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Impairment modelling for financial assets under IFRS 9

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Abstract

IFRS 9 introduces new impairment rules in order to respond to G20's complaint about the complexity and the lack of efficiency of the IAS 39 standard. The main issue was a delayed recognition of credit losses on loans and other financial instruments. This new Standard is mandatory from January 1th 2018.

This thesis reviews the implementation of this new regulatory requirement and the way in which institutions are preparing for the application of the new Standard. We will start with an overview of the IFRS 9 standard by explaining the latter and what are the key steps in its implementation. We will then put into practice the various theoretical points in a case study. More precisely, we will apply the calculation of the expected credit loss, which is the main topic of this new requirement, in its entirety by basing our calculations on a concrete example namely, a private bank in Luxembourg. We will conclude this thesis by citing the impacts that this new regulation will have on entities by basing our calculation on three different banks.

The case study will show that the implementation of the new IFRS 9 impairment requirements is rising the credit loss allowances of many banks and financial institutions. However, this growth will vary by entity, depending on its portfolio. The case study also demonstrates that the IFRS 9 loan loss allowances increase timely with the raise of the probabilities of default when the credit standing deteriorates. Finally, the impact assessment will show that the impact can be less significant than predicted by the European Banking Authority (EBA).

Key Words: IFRS 9, IAS 39, Expected Credit Loss, Impairment, ECL, Financial Instruments, IFRS accounting, Credit Risk, Probability of Default, PD, Exposure at Default, EaD, Loss Given Default, LGD.

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TABLE OF CONTENTS

I. GENERAL INTRODUCTION 1

II. IFRS 9 "*FINANCIAL INSTRUMENT*" 3

1. Introduction 3

2. General context 4

2.1. IAS 39 4

2.2. Why the IAS 39 standard needed an update? 5

2.3. Overview of the IFRS 9 requirements 6

2.3.1. Phase I: *Classification and Measurement* 6

2.3.2. Phase II: *Impairment* 8

2.3.3. Phase III: *Hedge Accounting* 8

3. Impairment phase: loss allowance 9

3.1. History and background of the impairment model 9

3.1.1. November 2009 9

3.1.2. January 2011 10

3.1.3. March 2013 11

3.1.4. July 2014 12

3.2. Approaches 13

3.2.1. General three-stage approach 13

3.2.2. Simplified approach 13

4. Expected Credit Loss Modelling 15

4.1. Scope 15

4.2. General approach: the three-stage model 16

4.2.1. Scope: which financial assets are concerned? 16

4.2.2. How to measure the loss allowance? 19

4.2.3. Staging: when should an impairment loss be recognized? 22

4.2.4. Which entities will be affected by the new Standard? 27
4.3. Probability of default modelling 28
4.3.1. Merton model 28
4.3.2. Weibull distribution 33
4.3.3. Migration matrix 35
4.3.4. Through the cycle PD vs. point-in-time PD 38
5. Conclusion 40
III. CASE STUDY 41
1. Introduction 41
2. Reminder of the problematic 41
3. The Bank 41
3.1. Description of the Bank 41
3.2. The Bank's portfolio 42
4. The ECL modelling 42
4.1. ECL calculation of bonds 43
4.1.1. Objective 43
4.1.2. Methodology 44
4.1.3. Results 49
4.2. ECL calculation for retail and corporate mortgages 53
4.2.1. Objective 53
4.2.2. Methodology 53
4.2.3. Results for retail mortgages loans 57
4.2.4. Limits 58
4.2.1. Results for corporate mortgages 61
4.3. ECL calculation for financial institutions loans 64
4.3.1. Objective 64

4.3.2. Methodology 65
4.3.3. Results 69
IV. IMPACTS OF IFRS 9 71
1. Scope 71
2. Existing treatment of impairment provisions in regulatory capital 71
3. Results on EBA impact assessment of IFRS 9 74
4. Estimated quantitative impact of IFRS 9 on three Luxembourgish banks 76
V. LIMITATIONS 78
VI. GENERAL CONCLUSION 79
VII. APPENDIX 81
VIII. BIBLIOGRAPHY 82
1. Books 82
2. Papers 82
3. Regulation 85
4. Master thesis 85
5. Internet website 86

Abbreviations

BS	Black-Scholes
C&M	Classification and Measurement
CDS	Credit Default Spread
CET1	Core Equity Tier 1 capital
CL	Credit Losses
CRR	Capital Regulatory Requirement
CSSF	Commission de Surveillance du Secteur Financier
EaD	Exposure at Default
EBA	European Banking Authority
ECL	Expected Credit Loss
ED	Exposure Draft
EEA	European Economic Area
EL	Expected Loss
FASB	Financial Accounting Standard Board
FVTOCI	Fair Value Through Other Comprehensive Income
FVTPL	Fair Value Through Profit & Losses
HPI	Housing Price Indices
IASB	International Accounting Standard Board
IFRS	International Financial Reporting Standards
IRB	Internal Rating Based approach
LGD	Loss Given Default
P&L	Profit and Loss
PD	Probability of Default

RDO	Rate of Default Occurring
RR	Recovery Rate
RWA	Risk Weighted Assets
SA	Standardized Approach
The Standard	International Financial Reporting Standards 9 (IFRS 9)
UL	Unexpected Loss

List of Tables

Table 1 - Moody's and S&P's credit rating table....36

Table 2 - One-year global corporate average transaction rate (1981-2015) 37

Table 3 - Through the cycle and point-in-time PD 39

Table 4 - Information related to bond's portfolio 44

Table 5 - Average Cumulative Issuer-Weighted Global Default Rates by Alphanumeric Rating, 1983-2010, provided by Moody's....48

Table 6 : Bond's information....49

Table 7 - Credit Loss Calculation, default on the 6th month 50

Table 8 - Discount factor calculation 51

Table 9 - Marginal Default Rates....51

Table 10 – ECL Calculation....52

Table 11 – ECLs calculation summary table 53

Table 12 – PD calculation for retail/corporate mortgages loans....55

Table 13 - Retail mortgage loan's data....57

Table 14 - House Price Index for Belgium and Luxembourg....59

Table 15 - ECLs calculation for retail mortgages loans....61

Table 16 - Corporate mortgage loan's data 62

Table 17 - ECLs calculation of corporate mortgage loans....64

Table 18 - Average one-year alphanumeric rating migration rates, 1983-2010 66

Table 19 - Counterparty rating and PD mapping table 67

Table 20 - Financial institutions' data 69

Table 21 - ECLs calculation for financial institutions 70

Table 22 - Treatment of impairment in definition of regulatory capital resources 73

Table 23 - Accounting provision (Standardised approach).....77

Table 24 - CET 1 ratio and Capital ratio 77

List of Figures

Figure 1 - Process for determining the classification and measurement of financial assets.....8

Figure 2 - Loss allowance comparison chart between ED 2009 and ED 2013.....12

Figure 3 - IFRS 9 Timeline.....13

Figure 4 - Summary of the IFRS 9 general impairment model 27

Figure 6 - Probability distribution function 34

Figure 5 - Probability density function 34

Figure 7 - Belgium regression curve and 2018/19 forecasts.....59

Figure 8 - Luxembourg regression curve and 2018/19 forecasts.....60

Figure 9 - Decision tree for obtaining the 1-year PD information.....65

Figure 10 - Illustration of impact of existing prudential treatment of provisions.....74

Figure 11- Summary of the estimated quantitative impact of IFRS 9 76

I. General Introduction

During the financial crisis, the delayed recognition of credit losses on loans and other financial instruments was acknowledged as a weakness in the current accounting standards. Particularly, the existing model in IAS 39 which was an 'incurred loss' model, delays the recognition of credit losses until there is evidence of a trigger event. This was designed to limit an entity's ability to create reserves that can be used to help earnings during hard times. In consequence to this non-neglecting delay, financial authorities decided, in 2009, to develop a single financial reporting model for financial instruments that provides investors with the most useful, transparent, and relevant information about an entity's exposure to financial instruments while reducing the complexity in accounting. In July 2014, the ISAB published the final version of the new standard, IFRS 9 "*Financial Instruments"* which the mandatory effective date is January 1st 2018.

This thesis will hence, focus on the implementation of this new regulatory requirement and the way in which institutions are preparing for the application of the new Standard. Luxembourgish banks are the ones that will be most affected by this Standard and will therefore be the central element of this thesis.

In the first part of the thesis, we will first provide an overview of the standard IFRS 9 *"Financial Instruments"* and more specifically on the phase II of the Standard, namely the impairment phase and the calculation of the expected credit losses (ECLs). The new expected credit loss standard will be a more forward-looking approach that highlight changes to the probability of future credit losses, even if no such triggering events have yet occurred. This require entities to account ECLs from when financial instruments are first recognised and to recognise full lifetime expected losses on a timelier basis.

In the second part of the paper, we will proceed to a case study based on a realistic example related to Luxembourgish private banking. Thus, we will put into practice the methodology

present in the Standard that is used by Luxembourgish banks in order to allocate the necessary loss allowance while adding a forward-looking information. Adopting the expected credit losses requirements will require many entities to make significant changes to their current systems and processes, thus this thesis is regrouping the early assessment and planning made by banks in 2017 which will be key to managing successful implementation.

Finally, in the last part of this paper, we will understand the estimated impact of IFRS 9 on regulatory own funds of three Luxembourg banks, which can give us an overview of the impact on the Luxembourgish market. Indeed, the new requirements will demand larger loss allowances for banks, similar financial institutions and investors in debt securities. In consequence, this will reduce equity and have an impact on regulatory capital.

II. IFRS 9 "*Financial Instrument*"

1. Introduction

This section will incorporate much of the theory regarding the new IFRS 9 standard and will be divided into three parts.

In the first part of this section, we will address the general context of IFRS 9 "*Financial Instruments*" new standard. We will slightly introduce the previous standard *IAS 39 "Financial Instrument: Recognition and Measurement"* and explain why the IAS 39 standard needed an update. We will also get an overview of the IFRS 9 requirements by presenting the three phases that the Standard contains.

Afterwards, the second part of this section will be devoted to the second phase of the IFRS 9 standard, namely, the impairment model. In this section, we will first of all, make a step backwards by dedicating a part of the thesis to the history and the background of the second phase of the new Standard. We will present a timeline of the different drafts that have emerged since 2009, following the financial crisis, which was the main decisive element of the new reform, until the publication in 2014 of the final version of the Standard. Then, we will go through various approaches to calculate the loss allowance which is the main topic of this impairment model.

Finally, the last part of this section will be related to the expected credit loss (ECL) in general. We will at first have lay the scope of this new requirement. Then we will give detailed explanation of the general approach of the loss allowance of the new IFRS standard. We will review the three-step approach by explaining the general aspect at first and present which assets are concerned by this model. Then we will see how to measure the loss allowance, when should an impairment loss be recognized and which entities will be impacted by this new requirement. Lastly, we will present three probability of default model, we will then choose one of this model for the case study part which is following this section.

2. General context

2.1. IAS 39

IAS 39 "*Financial Instruments: Recognition and Measurement*" has been approved in December 1998 (applicable to the financial statements opened as of 1 January 2001). It was revised in October 2000 and December 2003. This last revision is applicable to the financial statements with effect from 1 January 2005. IAS 39 follows IAS 32 "*Financial Instruments: Disclosure and Presentation*" to which it is related to. The latter was approved in March 1995 and revised in December 1998, October 2000 and December 2003 (Obert, 2004).

IAS 39 prescribes rules for accounting and reporting of almost all types of financial instruments which are defined as "*any contract that gives rise to both a financial asset of an entity and a financial liability or an equity instrument of another entity*". They include cash, deposits, debt & equity securities (bonds, treasury bills, shares…), derivatives, loans & receivables and many others (IAS 39).

This standard is classifying financial assets into four main categories: financial asset at fair value through profit or loss; held-to-maturity financial investments; loans and receivables; available-for-sale financial assets. For the liabilities, there is two main categories: financial liabilities at fair value through profit or loss and other financial liabilities measured at amortized cost using the effective interest method (IAS 39).

Regarding the impairment model, entities should assess at the end of each reporting date whether there is any objective evidence that a financial asset is impaired. Only if there is such evidence, entities have to calculate the amount of impairment loss which will be recognized to profit or loss account (Silvia, 2012). This situation was the main reason of the updated that we will introduced in the following section.

2.2. Why the IAS 39 standard needed an update?

Prior to the financial crisis, the two accounting authorities, the Financial Accounting Standards Board (FASB) and the International Accounting Standards Board (IASB), had already planned to revise and improve their respective standards on accounting for financial instruments. Furthermore, once the financial crisis arose, it confirmed the needs for changes in the application of these standards. Indeed, the financial crisis truly revealed that accounting standards in general were not appropriate for the current economic environment and showed that they were not efficient enough to face this changing environment (FASB, 2010).

During the financial crisis, a delayed recognition of credit losses on loans and other financial instruments was identified as one of the main weakness in existing accounting standards. At that time, the impairment requirements model was IAS 39 which was based on an 'incurred loss model'. This model recognises credit losses merely after a credit loss event occurs or once there is an evidence of a trigger event (e.g. borrower loss of employment, decrease in collateral values, past-due status). However, in practice, losses are rarely incurred evenly over the lifetime of loans, they are more likely to arrive randomly. In consequence, there were a mismatch in the timing of the recognition of the credit spread charged on the loans over their lives and any impairment losses that only get recognised at a later date. Also, the fact that many users of financial statements have told the FASB and the IASB that the requirements in IAS 39 used multiple impairment models which made them hard to understand, apply and interpret making that an additional concern (Ernst & Young, 2014).

After the economic crisis, it was clear that urgent changes were needed. And this explains why, in order to support financial statement's users, financial authorities decided to develop a single financial reporting model for financial instruments that provides investors with the most useful, transparent and relevant information about an entity's exposure to financial instruments while reducing the complexity in accounting (FASB, 2010).

The final version of the IFRS 9 standard will replace IAS 39 "*Financial Instrument: Recognition and Measurement"* and will bring together the classification and measurement, impairment and hedge accounting phases, which will be divided in three specific parts (IASB, 2014):

- a single classification and measurement approach for financial assets based on their business model in which they belong to and their cash flow characteristics;
- a new impairment model based on excepted credit loss that will proceed to a timelier losses recognition for all financial assets;
- an improved hedge accounting model that will establish a better connection between accounting and risk management.

Furthermore, these changes will simplify financial reporting by implementing a clear, an easier way to classify financial instruments, removing the threshold for credit loss recognition and changing the requirements for hedge accounting (FASB, 2010).

2.3. Overview of the IFRS 9 requirements

In July 2014, the International Accounting Standards Board (IASB) published final version of IFRS 9 "*Financial Instruments*". The project had been divided into three phases to facilitate financial statement users by using a step by step approach. The first phase is developing the classification and the measurement of the financial asset. Then, the second phase is about the impairment phase which will determine the loss allowance of financial assets. Finally, the third and the final phase of the Standard will be focused on the hedge accounting.

2.3.1. Phase I: *Classification and Measurement*

In opposition to IAS 39, IFRS 9 applies one classification approach for all types of financial assets. Financial assets should be classified and measured by using a two-criteria method that should be applied by entities. Entities have to first analyse their (a) business model regarding their financial assets management and in a second time, they have to analyse (b) the contractual cash flow characteristics of their financial assets.

(a) A business model provides information on how an entity manages its financial assets on an aggregated level in order to achieve a particular business objective. In other words, this is how entities are generating cash flows, either by collecting contractual cash flows, selling financial assets or both. The elaboration of the business model is based on fact and objective information such as business plan or the amount of sales. Indeed, the

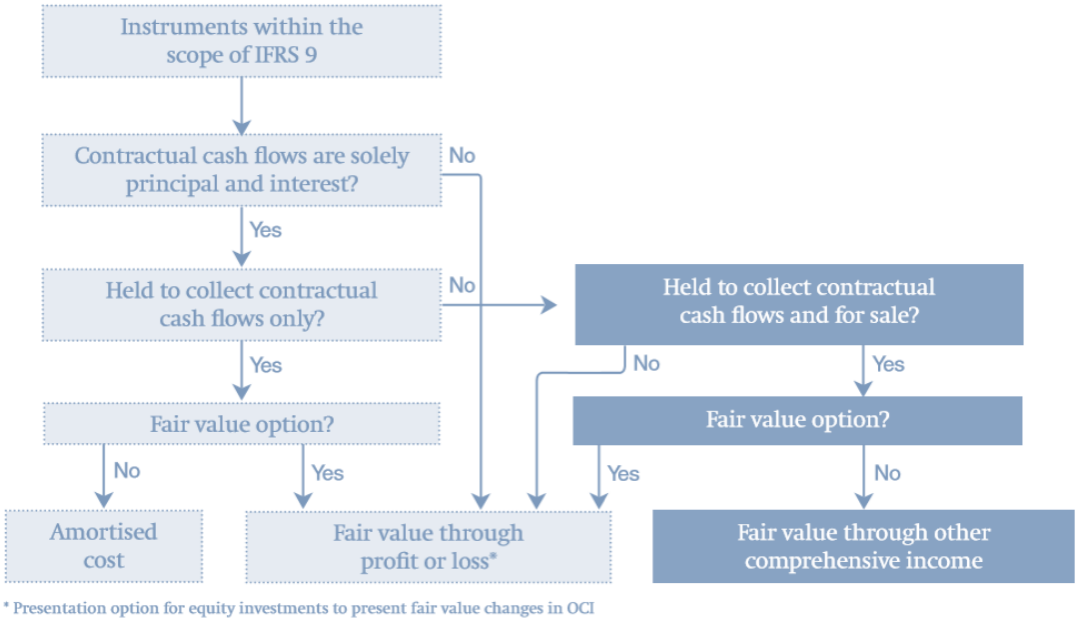
judgment can only be used when there is available evidence. Each type of financial asset is associated with a certain objective regarding the business model, that makes the classification easier to proceed (IASB, 2014).

- Financial assets classified and measured at amortised cost (AC) are held in a business model whose objective is to hold assets in order to collect contractual cash flows;
- Financial assets classified and measured at fair value through other comprehensive income (FVTOCI) are held in a business model whose objective is achieved by both collecting contractual cash flows and selling financial assets;
- Any financial assets that are not held in one of the two business models mentioned above are measured at fair value through profit or loss (FVTPL).

(b) For the classification of a financial asset, entities have to determine whether their contractual cash flows are solely payments of principal and interest (SPPI) or not. This SPPI test means that the cash flows of the asset are only the repayment of the principal and interest on the principal remaining due. Only financial assets that meet the SPPI criteria are eligible for amortised cost (AC) or fair value through other comprehensive income (FVTOCI) measurement depending on the business model in which the asset is held (IASB, 2014).

The figure below is presenting the procedure to follow for the classification and measurement of financial assets.

Figure 1 - Process for determining the classification and measurement of financial assets



Source: IFRS 9 "*Financial Instruments*"; Project Summary

2.3.2. Phase II: *Impairment*

As stated previously, new impairment model has been added in the final version of July 2014 that replaces the complex and multiple impairment model existing in IAS 39 and which is a more forward-looking model. This model will be detailed in the section *4. Expected credit loss* below.

2.3.3. Phase III: *Hedge Accounting*

In November 2013, chapters relating to hedge accounting have been published and not been modified ever since. The main objective of this hedge accounting phase is to reflect in an entity's financial statements the effects of its risk management activities. It is important to analyse the consequences of these activities in order to manage the various risks to which the entity is likely to be exposed (such as foreign exchange risk, interest rate risk or the price of a commodity), since these risks could affect the profit and loss statement (P&L) (IASB, 2014).

3. Impairment phase: loss allowance

3.1. History and background of the impairment model

3.1.1. November 2009

In November 2009, that the International Accounting Standard Board (IASB) and the Financial Accounting Standard Board (FASB) decided to develop the new accounting standard in response to request done by the G20, investors, regulatory bodies and prudential authorities in the improvement of the accounting requirements for financial instrument. The IASB thus published an Exposure Draft (ED) "*Financial Instruments: Amortised Cost and Impairment"*, which was a single set of global standard and proposed an impairment model based on expected losses rather than incurred losses, for all financial assets recorded at amortised cost. The main objective of this draft was to determine principles for the measurement at amortised cost of financial assets and financial liabilities that will provide useful information to users of financial statements for the assessment of the amounts, timing and uncertainty of their future cash flows. This ED also completes and improves the principles by recognising, classifying, measuring, presenting and providing disclosures about financial assets and liabilities present in IAS 32 "*Financial Instruments: Presentation*", IAS 39 "*Financial Instruments: Recognition and Measurement*" and IFRS 7 "*Financial Instruments: Disclosures*" (IASB, 2009).

This model obliges entities to recognise ECLs over the lifetime of a financial asset since initial recognition, by including these losses in the calculation of the effective interest rate (EIR). By using this method, the loss allowance will be based on the entire lifetime of the financial asset and so 'match' the recognition of credit losses. Subsequent changes in credit loss expectations would be reflected in catch-up adjustments to profit or loss based on the original EIR. With this method, two problems arose:

- the Board was more in favour of a model that would differentiate the initial estimates of ECLs from the future changes in these estimates; and
- the Board was also worried about the operational difficulties and cost that the implementation of the model would generate (IASB, 2009).

As a result of these constraints, the IASB decided to make the distinction between the determination of the expected credit loss and the effective interest rate, which will lead to a different measurement of loss allowance for both ECL and EIR. The latter will not be adjusted for initial expected credit losses anymore. This method will reduce the operational cost that could arise due to the huge change in the implementation (IASB, 2009).

However, there is still some concerns about this draft. The IASB is convinced that discounting ECL by using the original EIR will generate a double-count of the ECL compute at initial recognition. Hence, the IASB concluded that identifying lifetime ECLs on initial recognition was not suitable. The underlying solution was thus to follow a dual-measurement model that would require an entity to recognise:

- "*A portion of the lifetime ECLs from initial recognition as a proxy for recognising the initial ECLs over the life of the financial asset and;*
- *The lifetime ECLs when credit risk has increased since initial recognition (i.e., when the recognition of only a portion of the lifetime ECLs would no longer be appropriate because the entity has suffered a significant economic loss)*" (IASB, 2009)

It should be noted that that any method that is approaching the model present in the 2009 ED will include a recognition threshold for lifetime ECL. This will result in a cliff effect, this is a significant increase in the loss indemnity which represents the difference between the part that was previously recognized and the lifetime ECLs (IASB, 2009)

3.1.2. January 2011

In January 2011, the FASB decided to develop an alternative expected credit loss model and realised a supplementary document on impairment. In December 2012, the FASB proposed an update, *Financial Instruments Credit Losses*, that would require an entity to recognise a loss allowance for ECLs from initial recognition at an amount equal to lifetime ECLs (International Accounting Standard Board, 2009).

3.1.3. March 2013

In March 2013, the International Accounting Standard Board (IASB) published its third Exposure Draft (ED); *Financial Instruments: Expected Credit Losses* (ED/2013/3), on impairment of financial assets, based on the common project with the FASB. This draft proposed that entities should recognise two different loss allowance or provision depending on the situation faced:

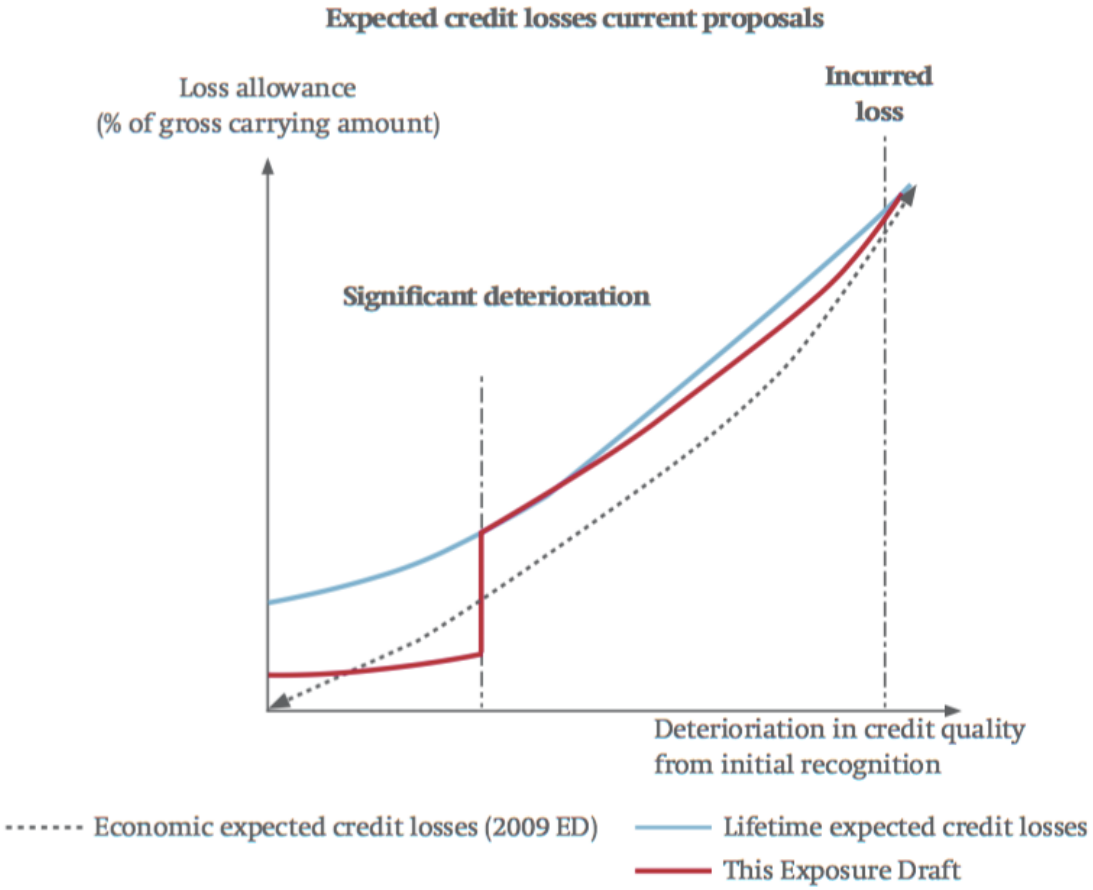
- For financial instrument that had not yet seen a significant increase in credit risk since initial recognition, entities should recognise an amount of loss allowance equal to 12-month ECLs;
- For financial instrument that had seen a significant increase in credit risk, entities should recognise a loss allowance equivalent to lifetime ECLs.

This new model was designed for three specific purposes, namely to:

(a) "Ensure a more timely recognition of expected credit losses than the existing incurred loss model;
(b) distinguish between financial instruments that have significantly deteriorated in credit quality and those that have not; and
(c) better approximate the economic expected credit loss." (IFRS 9, 2014).

The following diagram shows properly the difference between the 2009 ED and the 2013 ED. The new model is more of a two-step model rather than the one proposed in the 2009 ED which shows a steady increase due to the non-revision of the expected credit loss assumptions made at initial recognition. Indeed, the two-step model first 'overstates' the loss allowance, then as the credit quality 'deteriorates', it understates the allowance, and then 'overstates' it again, as soon as the deterioration is significant (IFRS, 2013).

Figure 2 - Loss allowance comparison chart between ED 2009 and ED 2013

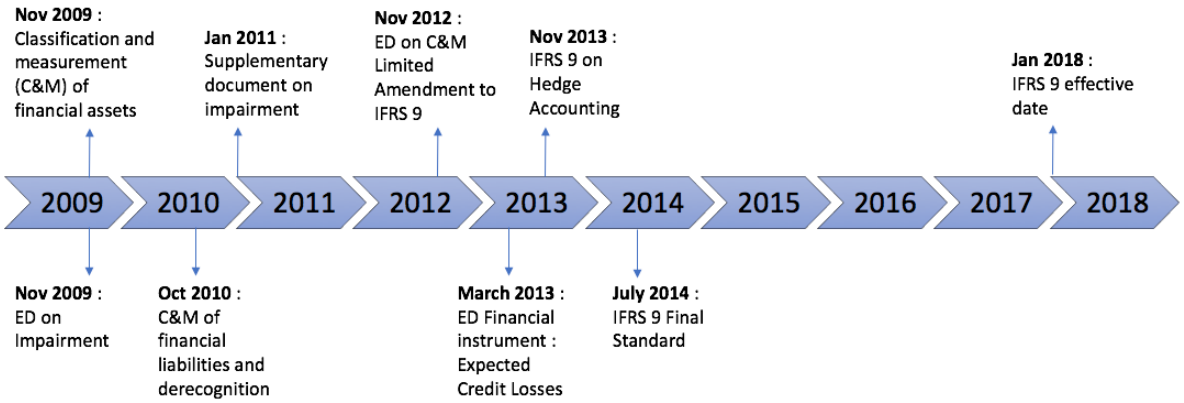


Source: Exposure Draft 2009 "*Financial Instruments: Amortised Cost and Impairment*"

3.1.4. July 2014

In July 2014, the IASB finalised and released the impairment requirements after having readjusted some arguments of the 2013 ED proposals. The aim of these changes was to provide additional clarifications and further guidance to help entities implement the proposed requirements. These changes resulted in the development of the final version of IFRS 9 *"Financial Instruments"*, which will be effective as of January 1, 2018. The graph bellow is showing the IFRS 9 timeline.

Figure 3 - IFRS 9 Timeline



Source: PWC - IFRS 9: Excepted credit losses

3.2. Approaches

3.2.1. General three-stage approach

IFRS 9 establishes a three-stage approach for impairment of financial assets, based on whether there has been a significant deterioration in the credit risk of a financial asset. These three stages (stage 1, stage 2 and stage 3) then determine the amount of impairment to be recognised (12-month ECL or lifetime ECL). This section will be detailed in the section *4.2 General approach: the three-stage model*, latter in this thesis.

There are two alternatives to the general approach: the simplified approach which will be explained hereunder, and the purchased or originated credit-impaired financial assets (see section *4.2.3.4 Stage 3: credit-impaired financial assets*).

3.2.2. Simplified approach

Determining the stage of a financial asset is not necessary in this simplified model. Indeed, this approach does not require entities to track changes in credit risk it requires entities to recognise a loss allowance but the loss should always be recognized at a lifetime expected credit loss on each reporting date directly from origination. Entities are required to apply the simplified model for trade receivables or contract assets that do not contain a significant financing component. IFRS 15 "*Revenue from contracts with customers*" specifies how and when an IFRS reporter

will recognise revenue and requires entities to provide users of financial statements with more informative, relevant disclosures (Silvia, 2014).

Applying the simplified approach to trade receivables and contract assets that do not contain a significant financing component automatically makes sense, especially for trade receivables and contract assets that are due in 12-months or less, because in this case 12-month ECL is the same as lifetime ECL. However, entities have the right to choose whichever approach they want to apply between both simplified and general approach for:

- All trade receivables or contract assets that result from transactions which are fully *IFRS 15 "Revenue from contracts with customers"* compliant and that contain a significant financing component. The chosen strategy may turn to be different from trade receivables to contract assets.
- All lease receivables that result from transactions that are within the scope of *IFRS 17 "Leases"*. Once again, the policy choice may be applied differently to finance and operating lease receivables.

The IASB noticed that allowing entities to make their own policy choices would decrease comparability among them. However, the Board also believes that it would improve some of the concerns regarding tracking changes in credit risk for entities that do not have sophisticated credit risk management systems (Ernst & Young, 2014).

4. Expected Credit Loss Modelling

4.1. Scope

The ECL requirements must be adopted with the other IFRS 9 requirements from 1 January 2018, with early application permitted if the other IFRS 9 requirements are adopted at the same time.

The ECL model from the IFRS 9 standard is a more-forward looking model than the IAS 39 impairment model. In the new standard, holders of financial assets no longer have to only consider historical information that provides objective evidence that financial assets are impaired. Today, they are required to consider reasonable and supportable information that is available without undue cost or effort and that includes forecasts of future economic conditions when calculating ECLs. Under IAS 39, loss allowances were only recorded for impaired exposures, contrary to IFRS 9, for which entities are now required to record loss allowances for all credit exposures not measured at fair value through profit or loss (FVTPL) (Ernst & Young, 2014).

The principle of the expected credit loss model is to reveal principally the deterioration in the credit quality of financial instruments. ECLs recognised as a loss allowance depends on the amount of credit deterioration observed since initial recognition and are an estimation of credit losses over the lifetime of a financial instrument (Ernst & Young, 2014).

According to IFRS 9: 5.5.17, the measurement of the expected credit losses should reflect:

(a) *"An unbiased and probability-weighted amount that is determined by evaluating a range of possible outcomes;*
(b) *The time value of money; and*
(c) *Reasonable and supportable information that is available without undue cost or effort at the reporting date about past events, current conditions and forecasts of future economic conditions."*

4.2. General approach: the three-stage model

4.2.1. Scope: which financial assets are concerned?

The IAS 39 incurred loss model is replaced by the new impairment requirements in IFRS 9 "*Financial Instruments*" which are based on an expected credit loss model. This model indicates that an entity shall recognise a loss allowance for expected credit losses on the following (Deloitte, 2013):

- Financial assets (bank deposits, loans, debt securities and trade receivables) measured at amortised cost (AC);
- Financial assets mandatorily measured at fair value through other comprehensive income (FVTOCI);
- Lease receivables under IFRS 17 "*Leases"* or IFRS 16 "*Leases";*
- Contract assets under IFRS 15 "*Revenue from Contracts with Customers"*;
- Loan commitments that are not measured at fair value through profit or loss (FVTPL);
- Financial guarantee contracts that are not measured at fair value through profit or loss (FVTPL).

4.2.1.1. At amortised cost

The amortised cost of a financial asset or financial liability is defined in the IFRS 9 standard as: *"The amount at which the financial asset or financial liability is measured at initial recognition minus the principal repayments, plus or minus the cumulative amortisation using the effective interest method of any difference between that initial amount and the maturity amount and, for financial assets, adjusted for any loss allowance".* (IFRS 9, 2014)

In order to measure a financial instrument at amortized cost, unless this instrument is designed at FVTPL, it must absolutely pass the following two tests:

1) Business model test: the financial asset must be held within a business model whose objective is to hold financial assets to collect their contractual cash flows;

2) Cash flow characteristics test: the contractual terms of the financial asset must pay cash flows that are meeting the SPPI criteria (Solely Payments of Principal and Interest) on the principal amount outstanding.

4.2.1.2. Fair Value

Fair value is defined in the standard IFRS 13 "*Fair Value Measurement"*, as followed: *"The objective of a fair value measurement is to estimate the price at which an orderly transaction to sell the asset or to transfer the liability would take place between market participants at the measurement date under current market conditions."* However, fair value can be defined in various ways depending on the subject that we are working on (IFRS 13, 2013).

Fair value can also be defined as the asset and liabilities value of a subsidiary firm when its financial statements are consolidated with the parent company. This accounting treatment is unusual because original cost is used to value assets in most cases. When the parent company buys an interest from its subsidiary firm, the assets and liabilities of this branch are recorded at fair value. The financial situation of the two companies, which in fact are one company, is also translated into its true value (IFRS 13, 2013).

Moreover, fair value can also be defined as a valuation method of assets. Sometimes, executing a company valuation can be challenging for accountants (i.e. determine the fair value of an asset that is not active on the stock exchange). In those cases, accountants usually use the discounted cash flows generated by the asset to determine its fair value (IFRS 13, 2013).

The fair value of certain investments may also be based on the market value on which the security is traded. Market makers present in the stock exchange are providing a bid and ask price for each security. For instance, if the investment is a stock, the investor can thus sell the stock at the bid price to the market maker or buy the stock from the marker maker at the ask price. The most trustworthy method to determine an investment's fair value is therefore to list the security on an exchange. Regarding derivatives (e.g. call or put option), the fair value is determined by the value of the underlying asset whereas in the futures market, fair value is equal to the spot price after considering compounded interest and dividends lost lead to the fact

that the investor owns the futures contract rather than the physical stocks, over a certain period of time (IFRS 13, 2013).

However, the fair value that we are interested in is the fair value through profit and loss (FVTPL) and the fair value through other comprehensive income.

Fair value through profit and loss (FVTPL)

A financial liability that meets one of the following conditions is measured at fair value through profit or loss (FVTPL):

a) *"it meets the definition of held for trading.*
b) *upon initial recognition, it is designated by the entity as at fair value through profit or loss in accordance with paragraph 4.2.2 or 4.3.5.*
c) *it is designated either upon initial recognition or subsequently as at fair value through profit or loss in accordance with paragraph 6.7.1."* (IFRS 9, 2014)

"Financial assets are measured at fair value through profit or loss if they are not held within a business model whose objective is to hold assets to collect contractual cash flows or within a business model whose objective is achieved by both collecting contractual cash flows and selling financial assets."

Fair value through other comprehensive income (FVTOCI)

If a debt instrument meets the cash flow characteristics test and is not designated at FVTPL under the fair value option and if it is held within a business model whose objective is to hold financial assets in order to collect contractual cash flows and sell financial assets, the debt instrument must be measured at FVTOCI.

4.2.2. How to measure the loss allowance?

The loss allowance will be measured by using the ECL calculation model.

As mentioned previously, lending institutions have to comprehend, compute and analyze the loss that may occur resulting from lending to a company that may default, namely, the expected credit loss (ECL) which is obtained by multiplying three of the following component, the probability of default (PD), the loss given default (LGD) and the exposure at default (EaD):

$$\mathrm{EL} = \mathrm{PD} * \mathrm{LGD} * \mathrm{EaD}$$

Probability of default and loss given default are risk metrics used in the measurement and management of credit risk. The exposure at default is the total exposure to credit risk at the time of default, which usually will not be larger than the borrowing facility (Schuermann, 2004). These three key risk parameters are necessary for the assessment of credit risk of financial institutions and will be explained in details in the next section.

4.2.2.1. Probability of Default (PD)

The probability of default (PD) is one of the first key risk parameter necessary for the assessment of credit risk. It is defined in the capital regulatory requirement document (CRR) as the probability of default of a counterparty over a one year period or over remaining time to maturity depending on either we are applying respectively the 1-year PD or the lifetime PD. In other word, this is the likelihood that a loan will not be repaid in its entirety and will fall into default. Entities should compute PD for every borrower by taking into consideration the credit history of the borrower and the nature of the investment. PD can be obtained by using external ratings agencies such as Standard and Poors (S&P) or Moody's. However, banks are still suggested to use internal rating methods. PD is expressed in a percentage of the total amount of the loan and can be ranged from 0% to 100%. To give an example, a company A with a PD of 55%, will be considered as less risky than a company B with a 75% PD, because the company A is less susceptible to go into default than the company B that is more likely to be considered as risky (Risk Articles, 2017).

4.2.2.2. Exposure at Default (EaD)

The exposure at default (EaD) is the second parameter for the assessment of credit risk and represent the total amount that a bank or another financial institution is exposed to at the time of a loan's default, namely the outstanding amount[1]. It is also defined as the estimation of the exposure at a future default date, taking into account expected variations in the exposure after the reporting date, including repayments of principal and interest, and expected drawdowns on committed facilities.

4.2.2.3. Loss Given Default (LGD)

The loss given default (LGD) is the third key parameter for the assessment of credit risk and expresses the percentage of a financial exposure that a bank or other financial institution might lose if a borrower goes into default on a loan[2]. The LGD is based on the difference between the contractual cash flows due and those that the lender would expect to receive, including from any collateral. It can be obtained by computing the loan-to-value (LTV) which is define as the value of the asset purchased. This is the ratio of the loan amount to the amount of the collateral which is a guarantee give to the lender by the borrower as security for repayment of a loan, to be forfeited in the event of a default.

$$Loan - to - value = \frac{Loan\,Value}{Collateral\ value}$$

However, the LGD can also be computed by using the recovery rate (RR), which is the extent to which principal and accrued interest on a debt instrument that is in default can be recovered, and it is expressed as a percentage of the instrument's face value[3].

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[1] http://www.investopedia.com/terms/e/exposure_at_default.asp

[2] http://www.investopedia.com/terms/l/lossgivendefault.asp

[3] http://www.investopedia.com/terms/r/recovery-rate.asp

$$\text{RR} = \frac{\text{Value of Collateral}}{\text{Value of the Loan}}$$

The loss given default is thus obtained by doing one minus the recovery rate.

$$LGD = 1 - Recovery\ Rate\ (RR)$$

4.2.2.4. Discount rate

The discount rate is the rate of return usually used to discount an expected loss to a present value at the reporting date using the effective interest rate (EIR) at initial recognition. It is also used in the discounted cash flow (DCF) analysis to determine the present value of future cash flows.

$$Discount\ Rate = \frac{1}{(1+r)^i}$$

where,

i = the year in which the coupon occurs
r = effective interest rate (EIR)

4.2.2.5. Default

By definition, a debt instrument can experience a loss only if there has been a default. Indeed, after giving an explicit assessment of the PD, LGD and EaD of an exposure, it is imperative to recognise that in order to promote consistency, a reference definition of default is required. However, the IFRS 9 standard does not properly default definition and only mention the following section; *"an entity shall apply a default definition that is consistent with the definition used for internal credit risk management purposes for the relevant financial instrument and consider qualitative indicators (for example, financial covenants) when appropriate"* (IFRS 9, 2014). Indeed, different definitions may be used for different purposes.

Overall, default occurs when a debtor is unable to meet the legal obligation of debt repayment[4]. However, the BCBS give a definition of default for purposes of the New Basel Accord (BCBS, 2001):

"*A default is considered to have occurred with regard to a particular obligor when one or more of the following events has taken place.*

(a) It is determined that the obligor is unlikely to pay its debt obligations (principal, interest, or fees) in full;
(b) A credit loss event associated with any obligation of the obligor, such as charge-off, specific provision, or distressed restructuring involving the forgiveness or postponement of principal, interest, or fees
(c) The obligor is past due more than 90 days on any credit obligation; or
(d) The obligor has filed for bankruptcy or similar protection from creditors."

The measurement of losses in the event of default will thus depend on the definition of the default term that the entity will use. Many cases of defaults may result in no loss incurred depending on the definition applied. For instance, an entity may go 90 days past due on a loan payment and afterward face on all of its obligations. In consequence, this event would count as a default but would result in full recovery. A bank that ignores such cases will under-estimate recovery rates since the exposure and falsify its loss data. The bank's model will subsequently produce a pessimistic image of losses given default (LGD) (Schuermann, 2004).

4.2.3. Staging: when should an impairment loss be recognized?

An impairment loss should be recognized as soon as a financial instrument is purchased and then a loss allowance is established. However, the amount of the loss allowance will depend on which staging categories the instruments belong to (SAP, 2014).

[4] http://www.investopedia.com/terms/d/default2.asp

4.2.3.1. Significant increase in credit risk

The paragraph B5.5.13 of the IFRS 9 standard mention that: "*the methods used to determine whether credit risk has increased significantly on a financial instrument since initial recognition should consider the characteristics of the financial instrument and the default patterns in the past for comparable financial instruments.*" (IFRS 9, 2014).

Furthermore, the IFRS 9 standard define a significant increase in credit risk as an important raise in the probability of a default occurring since initial recognition. The Standard provides different ways to define this recognition namely, whether the asset is undergoing a deterioration in credit risk which must be consistent with the IFRS 9 requirements. However, the standard has a clause that stipulates that the credit risk has increased significantly when contractual payments are more than 30 days past due (Deloitte, 2013).

Moreover, the Standard allows entities to consider that a financial instrument is not subject to a significant increase in credit risk if it has been categorized as having a "low credit risk" at the reporting date, an 'investment grade' rating might be an indicator for a low credit risk. IFRS 9 considers that if a financial instrument is considered to have a low risk, there is a very low probability that the instrument will default. Namely, the borrower is fully capable of meeting short, medium and long-term cash-flow payments and can cope with current and future economic conditions (Deloitte, 2013).

4.2.3.2. Stage 1: performing financial assets

This category includes financial assets in good financial condition. These assets are expected to perform in a regular manner while remaining in line with the terms in their contracts. Also, they are identifiable by the fact that they do not have any sign of an increase in credit risk (Silvia, 2014), namely, no significant deterioration in credit quality (SAP, 2014).

Regarding the amount of losses, a stage 1 financial instrument should equal to the 12-month expected credit loss. Indeed, the paragraph 5.5.5 of the IFRS 9 standard mention "*if, at the reporting date, the credit risk on a financial instrument has not increased significantly since initial recognition, an entity shall measure the loss allowance for that financial instrument at*

an amount equal to 12-month expected credit losses". The 12-month expected credit loss is defined in the IFRS 9 standard as *"the portion of lifetime expected credit losses that represent the expected credit losses that result from default events on a financial instrument that are possible with the 12-month after the reporting date."* Namely, this is the expected credit loss of a financial asset occurring within the first 12-month of the lifetime of the asset. IFRS 9 requires that the 12-month expected credit losses apply to recognizing impairment loss immediately from initial recognition of these assets (Silvia, 2014). However, we need to be careful about the 12-month ECL definition. This is not the expected cash shortfalls over the next twelve months, this is actually the effect of the entire credit loss on an asset weighted by the probability that this loss will occur in the next 12 months (SAP, 2014).

For this category, the interest revenue is calculated by using the effective interest rate method which is obtained by applying the EIR to the gross carrying amount of a financial asset. As defined in the Standard, the gross carrying amount is defined as being "*the amortised cost of a financial asset, before adjusting for any loss allowance*" (IFRS 9, 2014).

4.2.3.3. Stage 2: financial assets with significantly increased credit risk

Financial instruments being categorized in stage 2 are assets of whose credit risk significantly increased during the life of the financial asset. The credit risk of an asset can arise for instance when a borrower is no longer able to face its obligation at any time during the life of the financial instrument. In this case, the entity needs to recognize full lifetime expected credit losses. It is also possible that the credit risk may increase significantly since initial recognition, this is the case when contractual payments are more than 30 days past due or when the asset rating downgrade from an investment grade to a speculative grade. As a result, credit quality is no longer classified as low risk and entities should still recognize lifetime expected credit losses as in stage 2 (SAP, 2014).

For stage 2, interest revenue is calculated with the exact same method as in stage 1, namely on gross carrying amount.

4.2.3.4. Stage 3: credit-impaired financial assets

The stage 3 category contains credit-impaired financial assets. The appendix section of the IFRS 9 standard is defining credit-impaired financial assets as the following: "*A financial asset is credit-impaired when one or more events that have a detrimental impact on the estimated future cash flows of that financial asset have occurred. Evidence that a financial asset is credit-impaired include observable data about the following events:*

a) *significant financial difficulty of the issuer or the borrower;*
b) *a breach of contract, such as a default or past due event;*
c) *the lender(s) of the borrower, for economic or contractual reasons relating to the borrower's financial difficulty, having granted to the borrower a concession(s) that the lender(s) would not otherwise consider;*
d) *it is becoming probable that the borrower will enter bankruptcy or other financial reorganization;*
e) *the disappearance of an active market for that financial asset because of financial difficulties; or*
f) *the purchase or origination of a financial asset at a deep discount that reflects the incurred credit losses".*

In other words, financial assets are categorized in stage 3 when certain default events have occurred and that evidence can be observed thus they are already considered as credit impaired. Nevertheless, this time, interest revenue is calculated and recognized based on the amortized cost, meaning the net carrying amount which is representing by the gross carrying amount less the loss allowance (Silvia, 2014). We also have to bear in mind the fact that ECLs take into account both the amount and the timing of payments, a credit loss thus arises even if the holder expects to receive all the contractual payments due, but at a later date.

4.2.3.5. Summary

To summarize, if and asset is categorized at low credit risk or as an investment grade, rated at first recognition, the stage 1 is applying and the 12-month expected credit loss is in vigor and calculated as follows (Zazzara, 2016):

$$\frac{(\text{EAD} * \text{PD} * \text{LGD})}{(1 + \text{Effective Interest Rate})}$$

If there is a significant increase in credit risk which means 30-day past due or a transition to a speculative grade, this asset is considered as a stage 2 and the lifetime expected credit loss is calculated. Moreover, it should be noted that PD estimation should be done until maturity. ECL for this stage is computed by using the following formula (Zazzara, 2016):

$$\frac{(\text{EAD}_t * Marginal\ PD_t * LGD_t)}{(1 + \text{Effective Interest Rate})_t}$$

with,

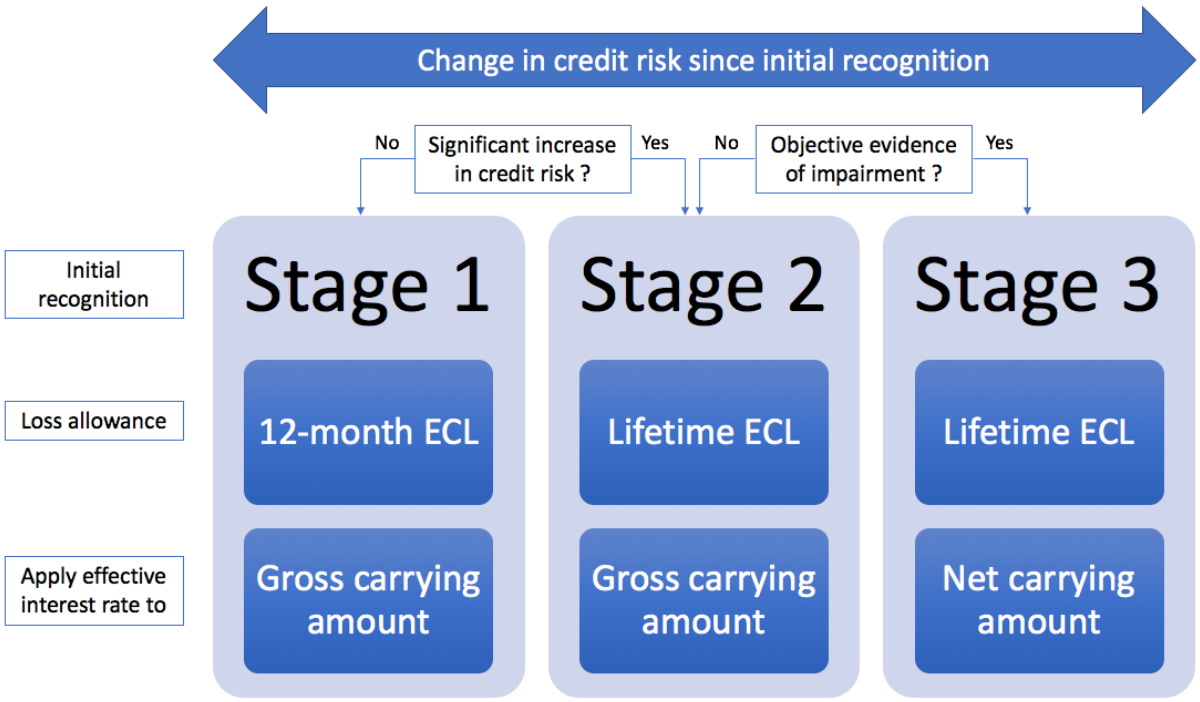
t = the year in which the coupon occurs

If assets are defaulted exposures, namely, 90-day past due or official default, the lifetime expected credit loss is also calculated and there is no need to estimate PD, since this is equal to 100% (Zazzara, 2016).

$$\text{EAD} * \text{PD} = 100\% * \text{LGD}$$

The figure below summarises the general approach in recognising either 12 months or lifetime ECLs for the IFRS 9 impairment model.

Figure 4 - Summary of the IFRS 9 general impairment model



Source: IFRS 9 "*Financial Instruments*"; Project Summary

4.2.4. Which entities will be affected by the new Standard?

All assets within the scope of IFRS 9 are measured at:

- amortised cost (AC);
- fair value through other comprehensive income (FVTOCI); or
- fair value through profit or loss (FVTPL).

Entities that primarily measure their financial assets at amortized cost will be more impacted by the new Standard than entities that measure the majority of their assets at their fair value. Entities that measure assets at amortized cost are generally bank institutes while investment firms, brokers and dealers on the financial markets measure their assets at fair value (FASB, 2010).

4.3. Probability of default modelling

In this section, different approaches and alternatives regarding probability of default modelling for occurrence of default will be introduced. Namely, Merton model, Weibull distribution and Migration matrix model. Indeed, the PD is one of the key parameter regarding the assessment of the loss allowance, thus explained how it can be modelled seems to be a necessary point to be addressed in the paper. The main and same objective of these three methods is to see how the probability of default is behaving. There is for sure different modelling method, however, during the case study part, we will apply the migration matrix approach. Finally, we will give a brief overview of the through the cycle PD vs the point-in-time PD.

4.3.1. Merton model

4.3.1.1. Overview

The Merton model is an analysis model used by financial institutions like banks and insurances companies to assess the credit risk of the company's debt. Namely, in order to understand whether an entity is capable of meeting its financial obligations and the probability that the company will go into credit default. One way to do this is by using a structural credit risk model. The Merton credit risk model is a structural model deriving from the Black-Sholes option pricing model from which the Black-Sholes (BS) formula is based on. We will first proceed to an overview of this model and finish on the Merton model.

Created in 1973, the BS formula is used by traders and investor in financial markets to compute the price of financial securities (i.e. European put and call option)[5]. The Black-Scholes model is based on basic assumptions:

- all options are European (meaning that they are exercised only at the time of expiration);
- no dividends are paid out;
- efficient markets (which means that market movements are unpredictable);

[5] http://www.investopedia.com/terms/m/mertonmodel.asp

- no commissions (or taxes, each financial asset is perfectly divisible);
- underlying stocks' volatility and risk-free rate are constant;
- returns on underlying stocks are regularly distributed.

The formula for the Black-Sholes model is

$$c = S_0\, N(d_1) - Ke^{-rT} N(d_2)$$

$$p = Ke^{-rT} N(-d_2) - S_0\, N(-d_1)$$

with,

$$d_1 = \frac{\ln(S_0/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$$

and,

$$\mathrm{d}_2 = \frac{\ln(S_0/K) + (r - \sigma^2/2)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}$$

where,

- c = *theoretical call premium*
- p = *theoretical put premium;*
- S = *current stock price;*
- K = *option striking price;*
- T = *time horizon;*
- σ = *percentage standard deviation (volatility) of stock.*
- N = *cumulative standard normal distribution;*
- r = *risk free rate*
- e = *exponential term;*

As mention above, the Merton model was developed based on the Black-Scholes option pricing model which can be used for equity valuation but also for credit risk management. The valuation of firm equity can thus be obtained as a call option on firm assets. The Merton model also

permits to estimate a risk neutral probability of default (PD) of a company which shows the likelihood that a company will not be able to repay its debt during a certain amount of time. Namely, that at maturity the value of assets will worth less than the entire amount of debt. Regarding options, the risk neutral PD indicates the probability that the option ends up out-of-the money which means that the (call) put option have at maturity, a strike price (higher) lower than the market price of the underlying asset (Breaking Down Finance).

The Merton model for calculating probability of default (PD) uses the Black Scholes equation to estimate the value of this option because the market knows it best and first. Indeed, the price behaviour of that security will be the first to indicate that something is expected to go wrong which is a worthier data than an analyst research report. This is why the Merton model is actually a variation of the Black Scholes model, we just need to measure the valuation of firm equity as a call option on firm assets (Jawwad, 2012).

We thus assume that the value of firm becomes valuable as the firm grows and becomes less valuable as the firm declines, just as an option. As long as firm assets, which represent the valuation of the firm, exceed firm liabilities, the entity is doing well. Otherwise, as soon as the value of liabilities exceeds the value of assets, there is no interest for the owner of firm equity to exercise the option (Jawwad, 2012).

To simplify, this model considers that the debt of the company is composed of a single bond zero coupon with a maturity T. The model components are mapped as under (Hull, 2014):

- V_0 = *market value of asset today (spot price);*
- V_T = *market value of asset at the date T;*
- E_0 = *market value of equity today;*
- E_T = *market value of equity at the date T;*
- D = *book value of liabilities (interest and principal) to be repaid on date T (strike);*
- T = *time horizon;*
- μ = *risk free rate*
- σ_E = *percentage standard deviation (volatility) of equity.*
- σ_V = *percentage standard deviation (volatility) of asset value.*

In the Black-Scholes analysis, we are figuring out what is the probability that $S_T > K$. However, if we want to analyse the case of default, we have to know what is the probability that $S_T < K$. By flowing the right notation, if $V_T < D$, it is rational for the firm (at least in theory) to go into default on the debt at date T. The value of the shares is null in this case. On the other hand, if $V_T > D$, the company reimburses its debt at date T. The value of the shares is therefore written as follows (Hull, 2014):

$$E_T = \max(V_T - D; 0)$$

The shares are therefore a call on the value of the assets with an exercise price equal to the value of the debt at date T. The formula of Black-Scholes then gives the value of the shares as of date 0 (Hull, 2014).

$$E_0 = V_0 N(d_1) - De^{-\mu T} N(d_2)$$

with,

$$d_1 = \frac{\ln(V_0/D) + (\mu + \sigma_V^2/2)T}{\sigma_V \sqrt{T}}$$

and,

$$\mathrm{d}_2 = d_1 - \sigma_V \sqrt{T}$$

N is the cumulative normal distribution function whose value is calculated at d_1 and d_2.

The value of the debt is now equal to $V_0 - E_0$. Under these conditions, the risk neutral probability of default is thus calculated as follows:

$$\mathrm{PD} = \mathrm{N}(-d_2)$$

Indeed:

$$\mathrm{P}(V_T < \mathrm{D}) = 1 - \mathrm{N}(d_2) = \mathrm{N}(-d_2)$$

However, the computation of probability requires the market value of assets V_0 and volatility of asset value σ_V, which are usually unknown. On the other hand, if the company is listed on the stock exchange, E_0 is known and σ_E can be estimated. Moreover, the Ito lemma implies

$$\sigma_E E_0 = \frac{\delta E}{\delta V}\sigma_V V_0$$

And as $\frac{\delta E}{\delta V} = N(d_1)$, we have

$$\sigma_E E_0 = N(d_1)\sigma_V V_0$$

With the previous equation:

$$E_0 = V_0 N(d_1) - De^{-rT}N(d_2)$$

We are now easily able to estimate both V_0 and σ_V.

4.3.1.2. Advantages

The introduction of monotonic transformations of the probability of default obtained by the Merton model can give a good estimation of the real probabilities and the risk-neutral probabilities of default. It may seem abnormal to consider a risk-neutral probability of default as $N(-d_2)$ to estimate a probability of default, however the monotonic transform calibration shows that what matters is that the order of the risk-neutral probabilities is the same as the real probabilities.

4.3.1.3. Limitations

So far, we have assumed that the debt was repayable on a single date (*T*). In practice, repayments can be spread over time. The relationship between V_0 and V_E is then becoming more complex. In this case, it is preferable to opt for an alternative model.

4.3.2. Weibull distribution

4.3.2.1. Overview

Proposed by the Swedish engineer and mathematician Ernst Hjalmar Waloddi Weibull (1887-1979), the Weibull law is a continuous probability law which widely use the Weibull distribution function that describes the time dependent development of cumulative default rates and to model product lifetimes due to its great flexibility. This is a special case of generalized extremum law in the same way as the Gumbel distribution or the Frechet distribution.

A function that can be used for the modelling of probability of default has to fulfil the following elementary economic requirements:

1. $F_t = 0, for\ t \leq 0$
2. $F_t > 0, for\ t > 0$
3. $F_t > 0, for\ t \geq 0$
4. $lim_{t\to\infty} F_t = 1$

These requirements are fulfilled by all functions that are distribution functions of continuous random variables with values in [0; ∞ [. As it can be read below, especially the Weibull distribution turns out to be useful for the modelling of rating classes because of its memory keeping according to the parameter *k*.

For $\lambda, k > 0$ and time $t \geq 0$ the density function is given as

$$f(t) = \lambda k(\lambda t)^{k-1}\, e^{-(\lambda t)^k}$$

and the distribution function by

$$MPD(t) = 1 - \exp\,(-\lambda t)^k).$$

For different values of λ and k the following graphs can be drawn:

Figure 6 - Probability density function

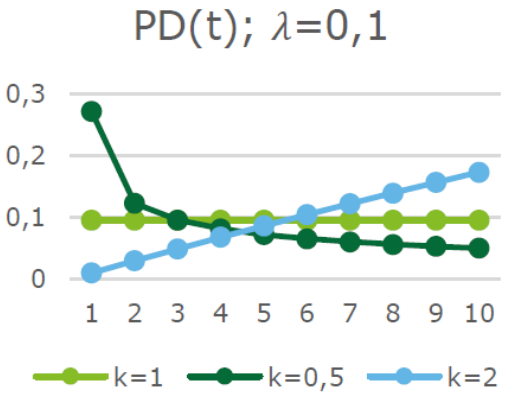
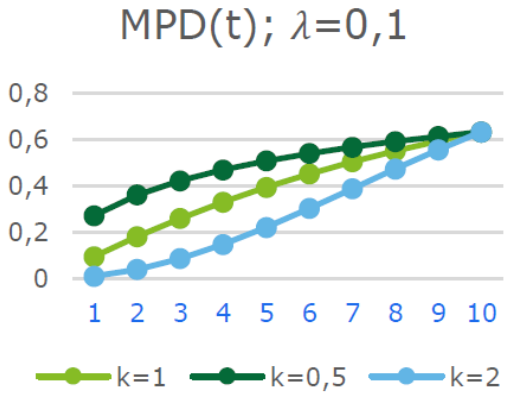


Figure 5 - Probability distribution function



Source: Internal Deloitte presentation

4.3.2.2. Advantages

It is natural to compare the Weibull distribution to the Exponential distribution since for k=1 the distributions are the same. For *k* different from 1, we can say that the distribution considers the past history of the object that is modelled and that not only related to time but also to the use of the object. The parameter *k* gives the possibility to model objects according to increasing (= aging system), decreasing or constant default rates. Therefore, the Weibull distribution has a lot of applications that other distributions like the Exponential distribution do not have.

4.3.2.3. Limitations

In order to determine the parameters of the Weibull distribution function which is the best fit for certain bank's portfolio, the bank needs to rely on historical data on the observed defaults. The historical data has to be relevant in terms of sample size, granularity and accurateness. In some cases, banks don't have such data in their databases. In general, if enough data is given, it has to be mentioned that choosing the correct distribution is not that easy because one has to investigate the data in detail. If there are outliers one as to start to investigate the influence of the outliers. After that one has to find the best fitting distribution for the given data. This is a limitation to every possible probability distribution, not only to the Weibull distribution.

4.3.3. Migration matrix

4.3.3.1. Overview

A migration matrix or transaction matrix is a square matrix which gives the probabilities of moving from one state to another in a dynamic system. In each row, there are probabilities of moving, from the state represented by that row, to the other states. As part of this thesis, this is the rating transition matrices, they show the probability of a company migrating from on rating category to another during a certain period of time. They are based on historical data. The rating categories can be either those used by the financial institution or those produced by rating agencies such as Moody's, S&P or Fitch.

In developed countries, estimations of migration matrices are published by external rating agencies. Rating agencies such as Moody's, Fitch or Standard & Poor's are specialized in the rating of bonds issued by companies. A credit rating is a measure of the creditworthiness of an issuer, which could be a company, a country or a bond for example. Rating companies usually use letter for representing rating grades. In the system developed by Moody's, the best marks are Aaa. Bonds that receive this rating are considered to have a probability of default of almost zero. The following ratings are Aa, A, Baa, Ba, B and Caa. Only bonds rated above Baa are considered relatively safe (investment grade). Within investment grade, there are different levels of creditworthiness (prime, high grade, upper medium grade, etc.). The corresponding ratings at S & P and Fitch are AAA, AA, A, BBB, BB, B, CCC. The categories of notes, both at Moody's, S & P, or Fitch, are subject to various subdivisions. For example, Aa is divided into Aa1, Aa2 and Aa3 at Moody's. Once passed below the bare of BBB- for S&P for example, every bond below this grade is considered as non-investment grade. They have a higher probability of default than the investment grade and C there is the default level. A default rating indicates that the obligator has failed in meeting its obligations (Hull, 2014). The following table is summarizing every rating levels.

Table 1 - Moody's and S&P's credit rating table

Moody's	S&P	Rating description
Aaa	AAA	Prime
Aa1 Aa2 Aa3	AA+ AA AA-	High grade
A1 A2 A3	A+ A A-	Upper medium grade
Baa1 Baa2 Baa3	BBB+ BBB BBB-	Lower medium grade
Ba1 Ba2 Ba3	BB+ BB BB-	Non-investment grade speculative
B1 B2 B3	B+ B B-	Highly speculative
Caa1 Caa2 Caa3	CCC+ CCC CCC-	Substantial risks
Ca	CC	Extremely speculative
	C	Default imminent
C	RD/SD/D	In default

Source: Multiple market (the rating table)

Ratings are constantly changing over time, which could have a huge impact on the issuer. If a company faces economical changes for instance, this could lead to a downgrade from rating companies, which could indicate that the entity is unable to meet its debts obligations. In the case of bonds, the rating influences the market value of the bond even if no default occurs. In other words, if a downgrade occurs, it can result in a financial loss for the issuer who owns it. Indeed, a downgrade implies that the bond is risked which causes its market value to fall.

We will illustrate this methodology with a concrete example. Table 2 represent the matrix of one-year transition probabilities of ratings in percent based on historical data. This table is showing that over the long term (1981-2015), higher ratings are more stable than lower ratings. For example, the probability that a bond rated AAA will remain in this category after one year is equal to 87.1% and CCC/C ratings were still rated CCC/C 44.2% of the time. It has a probability of 0.52% to be rated B the following year and a probability of defaulting during the same time period of 0.06%.

Table 2 - One-year global corporate average transaction rate (1981-2015)

From/To	AAA	AA	A	BBB	BB	B	CCC/C	Default
AAA	**87.08**	9.15	0.79	0.00	0.02	0.00	0.00	0.00
AA	0.53	**86.69**	8.06	0.53	0.06	0.07	0.02	0.02
A	0.03	1.81	**87.65**	5.39	0.33	0.13	0.02	0.06
BBB	0.01	0.11	3.55	**85.43**	3.82	0.52	0.12	0.19
BB	0.01	0.03	0.13	5.08	**76.78**	6.96	0.64	0.73
B	0.00	0.03	0.09	0.21	5.25	**74.27**	4.39	3.77
CCC/C	0.00	0.00	0.14	0.20	0.61	12.84	**44.19**	26.36
Default	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**100**

Source: Standard and Poor's Rating table

4.3.3.2. Advantages

The advantage of this migration matrix method is that all the specificities of the contracts in progress can be integrated into the analysis. Indeed, this approach is based on the simultaneous change of rating of the various counterparties. If, for example, we want to estimate the loss allowance over a period of one year, in each simulation, a sample of the rating migration matrix of all the counterparties is drawn, as well as a sample of the variations of the values of market data relevant for the analysis. Moreover, if, for example, the rating of a counterpart suddenly changes from A to BBB, or even lower, the simulation can take this assessment into account on a monthly basis. A condition stipulating that a loss is retained if, for example, the rating passes from A to a default situation can also be included in the model.

4.3.3.3. Limitations

This method which is deduced from the historical data represents the probabilities in the real universe and therefore has some limitations. Indeed, these probabilities are privileged to others mainly for the analysis of scenarios and the calculation of Value at Risk (VaR), which is limiting its use.

4.3.4. Through the cycle PD vs. point-in-time PD

The Merton model develop a methodology for point-in-time (PIT) and through-the-cycle (TTC) probability of default (PD). In order to reduce the procyclicality of the capital requirements such methodology is crucial.

The probability of default usually used by banks is internal and based on internal credit risk modelling and analyses.

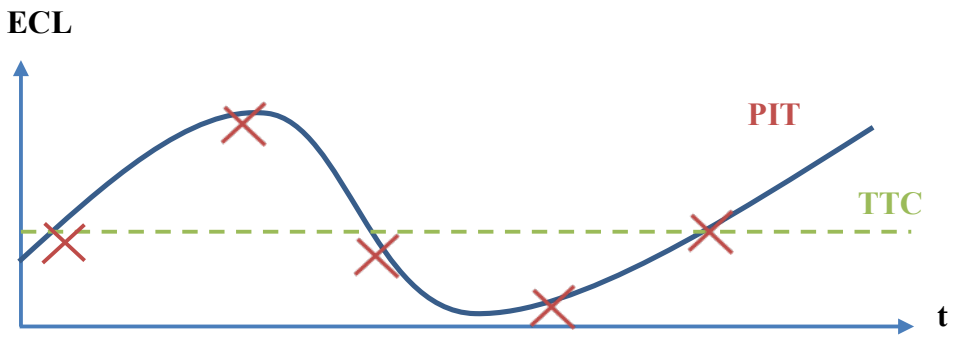
Point-in-time (PIT) takes the probability of default at a given point of time while through the cycle (TTC) takes the average PD through the entire life of the financial instrument. Basel II rules require the use of through-the-cycle method PD, LGD and EaD. However, IFRS 9 requires now entities to compute their PD, LGD and EaD by using the point-in-time method.

Through-the-cycle method is looking through the current state of the credit cycle and assess precisely variations of default rates over time. Even though a borrower rating may remain unchanged, its PD may differ through the credit cycle. Through-the-cycle PD measure default risk over a long horizon, five or more years. This measure displays much less volatility and procyclicality over the cycle.

Point-in-time PD measure default risk over a short horizon, one year or less. This measure is obtained by utilizing all available and pertinent information as of a given date. This information includes macroeconomic trends such as house price indicates, unemployment, GDP growth rate, and so one and not only the firm's credit risk expectations and characteristics. By taking into account this not idiosyncratic information, PDs can reflect the current economic environment and be more IFRS 9 compliant.

The CSSF required banks to implement their own model for PD calculation and most of the time their model is based on a yearly basis. This methodology is the PIT based on the Capital Regulatory Requirement directive however, PD should be modeled on historical data for at least five years as the TTC method in order to include the forward-looking information. The table 3 below is giving a comparison table of both methods.

Table 3 - Through the cycle and point-in-time PD

	Through the Cycle	Point in Time
Risk control	• Short and medium-term assessment of current credit risk, possibly limited • Diminishes the risk cyclicality	• Exactly mapping the current risk • Higher risk volatility
Overall bank controlling	• Pricing on short and medium-term business possibly not appropriately risk related • Slight fluctuation of regulatory capital	• Equity capital requirement fluctuates strongly pro-cyclically • More precise internal controlling of bank
Distribution TTC vs. PIT		
Aspects of modelling	• **Structural components** of default risk • Probability of default of rating classes depends on economic cycle • Long term average rating • Longer residence time of debt holder in their rating classes	• **Structural and cyclical components** of default risk • Estimation of actual and annual PD • Strong variation between the rating classes
	Stability of results	**Precision of estimation**

Source: Internal Deloitte presentation

5. Conclusion

In this section, we focused on the phase 2 of the new IFRS 9 requirement, the impairment model. We reviewed the majority of the points present in the standard by focusing our content more precisely on the calculation of the expected credit loss. We have given an overview of this model and explained how it should be applied by banks and financial institutions according to IFRS 9. We also discussed the different methods of modelling one of the main parameters of the ECL, namely, the probability of default.

All this theoretical section is allowing us to lay down the bases in order to carry out a case study based on concrete data. The remainder of this thesis will be covered by a calculation of the expected credit loss for a private bank present in the Grand Duchy of Luxembourg. We will then go through the impacts that this implementation is generating.

III. Case Study

1. Introduction

The aim of this section is to provide a framework to determine how the expected credit losses can be developed for different financial instruments. In order to illustrate every step described in the previous section, we decided to base our calculation on a realistic example related to private banking. In this section, we will first give a rapid reminder of the problematic in order to put everything into context. Then we will introduce the bank on which the case study will be based on, as well as a description of its portfolio. The rest of the section will be focused on expected credit loss calculation of different types of loans that the bank has in its portfolio. We will first compute the ECL for the bonds, then we will analyse the retail mortgage loans and the corporate mortgage loans. Finally, we will end this section by presenting the methodology used to compute the ECL for institutions.

2. Reminder of the problematic

As detailed above, the problematic of this thesis is to analyse the impairment phase of the new standard IFRS 9 and to highlight the impacts that banks will face by implementing these new requirements. In order to do so, we have decided to base our analyses on a specific bank and to calculate the expected credit loss (ECL) of each exposure in its portfolio in order to demonstrate one of the methodology that banks could use and the impact of such an implementation within the bank.

3. The Bank

3.1. Description of the Bank

As part of this thesis, the bank on which we will based our analysis is a private bank located in the Grand-Duchy of Luxembourg. For reasons of anonymity, the selected bank will be called “the Bank” throughout the thesis. The Bank has been active as a private bank for more than 20 years by offering services to individuals and professionals in Luxembourg and its bordering regions. Since the bank must remain anonymous, we will not disclose further information.

3.2. The Bank's portfolio

The bank carries a portfolio which is a grouping of financial assets such as usually stocks, bonds and cash equivalents. However, the Bank that we based our analysis on have in portfolio four different asset categories: corporate and governmental bond, retail mortgage loans, corporate mortgage loans and institutions loans. We thus have decided to take each of these four categories into account so that the analysis can be as exhaustive as possible.

- Bonds: a bond is a debt instrument in which an investor lends money to an entity, typically corporate or governmental, which borrows the funds for a defined period of time at a variable or fixed interest rate[6].
- Retail mortgage loans: a retail mortgage loan is a debt instrument in which an investor lends money to individuals, usually individuals that want to buy a house, rather than entities.
- Corporate mortgage loans: a corporate mortgage loan is a debt instrument in which an investor lend money to companies, that allows them to purchase property.
- Institutions loans: an institution loan is a debt instrument in which an investor lends money to financial institutions, rather than retail or corporate borrowers.

4. The ECL modelling

The first step in carrying out the case study and in order to compute the expected credit loss was to collect the bank's data including its portfolio and certain components corresponding to the exposures present in the portfolio as of 31/12/2016.

In order to carry out the various calculations, it was essential to be able to have certain elements, such as the type of counterparty of the exposure. We also had to know if the exposure had a collateral or not, and if so what is the type and the amount of this collateral. Moreover, we had to obtain information regarding the maturity date and the amount of the exposure. Once we had

[6] http://www.investopedia.com/terms/b/bond.asp

the entire portfolio and all the information needed, it was possible to segment the portfolio according to the different types of exposures so that the case study could cover different financial instruments. We therefore conducted a case study on the four types of financial instruments that the Bank owns. We thus create four Excel sheets for each one of the categories that will be covered within this case study.

The first part of the case study will therefore focus on the bonds; some come from the sovereign sector, others from the banking sector. For this section, given the low volume of the population, which is six, including government and corporate bonds, we have decided to take into account all the exposures within the portfolio. We have therefore produced an excel file calculating the expected credit loss for each different bond.

After having computed the ECLs for bonds, we will calculate the ECLs for the loans that the Bank grants by separating them according to the counterparty, namely, retail and corporate mortgage loans and financial institutions loans. For these other three types of counterparty, we also had to get further information such as whether the exposure was considered as past due or not.

4.1. ECL calculation of bonds

4.1.1. Objective

The main objective of this section is to obtain the expected credit losses (ECL) for each of the bonds in the bank's portfolio. In this section, we will put into practice, the PD modelling present in the section 4.3. Probability of default. As previously mentioned, we have chosen to use the migration matrix method to proceed to this calculation. Moreover, it should be noted that we based our analysis on the case study of Gebhardt G. regarding the impairments of Greek Government Bonds under IAS 39 and IFRS 9.

4.1.2. Methodology

4.1.2.1. Collecting data

In order to compute the expected credit loss (ECL) for each of the bonds within the bank's portfolio, the first step was, as previously mentioned, to collect from the bank a certain amount of information for each bond. We needed information such as the coupon rate, the nominal amount, the rating of the counterparty at the reporting and starting date, and the frequency of payments of coupons. You will find bellow a table summarizing the information used for this section.

Table 4 - Information related to bond's portfolio

Name of the bond	Rating at reporting date	Rating at starting date	Maturity	Amount	Coupon rate	Coupon Date	Frequency
USA 1,375% 31MAR20	Aaa	Aaa	31/03/20	750.000	1,375%	30-Sep and 31-Mar	Half yearly
BELGIUM 0,875% 25JUN18	Aa3	Aa3	25/06/18	1.500.000	0,875%	25-Jun	Yearly
FRANCE 0,875% 25NOV19	Aa2	Aa2	25/11/19	400.000	0,875%	25-Nov	Yearly
GRAND-DUCHE 5,4PC 21MAR23	Aaa	Aaa	10/07/23	90.000.000	2,125%	10-Jul	Yearly
SLOVENIA 5,4% 23MAR22	Ba1	Baa3	23/03/22	7.500.000	5,4%	25-Mar	Yearly
IRELAND 5,4% 13MAR25	A3	A3	13/03/25	45.000.000	5,4%	13-Mar	Yearly
BIL 0,550% 15JAN19	B1	Ba3	15/01/19	3.500.000	0,550%	27-Sep and 27-Dec	Quaterly

Source: author's calculation

4.1.2.2. Definitions and formulas

By the time all the data was in our possession, we were able to calculate the ECLs, which is defined as a probability-weighted estimate of credit losses (CL) (i.e. the present value of all cash shortfalls) over the expected life of the financial instrument. The Standard does not provide any specific model to use in order to calculate the expected credit loss. However, the ECL can be compute based on four main elements (Global Public Policy Committee, 2016):

$$ECL = PD * LGD * EaD$$

- Probability of default is the estimation of the likelihood of default over a given time horizon.
- Loss given default is the estimation of the percentage of loss arising in case of default.
- Exposure at default is the estimation of the exposure at a future default date.
- Discount rate is used to discount an expected loss to a present value at the reporting date.

The ECL formula will be used latter on this case to compute the ECL for each type of asset. However, regarding the bond calculation another formula will be used:

$$ECL_t = Outstanding\ Balance_t - \sum_{i=1}^{N} E[Cash\ Flow_{t+i}] \times \left(1 + \frac{r}{12}\right)^{-i}$$

where,

- E [$Cash\ Flow_{t+i}$] is the expected cash flow in the i^{th} month from reporting date t;
- N is the number of remaining months; and
- r is the original effective interest rate (or credit-adjusted effective interest rate for purchased or originated credit-impaired financial assets).

4.1.2.3. Assumptions

After receiving the entire portfolio of the bank and every needed component, the next step was to subtract expected cash flows for which we had to make assumptions because IFRS 9 requests that entities use their own expectations for expected cash flow in case of default. Moreover, the paragraph 5.5.18 of the Standard asks for a scenario analysis in which "*an entity need not necessarily identify every possible scenario. However, it shall consider the risk or probability that a credit loss occurs by reflecting the possibility that a credit loss occurs and the possibility that no credit loss occurs, even if the possibility of a credit loss occurring is very low*" (IFRS 9, 2014).

We thus assume that each bond could default in any of the coupon dates, yearly, half-yearly or quarterly depending on the case. Moreover, we assume that contractual interests are paid before the default but not after and neither the following years. In other words, we had therefore assumed that the default occurred in the first year of the bond and this every year for the entire lifetime of the bond. This default creates an immediate loss in the expected cash flows. We also assumed that in the event of default, the year after the default, the bond generates its coupon in the usual way, but after that, it is no longer the case. As the default occurred, the bond no longer generates any cash flow, except as already mentioned, the year immediately after the default occurs.

4.1.2.4. Calculation

1) Cash Shortfall

Regarding the calculating part, the first thing to do was to compute the cash shortfalls for every coupon date. These are the cash flows that the bank expects to receive and are obtained by subtracting expected cash flows from contractual payments.

$$Cash\ shortfall = contractual\ payments - \ expected\ cash\ flow$$

Contractual payments for the entire life of the bond represent the coupon received on each coupon date. We get these by multiplying the coupon rate with the nominal amount of the bond for each period during the lifetime of the bond.

$$Contractual\ payments = coupon\ rate * nominal\ amount$$

Moreover, it is important to bear in mind that at maturity, the bond generates the coupon plus the return capital. Expected cash flows are obtained by following assumptions shaped earlier which are that contractual interest are paid before the default but not after and neither the following years and by multiplying the nominal amount with the LGD determined for the particular bond.

$$Expected\ cash\ flows = nominal\ amount * LGD$$

2) Present value (PV)

Once that the cash shortfall is computed, the second step was to compute the present value of each cash flow. The present value is obtained by discounting these cash flows with the discount factor.

$$Present\ Value_t = \frac{Cash\ Flow}{(1+r)^i}$$

where,

- i = the i^{th} month from the reporting date
- r = the original effective interest rate
- t = the reporting date

3) Credit loss

After obtaining the present value of each coupons by multiplying the various expected cash flows by their respective discount factor, we were able to compute the credit loss. This is the sum of all the present values generated by the bond throughout its lifetime. We computed credit loss for each scenario, in other words, for the cases of a default on each year (or quarters, depending on the coupons dynamics).

$$\sum_{i=1}^{N} E[Cash\ Flow_{t+i}] \times \left(1 + \frac{r}{12}\right)^{-i}$$

where,

- $E[Cash\ Flow_{t+i}]$ = the expected cash flow in the i^{th} month from reporting date t;
- N = the number of remaining months; and
- r = the original effective interest rate

4) Expected credit loss

Finally, the last step through this calculation was to compute the expected credit loss. In order to proceed to this calculation, we used a sum of marginal losses approach whereby ECLs are calculated as the sum of losses occurring in each time period. The marginal losses are derived from credit losses which takes into account losses in case of default and the marginal probability of default for each period.

$$Expected\ Credit\ Loss = Marginal\ PD * Credit\ Loss$$

In order to compute the marginal probabilities of default, we had to obtain the rating of the bond first. Once we had the rating, we had to collect the year-to-year differences of the cumulative default rates. We decided to use the average cumulative issuer-weighted global default rates table based on historical data provided by the rating agency Moody's for the period 1983-2010.

Table 5 - Average Cumulative Issuer-Weighted Global Default Rates by Alphanumeric Rating, 1983-2010, provided by Moody's

Rating	1	2	3	4	5	6	7	8	9	10
Aaa	0	0.016	0.016	0.048	0.086	0.132	0.182	0.186	0.186	0.186
Aa1	0	0	0	0.094	0.141	0.158	0.158	0.158	0.158	0.158
Aa2	0	0.014	0.088	0.192	0.334	0.431	0.495	0.561	0.635	0.718
Aa3	0.048	0.127	0.182	0.254	0.327	0.38	0.415	0.435	0.444	0.502
A1	0.061	0.217	0.461	0.672	0.855	0.992	1.089	1.18	1.297	1.468
A2	0.065	0.174	0.351	0.578	0.788	1.073	1.463	1.918	2.324	2.642
A3	0.058	0.214	0.439	0.627	0.923	1.235	1.55	1.907	2.255	2.5
Baa1	0.146	0.38	0.643	0.897	1.204	1.501	1.801	2.016	2.207	2.473
Baa2	0.176	0.486	0.897	1.519	2.078	2.686	3.226	3.723	4.337	5.098
Baa3	0.302	0.876	1.558	2.219	3.099	3.993	4.84	5.847	6.79	7.735
Ba1	0.709	1.986	3.721	5.546	7.226	9.012	10.455	11.506	12.537	13.694
Ba2	0.8	2.286	4.198	6.249	8.077	9.538	10.953	12.522	13.97	15.243
Ba3	1.826	5.291	9.371	13.66	17.163	20.379	23.342	26.385	29.384	32.311
B1	2.512	6.969	11.678	15.866	20.159	24.509	29.191	33.167	36.694	39.935
B2	3.986	9.863	15.713	21.076	25.701	29.903	33.774	37.281	40.724	43.516
B3	7.584	16.097	24.299	31.262	37.199	42.764	47.117	51.039	53.727	56.154
Caa1	9.94	21.715	32.211	40.782	48.782	54.343	57.144	60.441	65.864	70.904
Caa2	19.045	30.446	39.104	46.371	51.475	55.336	58.498	61.973	65.153	70.38
Caa3	29.542	45.41	54.642	61.612	67.565	69.136	71.854	75.593	80.516	92.822
Ca-C	38.739	50.58	59.678	66.353	71.652	73.385	75.92	78.884	78.884	78.884
Inv Grade	0.095	0.274	0.508	0.769	1.054	1.343	1.622	1.907	2.185	2.467
Spec Grade	4.944	10.195	15.233	19.671	23.477	26.82	29.79	32.433	34.804	36.967
All rated	1.819	3.717	5.485	6.988	8.241	9.303	10.212	11.006	11.706	12.344

*Data in percent

Source: Moody's Investors Service

5) Staging: 12-month ECL or Lifetime ECL

As mentioned previously, under IFRS 9, entities are required to recognise an allowance for either 12 months (obtained by calculating ECL for the first year of life of the bond) or lifetime expected credit loss (obtained by realizing the sum of all ECLs obtained throughout the lifetime of the bond). They will then assign these different ECLs depending on whether there has been a significant increase in credit risk since initial recognition (stage 1 or stage 2). Thus, in order to determine in which stages each one of the bonds belong, we had to analyse credit ratings by comparing the rating at starting date and the rating at reporting date. We also had to analyse

either they have been a significant increase in credit risk by determining if there was a rating deterioration from an investment grade to a speculative grade. By comparing these two ratings, we can identify whether we place the exposure in the stage 2 or stage 3 category. More precisely, stage 3 is triggered when the bond is in default at its starting date, however, another method is relevant, the "x notches rules". The bond can be considered as a stage 3 in the case where the bond's rating has dropped down by 5 notches and brings the bond to default.

4.1.3. Results

In order to explain the results of this methodology, we decided to choose one of the six obligations that we analysed, in the Excel file, the one being considered as stage 1. We have decided to choose the US treasury bond (USA 1,375% 31MAR20) which is considered as being in the stage 1 category. For the analysis of the result, choosing to analyse a stage 1 bond rather than a stage 2 or a stage 3 bond makes barely a difference. The only difference is that it would be the lifetime PD that will apply rather than the 12-month PD.

The nominal value of the US bond is 75.000.000 USD, with a coupon rate of 1,375% and with a due date on 31/03/2020 (maturity date). This US bond has a Aaa-rating, which means that it is a high-quality bond classified in the investment grade category. For the rating as of 31/03/2015 (starting date), the Moody's rating belongs to the same Aaa-rating category which means that the bond is a stage 1 instrument. Indeed, since the rating has not changed, there has therefore been no increase in credit risk. As a result, the 12-month ECL will apply. The following table is regrouping the data needed for this calculation.

Table 6 : Bond's information

Name of the bond	Rating Moodys	Start Date	Maturity	Currency	Amount	Coupon Date	Frequency
USA 1,375% 31MAR20	Aaa	31/03/15	31/03/20	USD	750.000	30-Sep and 31-Mar	Half yearly

Source: author's calculation

After obtaining the data, we had to calculate the credit loss, for each of the coupon payment dates. The table below will serve as an example to explain the results.

Table 7 - Credit Loss Calculation, default on the 6th month

Credit Loss - Default on Month 6 (2017) (in USD)	31-12-16	30-06-17 6M	31-12-17 12M	30-06-18 18M	31-12-18 24M	30-06-19 30M	31-12-19 36M	30-06-20 42M	31-12-20
Contractual Payments		10.313	10.313	10.313	10.313	10.313	10.313	760.313	
- Expected Cash Flows		-	(412.500)	-	-	-	-	-	-
Cash Shortfalls		10.313	(402.188)	10.313	10.313	10.313	10.313	760.313	-
Discount Factor (ieff = 1,375%)		0,99320	0,98644	0,97972	0,97306	0,96644	0,95986	0,95333	0,94684
Present Value Cash Shortfalls		10.242	(396.732)	10.103	10.035	9.966	9.899	724.827	-
Credit Loss	378.339								

Source: author's calculation

We first calculated the contractual payments by multiplying the coupon rate (1,375%) with the nominal amount (750,000 USD). The holder of the bond must therefore pay the interest every six months, i.e. 10,313 USD. When the bond matures, it must repay the coupon plus the principal amount, which raises the amount to 760,313 USD. The next step is to calculate the cash flows that the bond is supposed to generate, i.e. the expected cash flows. However, as stated above, we have assumed that the default occurs on the first payment date, i.e. at the sixth month of the lifetime of the bond, since the frequency of payments is semi-annual. With this assumption, the bond does not generate any cash flow on the first coupon payment date and this is on the second date that cash flow appears and that the loss given default intervenes. Indeed, the LGD is the percentage of the loss incurred in the event of default. However, since the expected cash flow is the amount that the lender is expected to receive from the borrower, we have to use the recovery rate in this study case. The RR which represents the extent to which the principal and accrued interest of a defaulted financial instrument can be recovered and is expressed as a percentage of the nominal value of the instrument. The LGD is calculated as (1 - recovery rate) and here, since the financial instrument analyse is a bond, we have complied with the Capital Regulatory Requirement (CRR) specifications, i.e. that the LGD is equal to 45%, which means that 45% of the nominal value will be lost if the counterparty goes in default. The recovery rate therefore makes it possible to estimate the loss that would occur in the event of a default, which is calculated as (1 - the recovery rate). Thus, since the LGD is 45%, the RR is 55%. Therefore, in the period following the default, the holder of the bond will receive only 55% of the face value of the bond, i.e. 412,500 USD (55% x 750,000 USD). During the remainder of the bond's lifetime, the bond will no longer generate any cash flow.

Since the cash shortfall is obtained by doing the sum of the contractual payments and the expected cash flows, which represents the expected losses generated by the obligation, the cash shortfall amounts 10.313 USD for every coupon date expect for the year following the default and the maturity date for which the amounts are respectively 402.188 USD and 760.313 USD. Afterward, we still need to update these losses using the discount factor for each coupon payment period. Below, a table representing the different discount factor for each one of the coupon payment period by using the following formula applied to the first 6 months of the lifetime of the bond.

$$Discount\ factor = \frac{1}{(1+r)^t} = \frac{1}{(1+1{,}375\%)^{0{,}5}} = 0{,}993195$$

Table 8 - Discount factor calculation

Discount Factor	1	2	3	4	5	6	7	8
r	1,375%	1,375%	1,375%	1,375%	1,375%	1,375%	1,375%	1,375%
T	0,5	1	1,5	2	2,5	3	3,5	4
P(T)	0,993195	0,979724	0,973057	0,966435	0,966435	0,959859	0,953327	0,946840

Source: author's calculation

After having computed almost every component of the ECL, we still have to compute the marginal default rate based on the Table 3: Average Cumulative Issuer-Weighted Global Default Rates by Alphanumeric Rating, 1983-2010, provided by Moody's. For each year, we had a rating and we compute the difference through years by using the following formula:

$$Marginal\ Default\ Rate_{ti} = Cumulative\ Default\ Rate_{ti+1} - Cumulative\ Default\ Rate_{ti}$$

The table below represent the calculation done.

Table 9 - Marginal Default Rates

Moody's Sovereign Default Rates (1983-2010) Rating : Aaa	6M	12M	18M	24M	30M	36M	42M
Cumulative Default Rates	0,001%	0,001%	0,016%	0,016%	0,016%	0,016%	0,048%
Marginal Default Rates (PD t M)	0,001%	0,000%	0,015%	0,000%	0,000%	0,000%	0,032%

Source: author's calculation

Once every credit loss was computed, we just add to create a summary table with every credit loss for each coupon date, then multiplying them by their respective marginal rate in order to obtain the ECL calculation for each coupon date. The table below shows all credit losses for each coupon payment period multiplied by the marginal default rate in order to obtain the ECL.

Table 10 – ECL Calculation

Calculation of expected credit losses (ECL) (in USD)	31/12/16	30/06/17 6M	31/12/17 12M	30/06/18 18M	31/12/18 24M	30/06/19 30M	31/12/19 36M	30/06/20 42M
Credit Loss (Default in Year t)		378.339	370.866	363.444	356.072	348.750	341.478	334.255
x Marginal Default Rate		0,001%	0,000%	0,015%	0,000%	0,000%	0,000%	0,032%
= ECL (for each Default Year)		3,78	0	54,5165278	0	0	0	106,9616362
Lifetime ECL as of 31 Dec 2016	165							
12-month ECL as of 31 Dec 2016	4							

Source: author's calculation

Since this US treasury bond is categorized as stage 1, this is the 12-month ECL that will be applied, which amounts to 4 USD = (378,339 x 0,001%) + (370,866 x 0,000%) as of 31/12/2016. However, we also have computed the lifetime ECL which is the sum of ECL of each default year and amounts to 165 USD.

For the other bonds, the same methodology is used. We have decided to present in the thesis only one bond of the portfolio. However, you will find in the Excel file present in the CD-ROM attached every calculation made for each of the six bonds.

Table 10 here under is a summary of the ECL obtained for each one of bonds present in the portfolio of the Bank.

Table 11 – ECLs calculation summary table

Description of the bond	Rating from staring date	Rating from reporting date	Stage	ECL amount
United States of America	Aaa	Aaa	1	4
Belgium	Aa3	Aa3	2	7
France	Aa2	Aa2	2	2
Grand-Duchy of Luxembourg	Aaa	Aaa	1	397
Slovenia	Ba1	Baa3	2	683,209
Ireland	A3	A3	1	16,107
BIL	B1	Ba3	1	86,092

Source: author's calculation

4.2. ECL calculation for retail and corporate mortgages

4.2.1. Objective

In this section, the main objective is to analyse the methodology used for computing the ECL on other financial instruments and here retail and corporate mortgage loans. In this section, the methodology used will be slightly different. We decided to merge the methodology section of both the retail and corporate mortgages because the methodology used to obtain the ECL is completely the same. However, we are going to separate the result section in order to show different types of outcomes.

4.2.2. Methodology

The first step in the calculation was to determine to which stage every exposure belongs. In order to execute this step, we had to assign a definition for each one of the three stages and distinguish the exposures that were past due and those that were not. The IFRS 9 standard is defining past due as when a counterparty has failed to make a payment when that payment was contractually due. For those exposure that were past due, we had to identify for how many days they were. Here are the assumptions of the definitions of the three stages that we have made:

- **Stage 1:** if the number of days past due is less than 31 days, then the exposure is considered as Stage 1, for which the calculation of 12-Months ECL is required.

- **Stage 2**: if the number of days past due is between 31 and 90 days, the instrument belongs to a stage 2 category, for which the lifetime ECL is of vigour.
- **Stage 3**: if the number of days past due is greater than 90 days, in this case it would be categorized as a stage 3 instrument, for which the lifetime ECL will be applied.

As previously mentioned, the ECL is obtained by multiplying the PD, the LGD and the EaD:

$$\text{ECL} = \text{PD x LGD x EaD}$$

During this next step, we will therefore detail each of the components of the calculation of expected credit loss.

4.2.2.1. Probability of default (PD)

As defined in the IFRS 9 standard, the "probability of default" or "PD" is defined as the probability of default of a counterparty over a one year period regarding the 12-month PD and over remaining time to maturity of the instrument for the lifetime PD.

The methodology used in this section is the migration matrix approach. The latter is defined in on the previous section, namely in section 3.5.3 of this thesis. The method used to calculate the PD for the mortgage loans is based on historical data. Indeed, we had to identify the number of retail and corporate mortgage loans, that between 31/12/2014 and 31/12/2015 went from not past due, 30, 60 or 90 days past due to default. It is important to note that data from 2014 and 2015 are used in this section because the 2016 data were not accurate enough. Once we had the number of exposures that went to default for each one of past due categories, we had to divide the number by their respective headcount bucket, so that we can have the PD for each category. The headcount bucket is the entire exposure present in each category.

a. Class 0 days: $PD = \frac{17}{7752} = 0.22\%$
b. Class 30-60 days: $PD = \frac{2}{25} = 5.71\%$
c. Class 90 days: $PD = \frac{1}{6} = 16.67\%$

d. Class Default: $PD = \frac{77}{77} = 100\%$

The class 0 days is regrouping the percentage of exposure that was not past due and went to default over 2014 and 2017. From 7752 expositions, 17 went to default. The class 30-60 days represented the 2 exposures of 25 that was in 2014, 30 or 60 days past due and went into default in 2015. As for the class 90 days, 16,67% is the percentage of expositions that were between 61 and 90 days past due in 2014 and went into default in 2015. Regarding exposures that were over the 90 days past due in 2014, calculate a PD was not very necessary since they were already considered as default and that in consequence the PD was 100%. However, we still have made the calculation in order to be consistent. The table below is a summary of the calculation done in the Excel file.

Table 12 – PD calculation for retail/corporate mortgages loans

From xx to default	Headcount bucket	PD	Class
17	7752	0.22%	Class 0
2	35	5.71%	Class 30-60
1	6	16.67%	Class 90
77	77	100%	Class default

Source: author's calculation

4.2.2.2. Loss Given Default (LGD)

As defined in the Capital Regulatory Regulation (CRR) the loss given default or LGD *"means the ratio of the loss on an exposure due to the default of a counterparty to the amount of outstanding default"*. (European Union, 2013)

The LGD depends on the quality of the contract, we thus relied the LGD on the collateral of the exposure. Indeed, a collateral is a pledge given by a borrower to the lender to secure repayment of a loan. It serves as a protection for the lender against a default from the borrower[7]. In lending agreements, if the borrower does default due to for example insolvency, the borrower gives up

[7] http://www.investopedia.com/terms/c/collateral.asp

the collateral, which in mortgage loans as it is the case in this study, is a property. This is why the collateral is an appropriate basis for calculating the LGD. Indeed, when the collateral is substantial, the ratio of losses on an exposure will be low or even null. This is when the collateral is greater than the amount of the exposure. We then talk about an over collateralized exposure.

When exposures had no collateral, or when the amount was not provided by the bank, due to lack of data, we fixed our LGD to 45% as defined in the CRR document. Otherwise, based on the collateral, we have computed the Loan-to-Value ("LTV"), which is typically examined by lenders before approving a mortgage because a high LTV is generally seen as a risk and will cost the borrower more. LTV is thus calculated as followed:

$$Loan - to - value = \frac{Loan\ Value}{Collateral\ Value}$$

We can also use the Recovery Rate ("RR") in order to compute the LGD, and this is the method that we used in this section as for the bond section. The RR is a percentage of a debt instrument's face value that give the proportion to which principal and accrued interest can be recovered in case of default. Recovery rate was estimated as follows:

$$Recovery\ Rate = \frac{Collateral\ Value}{Loan\ Value}$$

4.2.2.3. Exposure at Default (EaD)

Regarding the estimation of the EaD, best practise which the banks follow is to develop more sophisticated models in order to obtain this amount. However, due to limited data availability in our case, we did not develop sophisticated model and we used simplified method for obtaining the exposure at default. We have estimated the EaD as the outstanding amount of the loan and we did not take any collateral value into account, in this case.

$$\text{EaD} = \text{outstanding amount of the loan}$$

Now we have every component defined, we can analyse the results of both retail and corporate mortgage loans.

4.2.3. Results for retail mortgages loans

The table bellow shows one part of the exposure present in the portfolio of the Bank. In order, to proceed to our calculation, we had to obtain some information such as the number of days past due of the amount of the collateral. In order to explain in details the results obtained, we decided to base our analysis on one specific loan present in the Bank's portfolio, namely, the loan 143923700.

Table 13 - Retail mortgage loan's data

Reporting date	Loan code	Counterparty Type	Loan Type	Collateral	Maturity	Outstanding	Past due days	Collateral value	Risk Weight
31/12/16	145723700	Retail	Loan - Mortgage	Residential mortgage	17/10/25	327.504,47	360	N/A	100%
31/12/16	143923700	Retail	Loan - Mortgage	Residential mortgage	11/06/28	391.040,93	360	358.000,00	100%
31/12/16	145103700	Retail	Loan - Mortgage	Residential mortgage	20/07/30	165.407,98	90	150.000,00	35%
31/12/16	173763800	Retail	Loan - Mortgage	Residential mortgage	28/12/45	576.900,09	0	80.000,00	35%
31/12/16	162463800	Retail	Loan - Mortgage	Cash on deposits	28/10/16	433.279,11	0	13.679,76	35%
31/12/16	173663800	Retail	Loan - Mortgage	Residential mortgage	22/04/36	747.563,70	0	450.000,00	35%
31/12/16	173003800	Retail	Loan - Mortgage	Residential mortgage	22/09/40	630.480,79	0	N/A	35%
31/12/16	168333800	Retail	Loan - Mortgage	Residential mortgage	06/11/43	341.904,53	0	125.000,00	35%
31/12/16	158303700	Retail	Loan - Mortgage	Residential mortgage	25/03/30	480.029,39	0	N/A	35%
31/12/16	171723800	Retail	Loan - Mortgage	Residential mortgage	11/03/45	461.769,20	0	320.000,00	35%
31/12/16	170693800	Retail	Loan - Mortgage	Residential mortgage	27/10/44	449.548,80	0	350.000,00	35%
31/12/16	172493801	Retail	Loan - Mortgage	Commercial mortgage	15/12/36	1.030.630,45	0	1.000.000,00	35%
31/12/16	173473800	Retail	Loan - Mortgage	Residential mortgage	26/11/35	534.879,43	0	450.000,00	35%
31/12/16	150693800	Retail	Loan - Mortgage	Cash on deposits	21/04/26	108.105,08	0	1.214,18	35%
31/12/16	114843800	Retail	Loan - Mortgage	Residential mortgage	28/03/44	286.278,67	0	200.000,00	35%
31/12/16	171593802	Retail	Loan - Mortgage	Residential mortgage	17/12/45	233.579,39	0	N/A	35%
31/12/16	166853802	Retail	Loan - Mortgage	Residential mortgage	29/08/36	216.048,06	0	N/A	35%
31/12/16	174961400	Retail	Loan - Mortgage	Residential mortgage	25/08/19	203.298,57	0	N/A	35%
31/12/16	170133800	Retail	Loan - Mortgage	Residential mortgage	28/11/44	361.134,31	0	325.000,00	35%
31/12/16	170483801	Retail	Loan - Mortgage	Residential mortgage	14/11/44	513.732,14	0	520.000,00	35%
31/12/16	142443800	Retail	Loan - Mortgage	Residential mortgage	29/09/17	90.103,64	0	N/A	35%
31/12/16	59713800	Retail	Loan - Mortgage	Residential mortgage	04/09/18	39.309,64	0	N/A	35%
31/12/16	159533700	Retail	Loan - Mortgage	Commercial mortgage	16/06/38	463.667,98	0	500.000,00	35%
31/12/16	8573700	Retail	Loan - Mortgage	Residential mortgage	09/02/30	217.535,74	0	1.117.500,00	35%
31/12/16	8603700	Retail	Loan - Mortgage	Residential mortgage	15/10/19	17.698,46	0	150.000,00	35%
31/12/16	15823800	Retail	Loan - Mortgage	Residential mortgage	05/12/23	45.406,51	0	700.000,00	35%
31/12/16	15903701	Retail	Loan - Mortgage	Residential mortgage	27/03/22	40.719,88	0	850.000,00	35%
31/12/16	16023701	Retail	Loan - Mortgage	Residential mortgage	13/09/22	53.007,03	0	754.000,00	35%
31/12/16	16183800	Retail	Loan - Mortgage	Residential mortgage	09/03/22	280.069,74	0	1.950.000,00	35%

Source: author's calculation

The first step was to carry out the determination of the various stages of each loan in order to obtain the corresponding PD. In order to do this, as previously mentioned, we used the number of days past due, which is the number of days that the borrower was in default. In the case of our analysis, the loan is 360 days past due which means that the loan is already impaired and that the PD for this loan is automatically 100%. The second step was to obtain the LGD. We thus calculated the LTV in order to be able to attribute a recovery rate to each loan. The LTV is based on the amount of the collateral and the amount of the loan, whichever was greater than 100%, meaning that the amount of the loan was higher than the amount of the collateral and

therefore the recovery would not be full. For the case of the second row of the Excel file, the outstanding amount of the exposition is 391,041 USD while the amount of the collateral is 358.000 USD, the LTV is 109%. This gives a recovery rate of 91.55% which is the percentage of the entire outstanding amount that will be recovery by the borrower. This leads to obtaining a LGD of 8.45%.

The calculation of the ECL is then obtained by applying the following formula:

ECL = PD x LGD x EaD
ECL = 100% x 8.45% x 391.041
ECL = 33,040.93 EUR

However, there is some limits to its calculation. Indeed, IFRS 9 requires entities to be fully IFRS 9 compliant which means that entities should add a forward-looking information to their calculation which will be explained in the "Limits" section below.

4.2.4. Limits

During this analysis, we used the matrix method by grouping the various loans into their past due days in order to calculate the PD because this method was a simplified way of obtaining the desired result. However, in order to be fully compliant IFRS 9, the method used must absolutely contain forward looking information for a certain amount of time, which is not the case so far. Indeed, the PD and the LGD are currently based on past or present data. In other words, banks had to insert macroeconomic information in their model. In our case, we decided to insert a forward-looking time horizon of 1 year, which is not a specific rule defined by IFRS 9 standard but something that we decided to apply. We have therefore chosen to base our analysis on the house pricing index (HPI) of countries. In order to choose on which countries, we are going to do our analysis, we simply decided to look at the HPI of the countries from which the different exposures of the Bank originated, namely Belgium and the Grand Duchy of Luxembourg. As it is mortgage loans, this choice of HPI data makes sense. The house pricing index (HPI) for Belgium and Luxembourg for the years 2014 to 2016 are taken from the Eurostat homepage. We took the index of the first quarter of 2014, 2015 and 2016, however we took the last quarter of 2016 to apply it to 2017 because it was the last data available on the website.

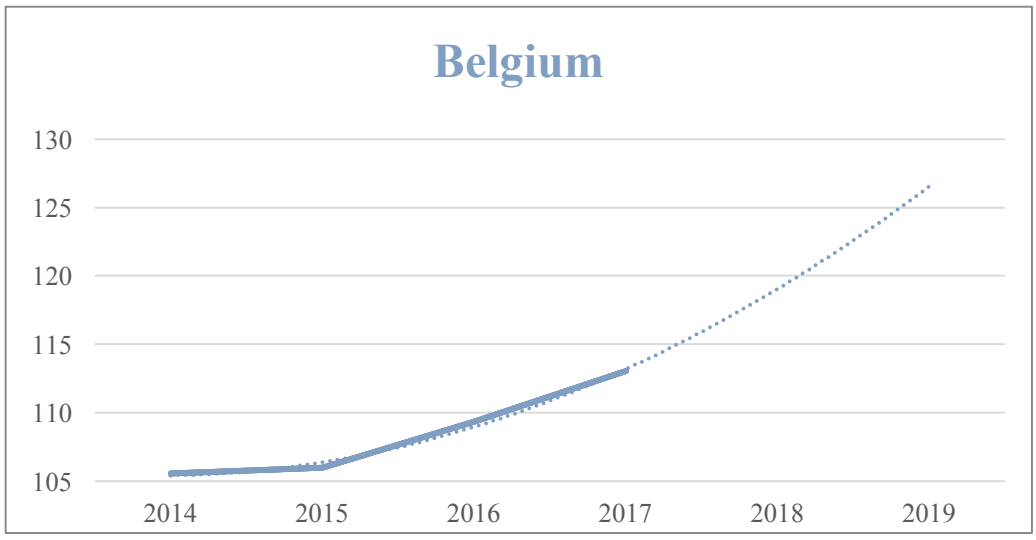
Table 14 - House Price Index for Belgium and Luxembourg

HPI	Q1 2014	Q1 2015	Q1 2016	Q4 2016
Belgium	105,53	105,97	109,34	113,05
Luxembourg	114	122,03	128,07	135,76

Source: Europa.eu, Eurostat

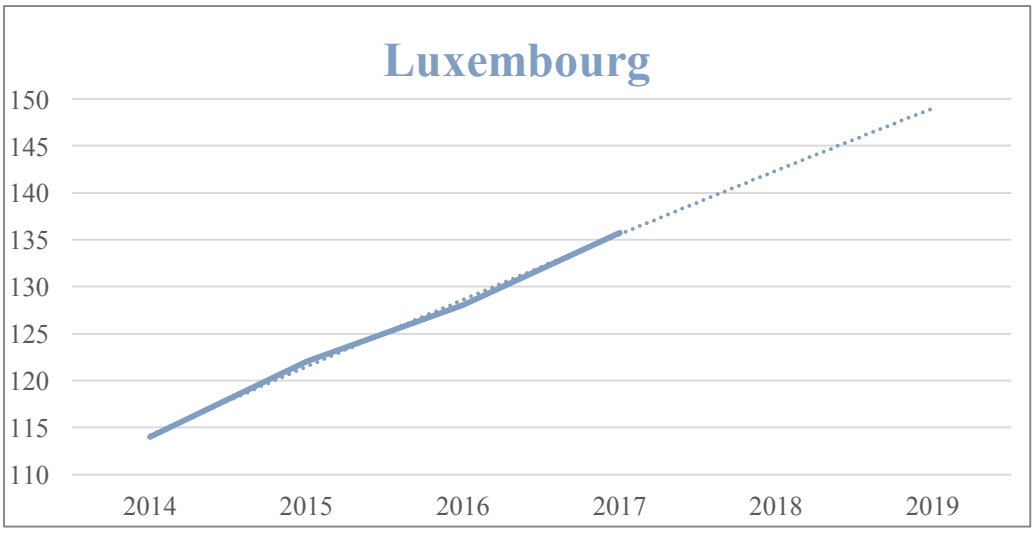
Based on these data we created a polynomial regression curve in order to predict the house price index for 2018 and 2019. The following graphs are the results obtained from the regression curve.

Figure 7 - Belgium regression curve and 2018/19 forecasts



Source: author's calculation

Figure 8 - Luxembourg regression curve and 2018/19 forecasts



Source: author's calculation

Then, the price of the real estates in 2018 is computed by applying these forecasts. We are multiplying the current price of the real estate by (1+x)%, where x is the expected growth for both Luxembourgish and Belgian market in 2018 which is the forward-looking information needed to be IFRS 9 compliant. In this case, the current price of the real estate is 113.05 for Belgium and 135.76 for Luxembourg and the expected growth, is 3.49% $= \frac{(117-113{,}05)}{113{,}05}$ and 4.96%$= \frac{(142{,}5-135{,}76)}{135{,}76}$ respectively for Belgium and Luxembourg. To put this strategy into practice, we decided to multiply the collateral value of all loans with collateral by the expected growth. The table below is one part of the ECL loan calculation.

Table 15 - ECLs calculation for retail mortgages loans

			x(BE)	3,49%	x(LUX)	4,96%								
Loan code	Collateral value	Collateral value w/ forward looking info	Stage 1	Stage 2	Stage 3	ECL Stage 1	ECL Stage 2	ECL Stage 3	Years maturity	LTV	Recovery Rate	LGD	Risk Weighted ECL	1Y PD
145723700	N/A	N/A	0	0	1	0,00	0,00	147.377,01	9	N/A	N/A	45,00%	147.377,01	100%
143923700	358.000,00	370.508,62	0	0	1	0,00	0,00	20.532,30	11	106%	94,75%	5,25%	20.532,30	100%
145103700	150.000,00	155.241,04	0	1	0	0,00	1.694,49	0,00	14	107%	93,85%	6,15%	593,07	16,6667%
173763800	80.000,00	82.795,22	1	0	0	1.083,56	0,00	0,00	29	697%	14,35%	85,65%	379,25	0,2193%
162463800	13.679,76	14.157,73	1	0	0	919,13	0,00	0,00	0	3060%	3,27%	96,73%	321,69	0,2193%
173663800	450.000,00	465.723,13	1	0	0	618,07	0,00	0,00	19	161%	62,30%	37,70%	216,32	0,2193%
173003800	N/A	N/A	1	0	0	622,18	0,00	0,00	24	N/A	N/A	45,00%	217,76	0,2193%
168333800	125.000,00	129.367,54	1	0	0	466,09	0,00	0,00	27	264%	37,84%	62,16%	163,13	0,2193%
158303700	N/A	N/A	1	0	0	473,71	0,00	0,00	13	N/A	N/A	45,00%	165,80	0,2193%
171723800	320.000,00	331.180,89	1	0	0	286,38	0,00	0,00	28	139%	71,72%	28,28%	100,23	0,2193%
170693800	350.000,00	362.229,10	1	0	0	191,49	0,00	0,00	28	124%	80,58%	19,42%	67,02	0,2193%
172493801	1.000.000,00	1.034.940,29	1	0	0	0,00	0,00	0,00	20	100%	100,00%	0,00%	-	0,2193%
173473800	450.000,00	465.723,13	1	0	0	151,66	0,00	0,00	19	115%	87,07%	12,93%	53,08	0,2193%
150693800	1.214,18	1.256,60	1	0	0	234,32	0,00	0,00	9	8603%	1,16%	98,84%	82,01	0,2193%
114843800	200.000,00	206.988,06	1	0	0	173,88	0,00	0,00	27	138%	72,30%	27,70%	60,86	0,2193%
171593802	N/A	N/A	1	0	0	230,51	0,00	0,00	29	N/A	N/A	45,00%	80,68	0,2193%
166853802	N/A	N/A	1	0	0	213,21	0,00	0,00	20	N/A	N/A	45,00%	74,62	0,2193%
174961400	N/A	N/A	1	0	0	200,62	0,00	0,00	3	N/A	N/A	45,00%	70,22	0,2193%
170133800	325.000,00	336.355,59	1	0	0	54,34	0,00	0,00	28	107%	93,14%	6,86%	19,02	0,2193%
170483801	520.000,00	538.168,95	1	0	0	0,00	0,00	0,00	28	95%	100,00%	0,00%	-	0,2193%
142443800	N/A	N/A	1	0	0	88,92	0,00	0,00	1	N/A	N/A	45,00%	31,12	0,2193%
59713800	N/A	N/A	1	0	0	38,79	0,00	0,00	2	N/A	N/A	45,00%	13,58	0,2193%
159533700	500.000,00	517.470,15	1	0	0	0,00	0,00	0,00	21	90%	100,00%	0,00%	-	0,2193%
8573700	1.117.500,00	1.156.545,78	1	0	0	0,00	0,00	0,00	13	19%	100,00%	0,00%	-	0,2193%
8603700	150.000,00	155.241,04	1	0	0	0,00	0,00	0,00	3	11%	100,00%	0,00%	-	0,2193%
15823800	700.000,00	724.458,20	1	0	0	0,00	0,00	0,00	7	6%	100,00%	0,00%	-	0,2193%
15903701	850.000,00	879.699,25	1	0	0	0,00	0,00	0,00	5	5%	100,00%	0,00%	-	0,2193%
16023701	754.000,00	780.344,98	1	0	0	0,00	0,00	0,00	6	7%	100,00%	0,00%	-	0,2193%
16183800	1.950.000,00	2.018.133,57	1	0	0	0,00	0,00	0,00	5	14%	100,00%	0,00%	-	0,2193%

Source: author's calculation

Once this forward-looking information is added, we have a different collateral value, which went from 358,000 EUR to 370,508.62 EUR. This demonstrates that by adding the forward-looking information, the collateral value tends to increase. This leads to different loan-to-value and recovery rate and thus a different LDG of 5.25%. In consequence, we have a different ECL of 20,535.30 EUR. We can see that following the addition of the expected growth of, in this case, the Belgian market, the ECL amount had decreased which makes sense since the collateral value has increased, resulting in a significantly higher recovery rate. This means that the lender is supposed to recover a larger amount than expected and that the loan will be considered as less risky than previously.

It should be noted that whenever we meet the N/A symbol, is it because of the availability of the data. Indeed, we could not get all the collateral amounts of each loans by the Bank. Therefore, we were not able to calculate the LTV for these rows and thus apply the LGD at 45%.

4.2.1. Results for corporate mortgages

Regarding the results for corporate mortgage loans, since the methodology is exactly the same as the previous section, namely ECL calculation for retail mortgage loans, we are going only to summarise the obtained results. On the basis of the data presented in the table below, we were

able to calculate each of the necessary components, namely the PD, LGD and EaD, so that we can calculate the expected credit losses. However, since we already have explained and calculated the forward-looking information required to be IFRS 9 compliant, the following results already take into account this new component. Moreover, since the methodology is largely the same as for retail loans, we will analyse a slightly different exposure to explain our calculations. We will use a case where the loan is considered to be over collateralised, namely when the collateral value is higher than the outstanding value, i.e. 130443700.

Table 16 - Corporate mortgage loan's data

Reporting date	Loan code	Counterparty Type	Loan Type	Maturity	Outstanding	Past due days	Collateral value	Collateral value w/ forward looking info	Risk Weight
31/12/16	174801400	Corporates	Loan - Mortgage	14/07/36	1.724.109,13	0	875.000,00	918.440,63	35%
31/12/16	173713800	Corporates	Loan - Mortgage	23/12/35	1.462.707,86	0	597.422,28	627.082,17	35%
31/12/16	173723800	Corporates	Loan - Mortgage	23/12/35	585.447,17	0	190.000,00	199.432,82	35%
31/12/16	172153800	Corporates	Loan - Mortgage	15/04/30	1.753.550,89	0	1.500.000,00	1.574.469,65	35%
31/12/16	174551400	Corporates	Loan - Mortgage	20/05/18	1.022.859,57	0	690.000,00	724.256,04	35%
31/12/16	170651402	Corporates	Loan - Mortgage	16/03/18	1.376.765,61	0	1.180.000,00	1.238.582,79	35%
31/12/16	155953700	Corporates	Loan - Mortgage	11/03/29	942.709,51	0	700.000,00	734.752,50	35%
31/12/16	146323700	Corporates	Loan - Mortgage	20/12/25	407.713,13	0	150.000,00	157.446,97	35%
31/12/16	170363802	Corporates	Loan - Mortgage	08/09/18	540.722,38	0	N/A	N/A	35%
31/12/16	173773800	Corporates	Loan - Mortgage	29/12/35	530.315,95	0	359.610,00	377.463,35	35%
31/12/16	174851400	Corporates	Loan - Mortgage	23/08/18	448.945,35	0	N/A	N/A	35%
31/12/16	174101400	Corporates	Loan - Mortgage	05/12/18	157.762,02	0	N/A	N/A	35%
31/12/16	174983800	Corporates	Loan - Mortgage	02/09/36	719.394,18	0	750.000,00	787.234,83	35%
31/12/16	146913700	Corporates	Loan - Mortgage	26/01/31	75.677,61	0	N/A	N/A	35%
31/12/16	175483800	Corporates	Loan - Mortgage	22/11/36	1.983.759,82	0	2.200.000,00	2.309.222,16	35%
31/12/16	130443700	Corporates	Loan - Mortgage	18/05/24	34.607,11	0	520.000,00	545.816,15	35%
31/12/16	130713700	Corporates	Loan - Mortgage	19/02/21	47.637,82	0	355.727,21	373.387,80	35%
31/12/16	132663701	Corporates	Loan - Mortgage	21/01/33	227.523,59	30	500.000,00	524.823,22	35%
31/12/16	133593700	Corporates	Loan - Mortgage	02/03/21	30.043,22	0	198.314,82	208.160,44	35%
31/12/16	138263700	Corporates	Loan - Mortgage	06/03/28	332.481,85	0	745.000,00	781.986,59	35%
31/12/16	139823700	Corporates	Loan - Mortgage	10/09/23	80.571,63	0	263.834,00	276.932,42	35%
31/12/16	140113700	Corporates	Loan - Mortgage	30/06/27	335.876,59	210	440.000,00	461.844,43	100%
31/12/16	146323701	Corporates	Loan - Mortgage	16/12/29	318.449,00	0	365.000,00	383.120,95	35%
31/12/16	146323800	Corporates	Loan - Mortgage	30/12/23	129.698,60	0	400.000,00	419.858,57	35%
31/12/16	147293700	Corporates	Loan - Mortgage	23/02/26	73.326,01	90	200.000,00	209.929,29	35%
31/12/16	148143700	Corporates	Loan - Mortgage	15/05/31	252.576,43	180	542.000,00	568.908,37	100%
31/12/16	149183700	Corporates	Loan - Mortgage	21/09/21	39.772,70	360	495.000,00	519.574,99	100%
31/12/16	157623700	Corporates	Loan - Mortgage	18/12/39	239.209,16	0	410.000,00	430.355,04	35%
31/12/16	158763900	Corporates	Loan - Mortgage	11/03/34	444.069,02	0	619.809,69	650.581,03	35%
31/12/16	160123700	Corporates	Loan - Mortgage	31/03/36	233.871,93	0	750.000,00	787.234,83	35%
31/12/16	160153800	Corporates	Loan - Mortgage	10/09/39	879.555,98	0	1.300.000,00	1.364.540,37	35%
31/12/16	161123700	Corporates	Loan - Mortgage	27/07/41	466.491,65	0	820.000,00	860.710,08	35%

Source: author's calculation

Regarding the probability of default, we used the same method as the one described in section *4.5.2.1 Probability of default* and we therefore obtained the same PD values for each of the classes (*cf. Table 9: PD Calculation for mortgages loans*). Since there are no past due days for the loan used for this analysis, it is considered as belonging to the class 0 that result in a PD of 0.22%, which is closed to zero because there is a tiny chance that the borrower will go to default.

For the loss given default calculation, we also used the same method as previously by computing the loan-to-value and the recovery rate.

Given that the collateral value is higher that the loan value, this means that the loan is over collateralized. This leads to the fact that even if the borrower goes into default one day, the collateral, which is in this case a saving deposit, will automatically cover the entire amount of losses. It should be noted that we used the collateral value which takes into account the forward-looking information namely the expected growth of both house pricing index of Belgium and Luxembourg which are respectively 3.49% and 4.96%. We thus obtain a loan-to-value of 6%

$$Loan - To - Value = \frac{Loan\ Value}{Collateral\ Value^{8}} = \frac{34{,}607.11}{545{,}816.15} = 6\%$$

In the meantime, since the loan is over collateralized, the recovery rate should be over 100% and thus the lender would likely receive more than what he lends to the borrower, which makes no sense. Thus, we set the recovery rate obtained below 100% for all the RR higher than 100% by using the "MIN" formula in Excel. Consequently, the recovery rate for this particular loan is equal to 100% which means that the lender has 100% chance to receive the entire amount of the loan in case of default.

$$Recovery\ Rate = \frac{Collateral\ Value}{Loan\ Value} = \frac{545{,}816.15}{34{,}607.11} = 100\%$$

Since the recovery rate is equal to 100%, this means that the LGD will therefore be equal to zero. Indeed, the LGD is obtained by subtracting the RR of 1.

$$LGD = 1 - Recovery\ Rate = 1 - 100\% = 0.00\%$$

Regarding the exposure at default, the amount used is the outstanding amount as for the other sections. The ECL is thus obtain as follow:

ECL = PD x LGD (with the forward-looking information) x EaD

[8] Collateral value with the forward-looking information

ECL = 0% x 0.22% x 34.607,11

ECL = 0 EUR

The table 16 below is one part of the corporate mortgage portfolio including the current loan used for the analysis.

Table 17 - ECLs calculation of corporate mortgage loans

	x(BE)	3,49%	x(LUX)	4,96%								
Loan code	Stage 1	Stage 2	Stage 3	ECL Stage1	ECL Stage 2	ECL Stage 3	Years maturity	LTV	Recovery Rate	LGD	Risk Weighted ECL	1Y PD
174801400	1	0	0	1.766,82	0,00	0,00	20	188%	53,27%	46,73%	618,39	0,2193%
173713800	1	0	0	1.832,51	0,00	0,00	19	233%	42,87%	57,13%	641,38	0,2193%
173723800	1	0	0	846,52	0,00	0,00	19	294%	34,07%	65,93%	296,28	0,2193%
172153800	1	0	0	392,72	0,00	0,00	13	111%	89,79%	10,21%	137,45	0,2193%
174551400	1	0	0	654,83	0,00	0,00	1	141%	70,81%	29,19%	229,19	0,2193%
170651402	1	0	0	303,03	0,00	0,00	1	111%	89,96%	10,04%	106,06	0,2193%
155953700	1	0	0	456,05	0,00	0,00	12	128%	77,94%	22,06%	159,62	0,2193%
146323700	1	0	0	548,83	0,00	0,00	9	259%	38,62%	61,38%	192,09	0,2193%
170363802	1	0	0	533,61	0,00	0,00	2	N/A	N/A	45,00%	186,76	0,2193%
173773800	1	0	0	335,20	0,00	0,00	19	140%	71,18%	28,82%	117,32	0,2193%
174851400	1	0	0	443,04	0,00	0,00	2	N/A	N/A	45,00%	155,06	0,2193%
174101400	1	0	0	155,69	0,00	0,00	2	N/A	N/A	45,00%	54,49	0,2193%
174983800	1	0	0	0,00	0,00	0,00	20	91%	100,00%	0,00%	-	0,2193%
146913700	1	0	0	74,68	0,00	0,00	14	N/A	N/A	45,00%	26,14	0,2193%
175483800	1	0	0	0,00	0,00	0,00	20	86%	100,00%	0,00%	-	0,2193%
130443700	1	0	0	0,00	0,00	0,00	7	6%	100,00%	0,00%	-	0,2193%
130713700	1	0	0	0,00	0,00	0,00	4	13%	100,00%	0,00%	-	0,2193%
132663701	1	0	0	0,00	0,00	0,00	16	43%	100,00%	0,00%	-	5,7143%
133593700	1	0	0	0,00	0,00	0,00	4	14%	100,00%	0,00%	-	0,2193%
138263700	1	0	0	0,00	0,00	0,00	11	43%	100,00%	0,00%	-	0,2193%
139823700	1	0	0	0,00	0,00	0,00	7	29%	100,00%	0,00%	-	0,2193%
140113700	0	0	1	0,00	0,00	0,00	11	73%	100,00%	0,00%	-	100,0000%
146323701	1	0	0	0,00	0,00	0,00	13	83%	100,00%	0,00%	-	0,2193%
146323800	1	0	0	0,00	0,00	0,00	7	31%	100,00%	0,00%	-	0,2193%
147293700	0	1	0	0,00	0,00	0,00	10	35%	100,00%	0,00%	-	16,6667%
148143700	0	0	1	0,00	0,00	0,00	10	44%	100,00%	0,00%	-	100,0000%
149183700	0	0	1	0,00	0,00	0,00	10	8%	100,00%	0,00%	-	100,0000%
157623700	1	0	0	0,00	0,00	0,00	10	56%	100,00%	0,00%	-	0,2193%
158763900	1	0	0	0,00	0,00	0,00	10	68%	100,00%	0,00%	-	0,2193%
160123700	1	0	0	0,00	0,00	0,00	10	30%	100,00%	0,00%	-	0,2193%
160153800	1	0	0	0,00	0,00	0,00	10	64%	100,00%	0,00%	-	0,2193%
161123700	1	0	0	0,00	0,00	0,00	10	54%	100,00%	0,00%	-	0,2193%

Source: author's calculation

4.3. ECL calculation for financial institutions loans

4.3.1. Objective

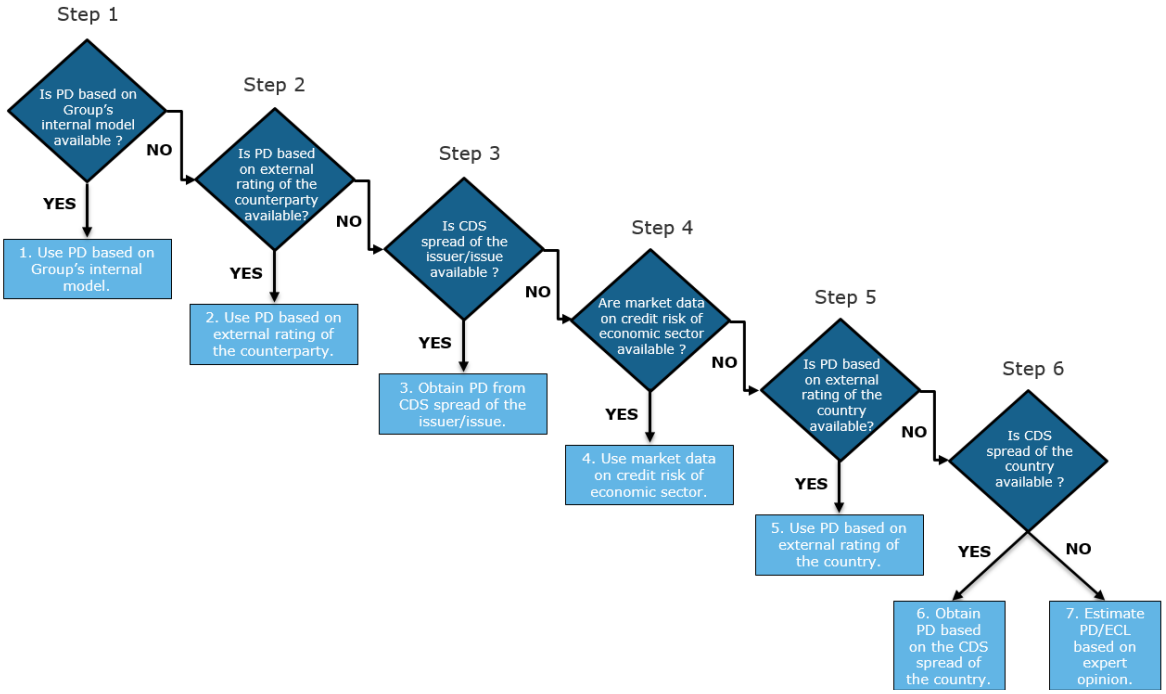
The objective of this section is to calculate the expected credit loss for each category of financial instruments, namely, the financial institutions exposures. The methodology used here closely bear a resemblance to the one used for the previous section, namely the calculation of the ECL for retail mortgages and corporates mortgages except for a few changes.

4.3.2. Methodology

4.3.2.1. Probability of default (PD)

Regarding the probability of default calculation for this section, the first step was to find the rating of each of the exposures present in the portfolio. In order to perform this calculation, we created a mapping table based on the counterparty code in order to match the counterparty code to its financial institution. Once we knew which counterparty corresponded to which code and therefore which exposure, it was time to find the rating of the counterparty and since the exposures were financial institutions, we decided to opt for the external rating method. We thus went to each of their websites to obtain either the S&P or Moody's rating. However, in some cases, the institution's rating was not available on the website, consequently we decided to use the rating of the country corresponding to the exposure. The decision tree below shows the different questions that must be asked if the probability of default is not available.

Figure 9 - Decision tree for obtaining the 1-year PD information



Source: author for Deloitte's presentation

In this study case, we stopped at the fifth step of the decision tree for obtaining the 1-year-PD since some data were not available. Indeed, the PD based on group's internal model, the PD based on external rating of the counterparty, the credit default spread (CDS) which is defined as *"a particular type of swap designed to transfer the credit exposure of fixed income products between two or more parties*[9]*"*, and market data on credit risk of economic sector, all these data were not available to us "*without undue cost and effort",* as the IFRS 9 standard required. Since, every exposure of the portfolio for this type of loan was institutions present in the Grand Duchy of Luxembourg, the Aaa-rating of this country was hence used for all the counterparties. After having found either the rating of the institution or the rating of the corresponding country, we have based ourselves on the table below which covers the average one-year Alphanumeric rating migration rates, 1983-2010* provided by Moody's in order to find the corresponding PD. In this following table, we only used the last column "default" and applied the different ratings. In cases where we have only a PD of 0%, we decided to apply a PD of 0.01% in order to obtain a non-zero amount for the ECL.

Table 18 - Average one-year alphanumeric rating migration rates, 1983-2010

Average One-Year Alphanumeric Rating Migration Rates, 1983-2010*

From/To	Aaa	Aa1	Aa2	Aa3	A1	A2	A3	Baa1	Baa2	Baa3	Ba1	Ba2	Ba3	B1	B2	B3	Caa1	Caa2	Caa3	Ca-C	WR	Default
Aaa	86.236	5.828	2.914	0.552	0.306	0.128	0.014	0.012	0.000	0.000	0.017	0.017	0.000	0.002	0.000	0.000	0.000	0.002	0.000	0.000	3.972	0.000
Aa1	2.188	74.914	8.364	6.413	1.600	0.528	0.129	0.165	0.033	0.006	0.000	0.000	0.003	0.000	0.000	0.012	0.000	0.000	0.000	0.000	5.645	0.000
Aa2	1.062	4.739	74.219	9.255	3.458	1.320	0.450	0.110	0.114	0.008	0.024	0.000	0.000	0.016	0.008	0.006	0.000	0.024	0.000	0.004	5.183	0.000
Aa3	0.214	1.491	4.375	74.940	8.841	2.909	0.995	0.267	0.215	0.083	0.022	0.029	0.016	0.016	0.000	0.000	0.003	0.000	0.000	0.000	5.537	0.047
A1	0.063	0.114	1.338	5.348	75.430	8.043	2.908	0.697	0.386	0.159	0.227	0.120	0.041	0.071	0.020	0.010	0.000	0.006	0.000	0.000	4.960	0.060
A2	0.078	0.037	0.230	1.130	5.190	75.750	7.976	2.863	0.840	0.397	0.185	0.104	0.116	0.052	0.041	0.012	0.034	0.029	0.006	0.000	4.866	0.064
A3	0.050	0.057	0.14β	0.248	1.870	6.707	73.370	6.762	3.224	1.060	0.446	0.178	0.178	0.101	0.052	0.023	0.008	0.004	0.007	0.014	5.442	0.057
Baa1	0.030	0.043	0.084	0.152	0.271	1.845	6.808	72.636	7.382	2.969	0.783	0.405	0.297	0.365	0.071	0.045	0.056	0.031	0.007	0.021	5.556	0.142
Baa2	0.046	0.073	0.040	0.084	0.169	0.712	2.631	5.867	73.603	6.747	1.642	0.634	0.569	0.480	0.241	0.111	0.119	0.018	0.028	0.011	6.005	0.171
Baa3	0.049	0.012	0.037	0.046	0.128	0.254	0.583	2.735	8.738	69.997	5.019	2.589	1.126	0.835	0.375	0.270	0.193	0.096	0.103	0.044	6.481	0.292
Ba1	0.026	0.002	0.028	0.050	0.178	0.143	0.355	0.574	3.058	9.795	63.002	4.747	3.869	1.493	1.092	0.668	0.126	0.150	0.046	0.056	9.868	0.674
Ba2	0.000	0.000	0.027	0.000	0.027	0.080	0.066	0.304	0.747	3.176	8.678	62.466	7.005	2.943	2.251	1.030	0.208	0.194	0.084	0.112	9.841	0.760
Ba3	0.000	0.019	0.011	0.028	0.022	0.146	0.132	0.161	0.292	0.716	2.535	6.180	63.876	5.948	4.429	2.142	0.499	0.329	0.071	0.118	10.618	1.729
B1	0.029	0.013	0.016	0.008	0.039	0.083	0.091	0.065	0.126	0.278	0.452	2.450	6.541	63.918	6.685	3.973	1.257	0.548	0.262	0.366	10.421	2.381
B2	0.000	0.000	0.007	0.016	0.019	0.000	0.039	0.096	0.094	0.139	0.276	0.604	1.883	6.961	61.573	7.892	3.312	1.617	0.507	0.598	10.593	3.775
B3	0.000	0.005	0.041	0.000	0.008	0.020	0.069	0.042	0.047	0.096	0.083	0.225	0.575	2.341	6.338	59.094	6.346	3.909	1.202	1.160	11.240	7.158
Caa1	0.000	0.041	0.000	0.000	0.000	0.033	0.000	0.066	0.000	0.004	0.066	0.037	0.254	0.792	2.232	8.529	51.079	8.512	4.361	2.761	11.885	9.349
Caa2	0.000	0.000	0.000	0.000	0.000	0.012	0.000	0.012	0.061	0.232	0.104	0.086	0.440	0.763	1.252	3.720	7.176	46.051	5.106	5.014	12.075	17.895
Caa3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.140	0.105	0.000	0.175	0.350	1.419	2.698	6.694	38.549	7.692	14.824	27.352
Ca-C	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.052	0.209	0.226	0.556	1.633	1.738	3.423	3.875	35.778	16.994	35.447

Source: Moody's Investors Service

[9] http://www.investopedia.com/terms/c/creditdefaultswap.asp

The table below is a transcript of the mapping table that we used in our Excel file, regrouping the counterparty code, the name of the institution, both S&P and Moody's rating when available, the country rating and the probability of default of each one of the counterparty.

Table 19 - Counterparty rating and PD mapping table

Counterparty code	Name of the institution	S&P Rating	Moody's Rating	Country[10] Rating	Probability of default (PD)
100016	Banque et Caisse d'Epargne de l'Etat (BCEE) [11]	AA+	Aa2	Aaa	0,01%
100017	BIL[12]	A-	A2	Aaa	0,064%
100018	BGL BNP Paribas Luxembourg[13]	A	A1	Aaa	0,060%
100019	KBL European Private Bankers	-	-	Aaa	0,01%
100023	Banque et Caisse d'Epargne de l'Etat[14]	AA+	Aa2	Aaa	0,01%
100026	ING[15]	A-	Baa1	Aaa	0,0142%
100027	Raiffeisen Bank			Aaa	0,01%
100028	Banque de Luxembourg	-		Aaa	0,01%
100048	BCL - kit commerces + publics	-		Aaa	0,01%
100049	BCL - Compte Euro Bloqué (avance)	-		Aaa	0,01%
100098	Fortuna web - banking	-		Aaa	0,01%
100099	Domiciliations / op	-		Aaa	0,01%
100100	Decompte c.p.d.	-		Aaa	0,01%

[10] Grand-Duchy of Luxembourg
[11] https://www.bcee.lu/en/Discover-BCEE/Ratings-Awards
[12] https://www.bil.com/en/bil-group/the-bank/Pages/discover-BIL.aspx

[13] https://www.bgl.lu/fr/banque/pages/a-propos-de-bgl-bnp-paribas/nous-connaitre/donnees-financieres-et-juridiques/ratings.htm
[14] https://www.bcee.lu/en/Discover-BCEE/Ratings-Awards
[15] https://www.ing.com/investor-relations/ratings.htm

100101	Encaissement Coupons	-		Aaa	0,01%

Source: respective financial institutions' websites

4.3.2.2. Loss Given Default (LGD)

In the upper sections, when exposures had no collateral, or when the amount was not provided by the Bank, we based our LGD on the Capital Regulatory Requirement document in order to be conservative. Indeed, the first paragraph of the article 161 of the CRR regarding the Loss Given Default is given a clear definition on which LGD percentage should be applied in which situation (European Union, 2013):

"Institutions shall use the following LGD values:

(a) senior exposures without eligible collateral: 45%

(b) subordinated exposures without eligible collateral: 75 %;

(c) institutions may recognise funded and unfunded credit protection in the LGD in accordance with Chapter 4;

(d) covered bonds eligible for the treatment set out in Article 129(4) or (5) may be assigned an LGD value of 11,25 %;

(e) for senior purchased corporate receivables exposures where an institution is not able to estimate PDs or the institution's PD estimates do not meet the requirements set out in Section 6: 45 %;

(f) for subordinated purchased corporate receivables exposures where an institution is not able to estimate PDs or the institution's PD estimates do not meet the requirements set out in Section 6: 100 %;

(g) For dilution risk of purchased corporate receivables: 75%."

In terms of loans to financial institutions, we are aware that there is no collateral in this type of loan. As a result, the paragraph 1 (a) of Article 161 of the CRR will be applied. The loss given default will therefore be 45% for all the exposure present in this section.

4.3.2.3. Exposure at Default (EaD)

Regarding the exposure at default, since there is no collateral, the quantity exposed in case of default is the entire amount of the outstanding value of the exposure.

4.3.3. Results

It is in this section that the results obtained for the calculation of the ECL for loans due to financial institutions will be presented and detailed. The table below corresponds to all the calculations made in order to obtain the expected credit loss for each of the exposures. We will again focus the analysis of our results on one specific line of the Excel sheet, namely, the loan 1000270216.

Table 20 - Financial institutions' data

Reporting date	Loan code	SORTE	Counterparty Type	Collateral	Maturity	Outstanding	Past due days	Collateral value	Risk Weight
31-12-16	1000279001	9001	Institutions	None	10-03-17	15.000.000,00	0	N/A	20%
31-12-16	1000270216	0216	Institutions	None		5.049.350,51	0	N/A	20%
31-12-16	1000279000	9000	Institutions	None	23-05-17	5.000.000,00	0	N/A	20%
31-12-16	1000279002	9002	Institutions	None	15-02-17	5.000.000,00	0	N/A	20%
31-12-16	1000279004	9004	Institutions	None	04-08-17	2.000.000,00	0	N/A	20%
31-12-16	1000170216	0216	Institutions	None		1.471.547,97	0	N/A	20%
31-12-16	1000160201	0201	Institutions	None		1.084.764,12	0	N/A	20%
31-12-16	1000280201	0201	Institutions	None		819.544,45	0	N/A	20%
31-12-16	1000289004	9004	Institutions	None	28-09-17	797.316,68	0	N/A	20%
31-12-16	1000280216	0216	Institutions	None		673.960,25	0	N/A	20%
31-12-16	1000169001	9001	Institutions	None	17-01-17	556.587,44	0	N/A	20%
31-12-16	1000169000	9000	Institutions	None	16-02-17	555.715,80	0	N/A	20%
31-12-16	1000180205	0205	Institutions	None		304.254,64	0	N/A	20%
31-12-16	1000289002	9002	Institutions	None	02-02-17	263.533,79	0	N/A	20%
31-12-16	1000160203	0203	Institutions	None		207.478,60	0	N/A	20%
31-12-16	1000170203	0203	Institutions	None		153.089,39	0	N/A	20%
31-12-16	1000160216	0216	Institutions	None		147.333,84	0	N/A	20%
31-12-16	1000289005	9005	Institutions	None	02-03-17	146.460,22	0	N/A	20%
31-12-16	1000189003	9003	Institutions	None	08-02-17	135.396,45	0	N/A	20%
31-12-16	1000189002	9002	Institutions	None	08-02-17	129.892,27	0	N/A	20%
31-12-16	1000170201	0201	Institutions	None		53.519,93	0	N/A	20%
31-12-16	1000160287	0287	Institutions	None		43.891,22	0	N/A	20%
31-12-16	1000160210	0210	Institutions	None		37.896,60	0	N/A	20%
31-12-16	1000289000	9000	Institutions	None	24-08-17	30.622,06	0	N/A	20%
31-12-16	1000160286	0286	Institutions	None		14.985,58	0	N/A	20%
31-12-16	1000160244	0244	Institutions	None		11.621,97	0	N/A	20%
31-12-16	1000160218	0218	Institutions	None		6.650,81	0	N/A	20%
31-12-16	1000260216	0216	Institutions	None		5.398,76	0	N/A	20%
31-12-16	1000160205	0205	Institutions	None		3.144,82	0	N/A	20%
31-12-16	1000190216	0216	Institutions	None		3.143,76	0	N/A	20%
31-12-16	1000180216	0216	Institutions	None		2.342,70	0	N/A	20%

Source: author's calculation

For this loan, we obtained a PD of 0.01% given that the counterparty code is 100016 and is corresponding to the *Banque et Caisse d'Epargne de l'Etat* which have a AA+ S&P rating. As mention previously, since the rating is good and begets a 0% PD, we assigned a 0.01%, which is close to zero in order to avoid having a zero ECL amount. Regarding the LGD, as discussed above, we applied the 45% LGD since there is no collateral associate to this loan. For the exposure at default, is the outstanding amount that is used which amounts to 5,049,350.51 USD.

Now that we have all the information needed, we are able to compute the ECL properly by using the following formula.

ECL = PD x LGD x EaD

ECL = 0.01% x 45% x 5,049,350.51

ECL = 227.22 EUR

Regarding the staging, since every line present in the portfolio has none days past due, they are all considering as being a part of the stage 1 category. The table below shows one part of the calculation made for every institutions exposure.

Table 21 - ECLs calculation for financial institutions

Loan code	Stage 1	Stage 2	Stage 3	ECL Stage1	ECL Stage 2	ECL Stage 3	Years maturity	Recovery Rate	LGD	Risk Weighted ECL	1Y PD
1000279001	1	0	0	675,00	0,00	0,00	0	N/A	45,00%	135,00	0,0100%
1000270216	1	0	0	227,22	0,00	0,00	117	N/A	45,00%	45,44	0,0100%
1000279000	1	0	0	225,00	0,00	0,00	0	N/A	45,00%	45,00	0,0100%
1000279002	1	0	0	225,00	0,00	0,00	0	N/A	45,00%	45,00	0,0100%
1000279004	1	0	0	90,00	0,00	0,00	1	N/A	45,00%	18,00	0,0100%
1000170216	1	0	0	66,22	0,00	0,00	117	N/A	45,00%	13,24	0,0100%
1000160201	1	0	0	48,81	0,00	0,00	117	N/A	45,00%	9,76	0,0100%
1000280201	1	0	0	36,88	0,00	0,00	117	N/A	45,00%	7,38	0,0100%
1000289004	1	0	0	35,88	0,00	0,00	1	N/A	45,00%	7,18	0,0100%
1000280216	1	0	0	30,33	0,00	0,00	117	N/A	45,00%	6,07	0,0100%
1000169001	1	0	0	25,05	0,00	0,00	0	N/A	45,00%	5,01	0,0100%
1000169000	1	0	0	25,01	0,00	0,00	0	N/A	45,00%	5,00	0,0100%
1000180205	1	0	0	13,69	0,00	0,00	117	N/A	45,00%	2,74	0,0100%
1000289002	1	0	0	11,86	0,00	0,00	0	N/A	45,00%	2,37	0,0100%
1000160203	1	0	0	9,34	0,00	0,00	117	N/A	45,00%	1,87	0,0100%
1000170203	1	0	0	6,89	0,00	0,00	117	N/A	45,00%	1,38	0,0100%
1000160216	1	0	0	6,63	0,00	0,00	117	N/A	45,00%	1,33	0,0100%
1000289005	1	0	0	6,59	0,00	0,00	0	N/A	45,00%	1,32	0,0100%
1000189003	1	0	0	6,09	0,00	0,00	0	N/A	45,00%	1,22	0,0100%
1000189002	1	0	0	5,85	0,00	0,00	0	N/A	45,00%	1,17	0,0100%
1000170201	1	0	0	2,41	0,00	0,00	117	N/A	45,00%	0,48	0,0100%
1000160287	1	0	0	1,98	0,00	0,00	117	N/A	45,00%	0,40	0,0100%
1000160210	1	0	0	1,71	0,00	0,00	117	N/A	45,00%	0,34	0,0100%
1000289000	1	0	0	8,82	0,00	0,00	1	N/A	45,00%	1,76	0,0640%
1000160286	1	0	0	4,32	0,00	0,00	117	N/A	45,00%	0,86	0,0640%
1000160244	1	0	0	3,35	0,00	0,00	117	N/A	45,00%	0,67	0,0640%
1000160218	1	0	0	1,92	0,00	0,00	117	N/A	45,00%	0,38	0,0640%
1000260216	1	0	0	1,55	0,00	0,00	117	N/A	45,00%	0,31	0,0640%
1000160205	1	0	0	0,91	0,00	0,00	117	N/A	45,00%	0,18	0,0640%
1000190216	1	0	0	0,91	0,00	0,00	117	N/A	45,00%	0,18	0,0640%
1000180216	1	0	0	0,67	0,00	0,00	117	N/A	45,00%	0,13	0,0640%

Source: author's calculation

IV. Impacts of IFRS 9

1. Scope

The effect of IFRS 9 standard on regulatory capital planning is likely to be significant. This is illustrated by the results of various impact assessments and surveys performed on institutions across the European Economic Area (EEA), but also on world-wide level (more details on the results are provided in the following sections). Although the final impairment requirements to be included in IFRS 9 will affect IFRS reporters in all sectors of the economy, the impact is going to be greatest for credit institutions.

The results of the performed impact assessments show that the impairment requirements being developed for IFRS 9 will probably lead to significantly greater provisioning levels than those made under IAS 39, and impairment provisions are also likely to be in excess of existing expected loss calculations used for Basel purposes.

It is reasonable to expect that capital resources at credit institutions will fall, as the impairment provisions calculated under IFRS 9 would likely to be higher than the Basel expected loss due to the impact of the measuring lifetime expected losses on stage 2 assets. In the current climate, regulatory capital requirements and related buffers are unlikely to fall, even though there may be some conceptual rationale for this impairment provisions increase. It is always possible that regulators could impose even greater adjustments to accounting values once the final accounting rules are finalised and the impact on credit institutions is assessed.

In the following subsections, more details on IFRS 9 impact assessment are given.

2. Existing treatment of impairment provisions in regulatory capital

Generally, increasing the level of impairment reduces the level of accounting net assets. However, in calculating regulatory capital resources, there are differing adjustments made to accounting impairment raised on assets held in the regulatory "banking book" in the regulatory capital rules. This depends on whether the asset is subject to the standardised or internal ratings

based (IRB) approach to the calculation of capital requirements associated with credit risk. The following analysis treats Basel III rules as the "existing" rules given that they have been implemented in the majority of jurisdictions with systemically important financial sector entities (Deloitte, 2013).

In the following table, the treatment of impairment provisions in definition of regulatory capital resources is described.

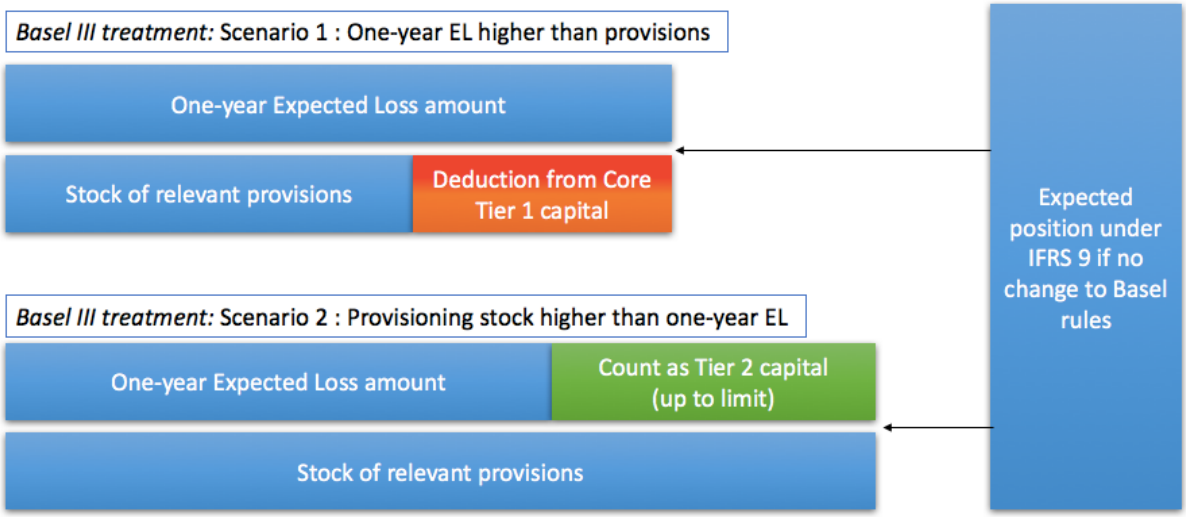
Table 22 - Treatment of impairment in definition of regulatory capital resources

Method	Description	Treatment of impairment
Standardised approach (SA)	Used by smaller credit institutions.	Any impairment loss on a loan taken to the income statement has a 1:1 impact on Core Tier 1 capital as it reduces retained earnings. However, the cumulative collective impairment provisions can be eligible to count as Tier 2 capital resources up to a 'ceiling' of 1.25% of Risk Weighted Assets (RWAs) calculated under the standardised approach. An example of such impairment provisions would be those held to cover latent (incurred but not reported) losses on a pool of performing residential mortgages.
Internal rating based approach (IRB)	Most major credit institutions have applied for the IRB approach on some or all lending portfolios, which allows for credit institutions to use their own computations of capital requirements. To obtain this approach, at least 85% of RWAs must be subject to the IRB approach (in order to prevent selective use of internal modelling for those portfolios for which internal models are most beneficial).	The IRB approach uses a one-year time horizon, and introduces the concept of Unexpected Loss (UL) and Expected Loss (EL) over that period. In essence, in the definition of eligible capital resources, the EL replaces the stock of accounting impairment provisions on portfolios subject to measurement on the IRB approach (as long as the EL exceeds accounting impairment). However, in scenarios where the accounting impairment stock is greater than the EL, the surplus over the EL is allowable to count as Tier 2 capital resources up to a ceiling of 0,6% of RWAs.

Source: Deloitte – Going up? The impact of impairment proposal on regulatory capital

The following figure illustrates and described the impact of existing prudential treatment of provisions.

Figure 10 - Illustration of impact of existing prudential treatment of provisions



Source: Deloitte – Going up? The impact of impairment proposal on regulatory capital

3. Results on EBA impact assessment of IFRS 9

In the context of the forthcoming implementation of IFRS 9 in the European Union, the European Banking Authority (EBA) launched an impact assessment of the Standard on a sample of approximately 50 institutions across the European Economic Area (EEA) in January 2016.

Based on the results of the performed assessment, it can be concluded that the total estimated impact of IFRS 9 is mainly driven by the impairment requirements and, to a lesser extent, by the classification and measurement requirements of IFRS 9. The main impact seems to be driven by the estimation of lifetime ECL for stage 2 exposures (i.e. exposures that have experienced a significant increase of credit risk but are not defaulted) (European Banking Authority, 2016).

It can also be concluded that the estimated change in provisions varies from portfolio to portfolio – and, therefore, across entities – and different factors could influence the impact of IFRS 9 in percentage terms on own funds, such as: the existing level of provisions under IAS 39; the bank's current level of own funds; or the use of a SA or an IRB approach for measuring

credit risk for prudential purposes (for SA banks, any increase in provisions under IFRS 9 will be directly recognised in CET1, while for IRB banks, the impact would depend on the excess/shortfall situation).

The assessment result show that the estimated increase of provisions compared to the current levels of provisions under IAS 39 is 18% on average and up to 30% for 86% of respondents.

In terms of the estimation of the total quantitative impact of IFRS 9, the results show that CET 1 and total capital ratio are estimated to decrease, on average, by 59 bps and 45 bps respectively. CET1 and total capital ratio are estimated to decrease by up to 75 bps for 79% of respondents. However, as is the case when using statistical metrics, it should be noted that some of the estimates relating to the total sample of respondents were different from the above-mentioned estimates. Other metrics (median and weighted average) used for the analysis are included in the following table. This table includes a summary of the estimated quantitative impact of IFRS 9 for the sample and information on the assumptions used to calculate the averages (European Banking Authority, 2016).

Figure 11- Summary of the estimated quantitative impact of IFRS 9

Estimated increase of provisions IFRS 9	
in %	
Median[1]	20%
Average	
Mid of estimated range[2]	18%
Weighted Average[3]	
Conservative estimation in range[4]	**26%**
Mid of estimated range	21%
75th percentile[1]	**30%**
% of respondents below or at the data point of the 75th percentile	*86%*

Estimated impact on CET1 ratio IFRS 9			
In bps	**Total impact of IFRS 9**	**Classification and measurement**	**Impairment**
Median	**-50**	**-25**	**-50**
Average			
Mid of estimated range	-59		
Weighted Average			
Conservative estimation in range	**-55**		
Mid of estimated range	-42		
75th percentile	**-75**	**-25**	**-75**
% of respondents below or at the data point of the 75th percentile	*79%*	*88%*	*85%*

Estimated impact on total capital ratio IFRS 9			
In bps	**Total impact of IFRS 9**	**Classification and measurement**	**Impairment**
Median	**-25**	**-25**	**-25**
Average			
Mid of estimated range	-45		
Weighted Average			
Conservative estimation in range	**-43**		
Mid of estimated range	-30		
75th percentile	**-75**	**-25**	**-50**
% of respondents below or at the data point of the 75th percentile	*79%*	*88%*	*75%*

[1] The median and the 75th percentile refer to the upper limit of a range selected from the survey.
[2] Mid of estimated range is the value between the lowest and highest values within a bank's estimated range of impact.
[3] Weighted average is calculated on the basis of the % of the total assets under IAS 39 of each bank to the sample.
[4] Conservative estimation is the highest value within a bank's estimated range of impact.

Source: EBA - Report on the results from the EBA impact assessment of IFRS 9

4. Estimated quantitative impact of IFRS 9 on three Luxembourgish banks

Due to the potential impact of IFRS 9 on Luxembourgish credit institutions' financial and prudential reporting as well as their internal systems, the Commission de Surveillance du Secteur Financier (CSSF) performed an impact assessment in April 2017.

In the following tables, we summarized the observed results on the impact assessment of the bank analysed in our case study ('Bank 1' in the tables below). Additionally, we provide the

results on impact assessment of two other Luxembourgish banks. Since these results are not publicly available, it was not possible to collect larger data sample.

Table 23 - Accounting provision (Standardised approach)

	Accounting provisions (Standardised approach)	
	As per IAS 39	As per IFRS 9
Bank 1	1.624.813 EUR	2.044.526 EUR
Bank 2	-	132.312 EUR
Bank 3	-	585.976 EUR

Source: author's calculation

Table 24 - CET 1 ratio and Capital ratio

	CET 1 ratio		Total Capital Ratio	
	As per IAS 39	As per IFRS 9	As per IAS 39	As per IFRS 9
Bank 1	10.9%	10.5%	10.9%	10.5%
Bank 2	57.1%	57.1%	57.1%	57.1%
Bank 3	16.8%	16.8%	16.8%	16.8%

Source: author's calculation

As it can be seen from the results, the impact on the capital ratio of Bank 1 is more significant than in case of the other two banks. Furthermore, it can be observed that the impact on the capital ratios of these three Luxembourgish banks is less significant than anticipated within EBA's assessment. However, it should be noted that the results on the sample of three banks cannot be considered as representative indicator for the whole Luxembourgish market.

As already stated in the previous section, since the quantitative impact of IFRS 9 depends on different factors (i.e. the existing level of provisions under IAS 39, the bank's current level of own funds, …), we conclude that it is expected that the impact of IFRS 9 will vary from portfolio to portfolio and, consequently from bank to bank.

V. Limitations

For the private banking sector in Luxembourg the collection of the necessary data for the calculation of expected credit losses according to IFRS 9 turned out to be a material factor. As it can be seen in the calculation of the PD of retail and corporate mortgages in the case study above, data on defaults is existing but it is not enough data for the modelling of a sophisticated PD model. That inconvenience result in the future challenge for most of the Luxembourgish credit institutions to better monitor their portfolio and to add the necessary fields in their banking systems.

Our decision to perform the modelling as it is described in the case study is driven by the availability of data. It turned out that the main task in the implementation of a simple, less sophisticated ECL model is to be compliant to the IFRS 9 standard.

Summarizing, it can be stated that for the Luxembourgish banking sector the biggest limitation to the implementation of the calculation of expected credit losses according to IFRS 9 is the lack of data. In the future, we expect an increase in the quality of data and hence also a continuous evolution in the ECL models.

VI. General Conclusion

In 2009, current accounting standards had to face some weaknesses. In fact, they were partially the cause of the delayed recognition of credit losses noticed on loans and other financial instruments. The impairment model present at that time was the IAS 39 "*Financial Instrument: classification and measurement"* which was an 'incurred loss' model. This means that banks had to delay the recognition of credit losses until there was evidence of a trigger event. In consequence, the Financial Accounting Standard Board and International Accounting Standard Board decided to put their knowledge together in order to publish another standard that would include a more timely and forward-looking information.

The new IFRS 9 impairment requirements remove the IAS 39 threshold for the recognition of credit losses and result in an earlier recognition of expected credit losses. Indeed, credit events no longer need to take place before credit loss recognition to be taken into consideration. With this Standard, entities update the amount of loss allowance at every reporting date which reflect precisely changes in credit risk since initial recognition. This method leads to some consequences regarding the behaviour of the holder of financial asset. In order to provide users of financial statements with clearer and useful information, the holder has to take into account more timely and forward-looking information.

In order to put into practice the requirements made by the Standard, we decided to carry out a case study based on a realistic example of private banking in order to show how the banks are implementing the new requirements. The aim of the case study was to compute the expected credit loss for each of the exposures that the bank selected for the analysis had, by classifying its exposures by counterparty type. We carried out all the steps one by one, from the definition of the stage of the exposure to the calculation of each one of the component present in the expected credit loss.

The case study showed that the implementation of the new IFRS 9 impairment requirements is rising the credit loss allowances and this may affect many entities, mainly banks and financial institutions. Nevertheless, this growth will vary by entity, depending on its portfolio. Entities with shorter term and higher quality financial instruments are likely to be less significantly

affected. In the same way, financial institutions with unsecured retail loans are more likely to be affected by this new requirement that those with collateralised loans such as mortgages. The case study also demonstrates that the IFRS 9 loan loss allowances increase timely with the raise of the probabilities of default when the credit standing deteriorates.

Close to initial recognition, the requirement to recognise 12-month expected credit losses may temporarily result in 'too much'-impairments. However, the case study reveals that as long as the increase in credit risk is not yet significant, the resulting impairments still appear 'little' if not 'too little' because of the low one-year default probabilities. The increase of impairments varies with the increase in credit risk, thus there is still a delay until there is a significant increase in credit risk.

Furthermore, the need to incorporate forward-looking information means that application of the Standard will require considerable judgement as to how changes in macroeconomic factors will affect ECLs. The increased level of judgement required in making the expected credit loss calculation may also mean that it will be more difficult to compare the reported results of different entities. However, entities are required to explain their inputs, assumptions and techniques used in estimating the ECL requirements, as we did in the study case which should provide greater transparency over entities' credit risk and provisioning processes.

Moreover, with this forward-looking information, which is generally measured with the addition of a macroeconomic factor, losses are likely to result in higher volatility in the ECL amounts charged to profit or loss. The level of loss allowances will increase as economic conditions are forecast to deteriorate and will decrease as economic conditions become more favourable.

Finally, regarding the impact of the IFRS 9, we first analysed the EBA impact assessment of IFRS 9 EBA. The latter shows that the impairment requirements being developed for IFRS 9 will probably lead to significantly greater provisioning levels than those made under IAS 39, as already concluded previously. However, in the last part of the impact section of this thesis we have estimated the quantitative impact of the new requirements on three banks including the one studied in our case study. This assessment shows that impact on the capital ratios of these three Luxembourgish banks is less significant than anticipated within EBA's assessment.

VII. Appendix

Every appendix of this thesis is consolidated in the attached CD-ROM.

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