A qualitative and quantitative analysis of the risk parameter LGD based on the Basel II Framework

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Abstract

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Purpose: The purpose of this thesis is to get a deeper understanding of the risk parameter LGD and try to identify which variables drive it and how. Further the purpose of analysing the LGD/LTV relationship is to see how the risk parameter interacts with other parameters that are included in risk management. Everything in this thesis has a starting point in the Basel II Framework which has the purpose to see how well the Basel II guidelines and regulations work with LGD.

Methodology: The thesis is divided into two separate analyses, a qualitative and a quantitative. The LGD values that are received from the statistical model are used as the historical data upon which the qualitative verbal LGD estimation model is based.

Conclusion: The quantitative analysis showed a positive but non-linear relationship between the risk parameter LGD and LTV. When looking closer at the variables included in both the LGD model and the LTV model, the analysis showed that all variables that where included, in some way had an affect. To create variations, both in LGD and the LGD/LTV relationship, the changes in the variables had to be unrealistically large. The Basel II Framework gives the banks several choices when setting up bank internal models. My verbal estimation model set up in this thesis was done accordingly to the workout LGD estimation model which could work in reality if the correct statistical data was inserted.

Abbreviations

	English	Swedish
BIS	Bank of International Settlements	
CEBS	Committee of European Banking Supervisors	
DR	Default Rate	Fallisemangskvot
CRE	Commercial Real Estate	Kommersiell fastighet
EAD	Exposure at Default	Exponering vid fallissemang
ECAI	External Credit Assessment Institute	Rating- agentur
EL	Expected Loss	Förväntad förlust
ELGD	Expected Loss Given Default	Förväntad förlust vid fallissemang
FI	Finans Inspektionen, Swedish supervisor	
IRBA	Internal Rating-Based Approach	IRK ansats
IPRE	Income Producing Real Estate	Inkomstgenererande fastigheter
LGD	Loss Given Default	Förlust givet fallissemang
LTV	Loan To value	Belåningsgrad
M	Maturity	Löptid
PD	Probability of Default	Sannolikhet för fallissemang
RBA	Rating-Based Approach	Rating baserade ansatser
RDS	Reference Data Set	Referens data
RLGD	Realised Loss Given Default	Realiserad förlust givet fallissemang
RRE	Residential Real Estate	Boende fastigheter
SPR	Supervisory Review Process	FI's övervaknings process
UL	Unexpected Loss	Oväntade förlust
QIS	Quantitative Impact Study	Kvatitativ studie över BII`s inverkan

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1. Introduction

1.1 Background

Financial institutes have due to previous financial crises during the 90´s started to look at their loan portfolios in a more statistical way. Credit risk affects a banks daily activity and in Sweden where banks loan portfolios mainly consist of retail loans it is important to find new methods and models to secure one from financial risks. Common rules and guidelines have since long been requested by international banks and several of them have on their own been developing and implementing internal models and methods to improve their routines to actually reflect market conditions.

From 1st January 2007 banks are to work under the new capital accord, Basel II. The changes have for many financial institutes been expensive and difficult, but these new methods for risk management the Basel Committee hopes to be able to prevent future financial crises and reduced expensive capital requirements. Basel II consists on a set of minimum rules which all banks have to follow. Further, the framework gives guidelines on more advanced methods for assessing the economic capital which are optional to implement. For credit risk, financial institutes can implement an advanced IRB approach which allows them to undertake their own estimation of the risk parameters PD (Probability of Default), EAD (Exposure at Default) and LGD (Loss Given Default). In most literature and research papers, effort has been put into the estimation and understanding of PD. This leaves often little room for LGD, which is the one variable that at the present leaves the most unanswered questions. A loss is not mainly determined by if an exposure defaults, rather than how big the recovery rate is going to be. During the work on Basel II a lot of research has been done to see if the framework needs adjustment. The main result of the latest research paper QIS 5[1], states that almost all banks will see benefits from Basel II in the form off reduced capital requirements. In Sweden, the retail segment and especially real estate loans will contribute with the biggest decrease of the capital requirement.[2] Adopting the advanced IRB approach for a retail portfolio, a bank must develop an internal LGD model.

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[1] BIS, Banking Committee on Banking Supervision, *Results of the fifth quantitative impact study (QIS 5).*
[2] Finansinspektionen, Rapport 2006:6, *Bankernas kapitalkrav med Basel 2.*

The function for the economic capital[3] is based on a combination of several parameters, rather than a single parameter, leaving it to be very important to create an internal model where all parameters interact. The Basel II Framework[4] considers the LGD parameter to be an independent stochastic variable, which makes it a difficult parameter to estimate.

1.2 Problem discussion

By looking at the financial crisis's we have had over the past decades, we can see that they have mostly been a product of inconsistent economic policies and lack of supervision of banks and other financial institutes. A financial crisis would today, with our complex and international financial system, not only have consequences for one country but to the entire global economy. The main part of Basel II, the capital requirement regulations, is aimed at increasing the global financial stability. Holding economic capital as safety for outstanding credits is both expensive and ineffective for a bank. Never the less, it is necessary for the survival of the bank to have this safety buffer in case UL (Unexpected Loss) should occur. Generally banks are able to calculate the amount of credit losses that will occur during the following year, so called EL (Expected Loss). Some years the credit losses will increase due to external factors like the economic cycle. It is hard to predict exactly when these losses will occur, but it is even more important to have an estimated value of the amount. It is in these cases that the economic capital is needed as reserve. When an exposure defaults the loss is determined by external factors which are linked to the secondary collateral market, making the LGD parameter facility-specific. Just like the credit risk, LGD is linked to the economic cycle making its value increase during a downturn period.

Several factors drive LGD and these need to be considered when establishing a process for estimating LGD. There has been a lot of analysis done and several work papers written on how to identify and implement all factors necessary in order to estimate correct LGD values. It is important to see the difference between estimating LGD and calculating LGD values for defaulted exposures. The actual LGD values will serve as historical data for future LGD estimations.

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[3] The economic credit capital is through out the thesis referred to as economic capital. Not to be mistaken for the entire economic capital of a bank.

[4] BIS, Banking Committee on Banking Supervision, *International Convergence of Capital Measurement and Capital Standards, A Revised Framework.*

1.3 Question

According to the new Basel capital accord[5], how should a LGD estimation model for a RRE portfolio be created and by which factors is it driven? When actual LGD and LTV values have been calculated, can one tell something about the relationship between these parameters and how are they affected when changes in their models/factors are made?

1.4 Purpose

This thesis will use a normative purpose when analysing a model for RLGD values, which shall contribute to a deeper understanding of the risk parameters and its characteristics. Further, the thesis will also analyse the relationship between RLGD and LTV as well as the different variables included in their models. This will be done as a line in the normative purpose which will lead me to find the answers to my question above.

Because RLGD values serve as historical data for the model that estimates future LGD, the thesis will also include an explicit purpose where the Basel II framework is used as a starting point in order to understand how and why the estimation model is set up.

1.5 Delimitation

Due to the limited time that is given for the thesis, it will not allow me to get the deep insight on LGD as I would like to have had. I decided to narrow my field of interest so that I at least can get a good understanding within a specific area. In Sweden the 4 largest banks[6] have had very few credit losses during the last years if compared with similar banks across Europe. According to Finansinspektionen, FI, this is due to the fact that after the Swedish bank crisis during the 90´s, all banks "cleaned up" their loan portfolios and weeded out the "bad" credits[7]. The main part of the Swedish banks credit loans are retail loans so I decided to look closer into retail loans, specifically those with residential real estate as the underlying collateral. The real estate buildings will be residential houses that do not generate any form of income.

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[5] BIS, Banking Committee on Banking Supervision, *International Convergence of Capital Measurement and Capital Standards, A Revised Framework*
[6] Handelsbanken, Nordea, SEB, Swedbank.
[7] Finansinspektionen, Rapport 2006:6, *Bankernas kapitalkrav med Basel 2.*

LGD can be measured in many different ways and using a variety of models. Due to secrecy laws and the fact that all banks operate differently, I chose to set up two models (one model for RLGD and one estimation model) that suite my specific data. Within the model for RLGD I will only include exposures that are already defaulted, which leaves out the possibility of double default[8]. It is also presumed that the banks are not able to sell the credit exposures, neither before nor after default. During the work on Basel II, the Framework has been calibrated to better suit the routines of financial institutes. If nothing else is mentioned the Basel II information used primarily in the thesis is collected from the paper with the latest completed changes, the Consultative Paper from 2005.[9]

1.6 Target group

This thesis is foremost written for people with interest in Basel II and for economic students who wish to get a broader understanding for the technical details of LGD.

1.7 Further outline

Chapter 2 –Methodology

This chapter will describe the work of choosing appropriate data and working method for the thesis. It shall further describe the statistical analysis and the criticism surrounding the methods and sources that where used.

Chapter 3 – Literature exposition

To be able to fully understand the coming analysis this chapter gives the necessary information about Basel II, Credit risk and the advanced IRB method. These are the 3 main areas in which LGD is used.

Chapter 4 – Practical referents frame

This chapter will work as a transitory chapter between the literature chapter and the analysis. Information about the LGD parameter and the rules for setting up an LGD estimation model according to Basel II will give the final tools for the analysis.

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[8] Double default happens when an exposure has defaulted and the regained the status non-default to once again become default. The possibility of defaulting a second time is higher than the average possibility of default.
[9] BIS, Banking Committee on Banking Supervision, *International Convergence of Capital Measurement and Capital Standards, A Revised Framework.*

Chapter 5 – Qualitative analysis

In this chapter a verbal estimation model will be set up according to the Basel II Framework and the rules of FI. The way of determining how to set up this estimation model will be based on the statistical data that I received from SEB for the quantitative analysis.

Chapter 6 – Quantitative analysis

Here the results of my quantitative analysis will be presented and interpreted. A closer look at different factors will be taken to understand their effects on LGD and the LGD/LTV relationship.

Chapter 7 – Conclusion

This chapter will present my findings and the conclusions that I will have come to during my work.

2.   Methodology

The main part of this thesis is going to be written as a qualitative analysis, which will provide a broad overview of the entire subject. It will be the basis upon which the verbal estimation model of LGD will be built. This estimation model will help me to narrow down the important factors and rules, which are essential for the mathematical model. The qualitative analysis is placed in the beginning of this thesis, an estimation model has to be based upon real calculated LGD values, like the ones received from the quantitative analysis at the end of the thesis. The reason for the qualitative analysis to be placed in the beginning is that it contains much important information that is helpful when analysing the statistical model.

My model to calculate RLGD for default exposures will give the final quantitative understanding of the risk parameter. It is important to see the difference between the verbal estimation model that will be discussed in the first part of the essay[10], and the mathematical model in the second half that will be calculating LGD values when default already has occurred.[11] The results from the mathematical LGD model will serve as data for the analysis of the RLGD/LTV relationship. A regression model will in a mathematical way be able to explain the relationship between these two variables and provide information about them. Further analysis will be made where the factors included in RLGD and LTV will be altered to see the effects of these changes.

2.1   Choice of data

To be able to find an answer to my research question data has been gathered and selected. The boundaries set up for the selection of data[12] where necessary to keep the thesis within its limits, but then at the same time would allow me to find the data that would give me the deep understanding of LGD that I required. The main source for my data material was Basel II´s Consultative Paper 2005, supplied by the Basel Committee.[13]

The quantitative analysis of the RLGD model for the advanced IRB approach requires different kinds of input factors and the data material for this approach has been simulated by

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[10] See *chapter 3 to 5*
[11] See *chapter 6*
[12] See *chapter 1.5*
[13] www.bis.org

Jonas Ljungqvist and Gösta Olavi from SEB, Stockholm. I collected different types of data that could potentially be used to make different kinds of models. This was done to ensure that the data did not to give me any guidance on which model to use. The analysis is based on information about private people's real estate loans, which is a very sensitive matter. This personal information is bound to secrecy by the Swedish law and banking regulations. A simulation can create reality-like numbers, which in the end can lead me to the same conclusive results as if I had access to real data. Because the statistical data that I received from SEB only shows simulated results and the RLGD model does not reflect an actual model used by a specific bank I did not see it as necessary to contact any other bank for the purpose of getting further data. Which internal advanced IRB model the banks use and which process for the implementing of Basel II is not always official which leads to the fact that this essays interpretation of LGD only can be done with the help of the Basel´s new capital accord and FI´s guidelines. One needs to be aware, while reading this essay, that the actual models used by the banks are more topical and adjusted for the banks specific needs and business. Further details on the data used in the quantitative analysis will be accounted for in *Chapter 6.*

2.2 Basic data

The collection of data has due to the time constraints been limited. Sufficient data has been gathered to achieve a knowledge which covers the entire subject.

2.2.1 Primary data

The material included in the quantitative analysis can be considered primary data even though it is simulated. It has not in previous cases been processed or altered for research. I do not believe the simulated data to have less credibility than actual data due to the fact that Jonas Ljungqvist and Gösta Olavi work in risk management and are more than capable to simulate such data. Further I would classify my conversations with Jonas Ljungqvist and Gösta Olavi as primary data. These conversations should not be considered as interviews, they where there to help with the interpretation and understanding of technical terms regarding the Basel Framework and LGD.

2.2.2 Secondary data

The interpretation of the design of the LGD model required extensive information on the subject. Framework with rules, articles and research papers have been collected as secondary material through LOVISA, the library, the Internet and from my notes from the class "Evaluation and management of financial risks"[14]. All collected material has been used for the qualitative analysis and as a helping hand during the interpretation of the results from the quantitative analysis.

2.3 Statistical method

My data will be analysed with a regression analysis to see if there is a relationship between the two parameters RLGD and LTV and to what extent conclusions about this relationship can be drawn and how it will be affected by changes in the variables. The changes in the factors of the RLGD model are going to be made in order to se how sensitive the RLGD parameter is to external changes. Depending on the RLGD/ LTV results that will be received from the model a linear or non-linear regression model will be used. The data received from Jonas Ljungqvist and Gösta Olavi from SEB contains 2263 exposures that have defaulted with information about loan amount, collateral value at different times, workout costs and discount rate. All mathematical calculations have been made in Excel and Eviews.

2.4 Methodology criticism

A qualitative analysis always leaves room for interpretation of the underlying information. This means that the analysis becomes objective, especially here were the Basel II rules work more as guidelines which give the banks the opportunity to evolve and develop methods beyond the minimum requirements. The qualitative analysis cannot contribute to any criticism of the guidelines or rules but can identify existing problems within the LGD area. The statistical analysis gives an understanding of the LGD parameter in a more concrete way but the choice in data material for the quantitative analysis, is due to it being simulated, not optimal but under the circumstances this method was the best way to go about things in finding appropriate data.

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[14] Byström, H., "Evaluation and management of financial risks"

The 2263 observations can be considered as enough observations to get mathematical results that are reliable, but not all results from the model and the LGD/LTV relationship can be taken with a certainty due to fact that they are simulated. One could criticise the fact that a statistical estimation model has not been created to connect the RLGD model and the estimation process of LGD values. This would indeed give the final understanding of the task that financial institutes face; creating an entire process for the LGD risk parameter. Due to the limited time and my knowledge I found that I could not do justice to such a model and it would not give me any correct results if not all relevant factors could be included.
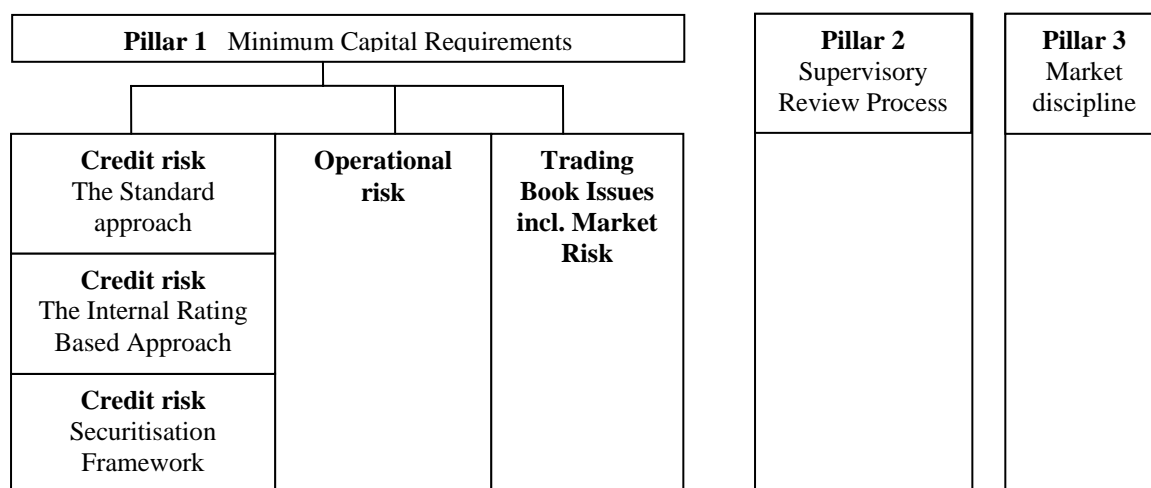
2.5 Source criticism

One should always be critical to the collected information and ensure that it is reliable and usefull. As far as the primary data is concerned, I consider it to be trustworthy due to Jonas Ljungqvist and Gösta Olavi´s long working experience within this area. As for the secondary material it may have altered over time and some of the rules for LGD may be out of date. To avoid this I have always tried to update my sources and material but I can not guaranty that I have found all relevant facts and rules issued by the Basel Committee and the Swedish supervisory FI.

The material can be considered to be subjective because most of it comes from one single source, the Basel Committee. I do however feel that the committee has been founded to work towards a better financial future for all countries, which makes it in my opinion an impartial organisation.

3. Literature exposition

3.1 Basel II

In June 2004 the revised Basel II Framework "Revised Framework on International Convergence of Capital Measurements and Capital Structure"[15] was published. The new framework is an improvement of its forerunner Basel I and will be implemented, through a directive, into the EU. Finansinspektionen, FI, in Sweden is of the opinion that the ground rules in this directive are the ones that shall be implemented by the Swedish banks. They also strongly advise that "the rules for the financial institutes should be elaborated and clarified by law or regulations. "[16] The purpose of these new Basel II rules is to create methods and routines that more accurately explain the risk on the markets and to be able to separate and identify them on an early stage. Focus has also been laid on the principles for active qualitative bank supervision, in order to inherence the market disciplines. The old Basel I rules merely gave the bank an overview of the risks that were not sensitive to the economic cycle, nor did they make a difference between borrowers with different kinds of credit credibility. To set the capital requirement according only to the basics of credit- and market risks does today no longer correspond with a banks real risk profile. Through Basel II, the risks will be analysed from different perspectives giving the economic capital more dimensions. The main rule from Basel I still remain in the new framework: the ratio between the economic capital and the risk weighted capital should hold a value of over 8%.

Pillar 1 Minimum Capital Requirements			Pillar 2 Supervisory Review Process	Pillar 3 Market discipline
Credit risk The Standard approach	**Operational risk**	**Trading Book Issues incl. Market Risk**		
Credit risk The Internal Rating Based Approach				
Credit risk Securitisation Framework				

Picture 1: The 3 Pillars of the Basel II Framework, *www.bis.org*

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[15] BIS, Banking Committee on Banking Supervision, *International Convergence of Capital Measurement and Capital Standards, A Revised Framework.*

[16] Finansinspektionen, Remissvar, *Finansdepartementets promemoria om nya kapitaltäckningsregler,Page 1.*

The first pillar contains regulations for the capital measurements and these rules have not been adjusted to suit any specific institutes systems or portfolios. The pillar presents general fundamental minimum guidelines which the banks are required to follow and may develop further if they wish. The three risk areas are credit-, market- and operational risk. Due to the fact that the operations of the banks become more international and the IT-systems have evolved, the field of operational risk has become an area of its own. Exactly when the term "operational risk" was discovered is widely debated among professionals. The Basel Committee defines operational risks as: "Risks that lead to direct or indirect losses due to non specific or failed internal processes, human errors, incorrect systems or external events".[17]

The capital requirement for credit risk can be measured using one of three approaches: Standard approach, foundation IRB approach and the advanced IRB approach. The standard approach is based on the idea that there should be a method that provides external ratings to banks that are not able or do not have the financial possibility to develop own internal methods and models. This approach derives from Basel I's standard approach and contains the minimum requirements that the banks must undertake before January 2007. The external rating based values supplied by the supervisory of each country assign different rating classes to different risk weights, depending on the solidarity and credit credibility of the counterparty. In the foundation IRB approach the banks will measure some of the risk parameters with internal models and the rest will be supplied externally. The LGD parameter is usually supplied, due to the difficulties in the estimation process. Most of the financial institutes will in some form be using internal models to estimate the credit risk. The advanced IRB approach demands the approval of the supervisor and will give the financial institutes the opportunity to adjust the models to their own systems and portfolios which will help them decrease the capital requirement.[18] A more technical description of the advanced IRB approach will follow in *chapter 3.3*.

To make the work and understanding for risk management easier the Basel Committee requires that the financial institutes work together with the countries supervisors under the second pillar, SRP, Supervisors Review Process. This pillar is more individually adjusted to suit the needs of individual institutes. Through the survey of FI the banks are encouraged to

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[17] BIS, Banking Committee on Banking Supervision, *International Convergence of Capital Measurement and Capital Standards.*
[18] Finansinspektionen, Rapport 2006:6, *Bankernas kapitalkrav med Basel 2.*

regularly overlook and continue to improve their internal risk management practices. In that section the banks will be working with more soft measurements / factors that shall provide the banks with an entire picture of their risk profile.

The third pillar was developed with the knowledge that a well-informed market participant will be able to make better and more risk adjusted decisions. By letting the public take part of the risk profiles of the financial institutes the credit borrowers will be able to make demands, which in the long run will benefit both parties. Most banks account for their business in their annual report. Basel II encourages a widening of the openness in this report and would like to see the banks also accounting for some of their internal routines and methods. Through the public demands the Basel Committee hopes to give the banks enough incitement to perform so that system risks decrease.

3.2 Credit risk

Sweden's banks accounted for a total credit loss of 180 billion Kronor during the Swedish bank crisis in 1990 –1993. Most of the credits issued during that time where directly or indirectly real estate related. The credit exposures did not match the actual risks and the banks did not hold enough economic capital at that time.[19] After the crisis the banks issued credit exposures with great care and revaluated their portfolios. The credit risk can be divided into the underlying factors that drive the credit default. To understand this, one needs to understand the definition of credit risk. The credit risk is the risk that the credit credibility of the borrower can suddenly and unexpectedly change, which would deteriorate the value of the investment.[20] This may happen if the obligators private economy defaults due to market downturns, interest increases etc.

Credit risk has been modeled for the last 30 years. The first models where so called structural form models which where based on Mertons model from 1974.[21] The structural models looked at the value of the assets of the borrower and linked it to default, which occurred when the value of the assets was smaller than the value of the liabilities. Mertons model proved itself to be very successful but made the assumption that default could only occur at the end of

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[19] Carlsson, B., Nyblom, H., *Redovisning av kreditförluster i banker.*
[20] " Evaluation and management of financial risks", NEK 725
[21] BIS, Monetary and Economic Department, Working Paper, No. 113, *The link between default and recovery rates: effects on the procyclicality of regulatory capital ratios*

a credits lifetime. The reduced form models and Credit value-at-risk models (JP Morgan's CreditMetrics ®, KMV's CreditPortfolioManager ®) that came after the structural models where based not on the characteristics of the borrower but instead on exogenous risk parameters, like recovery rate and PD, which can stochastically vary in time. Since the 1990s, credit models have had a rapid development and today almost all of the world leading banks have developed their own internal credit models. Before mathematical methods where developed a lot of credits where issued on objective opinions of a group of experts and when it came to revaluating an issued credit due to new macroeconomic information it was often very expensive and time consuming. The new mathematical models save a great deal of time and give a good view over the credit during its entire lifetime.

3.3   Advanced IRB approach

Because the delimitation in the essay is set to only include retail loans with real estate as the underlying collateral, this chapter will only include the interpretation of the advanced IRB approach according to these conditions. With internal methods and systems the credit risk will become more risk sensitive and the committee wants to encourage what is refereed to as incentive compatibility, which means that the bank will keep on evolving and developing new methods and risk management routines. When an institute receives the supervisor's approval to use their own methods for estimating the risk parameters, then they also have to apply these methods for any subsidiary companies within their financial group. The minimum requirements do not have to be fulfilled by every single subsidiary company, merely all together. The internal risk classification system includes all different kinds of methods, work-, decision- and control processes as well as the IT-system and the daily routines used when quantifying credit risk. An independent central unit shall exist at every institute, to run tests and regularly control the risk management routines and methods / models. The central unit is responsible for reporting to the board of directors and executives, as a line in pillar three.

Banks differentiate between their expected losses, EL and their unexpected losses, UL that occur during a year. EL is thought of as the cost for having a financial business and shall therefore be covered by the ongoing income and profits. To secure one from UL, Basel II requires the bank to hold economic capital.
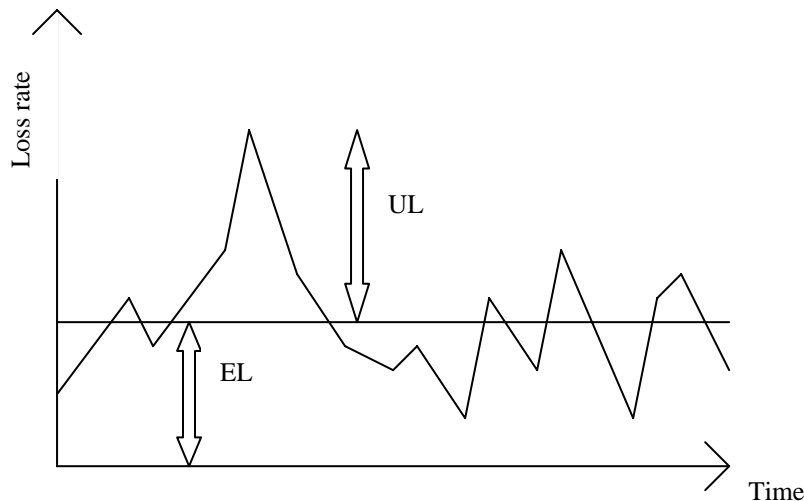
Picture 2: EL/UL, Basel Committee of Banking Supervisory, *An explanatory Note on the Basel II IRB Risk Weight Functions*, July 2005.

If the economic capital value covers UL then the possibility to remain solvent for yet another year is equal to the confidence level that the Basel framework has set a to be 99,9%. To calculate the economic capital requirement level for credit risk one calculates the risk weight amount and EL. These are decided by the risk parameters PD, EAD and LGD. [22]

Example: Formula for the risk weighted amount for a retail exposure.

$$\text{Risk weight} = \{\ LGD \times N[(1-R)^\wedge - (1/2) \times G(PD) + (R \div (1-R))^\wedge (1/2) \times G(0,999)] - PD \times LGD\ \} \times 12,5 \times 1,06$$

R = Correlation parameter (For residential real estate, R=0,15) [23]

N(x) = Cumulative standard normal distribution

G(z) = Inverse to the cumulative standard normal distribution

Nevsten, P. showed in his essay[24] that credit defaults within the retail segment are correlated and that a high number of defaults are likely to lead to an increase in LGD. The correlation is here measured on a portfolio level.

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[22] Depending on what kind of credit exposures and customers the maturity, M, must also be accounted for. This does not apply for retail exposures.

[23] BIS, Banking Committee on Banking Supervision, *International Convergence of Capital Measurement and Capital Standards, A Revised Framework.*

[24] Nevsten, P., Analys av hypoteksbolagens kreditrisk för bostadslån – En kvalitativ studie av hypoteksbolagens låntagare och deras säkerheter

3.3.1 General regulations

Credit exposures vary in risk depending on the counterpart, macroeconomic factors, collateral etc. Each exposure is therefore classified to an exposure class in which the other exposures show similar characteristics. Retail exposures are credits issued to a person and one single retail exposure does usually not constitute a large credit risk so similar retail exposures are grouped together and treated like a portfolio. Within the retail sector the banks can separate portfolio exposures due to different factors, like collateral. Real estate loans have therefore become a specific subgroup. Credit exposures with RRE collateral have a large effect on the LGD parameter because of the recoveries. For the risk classification system of an exposure there shall be clear routines and it shall always be built on actual information. Continuous evaluations oversee that the exposures in different risk classes continue to be equivalent to the risk profile created with analyses from the world economy. When the risk classes undergo their yearly revaluation the bank also tests their system for discriminatory power. It shows how well the risk classification system sorts out the exposures that will default within the forthcoming year.

3.3.2 Risk parameter

The estimated risk parameters are based on historical empirical data, from a time period long enough to give reliable values. The estimation for retail exposures have to be based on data going back 5 years. Due to the fact that many banks still do not have had the time to gather a database containing historical data dispensation has been given until 2009. From the turn of the year 2006/2007 the estimates have to be based on historical data going back 2 years. As long as the estimates are not based on data from the accurate time period a safety marginal has to be added.

3.3.2.1 Probability of Default, PD and Exposure at Default, EAD

The probability that the counterpart will not be able to fulfil his commitment is called PD. Depending on the characteristics of the exposure, it receives a risk classification. External ratings for persons/companies may be used as the foundation for this classification, but it has to be completed with an internal qualitative analysis. For retail exposures all risk

classifications must be able to be used on all risk parameters. One of the main problems is to determine the exact date of default. Basel II defines that an exposure has defaulted when:

1) the institute with a large probability can determine that the counterpart no longer will be able to fulfil his/her duties.

2) if the counterpart is more than 90 days late with payment. For small insignificant amounts the banks can extend this time limit. [25]

The first definition is a subjective interpretation not as often used as the second objective interpretation, which is standard when defining default for retail exposures. When a bank has defined a counterpart's exposure as defaulted, they should consider all the other exposures that the same counterpart has with the institute to be defaulted.

The EAD gives the value of the outstanding amount at the time of default including eventual future draw downs of yet unused credit lines. For credit card exposures EAD can be especially hard to estimate due to the simplicity of making further withdrawals after the time of default but in this thesis the definition will be made that EAD is the outstanding amount of the loan. Financial institutes may use own internal methods to estimate EAD or fall back on external data sources. The same rules are applied for EAD as for the other risk parameters when it comes to the dispensation on the time period of the historical data used for the estimation model, except that EAD estimates have to fall back on 7 years of historical data.

3.3.2.2 LGD

There are two approaches when estimating LGD. The foundation approach is used by banks that do not posses the resources to create their own internal LGD models. The banks that work accordingly to the advanced method will use their own internal models to estimate LGD. For retail exposures the banks have to estimate all the risk parameters internally. A further description of the bank internal estimation model will follow in *chapter 4.2.*

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[25] BIS, Banking Committee on Banking Supervision, *International Convergence of Capital Measurement and Capital Standards, A Revised Framework*

4. Practical Referents Frame

4.1 Retail loans

The type of loans that are incorporated in the retail segment varies between countries. Sometimes small corporate loans can be found within the retail segment but this thesis will define retail loans only as a large volume of loans to private people which are of individual small amounts. Further, as stated once before, the primary target for this analysis is the subgroup in which loans are secured by RRE.

"With real estate one refers to what is described in chapter 1, 1§ in jordabalken including foreign equivalence. This includes also buildings on some one else's property and stocks in Finish real estate companies." [26]

My definition for retail exposures agrees with the definition presented by the Basel Committee: "The definition shall be based on criteria's which can capture the homogeneity of the portfolio where the individual loans have very little risk."[27] The criterion states that the banks must be able to sort out different specific product types and that the exposure is towards an individual person. All retail exposures must be able to be sorted into portfolios with equal exposure characteristics. This forces the financial institutes to look at each credit exposure individually. It also needs to be considered that the value of the real estate not in an essential way is depends on the credit credibility of the borrower or that the main source for repayment comes from what the real estate generates. Not every real estate has to be evaluated before it is used as collateral. The banks may use statistical methods to evaluate an amount for the RRE but the value should always reflect the market value that can be obtained by a liquidation of the property. The exposures in a portfolio are expected to show homogeny default characteristics and that their lost performance will follow a predicted time pattern. Due to the homogeny segments, retail loans show very small values of default correlation.[28] RRE exposures follow different time patterns due to when they where originated, but very few banks include the risk parameter M for retail loans. The normal way is to base all parameters on a 1-year maturity.

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[26] Finansinspektionen, *Utkast till kommande kapitaltäckningsföreskrifter om kreditriskskydd för institut som använder IRK-metoden, Page 9.*

[27] BIS, Banking Committee on Banking Supervision, *International Convergence of Capital Measurement and Capital Standards, A Revised Framework.*

[28] See the Example in *Chapter 3.3.*

4.2 LGD

4.2.1 General rules

Before analysing the LGD parameter it is important to remember that LGD can be estimated / calculated at different times during a credits lifetime. Initially, before default, at default and then at the end when all collateral has been liquidated. Every estimation requires different methods and approaches to receive LGD values appropriate to the surrounding circumstances. For ex ante default exposures the banks will continuously estimate LGD values, so called expected LGD, ELGD. For ex post default exposures a realised LGD, RLGD is calculated based on actual realised values. Because studies on LGD are limited (as apposed to studies on PD)[29] the factors that drive LGD remain to be further studied. Due to this, my thesis will look more into the rules for LGD estimation and give a broad understanding rather than to look into specific validation methods.

The LGD parameter is a highly important parameter to the minimum capital due to the latter's sensitivity towards variations in LGD. The definition of Loss and Default are therefore the key factors in determining how to work with LGD. The definitions can vary from institute to another leaving the LGD values to be bank specific values. Loss is always to be considered as an economic loss and default is defined under the criterions described during earlier chapters.[30] The definitions for Loss and Default must be the same for PD as for LGD in order to obtain accurate values for economic capital and EL. At any time when an exposure defaults, LGD is expressed as a percentage of EAD and will therefore take on a number between zero and one. LGD estimates should give a value of a long-run average LGD but should also be adjusted with a view of LGD estimates during economic downturn in order not to underestimate risk.[31]

4.2.2 Estimation methods

According to Basel II all LGD estimates must have their background in historical LGD data. To ensure this it is of great value that the financial institutes in the near future build up a

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[29] BIS, Banking Committee on Banking Supervision, Working Paper, No. 14, *Studies on the Validation of Internal Rating Systems.*

[30] BIS, Banking Committee on Banking Supervision, *International Convergence of Capital Measurement and Capital Standards, A Revised Framework.* Also see *chapter 3.3.2.1.*

[31] See *chapter 4.2.3.*

substantial databank. Due to lack of current existing LGD data, banks have started pooling data which also can also be used as a benchmark when validating LGD estimates. Until LGD becomes realised it is a random variable, independent of default.[32] The default of an exposure has no inflict on the path of the ELGD although it is an essential factor when turning an estimated LGD into a realized LGD.

A reference data set, RDS, is used to assign expected LGD accordingly to non defaulted exposures. There are two different methods used for this purpose. The subjective method is often used in the early stage of the internal risk modeling and is based on an opinion from an expert. The financial institutes do not make use of this method on its own because it does not contain any statistical data to back up the opinion; it is merely seen as a complement. The objective method is the main method used and can be divided into two subgroups. The explicit subgroup samples default data from the RDS and on the other side the implicit subgroup derives LGD from measurements of total losses and PD estimates. The implicit method is less expensive but will not provide as accurate LGD estimates as if they are modeled directly from realized LGD (explicit method).[33]

Within the explicit and implicit subgroups there are a total of four methods to estimate LGD.

1) *Market LGD* is based upon observations of market prices of traded defaulted loans. This approach is often used for estimating LGD values when applied on corporate, sovereign or bank credits. It is important is to find market prices that accurately reflect the actual conditions. The market LGD belongs in the group of explicit methods.

2) The *implied market LGD* belongs to the implicit group. Here non defaulted bond prices and credit spreads are used in an asset pricing model creating estimates for LGD. A credit spread for a risky bond reflects the EL for the bond. From the EL, PD and LGD estimates can be abstracted. Due to fact that the random LGD variable is independent of default this method could give accurate estimates if appropriate non defaulted credit spreads were found. This approach has though been up for discussion under the assumption that it does not comply with the requirements in the Revised Framework.

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[32] Two random variables are independent if knowledge of the value of one of them tells nothing about the value of the other. Frye, J., *Loss Given Default and Economic Capital.*
[33] BIS, Banking Committee on Banking Supervision, Working Paper, No. 14, *Studies on the Validation of Internal Rating Systems.*

3) The *implied historical LGD* is the most common method used within the retail segment. It makes use of old values for total losses and estimates of PD and obtains LGD estimates in the same way as an implied market LGD. A slight disadvantage is that the method relies entirely on the correct validation of the PD estimate.

4) The *workout LGD* that belongs to the explicit methods and is the most common used method amongst banks who want to satisfy only the most basic requirements of the Revised Framework. A workout LGD is obtained discounting cash flows coming from future recoveries minus workout costs, back to the default date. The workout LGD is then used in a model to assign an estimated LGD for a non-defaulted exposure. This model can either be designed to be very sophisticated or it can just use the sample mean of the workout LGD's. Although this method seems fairly simple it also raises a lot of questions. Once again the definitions of loss and default play an important part, as does the measuring of the recovery rate, the determination of the workout costs and the selection of an appropriate discount rate.[34] The main advantage with the workout LGD model is that if a loan is fully repaid during the workout period the outstanding balance on the default date will equal all the future cash flows discounted. It will therefore provide a much more accurate value than for example the market LGD where the market prices do not incorporate the possibility of a full repayment.

4.2.3 Downturn LGD

A big part of the LGD estimation process involves determining during which events LGD values might be higher than normal. The Basel Committee refers to this as "downturn LGD" and they are still working together with the industry and national supervisors to find appropriate approaches for a downturn LGD estimate. During times in which the economy is in distress, defaults show a habit to increase and cluster, which may lead to a decrease in recovery rates. LGD estimates aim to be predictive of the future and if downturn economic factors are not incorporated in the estimates, they may understate loss severely.[35]

The Basel Committee has elaborated paragraph 468 of their Framework Document to help counsel the financial institutes on downturn LGD estimation. Paragraph 468 requires that

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[34] All these questions will be discussed later on in *chapter 5.2* where I will use a workout model to calculate realised LGD on my own data set.

[35] BIS, Basel Committee on Banking Supervision, *Guidance on Paragraph 468 of the Framework Document, Page 1.*

"estimated LGD parameters must reflect economic downturn conditions when necessary to capture relevant risk". [36] Difference is made between if banks have their own internal LGD models or not. With an internal model one can look at the factors that drive LGD separately from a cyclical point of view leading to appropriate adjustments in receiving downturn LGD values. One can also see to previous downturn data for similar exposures and make the adjustments in their values. There are still many issues that remain to be solved on downturn estimation. Data limitation constitutes to be a large problem when estimating LGD and data material during economic distress can be even harder to come by. Note that not all exposure classes bring variation in LGD during a downturn. The banks must therefore look at each exposure class individually and identify the class's own characteristic downturn periods. Economic downturn appears "when credit losses are substantially higher than average."[37] A downturn in the economy (for example in GDP) may not necessary lead to a downturn in a particular exposure class. This downturn may occur much later due to delay or it may not occur at all. Some exposure classes, like RRE, may be sensitive to local economic conditions leaving a bank to identify even the future local politic and economic decisions. The downturn LGD estimates are required to capture all relevant risks.

The Basel Framework does not suggest any concrete approaches for the estimation of downturn LGD. It simply suggests different methods to tackle any problems that may arise during the estimation process. Due to lack of data, several banks acquire their LGD estimates from an external data source. These external estimates have to be transformed from long-run average LGD's to downturn LGD's. Two approaches have been up for discussion on this task. The banks could either report their downturn LGD data that they have assessed during adverse conditions giving the external databank information. The other approach involves a single mapping function. The banks would then adjust their LGD estimates according to a linear function producing higher downturn LGD estimates.[38] This approach requires historical LGD data. In the end, what ever approach one uses (either internal or external), ELGD of an exposure may never have a lower value than the expected LGD estimate that does not include economic downturn conditions.

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[36] BIS, Banking Committee on Banking Supervision, *International Convergence of Capital Measurement and Capital Standards, A Revised Framework Paragraph 468.*
[37] BIS, Basel Committee on Banking Supervision, *Guidance on Paragraph 468 of the Framework Document.*
[38] For example: LGD= 0,08+0,92*ELGD

4.2.4 Problems with LGD implementation and estimation

With the LGD estimates a lot of problems arise, not least with the estimation of downturn LGD. The determinants included in an LGD model are sensitive to external factors leaving LGD to vary over time. The main issue that needs to be solved is the fact that many financial institutes lack sufficient data to receive appropriate long-run average LGD estimates. This will lead to LGD values that not fully reflect the accurate conditions and that in the future may function as wrongful historical data. "Average historical LGD is a downward-biased estimator of ELGD" according to Frye, J.[39], which requires the sample of historical LGD to be sufficient enough when estimating LGD, to even out the periods of high defaults which lead to periods of high LGD estimates.

Another problem occurs when one disregards from the systematic risk underlying LGD. Depending on which method[40] is used to measure LGD, one has to choose the right determinants so that the LGD values are neither under- nor overstated. The most important determinants are the recovery rate and the discount factor which are both systematically related to economic conditions.

4.3 LTV

When applying for a credit, lenders see to the important key risk factor "loan to value", LTV. This mathematical calculation shows the ratio as a percentage between the loan amount and the value of the underlying security. The lower the LTV ratio, the greater the chances that the borrower will receive lower loan rates. High-risk borrowers are generally considered having a LTV over 80% and studies have indicated that LTV values are connected to the LGD values leaving a rise in LTV increasing the LGD value.[41]

LTV measurements leave room for measurement errors in V (collateral value), which can be measured in different ways leaving LTV to be a bank specific value. Choosing to work with the market value will give a more accurate value for a specific property but can be deceiving if the market is experiencing a real estate boom or decline. The other possibility is to look at historical values and take an average of the RDS. This will smoothen out real estate cycles but

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[39] Frye Jon, Loss Given Default and Economic Capital
[40] See *chapter 4.2.2*
[41] Johnson, J., Risk-based Capital Guidelines; Implementation of New Basel Capital Accord.

will not give a specific value to specific collateral. When comparing LTV to LGD a market value will give more accurate results because it is the markets price that one will receive when liquidating the collateral. The Loan amount, L, is usually the amount of the credit when originated, but will in this thesis be the outstanding value of the exposure at the point in time of default.

5. Qualitative analysis

When estimating LGD values two approaches may be used: either creating an own internal model or receiving appropriate LGD values from FI. Creating an estimation model for LGD would be to time consuming for this limited essay and it would require data material and knowledge that I do not possess, but I think that by receiving LGD values from FI, banks disregard a great number of bank internal and credit specific factors. This analysis will therefore focus on creating a verbal estimation model based on the limited statistical data I have collected. The verbal estimation model will be an objective model that falls under the advanced IRB approach.

To establish an estimation model for LGD it is necessary to analyse the Basel II Framework and the rules set up by the supervisor, FI. One of Basel II´s main regulation is that any estimation of risk parameters must be based on historical data. In this case my statistical LGD values received from the mathematical workout model[42] will constitute them. The RDS values are only useful if they are used in an estimation of LGD for similar credit exposures. The estimation model will therefore estimate LGD for retail exposures with RRE as collateral. How the model used to assign estimated LGD to non-defaulted exposures is created is a bank internal choice. The estimation model can either be very sophisticated or one could just use a sample mean of the entire realised workout LGD´s. The sample mean for my RLGD data is 0,136.[43] This value seem justified and accurate because of the fact that RRE credits not often experience high LGD values due to there high recovery rates. The LGD value could on the other hand be too low if the possibility of a downturn in the economy not is accounted for in the value. For RRE credits banks often use the implied historical LGD method.[44] It relies on old values for the total loss and estimates for PD. From these values estimates for LGD are abstracted. This method includes future information and expectations in the form of the PD-estimates, but if these are falsely estimated the LGD estimates will be affected. This implied historical LGD method could be a good method to use for my analysis but due to the fact that I do not possess any information about total loss or PD I chose the workout LGD method. It seems to me that by using this method one can create a model in which one can incorporate many more factors, for example macro economic factors. Further I also find it important that
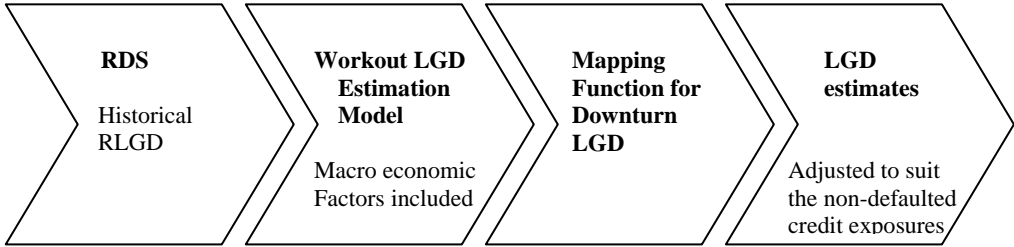
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[42] See *chapter 6*
[43] See *chapter 6.3*
[44] See *chapter 4.2.2.*

the LGD estimates are based on old RLGD values and not some other variables due to estimation errors or calculation faults.

Macro economic factors are highly important when estimating LGD. It is these changes in the economic factors that affect how the LGD distribution will look. My statistical data lacks information about the global economy and so to be able to analyse some part of the estimation process I will make the assumption that macro economic conditions as they are today, 10 January 2007. We do not experience a downturn in the economy today, but the Basel II Framework is very clear on the point that the estimates have to be forward looking. In the case where just a sample mean is used, it does not include forward looking information. If I would have had access to more observations in the RDS, then possibly data that was calculated during a downturn period could be identified and used to adjust my RLGD values. This could have been done with a mapping function.[45] Our economy today shows signs of a good and stable economy but we can in the future expect recessions. How big the downturn on the economy will be is hard to foresee, which leads to the fact that it is difficult to set an amount to the value one wishes to incorporate in the downturn mapping function. I will not try to analyse the mapping function any further, merely observe the fact, that the sample mean RLGD = 0,136 should in some way be adjusted to better incorporate eventual future downturns.

My verbal LGD estimation model:

RDS

Historical
RLGD

**Workout LGD
Estimation
Model**

Macro economic
Factors included

**Mapping
Function for
Downturn
LGD**

**LGD
estimates**

Adjusted to suit
the non-defaulted
credit exposures

Picture 3: Verbal LGD estimation model

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[45] See *Chapter 4.2.3*

6. Quantitative analysis

6.1 Model

It is given, because of its complexity and my lack of real and historical data that the model created in this essay is required to be limited. A workout model that discounts future known cash flows is a model that is widely used and fairly simple, but still incorporates all important factors and gives an accurate image of the prevailing market. More advanced approaches may be more favorable due to fact that they allow for a more wider range of more complex collateral, but since RRE is a collateral which value is solely determined by its secondary market I find that a workout model will be correct for this analysis. LGD will here, as it has been throughout the essay, be measured as a percentage of EAD.

LGD Workout model

$$LGD = 1 - EAD^{-1} * ((Recovery\ rate - workout\ costs) / (1+discount\ rate)^{workout\ time})$$

Before default occurs the exposure neither generates loss nor gain. After default one still has an amount of risk due to the uncertainty of the cash flows that will arise from future liquidation of the collateral. This risk needs to been incorporated in form of a higher discount rate. If the future cash flows from the collateral, for some reason should be known, the discount rate will equal the risk-free rate. LGD values have been calculated for each of the 2263 exposures. Although the exposures are similar and certainly by a bank would be treated as a portfolio, it makes no sense in this analysis to treat them as one portfolio and only calculate one LGD. Changes in the variables of the model have to be made for each exposure in order to se any effects on LGD.

6.2 Factors

There are numerous factors that could be included into the workout model. Due to my limitations I decided not to look at an exposures possibility of reconstruction. This means that an exposure that is defaulted can go back to the status non-defaulted. I do not have any data on this matter and have therefore excluded this factor from my model. Further the assumption is made that once an exposure has defaulted there can be no further repayments on the loan.

Factors used for my LGD workout model

Discount rate: 5%

Workout costs: 2% per year

Loan amount at default point in time: 100 000

Collateral information for 2262 exposure observations:

Market value at default point in time

Market value at liquidation point in time

Amount received in liquidation of the collateral (recovery rate)

Time to liquidate the collateral (years)

The loan amount at default point in time is 100 000 which can be considered being a very low value when it comes to RRE credits. Since the data is simulated I can not tell anything about the background of these exposures. One idea could be that the credits have had a long lifetime and that the borrowers have had enough time to repay a large part of the credits or that the credits have been originated for RRE located out in the countryside where real estate prices are lower.

The most important factor is the recovery rate, which until it has been realised is an uncertain cash flow. As written above one "evens out" this risk by adding to the discount rate. The recovery rate is in this analysis determined by the size of the collateral. The market price on the collateral plays a big part in determining how much the bank could recover in case of default. The recovery rate is very volatile, which makes it especially important to also look at other macro economic factors. Due to limited knowledge about the macro economic surrounding (due to simulated data), macro economic factors have here not received the attention that they otherwise require. The RRE market often reacts very slowly to new changes in the economy leaving their values to not fluctuate identically with the movements of GDP.[46] The point in time of default is therefore a sensitive issue and we often see that during a downturn in the economy, default rate and also recovery rate have a tendency to rise.[47] The amount received by liquidation of the collateral is the amount that will give the accurate value that the bank can expect to receive, which is not always similar to the market value at the time of liquidation or at the time of default. The recovery rate obtained from selling the collateral is then subtracted with the costs that arise in connection with the workout

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[46] Dybing Helén, *Immobiliengüter und Bankenregulierung: "Konsequenzen von Basel II"*.
[47] See *chapter 4.2.3*

period. These are measured annually and are usually made out to be 1% - 2% of the loan amount.[48]

The discount rate contains a risk free rate and an additional rate that reflects both a time value of the money and a risk premium appropriate to the undiversified risk. Because it is more risky to hold a defaulted loan, the discount rate used in the workout model should not to be the same as the rate for the original loan. Some collateral types are to prefer, like cash collateral rather than RRE. It can often take years before RRE can be liquidated leaving a great uncertainty. The discount rate that I received from SEB is 5%. If we would consider the economic market that we have today, January 2007, the discount rate can be interpreted as a 3,05% risk-free rate[49] and a 1,3% risk premium rate. Due to a rather stabile RRE market that we have experienced over the last couple of years the liquidation of RRE collateral should not present a problem nor should the received amount differ a great deal from the estimated market value. Without anything to compare to I can not make any further statements about the size of the risk premium but it is not that large that one could assume a high risk involved. The time it takes to liquidate the collateral can vary from shortly after the time of default and up to several years. My time data reaches from 0,511 – 4,661 years.

6.3   Results of the LGD workout model

Because of the large amount of observations my data will not be inserted in the essay. The results will therefor mainly consist of regression output and different types of graphs.

The LGD values received as output from the workout model have an average of 13,6%. This can be considered to be a rather low value based on the fact that the values the supervisors supply to the financial institutes that do not posses own LGD estimates are 35% for the secured part of a RRE loan and 45% for the unsecured part.[50] Although these are estimated values they can be compared to my RLGD values due to the fact that one estimates LGD in hope of them representing values as close as possible to real LGD values. When looking at *Picture 4* below one can see that the model produced several negative LGD values. This

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[48] Dermine, J., Neto de Carvalho, C., *Bank Loan Losses-Given-Default, A Case Study*
[49] www.omxgroup.se, Risk free rate = discount rate from a three month treasury bill
[50] BIS, Banking Committee on Banking Supervision, *International Convergence of Capital Measurement and Capital Standards, A Revised Framework, Paragraph 289.*

happens when the discounted recovery rate for the credit is larger than the outstanding value of the loan. Although LGD only takes on values between 0 and 1 (otherwise financial institutes could make profit on defaulted credits) I will not exclude these negative values from my data so that a comparison can be made when I make changes in different factors. As a start I will look at each factor included in the workout model individually to establish their characteristics and importance.
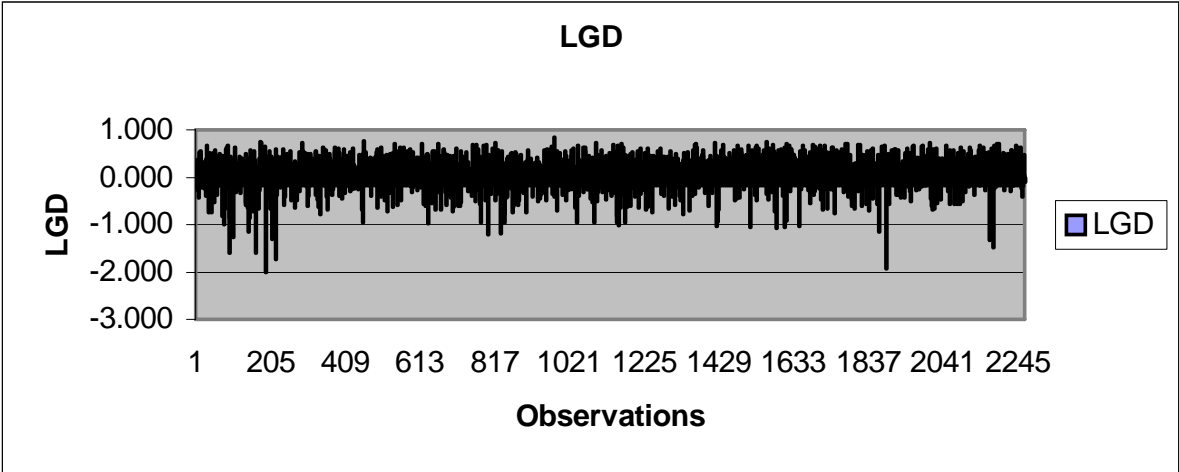

Picture 4: LGD values from workout LGD-model.

Almost all the LGD values vary between 0 and 0,75. There is not a single exposure that has a LGD of 100%. Loosing the entire outstanding loan amount is possible if one does not receive a recovery amount. In this case where RRE serve as collateral the secondary market will pay an accurate and market justified price, which if the market works correctly, never will take on such a small recovery amount or even the amount zero.

6.3.1 Recovery rate

In *Picture5* the LGD values where calculated with recovery rates based on the amount received by liquidation of the collateral. As described earlier in *chapter 6.2* I decided to calculate with this value because I found it to be the most accurate. If the workout LGD had been calculated using the market value at the default point or the liquidation point, no greater difference would have been visible in my results. I have found that the recovery rate is the one factor included in my workout model that has the largest effect on the LGD. The R^2 value, that measures how well LGD is described by the recovery rate, confirms the importance of this factor with its high value of 0,9893. The model describing how LGD can be explained by

variations in the recovery rate fits the observation data extremely well. The negative slope shows that in an event of an increase in the recovery rate the value of LGD will decline.
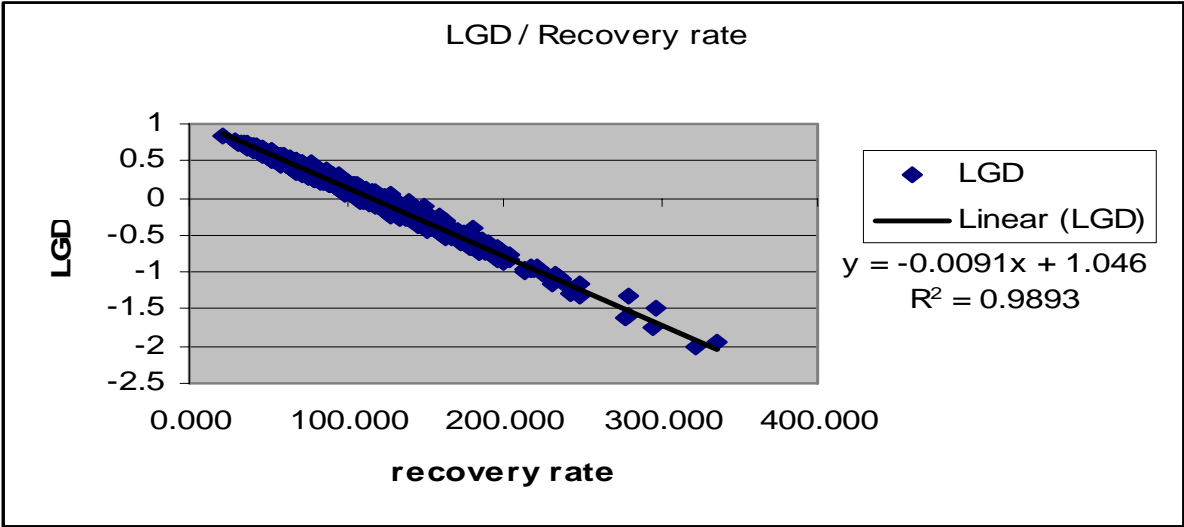
Picture 5: LGD values as a result of changes in the recover rate variable.

6.3.2 Time

The time variable was found to not only affect the LGD values trough the mathematical relationship in the workout model, but also through the fact that a longer time period contributes to an overall enhancement of the risk. The relationship between LGD and the time variable is linear, as shown in *picture 6*. The slope is 0,0665, which shows small positive effect on LGD when the time variable is altered. The small size of the positive value of the slope could be explained by the fact that the workout time period is not as strongly connected to LGD as the recovery rate. The secondary collateral market can give high recovery rates even after a long workout time period. But the positive characteristic does certainly come from the fact that the longer the workout time period the higher the possibility that the collateral value may change. The measurement $R^2 = 0{,}0117$ states that the data does not fit the model very well and that the variations in LGD only by a very small amount can be explained by the time variable.
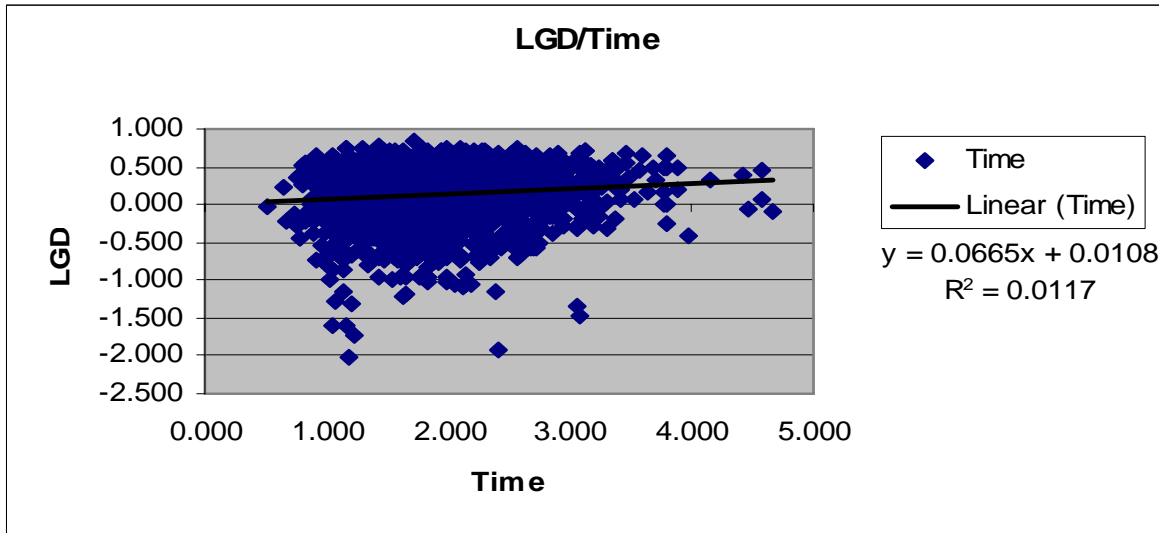
Picture 6: LGD values as a result of changes in the time variable.

Although the time variable did not describe my LGD data very well it is an important factor to pay attention to, especially during times of downturns in the economy when liquidation of collateral can de difficult and LGD values large and vary often.

6.3.3 Discount rate

The discount rate of 5% represents both the time value of the money and the risk of not knowing the final recovery rate. My LGD values increase when the value of the discount rate is raised, which is to be considered logical when looking at the LGD workout model. If the discount rate is doubled the LGD values increase on average 2,78 times and if the rate is tripled it increases LGD by an average of 4,34. When tripling the discount rate one would receive a rate of 15% which, even if the risks surrounding the exposure where substantial, would be a far too high value, at least in a country like Sweden. The idea of looking at a value like this is only to get an understanding of how LGD reacts on variations in the discount rate.

6.3.4 Workout costs

The workout costs usually come to some percentage of the outstanding loan amount. My workout cost equals 2% leaving the credit to cost two thousand per year. The costs are subtracted from the recoveries which in comparison to the recovery rate of RRE represent a

very small sum. When doubling the workout costs to four thousand, the average LGD values will double as well and likewise if the costs are tripled. The same issue arises here as with the discount rate. The workout costs that where used in this calculation would never exist in reality, but give us a mathematical understanding of the connection between the variables.

6.4 LTV analysis

The LTV values are calculated according to the formula:

LTV = Outstanding loan amount / discounted value of the collateral value received at liquidation.

LTV can like LGD be estimated and calculated during the entire lifetime of the credit. When a credit is originated the banks look close at the LTV ratio. A high LTV credit is considered to hold more risk than a low LTV credit. To be able to compare the LTV data to my LGD data the same criterions must apply for both models. Because the cash flows in the LGD model where discounted back to the default time point the same must be done to the collateral value in the LTV model in order for the two parameters to be comparable. The LTV values that are calculated are therefore the LTV values at the time of default.
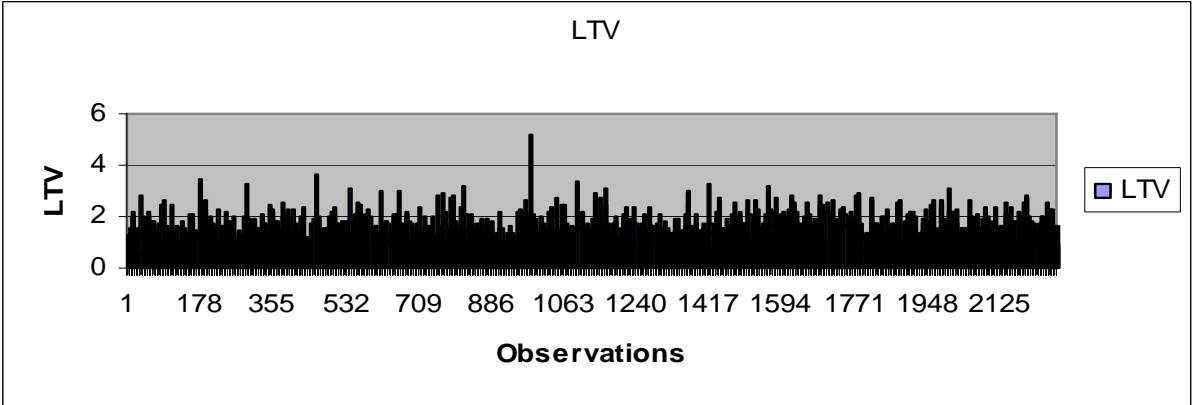

Picture 7: LTV values

The LTV values received are all grouped within the same range with an LTV average of 1,26. RRE credits usually have low LTV values due to their high values of collateral which leaves me to draw the conclusion that the received LTV result is to large. A high value like this could occur if the prices on the RRE market rapidly decrease.

6.4.1 Changes in the LTV variables

The outstanding loan amount at the time of default is a value that cannot be changed after default according to my limitations that I set up. This means that once a credit is default the borrower can not make any further repayments. But if we play with the idea that the loan amount could increase to the double, 200 000, (all other things remain the same) then the LTV ratio would double. The same applies if the value of the collateral would increase, the LTV value would decrease by double.

6.5 LGD/LTV analysis

By changing the different factors in the LGD and LTV models one can get an understanding of how these two parameters work and what drives them. To expand the analysis further the connection between the parameters LGD and LTV is also analysed. Due to the fact that I have altered my models slightly to better suit my data, the results that I received can probably not be compared to actual LGD/LTV data.
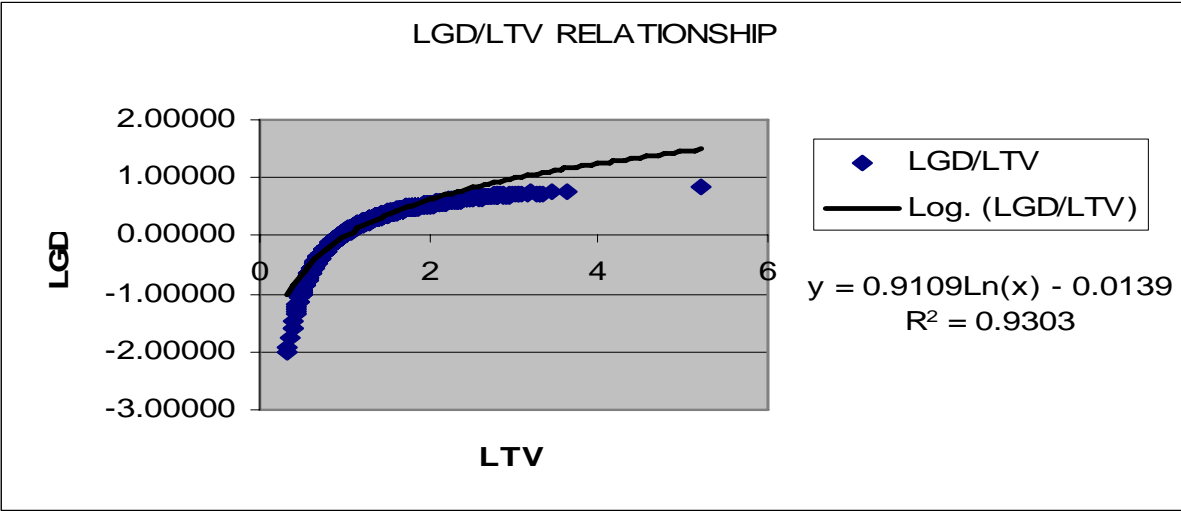
Picture 8: LGD/LTV relationship.

Regression output:

Dependent Variable: LGD
Sample: 1 2263
Included observations: 2263
LGD = C(1)*LOG(LTV) - C(2)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.910913	0.005245	173.6585	0.0000
C(2)	0.013879	0.002123	6.536424	0.0000

R-squared 0.930255

As can be seen in *picture 8* the relationship is described by a log.-function. This function is a non-linear function and the *regression output* can not interpreted as it would have been had it been a linear function. The relationship is of a positive kind, hence the positive value of the slope. One should be aware that the slope even though it is positive, is not constant. It makes sense that if LTV increases, LGD should increase. Higher LTV values occur if either the loan amount increases or if the value of the collateral decreases. In the previous chapter[51] I determined that the loan amount cannot be changed, so in order for the LTV value to increase, the collateral value has to decrease, which also affects the LGD model by increasing the LGD values. The variation in LGD is very well explained by the variations in LTV, which is shown by the R^2 value = 0,9303. One can also draw the conclusion that the LTV variable is relevant to the dependent LGD variable due to the high t-statistic = 173,6585.
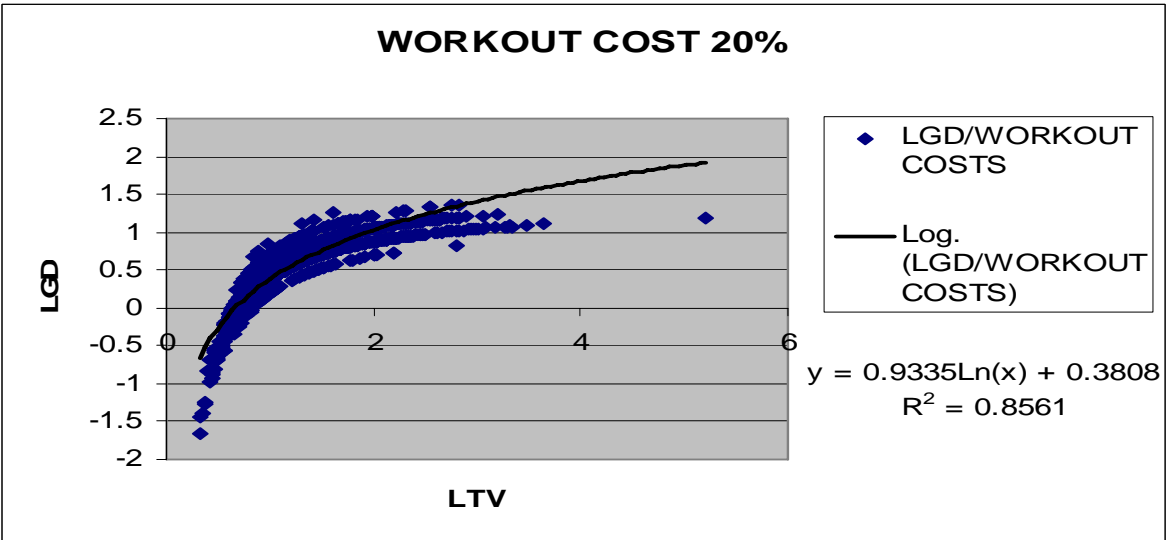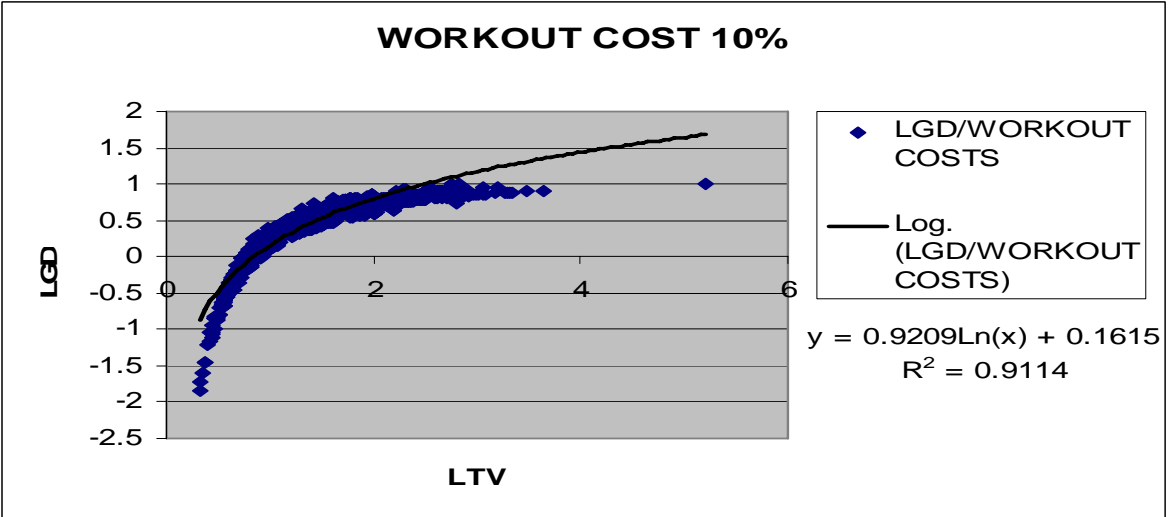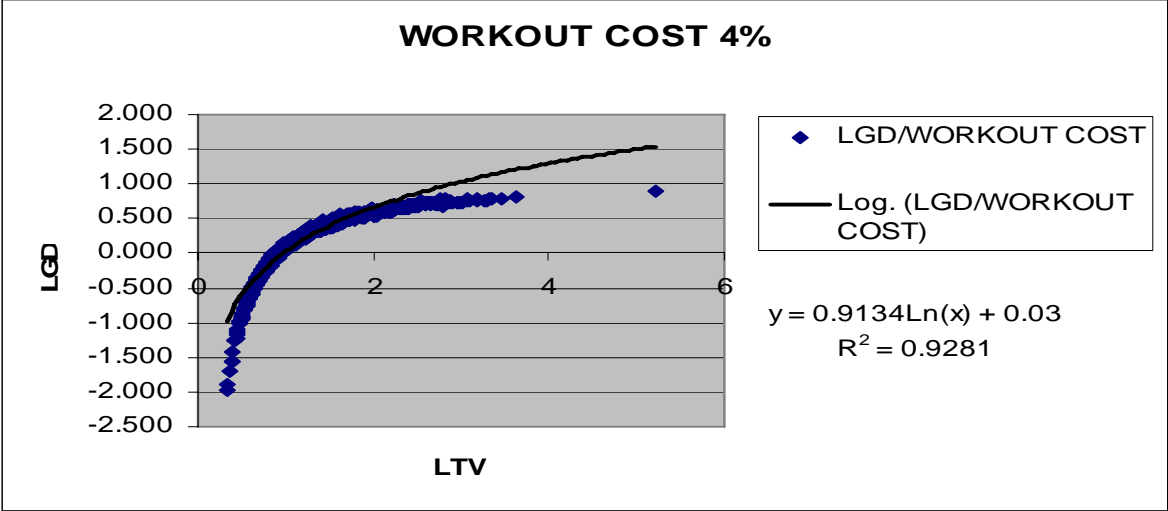
6.5.1 Changes in the LGD/LTV variables

Changes in recovery rate, time and discount rate do not affect my LGD/LTV relationship in any large visible way. This can be explained by the fact that these factors are included in both the LGD and LTV models. The variations therefore have a similar effect on both models leaving the LGD/LTV relationship unchanged. Another explanation to my results could be the fact that my data has been simulated and does not include any exposures that show large abnormalities. This could be the reason why the data in the graph all lie on a line and are not spread out.[52] When changes in the workout costs are made one can discover small changes

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[51] See *chapter 6.4.1*
[52] *See Picture 8*

occurring in the LGD/LTV relationship. Before looking at the graphs in *picture 9*, it is important to say that no banks would have workout costs that are 10% or 20%.

WORKOUT COST 4%

$y = 0.9134Ln(x) + 0.03$

$R^2 = 0.9281$

WORKOUT COST 10%

$y = 0.9209Ln(x) + 0.1615$

$R^2 = 0.9114$

WORKOUT COST 20%

$y = 0.9335Ln(x) + 0.3808$

$R^2 = 0.8561$

Picture 9: LGD/LTV relationship with changes in the workout cost.

The graphs are included in this analysis to show that substantial variations are required in the factors to create any difference in the LGD/LTV relationship. The larger the value of the workout costs the larger the spread in the LGD/LTV relationship. An increase in the costs will lead to an increase in LGD but will leave the LTV model unaffected. The graph that contains an increase of the workout costs to 20%[53] is the graph that shows the most variations and several observations of the LGD/LTV relationship have started to shift up towards the top left corner. This would imply that when costs increases, the observations show an increase in LGD and at the same time a decrease in the LTV parameter. This is found to be accurate when looking at the log.-function for LGD/LTV. The overall conclusion can be drawn that changes in the workout costs, that are within reason, will not affect the LGD/LTV ratio visibly.

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[53] See *Picture 9*

7.   Conclusions

Looking at the LGD results received from my mathematical analysis, the conclusion can be drawn that a workout model will provide good LGD values as long as the model contains the right variables. The recovery rate received from liquidating the collateral is the variable that shows the strongest connection with LGD. How to define the recovery rate is very important even if my LGD values did not show any major differences if I calculated with the market value at liquidation point in time or the actual value received. The other variables contained in the LGD model show only small affects on the RLGD values when changes are made. There needed to be unreasonably large changes in these variables for them to create significant variation in LGD, which, especially in the case of the discount rate and workout costs, does not represent reality like events. The time variable shows a positive connection with LGD. This could be expected due to the fact that the longer it takes to establish an actual amount for the recovery rate, the larger the risk. This result depends of course on which economic state the market is in. If we assume a stable economy like we have today, the conclusion can be drawn that the LGD/Time connection is accurate.

From looking at the LGD/LTV relationship one can come to the conclusion that the relationship is strong and it also seems to require unreasonably large changes in all the variables of the models to create visible variations in it. Changes in the workout cost variable did create the largest spread of the LGD/LTV observations. This came as a surprise, as I would have thought that changes in the recovery rate would be more significant. The LGD/LTV relationship is a non-linear log-function with a positive slope which leaves the variations in LGD very well explained by the variations in LTV. The interpretation of non-linear regression output is difficult, especially in this thesis where the statistical data has been simulated and very limited background information is known. This leaves my results from the mathematical analysis to be questioned and it would have been preferable to have been able to test my models with actual loan data.

The Basel II Framework gives overall very good guidelines for setting up an estimation model. The verbal workout LGD estimation model should be able to give accurate estimates and it incorporates all necessary factors. The conclusion to set up the verbal estimation model according to the workout method was in my opinion correct, but it is of course hard to say

with certainty, due to the fact that no other of the estimation methods could be applied to my limited data and that the estimation model was not tested with actual data. The decision to use a more complex estimation model rather than just the sample mean of RLGD seems to be a smart choice. The more relevant information one can incorporate into a model the more precise the model.

8.   References

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