

BALANCE SHEET OPTIMIZATION TOOL

Under the Basel III framework

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Abstract

Balance Sheet optimization tool – Under the Basel III framework

The most recent regulatory framework implemented by the Basel Committee on Banking Supervision (BCBS) was introduced as an incentive to enhance market discipline and supervisory power of the regulatory authorities. However, these changes seem to challenge financial institutions in structural aspects that could negatively impact the profit efficiency. This paper tries to fill this risk management role need by presenting a customized tool that enables banks to effectively manage their balance sheet, while taking into account the constraints required by Basel III.

Following that, this paper also investigates the impact of the Basel III requirements on several parameters and finishes with two types of impact studies. The first type addresses the banking regulatory requirements and the second performs stress tests.

The study used real data of a Portuguese commercial bank named through the paper as ‘Bank I’.

Our results suggest that the tool manages to significantly improve the profitability of ‘Bank I’ while making it compliant with the Basel III framework by finding its optimal balance sheet composition. It also shows that both capital and liquidity requirements have a negative impact on the retained profit. Concerning the results taken from the stress tests we conclude that higher restrictions influence negatively the retained profit and that under certain stress scenarios ‘Bank I’ would present worryingly high losses.

The tool does not capture the cost of changing the composition of the balance sheet, even though that would provide relevant information.

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Preface

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PART I

1.1 - Introduction

The last financial crisis (late 2007) exposed several weaknesses in the overall banking system. The regulatory framework implemented at that time proved to be insufficient for banks to absorb unexpected losses in certain situations of financial distress. For that reason, in December 2010, the regulatory authorities (Basel Committee on Banking Supervision - BCBS) introduced “*Basel III: A global regulatory framework for more resilient banks and banking system*” and a consultation document, with a later revision on June 2011. The documents gave a new set of revisions and norms to further complement the regulatory system, in order to increase effectiveness where the previous regime failed.

The major focus of the enhanced rules are, firstly, the establishment of stricter capital standards through more restrictive capital definitions, higher weights on the risk weighted assets (RWA) computation, higher minimum capital requirements, and two additional capital buffers. Secondly, it aims to strengthen liquidity rules by imposing two liquidity ratios.

“Increased capital requirements, (...) and deal with the regulatory reform will put pressure on margins (...). Investor returns will likely decrease at a time when firms need to encourage enhanced investment to rebuild and restore buffers.”¹

As mentioned in the citation above extracted from a consultative document, and as various other studies demonstrate², the implementation of such rules will be a challenge to the banking industry, as it will foment pressure on a bank’s profitability and return on equity.

Among the different businesses in which banks operate (retail, commercial, insurance etc.), the capital market operations will be the most affected. Stricter capital requirements, will undoubtedly impact sales and trading activities, as well as all the others areas connected to it such as securitizations and OTC³ derivatives.

¹ “*Basel III: Issues and implication*” (KPMG), 2011

² “*McKinsey working papers on risk number 26*”; “*Basel III and Its Consequences*” (Accenture)

³ Over the Counter

The previously mentioned liquidity measures will also impose restrictions on financial institutions as they will have to be able to deal with higher funding costs from the adoption of strategies to limit unstable sources of funding.

Despite all the difficulties financial institutions might have in the forthcoming years, as AN Berger & CHS Bowman (2013)⁴ observe, these measures are seen to be fundamental in order to reduce the probability of insolvency, to maintain financial healthiness, as well as the reliability on the banking industry, and consequently lead to economic stability.

However, it is important to mention that theory provides conflicting opinions regarding the positive correlation between capital requirements and risk reduction in banking. As Blum (1999)⁵ argues, capital requirements may increase risk-taking behaviors:

“If raising equity is excessively costly, the only possibility to increase equity tomorrow is to increase risk today”.

Financial institutions will have to be able to balance shareholder’s demands and expectations, as well as the requirements of supervisory authorities, forcing them to look for a good equilibrium between solvency, liquidity and profitability.

Therefore, there is an urge for banks to evaluate the impact of the framework on their structure through capital planning and optimization processes. Institutions will have to reassess their operational, strategic and financial management structures to obtain their optimal balance sheet mix. Further, there should be an emphasis on organic capital generation within the transition along the years of implementation of Basel III rules, as well as on strategies to manage RWA’s.

How should the optimal balance sheet composition of a bank be, in order to maximize its returns, while making it compliant with the Basel III framework?

As the banking industry has shown an impressive evolution over the last decades, and being the financial crisis a very recent event, there is a clear lack of available material on this topic. This study intends to further contribute to existing literature on the subject by presenting a customized modeling tool that enables each financial institution to effectively manage its balance sheet, while taking into account not only the constraints required by the new framework presented in Basel III but also its specificities, risk profile and strategic objectives.

⁴ “How does capital affect bank performance during financial crises”- Allen N. Berger, Christa H.S. Bouwman - Journal of Financial Economics, 2013

⁵ “Do capital adequacy requirements reduce risks in banking?”- Blum, Journal of Banking & Finance 23 (1999)

The tool contains a balance sheet optimization stochastic model which is used for optimization and simulation purposes. The tool is customized so that it could be adapted to each financial institutions' specifications, such as its dimension, core business as well as its economic situation.

The data used consisted on the financial figures of a Portuguese commercial bank for the year of 2013, named 'Bank I' for confidential purposes. Observing the outcomes of the model, it can be concluded that it manages to propose a balance sheet composition that increases the profitability of 'Bank I', while making it compliant with the requirements imposed by the Basel III framework.

This paper is structured as follows. Part II introduces the reader to the topic by describing the current situation of the banking industry and its regulation of the last years. Part III is divided in four sections and describes the model and results. Section I, describes the components of the model, Section II gives insights about the optimization technique. Section III explains the data and assumptions the model relied on. Section IV presents the results of the simulation and the results of the two impact studies. Finally, Part IV presents the concluding remarks and suggestions for further research on this topic. The annexes serve as a complement of additional information to respect confidentiality of the data and also to help the reader understand the components of the model.

PART II

2.1 – Financial crisis: Antecedents

Liquidity in financial markets was a major problem during the crisis of late 2007.

To analyze the main causes of this event, two perspectives are explored, namely the two sides of a trade process. The “buy-side” and the “sell-side”.

The greater stability preceding the 2007 crisis (Blanchard & Simon (2001)⁶, Dalsgaard & Jørgen Elmeskov (2002)⁷), is likely to have given a naïve sense of reduced risk to investors, which probably increased the appetite on the “buy-side” for riskier financial instruments and leverage. Adding to that, a number of potentially destabilizing events such as the LTCM collapse, the Eastern Europe and Asian crises, the dot-com bubble of 2000; and the 9/11 attack, were overcome amazingly quickly.

Still on the “buy-side”, arbitrageurs and investors leveraged their investments using collateralized borrowings from brokers who set margins as collateral to keep within their Value at Risk measure (VaR). In a margin account, the broker can re-evaluate its position and sell the securities locking the losses of the investor, in case stock prices decline aggressively. The investor, who will not be able to participate in any eventual future rebound of the stock, is confronted with funding liquidity risk.

On the “sell-side”, in the first instance, banks developed methodologies to engage in regulatory arbitrage, by grouping certain types of assets (structured asset-backed securities – ABS) and by selling them as a package to other financial institutions or private investors, spreading these risky instruments among the institutions that compose the financial market. The ABS contained different types of loans, mortgages, receivables, bonds and etc., so that banks could take advantage of having much less regulatory capital required to keep securitized debt instruments than they would have for holding the assets themselves.

⁶ “Ongoing changes in the business cycle – evidence and causes”- Thomas Dalsgaard, Jørgen Elmeskov and Cyn-Young Park - SUERF, 2002

⁷ “The Long and Large Decline in U.S. Output Volatility”- O Blanchard, J Simon - Brookings papers on economic activity, 2001

Financial institutions were therefore extremely leveraged with debt, and “*contrary to intuition, empirical evidence has shown that bank leverage rises during boom times and falls during downturns. (...) the expansion and contraction of the balance sheet amplify rather than counteract the credit cycle*”⁸ (pro-cyclicality of leverage). In other words, financial institutions manage their leverage using collateralized borrowings and lending, hence, monetary policy has an impact in how the bank’s balance sheet grows as it “*anticipates the potential disorderly unwinding of leverage*”⁹. The balance sheet of financial institutions contracts when monetary policy is “tight”, reducing the liquidity. On the contrary, when monetary policy is “loose”, financial institutions tend to expand their balance sheets, increasing the liquidity supply.

The purchase of ABS was commonly hedged by buying credit default swaps (CDS), which is a protection against the default of the asset.

While institutions became holders of this securitized debt instruments, and as market participants held an excessive amount of CDS against the default of the assets, institutions had a huge exposure to wrong way risk, which could easily “blow up” in a situation of financial distress.

Thus, financial institutions had much exposure between themselves and were much more exposed to structured financial instruments.

Secondly, the desynchronization between the maturity of inflows and outflows of financial institutions, known as maturity mismatch¹⁰, induces funding liquidity risk. This mismatch occurs because the big part of the assets of a bank has greater maturity than its debt instruments, making them to be repeatedly refinanced. Many banks were engaging in funding strategies that relied on short term funding, increasing their exposure to funding liquidity risk.

As referred by Kashyap et al. (2008)¹¹, it is difficult to tell whether an investor/financial manager is generating true risk adjusted excess returns, or whether the current returns are simply compensation for a risk that is higher than assessed, especially with new financial instruments.

As it turns out, there were misleading proxies for risk assessment before the crisis that were not able to capture the true risk of these financial products.

⁸ “*The LR world bank: A New Binding Limit on Banks*”- Katia D’Hulster (2011) - The worldbank

⁹ “*Financial intermediaries, financial stability, and monetary policy*”- T Adrian & HS Shin (2008) - FRB of New York Staff Report

¹⁰ For more detail see: “*Collective moral hazard, maturity mismatch and systemic bailouts*” - Emmanuel Farhi, Jean Tirole (2009) - nber.org

¹¹ “*Rethinking Capital Regulation*”- Anil K Kashyap, Raghuran G. Rajan and Jeremy C. Stein (2008), pg 7

Having that, it was just a matter of having a financial stress situation to trigger the blow up of the imbalances. The trigger was “*an increase in subprime mortgages defaults*”¹² and the increase of interest rates, which made homeowners unable to meet their financial obligations, plumping even more house prices. For more details about the causes of the most recent financial crisis see Acharya et al. (2009)¹³

While banks had much exposure to maturity mismatch between their assets and debt instruments, and were highly leveraged with debt, the uncertainty and the substantial increase on mortgages defaults led bank’s funding sources to exhaust, finding themselves short on cash to meet their obligations. An amplified domino effect was produced instantly, ending with the collapse of the stock market. Many central banks and governments injected great amounts of liquidity in institutions for the sake of financial stability.

2.2 - Basel Framework

2.2.1 - BIS

The Bank for International Settlements (BIS) is the oldest financial organization and helps central banks in their pursuit of monetary and financial stability. Its role is to promote communication between them and to conduct research on policy effects on issues confronting central banks and financial supervisory authorities.

Along with ten central banks from Belgium, Canada, France, Italy, Japan, the Netherlands, the United Kingdom, the United States Germany and Sweden, the BIS established a committee called Basel Committee on Banking Supervision (BCBS) that would function as a forum that would meet every three months for regular cooperation on banking supervisory matters, as well as to propose the regulatory framework needed to have financial stability.

“The economic, monetary, financial and legal research of the BIS supports its meetings and the activities of the Basel-based committees. The BIS is also a hub for sharing statistical information

¹² “*Deciphering the liquidity and credit crunch 2007-08*”; Markus K. Brunnermeier (2008) – NBER papers

¹³ “*The Financial Crisis of 2007-2009: Causes and Remedies*”- V Acharya, T Philippon, M Richardson and N Roubini (2009)

amongst central banks, and for publishing statistics on global banking, securities, foreign exchange and derivatives markets."¹⁴

Therefore, this organization is very important to the financial system's health, since it regulates capital adequacy of banks and encourages transparency.

The Committee is further sub-divided in four divisions:

Standards Implementation Group (SIG), Policy Development Group (PDG), Accounting Task Force (ATF), Basel Consultative Group (BCG), in which each has specific task forces to work on.

In the majority of European countries, these binding capital rules are presented in the Capital Requirements Regulation and Directive (CRD IV), which is the EU implementation of Basel III and applies to banks and investment firms.

Along the years of existence, the BCBS became the main structure for influencing banking supervisory standards.

2.2.2 - Regulatory History

There are important intentions in having directives in the banking industry. Since financial institutions provide several vital services to the economy of the respective country/region, they are highly regulated. The increasing integrity of financial global financial markets and the reliance that economies hold on banks, makes it imperative for regulatory organizations to maintain control over certain practices of these institutions.

Other motivations supporting the need of banking regulation are related to asymmetric information and its consequences, such as adverse selection and moral hazard between financial institutions and depositors. As bank debt is mainly held by a great number of small depositors, without a representative of depositors that would monitor their activities, banks would have freedom with their funding to perform highly risky investments.

Regulatory capital requirements for financial institutions are part of a broader set of measures used in banking prudential regulation and we have seen that financial regulation and supervision have an important role in maintaining integrity in the financial system, giving market confidence (liquidity

¹⁴ www.bis.org site

role), and investors protection. Due to the measures imposed along the years of existence, financial regulation has also influenced the structure of the banking system.

Bank regulation pursues in implementing capital and liquidity requirements, reserve requirements, corporate governance, financial disclosure requirements, credit rating requirements, risk exposures quantification, activity and affiliation restrictions.

2.2.3 - Basel I

Basel I was the first Basel accord presented by the BCBS in 1988 (and effective on 1992) with the goal to create a level playing field for “*internationally active banks*”. The focus was on credit risk and in preventing international banks from building business volume without adequate capital backing, meaning that banks from different countries competing for the same loans would have to set aside roughly the same amount of capital in the loans.

Hence, this accord was welcomed for incorporating risk into the calculation of capital requirements.

Cooke Ratio. This ratio named after Peter Cooke (Bank of England and chairman of BCBS at that time), informed that each bank must maintain a total risk-weighted capital ratio of at least 8%, in which the weights attributed to each asset depended on the institutional nature of the borrower.

The capital amount to compute this ratio was composed by Tier 1, composed by the shareholder’s equity and retained profits, and Tier 2, composed by additional resources. The minimum amount of Tier 1 capital should be 50% of the total capital.

The Basel I accord grouped assets into four risk weights classes (below).

Asset Type	Risk Weight Attributed
Cash	0%
Government security (OECD)	
Interbank Loans (OECD)	20%

Secured loans by residential properties	50%
Corporate Loans	100%

Table 1: Basel I - Standardized Approach Risk weights per class

$$Total\ RWA = \sum_{i=1}^n (Asset\ (i)exposure * Risk\ Weight(i)) \quad With\ i = 1, 2, 3 \dots n$$

Being fairly simple to monitor, as it applied to all loans of a particular category, the costs incurred in its computations were little. However, this simplistic categorization that for example did not distinguish between loans of very different degrees of credit risk, did not reflect the “real” risk a certain borrower actually possessed which caused banks, and its depositors, being in more risky positions than accounted for. Adding to that, this accord did also not account for other type of more complex instruments. Especially for investment banks, their operations relied a lot on sales and trading and the exposure to this type of complex financial instruments was not captured by the Basel I standards, whether risky or not. Financial institutions exploit variances between a portfolio’s “real” risk and the risk measured by the regulation, known as regulatory capital arbitrage (RCA). As Jones (2000)¹⁵ referred, RCA has challenged the effectiveness of Basel I as the capital ratios became no longer reliable measures of capital adequacy.

Ignoring the risks not evaluated by the standards, only promoted an underestimation of the risks incurred by the financial institution.

2.2.4 - Basel II¹⁶

¹⁵ “Emerging problems with the Basel Capital Accord: regulatory capital arbitrage and related issues” – D Jones, (2000)

¹⁶ See “The new basel capital framework and its implementation in the European union” – F Dierick, Fatima Pires, Martin Scheicher, and Kai Gereon Spitzer (2005), page 9, for a detailed chronology of the Basel II process

Aware of the inaccuracy of the framework established in that time, the BCBS issued a consultative paper to address the major limitations of Basel I (June 1999) and Basel II. However, this accord was only finally published in 2004 and planned to be implemented from 2006.

First, the Committee pointed out that Basel I was able to achieve certain goals needed to a more robust financial system:

“The Committee believes the 1988 Accord and subsequent additions and amendments have helped to strengthen the soundness and stability of the international banking system and have enhanced competitive equality among internationally active banks. (...)The widespread adoption of the Accord in many countries has contributed to achievement of the objective of competitive equality¹⁷”

However, they also highlighted three important existing flaws¹⁸:

- 1- *“However, the financial world has (...) evolved significantly (...) to the point where a bank’s capital ratio, calculated using the current Accord, may not always be a good indicator of its financial condition. The current (...) degrees of credit risk exposure are not sufficiently calibrated as to adequately differentiate between borrowers’ differing default risks”*
- 2- *“(…) ability of banks to arbitrage their regulatory capital requirements and exploit divergences between true economic risk and risk measured under the Accord. Regulatory capital arbitrage can occur in several ways, for example, through some forms of securitization, and can lead to a shift in banks’ portfolio concentrations to lower quality assets”*
- 3- *“(…) the Accord does not provide the proper incentives for risk mitigation techniques. For example, there is only minimal capital relief for collateral, and in some cases, the Accord’s structure discourages the use of credit risk mitigation techniques”*

This new framework dealt with one of the key flaws of Basel I already referred. It finally addressed the capital requirements needed in function of its risk weighted assets (RWA’s). Both the class of the borrower (retail, financial firms, non-financial corporations etc.) and the particular risk of each counterparty within a class, would determine the risk weight used to compute the capital required to be in compliance with the accord.

¹⁷ BIS – Consultative Paper – June 1999, page 8, paragraph 5

¹⁸ BIS – Consultative Paper – June 1999, page 8, paragraph 6, 7 ,8

Basel II was built upon **three Pillars**:

PILLAR I. MINIMUM CAPITAL REQUIREMENTS

It points out the capital requirements given a calculated amount for three types of risk:

Credit risk, operational risk and market risk.

A. Credit Risk.

According to Basel II rules, banks may adopt one of the two following approaches to compute their minimum capital requirements for credit risk:

The Standardized Approach (SA)

Under this approach, each asset exposure (amount) is given a risk weight. The sum of all the risk weighted exposures gives the total RWA of the institution. The risk weight is based on an external rating institution's assessment of the counterparty risk.

This approach seems to rely on a non-realistic assumption, as in many countries no external ratings exist for several corporate loans. Therefore, capital charges for loans to unrated companies remain unchanged compared to Basel I¹⁹.

The Internal Rating Based approach (IRB)

Under this approach, each risk weight is calculated as a function of four different parameters:

Paramete Description	
PD	Borrower's Probability of Default
LGD	Percentage of loss over exposure amount in case of default
EAD	Gross exposure under a facility upon default of an obligor
M	Maturity of asset the exposure

Table 2: Basel II-Parameters within IRB approach

Additionally, banks could choose between the 'Foundation' and the 'Advanced' variants. While using the first variant, they were obliged to disclose the first parameter (Probability of Default) obtained by their internal methods. The other three parameters would be set out by the regulatory authorities. On the other hand, financial firms could adopt the 'Advanced' variant, in which they

¹⁹ See "Bank size and risk-taking under Basel II" - Hakenes and Schnabel(2006), page 4, for more detailed information about limitations on using the Standardized Approach

had to collect sufficient data on loans to develop a method for rating them within various portfolios. Therefore, they would be responsible for developing and disclose the four parameters obtained from their own internal computations.

This requires highly complex modelling and offers the financial institutions with the necessary expertise the possibility of deriving more risk sensitive weights.

By observing the simplistic example given in Appendix 1 of this document, it can be understood the purpose Pillar I tries to achieve by setting a much greater amount of required capital in loss-prone loans (risky loans) than those carried out by lower risk loans.

As it would be expected, not every financial firm would be qualified to adopt the IRB approach (especially the AIRB), as Basel II provides a list of minimum requirements to be fulfilled and its adoption would be accompanied by increased costs (staff, technology, recruitment & education etc.). Nevertheless, banks have incentives to use this approach as essentially its adoption would imply lower capital requirements²⁰. This was captured, under certain conditions (bull market conditions and for the sample used), by the studies issued by the BCBS on 2006 (Quantitative Impact Study 5), in which they conclude that for the sample used, the capital requirements under the IRB, and especially the AIRB, compared to those under Basel I framework, are significantly lower.

B. Operational Risk²¹

“Operational Risk is not a new risk... However, the idea that operational risk management is a discipline with its own management structure, tolls and processes... is new.” (British Bankers Association website)

There are many definitions for operational risk²². Essentially, it is the risk of loss resulting from internal processes, people, systems and models or from external events like legal risks, excluding the market, credit, liquidity, strategic and reputational risks.

There are three methods that could be used:

- i) Basic Indicator approach: the required capital is 15% of the bank's three-year average gross income. It is the simplest approach.

²⁰ See *“Bank size and risk-taking under Basel II”* - Hakenes and Schnabel (2006) and *“Loan pricing under Basel capital requirements”*- Rafael Repullo and Javier Suarez (2003), page 3, for more information

²¹ Operational risk events can be quite expensive. Citibank and JP Morgan Chase suffered large losses from Enron and MCI, the Royal Bank of Scotland took a large fraud loss from their subsidiary All First Financial

²² *“The invention of operational risk”* - M Power (2005) ; for more detailed information

- ii) Standardized Approach: it distinguishes eight different business lines in which each receives the respective risk weight. Meant for somewhat more sophisticated banks.
- iii) Advanced Measurement Approach: it contains the use of four data elements. External loss data, internal, scenario analysis and business environment and internal control factors. It must be approved by the national supervisor and it is made for banks that use the IRB approach to evaluate credit risk.

C. Market Risk

“Market risk is defined as the risk of losses in on and off-balance sheet positions arising from movements in market prices. The risks subject to this requirement are:

- *the risks pertaining to interest rate related instruments and equities in the trading book;*
- *foreign exchange risk and commodities risk throughout the bank”* (BIS, 1996, page 1)

It is mandatory for financial institutions to disclose certain information to other market participants about their risk profiles and regulatory capital procedures. The preferred approach used is the Value at Risk (VaR) or the more complex Conditional Value at Risk (CVaR)²³.

This type of risk in the Pillar I of Basel II is computed in the same manner as under Basel I and remained unchanged.

The complexity of Pillar I of Basel II resides on the fact that banks have many different asset classes that require different treatment. Minimum standards must be established for rating system design, including testing and documentation requirements.

PILLAR II. SUPERVISORY REVIEW PROCESS

It focuses on supervisory oversight. It requires supervisors to review a bank’s capital adequacy assessment process, which may indicate a higher capital requirement than Pillar I minimums.

PILLAR III. MARKET DISCIPLINE

It looks at market discipline and public disclosure by setting out requirements on banks to publish information about their risk exposure, risk management, and other more strategic information disclosures.

Conclusion on Basel II.

²³ *“Optimization of Conditional Value-at-Risk”*- R Tyrrell Rockafellar & Stanislav Uryasev (1999)

Basel II lays down a more comprehensive measure and minimum standard for capital adequacy. It seeks to improve on existing rules by aligning regulatory capital requirements more closely to underlying risks that banks face. Finally, it attempts to fix some of the problems from the original accord by defining risk more accurately.

2.2.5 - Basel III

“The objective of the reforms is to improve the banking sector’s ability to absorb shocks arising from financial and economic stress, whatever the source, thus reducing the risk of spillover from the financial sector to the real economy. This document sets out the rules text and timelines to implement the Basel III framework.”²⁴”

In response to the current crisis beginning in 2007, in 2012 the Basel Committee issued the consultative document entitled “*Strengthening the Resilience of the Banking Sector*” commonly referred as Basel III and the “*International Framework for Liquidity Risk Measurement, Standards and Monitoring*”.

This framework was to be implemented from 2013 to 2019.

The financial firms were unable to absorb the unexpected losses observed in the capital markets. Hence, sudden changes in asset quality and value quickly wiped out the bank’s capital. Adding to that, the interconnectedness of institutions, the already referred maturity mismatch between liabilities and assets, and the pro-cyclical deleveraging effect accelerated the decline of the asset’s value.

Before Basel III, the regulation did not account the pro-cyclical effect. This subject is developed in the following section.

In terms of the strengthening of the capital framework, the new rules update the three pillars of the previous regime upon five different aims:

1. Raise quality and transparency of the **capital base**

²⁴ “*Basel III: A global regulatory framework for more resilient banks and banking systems*” pg 1 (2010)

Under Basel III the definition of capital will be restricted. The Committee sees as critical that bank's risk exposures are backed by a high quality capital base. Adding to that, inconsistencies in the definition of capital across banks between and within different countries made it merely impossible to the market to compare the quality of capital between financial institutions.

Total regulatory capital will consist on the sum of 'Core Tier 1' capital and 'Tier 2' capital.

- i) Tier 1 Capital
 - a. Common Equity Tier 1 (CET1)
 - b. Additional Tier 1 capital

- ii) Tier 2 capital

There is a single criteria for instruments included on each of the three categories.

Common Equity Tier 1 capital

- Common shares issued by the bank
- Stock surplus (share premium) resulting from instruments issued included in CET1
- Retained profit
- Accumulated other comprehensive income and other reserves
- Common shares issued by consolidated subsidiaries (minority interest) that meet criteria;
- Regulatory adjustments applied in the calculation of CET1

Additional Tier 1 capital

- Instruments issued by bank that meet criteria for Add Tier 1 capital not included in CET1
- Stock surplus (share premium) resulting from instruments issued included in Add Tier1
- Instruments issued by consolidate subsidiaries of the bank and held by third parties that meet the criteria
- Regulatory adjustments applied in the calculation of Additional Tier 1 capital

Tier 2 capital

- Instruments issued by bank that meet criteria for Add Tier 1 capital not included in Tier 1
- Stock surplus (share premium) resulting from instruments issued included in Tier 2
- Instruments issued by consolidate subsidiaries of the bank and held by third parties that meet the criteria
- Certain loan loss provisions²⁶
- Regulatory adjustments applied in the calculation of Additional Tier 2 capital

<i>CET 1</i>	<i>Tier 1</i>	<i>Total Capital</i>	<i>Year</i>
3,5%	4,5%	8,0%	2013
4,0%	5,5%	8,0%	2014
4,5%	6,0%	8,0%	2015-2019

Table 3: Capital phase-in requirements

2. Enhancing risk coverage, particularly the counterparty risk

Under Basel III, financial institutions must add a capital charge to cover mark-to-market counterparty risk losses (Credit Value Adjustments – CVA) for OTC derivatives. Moreover, the Committee is raising counterparty credit risk (CCR) management standards like the treatment of wrong-way risk. These measures along with the other described more profoundly in the official document will create strong incentives for banks to move exposures to such central counterparties (CCPs).

3. Supplementing the risk-based capital requirement with a LR²⁷

Excessive accumulation of on-and-off-balance sheet leverage was other cause for the incapacity of banks to absorb accumulated losses. The needed deleverage process led to a decrease in credit availability in the market.

As a measure to control the excessive leveraging, a leverage ratio (LR) defined by the percentage of own capital per unit of assets was set at 3%, hence, a bank's total assets (both on-and-off-balance

²⁶ As specified in “*Basel III: A global regulatory framework for more resilient banks and banking systems*” paragraph 60 and 61

²⁷ See “*Basel III LR framework and disclosure requirements*” 2014, for more detailed information

sheet) should not be 33.3 times the bank's Core Tier 1 capital. National supervisors started monitoring the LR on 1 January 2013, and will analyze its effect on specific internal models. In 2017 it enters the adjusting period and in 2018 it will be headed for a Pillar I implementation.

4. Reducing pro-cyclicality and promoting countercyclical buffers

The Basel Committee introduced some measures to make banks more resilient to pro-cyclical processes by ensuring that these could function as a “*shock absorber, instead of a transmitter of risk to the financial system and broader economy*”.

The Committee proposed two capital buffers that banks will have to hold above the regulatory minimum.

Countercyclical capital buffer.

As the name indicates, this buffer serves to react against the pro-cyclicality process. This buffer will be implemented from 2016 to 2019 and it is supposed to be implemented as a phase-in process in which each year there is an increase of 0.625%, till reach the maximum of 2.5% of the RWA on 2019.

It ensures that the bank's capital requirements take account of the macro-financial environment in which they operate.

National authorities will monitor indicators (credit growth and etc.) and make assessments about the level of credit growth. Also, internationally active banks will look at the geographic location of their private sector credit exposures and compute their institution specific countercyclical buffer.

Capital conservation buffer.

The conservation capital buffer will be phased-in from 2016 to 2019. This buffer will have a maximum value of 2.5% comprised of Common Equity Tier 1 Ratio above the minimum capital requirement²⁸.

It ensures that banks build up enough capital outside periods of stress which can be drawn down as losses are incurred. Outside stress periods, banks should hold buffers of capital above the regulatory

²⁸ CET1 must first be used to meet the minimum requirements (6% Tier 1 and 8% Total capital) before the remainder can contribute to the capital conservation buffer.

minimum. However, when the capital level falls below the minimum requirement plus the buffer, banks should rebuild them through:

- i. Raising private capital in the market
- ii. Reducing earning’s distributions (dividend, share-backs and staff bonus)

The constraints imposed only relate to distributions, not to the operation of the bank.

The table below shows how the minimum capital conservation ratios will be implemented to the various levels of the Common Equity Tier 1 (CET1) capital ratios of banks.

<i>CET 1 Ratio</i>	<i>Min.Conservation Ratio</i>
4,5% - 5,125%	100%
> 5,125% - 5,75%	80%
> 5,75% - 6,375%	60%
> 6,375% - 7,0%	40%
> 7,0%	0%

Table 4: Minimum capital conservation requirements

5. Addressing systemic risk and interconnectedness

Not only pro-cyclicality amplified the downturn of the current crisis but also excessive interconnectedness among financial firms transmitted shocks across the financial system destabilizing the economy. For that, the Committee introduced the following additional issues:

- Capital incentives to use CCP for OTC instruments
- Higher capital requirements for trading activities
- Higher capital requirements for inter-financial sector exposures, and
- Introduction of liquidity requirements

This last topic was extensively addressed by the Committee and is also one of the novelties introduced by Basel III.

2.2.5.1 - Liquidity Proposals

Throughout the liquidity phase problem in the beginning of the last financial crisis, many banks suffered liquidity difficulties as the market was being drained up.

The introduction of liquidity requirements is meant to penalize excessive reliance on short-term interbank funding to support longer maturity assets, with the aim of reducing the spillover “domino” effect between banks. For that, the Committee imposed two minimum ratios for funding liquidity.

1. *Liquidity Coverage Ratio*²⁹

This ratio ensures short-term resilience on a bank’s liquidity situation. It guarantees that banks always have a 30-day asset liquidity cover for emergency situations (stress scenario). The Basel Committee is proposing a Liquidity Coverage Ratio (LCR) defined as:

$$LCR = \frac{HQLA}{30 \text{ day Net Cash Outflows}} \geq 100\%$$

Where the numerator (HQLA) stands for high quality liquid assets and must follow certain requirements. It includes instruments with a low correlation to risky assets, listed in active developed, stable and recognized exchange markets, with market makers and low concentration of buyers and sellers, and must be easily converted to cash in stressed markets.

Example of high quality liquid assets:

- Cash
- Central bank reserves
- Marketable claims on sovereigns, central Banks (CB), IMF etc.
- Well rated government debt issued in the currency of the country
- Eligible corporate and covered bonds

Finally, the denominator (net cash outflows) is defined as the total expected cash outflows minus the expected inflows for the subsequent 30 days.

²⁹ More details on: “Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools”, 2013 (238)

2. *Net Stable Funding Ratio*³⁰

This ratio ensures resilience on a bank's liquidity situation over a one year time horizon. The NSFR objective is to limit an over-reliance on short-term wholesale funding and reassure a more serious assessment of liquidity risk across all on-and-off-balance sheet items as it ensures that long-term assets are funded with at least a minimum amount by stable funding (liabilities) in relation to their liquidity risk profile.

Essentially, the Committee is proposing that the asset and liabilities liquidity characteristics of banks are matching the structure imposed by this ratio.

$$NSFR = \frac{\text{Available Stable Funding}}{\text{Required Stable Funding}} \geq 100\%$$

The numerator (ASF) is the portion of the available amount expected to reliable sources of funding over a one-year period under stress conditions. It comprises various sources of different nature in which each one has a determined coefficient aggregated to.

Example of available stable funding sources:

- Total regulatory capital
- Eligible stable deposits and term deposits
- Operational deposits and other funding

The denominator (RSF) is based on on-and-off-balance- sheet exposures and is the weighted sum of the liquidity characteristics of the various types of assets.

Example of required stable funding:

- Unencumbered Level 1, Level 2A & 2B Assets
- Eligible residential mortgages
- Other eligible loans and assets

³⁰ More details on: "Basel III: Net Stable Funding Ratio", 2014 (271)

PART III

3.3 - *The Model: Introduction*

As seen, the implementation of the most recent framework presented by the Committee (Basel III) is a challenge to banks as it might increase pressure on a bank's profitability.

Researchers have tried for many years to analyze the decision process of financial firms to structure their balance sheet in order to meet shareholder's and management's expectations. Although the ultimate strategy applied could be a decision of the board, from the bank's perspective, it is critical to benchmark the structure of its balance sheet instruments in an algorithmic process.

Institutions will have to reevaluate their exposures in order to be compliant with Basel III and be profitable. Managing the balance sheet (BS from now on) is one of the key aspects that banks will reassess. Efficiently managing the BS by maximizing the returns, while taking into account conflicting goals such as strategic constraints and being in compliance with regulatory requirements, is a complex task. Given the particular aspects of each bank (risk appetite, strategy of the institution, dimension, etc.), managers are expected to know whether there is an "optimal BS" mix composition that would satisfy the objectives of the bank.

In this section it is proposed a model that serves the institution to exactly achieve this goal. The model takes the initial BS (defined as *Inputs* inserted by the user) as the starting point and moves to an "optimal" BS, while taking certain restrictions into account.

A user-friendly tool was constructed with the model in it, so that it can be used to advise banks on how their BS should be structured, while taking into account its specificities. It was built in *Excel*, *VBA*, and using the *Solver* as the optimization method (optimization algorithm). After the model determines the "optimal BS", it presents the modifications made in the structure of the BS and the results obtained from it.

This section describes the BS, how the tool deals with the different parameters, with future uncertainty (stochastic simulation), with the transition from one year to another and the constraints imposed.

Due to its complexity, the model is described in separated sections.

SECTION I

3.1.1 - Components of the Model

As the model intends to portray the impact of the framework of Basel III on banks, the model was constructed to perform until the year of 2019. Having that said, the model forecasts the information obtained by the initial BS (*Inputs*) to the following years till 2019. For that, among other actions, the model constructs a yearly balance sheet and a profit & loss account³¹.

As said earlier, the model focuses in the BS of banks to perform. However, there are two main difficulties in doing a standard model to fit to any bank:

- i. The BS of banks is composed by a great number of types of assets, liabilities, and even equity instruments, and
- ii. Each bank has its own BS composition with different types of assets, liabilities and equity instruments

To take all the instruments into account would make the model too complex, slow and intractable. Consequently, the presented model has its own set of balance sheets' instruments pre-defined. The BS of the model was made in a way that could be adapted to different types of banks.

The tool has two main separated steps to perform. First, there is the introduction of several parameters as "*Inputs*" by the operator, so that the tool is calibrated to the institution. Therefore, the BS of each institution fits into the BS of the model. Once all the inputs (parameters) are defined, the second step is to run the model by clicking a defined button in the tool. The model automatically begins to perform several actions, and at the end of the simulation, the user can observe the output³² of the model and compare the differences between certain parameters between the "initial BS" and the "optimal BS".

³¹ More information about the profit & loss account and the yearly evolution of the BS in section 3.1.5 and section 3.1.8 respectively

³² More information about the output obtained by the model in section 3.4.1

3.1.2 - The customized Balance Sheet

The BS of the model has a total of sixteen (16) instruments and is composed by:

- Nine (9) Assets instruments
- Four (4) Liabilities instruments
- Three (3) Equity types

Figure 1, below, illustrates the BS of the model.

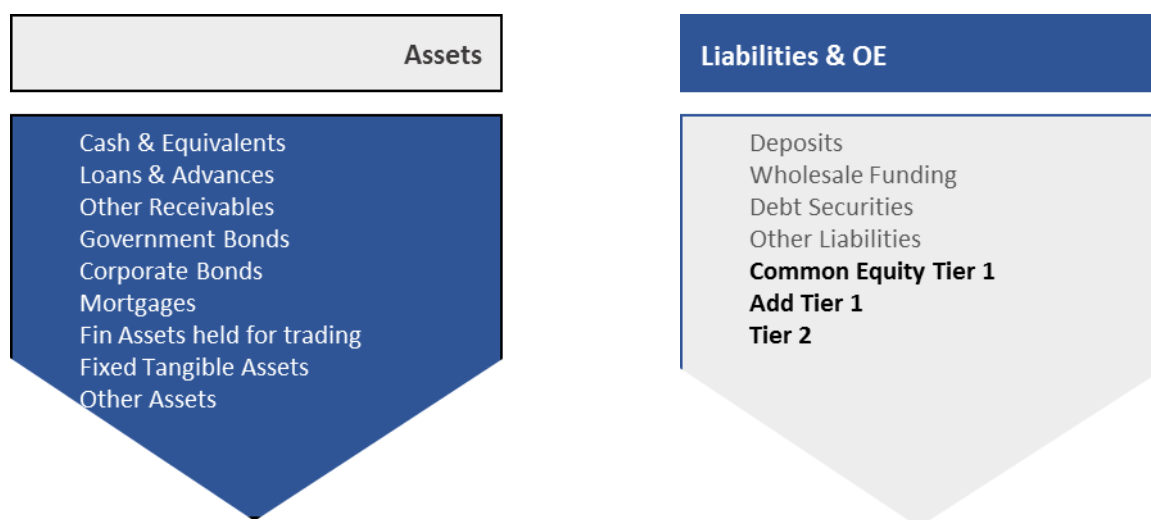


Figure 1: The balanced sheet of the model for year t

As the fundamental equation of accounting (balance sheet equation) shows, the balance sheet is in equilibrium when the sum of all the positions in the asset side equals the sum of those of the liabilities and equity side. Is not possible to go short on neither position of the BS, therefore:

$$X_i \geq 0, \quad i = 1, \dots, n \quad (\text{with } X \text{ being the exposure per item})$$

Also, the vector $\vec{Z} = (\vec{Z}_1, \vec{Z}_2, \dots, \vec{Z}_n)$, with $n \in \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16\}$ denotes the position of each instrument in the initial BS structure. Consequently, the vector $\vec{O} = (\vec{O}_1, \vec{O}_2, \dots, \vec{O}_n)$ denotes the position of each instrument of the “optimal BS” obtained by the model.

Each item of the balance sheet is presented as a vector and has its own properties (disaggregation). Thus, they are sub divided into sub classes. In other words, each vector has its matrix (matrices) affecting it.

A good example of a property is the *maturity* property. Apart from the ‘*Cash & Equivalents*’ instrument, all the BS items have a sub division of maturity.

There are nine (9) different properties (sub classes).

Each property is a matrix with dimension $n \times 1$, and they are defined below:

1. Maturity property: $M_i = \{1, 2, 3, 4, 5\}$

$$M = \left[\begin{array}{c} < 1 \text{ month} \\ 1 \text{ month} - 6 \text{ months} \\ 6 \text{ months} - 1 \text{ year} \\ 1 \text{ year} - 5 \text{ years} \\ > 5 \text{ years} \end{array} \right]$$

2. Credit Rating property: $C_i = \{1, 2, 3, 4\}$

$$C = \left[\begin{array}{c} AAA \text{ to } AA- \\ A+ \text{ to } A- \\ BBB+ \text{ to } BBB- \\ BB+ \text{ to } B- \end{array} \right]$$

3. Stability property: $S_i = \{1, 2\}$

$$S = \left[\begin{array}{c} Stable \\ Less Stable \end{array} \right]$$

4. Type C property: $T_{ci} = \{1, 2, 3\}$

$$\text{Type } C = \left[\begin{array}{c} \text{Retail} \\ \text{Fin Institutions} \\ \text{Corporate} \end{array} \right]$$

5. Type F property: $T_f = \{1, 2\}$

$$\text{Type } F = \left[\begin{array}{c} \text{Financial Institutions} \\ \text{Non Fin Institutions} \end{array} \right]$$

6. Type K property: $T_k = \{1, 2, 3, 4\}$

$$\text{Type } K = \left[\begin{array}{c} \text{OverNight Interbank L} \\ \text{REPO market} \\ \text{CB lending} \\ \text{Corporate Wholesale} \end{array} \right]$$

7. Type T property: $T_t = \{1, 2, 3\}$

$$\text{Type } T = \left[\begin{array}{c} \text{PPE} \\ \text{Non-Current A - Sale} \\ \text{Other TA} \end{array} \right]$$

8. Type T property: $Ta = \{1, 2, 3, 4\}$

$$Type A = \left[\begin{array}{l} Intangible \\ DTA \\ Minority Interest \\ Other Assets \end{array} \right]$$

9. Type T property: $Tl = \{1, 2, 3\}$

$$Type L = \left[\begin{array}{l} Provisions \\ DTL \\ Other Liabilities \end{array} \right]$$

Asset Instruments.

The total exposure of the left side of the BS (asset side) equals the sum of the individual exposures of the nine (9) different assets:

Eq.1:

$$\begin{aligned} X_{Total Assets} = & X_{Cash \& Equiv} + X_{Loans \& Adv (mi,tci)} + X_{Other Receiv (mi,tfi)} + X_{Gov Bonds (mi,Ci)} \\ & + X_{Corp Bonds (mi,Ci)} + X_{Mortgages (mi)} + X_{Fin A-trading (mi)} + X_{FTA (mi,Tt)} \\ & + X_{Other Assets (mi,Ta)} \end{aligned}$$

With X_i being the exposure per asset type i

As can be seen in eq.1, each asset type has its own properties (sub classes) affecting it.

Liabilities instruments.

Likewise the assets, the total exposure of the liabilities equals the sum of the individual exposures of the four (4) different liabilities:

Eq.2:

$$X_{TotalLiabilities} = X_{Deposits(mi,tci,S)} + X_{Debt\ Issued(mi)} + X_{WF(mi,tfi)} + X_{OtherLiabilities(mi,Tl)}$$

With X_i being the exposure per liability type i

Once again, in eq.2, each liability type has its own properties (sub classes) affecting it.

Equity instruments.

Lastly, the equity instruments are the ones left to define. The elements of the capital in the model are, as expected, in accordance with the framework presented by Basel III. Therefore, the capital is composed by three sub classes:

- Common Equity Tier 1 Capital
- Additional Tier 1 Capital
- Tier 2 Capital

$$Total\ Equity = Common\ Equity\ Tier\ 1 + Additional\ Tier\ 1 + Tier\ 2$$

The definition of each class is also in accordance to the Basel III framework. Thus, each element has its own instruments included, in accordance to what is discussed in section 2. *Basel III*.

3.1.3 - Bounds & Strategy of the institution

The balance sheet management is dependent on various variables, being the strategy and core business of the institution one of the most relevant. The strategy of the different types of banks (investment banks, commercial banks, retail banks, central banks, credit banks, savings & loans banks etc.), is diverse, therefore, they possess different BS composition. Essentially, each bank has

its own thoughts on the amount of exposure per position in each balance sheet instrument, and therefore, knows the interval (maximum and minimum exposures) on where it stands.

The model considers this interval by using an upper and lower bound per position, ensuring that each position remains within the interval. The bounds are inputs of the model, thus, it is the operator's accountability to define them. This helps defining the strategy of the institution by controlling how much exposure (with the corresponding risk), it want to hold in each instrument.

The bounds for the asset and liabilities instruments are defined as follows:

$$\begin{aligned}
 X_{Cash \& Equiv}^{Min} &\leq X_{Cash \& Equiv} \leq X_{Cash \& Equiv}^{Max} \\
 X_{Loans \& Adv}^{Min} &\leq X_{Loans \& Adv} \leq X_{Loans \& Adv}^{Max} \\
 X_{Other Receiv}^{Min} &\leq X_{Other Receiv} \leq X_{Other Receiv}^{Max} \\
 X_{Corp Bonds}^{Min} &\leq X_{Corp Bonds} \leq X_{Corp Bonds}^{Max} \\
 X_{Gov Bonds}^{Min} &\leq X_{Gov Bonds} \leq X_{Gov Bonds}^{Max} \\
 X_{Mortgages}^{Min} &\leq X_{Mortgages} \leq X_{Mortgages}^{Max} \\
 X_{Other Assets}^{Min} &\leq X_{Other Assets} \leq X_{Other Assets}^{Max} \\
 X_{FinA-trading}^{Min} &\leq X_{FinA-trading} \leq X_{FinA-trading}^{Max} \\
 X_{FTA}^{Min} &\leq X_{FTA} \leq X_{FTA}^{Max} \\
 X_{Deposits}^{Min} &\leq X_{Deposits} \leq X_{Deposits}^{Max} \\
 X_{Debt Issued}^{Min} &\leq X_{Debt Issued} \leq X_{Debt Issued}^{Max} \\
 X_{WF}^{Min} &\leq X_{WF} \leq X_{WF}^{Max} \\
 X_{Other Liabilities}^{Min} &\leq X_{Other Liabilities} \leq X_{Other Liabilities}^{Max}
 \end{aligned}$$

3.1.4 - Input stage

As referred before, there are two main steps to use the optimization tool. First, the user must introduce the parameters as “*Inputs*”, so that the tool is calibrated to the institution and the model could fit the bank’s specificities.

In the input phase, there are eight (8) steps the operator must complete to successfully run the model. Below, is the description of these eight (8) steps:

1. **Set initial year**: Set the initial year of the model. The model runs from the year given till 2019.
2. **Input of the BS**: introduction of the values of the BS per position type and its respective sub class (property).
3. **Input intervals**: insert the upper and lower bounds per position (both assets and liabilities instruments).
4. **Input Income/Expense**: insert the income (expense) per asset (liability) instrument; the standard deviation for the expected future income (expense) till year 2019 (stochastic process)³³; expected growth and decline and its standard deviation per position (both on assets and liabilities instruments).
5. **Risk Profile**³⁴: choose the risk profile of the bank.
6. **Tax & Plowback rate**: first, insert the tax rate and the plowback ratio attributable to the institution for each year. Secondly, define the allocation (in %) of the reinvestment of the retained profit in the assets (Loans and Corporate Bonds).
7. **Liquidity Ratios**³⁵: confirm or edit the Liquidity Ratios (LCR & NSFR) values.

³³ The stochastic process of the model is explained in section 3.1.7

³⁴ The Risk Profile and its components is explained in section 3.1.6

³⁵ The liquidity ratios are associated to a risk profile, thus, they will be determined once the user chooses a risk profile. However, the user can edit manually the values of these ratios after choosing a risk profile.

8. ***Stochasticity***³⁶: choose whether the user wants the model to make certain parameters stochastic or if the user has accurate estimates and there is no need for stochasticity.

3.1.5 - Profit & Loss account

As referred previously, the model constructs a yearly Profit & Loss account (P&L), and is from it that the retained profit is obtained. The P&L account is formed by the various types of income and expenses incurred by the institution. The total income and expenses are generally produced (but not only) by the bearing assets and liabilities instruments respectively.

Below it is defined the total income and expense:

Income (year t).

$$\begin{aligned} \text{Total Income} = & \text{Inc Cash (t)} + \text{Inc LoansAdv (t)} + \text{Inc O. Receivables} + \text{Inc Mortgages (t)} \\ & + \text{Inc GovBonds (t)} + \text{Inc CoprBonds (t)} + \text{Inc FinA Trading (t)} \\ & + \text{Inc Fee (t)} + \text{Inc O. Oper (t)} \end{aligned}$$

Expenses (year t).

$$\begin{aligned} \text{Total Expense} = & \text{Exp Deposits(t)} + \text{Exp Wholesale Funding (t)} + \text{Exp Debt Securities} \\ & + \text{Exp Fee (t)} + \text{Exp O. Oper (t)} + \text{Exp Staff (t)} \\ & + \text{Impairment costs (Mortgages, LoansAdv, O. Receivables)} \\ & + \text{Haircuts (GovBonds, CorpBonds, Finan A - Trading)} \end{aligned}$$

Retained profit (year t).

$$RE = \text{Plowback} * [(1 - \text{Tax}) * (\text{Total Income (t)} - \text{Total Expenses (t)})]$$

³⁶ See section “Stochastic process” for more detailed information about the stochastic process of the model

Therefore, is from the P&L account that the model takes the retained profit of each year. Then, the model reinvests it into the assets (in “Loans & Advances” and “Corporate Bonds”) at a rate defined by the user in “*Step 5*” of the “*Input stage*” phase.

3.1.6 - Risk Profile

As the previous section showed, the model has an embed option to choose the risk profile of the bank. The risk profile in the model is determined by the minimum values of the liquidity and capital ratios. Three risk profiles are defined: risk adverse, risk neutral and risk seeking.

Essentially, the risk profile determines the values the financial institution wants to reach for the liquidity and capital requirements. All the risk profiles are in compliance with Basel III, consequently, the *risk seeking* profile complies just with the minimums required by the framework, and nothing more. The other risk profiles have a buffer above the minimums required by Basel III, being the *risk adverse* the most conservative one and therefore, presenting the highest minimum required ratios.

Below, it is shown all the default values for the three risk profiles introduced in the model.

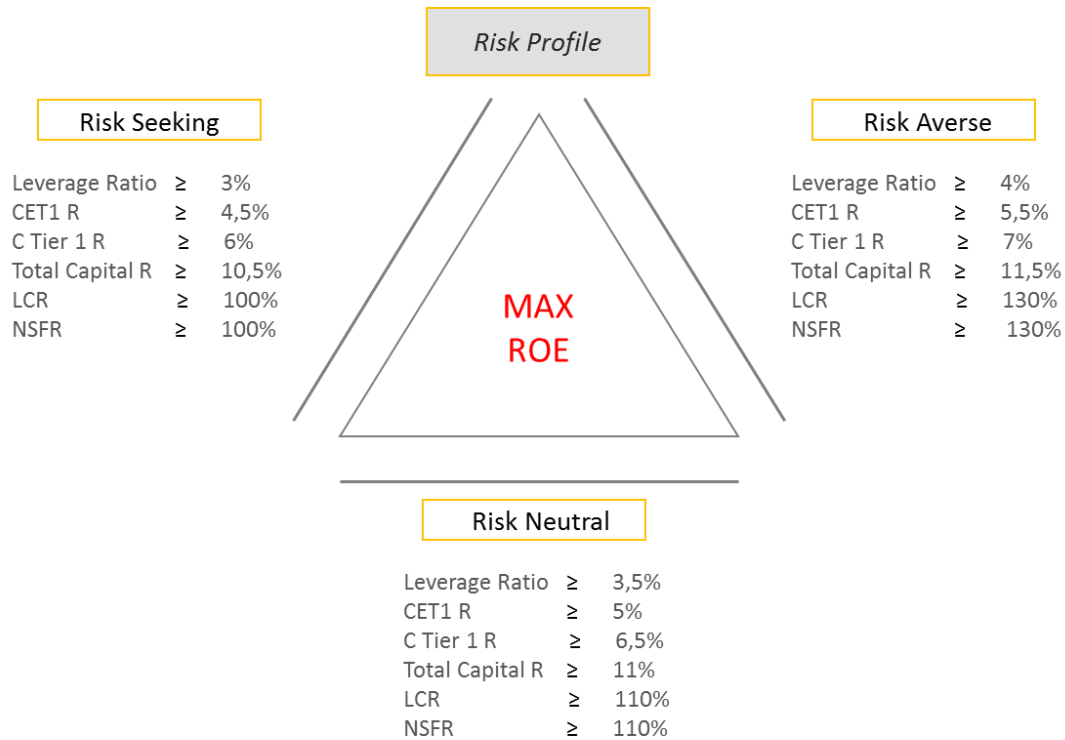


Figure 2 - The three risk profiles

In section 4 (Results), it is shown how the risk profile impacts the return on equity on ‘Bank I’, by running one simulation per risk profile.

3.1.7 - Stochastic process

Financial institutions generally have estimations for their expected income and expenses and the BS’s growth for the following years. However, these estimations are often not accurate.

Also, as previously referred in the beginning of section 3.1.3. *“Components of the model”*, the model forecasts till the end of year 2019. The parameters needed to the model perform are difficult to estimate since they are uncertain. As such, the tool is constructed so that the user has the choice to make certain parameters’ values normally distributed by assigning a mean and a standard deviation to each of them.

By doing so, the model takes into account the uncertainty of the future and the eventual fluctuation of the variables year after year.

There are two (2) types of stochastic parameters:

- i. Expected Income and Expenses of every year till 2019
- ii. Expected growth and decline of every asset and liability instrument

The first stochastic parameters types are defined below:

$$INC (X_{Cash \& \text{Equiv}})_t \sim N (\mu_i, \sigma_i)$$

$$INC (X_{Loans \& \text{Adv}})_t \sim N (\mu_i, \sigma_i)$$

$$INC (X_{Other \text{Receiv}})_t \sim N (\mu_i, \sigma_i)$$

$$INC (X_{Other \text{Assets}})_t \sim N (\mu_i, \sigma_i)$$

$$INC (X_{Fee \& \text{Comission}})_t \sim N (\mu_i, \sigma_i)$$

$$INC (X_{Corp \text{Bonds}})_t \sim N (\mu_i, \sigma_i)$$

$$INC (X_{Gov \text{Bonds}})_t \sim N (\mu_i, \sigma_i)$$

$$INC (X_{Fin \text{A-Trading}})_t \sim N (\mu_i, \sigma)$$

$$INC (X_{Mortgages})_t \sim N (\mu_i, \sigma_i)$$

$$INC (X_{FTA})_t \sim N (\mu_i, \sigma_i)$$

$$INC (X_{Other \text{Operacional Income}})_t \sim N (\mu_i, \sigma_i)$$

$$EXP (X_{Deposits})_t \sim N (\mu_i, \sigma_i)$$

$$EXP (X_{Debt \text{Issues}})_t \sim N (\mu_i, \sigma_i)$$

$$EXP (X_{Other \text{Liabilities}})_t \sim N (\mu_i, \sigma_i)$$

$$EXP (X_{Fee \& \text{Comission}})_t \sim N (\mu_i, \sigma_i)$$

$$EXP (X_{Staff})_t \sim N (\mu_i, \sigma_i)$$

$$EXP (X_{Depreciations \& \text{Amortizations}})_t \sim N (\mu_i, \sigma_i)$$

$$EXP (X_{WF})_t \sim N (\mu_i, \sigma_i)$$

$$EXP (X_{Other \text{Operacional Expenses}})_t \sim N (\mu_i, \sigma_i)$$

Therefore, in this first case, taken from the income generated from each assets instruments (and other sources of income), defined by the user as an *Input*, the model computes the rate of return obtained from each asset instrument (plus the other sources of income) and with the volatility (measured by the standard deviation) inserted also as an *Input* by the user, the model gives an estimate for each year.

In parallel, it computes the cost of each liability instrument (and other sources of expense), and gives an estimate for each year with the volatility (measured by the standard deviation) inserted as an *Input* by the user.

The second stochastic parameters type, defines how the balance sheet evolves through time, in terms of growth/decline. They are defined below:

$g (X_{Cash \& Equiv})_t \sim N (\mu_i, \sigma_i)$	$d (X_{Cash \& Equiv})_t \sim N (\mu_i, \sigma_i)$
$g (X_{Loans \& Adv})_t \sim N (\mu_i, \sigma_i)$	$d (X_{Loans \& Adv})_t \sim N (\mu_i, \sigma_i)$
$g (X_{Other Receiv})_t \sim N (\mu_i, \sigma_i)$	$d (X_{Other Receiv})_t \sim N (\mu_i, \sigma_i)$
$g (X_{Corp Bonds})_t \sim N (\mu_i, \sigma_i)$	$d (X_{Corp Bonds})_t \sim N (\mu_i, \sigma_i)$
$g (X_{Gov Bonds})_t \sim N (\mu_i, \sigma_i)$	$d (X_{Gov Bonds})_t \sim N (\mu_i, \sigma_i)$
$g (X_{Mortgages})_t \sim N (\mu_i, \sigma_i)$	$d (X_{Mortgages})_t \sim N (\mu_i, \sigma_i)$
$g (X_{FTA})_t \sim N (\mu_i, \sigma_i)$	$d (X_{FTA})_t \sim N (\mu_i, \sigma_i)$
$g (X_{Other Assets})_t \sim N (\mu_i, \sigma_i)$	$d (X_{Other Assets})_t \sim N (\mu_i, \sigma_i)$
$g (X_{Fin A-Trading})_t \sim N (\mu_i, \sigma_i)$	$d (X_{Fin A-Trading})_t \sim N (\mu_i, \sigma_i)$
$g (X_{Deposits})_t \sim N (\mu_i, \sigma_i)$	$d (X_{Deposits})_t \sim N (\mu_i, \sigma_i)$
$g (X_{WFF})_t \sim N (\mu_i, \sigma_i)$	$d (X_{WFF})_t \sim N (\mu_i, \sigma_i)$
$g (X_{Debt Issues})_t \sim N (\mu_i, \sigma_i)$	$d (X_{Debt Issues})_t \sim N (\mu_i, \sigma_i)$
$g (X_{Other Liabilities})_t \sim N (\mu_i, \sigma_i)$	$d (X_{Other Liabilities})_t \sim N (\mu_i, \sigma_i)$

As the model evolves over time, by defining expected growth (new agreements) and the expected decline (attrition), with volatility measured by the standard deviation, the model gives an estimate of the effective growth per asset and liability instrument for each year. By doing so, the model obtains the effective yearly growth/decline of the models' balance sheet.

Concluding this section, it must be referred that the user has the option not to include the stochastic simulation if it has accurate estimates for the Income and Expense and the yearly balance sheet's effective growth. This is done in (Step-7) of the *Input* phase.

3.1.8 - Balance Sheet - Evolution

This section was studied and constructed very carefully, as while the model performs simulations through time, the BS has to be always in equilibrium as given by the fundamental equation of accounting.

Consequently, an increase/decrease of the right-side of the BS, has to be followed by an increase/decrease by the same amount, on the left-side of the BS. However, in order to have a smart and accurate optimization tool, this equilibrium must follow certain rules.

It has already been seen that the model is set to run from the initial year till 2019. By default, the model is set to begin in the year of 2013. However, the tool gives the option to start the simulation from any year (> 2013), so that it could be used in the following years and not only in year 2013-2014³⁷.

Consequently, the operator must first choose the initial year in "Step – 1", if he/she wants the model to run from any different initial year.

The time-line of the model has now been set. Now, let us describe how the model transits from one year to another.

We have already seen the two components that have impact in the BS evolution. Let us recapitulate:

- i. Yearly estimated growth (decline) of each asset and liability instrument
- ii. Yearly retained profit (RP)

³⁷ See section 3.1.4 "*Input stage*" for more details

Hence, the yearly expected growth (decline) of the balance sheet, depends on the weighted average growth/decline of the asset and liability instruments, and on the retained profit generated in the previous year. As described in the section “*Inputs*”, the user must choose in “Step – 6”, the allocation (in %) of the reinvestment of the retained profit in the assets.

Now we can define (below) the evolution of each instrument (assets and liability):

$$X_{Cash \& \ Equiv} (T) = [1 + g(X_{Cash \& \ Equiv}) - d(X_{Cash \& \ Equiv})]t * X_{Cash \& \ Equiv}(t - 1)$$

$$X_{Loans \& \ Adv} (T) = [1 + g(X_{Loans \& \ Adv}) - d(X_{Loans \& \ Adv})]t * X_{Loans \& \ Adv}(t - 1) + RP_t * \varphi$$

$$X_{Other \ Receiv} (T) = [1 + g(X_{Other \ Receiv}) - d(X_{Other \ Receiv})]t * X_{Other \ Receiv}(t - 1)$$

$$X_{Corp \ Bonds} (T) = [1 + g(X_{Corp \ B}) - d(X_{Corp \ B})]t * X_{Corp \ B}(t - 1) + RP_t * (1 - \varphi)$$

$$X_{Gov \ Bonds} (T) = [1 + g(X_{Gov \ Bonds}) - d(X_{Gov \ Bonds})]t * X_{Gov \ Bonds}(t - 1)$$

$$X_{Mortgages} (T) = [1 + g(X_{Mortgages}) - d(X_{Mortgages})]t * X_{Mortgages}(t - 1)$$

$$X_{Fin \ A-Trading} (T) = [1 + g(X_{Fin \ A-Trading}) - d(X_{Fin \ A-Trading})]t * X_{Fin \ A-Trading}(t - 1)$$

$$X_{FTA} (T) = [1 + g(X_{FTA}) - d(X_{FTA})]t * X_{FTA}(t - 1)$$

$$X_{Other \ Assets} (T) = [1 + g(X_{Other \ Assets}) - d(X_{Other \ Assets})]t * X_{Other \ Assets}(t - 1)$$

$$X_{Deposits} (T) = [1 + g(X_{Deposits}) - d(X_{Deposits})]t * X_{Deposits}(t - 1)$$

$$X_{Debt \ Issues} (T) = [1 + g(X_{Debt \ Issues}) - d(X_{Debt \ Issues})]t * X_{Debt \ Issues}(t - 1)$$

$$X_{WF} (T) = [1 + g(X_{WF}) - d(X_{WF})]t * X_{WF}(t - 1)$$

$$X_{Other \ Liabilities} (T) = [1 + g(X_{Other \ Liabilities}) - d(X_{Other \ Liabilities})]t * X_{Other \ Liabilities}(t - 1)$$

With φ = allocation (%) of retained earnings to Loans & Advances

Thus, except for “*Loans & Advances*” and “*Corporate Bonds*”, all instruments evolve through time depending on its amount of exposure of the previous year and its expected effective growth/decline for that year. In the case of the two exceptions, we have to sum the respective portion of the retained profit (RP)³⁸.

Finally, the transition of the equity instruments can be described. As referred previously, to be in compliance with the Basel III framework, the total equity in the model is composed by three instruments. Their dynamics are as follows:

$$\begin{aligned}
 X_{CET\ T1}(T) &= X_{CET\ T1}(t-1) * [1 + g_A] + \\
 &+ [L_t * (g_A - g_L)] + [AddT1_t * (g_A - g_{A'})] + [T2_t * (g_A - g_{A'})] \\
 X_{Add\ T1}(T) &= X_{Add\ T1}(t-1) * [1 + g_{A'} - RP_t]
 \end{aligned}$$

$$X_{T2}(T) = X_{T2}(t-1) * [1 + g_{A'} - RP_t]$$

With $A'_t = Assets_t - RP_t$

With $g_A = Growth\ of\ Assets\ in\ year\ t$

With $g_L = Growth\ of\ Liabilities\ in\ year\ t$

As observed, the evolution of the total equity is the most complex of the three types of instruments. First, we can describe the Additional Tier 1 capital and Tier 2 capital, as they evolve similarly.

These two move through time according to the amount of exposure of the previous year and the growth rate of the total assets not taking into account the effect of the reinvestment of the retained profit in the assets of the previous year. The reason for this deduction is because (as it can be read on section “*Basel III*”) only the CET T1 is affected by the retained profit, whether positive (injected in CET T1), or negative (absorbed by CET T1), therefore, these two instruments grow/decline each year by the growth rate of the assets deducting the retained profit (RP).

Finally, let us define the CET T1.

The transition of the CET T1 is composed by four (4) sub-components.

³⁸ See section 3.1.8 - Balance Sheet – Evolution, for more information

- i. First, it grows according to the growth rate of the assets (RP included). This component ensures that the CET T1 absorbs the retained profit, thus keeping up with the growth of the asset side of the BS.
- ii. The second component balances the disequilibrium arisen from the difference between the assets and liabilities growth rate. Therefore, it is constituted by the amount of liabilities of the previous year, multiplied by the difference between the growth rate of the total assets and the total liabilities. Obviously, if the total assets and the total liabilities grow at the exact same rate, this portion will be zero. Therefore, in case the liability's growth is higher than the asset's growth, the model assumes that an injection of capital (CET 1 capital) occurs in case the profits are not enough to cover this difference. After the simulation, the tool shows ("*Output*" sheet) the quantity of injected capital per year.
- iii. The third and the fourth component go in parallel and they are the last tranche needed to have equilibrium in the BS. They function similarly, being one affected by the Add T1 capital and the other affected by the Tier 2 capital. They fill the gap obtained by the difference between the growth rate of the assets and the growth rate of the Additional Tier 1 capital and the Tier 2 capital. This two components are constituted by the amount of the respective equity capital type (Additional Tier 1 and Tier 2) of the previous year, multiplied by the difference between the growth rate of the total assets and the growth of the total assets' deducting the retained profit.

This complex method of computing the CET T1, ensures that it absorbs the total retained profit (whether positive or negative) by itself, the difference between the growth rate of the total assets and liabilities, and the difference between the growth rate of the total assets and the growth rate of the Additional Tier 1 capital and Tier 2 capital.

3.1.9 - RWA / Standardized Approach

The credit risk valuation method built-in in the model is the Standardized Approach³⁹. This approach attributes risk weights to the different type of assets to assess the capital requirement. The risk weights are determined by the supervisory committee, and depend on the category of the borrower (sovereign, bank, corporate or retail), its rating, and the type of asset.

To obtain the RWA of the total assets exposed to credit risk, the respective risk weights are multiplied by the amount of each asset position. Then, it is just a matter of adding all the risk weights, obtaining the total RWA's.

The following asset instruments are exposed to credit risk:

$$Z_i = 2, 3, 4, 5, 6, 8, 9$$

2. Loans & Advances
3. Other Receivables
4. Government Bonds
5. Corporate Bonds
6. Mortgages
8. Fixed Tangible Assets
9. Other Assets

The following matrices, reveal the risk weights of each instrument. The *Corporate & Government*

³⁹ See the consultative document “*The Standardized Approach to Credit Risk*” - 2001, & “*Credit Risk, the Standardized Approach*” – 2004, for more information.

Bonds instruments, need to be separated according to its rating.

$$\begin{array}{c} \overrightarrow{z1} \\ \overrightarrow{z2} \\ \overrightarrow{z3} \\ \overrightarrow{z4} \\ \overrightarrow{z5} \\ \overrightarrow{z6} \\ \overrightarrow{z8} \\ \overrightarrow{z9} \end{array} = \begin{array}{c} 0\% \\ * \\ 85\% \\ *2 \\ *3 \\ 35\% \\ 100\% \\ 100\% \end{array} \quad \begin{array}{c} * \\ z_{2,1} \\ z_{2,2} \\ z_{2,3} \\ *2 \\ z_{4,1} \\ z_{4,2} \\ z_{4,3} \\ z_{4,4} \end{array} = \begin{array}{c} 75\% \\ 100\% \\ 100\% \\ 0\% \\ 0\% \\ 20\% \\ 50\% \end{array} \quad \begin{array}{c} *3 \\ z_{5,1} \\ z_{5,2} \\ z_{5,3} \\ z_{5,4} \end{array} = \begin{array}{c} 20\% \\ 50\% \\ 100\% \\ 100\% \end{array}$$

Figure 3: Risk weight of the Asset Instruments-Standardized Approach

Having all the asset instruments (exposed to credit risk) risk weights defined, we can compute the total RWA:

$$RWA = \sum_{i=1}^6 x_i * w_i + \sum_{i=8}^9 x_i * w_i$$

SECTION II

3.2.1 - Optimization technique formalization

This section presents a simple example of the optimization problem built-in the model. It is shown how the Basel III constraints, ratios and variables were defined in the model.

3.2.1.1 - RoE.

$$ROE_t = \frac{\text{Retained Profit}_t}{\text{Total Equity}_t} = \frac{\text{Retained Profit}_t}{\text{CET1}_t + \text{AddT1}_t + \text{T2}_t}$$

3.2.1.2 - Capital Ratios.

$$\text{CET1 } R_t = \frac{\text{Common Equity Tier 1}_t}{\text{Total RWA}}$$

$$\text{Tier 1 } R_t = \frac{\text{Tier 1}_t}{\text{Total RWA}} = \frac{\text{CET}_t + \text{AddT1}_t}{\text{Total RWA}}$$

$$\text{Tier 2 } R_t = \frac{\text{Tier 2}_t}{\text{Total RWA}}$$

$$\text{AddT1}_{2013} \geq 1\%; \quad \text{Add1}_{2014} \geq 1.5\%; \quad \text{Add1}_{t \geq 2015} \geq 1.5\%$$

3.2.1.3 – Leverage Ratio.

$$\text{Leverage } R_t = \frac{\text{Tier } 1_t}{\text{Total Assets}} = \frac{\text{CET}_t + \text{AddT1}_t}{\text{Total Assets}}$$

3.2.1.4 - Liquidity Constraints⁴⁰.

$$\text{LCR}_t = \frac{\text{HQLA}_t}{\text{Net Cash Outflow (30 days)}}$$

$$\text{NSFR}_t = \frac{\text{Available Stable Funding}_t}{\text{Required Stable Funding}_t}$$

Having all the Basel III constraints defined in the model described both in section 3 and 4, and taking into account a “*Risk Seeking*” profile, for example, we are now able to formulate a simplistic version of the optimization problem constructed in the model so that the reader can infer the direction of the approach taken⁴¹:

$$\text{Max} = \text{ROE}_t$$

Subject to: $\text{LR}_t \geq 3\%$

$$\text{CET1}_{2013} \geq 3.5\%; \quad \text{CET1}_{2014} \geq 4\%; \quad \text{CET1}_{t \geq 2015} \geq 4.5\%$$

$$\text{CoreT1}_{2013} \geq 4.5\%; \quad \text{CoreT1}_{2014} \geq 5.5\%; \quad \text{CoreT1}_{t \geq 2015} \geq 6\%$$

$$\text{TCR}_{t < 2015} \geq 8\%; \quad \text{TCR}_{2016} \geq 8.625\%; \quad \text{TCR}_{t=2017} \geq 9.25\%; \quad \text{TCR}_{t=2018} \geq 9.875\%; \quad \text{TCR}_{t > 2019} \geq 10.5\%$$

⁴⁰ See Annex 2 for the detailed description of the two liquidity ratios used in the model

⁴¹ For more detailed information about the actual optimization process of the model, see Annex 3

$$LCR_{t < 2015} \geq 50\%; \quad LCR_{2015} \geq 60\%; \quad LCR_{2016} \geq 70\%; \quad LCR_{2017} \geq 80\%; \quad LCR_{2018} \geq 90\%; \quad LCR_{2019} \geq 100\%$$

$$NSFR_{2013} \geq 50\%; \quad NSFR_{2014} \geq 60\%; \quad NSFR_{2015} \geq 70\%; \quad NSFR_{2016} \geq 80\%; \quad NSFR_{2017} \geq 90\%; \quad NSFR_{2018} \geq 100\%; \quad NSFR_{2019} \geq 100\%$$

Concerning the implementation, and as previously referred, the model was constructed in *Excel*, *VBA*, and using the *Solver* – GRG Solving method. This method finds an optimal solution to a reasonably well-scaled, non-convex model.

SECTION III

3.3.1 - Data & Assumptions

The data of ‘Bank I’ was inserted in the tool (as an input), and in the next section 3.4.1 “*Results*”, it can be seen part of the performance and the improvements accomplished by the model. It can be verified whether the model managed to be in agreement with the liquidity and capital constraints and by how much it managed to increase the RoE (in basis points).

The data of the input is taken from the financial disclosures of the year of 2013.

Each asset (liability) instrument provides an income (expense). This income (expense) was obtained from the financial disclosures and was then transformed by the tool into a return (cost) rate. By doing that, the model observes which are the most profitable (costly) instruments.

Let us refer the following assumptions taken⁴²:

- i. Tax rate of the bank was assumed to be: [23% – 25%⁴³]
- ii. Plowback ratio: [50%]

⁴² See Annex 3 for more detailed information about the inputs used

⁴³ Tax rate for financial institutions in Portugal in the year of 2013 and 2014

- iii. Allocation of reinvestment of *Retained Profit* (φ): [50%]
- iv. Stochasticity of parameters used with the default values
- v. Lower and upper bounds as figure 4 shows below:

	Bounds	
	<i>Lower</i>	<i>Upper</i>
<i>Cash & Equiv</i>	90%	90%
<i>Loans & Adv</i>	70%	70%
<i>Other Receiv</i>	70%	70%
<i>Gov Bonds</i>	80%	80%
<i>Corp Bonds</i>	80%	80%
<i>Mortgages</i>	90%	90%
<i>Fin A - trading</i>	60%	60%
<i>FTA</i>	100%	0%
<i>Other A</i>	100%	0%
<i>Deposits</i>	90%	15%
<i>Debt Sec</i>	70%	35%
<i>WF</i>	60%	35%
<i>Other L</i>	100%	0%

Figure 4 -Bounds for each BS position

Be advised that assumptions ii-v, where taken as a hypothesis by the author of this paper, taking into account the core business and strategy of ‘Bank I’.

3.3.2 - Scenarios

Two types of impact studies were done:

- i. Risk Profile – Impact Studies
- ii. Stress Tests – Impact Studies

Concerning the risk profile impact studies, four different scenarios were simulated and their results discussed in section 3.4.1 “*Results*”. The scenarios are presented below in figure 5.

As figure 5 shows, four different simulations were run, to inspect the impact of each scenario on the return on equity (RoE). The first three take into account the liquidity and capital constraints, and the fourth scenario discards completely the liquidity constraints. This gives us a sense of the impact of the liquidity restraints imposed by Basel III on the RoE of ‘Bank I’.



Figure 5 – Risk Profile Impact Studies – 4 scenarios

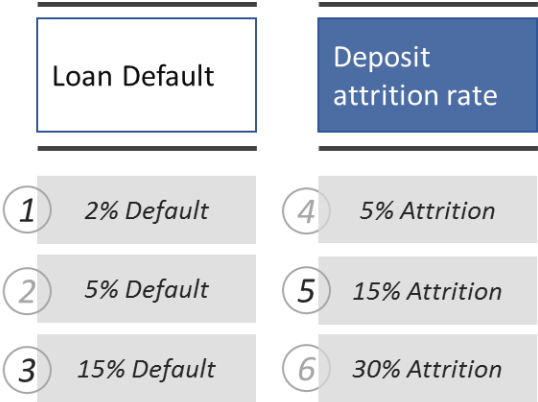


Figure 6 -Stress Scenario Impact Studiess

Regarding the second group, two different stress tests were simulated. To infer the impact of the stress test, each one had three different levels. One simulation per level was run so that it allows us to observe the marginal impact on the various parameters in study and whether tendencies exist. Figure 6 below illustrates this group.

SECTION IV

3.4.1 - Results

This section discusses part⁴⁴ of the results obtained by the model, using the data of ‘Bank I’ as the input. This is a commercial and mutual Portuguese bank that also provides small credit and investment services.

As referred in the previous section, two groups of impact studies are differentiated, and it is shown its impact on RoE and on other several parameters.

It would be interesting to see whether financial institutions are aware of their “optimal balance sheet”. If that was the case, the output of the model would be similar to the input (current composition). This would mean that the model could not find a different BS composition that would maximize the RoE while taking the Basel III requirements into account, and therefore, the bank was already in its “optimal BS” composition.

In figure 7 (below), it can be compared the percent change, in absolute value, of the different BS instrument, between the “initial BS” (current composition) and the “optimal BS” composition obtained by the model (output for that year). This simulation used the inputs of ‘Bank I’, in the year of 2013, using the “*Risk Seeking*” profile. Be aware that the red squares point out which BS instruments changed negatively.

To maintain confidentiality, the actual amount per position cannot be disclosed, however, in “Annex 3”, this information can be consulted.

⁴⁴ Due to confidential aspects concerning the use of real data, it is not permitted to show certain values. Therefore, in Section IV 3.4.1 “*Results*” it is not shown all the information available in this thesis. See Annex 3 for all the information obtained from the model.

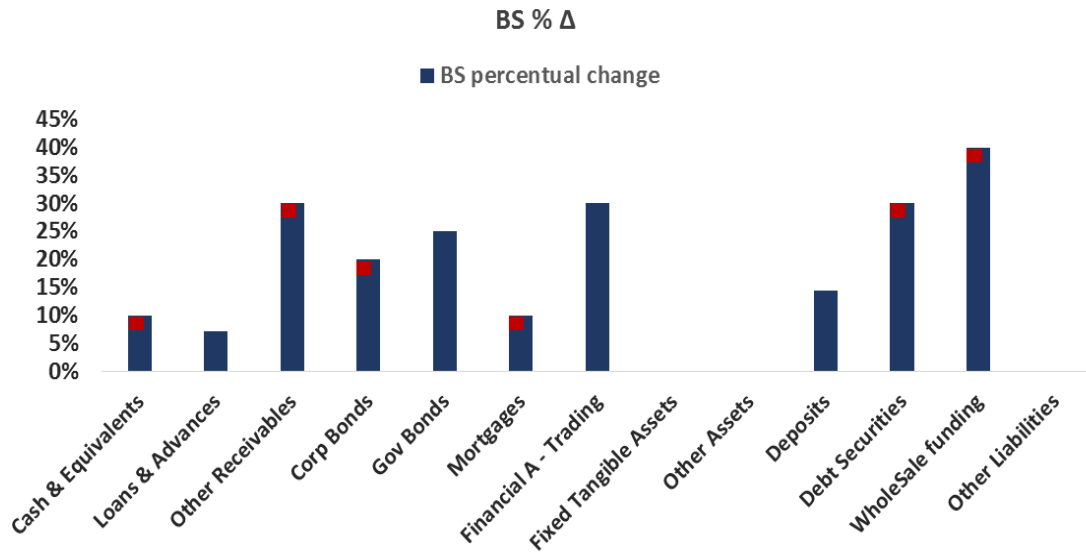


Figure 7: percent change in absolute value from "initial" to "optimal BS"

BS items with red squares had a negative change

It can be observed that 'Bank I' is far from being in its "optimal BS" composition. Moreover, it must be remembered that, as section 3.1.3 "Bounds & Strategy" explains, the model has an interval that constrains the change of the amount per position (upper and lower bound). Therefore, if the interval of the bounds were wider, the percent change would eventually be even higher.

Finally, concerning figure 7, it should be noticed that the "Wholesale Funding" liability instrument is the item which varies the most (negative change). This is due to the fact that in terms of prudential requirements, this type of funding contributes poorly to the liquidity requirements, as it is seen as a highly risky liability instrument, thus being largely penalized by the model.

As table 5 shows below, 'Bank I', as it is today and projecting its current situation to the following years till 2019, is not compliant with the liquidity constraints.

OUTPUT								
<i>Liquidity Ratios</i>		<i>Liquidity Ratios (values)</i>						
Year (t)		2013	2014	2015	2016	2017	2018	2019
LCR								
	<i>Required LCR</i>	50%	50%	60%	70%	80%	90%	100%
	<i>"Initial" LCR</i>	65%	55%	57%	48%	27%	24%	21%
	<i>LCR - Ouput</i>	50%	50%	68%	73%	97%	121%	151%
NSFR								
	<i>Required NSFR</i>	50%	60%	70%	80%	90%	100%	100%
	<i>"Initial" NSFR</i>	35%	35%	34%	27%	19%	18%	17%
	<i>NSFR - Ouput</i>	55%	60%	70%	80%	90%	100%	100%

Table 5: liquidity ratios from "initial" to "optimal BS"

Therefore, after the model performs its simulation, it manages to compose the BS in a way so that 'Bank I' is compliant with the liquidity constraints imposed by the Basel III. This can be observed by comparing the first and third line of table 5 of each liquidity ratio (LCR & NSFR).

Figure 8 (below) displays the values of the "initial" and the model's output of the liquidity ratios, so that it is easier to observe.

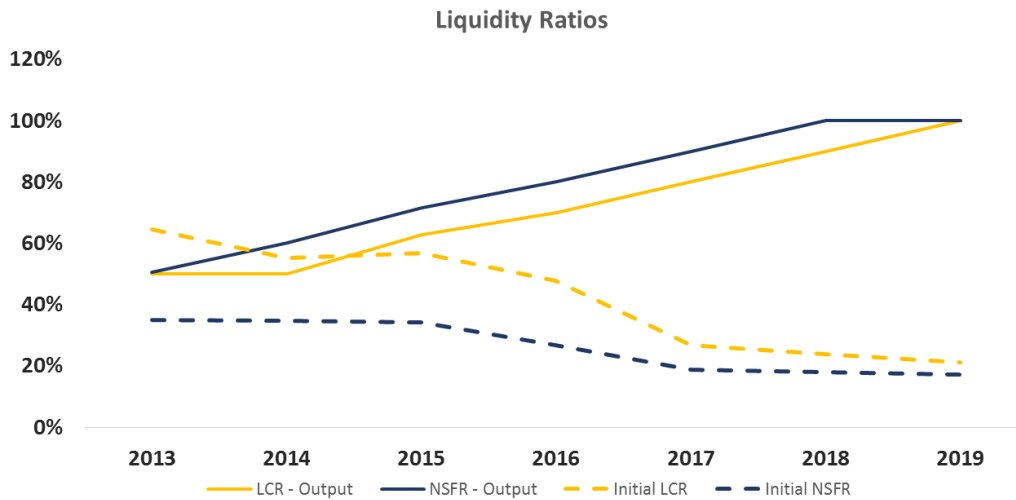


Figure 8: LCR & NSFR: "Initial" (current) and output of the model for Bank I

On the contrary, as it can be seen in figure 9 (below), ‘Bank I’ as it is today, it is practically within the capital requirements for the period.

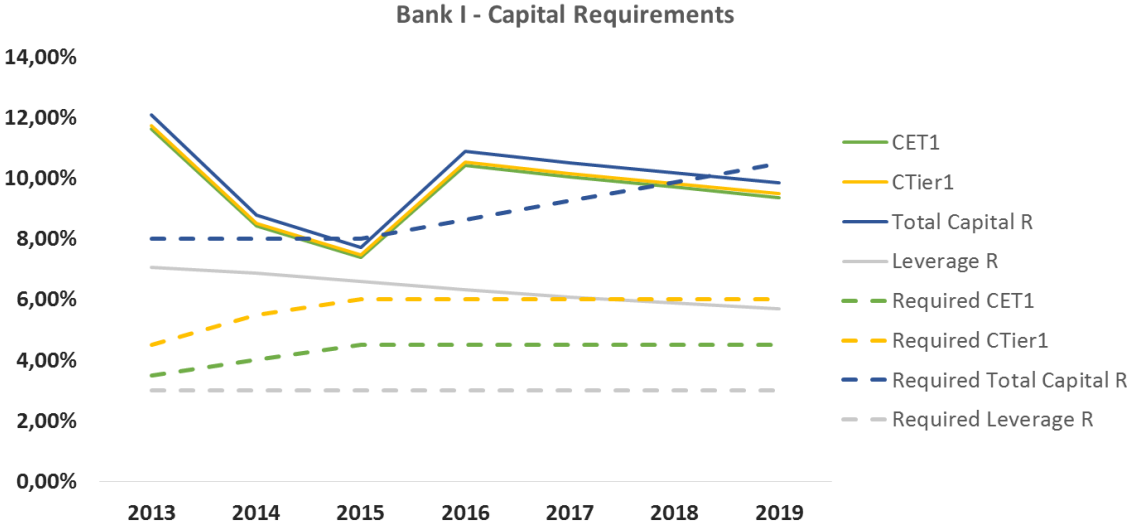


Figure 9: Comparison between Bank I Capital ratios and capital requirements

It must be observed now if this change in the composition of the BS has a corresponding positive impact, in other words, an increment on the RoE while respecting the Basel III framework.

For that, we refer the table 16 of Annex 4, which compares the values for the initial RoE and the output RoE obtained. Table 16 shows how the change in the composition of the balance sheet presented by the model, impacted positively the RoE. It not only managed to increase returns substantially and but also it made ‘Bank I’ to be compliant with the Basel III framework.

3.4.2 - Risk Profile Impact Studies

This section discusses the impact studies of the risk profile.

Below in table 6, it is shown the results for the first simulation (“Scenario 1”). Beat in mind, once again, that due to confidentiality, certain values cannot be disclosed (RoE, BS dimension etc.).

Therefore, instead of presenting the actual values of the RoE, table 6 presents its increment (in basis points) from the “initial ” to the “optimal BS”⁴⁵.

3.4.2.1 - Scenario 1

OUTPUT							
<i>Scenario 1</i>		<i>Including Liquidity requirements - Risk Seeking</i>					
BS Date (Year)	2013	2014	2015	2016	2017	2018	2019
Initial							
<i>CET1 R</i>	11,62%	8,43%	7,41%	10,41%	10,04%	9,65%	9,28%
<i>AddT1 R</i>	0,12%	0,12%	0,12%	0,12%	0,12%	0,12%	0,12%
<i>CTier1 R</i>	11,74%	8,55%	7,53%	10,53%	10,16%	9,77%	9,40%
<i>Total Capital R</i>	12,09%	8,78%	7,73%	10,88%	10,51%	10,12%	9,76%
<i>LR</i>	7,06%	6,87%	6,60%	6,32%	6,09%	5,85%	5,63%
<i>LCR</i>	65%	61%	57%	53%	50%	46%	43%
<i>NSFR</i>	35%	35%	34%	34%	33%	33%	33%
Optimized							
<i>CET1 R</i>	11,58%	8,63%	9,18%	13,34%	14,67%	16,69%	19,83%
<i>AddT1 R</i>	0,12%	0,12%	0,12%	0,12%	0,12%	0,12%	0,12%
<i>CTier1 R</i>	11,69%	8,75%	9,30%	13,46%	14,79%	16,81%	19,94%
<i>Total Capital R</i>	12,05%	8,98%	9,53%	13,84%	15,19%	17,25%	20,45%
<i>LR</i>	7,06%	7,19%	7,39%	7,69%	8,06%	8,51%	9,05%
<i>LCR</i>	50%	50%	61%	70%	80%	119%	152%
<i>NSFR</i>	51%	60%	70%	80%	90%	100%	100%
<i>ROE increase (BPS)</i>	484	748	881	986	1065	1131	1194

Table 6: Model's Output for "Scenario 1"

It follows that, even though ‘Bank I’ in the first scenario does not fulfil all the requirements imposed by the new framework, the model managed to change the composition of the BS so that ‘Bank I’ becomes in compliance with the “Risk Seeking” profile constraints.

Furthermore, as the last row of table 6 shows, it also increased significantly the RoE every year.

It should be pointed out the significant increase of the “*CET1*” ratio. This is due to:

- i. Increase of retained profit (RP). The significant increase of the RP, which is consequence of the “optimal BS” composition obtained by the model, is every year completely absorbed by

⁴⁵ See Annex 4 for the values for the RoE obtained by the model under the different scenarios

the common equity tier capital (right-side of BS). Thus, when the RP is highly positive (negative), the “CET1” ratio increases (decreases) not proportionally⁴⁶

- ii. Decrease of the total RWA’s. The model is aware of the risk weights associated to each asset instrument, therefore, while it changes the composition of the BS, it takes also into account the total RWA’s value, for minimum capital requirements purpose.

As a final note, the model improved significantly the financial situation of ‘Bank I’, especially considering the RoE and the liquidity ratios. It has also increased the capital ratios, even though apart from year 2019 (total capital ratio), did not need any apparent increment in this area.

Next, it is shown the output of the second simulation which is the output of the model under the characteristics of “Scenario 2”.

3.4.2.2 - Scenario 2

OUTPUT							
<i>Scenario 2</i>		<i>Including Liquidity requirements - Risk Neutral</i>					
BS Date (Year)	2013	2014	2015	2016	2017	2018	2019
Initial							
<i>CET1 R</i>	11,62%	8,43%	7,40%	10,43%	10,01%	9,64%	9,33%
<i>AddT1 R</i>	0,12%	0,12%	0,12%	0,12%	0,12%	0,12%	0,12%
<i>CTier1 R</i>	11,74%	8,55%	7,52%	10,55%	10,12%	9,76%	9,45%
<i>Total Capital R</i>	12,09%	8,78%	7,72%	10,90%	10,48%	10,11%	9,80%
<i>LR</i>	7,06%	6,87%	6,59%	6,33%	6,07%	5,85%	5,66%
<i>LCR</i>	65%	61%	57%	53%	50%	46%	43%
<i>NSFR</i>	35%	35%	34%	34%	33%	33%	33%
Optimized							
<i>CET1 R</i>	11,54%	8,57%	9,10%	12,72%	13,55%	14,37%	16,11%
<i>AddT1 R</i>	0,12%	0,12%	0,12%	0,12%	0,12%	0,12%	0,12%
<i>CTier1 R</i>	11,66%	8,68%	9,22%	12,84%	13,67%	14,49%	16,23%
<i>Total Capital R</i>	12,01%	8,91%	9,45%	13,20%	14,03%	14,86%	16,63%
<i>LR</i>	7,06%	7,21%	7,39%	7,67%	7,99%	8,40%	8,83%
<i>LCR</i>	60%	74%	90%	111%	113%	116%	132%
<i>NSFR</i>	71%	70%	86%	90%	100%	109%	110%
<i>ROE increase (BPS)</i>	484	736	857	925	991	1028	1096

Table 7: Model's Output for "Scenario 2"

⁴⁶ As the denominator of the Ratio (RWA’s) also changes

Once again, the model managed to obtain an output in conformity with the restraints imposed by “Risk Neutral” profile. Remember that under “Scenario 2”, not only the capital ratios but also the liquidity requirements are above the actual minimums imposed by the Basel III framework.⁴⁷

Table 7 shows that the indeed the LCR & NSFR are equal or above the minimum values, and the same applies to the capital ratios.

What is more interesting to see, and that was the actual point of this impact study, is that the “*Risk Neutral*” profile, when compared to the “*Risk Seeking*” profile, makes ‘Bank I’ not to have as high returns. The values are actually lower. Thus, we can affirm that for the data used and within this time period, ‘Bank I’ has lower returns when using the requirements imposed by “*Risk Neutral*” profile instead of the ones imposed by “*Risk Seeking*” profile.

Moreover, as ‘Bank I’ demonstrated a truly comfortable situation regarding the capital requirements, we can affirm that the increase of liquidity requirements (only) between these two risk profiles, made the model to output lower returns.

It would be interesting to see whether the third simulation follows this trend.

⁴⁷ See section “*Risk Profile*” and section “*Scenarios*” for more detailed information about the three different risk profiles choices in the tool and the five different scenarios simulated in this chapter.

3.4.2.3 - Scenario 3

OUTPUT

Scenario 3

Including Liquidity requirements - Risk Averse

BS Date (Year)	2013	2014	2015	2016	2017	2018	2019
Initial							
<i>CET1 R</i>	11,62%	8,45%	7,43%	10,46%	10,08%	9,75%	9,43%
<i>AddT1 R</i>	0,12%	0,12%	0,12%	0,12%	0,12%	0,12%	0,12%
<i>CTier1 R</i>	11,74%	8,57%	7,55%	10,58%	10,20%	9,87%	9,55%
<i>Total Capital R</i>	12,09%	8,80%	7,75%	10,93%	10,55%	10,22%	9,90%
<i>LR</i>	7,06%	6,89%	6,61%	6,35%	6,12%	5,92%	5,72%
<i>LCR</i>	65%	61%	57%	53%	50%	46%	43%
<i>NSFR</i>	35%	35%	34%	34%	33%	33%	33%
Optimized							
<i>CET1 R</i>	11,55%	8,66%	8,90%	12,47%	13,51%	15,03%	15,79%
<i>AddT1 R</i>	0,12%	0,12%	0,12%	0,12%	0,12%	0,12%	0,12%
<i>CTier1 R</i>	11,67%	8,77%	9,02%	12,59%	13,62%	15,15%	15,91%
<i>Total Capital R</i>	12,02%	9,00%	9,25%	12,93%	13,99%	15,54%	16,30%
<i>LR</i>	7,06%	7,21%	7,40%	7,64%	7,97%	8,40%	8,88%
<i>LCR</i>	85%	83%	97%	100%	110%	120%	133%
<i>NSFR</i>	70%	87%	90%	118%	124%	131%	130%
<i>ROE increase (BPS)</i>	484	728	806	906	1011	1082	1075

Table 8: Model's Output for "Scenario 3"

The model successfully obtained a conceivable output for the third simulation. More importantly, the model strengthens our initial theoretical belief that with increments of liquidity requirements, the institution obtains lower returns. This can be seen by observing the last row of table 8 (above) and comparing with the results of table 7 & 8.

The “*Additional Tier 1*” ratio not only remains unchanged between the three first scenarios, but also from the “initial BS” to the “optimal BS”. As a result, likewise the “Tier 2” capital, which is not disclosed in the tables, the model practically does not increase this ratio. This is due to the fact that this capital instruments grow in value at the same rate of the total assets not taking the retained profit into account.

Below, is the result of the fourth simulation.

3.4.2.4 - Scenario 4

OUTPUT							
<i>Scenario 4</i>							
<i>Excluding Liquidity requirements - Risk Seeking</i>							
BS Date (Year)	2013	2014	2015	2016	2017	2018	2019
Initial							
<i>CET1 R</i>	11,62%	8,44%	7,41%	10,43%	10,05%	9,68%	9,37%
<i>AddT1 R</i>	0,12%	0,09%	0,08%	0,12%	0,12%	0,12%	0,12%
<i>CTier1 R</i>	11,74%	8,53%	7,49%	10,55%	10,17%	9,80%	9,49%
<i>Total Capital R</i>	12,09%	8,79%	7,73%	10,90%	10,52%	10,15%	9,84%
<i>LR</i>	7,06%	6,88%	6,60%	6,33%	6,10%	5,87%	5,68%
<i>LCR</i>	65%	61%	57%	53%	50%	46%	43%
<i>NSFR</i>	35%	35%	34%	34%	33%	33%	33%
Optimized							
<i>CET1 R</i>	11,92%	9,70%	9,75%	14,43%	16,18%	19,65%	24,83%
<i>AddT1 R</i>	0,12%	0,10%	0,10%	0,14%	0,14%	0,16%	0,19%
<i>CTier1 R</i>	12,04%	9,80%	9,85%	14,57%	16,32%	19,81%	25,02%
<i>Total Capital R</i>	12,40%	10,08%	10,13%	14,97%	16,75%	20,30%	25,60%
<i>LR</i>	7,06%	7,19%	7,39%	7,69%	8,10%	8,58%	9,17%
<i>LCR</i>	111%	86%	99%	104%	146%	73%	0%
<i>NSFR</i>	13%	14%	15%	17%	19%	25%	32%
<i>ROE increase (BPS)</i>	484	759	895	1006	1092	1170	1235

Table 9: Model's Output for "Scenario 4"

Table 9 (above) shows how would be if the liquidity constraints would be eliminated. Therefore, in this simulation, 'Bank I' would not have to deal with liquidity minimums addressed by Basel III. We see instantly that in general, the unconstrained liquidity ratios are a lot inferior to those of the other scenarios. It is even more consolidated the idea that for the data used, the capital and liquidity constraints have negative impact on returns. Thus, for 'Bank I', increasing capital and liquidity constraints reduces the RoE.

Below in table 10⁴⁸, it is shown the return on equity increase (in basis point) obtained by the model for the four simulations.

⁴⁸ See Annex 4 for a similar table in which the values of the RoE are presented

OUTPUT

BS Date (Year)	<i>Difference between first four scenarios</i>						
	2013	2014	2015	2016	2017	2018	2019
Scenario							
1 ROE increase (BPS)	484	748	881	986	1065	1131	1194
2 ROE increase (BPS)	484	736	857	925	991	1028	1096
3 ROE increase (BPS)	484	728	806	906	983	1003	1075
4 ROE increase (BPS)	484	759	895	1006	1092	1170	1235

Table 10: Model's output for the RoE inscreases in the four scenarios

Now, it can be clearly seen that an increase in capital and liquidity constraints was followed by a decrease in returns (scenario 1, 2 and 3). And on the contrary, when liquidity constraints were eliminated, returns suffered a significant increment.

From the “*Risk Profile*” impact studies, it can also be taken other interesting point, which is that the risk profile does not have any impact on the “LR”. It can be observed that within the four scenarios it did not follow any trend or change significantly. However, the model manages to increase this ratio when it is run, and this is applicable to all four scenarios.

For a graphic perspective to the evolution of the return on equity (RoE) along the period, under the four different scenarios, we refer the reader to Annex 4.

3.4.3 - Stress tests Impact Studies

This section continues to analyze the impact on return on equity under certain hypothetical scenarios. These stress tests are part of the tool, so that the institutions could have an approximated idea of the impact in case a similar scenario materializes. The two scenarios are:

- i. Loan default
- ii. Deposit attrition rate increase

The tool is constructed so that the user can define the percentage of the loan default of the simulation (in the first stress test), or the percentage of the deposit attrition rate (for the second stress test).

The first scenario is a common situation in the banking industry and banks have been making progress in measuring credit risk⁵⁰ to control it. In this study, it is considered three different levels of defaulted loans (in percentage) so that it gives us insights about the trend of the impact.

Concerning the second scenario, it is inspired in many situations that happened in the last financial crisis (2007), in which for one reason or another⁵¹, depositors picked their money up from banks they lost trust on.

It is considered three different levels of deposit attrition rate.

3.4.3.1 - Loan default.

Table 11 (below), shows how this stress scenario impacted on certain parameters of ‘Bank I’. Once again, keep in mind that the RoE cannot be disclosed. Annex 5 reveals more detailed information.

OUTPUT											
<i>Scenario A (t=2016)</i>		<i>Loan Default</i>									
<i>Parameter</i>	<i>CET1 R</i>	<i>AddT1 R</i>	<i>CTier1 R</i>	<i>TC Ratio</i>	<i>LR</i>	<i>LCR</i>	<i>NSFR</i>	<i>ROE Δ d (BPS)</i>	<i>CET1</i>	<i>RWA</i>	
Initial											
0% <i>Default</i>	13,64%	0,13%	13,76%	14,14%	7,73%	70,9%	80,0%	0	-	-	
2% <i>Scenario i</i>	12,3%	0,13%	12,4%	12,8%	7,0%	74,1%	80,0%	-344	-	-	
5% <i>Scenario ii</i>	11,5%	0,14%	11,61%	12,02%	5,93%	70,6%	107,9%	-1748	-	-	
15% <i>Scenario iii</i>	5,38%	0,18%	5,56%	6,08%	2,25%	70,0%	80,0%	-15034	-	-	

Table 11: Stress scenario A - Loan Default

The column “RoE Δ d (BPS)” gives the difference between the RoE under “normal” circumstances (0% loan default) and the RoE under each level of loan default. By observing this column, it can be easily seen that as the rate of loan defaults increases, the returns decrease significantly. This makes the CET 1 Ratio decrease by absorbing the losses derived from the loan defaults. Consequently, the Total Capital ratio also decreases.

⁵⁰ “Bank loan losses-given-default: A case study”- J. Dermine and C. Neto de Carvalho (2006)

⁵¹ Bank run, rating downgrade, improper practices etc.

The LR also drops as the total value of the owner’s equity loses proportion in the BS. Interestingly, it does not largely impact the two liquidity ratios.

The RWA’s reduce in value as the item ‘Loans & Advances’ has a high risk rating, therefore, it contributes to the decrease of the total value of the RWA’s. However, the CET1 loses more in value proportionally, and that explains the decrease of the CET1 ratio⁵².

Below, in figure 9, the four scenarios are illustrated in a graphic in which the values for the y-axis (value of RoE) are not disclosed. It intends to portray the decrease of the RoE as the loan default increases.

In figure 17 of Annex 5 it is shown the same graph with the y-axis values (RoE) included.

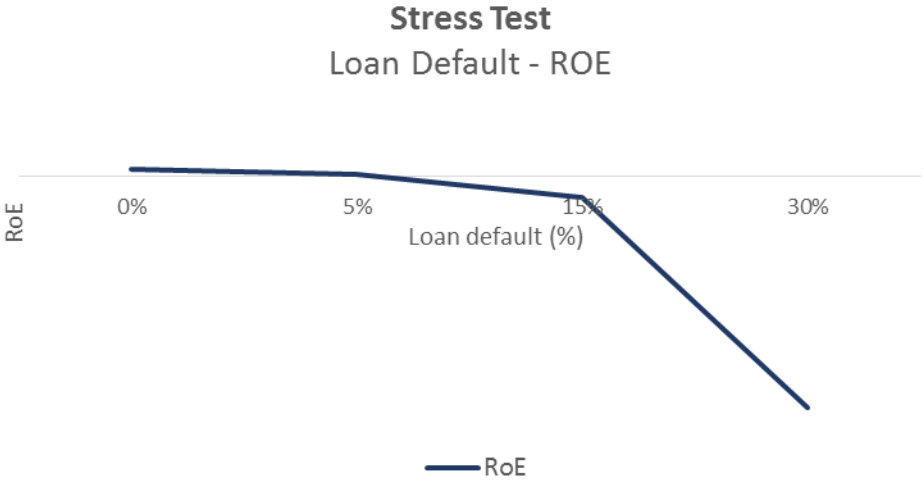


Figure 10: Stress scenario-Loan Default

It is visible the drastic decrease of the RoE as the loan default rate increases.

3.4.3.2 - Deposit attrition rate increase.

Concerning the second stress tests, it would be interesting to see whether a sudden increase in the deposit attrition rate would have any impact in the financial parameters of ‘Bank I’.

⁵² $CET1\ Ratio = \frac{CET\ 1}{RWA's}$

The results for this test are expressed in table 12 and discussed below.

OUTPUT

Scenario B (t=2015)		Deposits attrition rate increase									
Parameter	CET1 R	AddT1 R	CTier1 R	TC Ratio	LR	LCR	NSFR	ROE Δ d (BPS)	ROE	CET1	RWA
<i>Attrition rate</i>											
0%	12,40%	0,12%	12,52%	12,88%	7,41%	61,8%	70,0%	0	-	-	-
5% Scenario i	12,6%	0,12%	12,7%	13,0%	7,7%	0,5%	68,5%	-16	-	-	-
15% Scenario ii	13,8%	0,12%	13,89%	14,23%	8,51%	0,3%	70,3%	-98	-	-	-
30% Scenario iii	14,74%	0,11%	14,85%	15,16%	9,99%	0,1%	61,3%	-483	-	-	-

Table 12: Stress scenario B - Deposit attrition rate increase

First, it must be mentioned that table 12 shows the figures of ‘Bank I’ in the immediate moment after the deposit withdrawals happen.

Again, the column “RoE Δ d (BPS)” gives the difference between the RoE obtained in normal circumstances (no increment in the deposit attrition rate) and the RoE obtained for each scenario. This column shows that even though there is a clear negative correlation between deposit attrition rate and RoE, this relation is not as drastic as in Scenario A, therefore, returns have low sensitiveness to deposit withdrawals.

It follows that the LR⁵³ also increases in value. It is explained by the following:

As the numerator (C Tier 1) remains constant, with increases in the deposit attrition rate, the denominator (Total Assets) decreases.

A big impact on the LCR is observable. As depositors withdraw their savings from the bank, the institution has not that quantity of liquid assets to deliver the clients the amounts of money at such a short notice. For that, has to first liquidate their most liquid assets (Cash & Equivalent, Government Bonds), making the short-term liquidity ratio (LCR) to go far below the requirements. Also, as ‘Bank I’ relies a lot on retail deposits for its funding purposes, even a withdrawal of five percent has a significant impact in its funding liquidity situation.

Finally, the NSFR seems to be just slightly affected, as it relies on medium term funding to finance the assets.

⁵³ We refer the reader to page 22 on this paper to more information on the “LR”

Once again, as the RoE cannot be disclosed, figure 10 (below) illustrates a graphic of the four scenarios, in which the values for the y-axis (value of RoE) are not disclosed.

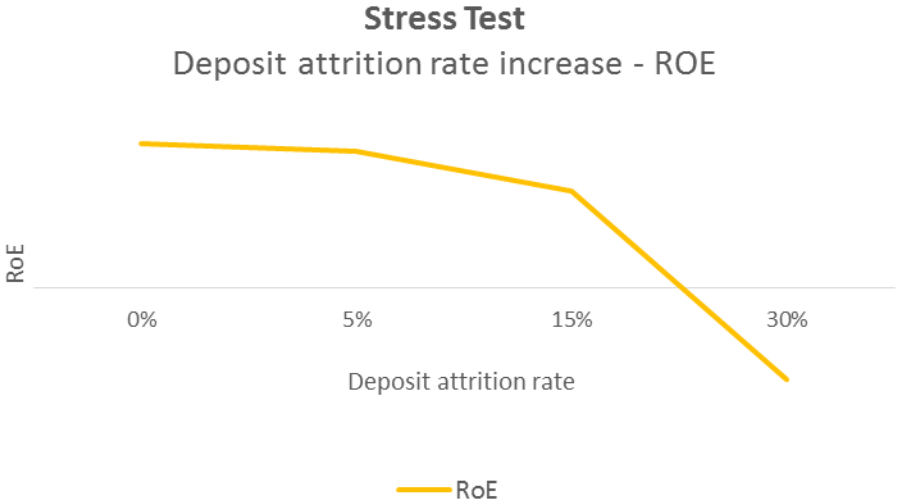


Figure 11 Stress scenario-Deposit attrition rate decrease

Just as table 12 illustrated, figure 11 shows that increases of the deposit attrition rate, makes the RoE to drop in value sharply.

In figure 18 of Annex 5, it can be observed the same graph with the y-axis values (RoE) included.

Concluding, we refer the reader to the following link (below), to see how the tool works:

<http://financialcleavage.wordpress.com/>

PART IV

4.1 – Conclusion

This study uses a balance sheet optimization model to overcome the existing challenges of the new regulatory framework presented by the BCBS under the name of Basel III. The study focused on regulation related to capital and liquidity requirements. The data used consisted on the financial figures of a Portuguese commercial bank for the year of 2013. Results show that the model succeeds in providing a plausible improved output.

Under the data and assumptions used, it was shown that the model manages to present a balance sheet composition that increases the return on equity of ‘Bank I’. Adding to that, it makes ‘Bank I’ to be it in compliance with the new regulatory framework presented by Basel III during the whole phase-in period. Hence, ‘Bank I’ as it is today, does not have an “optimal balance sheet” composition that enables it to maximize profits while making it compliant with Basel III, under the assumptions of this exercise.

Furthermore, the impact of the new regulation framework on profits of ‘Bank I’ was estimated and explored. Results indicate that as capital and liquidity requirements increase, ‘Bank I’ presents lower and even negative profits. Therefore, as F Pasiouras et al (2009)⁵⁴ discuss, stricter regulation related to the first Pillar has a negative impact on bank profits.

Moreover, the stress tests performed by the model give an alert to the susceptibility and exposure of ‘Bank I’ to corporate loans and mortgages, as these asset types comprise a big chunk of the bank’s total assets. According to the outputs of the model concerning the stress tests, a default on this type of asset has a big impact on profits. In fact, it makes ‘Bank I’ not to only be very far from the minimum requirements of the Basel III framework, but also presenting highly negative results.

Finally, this paper points out the reliance of ‘Bank I’ on retail deposits as the primary source of funding. Even though this source of funding is considered insensitive to risks (are often insured), and, as Huang & Ratnovski ⁵⁵ discuss, provide a stable source of long-term funding, ‘Bank I’

⁵⁴ “*The impact of banking regulations on banks’ cost and profit efficiency: Cross-country evidence*”- F Pasiouras, S Tanna, C Zopounidis (2009)

⁵⁵ “*The Dark Side of Bank Wholesale Funding*”- R Huang & L Ratnovski, (2011)

undergoes a stress financial situation in case of withdrawals. Thus, to overcome this sensibility the bank should either present more liquid assets.

Further Research

As for further research on the topic, it would be interest to capture the cost of changing each position of the assets and liability instruments (change composition of the balance sheet) so that this expense would be included in the calculations of the optimization model. This inclusion would only be possible if banks would have the information about the cost of changing one unit of each instrument, something that is not currently made.

Concerning the customized BS, its usage has the big advantage to be adaptable to every bank and it remains possible to model relatively quickly. The disadvantage is that the actual BS is specific for each bank. Hence, a possible extension of the model would be to replace the BS presented in the model by a much more detailed balance sheet. However, this would make the simulation much more complex and therefore slow, as it would optimize above the already existing thirteen dimensions. Moreover, it would not embody more accuracy in the parameters in study (capital and liquidity ratios, RoE etc.), as the instruments included in the optimization tool were chosen with the care of including all the instruments explored by the Basel III consultation papers.

As regards to the stress testing, it would be interesting to explore more intensively this section of the tool by adding new stress scenarios.

Part V

Annexes

Annex 1

1. For instance, it may appear to be good business to originate risky loans with their accompanying high interest rates. However, if the internal models calculate that these loans default more and thus need more capital charged against them, the loans may not be as profitable as lower risk, lower earning loans that require far less.

2. Example:

Safe loans: > 1 year maturity; PD = 0.25% ; LGD = 1% of the outstanding amount

Risky loans: > 1 year maturity; PD = 1% ; LGD = 10% of the outstanding amount

$$(\$10 \text{ M} \times .25\% = \$25,000)$$

$$(\$25,000 \times 1\% \text{ loss rate} = \$250)$$

For a \$10 M portfolio of the *safe loans*, the bank would expect to see \$25,000 in defaults in a year and a loss on the defaults of \$250

$$(\$10 \text{ M} \times 1\% = \$0.1 \text{ M})$$

$$(\$0.1 \text{ M} \times 10\% = \$10,000)$$

For a \$10 M in a *risky portfolio* the bank would expect to see \$0.1 million in defaults in a year and a loss on the defaults of \$10,000

Since the expected loss on the very risky portfolio is forty times greater than that of the safe portfolio, the bank would be obliged to put forty times more capital for the risky portfolio than for the same volume of safe loans.

Annex 2

LCR		
Stock of HQLA		Factor
<i>Level 1 A</i>		
z1,1	Cash & Equivalents	100%
z1,2	- Marketable securities	100%
z6,1,1	- Government Bonds (0%)	100%
<i>Total L1</i>		
<i>Level 2 A</i>		
z6,1,2	- Marketable securities	85%
z4,1,1	- Corporate Bonds (0%)	85%
<i>Level 2 B</i>		
z7	- Mortgages (RMBS)	75%
z4,1,2	- Corporate Bonds (20%)	50%
z4,1,3	- Corporate Bonds (50%)	50%
<i>Total L2</i>		
Total HQLA		
<i>Cash Outflows</i>		
z Deposits		
<i>- Retail & Small Business < 1 month</i>		
z5,1,1,1	Stable deposits	5%
z5,1,1,2	Less stable deposits	10%
<i>z9 Unsecured WF</i>		
z9,1,1	Overnight I. Lend	25%
z9,1,2	REPO market	100%
z9,1,3	Sovereign, CB, PES's	40%
z9,1,4	Non-fin Corp	40%
z5,1,2,1	Unsecured WF non-fin C (Stable)	40%
z5,1,2,2	Unsecured WF non-fin C (Unstable)	40%
z8,1	Unsecured WF by other legal customers	100%
z5,3	- Banks	40%
Total Cash Outflows		
<i>Cash Inflows</i>		
<i>Loans & Advances</i>		
z2,1,1	- Retail loans	50%
z4,1,i	- Corp Bonds (all R)	50%
z2,1,3	- Retail loans	50%
z2,2	- From Fin- Institutions	100%
<i>Other Receivables</i>		
z3,2	- From Corporate	50%
z3,1	- From Fin-Institutions	50%
Total Cash Inflows		
Net Outflows		
LCR		
NSFR		

Factors Required stable funding assets

	Factor
z1 & z6,1,1 - Assigned L1 in LCR	5%
z6,i & z4 - Assigned L2A in LCR	15%
z4,i,3 & z7 - Assigned L2B in LCR	50%
z2,2,2 - Loans to banks >6m	50%
z2,1,2 & z2,3,2 - (Loans) Operational. deposits in banks	50%
z2,i,3 Loans to non-fin (32.e)	50%
z7,>3 - Mortgages > 1y	65%
z2,>3,1 - Retail > 1 y	65%
z4,>3,i - Corporate Bonds > 1y	65%
z2,>3,3 Loans to non-fin (34.a)	85%
z11 <i>Fixed Tangible Assets</i>	
z11,1 - PPE	100%
z11,2 - Non-held for sale	100%
z11,3 - Other Tangible Assets	100%
z2,>3,2 - Loans not included above	100%

Total Required

Factors Available Stable Funding Assets

z5s Deposits - Stable < 1 y	
- Retail & Small Business	95%
z5nsr Deposits - Less Stable < 1 y	
z5corp - Retail & Small Business	90%
- Funding non-fin corporates < 1 y	50%
z5,<4,i	
z9,<4,3 & z9,3,1 - Funding p: CB & Banks 6m-1y	50%
z9,3,2 - WF - REPO	50%
z9,3,4 - WF - Corp Wholesale	50%
z9,<3,1 Other Liabilities	0%
z8 - All other liabilities	0%

SE

- Total Equity 100%

Total Available

NSFR

Annex 3

Parameters/Inputs of 'Bank I':

'Bank I''s balance sheet composition

(in thousands of €)

$X_{Cash \& \text{Equiv}}$	=	337605
$X_{Loans \& \text{Advances}}$	=	7096102
$X_{Other \text{Receivables}}$	=	233792
$X_{Government \text{Bonds}}$	=	1700879
$X_{Corporate \text{Bonds}}$	=	730161
$X_{Mortgages}$	=	8439929
$X_{Financial \text{A-Trading}}$	=	563755
X_{FTA}	=	1187426
$X_{Other \text{Assets}}$	=	685627
$X_{Deposits}$	=	13801758
$X_{Debt \text{Issues}}$	=	1045902
X_{WF}	=	4164123
$X_{Other \text{Liabilities}}$	=	438892
$X_{Common \text{Equity Tier 1}}$	=	1465121
$X_{Additional \text{Tier 1}}$	=	15000
$X_{Tier 2}$	=	44480

Bounds per Balance Sheet instrument

	Bounds	
	Lower	Upper
Cash & Equivalents	90%	20%
Loans & Advances	70%	35%
Other Receivables	70%	20%
Corporate Bonds	80%	25%
Government Bonds	80%	25%
Mortgages	90%	20%
Financial Assets held for trading	60%	30%
Fixed Tangible Assets	100%	0%
Other Assets	100%	0%
Deposits	90%	15%
Debt Securities	70%	35%
WholeSale funding	60%	35%
Other Liabilities	100%	0%

Table 13: Default bounds per BS position

Tax Rate & Plowback Ratio

	Rates	
	Tax Rate	Plowback
2013	25%	50%
2014	23%	50%
2015	23%	50%
2016	23%	50%
2017	23%	50%
2018	23%	50%
2019	23%	50%

Table 14: Default Tax and plowback rates

Reinvestment percentage allocation of Retained Earnings (φ)

	Percentage % Reinvestment RP	
	Loans & Advances	Corporate Bonds
2013	50%	50%
2014	50%	50%
2015	50%	50%
2016	50%	50%
2017	50%	50%
2018	50%	50%
2019	50%	50%

Table 15: Default rate of percent reinvestment of RP

Growth & decrease per BS instrument

$g (X_{Cash \& \text{Equiv}})t \sim N (0.07, 0.00)$	$d (X_{Cash \& \text{Equiv}})t \sim N (0.02, 0.00)$
$g (X_{Other \text{ Receiv}})t \sim N (0.07, 0.01)$	$d (X_{Other \text{ Receiv}})t \sim N (0.02, 0.01)$
$g (X_{Loans \& \text{ Adv}})t \sim N (0.07, 0.01)$	$d (X_{Loans \& \text{ Adv}})t \sim N (0.02, 0.01)$
$g (X_{Gov \text{ Bonds}})t \sim N (0.07, 0.01)$	$d (X_{Gov \text{ Bonds}})t \sim N (0.02, 0.01)$
$g (X_{Corp \text{ Bonds}})t \sim N (0.07, 0.01)$	$d (X_{Corp \text{ Bonds}})t \sim N (0.02, 0.01)$
$g (X_{Mortgages})t \sim N (0.07, 0.01)$	$d (X_{Mortgages})t \sim N (0.02, 0.01)$
$g (X_{Financial \text{ A-Trading}})t \sim N (0.07, 0.03)$	$d (X_{Financial \text{ A-Trading}})t \sim N (0.02, 0.03)$
$g (X_{FTA})t \sim N (0.03, 0.0)$	$d (X_{FTA})t \sim N (0.01, 0.0)$
$g (X_{Other \text{ Assets}})t \sim N (0.03, 0.0)$	$d (X_{Other \text{ Assets}})t \sim N (0.01, 0.0)$
$g (X_{Deposits})t \sim N (0.058, 0.0)$	$d (X_{Deposits})t \sim N (0.01, 0.0)$
$g (X_{Debt \text{ Issues}})t \sim N (0.058, 0.0)$	$d (X_{Debt \text{ Issues}})t \sim N (0.01, 0.0)$
$g (X_{WF})t \sim N (0.058, 0.0)$	$d (X_{WF})t \sim N (0.01, 0.0)$
$g (X_{Other \text{ Liabilities}})t \sim N (0.03, 0.0)$	$d (X_{Other \text{ Liabilities}})t \sim N (0.01, 0.0)$

Annex 4

RoE comparison.

OUTPUT								
<i>ROE</i>	<i>Return on Equity</i>							
Year (t)	2013	2014	2015	2016	2017	2018	2019	
<i>Initial</i>	-4,5%	-6,3%	-6,2%	-6,1%	-6,0%	-5,9%	-5,8%	
<i>Optimized</i>	0,3%	1,2%	2,8%	3,9%	4,9%	5,8%	6,6%	

Table 16: Comparison between initial RoE and the output obtained by the model

Table 16 shows how the change in the composition of the balance sheet presented by the model, impacted positively the return on equity. It managed to increase returns substantially and at the same time, 'Bank I' it is now compliant with the Basel III requirements.

Risk Profile Impact Study

It is shown below in figure 10 an example of how much the model changed the composition of 'Bank I's' balance sheet and for the inputs defined (bounds, risk profile, tax & plowback rate... etc.). It gives us the composition of the "initial" and the "optimal BS" obtained by the model for each assets & liability position, in the actual amount. This is a sample taken from the year of 2018 of a simulation using the "Risk Seeking" profile.

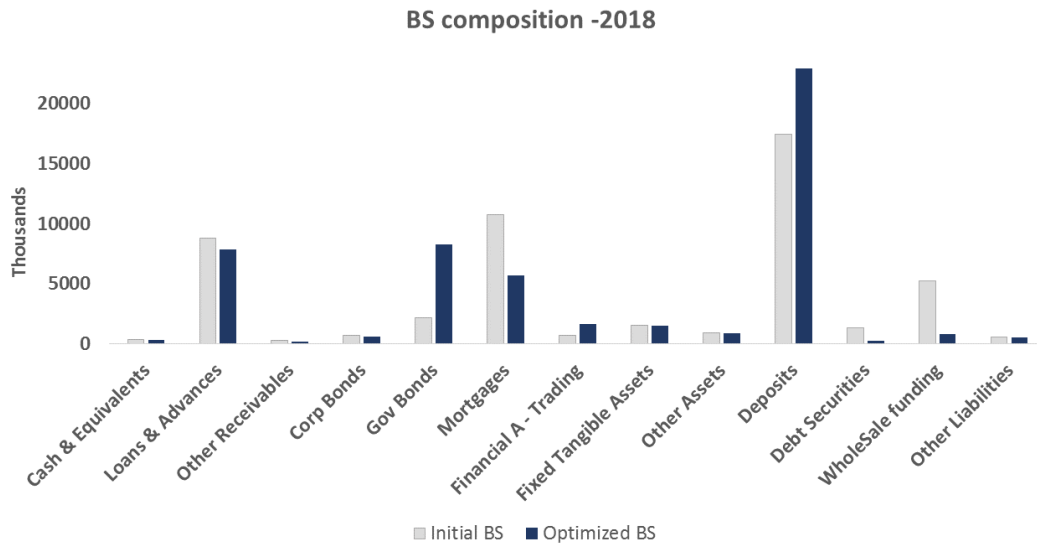


Figure 12: Model's output BS composition from "initial" to "optimal" BS

Below in table 17 are presented the values for the return on equity (RoE) for the current "initial" situation of 'Bank I' and the output of the model under the four different scenarios.

OUTPUT

"Optimized" RoE for the 4 scenarios

BS Date (Year)	2013	2014	2015	2016	2017	2018	2019
RoE							
Initial Scenario	-4,5%	-6,3%	-6,2%	-6,1%	-6,0%	-5,9%	-5,8%
1	0,32%	1,22%	2,61%	3,75%	4,60%	5,39%	6,14%
2	0,32%	1,03%	2,38%	3,17%	3,93%	4,44%	5,20%
3	0,32%	1,00%	1,86%	2,94%	3,50%	4,31%	4,94%
4	0,32%	1,33%	2,74%	3,93%	4,90%	5,79%	6,56%

Table 17: Model's output BS composition from "initial" to "optimal" BS to each scenario

As table 17 shows, ‘Bank I’ presents negative profit for the year of 2013 and it would also present negative results for the upcoming years if would not change its BS’s composition⁵⁶. However, the outcome proposed by the model allowed ‘Bank I’ to obtain significantly higher returns, even positive in this case.

The risk profile impact study done in this thesis, shows once again the negative relation between capital & liquidity constraints and return on equity. Table 17 demonstrates how the increase of capital & liquidity requirements, make ‘Bank I’ to have lower returns. Consequently, “Scenario 3” presents the lowest returns as it has the highest ratio requirements. On the contrary, “Scenario 4” presents the highest returns, as in this scenario, the liquidity requirements are abolished.

Below, there are four figures that present the evolution of the return on equity (RoE) under the “Risk Profile Impact Studies” four scenarios.

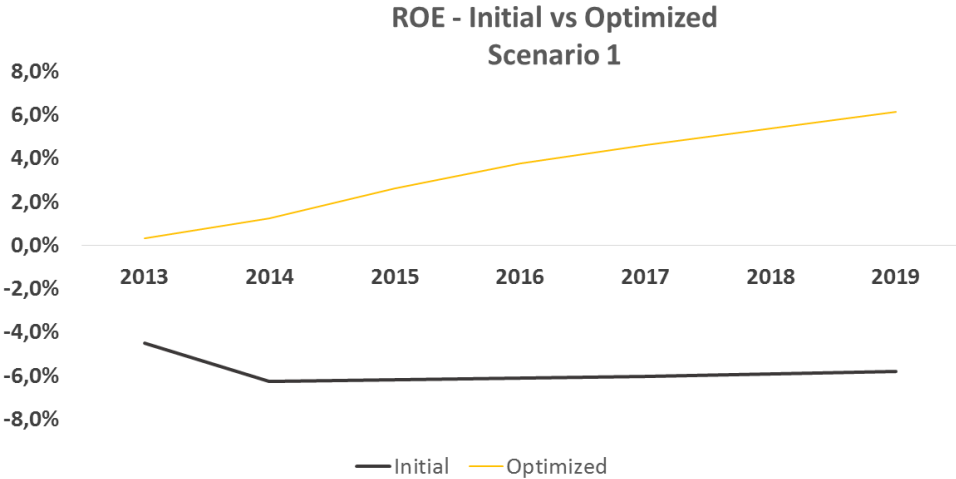


Figure 13:RoE evolution under "Scenario 1"

⁵⁶ If we consider that the BS instruments would provide the same income (assets) and the same expense (liabilities)

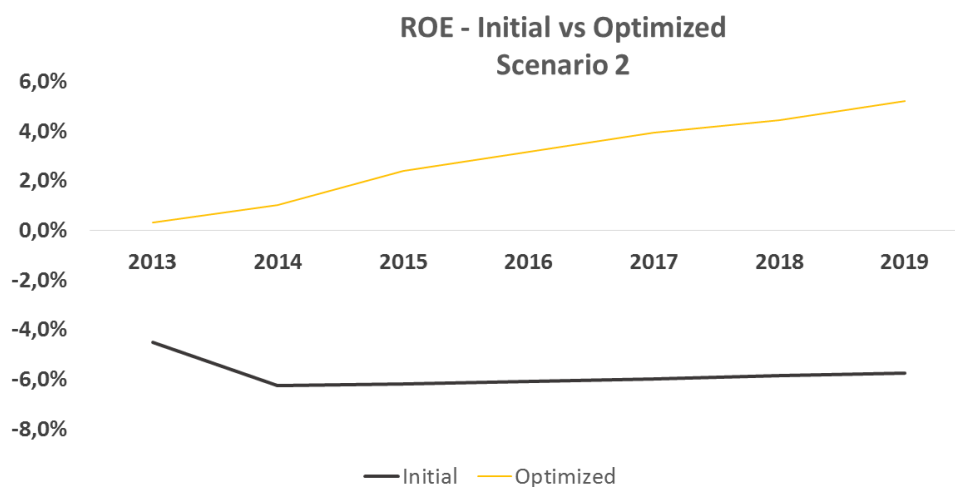


Figure 15: RoE evolution under "Scenario 2"

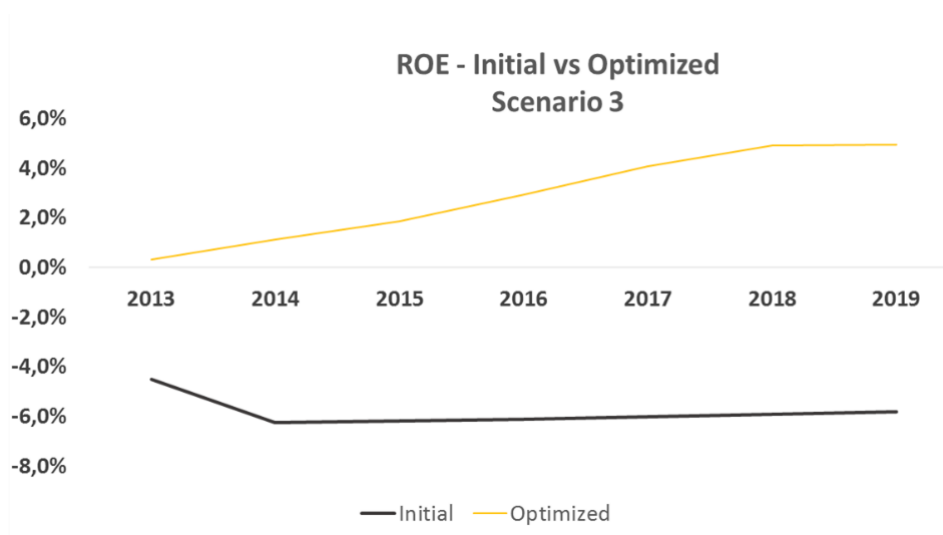


Figure 14: RoE evolution under "Scenario 3"

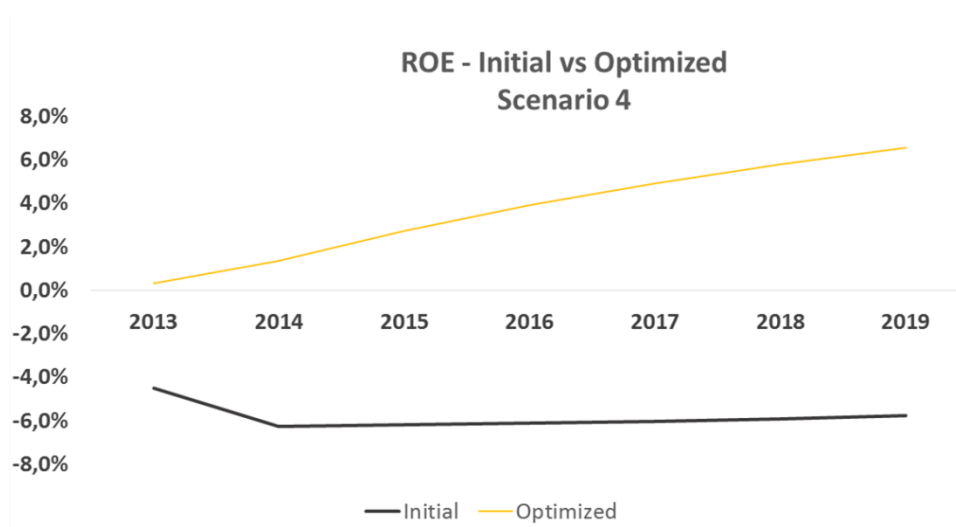


Figure 17: RoE evolution under "Scenario 4"

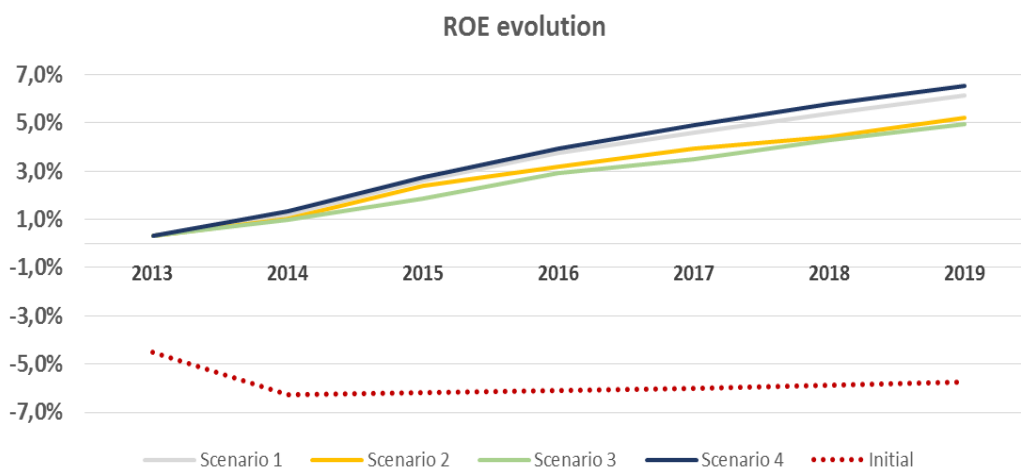


Figure 16: RoE evolution under de four scenarios

Annex 5

Stress tests – Impact Studies

OUTPUT

Scenario A (t=2016)		Loan Default									
Parameter	CET1 R	AddT1 R	CTier1 R	TC Ratio	LR	LCR	NSFR	ROE Δ d (BPS)	ROE	CET1	RWA
Initial											
0% Default	13,64%	0,13%	13,76%	14,14%	7,73%	70,9%	80,0%	0	4,2%	1862122	13656891
2% Scenario i	12,3%	0,13%	12,4%	12,8%	7,0%	74,1%	80,0%	-344	0,7%	1678642	13683032
5% Scenario ii	11,5%	0,14%	11,61%	12,02%	5,93%	70,6%	107,9%	-1748	-13,3%	1396445	12174401
15% Scenario iii	5,38%	0,18%	5,56%	6,08%	2,25%	70,0%	80,0%	-15034	-146,2%	501126	9310483

Table 18: Stress scenario-Loan Default

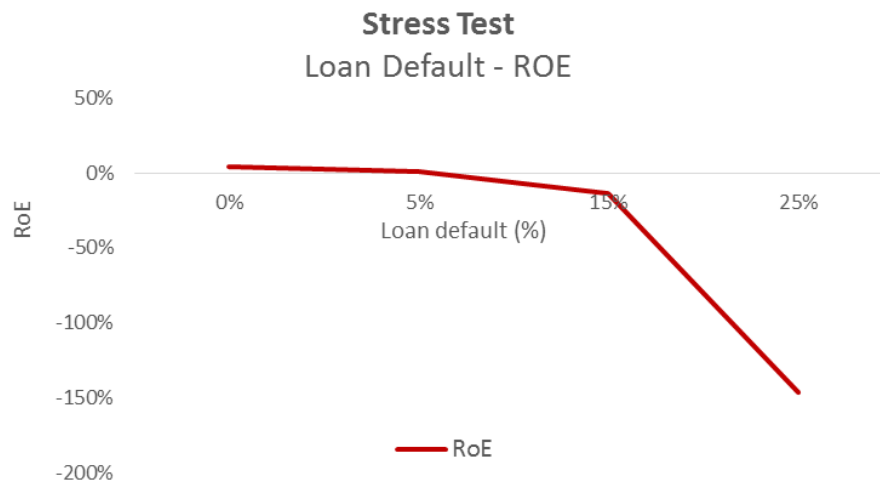


Figure 18 – Impact of Loan default on RoE

Table 18 confirms the significant impact of loan default on the return on equity. Observe that just a 2% rate of loan default implies a 350 basis point decrease on return, leading to a close to zero return on equity.

OUTPUT

Scenario B (t=2015)		Deposits attrition rate increase										
Parameter		CET1 R	AddT1 R	CTier1 R	TC Ratio	LR	LCR	NSFR	ROE Δ d (BPS)	ROE	CET1	RWA
Attrition rate												
0%		12,40%	0,12%	12,52%	12,88%	7,41%	61,8%	70,0%	0	3,0%	1696741	13685333
5%	Scenario i	12,6%	0,12%	12,7%	13,0%	7,7%	0,5%	68,5%	-16	2,8%	1684771	13582533
15%	Scenario ii	13,8%	0,12%	13,89%	14,23%	8,51%	0,3%	70,3%	-98	2,0%	1705034	12381049
30%	Scenario iii	14,74%	0,11%	14,85%	15,16%	9,99%	0,1%	61,3%	-483	-1,9%	1713328	11624017

Table 19: Stress scenario-Deposit attrition rate increase

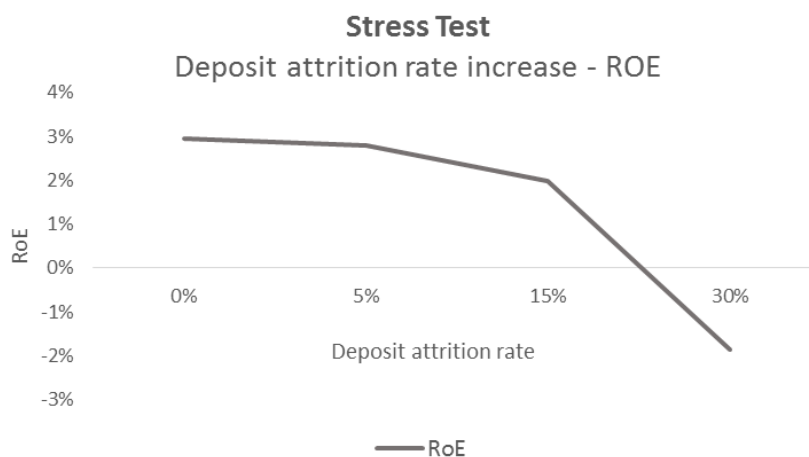


Figure 19 – Deposit attrition rate impact on RoE

Concerning scenario B it can be confirmed, by observing table 19, what was already illustrated before. In fact, the impact of deposit withdrawals has a significant less negative impact on return on equity. However, the short-term liquidity ratio (LCR) is highly impacted due to the decrease of high quality liquid assets (HQLA).

Part VI

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