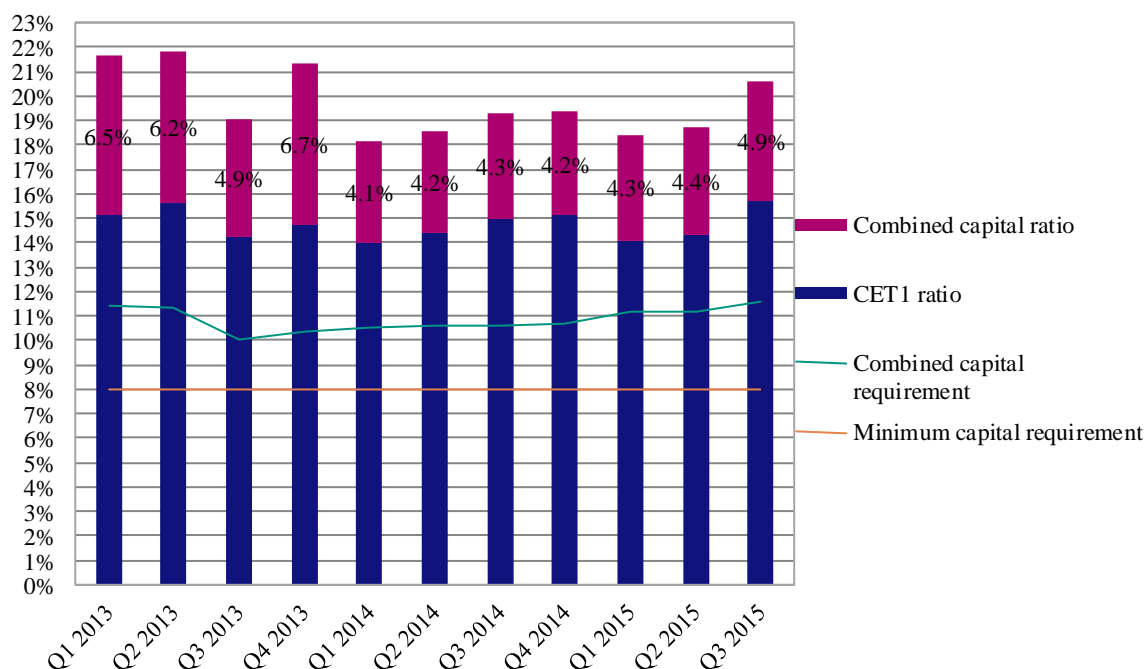
### 4.2.4 Capital requirements

Danske Bank's combined capital requirement was 11.6% of risk-weighted assets in the third quarter of 2015. The requirement changes over time due to changes in the riskiness of the bank's lending but it seems to be fairly stable around 11.0% (see figure 4.2).

---

<sup>108</sup> SKAT, 'Skatteprocenter', 2015

Figure 4.2: Danske Bank's development in capital ratios and requirements



Source: Danske Bank's quarterly Financial Reports 2013-2015

The combined capital requirement of 11.6% consists of the minimum requirement of 8.0%, a Pillar 2 requirement of 2.7%, a SIFI buffer of 0.6% and a countercyclical buffer of 0.3% due to exposures to Norway and Sweden. The SIFI buffer will be 3.0% when fully implemented in 2019 and a capital conservation buffer of 2.5% will also be required by 2019. In addition, the national regulatory authorities may command Danish banks to put aside capital in form of a countercyclical buffer if the economy is improving too quickly. This buffer can be a maximum of 2.5% by 2019. However, the Danish Business and Growth Ministry has confirmed a countercyclical capital buffer of 0.0% in 2016<sup>109</sup>. Because of Danske Bank's exposure to Norway and Sweden where countercyclical buffers of 1% are required, Danske Bank is required to hold additional capital equal to 0.3% of RWA. All the buffers will be phased in during the coming years as depicted in figure 4.3. It is assumed that the Pillar 2 requirement is constant at 2.7% but the effect on the optimal capital structure choice of a change in the Pillar 2 requirements to 1.5% and 3.0% will be calculated. The combined capital requirement, assuming no countercyclical buffer requirement and a constant Pillar 2 requirement and countercyclical buffer due to exposures in Norway and Sweden, will be approximately 16.5% of risk-weighted assets.

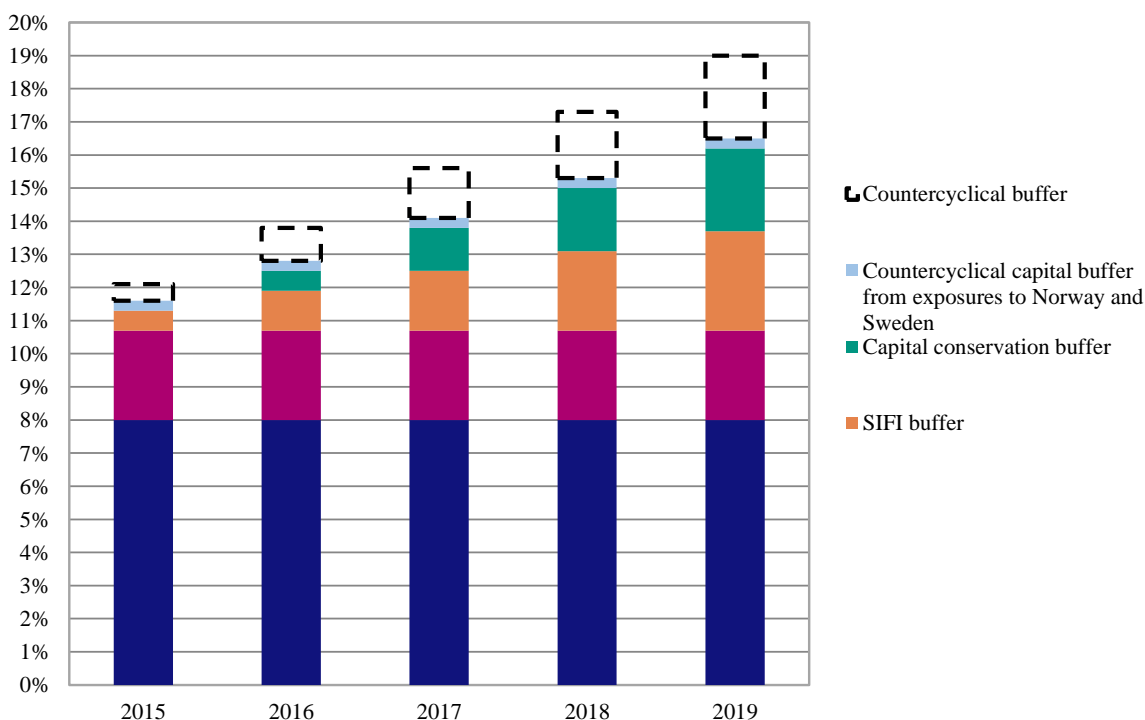
<sup>109</sup> Erhvervs- og vækstministeriet, 'Fastsættelse af den kontracykliske buffersats', 2015

Danske Bank can use CET1 capital for the entire combined capital requirement. However, the bank has an option to use a maximum of 3.5% points of the minimum requirement and 44% of the Pillar 2 requirement,  $44\% * 2.7 \approx 1.2\%$ , in total  $3.5\% + 1.2\% = 4.7\%$  subordinated capital. Hence, the minimum CET1 ratio, assuming Danske Bank has used all its pockets for subordinated capital, is  $11.6\% - 4.7\% = 6.9\%$ , which corresponds to 4.5% from the minimum requirement, 56% of the Pillar 2 requirement ( $56\% * 2.7\% \approx 1.5\%$ ), the 0.6% SIFI buffer and the 0.3% countercyclical buffer. The minimum required CET1 ratio of 6.9% of risk-weighted assets will increase in steps as the SIFI buffer and capital conservation buffer are phased in and will be  $6.9\% + 2.4\% + 2.5\% = 11.8\%$  in 2019 assuming no countercyclical buffer, a constant Pillar 2 requirement and a constant exposure to Norway and Sweden.

The subordinated capital ratio of 4.7% needed to minimize Danske Bank's required CET1 ratio, can consist of AT1 capital or a blend of AT1 capital and Tier 2 capital. Danske Bank can use Tier 2 capital for a maximum of  $2\% + 25\% * 2.7\% = 2.7\%$  of risk-weighted assets. Hence, assuming that Tier 2 capital is cheaper than AT1 capital, and AT1 capital is cheaper than CET1 capital, Danske Bank should hold at least 2.7% Tier 2 capital and  $4.7\% - 2.7\% = 2.0\%$  AT1 capital. At the moment, Danske Bank's issuance of AT1 and T2 capital corresponds to 2.4% of risk-weighted assets each, in total 4.8%, so the bank has exploited its opportunity to use subordinated capital to the fullest with a favor of AT1 capital.

However, since the models assume that banks' capital is uniform, and hence, that the optimal composition of Tier 2, AT1 and CET1 capital is given, the combined capital ratio will be used for calculation. The combined capital requirement that will be used in the model is 11.6% in order to estimate the short-term optimal capital ratio. A capital ratio of 16.5% will also be evaluated to see the effect of the full implementation of CRDIV. Lastly, a combined capital ratio of 19.0% will be used to see the full effect of the implementation of CRDIV with a countercyclical buffer of the maximum 2.5%. All results will be complemented with results where the Pillar 2 requirement is 1.5% and 3.0% in order to take into account variations in the Pillar 2 requirement. The minimum capital requirement that will be used in the models is 8%.

Figure 4.3: Danske Bank's capital requirements until 2019



Source: Danske Bank's Risk and Capital Management Report 2014 and 3<sup>rd</sup> Quarter Financial Report

#### 4.2.5 Marginal regulatory non-compliance cost rate

As concluded in section 2.5 about cases of regulatory non-compliance, there certainly are costs associated with breaching capital requirements. However, it is difficult to estimate a universal cost structure.

The marginal regulatory non-compliance cost rate,  $\omega$ , is a percentage of the absolute value of the capital breach,  $V^{\text{ComCap}} - V_{t=1}$ . Hence, a cost rate, that is equal to the cost rate in the HLR-model with a warning threshold, translates into a lower nominal cost because the regulatory costs in the HLR-model are defined in relation to the total capital requirement,  $V^{\text{ComCap}}$ . The cost rate used in the HLR-model with a warning threshold,  $\gamma$ , will be 10% as this is the number Harding, Liang and Ross (2009) use, and the cost rate used in the K-model,  $\omega$ , will be 25%. However, calculations with  $\omega=10\%$  and  $\omega=50\%$  will also be made.

#### 4.2.6 Risk free rate

The risk free rate is probably the most difficult model parameter to estimate. During the lion share of 2015, the interest rate of a 1-year Danish government bond has been negative. However, since the value of the bank's debt is  $C/r$ , positive coupon payments would result in negative levels of debt and besides, the Black-Scholes option pricing model would not be able

to cope with negative interest rates. Hence, the risk free interest rate will be assume to be very low, but positive, at 0.05%. As with many other models, very low interest rates tend to give the interest rate parameter a lot of weight. Therefore, interest rates of 0.5%, 1% and 2% will be used in order to test the robustness of the model.

### 4.3 Optimal capital structure in the HLR-model

The model parameters used in the HLR-model when applied to Danske Bank as well as results of the model are depicted in table 4.2. Even though  $\alpha$  does not enter the calculation of the bank's optimal level of capitalization, it does influence the maximum level of  $\beta$  that the regulator can choose. If  $\alpha=10\%$ ,  $\beta$  should be below 1.1. As can be seen, the assumed capital requirements result in values of  $\beta$  below 1.1.

Table 4.2: Results of the HLR-model for Danske Bank

Danske Bank: total value of assets, V = DKK 3,348 bn, value of risk-weighted assets, RWA = DKK 832 bn		Calc 1	Calc 2	Calc 3	Calc 4	Calc 5	Calc 6	Calc 7	Calc 8
$\sigma$	Volatility of asset returns	8.1%	8.1%	8.1%	8.1%	6.3%	9.9%	8.1%	8.1%
$\tau$	Effective corporate tax rate	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	28.0%
$r$	Riskless rate	0.05%	0.50%	100%	2.00%	0.05%	0.05%	0.05%	0.05%
$\underline{c}$	Minimum capital requirement	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	2.0%	8.0%
Max $\beta$	Maximum level of $\beta$ when $\alpha=10\%$	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
$\beta$	Stringency of capital requirement	1.09	1.09	1.09	1.09	1.09	1.09	1.02	1.09
C/r	Optimal amount of debt, DKK bn	137	1,348	1,745	2,115	337	45	725	206
v	Optimal firm value, DKK bn	3,352	3,527	3,637	3,748	3,363	3,349	3,369	3,356
Eq	Optimal book value of equity, DKK bn	3,212	2,000	1,603	1,233	3,011	3,303	2,623	3,142
Eq/V	Optimal book capital ratio in terms of total assets	95.92%	59.72%	47.87%	36.84%	89.95%	98.64%	78.34%	93.85%
Eq/RWA	Optimal book capital ratio in terms of risk-weighted assets	385.96%	240.31%	192.60%	148.22%	361.92%	396.92%	315.20%	377.62%
EqM	Optimal market value of equity, DKK bn	3,215	2,179	1,892	1,633	3,026	3,304	2,644	3,150
EqM/V	Optimal market capital ratio in terms of total assets	96.04%	65.07%	56.50%	48.77%	90.39%	98.67%	78.97%	94.08%
EqM/RWA	Optimal market capital ratio in terms of risk-weighted assets	386.44%	261.84%	227.35%	196.26%	363.71%	397.03%	317.74%	378.54%

The first calculation, 'Calc 1', is the base calculation where the base model parameters from section 4.2 are used. The capital ratio in terms of book value of equity over total value of assets is 95.92% when the bank optimizes its firm value. Hence, the model predicts that Danske Bank should fund its assets with 95% equity and 5% deposits. However, the optimal capital ratio in terms of risk-weighted assets is predicted to be 385.96%. This result is very extreme and far from the bank's target capital ratio at 17%. It is also above 100%, which is unimaginable.

The seventh calculation, 'Calc 7' uses a minimum capital requirement that is defined as  $\underline{c}_p$  in order to take into account the fact that the effective minimum requirement in terms of total assets is lower than 8% due to the fact that Danske Bank is required to hold 8% of capital in relation to risk-weighted assets, not total assets. This results in a minimum capital ratio of 2%. However, the model still predicts an optimal capital ratio that is well above 100% even though it is a little lower than the one predicted in the base calculation.

The second to sixth calculation, 'Calc 2' - 'Calc 6', use different values for the riskless interest rate and the asset volatility. They all predict an optimal capital ratio above 100%. The increase in the riskless interest rate to 2%, however, decreases the optimal capital ratio dramatically.

In the eighth and last calculation, 'Calc 8', the effective corporate tax rate is set to 28%, the level in 2006. This has the effect of decreasing the optimal capital ratio. This effect makes intuitive sense since a higher tax rate results in larger tax benefits associated with debt and the bank then optimally funds itself with relatively more debt.

#### 4.4 Optimal capital structure in the HLR-model with warning threshold

The extended HLR-model that includes a warning threshold, which is assumed to be the combined capital requirement, increases the predicted optimal capital ratios in calculations 1-8 marginally. Harding, Liang and Ross (2009) also find that the addition of a warning threshold does not change the bank's optimal capital ratio much due to the importance of tax benefits, which are only minimally affected by the warning threshold. This finding emphasizes the importance of the threat of liquidation if capital regulation is expected to create "... an incentive for banks to limit their use of deposits"<sup>110</sup>.

Table 4.3: Results of the HLR-model with warning threshold for Danske Bank

Danske Bank: total value of assets, V = DKK 3,348 bn, value of risk-weighted assets, RWA = DKK 832 bn									
		Calc 1	Calc 2	Calc 3	Calc 4	Calc 5	Calc 6	Calc 7	Calc 8
$\sigma$	Volatility of asset returns	8.1%	8.1%	8.1%	8.1%	6.3%	9.9%	8.1%	8.1%
$\tau$	Effective corporate tax rate	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	28.0%
$r$	Riskless rate	0.05%	0.50%	1.00%	2.00%	0.05%	0.05%	0.05%	0.05%
$c$	Minimum capital requirement	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	2.0%	8.0%
GCR	Combined capital requirement	11.6%	11.6%	11.6%	11.6%	11.6%	11.6%	2.9%	11.6%
Max $\beta$	Maximal level of $\beta$ when $\alpha=10\%$	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
$\beta$	Stringency of minimum capital requirement	1.09	1.09	1.09	1.09	1.09	1.09	1.02	1.09
$\gamma$	Stringency of combined capital requirement	1.13	1.13	1.13	1.13	1.13	1.13	1.03	1.13
$\delta$	Penalty for breaching combined capital requirement	5%	5%	5%	5%	5%	5%	5%	5.0%
C/r	Optimal amount of debt, DKK bn	45	1,199	1,640	2,043	171	9	203	80
v	Optimal firm value, DKK bn	3,349	3,507	3,620	3,734	3,356	3,348	3,354	3,351
Eq	Optimal book value of equity, DKK bn	3,303	2,149	1,708	1,305	3,177	3,339	3,145	3,268
Eq/V	Optimal book capital ratio in terms of total assets	98.66%	64.18%	51.00%	38.99%	94.89%	99.74%	93.95%	97.61%
Eq/RWA	Optimal book capital ratio in terms of risk-weighted assets	397.00%	258.25%	205.22%	156.87%	381.83%	401.34%	378.02%	392.76%
EqM	Optimal market value of equity, DKK bn	3,305	2,308	1,979	1,691	3,185	3,340	3,151	3,271
EqM/V	Optimal market capital ratio in terms of total assets	98.70%	68.94%	59.12%	50.52%	95.12%	99.75%	94.12%	97.70%
EqM/RWA	Optimal market capital ratio in terms of risk-weighted assets	397.15%	277.40%	237.88%	203.27%	382.74%	401.36%	378.73%	393.12%

#### 4.5 Optimal capital structure in the K-model

The base calculation as well as calculations with differing parameter values as outlined in section 4.2 will be presented in the following.

'Calc 1' in table 9.3 in appendix 2 is the base calculation where volatility of asset returns= 8.1%, the effective corporate tax rate=22%, the riskless rate=0.05%, the marginal regulatory non-compliance cost rate=25%, the combined capital requirement=11.6% and the average risk weight of assets=24.85%. These parameter values yield an optimal capital ratio (Eq/RWA) of 68.79%. This can be expressed as a capital buffer above the combined capital requirement of 57.19%, which seems like a lot when Danske Bank's current policy is a capital

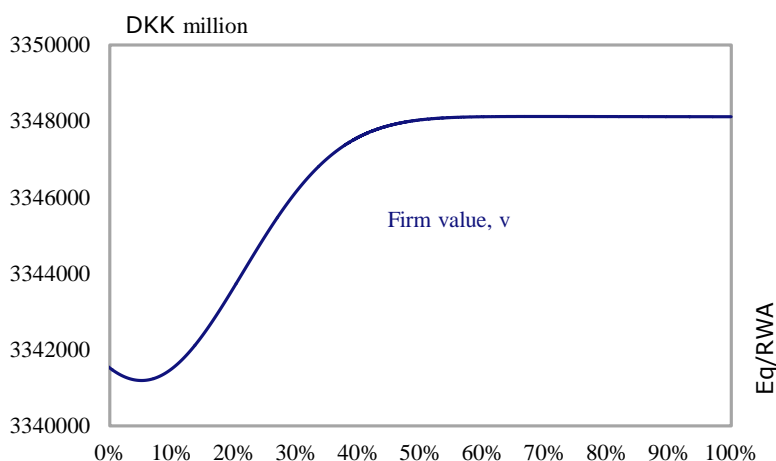
<sup>110</sup> Harding, Liang, Ross, 2009, p. 15

buffer of 'at least' 5.4%. In terms of asset values, the model predicts an optimal capital ratio (Eq/V) of 17.10%.

The firm value at the optimal capital ratio is DKK 3,348 billion. This is slightly larger than the value of assets, by DKK 76 million. Hence, the optimal capital structure choice seems to add very little relative value. However, this is not the case. As is seen in figure 4.4, even though the decision to have an optimal level of capital adds only marginal value, a choice of a sub-optimal capital structure can have quite large negative effects on firm value. The least optimal capital ratio is around 8%, which is the point where the bank breaches its minimum requirement and capital will be expropriated. It can also be seen that firm value increases below this point. However, a bank will not be allowed to choose a value below 8% since it would breach the minimum requirement and not be allowed to carry on with the same owners.

From figures 9.1-9.4 in appendix 2, one can see that the cost of expropriation is the dominating factor in terms of optimal capital structure. Regulatory non-compliance costs are only a fraction of these costs and tax benefits are even smaller in proportion. Therefore, the cost of increasing the capital ratio above the optimal 68.79% is small. This may partially be explained by the low riskless interest rate, which results in low debt service payments,  $C$ , as a proportion of assets. Since tax benefits are positively related to  $C$ , a lower riskless interest rate results in a lower level of tax benefits.

Figure 4.4: Firm value of Danske Bank in the K-model



The next three calculations, 'Calc 2'-'Calc 4' use higher riskless interest rates and, as expected, the optimal capital ratio decreases to 52.63% when  $r=2\%$ . Hence, the model has the same relation between  $C$  and  $r$  as the HLR-model. The assumption that banks pay the riskless interest rate on deposits and the assumption that the bank's debt only consists of deposits are crucial in this context. These assumptions are also used in the HLR-model. The value of the

optimal capital structure decision increases with  $r$ , and is at  $r=2\%$  equal to more than DKK 3 billion. This is due to the much higher value of tax benefits.

The next two calculations, 'Calc 5' and 'Calc 6', use a lower and a higher level of volatility. A higher asset volatility increases the risk that the bank may breach the capital requirement in connection with the next quarterly financial report. Therefore, it can be expected that asset volatility is positively correlated with the optimal capital ratio. As expected, when asset volatility is low, at 6.3%, the optimal capital ratio decreases by more than 11% points, to 57.18%, and when asset volatility is high, at 9.9%, the optimal capital ratio increases by about 11%, to 79.77%.

The next two calculations, 'Calc 7' and 'Calc 8', use different levels of marginal regulatory non-compliance cost rate. The impact on the optimal capital ratio is minimal.

The next two calculations, 'Calc 9' and 'Calc 10', explore the effects of fully phased-in capital requirements both if the full countercyclical capital buffer is applied and if it is not. Surprisingly, this does not affect the optimal capital ratio much. This can be explained by the relatively low value of regulatory non-compliance costs.

The last calculation, 'Calc 11', explores how the higher tax rate ten years ago, at 28%, affected the optimal capital structure. The effect is a minimal reduction in the optimal capital ratio, to 68.00%. Again, because of the low riskless interest rate, tax benefits do not weigh much in the value of the firm so the tax rate does not affect the optimal capital structure much. In reality, the optimal capital ratio must have been much lower due to the higher level of interest rates ten years ago.

#### 4.6 Brief summation of the case

All the selected models predict an optimal capital ratio that is well above Danske Bank's current capital ratio as well as Danske Bank's own capital ratio target. The HLR-model both with and without a warning threshold was particularly off. The HLR-model with a warning threshold that corresponded to the combined capital requirement predicted an optimal capital ratio of 397% in terms of risk-weighted assets and an optimal capital ratio in terms of total assets at 99%. The results were a little more realistic as the riskless interest rate was increased.

The K-model predicted an optimal capital ratio in terms of risk-weighted assets at 69% and an optimal capital ratio in terms of assets at 17%. Hence, the predictions were more realistic than the HLR-model's predictions but still far off compared to Danske Bank's own capital ratio target, at 'at least' 17% of risk-weighted assets. The riskless interest rate was negatively correlated with the optimal capital ratio, the asset volatility was positively correlated with the optimal capital ratio, the combined capital ratio was positively correlated with the optimal capital ratio but had only a marginal impact, which implies that the phase-in of higher capital requirements until 2019 will have little impact on Danske Bank's optimal capital ratio. Lastly, the tax rate was negatively correlated with the optimal capital structure



but had only a small impact, which is due to the current very low riskless interest rate that has the effect of marginalizing tax benefits.

## 5 Case 2: Sydbank

Sydbank is headquartered in Aabenraa and was established in 1970 as the result of a merger between four minor local banks in the southern part of Jutland. In 2012, Sydbank acquired Tønder Bank, which previously had been declared bankrupt because of increased requirements on the bank's solvency set by the Danish financial authorities. Sydbank is classified as a group 1 bank, because the bank's working capital is above DKK 65 billion.<sup>111</sup>

Sydbank is the fourth largest credit institution in Denmark, and due to its local anchoring in the border region of the southern part of Jutland, the bank also has branch offices in Flensburg, Kiel, and Hamburg in Germany<sup>112</sup>. The bank maneuvers in the business areas of lending to private and business customers, including wealth and asset management, and is thus a full scale service bank. Sydbank is rated A3 by Moody's.

### 5.1 Capital policy

Sydbank has communicated no target capital ratio but has highlighted the increase in the capital ratio between Q2 and Q3 in 2015 in its strategy "Blue Growth". The increase reflects an issuance of Tier 2 capital and a fall in risk-weighted assets. The financial result had a positive impact but all of it and more is expected to be paid in dividends or used for share buybacks. The issuance of Tier 2 capital can either be interpreted as an effort to increase the capital ratio or an effort to exploit pockets in capital requirements where Tier 2 capital can be used. However, since Sydbank makes no explicit statement about where they want to see their capital ratio, it will be assumed that they consider their current capital ratio, at 17.6%, as optimal.

### 5.2 Model parameters

In this section, the model parameters used to estimate the optimal capital structure for Sydbank are presented. The model parameters are obtained through Sydbank's Quarterly Financial Reports and Bloomberg. Additional assumptions and estimations will be explained accordingly.

#### 5.2.1 Value of assets

At the end of the third quarter of 2015, the total value of Sydbank's assets was DKK 140,921 million. At the same time, the total value of Sydbank's risk-weighted assets was DKK 68,897 million. This results in an average risk weight ( $\rho$ ) of 48.9%. The risk weight has fluctuated around 48% with a maximum of 50.4% and a minimum of 45.2% (see figure 5.1) since the first quarter of 2013. In order to be most forward-looking, the most current value of total assets and the average risk weight are chosen as model parameters. Hence, a value of total

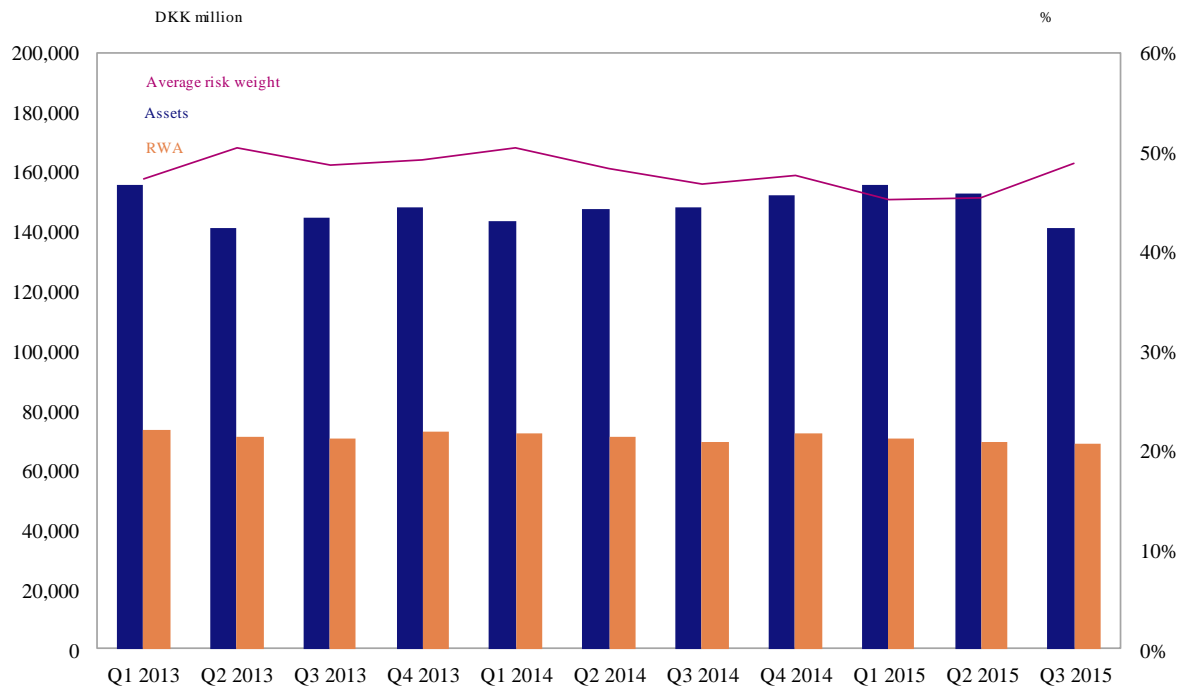
---

<sup>111</sup> Finanstilsynet, "Pengeinstitutternes størrelsesgruppering", 2015 and Baldvinsson, 2011, p. 23

<sup>112</sup> www.sydbank.dk -> Sydbank Tysklands historie

assets of DKK 140,921 million and an average risk weight ( $\rho$ ) of 48.9% are used as parameters in the models.

Figure 5.1: Sydbank's total and risk-weighted assets



Source: Sydbank's quarterly Financial Reports 2013-2015

### 5.2.2 Volatility of asset returns

The time period in which data on asset returns will be estimated will be limited to the period from the first quarter of 2013 to the most recent published financial report, the third quarter report of 2015. This choice naturally limits the number of observations to 11 and the number of returns data to 10. However, a too long period could potentially bias the results as the nature of the riskiness of assets change over time, so as in the case with Danske Bank, a compromise between a sufficient number of observations and a limited time period is made. The estimated volatility of asset returns for this period is 4.6% on a quarterly basis, which translates into 9.2% on a yearly basis. The standard error for the yearly estimation is 2.1%, therefore values of 7.1% and 11.3% for the volatility of asset returns will also be used in calculations. This value will be used in the base calculations 5-6. See appendix 3 for data.

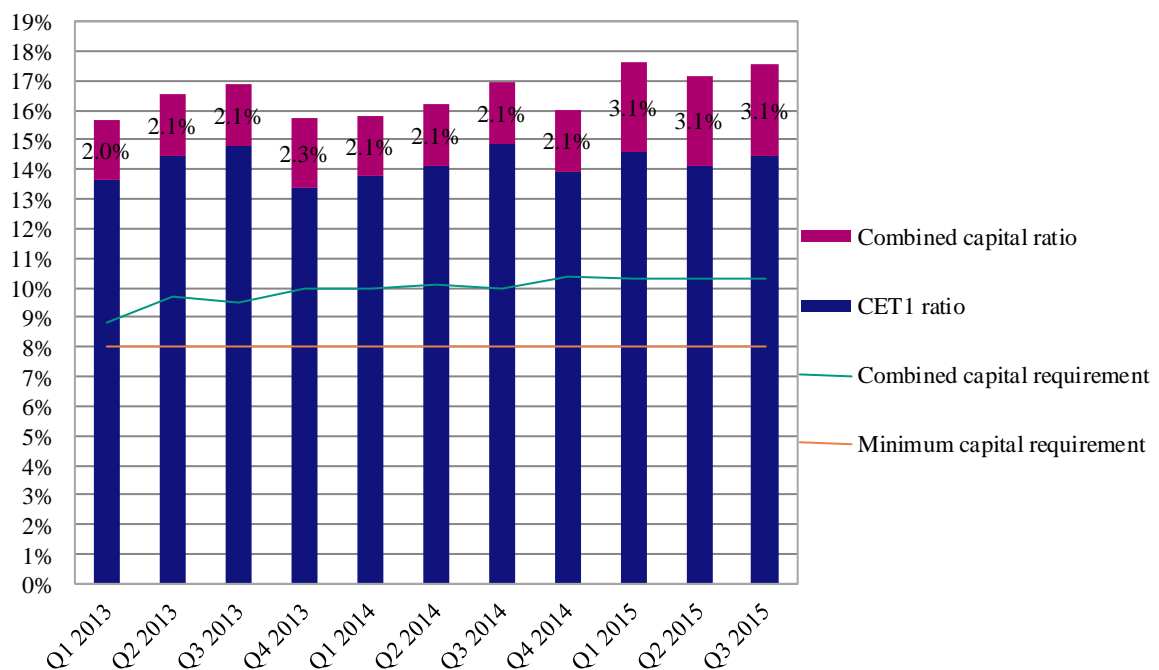
### 5.2.3 Effective corporate tax rate

The marginal corporate tax rate that will be used in the baseline calculation is the marginal corporate tax rate in 2016, 22%. However, a calculation with a marginal corporate tax rate of 28% will also be made in order to see the effect of the decline in the tax rate since 2006.

### 5.2.4 Capital requirements

Sydbank's combined capital requirement was 10.3% of risk-weighted assets in the third quarter of 2015. The requirement changes over time due to changes in the riskiness of the bank's lending but it seems to be fairly stable around 10.0%, though it may possess an upward trend (see figure 5.2).

Figure 5.2: Sydbank's development in capital ratios and requirements



Source: Sydbank's quarterly Financial Reports 2013-2015

The combined capital requirement of 10.3% consists of the minimum requirement of 8.0%, a Pillar 2 requirement of 2.1% and a SIFI buffer of 0.2%. The SIFI buffer will be 1.0% when fully implemented in 2019 and a capital conservation buffer of 2.5% will also be required by 2019. In addition, the national regulatory authorities may command Danish banks to put aside capital in form of a countercyclical buffer if the economy is improving too quickly. This buffer can be a maximum of 2.5% by 2019. However, the Danish Business and Growth Ministry has confirmed a countercyclical capital buffer of 0.0% in 2015<sup>113</sup>. All the buffers will be phased in during the coming years as depicted in figure 5.3. It is assumed that the Pillar 2 requirement is constant at 2.1% but the effect on the optimal capital structure choice of a change in the Pillar 2 requirements to 1.5% and 3.0% will also be calculated. The

<sup>113</sup> Erhvervs- og vækstministeriet, "Fastsættelse af den kontracykliske buffersats", 2015

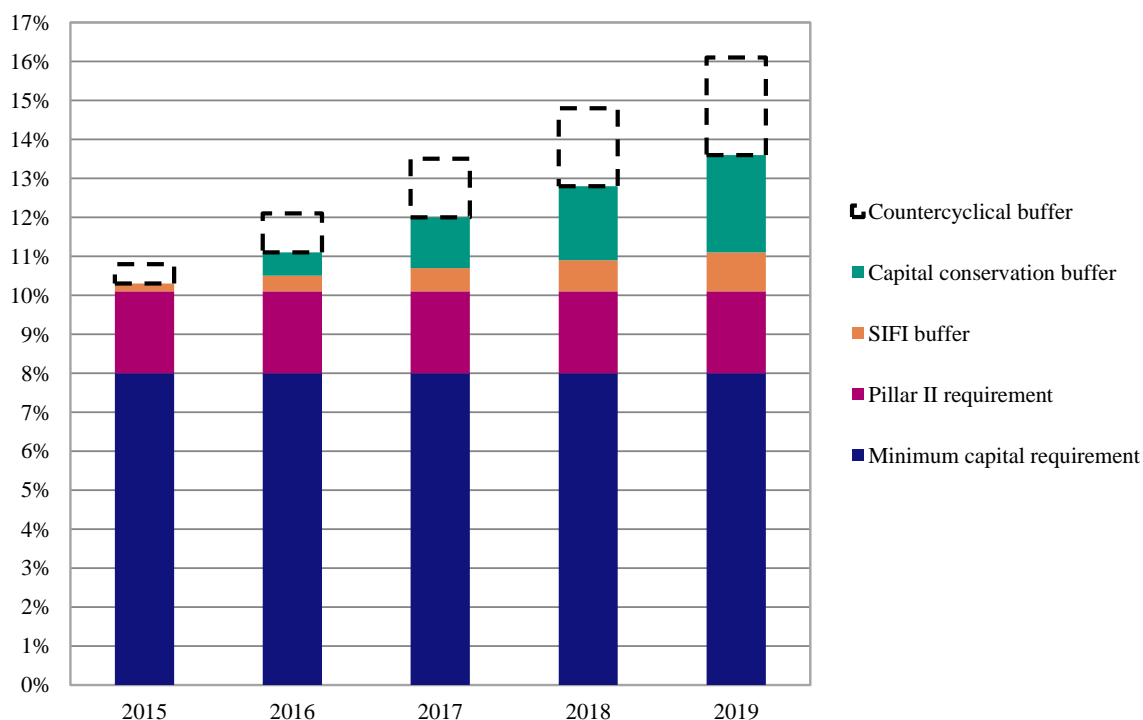
combined capital requirement, assuming no countercyclical buffer requirement and a constant Pillar 2 requirement, will be approximately 13.6% of risk-weighted assets.

Sydbank can use CET1 capital for the entire combined capital requirement. However, the bank has an option to use a maximum of 3.5% points of the minimum requirement and 44% of the Pillar 2 requirement,  $44\% * 2.1 \approx 0.9\%$ , in total  $3.5\% + 0.9\% = 4.4\%$  subordinated capital. Hence, the minimum CET1 ratio, assuming Sydbank has used all its pockets for subordinated capital, is  $10.3\% - 4.4\% = 5.9\%$ , which corresponds to 4.5% from the minimum requirement, 56% of the Pillar 2 requirement ( $56\% * 2.1\% \approx 1.2\%$ ) and the 0.2% SIFI buffer. The minimum required CET1 ratio of 5.9% of risk-weighted assets will increase in steps as the SIFI buffer and capital conservation buffer are phased in and will be  $5.9\% + 0.8\% + 2.5\% = 9.2\%$  in 2019 assuming no countercyclical buffer and a constant Pillar 2 requirement.

The subordinated capital ratio of 4.4% needed to minimize Sydbank's required CET1 ratio, can consist of AT1 capital or a blend of AT1 capital and Tier 2 capital. Sydbank can use Tier 2 capital for a maximum of  $2\% + 25\% * 2.1\% = 2.5\%$  of risk-weighted assets. Hence, assuming that Tier 2 capital is cheaper than AT1 capital, and AT1 capital is cheaper than CET1 capital, Sydbank should hold at least 2.5% Tier 2 capital and  $4.4\% - 2.5\% = 1.9\%$  AT1 capital. At the moment, Sydbank's issuance of Tier 2 and AT1 capital corresponds to 1.3 and 1.4% of risk-weighted assets respectively. Hence, there is room for additional issuances of Tier 2 and AT1 capital in the future.

However, since the models assume that banks' capital is uniform, and hence, that the optimal composition of Tier 2, AT1 and CET1 capital is given, the combined capital ratio will be used for calculation. The combined capital requirement that will be used in the model is 10.3% in order to estimate the short-term optimal capital ratio. A capital ratio of 13.6% will also be evaluated to see the effect of the full implementation of CRDIV. Lastly, a combined capital ratio of 16.1% will be used to see the full effect of the implementation of CRDIV with a countercyclical buffer of the maximum 2.5%. All results will be complemented with results where the Pillar 2 requirement is 1.5% and 3.0% in order to take into account variations in the Pillar 2 requirement.

Figure 5.3: Sydbank's capital requirements until 2019



Source: Sydbank's 3rd Quarter Financial Report and Finanstilsynet, "Systemisk vigtige finansielle institutter (SIFI)", 2015

### 5.2.5 Marginal regulatory non-compliance cost rate

As in the Danske Bank case, the cost rate used in the HLR-model with a warning threshold,  $\gamma$ , will be 10% and the cost rate used in the K-model,  $\omega$ , will be 25%. However, calculations with  $\omega=10\%$  and  $\omega=50\%$  will also be made.

### 5.2.6 Risk free rate

As in the Danske Bank case, interest rates of 0.05%, 0.5%, 1% and 2% will be used in order to test the robustness of the model.

## 5.3 Optimal capital structure in the HLR-model

The model parameters used in the HLR-model when applied to Sydbank as well as results of the model are depicted in table 5.1. Even though  $\alpha$  does not enter the calculation of the bank's optimal level of capitalization, it does influence the maximum level of  $\beta$  that the regulator can choose. If  $\alpha=10\%$ ,  $\beta$  should be below 1.1. As can be seen, the assumed capital requirements result in values of  $\beta$  below 1.1.

Table 5.1: Results of the HLR-model for Sydbank

Sydbank: total value of assets, V = DKK 141bn, value of risk-weighted assets, RWA = DKK 69 bn		Calc 1	Calc 2	Calc 3	Calc 4	Calc 5	Calc 6	Calc 7	Calc 8
$\sigma$	Volatility of asset returns	9.2%	9.2%	9.2%	9.2%	7.1%	11.3%	9.2%	9.2%
$\tau$	Effective corporate tax rate	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	28.0%
$r$	Riskless rate	0.05%	0.50%	1.00%	2.00%	0.05%	0.05%	0.05%	0.05%
$\underline{c}$	Minimum capital requirement	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	3.9%	8.0%
Max $\beta$	Maximum level of $\beta$ when $\alpha=10\%$	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
$\beta$	Stringency of capital requirement	1.09	1.09	1.09	1.09	1.09	1.09	1.04	1.09
C/r	Optimal amount of debt, DKK bn	3	51	67	84	10	1	13	5
v	Optimal firm value, DKK bn	141	147	151	156	141	141	141	141
Eq	Optimal book value of equity, DKK bn	138	90	74	57	131	140	128	136
Eq/V	Optimal book capital ratio in terms of total assets	97.87%	64.14%	52.17%	40.73%	93.11%	99.50%	91.13%	96.38%
Eq/RWA	Optimal book capital ratio in terms of risk-weighted assets	200.18%	131.19%	106.72%	83.31%	190.44%	203.52%	186.39%	197.13%
EqM	Optimal market value of equity, DKK bn	138	96	84	73	132	140	129	136
EqM/V	Optimal market capital ratio in terms of total assets	97.92%	68.41%	59.57%	51.49%	93.36%	99.51%	91.33%	96.48%
EqM/RWA	Optimal market capital ratio in terms of risk-weighted assets	200.28%	139.93%	121.84%	105.32%	190.95%	203.53%	186.81%	197.35%

The first calculation, 'Calc 1', is the base calculation where the base model parameters from section 5.2 are used. The capital ratio in terms of book value of equity over total value of assets is 97.87% when the bank optimizes its firm value. This is higher than the predicted optimal capital ratio for Danske Bank, which makes intuitive sense since Sydbank's asset volatility is higher. However, the optimal capital ratio in terms of risk-weighted assets is predicted to be 200.18%. This result is very extreme but still much lower than the one predicted for Danske bank. This is due to the fact that Sydbank's average risk weight of assets is much higher than the one for Danske Bank. The optimal level of capital in terms of risk-weighted assets is therefore lower for Sydbank as the total risk-weighted assets is a higher fraction of total assets. This result could mean that Danske Bank's lower average risk weight is too low, or at least, cannot be justified from the level of Danske Bank's asset volatility.

The additional calculations show the same fundamental pattern as in the Dansk Bank case and also predict optimal capital ratios that are far above what is observed.

#### 5.4 Optimal capital structure in the HLR-model with warning threshold

The extended HLR-model that includes a warning threshold, which is assumed to be the combined capital requirement, increases the predicted optimal capital ratios in calculations 1-8 marginally. This is the same result as in the Danske Bank case.

Table 5.2: Results of the HLR-model with warning threshold for Sydbank

Sydbank: total value of assets, V = DKK 141bn, value of risk-weighted assets, RWA = DKK 69 bn		Calc 1	Calc 2	Calc 3	Calc 4	Calc 5	Calc 6	Calc 7	Calc 8
$\sigma$	Volatility of asset returns	9.2%	9.2%	9.2%	9.2%	7.1%	11.3%	9.2%	9.2%
$\tau$	Effective corporate tax rate	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	28.0%
$r$	Riskless rate	0.05%	0.50%	1.00%	2.00%	0.05%	0.05%	0.05%	0.05%
$\zeta$	Minimum capital requirement	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	3.9%	8.0%
CCR	Combined capital requirement	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%	5.0%	10.3%
Max $\beta$	Maximum level of $\beta$ when $\alpha=10\%$	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
$\beta$	Stringency of minimum capital requirement	1.09	1.09	1.09	1.09	1.09	1.09	1.04	1.09
$\gamma$	Stringency of combined capital requirement	1.11	1.11	1.11	1.11	1.11	1.11	1.05	1.11
$\delta$	Penalty for breaching combined capital requirement	5%	5%	5%	5%	5%	5%	5%	5.0%
C/r	Optimal amount of debt, DKK bn	1	44	63	80	4	0	3	2
v	Optimal firm value, DKK bn	141	146	151	156	141	141	141	141
Eq	Optimal book value of equity, DKK bn	140	97	78	61	137	141	138	139
Eq/V	Optimal book capital ratio in terms of total assets	99.48%	68.98%	55.61%	43.02%	97.04%	99.94%	98.13%	98.91%
Eq/RWA	Optimal book capital ratio in terms of risk-weighted assets	203.48%	141.10%	113.75%	88.00%	198.48%	204.42%	200.72%	202.31%
EqM	Optimal market value of equity, DKK bn	140	102	88	75	137	141	138	139
EqM/V	Optimal market capital ratio in terms of total assets	99.49%	72.68%	62.47%	53.37%	97.15%	99.94%	98.18%	98.94%
EqM/RWA	Optimal market capital ratio in terms of risk-weighted assets	203.50%	148.66%	127.78%	109.16%	198.70%	204.42%	200.81%	202.37%

## 5.5 Optimal capital structure in the K-model

The base calculation as well as calculations with differing parameter values as outlined in section 5.2 will be presented in the following.

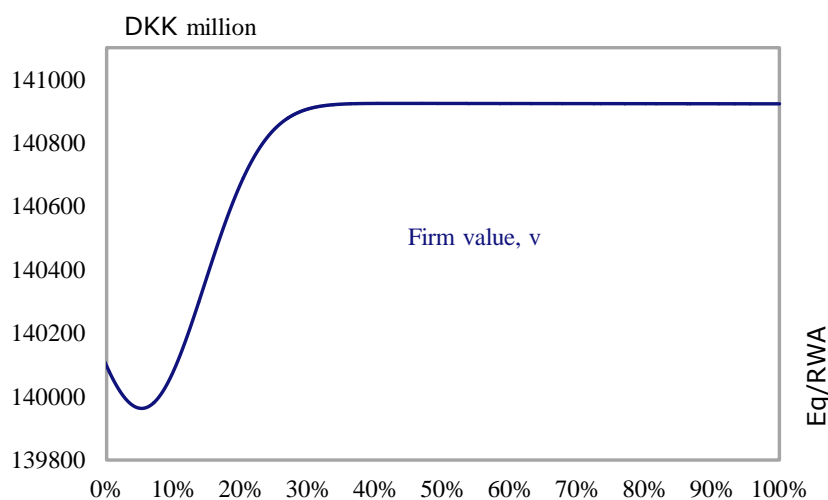
'Calc 1' in table 9.6 in appendix 3 is the base calculation where volatility of asset returns=9.2%, the effective corporate tax rate=22%, the riskless rate=0.05%, the marginal regulatory non-compliance cost rate=25%, the combined capital requirement=10.3% and the average risk weight of assets=48.89%. These parameter values yield an optimal capital ratio (Eq/RWA) of 43.42%. This can be expressed as a capital buffer above the combined capital requirement of 33.12%, which seems like a lot when Sydbank's current policy is a capital buffer of around 17%. However, when compared to the case of Danske Bank, the optimal capital ratio seems low when one takes into account the higher asset volatility and the combined capital requirement that is almost the same as Danske Bank's. This can be explained by the higher average risk weight of assets for Sydbank. Since the model is expressed in terms of total asset value, the capital ratio in terms of total assets translates into a capital ratio in terms of risk-weighted assets that is higher the lower the average risk weight is. A low average risk-weight should be associated with low risk assets, i.e. a low asset volatility. The results can suggest that either Sydbank's average risk weight is too high or Danske Bank's average risk weight is too low. Alternatively, the estimated asset volatilities are not equivalent to the true parameter value. A theoretically too high average risk weight can also be explained by differences in the calculation of risk-weighted assets. Danske Bank being a larger bank, will be able to afford more sophisticated calculation methods, which are associated with lower risk-weighted assets. This fact shows the importance of also looking at the capital ratio in terms of total assets.

In terms of asset values, the model predicts an optimal capital ratio (Eq/V) that is higher than the one predicted for Danske Bank, at 21.23% (Danske Bank: 17.10%), which is intuitive since Sydbank's asset volatility is higher. The firm value at the optimal capital ratio



is DKK 141 billion, which is only marginally larger than the value of assets, by DKK 3 million. As in the case with Danske Bank, the optimal capital structure has little added value in terms of the total value of assets, but it adds tremendous value compared to choosing the least optimal capital structure. As is seen in figure 5.4, the least optimal capital structure can have quite large negative effects on firm value. The least optimal capital ratio is associated with a firm value that is about DKK 1,000 million lower than the value of assets. From figures 9.5-9.8 in appendix 3, one can see that the cost of expropriation is the dominating factor in terms of optimal capital structure. Regulatory non-compliance costs are only a fraction of these costs and tax benefits are even smaller in proportion. Therefore, the cost of increasing the capital ratio above the optimal 43.42% is small.

Figure 5.4: Firm value of Sydbank in the K-model



Source

The next three calculations, 'Calc 2'-'Calc 4' use higher riskless interest rates and, as in the Dansk Bank case, the optimal capital ratio decreases to 35.16% when  $r=2\%$ . Hence, the relation between  $C$  and  $r$  is positive. The value of the optimal capital structure decision increases with  $r$ , and is at  $r=2\%$  equal to more than DKK 126 million. This is due to the much higher value of tax benefits when the riskless interest rate increases.

The next two calculations, 'Calc 5' and 'Calc 6', use a lower and a higher level of volatility. A higher asset volatility increases the risk that the bank may breach the capital requirement in connection with the next quarterly financial report. Therefore, it can be expected that asset volatility is positively correlated with the optimal capital ratio. As expected, when asset volatility is low, at 7.1%, the optimal capital ratio decreases by more than 7% points, to 36.41%, and when asset volatility is high, at 11.3%, the optimal capital ratio increases by about 6.5% points, to 50.02%.

The next two calculations, 'Calc 7' and 'Calc 8', use different levels of marginal regulatory non-compliance cost rate. The impact on the optimal capital ratio is minimal as in the Danske Bank case.

The next two calculations, 'Calc 9' and 'Calc 10', explore the effects of fully phased-in capital requirements both if the full countercyclical capital buffer is applied and if it is not. As expected, this does not affect the optimal capital ratio much. This can be explained by the relatively low value of regulatory non-compliance costs. When the capital requirements are fully phased-in and a full 2.5% countercyclical buffer applies, assuming no change in Pillar 2 requirements, the optimal capital structure is less than 3% points higher than in the base calculation.

Lastly, 'Calc 11', explores how the higher tax rate ten years ago, at 28%, affected the optimal capital structure. The effect is a minimal reduction in the optimal capital ratio, less than 0.5% points. Again, because of the low riskless interest rate, tax benefits do not weigh much in the value of the firm so the tax rate does not affect the optimal capital structure much. In reality, the optimal capital ratio must have been much lower due to the higher level of interest rates ten years ago.

## 5.6 Brief summation of the case

All the selected models predict an optimal capital ratio that is well above Sydbank's current capital ratio as well as Sydbank's own capital ratio target. The HLR-model both with and without a warning threshold was particularly off. The HLR-model with a warning threshold that corresponded to the combined capital requirement predicted an optimal capital ratio of 203% in terms of risk-weighted assets and an optimal capital ratio in terms of total assets at 99%. This result is very extreme but still much lower than the one predicted for Danske bank, which can be explained by the fact that Sydbank's average risk weight of assets is much higher than the one for Danske Bank.

The K-model predicted an optimal capital ratio in terms of risk-weighted assets at 43% and an optimal capital ratio in terms of assets at 21%. Hence, the predictions were more realistic than the HLR-model's predictions but still far off compared to Sydbank's own capital ratio policy at around 17% of risk-weighted assets. The correlations between model parameters and the optimal capital ratio predicted by the model corresponded to those exhibited in the Danske Bank case.

## 6 Case 3: Jyske Bank

Jyske Bank is headquartered in Silkeborg, Jutland and has its historical roots in the central region of Jutland. The bank is the third largest bank in Denmark and is classified as a group 1 bank.<sup>114</sup> Jyske Bank was established 1967 and is, like Sydbank and Danske Bank, a result of numerous mergers through the years.<sup>115</sup> To begin with, these mergers mainly took place in Jutland. However with the acquisition of Finansbanken in 1980, it became nationwide.

Jyske Bank is rated A3 by Moody's and A- by Standard & Poor's.

### 6.1 Capital policy

Jyske Bank has a long-term capital policy where the bank considers the expected long-term capital base at least every quarter. The bank's goal is a CET1 Ratio of 14% and a capital ratio of 17.5% in 2020. The current combined capital requirement is 10.7% and if it is assumed that this requirement will be the same in 2020, Jyske Bank considers a 3.3% buffer as optimal.

Jyske Bank has communicated their intention of issuing subordinated capital during the first half of 2016<sup>116</sup>.

### 6.2 Model parameters

In this section, the model parameters used to estimate the optimal capital structure for Jyske Bank are presented. The model parameters are obtained through Jyske Bank's Quarterly Financial Reports, Jyske Bank's yearly Risk and Capital Management Reports and Bloomberg. Additional assumptions and estimations will be explained accordingly.

#### 6.2.1 Value of assets

At the end of the third quarter of 2015, the total value of Jyske Bank's assets was DKK 531,063 million. At the same time, the total value of Jyske Bank's risk-weighted assets was DKK 174,853 million. This results in an average risk weight ( $\rho$ ) of 32.9%. The risk weight has been fairly stable since the second quarter of 2014 with a maximum of 35.4% and a minimum of 31.2%. However, since the acquisition of BRFKredit was incorporated in the financial report in the second quarter of 2014, the balance sheet before this point had a completely different size and risk profile. The total value of assets fluctuated around DKK 250,000 million and the average risk weight from the beginning of 2013 until the acquisition of BRFKredit fluctuated around 44% with a maximum of 45.4% and a minimum of 42.5% (see figure 6.1). Therefore, it seems to be the case that the average risk weight fluctuates around a constant when the nature of the business does not change suddenly, for example

---

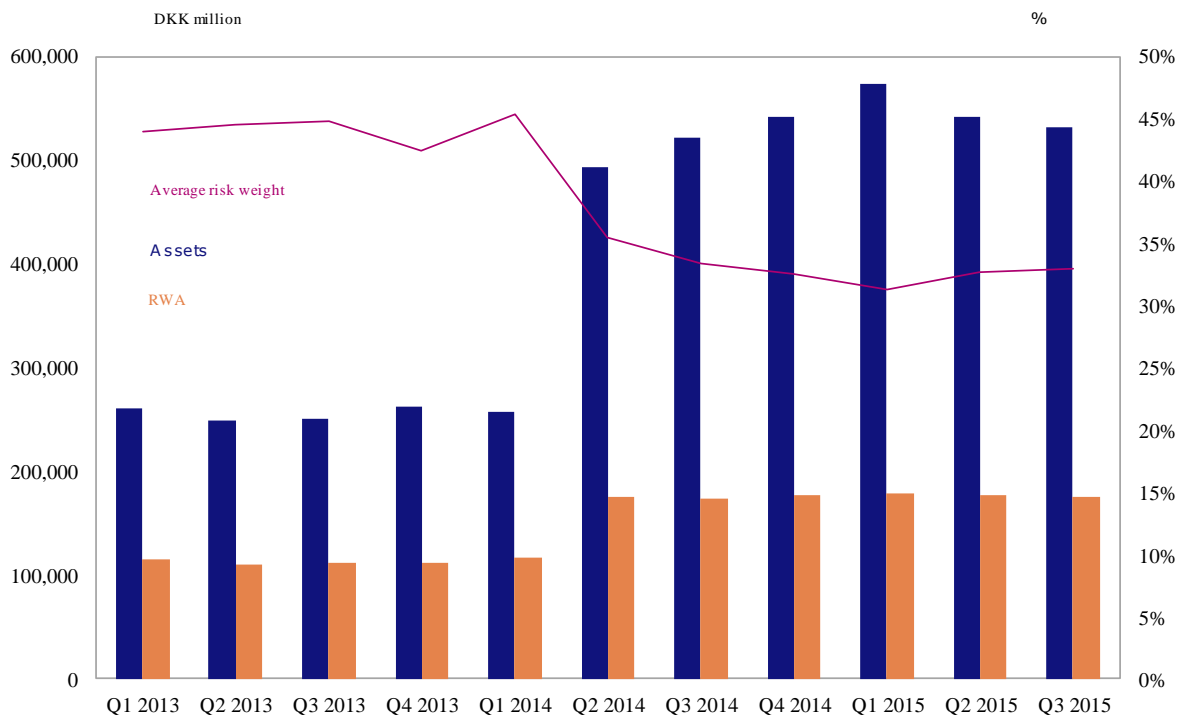
<sup>114</sup> Finanstilsynet, 'Pengeinstitutternes størrelsesgruppering', 2015 and Baldvinsson, 2011, p. 23

<sup>115</sup> [www.jyskebank.dk](http://www.jyskebank.dk) -> Om Jyske Bank -> Historie

<sup>116</sup> Jyske Bank 3 Quarter Financial Report 2015

because of a major acquisition. In order to be most forward-looking, the most current value of total assets and the average risk weight are chosen as model parameters.

Figure 6.1: Jyske Bank's total and risk-weighted assets



Source: Jyske Bank's quarterly Financial Reports 2013-2015

### 6.2.2 Volatility of asset returns

The estimation of Jyske Bank's volatility of asset returns is especially tricky due to the acquisition of BRFKredit in 2014. The estimated volatility will always be blurred by the fact that we cannot take into account sales and acquisitions as well as new and matured loans in the bank's assets. However, it is assumed that the volatility of assets is fairly constant over time and can be estimated from past data. The time period will be limited to the period where BRFKredit is visible in the balance sheet. This choice naturally limits the number of observations to six and the number of returns data to five.

The estimated volatility of asset returns for this period is 5.1% on a quarterly basis. The period before the acquisition, which has even less data points, gives an estimated volatility of assets of 4.0% on a quarterly basis. Had the whole period been used to estimate volatility, the sharp increase in the level of assets in the second quarter of 2014 would have resulted in an artificially high estimated volatility of 20.8% on a quarterly basis. The most correct estimation of volatility of asset returns is therefore 5.1% on a quarterly basis, which translates into 10.1% on a yearly basis. The standard error for the yearly estimation is 3.2%, therefore values of 6.9% and 13.3% for the volatility of asset returns will also be used in calculations. This value will be used in the base calculations 5-6. See appendix 4 for data.

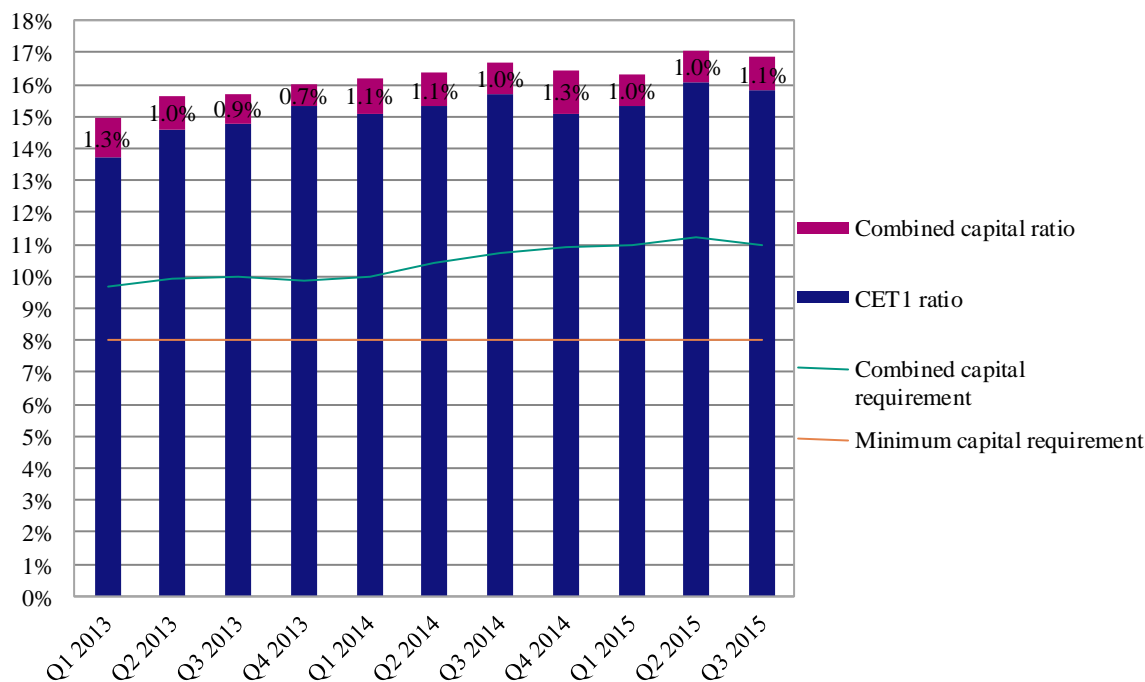
### 6.2.3 Effective corporate tax rate

The marginal corporate tax rate that will be used in the baseline calculation is the marginal corporate tax rate in 2016, 22%. However, a calculation with a marginal corporate tax rate of 28% will also be made in order to see the effect of the decline in the tax rate since 2006.

### 6.2.4 Capital requirements

Jyske Bank's combined capital requirement was 11.0% of risk-weighted assets in the third quarter of 2015. The requirement changes over time due to changes in the riskiness of the bank's lending but it seems to be fairly stable around 11.0% at least since the acquisition of BRFKredit (see figure 6.2).

Figure 6.2: Jyske Bank's development in capital ratios and requirements



Source: Jyske Bank's quarterly Financial Reports 2013-2015

The combined capital requirement of 11.0% consists of the minimum requirement of 8.0%, a Pillar 2 requirement of 2.7% and a SIFI buffer of 0.3%. The SIFI buffer will be 1.5% when fully implemented in 2019 and a capital conservation buffer of 2.5% will also be required by 2019. In addition, the national regulatory authorities may command Danish banks to put aside capital in form of a countercyclical buffer if the economy is improving too quickly. This

buffer can be a maximum of 2.5% by 2019. However, the Danish Business and Growth Ministry has confirmed a countercyclical capital buffer of 0.0% in 2016<sup>117</sup>. All the buffers will be phased in during the coming years as depicted in figure 6.3. It is assumed that the Pillar 2 requirement is constant at 2.7% but Jyske Bank expects it to fluctuate in the interval 1.5% to 3.0%. The combined capital requirement, assuming no countercyclical buffer requirement and a constant Pillar 2 requirement, is approximately 14.7% of risk-weighted assets.

Jyske Bank can use CET1 capital for the entire combined capital requirement. However, the bank has an option to use a maximum of 3.5% points of the minimum requirement and 44% of the Pillar 2 requirement,  $44\% * 2.7 \approx 1.2\%$ , in total  $3.5\% + 1.2\% = 4.7\%$  subordinated capital. Hence, the minimum CET1 ratio, assuming Sydbank has used all its pockets for subordinated capital, is  $11.0\% - 4.7\% = 6.3\%$ , which corresponds to 4.5% from the minimum requirement, 56% of the Pillar 2 requirement ( $56\% * 2.7\% \approx 1.5\%$ ) and the 0.3% SIFI buffer. The minimum required CET1 ratio of 6.3% of risk-weighted assets will increase in steps as the SIFI buffer and capital conservation buffer are phased in and will be  $6.3\% + 1.2\% + 2.5\% = 10.0\%$  in 2019 assuming no countercyclical buffer and a constant Pillar 2 requirement.

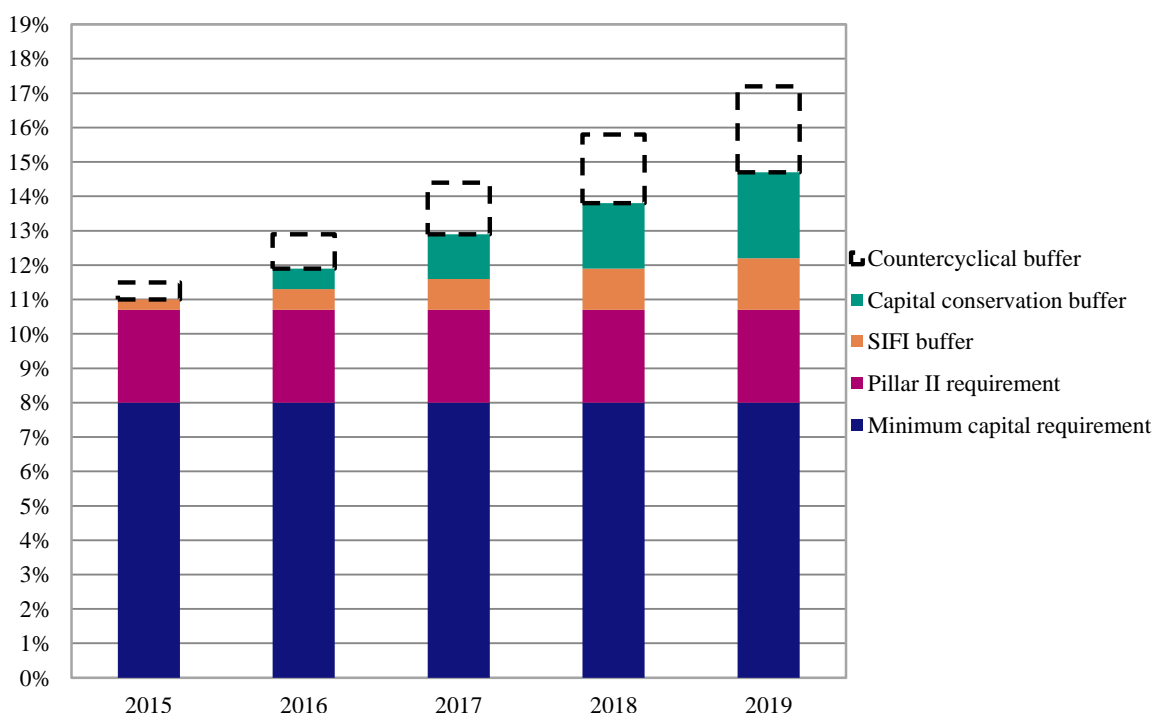
The subordinated capital ratio of 4.7% needed to minimize Jyske Bank's required CET1 ratio, can consist of AT1 capital or a blend of AT1 capital and Tier 2 capital. Jyske Bank can use Tier 2 capital for a maximum of  $2\% + 25\% * 2.7\% = 2.7\%$  of risk-weighted assets. Hence, assuming that Tier 2 capital is cheaper than AT1 capital, and AT1 capital is cheaper than CET1 capital, Jyske Bank should hold at least 2.7% Tier 2 capital and  $4.7\% - 2.7\% = 2.0\%$  AT1 capital. At the moment, Jyske Bank's issuance of subordinated capital only corresponds to 1.1% of risk-weighted assets. Hence, there is room for additional issuances of subordinated capital in the future. This analysis matches Jyske Bank's own announcement that they plan an issuance of subordinated capital in the first quarter of 2016.

However, since the models assume that banks' capital is uniform, and hence, that the optimal composition of Tier 2, AT1 and CET1 capital is given, the combined capital ratio will be used for calculation. The combined capital requirement that will be used in the model is 11.0% in order to estimate the short-term optimal capital ratio. A capital ratio of 14.7% will also be evaluated to see the effect of the full implementation of CRDIV. Lastly, a combined capital ratio of 17.2% will be used to see the full effect of the implementation of CRDIV with a countercyclical buffer of the maximum 2.5%. All results will be complemented with results where the Pillar 2 requirement is 1.5% and 3.0% in order to take into account variations in the Pillar 2 requirement.

---

<sup>117</sup> Erhvervs- og vækstministeriet, 'Fastsættelse af den kontracykliske buffersats', 2015

Figure 6.3: Jyske Bank's capital requirements until 2019



Source: Jyske Bank's Risk and Capital Management Report 2014 and 3<sup>rd</sup> Quarter Financial Report

### 6.2.5 Marginal regulatory non-compliance cost rate

As in the two cases above, the cost rate used in the HLR-model with a warning threshold,  $\gamma$ , will be 10% and the cost rate used in the K-model,  $\omega$ , will be 25%. However, calculations with  $\omega=10\%$  and  $\omega=50\%$  will also be made.

### 6.2.6 Risk free rate

As in the two cases above, interest rates of 0.05%, 0.5%, 1% and 2% will be used in order to test the robustness of the model.

## 6.3 Optimal capital structure in the HLR-model

The model parameters used in the HLR-model when applied to Jyske Bank as well as results of the model are depicted in table 6.1. Even though  $\alpha$  does not enter the calculation of the bank's optimal level of capitalization, it does influence the maximum level of  $\beta$  that the regulator can choose. If  $\alpha=10\%$ ,  $\beta$  should be below 1.1. As can be seen, the assumed capital requirements result in values of  $\beta$  below 1.1.

Table 6.1: Results of the HLR-model for Jyske Bank

Jyske Bank: total value of assets, V = DKK 531bn, value of risk-weighted assets, RWA = DKK 175 bn		Calc 1	Calc 2	Calc 3	Calc 4	Calc 5	Calc 6	Calc 7	Calc 8
$\sigma$	Volatility of asset returns	10.1%	10.1%	10.1%	10.1%	6.9%	13.3%	10.1%	10.1%
$\tau$	Effective corporate tax rate	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	28.0%
$r$	Riskless rate	0.05%	0.50%	1.00%	2.00%	0.05%	0.05%	0.05%	0.05%
$\underline{c}$	Minimum capital requirement	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	2.6%	8.0%
Max $\beta$	Maximum level of $\beta$ when $\alpha=10\%$	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
$\beta$	Stringency of capital requirement	1.09	1.09	1.09	1.09	1.09	1.09	1.03	1.09
C/r	Optimal amount of debt, DKK bn	6	173	237	299	40	1	61	12
v	Optimal firm value, DKK bn	531	550	566	583	533	531	532	531
Eq	Optimal book value of equity, DKK bn	525	358	294	232	491	531	470	519
Eq/V	Optimal book capital ratio in terms of total assets	98.81%	67.38%	55.37%	43.71%	92.40%	99.90%	88.51%	97.75%
Eq/RWA	Optimal book capital ratio in terms of risk-weighted assets	300.12%	204.64%	168.18%	132.77%	280.63%	303.43%	268.82%	296.90%
EqM	Optimal market value of equity, DKK bn	525	377	329	285	492	531	471	519
EqM/V	Optimal market capital ratio in terms of total assets	98.84%	70.93%	61.88%	53.58%	92.69%	99.91%	88.74%	97.81%
EqM/RWA	Optimal market capital ratio in terms of risk-weighted assets	300.19%	215.43%	187.93%	162.73%	281.52%	303.43%	269.51%	297.07%

The first calculation, 'Calc 1', is the base calculation where the base model parameters from section 6.2 are used. The capital ratio in terms of book value of equity over total value of assets is 98.81% when the bank optimizes its firm value. This is marginally higher than the predicted optimal capital ratio for Sydbank, which makes intuitive sense since Jyske Bank's asset volatility is marginally higher. The optimal capital ratio in terms of risk-weighted assets is predicted to be 300.12%. As in the two cases above, the model predicts an extremely high capital ratio in terms of risk-weighted assets.

The additional calculations show the same fundamental pattern as in the two cases above and also predict optimal capital ratios that are far above what is observed.

#### 6.4 Optimal capital structure in the HLR-model with warning threshold

The extended HLR-model that includes a warning threshold, which is assumed to be the combined capital requirement, increases the predicted optimal capital ratios in calculations 1-8 marginally. This is the same result as in the two cases above.

Table 6.2: Results of the HLR-model with warning threshold for Jyske Bank

Jyske Bank: total value of assets, V = DKK 531bn, value of risk-weighted assets, RWA = DKK 175 bn		Calc 1	Calc 2	Calc 3	Calc 4	Calc 5	Calc 6	Calc 7	Calc 8
$\sigma$	Volatility of asset returns	10.1%	10.1%	10.1%	10.1%	6.9%	13.3%	10.1%	10.1%
$\tau$	Effective corporate tax rate	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	28.0%
$r$	Riskless rate	0.05%	0.50%	1.00%	2.00%	0.05%	0.05%	0.05%	0.05%
$\underline{c}$	Minimum capital requirement	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	2.6%	8.0%
CCR	Combined capital requirement	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	3.6%	11.0%
Max $\beta$	Maximum level of $\beta$ when $\alpha=10\%$	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
$\beta$	Stringency of minimum capital requirement	1.09	1.09	1.09	1.09	1.09	1.09	1.03	1.09
v	Optimal amount of combined capital requirement	1.12	1.12	1.12	1.12	1.12	1.12	1.04	1.12
$\delta$	Penalty for breaching combined capital requirement	5%	5%	5%	5%	5%	5%	5%	5.0%
C/r	Optimal amount of debt, DKK bn	1	145	216	285	18	0	9	3
v	Optimal firm value, DKK bn	531	547	563	581	532	531	531	531
Eq	Optimal book value of equity, DKK bn	530	386	315	246	513	531	522	528
Eq/V	Optimal book capital ratio in terms of total assets	99.79%	72.66%	59.26%	46.37%	96.60%	100.00%	98.36%	99.48%
Eq/RWA	Optimal book capital ratio in terms of risk-weighted assets	303.07%	220.68%	179.97%	140.83%	293.40%	303.70%	298.74%	302.13%
EqM	Optimal market value of equity, DKK bn	530	402	346	296	514	531	523	528
EqM/V	Optimal market capital ratio in terms of total assets	99.79%	75.64%	65.19%	55.77%	96.73%	100.00%	98.39%	99.49%
EqM/RWA	Optimal market capital ratio in terms of risk-weighted assets	303.09%	229.72%	198.00%	169.38%	293.80%	303.71%	298.83%	302.17%



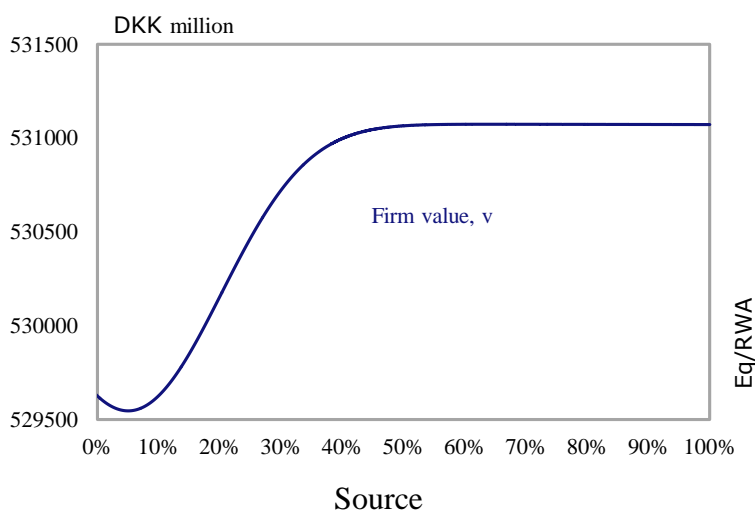
### 6.5 Optimal capital structure in the K-model

The base calculation as well as calculations with differing parameter values as outlined in section 6.2 will be presented in the following.

'Calc 1' in table 9.9 in appendix 4 is the base calculation where volatility of asset returns= 10.1%, the effective corporate tax rate=22%, the riskless rate=0.05%, the marginal regulatory non-compliance cost rate=25%, the combined capital requirement=11.0% and the average risk weight of assets=32.93%. These parameter values yield an optimal capital ratio (Eq/RWA) of 64.00%. This can be expressed as a capital buffer above the combined capital requirement of 53.00%. In terms of asset values, the model predicts an optimal capital ratio (Eq/V) at 21.07%, which corresponds to a capital buffer in terms of total assets of 17.45%, since the 11% combined capital requirement translates into a  $CCR \cdot \rho = 11\% \cdot 32.93\% = 3.62\%$  requirement in terms of total assets.

The firm value at the optimal capital ratio is DKK 531 billion, which is only marginally larger than the value of assets, by DKK 11 million. As in the two other cases, the optimal capital structure has little added value in terms of the total value of assets, but it adds tremendous value compared to choosing the least optimal capital structure. As is seen in figure 6.4, the least optimal capital structure is associated with a firm value that is about DKK 500 million lower than the value of assets. From figures 9.9-9.12, one can see that the cost of expropriation is the dominating factor in terms of optimal capital structure. Regulatory non-compliance costs are only a fraction of these costs and tax benefits are even smaller in proportion. Therefore, the cost of increasing the capital ratio above the optimal 64.00% is small.

Figure 6.4: Firm value of Jyske Bank in the K-model



The next three calculations, 'Calc 2'-'Calc 4' use higher riskless interest rates and, as in the two other cases, the optimal capital ratio decreases, to 49.75% when  $r=2\%$ . Hence, the relation between C and r is positive. The value of the optimal capital structure decision

increases with  $r$ , and is at  $r=2\%$  equal to more than DKK 478 million. This is due to the much higher value of tax benefits when the riskless interest rate increases.

The next two calculations, 'Calc 5' and 'Calc 6', use a lower and a higher level of volatility. A higher asset volatility increases the risk that the bank may breach the capital requirement in connection with the next quarterly financial report. Therefore, it can be expected that asset volatility is positively correlated with the optimal capital ratio. As expected, when asset volatility is low, at 6.9%, the optimal capital ratio decreases by more than 15% points, to 48.68%, and when asset volatility is high, at 13.3%, the optimal capital ratio increases by almost 14% points, to 77.89%.

The next two calculations, 'Calc 7' and 'Calc 8', use different levels of marginal regulatory non-compliance cost rate. The impact on the optimal capital ratio is minimal (about 0.25% points) as in the two other cases.

The next two calculations, 'Calc 9' and 'Calc 10', explore the effects of fully phased-in capital requirements both if the full countercyclical capital buffer is applied and if it is not. As in the Sydbank case, when the capital requirements are fully phased-in and a full 2.5% countercyclical buffer applies, assuming no change in Pillar 2 requirements, the optimal capital structure is less than 3% points higher than in the base calculation.

Lastly, 'Calc 11', explores how the higher tax rate ten years ago, at 28%, affected the optimal capital structure. The effect is a minimal reduction in the optimal capital ratio, less than 1% points. Again, because of the low riskless interest rate, tax benefits do not weigh much in the value of the firm so the tax rate does not affect the optimal capital structure much. In reality, the optimal capital ratio must have been much lower due to the higher level of interest rates ten years ago.

## 6.6 Brief summation of the case

All the selected models predict an optimal capital ratio that is well above Jyske Bank's current capital ratio as well as Jyske Bank's own capital ratio target. The HLR-model both with and without a warning threshold was particularly off. The HLR-model with a warning threshold that corresponded to the combined capital requirement predicted an optimal capital ratio of 303% in terms of risk-weighted assets and an optimal capital ratio in terms of total assets that was very close to 100%.

The K-model predicted an optimal capital ratio in terms of risk-weighted assets at 64% and an optimal capital ratio in terms of assets at 21%. Hence, the predictions were more realistic than the HLR-model's predictions but still far off compared to Jyske Bank's own capital ratio policy at 17.5% of risk-weighted assets. The correlations between model parameters and the optimal capital ratio predicted by the model corresponded to those exhibited in the Danske Bank and Sydbank cases.

## 7 Summary and concluding remarks

In the following, a conclusion on the thesis' research questions is given along with reflections on findings of the thesis. Lastly, other perspectives on the thesis' subject and suggestions for further research are discussed.

### 7.1 Conclusion

It is found that the development of Danish bank regulation has broadly reflected European bank regulation. In contrast to other European countries, the Danish government has treated bondholders less favorably by allowing bail-in on unsecured senior debt as in the case of Roskilde Bank.

When only considering capital requirements, and not disclosure and other requirements, there seems to be three capital requirements that are especially important and the breach of these have different but all severe consequences. These are the MDA requirement, the Pillar 2 requirement and the minimum capital requirement. These complex requirements make the bank's capital structure decision especially challenging.

However, as a starting point, the classic theories of firm capital structure were elaborated on. These theories provided a foundation for the subsequent discussion of theories that looks at optimal capital structure specifically for banks. The theories that deal with bank's optimal capital structure specifically all find inspiration from the classical corporate finance theories.

The HLR-model for optimal capital structure of banks takes into account deposit insurance, capital requirements, bankruptcy costs and tax-advantaged debt. It assumes that banks face bankruptcy if they fail to comply with their capital requirement but that some of this cost is balanced by the government's deposit insurance. When applied to the cases of Danske Bank, Sydbank and Jyske Bank, however, it dramatically overshoot the optimal capital structure. The real shortcomings of the model seemed to be the riskless interest rate's dramatic influence on results as well as the fact that it failed to take into account risk-weighted assets. The extended model, that included a second capital requirement, which was modeled as the combined capital requirement, overshoot the optimal capital structure marginally more than the base model.

The K-model was developed specifically to take into account the new regulatory framework where systemically important banks are not allowed to be liquidated but where shareholders and owners of banks' AT1 capital face the risk of a loss even though the bank is not liquidated. The predicted capital ratios of the K-model for the three bank cases were much more realistic but still much higher than the banks' own capital policy. The shortcoming of the model also seemed to stem from the current extremely low riskless rate. The inherent assumption that banks only use deposits, which pay the riskless interest rate due to deposit insurance, besides capital, was critical in terms of this shortcoming. In reality, many banks finance themselves through various forms of debt.

However, even though the model overshoot the optimal capital ratio, maybe due to insufficiently correct model parameters, the underlying predictions are interesting as they show how banks' optimal capital structures react in a regulatory framework that matches the assumption of the models. The inputs to the model have the following correlation with the predicted optimal capital ratio: the riskless interest rate was negatively correlated with the optimal capital ratio and the asset volatility, and the combined capital requirement were positively correlated with the optimal capital ratio. The riskless interest rate is positively related to the weight size of the bank's debt service payments, which are related to the size of tax benefits. Therefore a higher riskless interest rate increases the tax benefit associated with debt and lowers the optimal capital ratio. As in the HLR-model, the combined capital requirement only had a marginal impact, which implies that the phase-in of higher capital requirements until 2019 will have little impact on Danish banks' optimal capital ratios. The main factor in the optimal capital structure decision seems to be the risk of expropriation and the risk that tax benefits are lost in the process.

The results further imply that bank managers, investors and regulators should be careful not to forget to focus on the capital ratio in terms of total assets. It is tempting just to look at the capital ratio in terms of risk-weighted assets, as this is the ratio that is monitored in relation to capital requirements. However, the average risk weight can differ substantially between banks without an apparent difference in the riskiness of the banks' assets. Therefore, a bank with a very low average risk weight but an asset volatility that is comparable to banks with higher average risk weights, should target a higher capital buffer in terms of risk-weighted assets. It is striking that both Danske Bank, Sydbank and Jyske Bank target a capital ratio in the area of 17% as if this is an emerging industry standard. The nonexistent link between asset volatility and average risk weight is peculiar since risk weights are constructed in order to reflect the riskiness of assets.

The new regulatory framework in Denmark implies higher capital requirements for banks, but it also stresses the importance of systemically important financial institutions (SIFI), which should be kept alive at all cost. These SIFIs have additional capital requirements in order to assure that a collapse will not occur. However, it seems that the risks associated with breaching the minimum requirement, which has stayed the same since Basel I, is the main factor in banks' optimal capital structure.

The additional capital requirements, which imply serious costs if breached, are still minor compared to the costs associated with a higher risk of breaching minimum requirements and consequently lose tax benefits and the remaining equity value associated with a lower capital ratio. This implies that SIFIs' optimal capital structures will not be significantly different from non-SIFIs but that most banks' optimal capital structures are considerably higher than the level that is observed at the time of writing this thesis. Hence, the implementation of CRD IV is predicted to have the effect of increasing Danish financial institutions' optimal capital structures marginally. The increase should happen slowly during the coming years until the implementation is complete by 2019.

## 7.2 Other perspectives

The K-model could be modified to be expressed in terms of risk-weighted assets. The asset volatility should then be the volatility of risk-weighted assets. It is possible that a bank with a lower average risk weight also tends to have a lower volatility of risk-weighted assets. This is what could be expected considering the fact that risk weights are meant to reflect the riskiness of assets. However, the models in this thesis assume that the average risk weight is constant and hence, the volatility of risk-weighted assets corresponds to the volatility of total assets.

This thesis does not investigate banks' own autonomy when calculating risk-weighted assets, as the focus is on capital requirements, not corporate governance or disclosure requirements. However, this issue is highly relevant as the calculation of risk-weighted assets has a direct impact on the banks' capital requirements. Further research could examine this issue.

Another important aspect that has not been dealt with is the dilemma on how banks should respond to pressures from shareholders, regulatory authorities and customers. In November 2015, Jesper Berg, director of the FSA, warned that investors should not get used to the increasing dividend payments seen from banks this year, since banks should conserve their capital in times of economic expansion. Investors should therefore lower their expectations to banks' return on equity. However, it is a real dilemma how banks should tackle these different pressures.

As a last comment, this thesis does not consider the pricing of different capital instruments. Whether or not AT1 and Tier 2 capital are cheaper options than CET1 for banks depends on the market for this kind of debt as well as the bank's standing in markets. One could imagine that smaller banks would have a disadvantage in this regard. This issue would be highly relevant to investigate in order to elaborate, not only on the optimal relation between total capital and debt, but also on the optimal relation between CET1, AT1, Tier 2 and debt.

## 8 Bibliography

### 8.1 Literature

Abildgren, Kim, 'Dansk Pengehistorie 1995-2005', Danmarks Nationalbank, 2010

Abildgren, Kim et al., 'En fortælling om to danske bankkriser', Danmarks Nationalbank, kvartalsoversigt 1. kvartal – del 1, 2011

Baldvinsson, Cato et al., 'Dansk Bankvæsen', 6. udgave, Karnov Group, 2011

Berk, Jonathan, et al., 'Capital Structure in a Perfect Market', Second Edition, Pearson Education, 2011

Bundgaard, Birgitte et al., 'Sammensætning af pengeinstitutternes kapital – nye lovkrav og muligheder', Kvartalsoversigt / Danmarks Nationalbank, Årg. 41, nr. 3, 2002

Jeppesen, Morten, 'Blændværk: Roskilde Banks storhed og fald', Jyllands-Postens Forlag, 2009

### 8.2 Journals

Andersen, Henrik, 'Norwegian banks in a recession: Procyclical implications of Basel II', Working Paper, Norges Bank, 04, 2009

Berger, Allen N., et al, 'How Do Large Banking Organizations Manage Their Capital Ratios?', Springer Science, 2008

Harding, John P., et al, 'Bank Capital Requirements and Capital Structure', University of Connecticut, Department of Economics, 2009

Keiding, H, 'Economics of Banking', Palgrave Macmillan, 2015

Leland, H.E., 'Corporate Debt Value, Bond Covenants, and Optimal Capital Structure,' The Journal of Finance, 49(4), 1213-1252, September 1994

Long, Michael S., et al., 'Investment Patterns and Financial Leverage', University of Chicago Press, 1985

Merton, Robert Cox, 'An analytic derivation of the cost of deposit insurance and loan guarantees - An application of modern option pricing theory', North-Holland Publishing Company, Journal of Banking and Finance 1, 3-11, 1977

Shyam-Sunder, Lakshmi, et al., 'Testing static tradeoff against pecking order models of capital structure', Journal of Financial Economics, 1998

Sundaresan, Suresh, 'A Review of Merton's Model of the Firm's Capital Structure with its Wide Applications', Annu. Rev. Financ. Econ., 2013

Syvertsen, Bjørne Dyrre, 'Sammenligning av nordiske og norske banker basert på ulike soliditetsmål', Aktuell Kommentar, Norges Bank, nr. 9, 2012

Tarullo, Daniel K., 'Banking on Basel: The Future of International Financial Regulation', Peterson Institute for International Economics, 2008

### 8.3 Websites

[www.bankofengland.co.uk](http://www.bankofengland.co.uk)

[www.bis.org](http://www.bis.org)

[www.danskebank.com](http://www.danskebank.com)

[www.eba.europa.eu](http://www.eba.europa.eu)

[www.esrb.europa.eu](http://www.esrb.europa.eu)

[www.evm.dk](http://www.evm.dk)

[www.finansielstabilitet.dk](http://www.finansielstabilitet.dk)

[www.fi.se](http://www.fi.se)

[www.finansraadet.dk](http://www.finansraadet.dk)

[www.gii.dk](http://www.gii.dk)

[www.jak.dk](http://www.jak.dk)

[www.jyskebank.dk](http://www.jyskebank.dk)

[www.petersoninstitute.org](http://www.petersoninstitute.org)

[www.regjeringen.no](http://www.regjeringen.no)

[www.risikoraad.dk](http://www.risikoraad.dk)

[www.skat.dk](http://www.skat.dk)

[www.skm.dk](http://www.skm.dk)

[www.sydbank.dk](http://www.sydbank.dk)

## **8.4 Company Information**

Andelskassen J.A.K. Slagelse Annual Reports 2013 - 2014

Danske Bank Annual Report 2014

Danske Bank, Funding Plan, Danske Bank, 29 October 2015

Danske Bank's Risk and Capital Management Report 2014 and 3rd Quarter Financial Report

Roskilde Banks annual and quarterly reports, 2006 - 2008



Sydbanks Quarterly Financial Reports 2013-2015

## 8.5 News paper articles

Lund-Hansen, Christoffer, 'Finansiel Stabilitet: Det ser værre ud, end da vi kiggede første gang', Dagbladet Børsen, 22 December 2015

Mandrup, Mette, 'Finansiel Stabilitet vil sælge J.A.K. Slagelse i 2016', Finanswatch, 18 December 2015

Nymark, Jens, 'Fakta: Tredelingen af Roskilde Bank', Dagbladet Børsen, 29 September 2008

## 8.6 Submissions

Bank of England, "Strengthening capital standards: implementing CRD IV", Consultation Paper, Prudential Regulation Authority, August 2013

Bank for International Settlements, 'A brief history of the Basel Committee', Basel Committee on Banking Supervision, October 2015

Bank for International Settlements, 'Basel III: A global regulatory framework for more resilient banks and banking systems', Basel Committee for Banking Supervision, December 2010 (rev June 2011)

Bank for International Settlements, 'Basel III leverage ratio framework and disclosure requirements', Basel Committee for Banking Supervision, January 2014

Bank for International Settlements, 'Basel III: Monitoring Report', Basel Committee for Banking Supervision, September 2015

Bank for International Settlements, 'Basel III: The liquidity Coverage Ratio and liquidity risk monitoring tools', Basel Committee for Banking Supervision, January 2013

Bank for International Settlements, 'Basel III: The Net Stable Funding Ratio', Basel Committee for Banking Supervision, October 2014

Bank for International Settlements, 'Global systemically important banks: updated assessment methodology and the higher loss absorbency requirement', Basel Committee for Banking Supervision, July 2013

Bank for International Settlements, 'International Convergence of Capital Measurement and Capital Standards', A Revised Framework – Comprehensive Version, Basel Committee on Banking Supervision, June 2006

Bank for International Settlements, 'Results of the comprehensive quantitative impact study', Basel Committee on Banking Supervision, December 2010

Danmarks Nationalbank, 'Finansiell Stabilitet 1. halvår', 2 June 2015

Erhvervs- og Vækstministeriet, Finanstilsynet, 'Bekendtgørelse om kapital til opfyldelse af det individuelle solvenstillæg for pengeinstitutter og realkreditinstitutter', j.nr. 122-0032, Lovtidende A, 3 December 2015

European Banking Authority, 'CRD IV – CRR / Basel III monitoring exercise', 3 March 2015

European Banking Authority, 'EBA FINAL Draft Regulatory Technical Standards on criteria for determining the minimum requirement for own funds and eligible liabilities under Directive 2014/59/EU', 3 July 2015

European Banking Authority, 'Opinion of the European Banking Authority on the interaction of Pillar 1, Pillar 2 and combined buffer requirements and restrictions on distributions', 16 December 2015

Financial Stability Board, '2014 update of list of global systemically important banks (G-SIBs)', 6 November 2014

Finansiell Stabilitet A/S, 'Finansiell Stabilitet overtager kontrollen med Andelskassen J.A.K. Slagelse', 5 Oktober 2015

Finansrådet, 'Overdragelse af Roskilde Bank A/S til Finansiell Stabilitet A/S', 23 July 2009

Finanstilsynet, 'Anmodning om politimæssig efterforskning af Andelskassen J.A.K. Slagelse', 24 August 2015

Finanstilsynet, 'Markedsudvikling 2013', 8 May 2014

Finanstilsynet, 'Pengeinstitutternes størrelsesgruppering', 20 January 2015

Finanstilsynet, 'Redegørelse for Finanstilsynets tilsyn med Roskilde Bank i henhold til § 352 a i lov om finansiel virksomhed', 17 June 2009

Finanstilsynet, 'Redegørelse om inspektion i Andelskassen J.A.K. Slagelse', 3 March 2015

Finanstilsynet, 'Redegørelse om risikoplysning til Andelskassen J.A.K. Slagelse - overskridelse af tilsynsdiamantens pejlemærke for store engagementer', 31 May 2013

Finanstilsynet, 'Systemisk vigtige finansielle institutter (SIFI)', 30 June 2015

Finanstilsynet, 'Vejledning om tilsynsdiamanten for pengeinstitutter', gældende fra 01.01-2018, 9 July 2015

Moody's, 'Change in French Banks' Hierarchy of Claims Increases Clarity of Bank Resolution', 30 December 2015

Danmarks Nationalbanken, 'Roskilde Bank', Kvartalsoversigt - 3. kvartal 2008

SKAT, den juridiske vejledning, 'Skatteprocenter', Afsnit C.D.10.1.2, 31 July 2015

Skatteministeriet, 'Selskabsskattesatser i EU-landene 1995-2015', Generel Skattestatistik, 10 December 2015

Standard & Poor's 'Advance Notice Of Proposed Criteria Change: Ratings Uplift Due To Additional Loss-Absorbing Capacity', 5 November 2014

Swedish Financial Services Authority, 'Decision regarding the countercyclical buffer rate', 2015

Økonomi- og Erhvervsministeriet, 'Redegørelse vedrørende Roskilde Bank', 24 November 2008

## **8.7 Documentary**

DR1, 'Bankerot', 4 March 2009

## **8.8 Stock Exchange Announcements**

Roskilde Bank, 1 December 2006

## **8.9 Press releases**

Erhvervs- og vækstministeriet, Finanstilsynet, "Fastsættelse af den kontracykliske buffersats", 30 June 2015

Norwegian Ministry of Finance, 'Countercyclical buffer increases next year', 18 June 2015

## **8.10 Other legislation**

Lov om finansiel virksomhed, jf. lovbekendtgørelse nr. 928 af 4. august 2014

## 9 Appendices

### 9.1 Appendix 1: VBA code for the K-model

```
Function BSCallPrice(S, X, T, i, sigma)
' Calculates Black-Scholes binary call price
'S: Stock price
'X: Exercise price
'T: Time to maturity
'i: Interest rate
'sigma: standard deviation
Dim d1, d2, Nd1, Nd2

d1 = (Log(S / X) + (i + 0.5 * sigma ^ 2) * T) / (sigma * Sqr(T))
d2 = d1 - sigma * Sqr(T)

Nd1 = Application.NormSDist(d1)
Nd2 = Application.NormSDist(d2)

BSCallPrice = S * Nd1 - X * Exp(-i * T) * Nd2

End Function

Function BSPutPrice(S, X, T, i, sigma)
' Calculates Black-Scholes put price
'S: Stock price
'X: Exercise price
'T: Time to maturity
'i: Interest rate
'sigma: standard deviation
Dim d3, d4, Nd3, Nd4

d3 = (Log(S / X) + (i + 0.5 * sigma ^ 2) * T) / (sigma * Sqr(T))
d4 = d3 - sigma * Sqr(T)

Nd3 = Application.NormSDist(-d3)
```

$Nd4 = \text{Application.NormSDist}(-d4)$

$\text{BSPutPrice} = X * \text{Exp}(-i * T) * Nd4 - S * Nd3$

End Function

Function  $\text{BSBinaryPutPrice}(S, X, T, i, \text{sigma}, Q)$

' Calculates Black-Scholes put price

'S: Stock price

'X: Exercise price

'T: Time to maturity

'i: Interest rate

'sigma: standard deviation

'Q: Payoff

Dim d5, d6, Nd5, Nd6

$d5 = (\text{Log}(S / X) + (i + 0.5 * \text{sigma}^2) * T) / (\text{sigma} * \text{Sqr}(T))$

$d6 = d5 - \text{sigma} * \text{Sqr}(T)$

$Nd6 = \text{Application.NormSDist}(-d6)$

$\text{BSBinaryPutPrice} = Q * \text{Exp}(-i * T) * Nd6$

End Function

Function  $\text{BSBinaryCallPrice}(S, X, T, i, \text{sigma}, Q)$

' Calculates Black-Scholes binary call price

'S: Stock price

'X: Exercise price

'T: Time to maturity

'i: Interest rate

'sigma: standard deviation

'Q: Payoff

Dim d7, d8, Nd7, Nd8

$d7 = (\text{Log}(S / X) + (i + 0.5 * \text{sigma}^2) * T) / (\text{sigma} * \text{Sqr}(T))$

$d8 = d7 - \text{sigma} * \text{Sqr}(T)$

`Nd8 = Application.NormSDist(d8)`

`BSBinaryCallPrice = Q * Exp(-i * T) * Nd8`

`End Function`

Note: The above functions were used to calculate the value of expropriation costs, regulatory non-compliance costs and tax benefits. 10,000 values of  $C$  ranging from the point where the capital ratio in terms of risk-weighted assets is zero,  $t^*V*r(1-\rho)$ , in steps of  $0.01\% * t^*V*r*\rho$ , to the point where the capital ratio in terms of risk-weighted assets is 100%, were calculated in Excel. Using VBA code, the value of the firm was found for all 10,000 values of  $C$ . The maximum value was found using the `MAX()` function in Excel.

## 9.2 Appendix 2: Danske Bank

Table 9.1: Danske Bank's capital ratios

DKK million	Q1 2013	Q2 2013	Q3 2013	Q4 2013	Q1 2014	Q2 2014	Q3 2014	Q4 2014	Q1 2015	Q2 2015	Q3 2015
Assets	3,500,998.00	3,317,104.00	3,268,230.00	3,227,057.00	3,314,218.00	3,273,485.00	3,437,294.00	3,453,015.00	3,671,158.00	3,452,213.00	3,348,051.00
RWA	797,170.00	778,848.00	867,974.00	852,250.00	896,755.00	887,447.00	868,470.00	865,822.00	895,856.00	892,429.00	832,074.00
Capital	172,509.00	170,036.00	165,524.00	181,985.00	162,706.00	164,643.00	167,481.00	167,461.00	165,125.00	167,323.00	171,273.00
Combined capital ratio	21.6%	21.8%	19.1%	21.4%	18.1%	18.6%	19.3%	19.3%	18.4%	18.7%	20.6%
CEFT1 ratio	15.1%	15.6%	14.2%	14.7%	14.0%	14.4%	15.0%	15.1%	14.1%	14.3%	15.7%
Average risk weight	22.8%	23.5%	26.6%	26.4%	27.1%	27.1%	25.3%	25.1%	24.4%	25.9%	24.9%
Combined capital requirement	11.4%	11.3%	10.1%	10.4%	10.5%	10.6%	10.6%	10.6%	11.2%	11.1%	11.6%
Capital buffer	10.2%	10.5%	9.0%	11.0%	7.6%	7.9%	8.7%	8.7%	7.2%	7.6%	9.0%

Source: Danske Bank's quarterly financial reports Q1 2013 to Q3 2015

Table 9.2: Danske Bank's capital requirements 2015-2019

	2015	2016	2017	2018	2019
Minimum capital requirement	8.0%	8.0%	8.0%	8.0%	8.0%
Pillar 2 requirement	2.7%	2.7%	2.7%	2.7%	2.7%
SIFI buffer	0.6%	1.2%	1.8%	2.4%	3.0%
Capital conservation buffer	0.0%	0.6%	1.3%	1.9%	2.5%
Countercyclical capital buffer from exposures to Norway and Sweden	0.3%	0.3%	0.3%	0.3%	0.3%
Countercyclical buffer	0.5%	1.0%	1.5%	2.0%	2.5%

Source: Danske Bank's financial reports and Risk Management Reports



Table 9.3: Results of the K-model for Danske Bank

Danske Bank: total value of assets, $V = \text{DKK } 3.348 \text{ bn. value of risk-weighted assets, RWA} = \text{DKK } 832 \text{ bn}$		Calc 1	Calc 2	Calc 3	Calc 4	Calc 5	Calc 6	Calc 7	Calc 8	Calc 9	Calc 10	Calc 11
$\sigma$	Volatility of asset returns	8.1%	8.1%	8.1%	8.1%	6.3%	9.9%	8.1%	8.1%	8.1%	8.1%	8.1%
$\tau$	Effective corporate tax rate	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%
$r$	Riskless rate	0.05%	0.50%	1.00%	2.00%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%
$\omega$	Marginal regulatory non-compliance cost rate	25%	25%	25%	25%	25%	25%	10%	50%	25%	25%	25%
$\alpha$	Minimum capital requirement	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
CCR	Combined capital requirement	11.6%	11.6%	11.6%	11.6%	11.6%	11.6%	11.6%	11.6%	16.5%	19.0%	11.6%
$\rho$	Average risk weight of assets	24.85%	24.85%	24.85%	24.85%	24.85%	24.85%	24.85%	24.85%	24.85%	24.85%	24.85%
$C/r$	Optimal amount of debt, DKK bn	2,776	2,850	2,878	2,910	2,872	2,684	2,778	2,772	2,757	2,742	2,782
$v$	Optimal firm value, DKK bn	3,348	3,349	3,350	3,351	3,348	3,348	3,348	3,348	3,348	3,348	3,348
Eq	Optimal book value of equity, DKK bn	572	498	470	438	476	664	570	576	591	606	566
Eq/V	Optimal book capital ratio in terms of total assets	17.10%	14.88%	14.05%	13.08%	14.21%	19.82%	17.04%	17.20%	17.67%	18.11%	16.90%
Eq/RWA	Optimal book capital ratio in terms of risk-weighted assets	68.79%	59.88%	56.54%	52.63%	57.18%	79.77%	68.55%	69.19%	71.08%	72.89%	68.00%
EqM	Optimal market value of equity, DKK bn	572	499	472	441	476	664	570	576	592	607	566
EqM/V	Optimal market capital ratio in terms of total assets	17.10%	14.90%	14.10%	13.17%	14.21%	19.83%	17.04%	17.20%	17.67%	18.12%	16.90%
EqM/RWA	Optimal market capital ratio in terms of risk-weighted assets	68.80%	59.97%	56.73%	53.01%	57.19%	79.78%	68.56%	69.20%	71.09%	72.90%	68.01%
Eq/RWA-CR	Buffer to combined capital requirement	57.19%	48.28%	44.94%	41.03%	45.58%	68.17%	56.95%	57.59%	54.58%	53.89%	56.40%
EXP	Value of expropriation costs at optimal DKK	645,986	7,635,945	16,028,605	32,975,604	487,345	785,356	696,802	568,927	307,875	167,309	827,688
RN	Value of regulatory non-compliance costs at optimal, DKK	85,917	893,603	1,796,060	3,531,625	84,297	88,109	36,936	152,252	415,337	552,517	108,781
TB	Value of tax benefits at optimal, DKK	76,319,841	782,530,621	1,577,919,688	3,181,752,569	78,976,603	73,807,169	76,374,632	76,228,503	75,796,688	75,382,894	97,363,842
CSD	Value of capital structure decision at optimal, DKK	75,587,938	774,001,073	1,560,095,023	3,145,245,340	78,404,960	72,933,704	75,640,894	75,507,325	75,073,477	74,663,069	96,427,372
Eq/RWA_NR	Optimal book capital ratio in terms of risk-weighted assets if no regu	41.09%	40.68%	40.23%	39.32%	35.22%	46.50%	41.09%	41.09%	41.09%	41.09%	41.09%

Figure 9.1: Danske Bank's expropriation costs

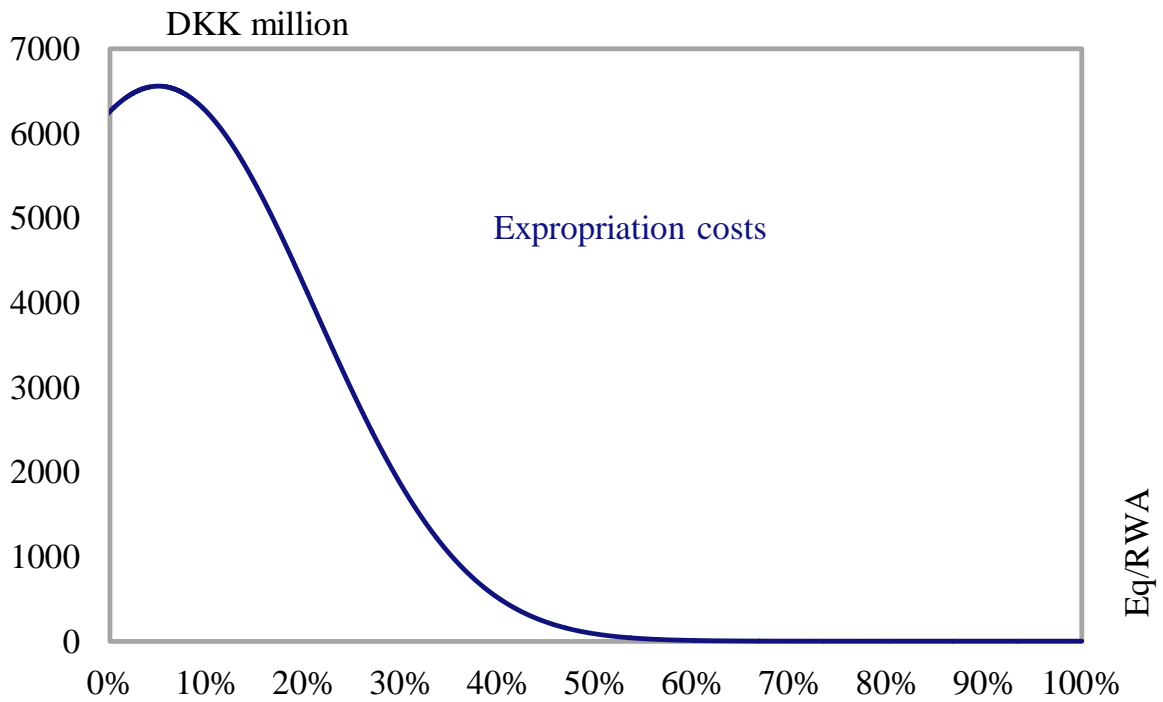


Figure 9.2: Danske Bank's regulatory non-compliance costs

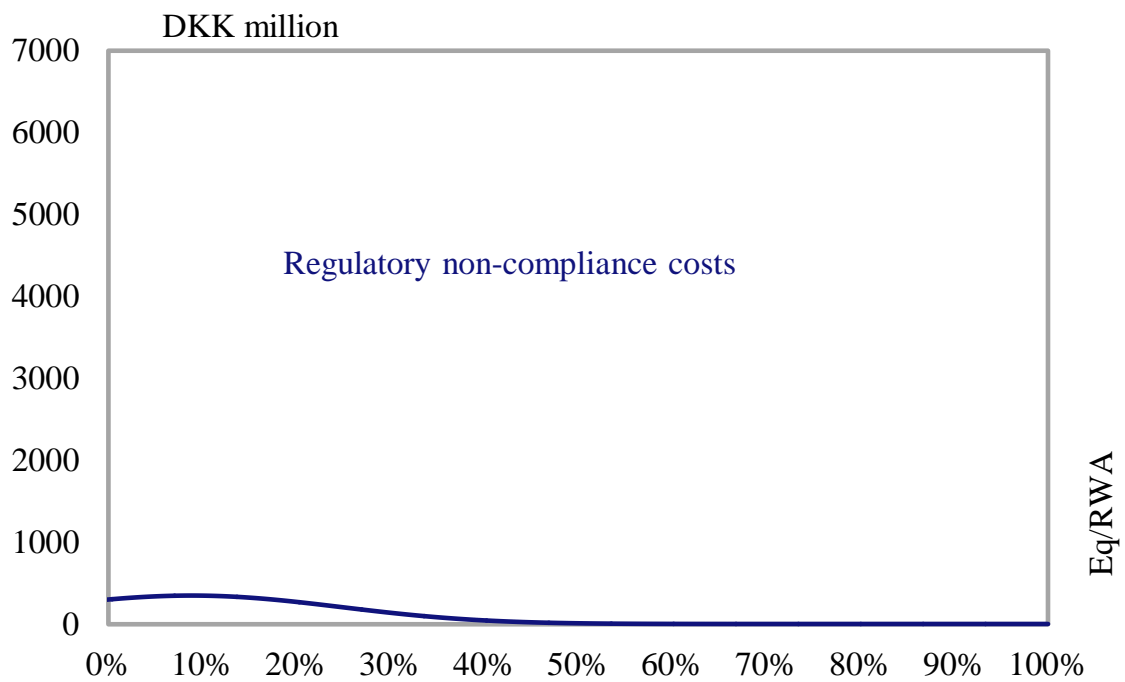


Figure 9.3: Danske Bank's tax benefits

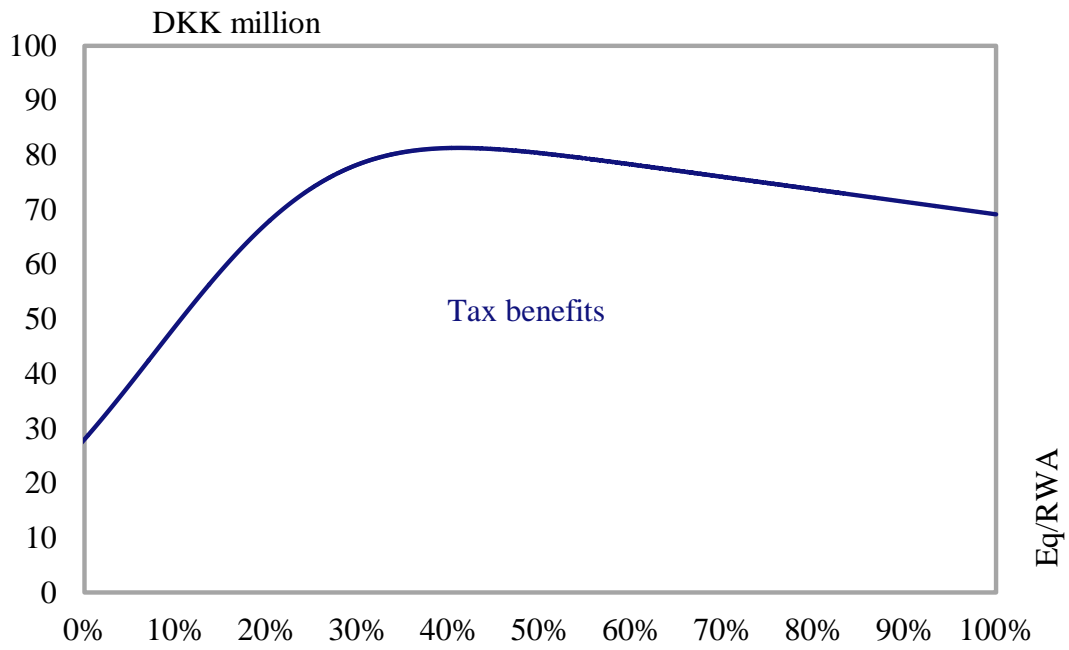
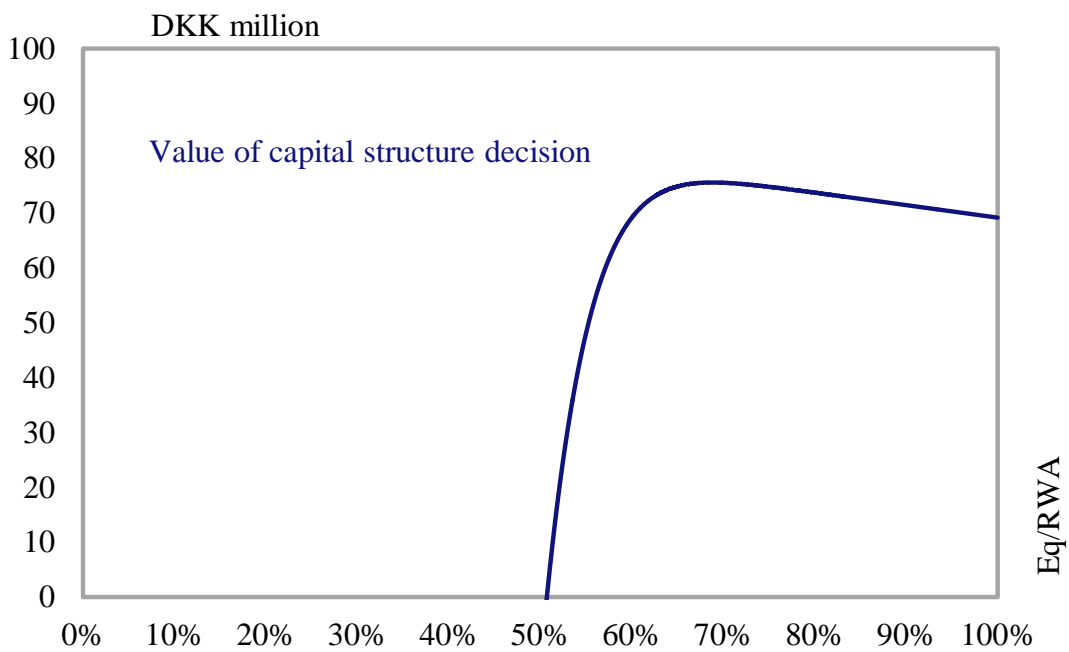


Figure 9.4: Value of Danske Bank's capital structure decision



### 9.3 Appendix 3: Sydbank

Table 9.4: Sydbank's capital ratios

DKK million	Q1 2013	Q2 2013	Q3 2013	Q4 2013	Q1 2014	Q2 2014	Q3 2014	Q4 2014	Q1 2015	Q2 2015	Q3 2015
Assets	155,385.00	141,390.00	144,526.00	147,892.00	143,362.00	147,408.00	148,207.00	152,316.00	155,662.00	153,059.00	140,921.00
RWA	73,508.00	71,304.00	70,339.00	72,749.00	72,205.00	71,310.00	69,432.00	72,467.00	70,297.00	69,493.00	68,897.00
Capital	11,514.00	11,777.00	11,872.00	11,430.00	11,416.00	11,545.00	11,787.00	11,596.00	12,399.00	11,946.00	12,095.00
Combined capital ratio	15.7%	16.5%	16.9%	15.7%	15.8%	16.2%	17.0%	16.0%	17.6%	17.2%	17.6%
CE11 ratio	13.7%	14.4%	14.8%	13.4%	13.8%	14.1%	14.8%	13.9%	14.6%	14.1%	14.4%
Average risk weight	47.3%	50.4%	48.7%	49.2%	50.4%	48.4%	46.8%	47.6%	45.2%	45.4%	48.9%
Combined capital requirement	8.8%	9.7%	9.5%	10.0%	10.0%	10.1%	10.0%	10.4%	10.3%	10.3%	10.3%
Capital buffer	6.9%	6.8%	7.4%	5.7%	5.8%	6.1%	7.0%	5.6%	7.3%	6.9%	7.3%

Source: Sydbank's quarterly financial reports Q1 2013 to Q3 2015

Table 9.5: Sydbank's capital requirements 2015-2019

	2015	2016	2017	2018	2019
Minimum capital requirement	8.0%	8.0%	8.0%	8.0%	8.0%
Pillar 2 requirement	2.1%	2.1%	2.1%	2.1%	2.1%
SIFI buffer	0.2%	0.4%	0.6%	0.8%	1.0%
Capital conservation buffer	0.0%	0.6%	1.3%	1.9%	2.5%
Countercyclical buffer	0.5%	1.0%	1.5%	2.0%	2.5%

Source: Sydbank's financial reports

Table 9.6: Results of the K-model for Sydbank

	Calc 1	Calc 2	Calc 3	Calc 4	Calc 5	Calc 6	Calc 7	Calc 8	Calc 9	Calc 10	Calc 11
Sydbank: total value of assets, $V = \text{DKK } 141 \text{ bn}$ , value of risk-weighted assets, $RWA = \text{DKK } 69 \text{ bn}$											
$\sigma$	9.2%	9.2%	9.2%	9.2%	7.1%	11.3%	9.2%	9.2%	9.2%	9.2%	9.2%
$\tau$	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%
$r$	0.05%	0.50%	100%	2.00%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%
$\omega$	25%	25%	25%	25%	25%	25%	10%	50%	25%	25%	25%
$\underline{z}$	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
CCR	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%	13.6%	16.1%	10.3%
$\rho$	48.89%	48.9%	48.9%	48.9%	48.9%	48.9%	48.9%	48.9%	48.9%	48.9%	48.9%
C/r	111	114	115	117	116	106	111	111	110	109	111
v	141	141	141	141	141	141	141	141	141	141	141
Eq	30	27	26	24	25	34	30	30	31	32	30
Eq/V	21.23%	19.00%	18.17%	17.19%	17.80%	24.46%	21.20%	21.29%	21.75%	22.52%	21.03%
Eq/RWA	43.42%	38.87%	37.16%	35.46%	36.41%	50.02%	43.37%	43.54%	44.48%	46.07%	43.01%
EqM	30	27	26	24	25	34	30	30	31	32	30
EqM/V	21.23%	19.03%	18.21%	17.28%	17.80%	24.46%	21.21%	21.29%	21.75%	22.53%	21.03%
EqM/RWA	43.42%	38.91%	37.25%	35.34%	36.41%	50.02%	43.37%	43.54%	44.48%	46.07%	43.02%
Eq/RWA-CCR	33.12%	28.57%	26.86%	24.86%	26.11%	39.72%	33.07%	33.24%	30.88%	29.97%	32.71%
EXP	29,145	337,404	715,355	1,501,618	22,283	35,255	30,036	27,089	15,112	5,371	37,321
RN	2.511	24,986	50,291	99,943	2,708	2,415	1,034	4,688	16,569	26,596	3,170
TB	3,052,255	31,346,353	63,253,501	127,668,528	3,185,062	2,927,215	3,053,202	3,049,984	3,032,187	3,002,074	3,894,564
CSD	3,020,599	30,983,963	62,487,855	126,066,968	3,160,072	2,889,545	3,022,182	3,018,207	3,000,506	2,970,107	3,854,074
Eq/RWA-NR	26.16%	25.96%	25.74%	25.29%	22.90%	29.15%	26.16%	26.16%	26.16%	26.16%	26.16%
Optimal book capital ratio in terms of risk-weighted assets if no rest.											

Figure 9.5: Sydbank's expropriation costs

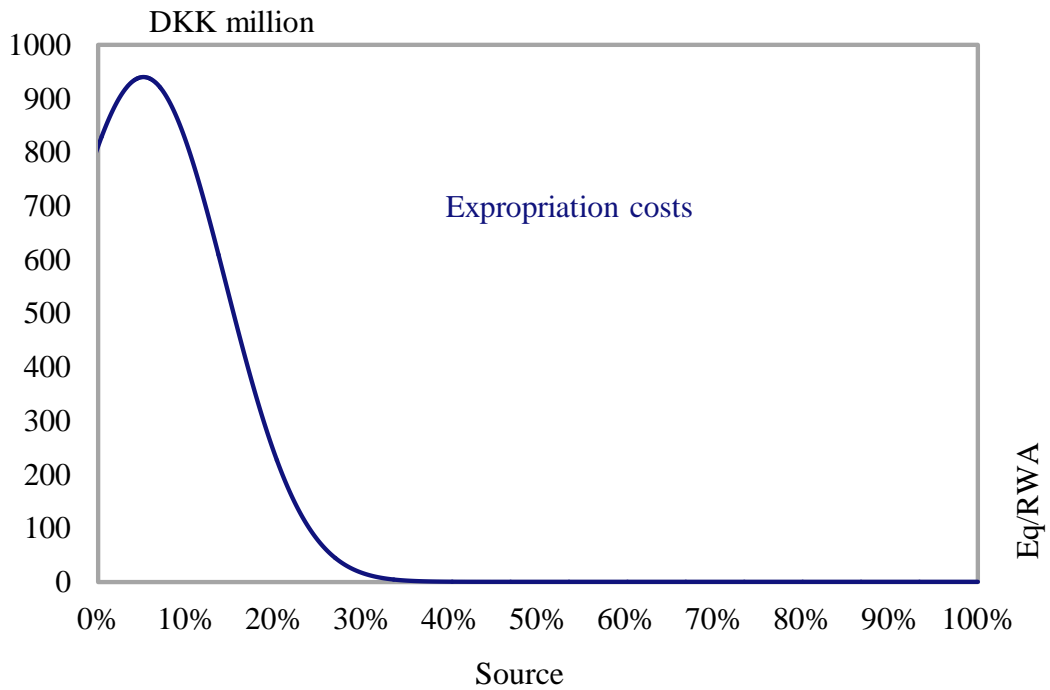


Figure 9.6: Sydbank's regulatory non-compliance costs

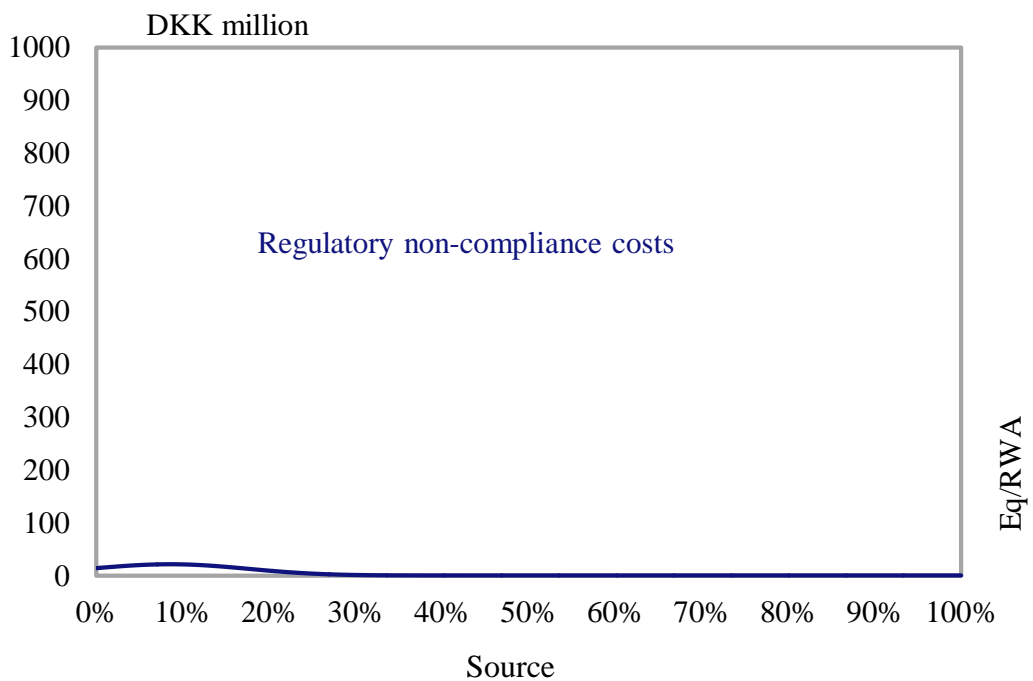


Figure 9.7: Sydbank's tax benefits

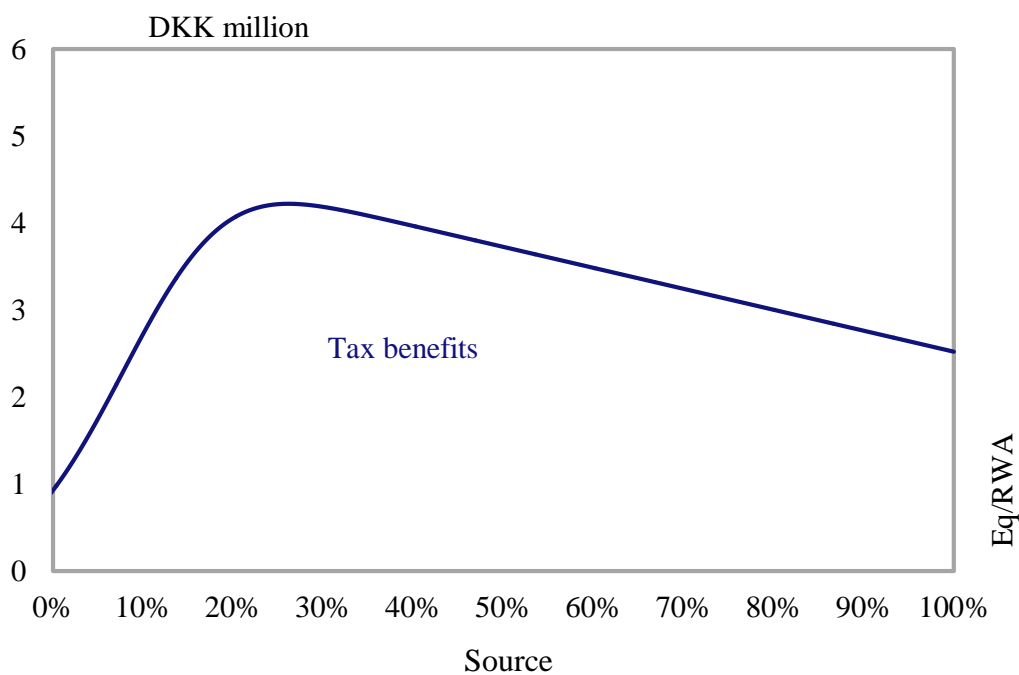
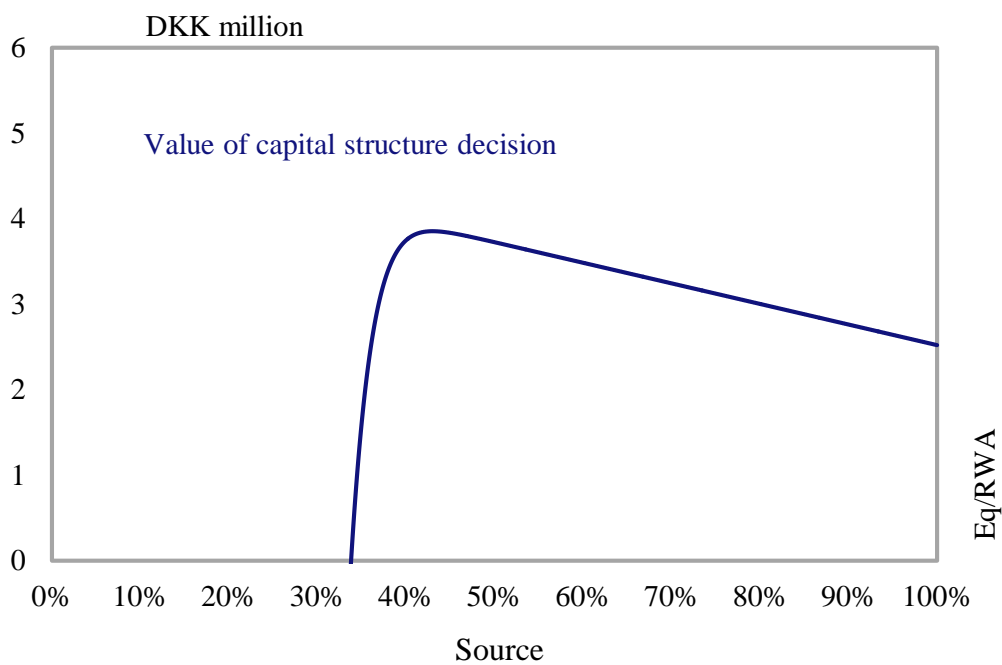


Figure 9.8: value of Sydbank's capital structure decision



## 9.4 Appendix 4: Jyske Bank

Table 9.7: Jyske Bank's capital ratios

DKK million	Q1 2013	Q2 2013	Q3 2013	Q4 2013	Q1 2014	Q2 2014	Q3 2014	Q4 2014	Q1 2015	Q2 2015	Q3 2015
Assets	260,797.00	248,285.00	250,263.00	262,004.00	257,428.00	493,577.00	521,140.00	541,679.00	573,076.00	541,031.00	531,063.00
RWA	114,640.00	110,422.00	111,921.00	111,276.00	116,885.00	174,772.00	173,601.00	176,433.00	178,841.00	176,979.00	174,853.00
Capital	17,146.00	17,255.00	17,597.00	17,831.00	18,928.00	28,578.00	28,986.00	28,990.00	29,206.00	30,177.00	29,473.00
Combined capital ratio	15.0%	15.6%	15.7%	16.0%	16.2%	16.4%	16.7%	16.4%	16.3%	17.1%	16.9%
CET1 ratio	13.7%	14.6%	14.8%	15.3%	15.1%	15.3%	15.7%	15.1%	15.3%	16.1%	15.8%
Average risk weight	44.0%	44.5%	44.7%	42.5%	45.4%	35.4%	33.3%	32.6%	31.2%	32.7%	32.9%
Combined capital requirement	9.7%	9.9%	10.0%	9.8%	10.0%	10.4%	10.7%	10.9%	11.0%	11.3%	11.0%
Capital buffer	5.3%	5.7%	5.7%	6.2%	6.2%	6.0%	6.0%	5.5%	5.3%	5.8%	5.9%

Source: Jyske Bank's quarterly financial reports Q1 2013 to Q3 2015

Table 9.8: Jyske Bank's capital requirements 2015-2019

	2015	2016	2017	2018	2019
Minimum capital requirement	8.0%	8.0%	8.0%	8.0%	8.0%
Pillar II requirement	2.7%	2.7%	2.7%	2.7%	2.7%
SIFI buffer	0.3%	0.6%	0.9%	1.2%	1.5%
Capital conservation buffer	0.0%	0.6%	1.3%	1.9%	2.5%
Countercyclical buffer	0.5%	1.0%	1.5%	2.0%	2.5%

Source: Jyske Bank's financial reports and Capital and Risk Management reports



Table 9.9: Results of the K-model for Jyske Bank

Jyske Bank: total value of assets, $V = \text{DKK } 531 \text{ bn}$ , value of risk-weighted assets, $\text{RWA} = \text{DKK } 175 \text{ bn}$												
	Calc.1	Calc.2	Calc.3	Calc.4	Calc.5	Calc.6	Calc.7	Calc.8	Calc.9	Calc.10	Calc.11	
$\sigma$	10.1%	10.1%	10.1%	10.1%	6.9%	13.3%	10.1%	10.1%	10.1%	10.1%	10.1%	10.1%
$\tau$	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	28.0%
$r$	0.05%	0.50%	10.0%	2.00%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%
$\omega$	25%	25%	25%	25%	25%	25%	10%	50%	25%	25%	25%	25%
$\lambda$	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
CCR	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	14.7%	17.2%	11.0%	11.0%
$\rho$	32.93%	32.93%	32.93%	32.93%	32.93%	32.93%	32.93%	32.93%	32.93%	32.93%	32.93%	32.93%
C/r	419	433	438	444	446	395	419	419	417	414	414	420
v	531	531	531	532	531	531	531	531	531	531	531	531
Eq	112	98	93	87	85	136	112	112	114	117	117	111
Eq/V	21.07%	18.47%	17.50%	16.38%	16.03%	25.65%	21.03%	21.16%	21.49%	21.99%	21.99%	20.84%
Eq/RWA	64.00%	56.09%	53.16%	49.75%	48.68%	77.89%	63.88%	64.26%	65.27%	66.80%	66.80%	63.28%
EqM	112	98	93	87	85	136	112	112	114	117	117	111
EqM/V	21.07%	18.49%	17.55%	16.47%	16.03%	25.65%	21.03%	21.16%	21.49%	22.00%	22.00%	20.84%
EqM/RWA	64.00%	56.16%	53.30%	50.02%	48.69%	77.90%	63.89%	64.27%	65.28%	66.81%	66.81%	63.29%
EqM/RWA-CCR	53.00%	45.09%	42.16%	38.75%	37.68%	66.89%	52.88%	53.26%	50.57%	49.60%	49.60%	52.28%
EXP	124,122	1484,407	3,132,973	6,546,012	83,504	16,142	129,545	115,139	78,470	44,365	44,365	160,016
RN	11,594	122,450	247,743	494,990	11,730	12,054	4,830	2,122,3	58,212	9,035	9,035	14,771
TB	11,525,174	18,896,684	240,245,637	485,554,256	12,261,826	10,857,256	11,530,934	11,512,692	11,464,191	11,390,687	11,390,687	14,712,383
CSD	11,389,458	17,289,827	236,864,920	478,513,254	12,166,592	10,684,061	11,396,559	11,378,330	11,327,509	11,255,288	11,255,288	14,537,596
Eq/RWA_NR	37.30%	37.00%	36.67%	36.00%	29.92%	43.78%	37.30%	37.30%	37.30%	37.30%	37.30%	37.30%
Optimal book capital ratio in terms of risk-weighted assets if no regu												

Figure 9.9: Jyske Bank's expropriation costs

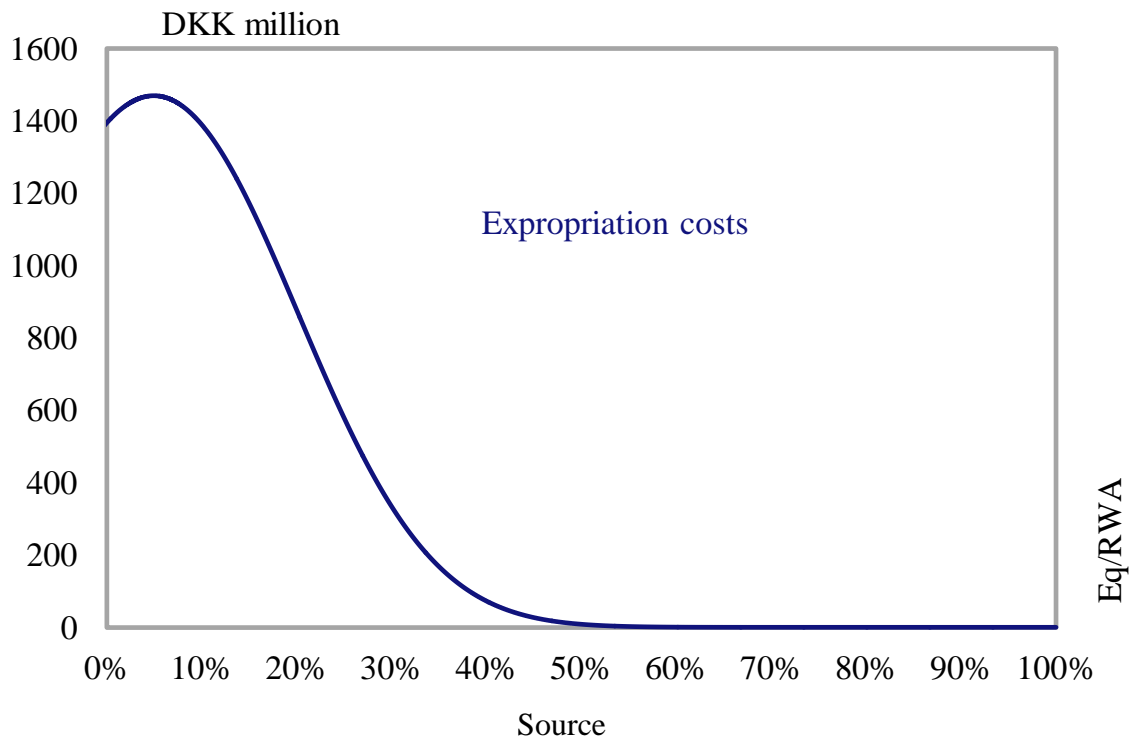


Figure 9.10: Jyske Bank's regulatory non-compliance costs

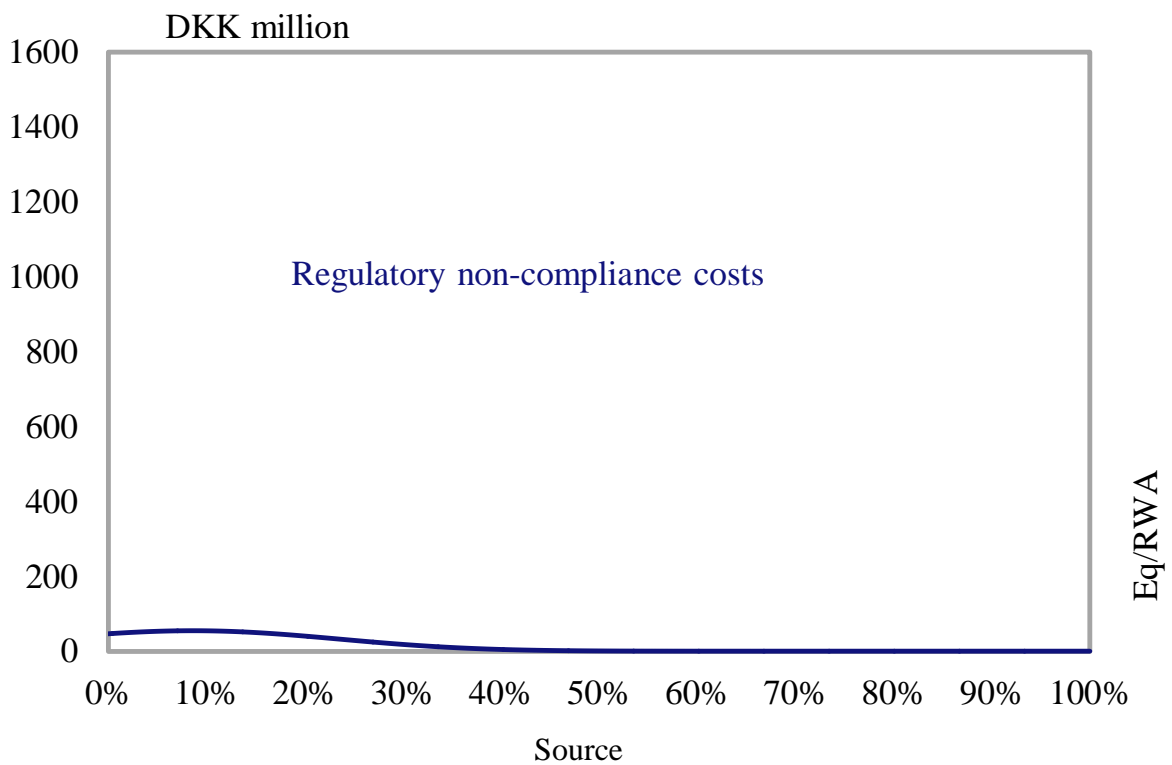


Figure 9.11: Jyske Bank's tax benefits

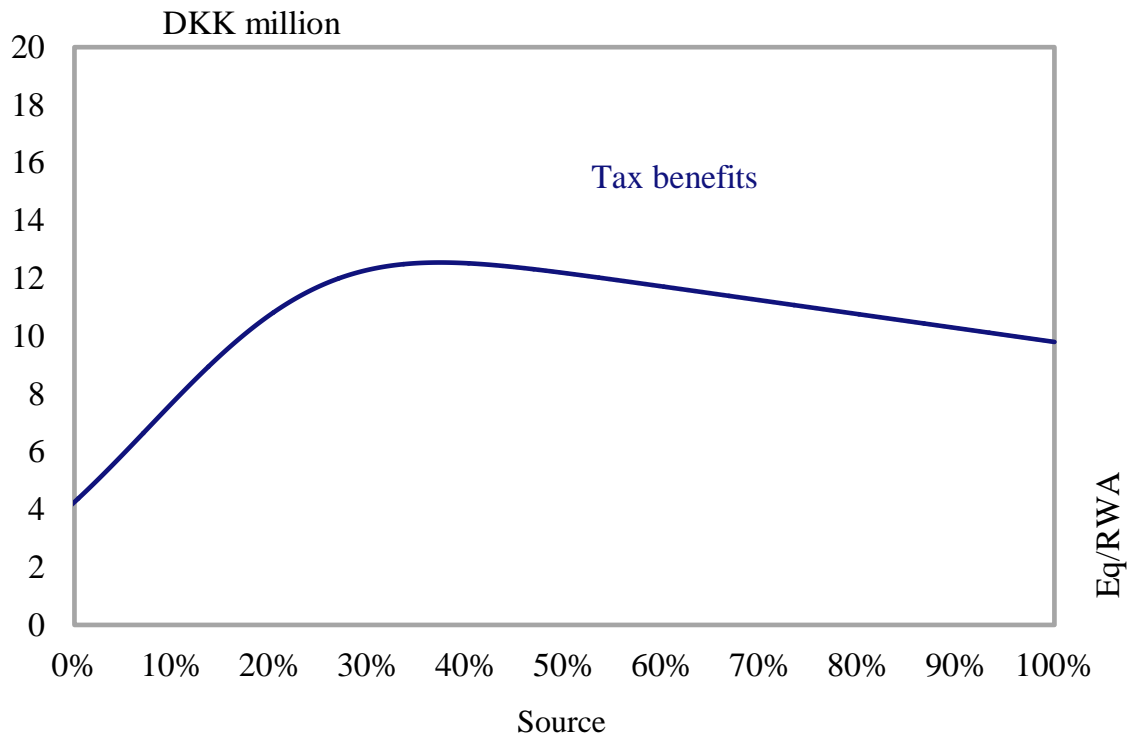


Figure 9.12: value of Jyske Bank's capital structure decision

