Monitoring the market value of loans in the Energy, Commodities & Transportation portfolio

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Management Summary

The aim of this research is to acquire more insight in how to monitor the market value of outstanding credit facilities within the portfolio of the Energy, Commodities & Transportation department. When the market values can be properly calculated the development of the markets of counterparties and the sector can be assessed. This can be useful for portfolio management actions.

Currently a method is used for this purpose which calculates the change in earnings of the loan between what is agreed at origination based on the market prospects at that time and what would be paid for similar risks on the current market (benchmarked using a relevant CDS spread). This change in earnings is interpreted as the indication of the change in market value.

Quoted market prices for loan facilities are generally not available, and because of the unique characteristics loans might have, prices for similar instruments are generally also not available. Hence the market value of loan facilities must be measured using valuation techniques. Instead of the existing method, which is used as a rule of thumb to give an indication of the change in market value, an alternative method is used to calculate the market value more precisely, but still in a practical way. The common risk-neutral discounted cash flow valuation theory should be used, which is summarized in the simplified formula shown below.

$$\mathrm{FV_i} = \sum_{t=i}^{N} \mathrm{E[loan\ facility\ payments_t|survival_t] * p[survival_t] * discount_t}$$
$$+ \sum_{t=i}^{N} \mathrm{E[loan\ recovery\ payments_t|default_t] * p[default_t] * discount_t}$$

The probabilities of default and survival are risk-neutral values representing all risk effects and the discount rate is the risk-free rate. The probabilities of default and survival are derived from CDS spreads that reflect the current market circumstances. A more extensive form of this formula with the payments identified and incorporated can be seen in Appendix 1.

In order to do better market value calculations the existing method is considered to be replaced with the theoretical method. For both the advantages and disadvantages are identified, which are summarized in the tables below.

Advantages	Disadvantages
Easier to automate	Indication of the change in market value as result
Less data needed	Not all cash flows are included
Less assumptions to be made	Amortization is by approximation taken into account
	One annual fixed value for inputs, leading to possible additional calculations
	No discounting

Table 1 - Advantages and disadvantages of the existing method

Advantages	Disadvantages
Market value as result	More difficult to automate
More types of cash flows are identified	More data needed
Amortization is directly taken into account	More assumptions to be made
Inputs can differ each year	
Cash flows are discounted	

Table 2 - Advantages and disadvantages of the theoretical method

Both methods are applied to a certain selection of loans to analyse the differences in the results and use of both methods. The calculated change in market value of the existing method is compared to the relative difference between the actual market values calculated with the theoretical method. This relative difference is calculated by using the inputs at origination first, calculating the market value at origination. After that the same calculation is done, but with the CDS spread as changing input as this represents the changing market circumstances. The CDS spread at the valuation date, representing the current market circumstances, is assumed to be a variable in order to see how the results of the methods differ under different market circumstances.

For both methods and all loan facilities in the selection, a higher CDS spread corresponds to a negatively changing market and hence a lower market value. There are however differences between the results of both methods. The first issue is the turning point from which CDS spread the market value change becomes negative. A negative result means that the market value, reflecting the current market circumstances, is lower than the market value that would be expected at origination. This turning point is in case of the theoretical method equal to the CDS spread at origination. Instinctively this makes sense, as the CDS spread is assumed to be the only changing variable and the changed CDS spread is compared to the CDS spread at origination. The turning point of the existing method is different. The reason of this different turning point is the fact that in the existing method the CDS spread is compared to the commercial margin of the loan set at origination, assuming that this margin properly represents the market conditions at origination. This is rarely the case, leading to possible extreme results of the existing method.

Due to the calculations made in each method and especially the simplifications made in the existing method, the theoretical method leads to better substantiated results, as the cash flows are discounted and risk-neutral probabilities of survival and default are calculated, representing the risk effects in the market. This is a different approach than comparing the CDS spread (seen as the external risk premium) with the commercial margin (seen as the internal risk premium). This approach uses annual earnings in the calculations directly, having the consequence that the results of the existing method can differ in terms of their value and slope of the graph for different loan facilities, making extreme, potentially unrepresentative results possible.

Further the theoretical method incorporates more variables and inputs can have different values per year, instead of the annual values inputs must have in the existing method. This is desirable, especially since the inputs of loan facilities within the ECT portfolio often differ per year in practice. For all these reasons, in order to monitor the market value of loan facilities in the ECT portfolio, the theoretical method is recommended to be used regularly instead of the existing method.

When the theoretical method is applied regularly, it is recommended to identify on which loan facilities the method can be applied. When this is clear, the most recent data can be used as inputs in an automated Excel sheet such as the one in Appendix 2 to relatively easily monitor the market values of these facilities. This creates insight in the market value of loans on both individual and portfolio level.

One main restriction of the theoretical method (also of the existing method) is that the method and data to be used is based on steps of a year between time points. Therefore it is a suggestion for further research to change the method so that it can be applied based on monthly or even daily time steps. This is especially useful, so that the method can also be applied on short-term oriented loan facilities, which facilities in the Commodities portfolio mostly are.

Many assumptions for the calculations, which data to use and where the data should be obtained were needed to be made in order to apply the theoretical method. It is a recommendation to reconsider these assumptions, as more accurate results may be possible.

Preface

This thesis is written as the graduation requirement for my Master's degree in Industrial Engineering and Management, specializing in the track Financial Engineering and Management. I have executed this project within the Portfolio Management team of Energy, Commodities & Transportation at ABN AMRO in Rotterdam. This thesis contains my research on the topic of monitoring the market value of loan facilities in the Energy, Commodities & Transportation portfolio.

At first, I would like to thank Theo van Drunen, the head of the ECT Portfolio Management team for providing me the opportunity and flexibility to do my research and investing time and effort supervising me. The meetings we had during my research were valuable, giving me additional insights and suggestions to improve the thesis. Further I would like to thank my colleagues in the Portfolio Management team for welcoming me, making me feel part of their team and for providing me with useful feedback when I had questions. It found it an enjoyable experience to work in this team, which I am grateful for.

Furthermore, I would like to thank my supervisors Toon de Bakker and Berend Roorda for our meetings, always providing me with useful feedback, suggestions and insights for the research. Next to that I would like to express my gratitude to Toon de Bakker for bringing me in contact with ABN AMRO, among other contacts of him in order to find a graduation project.

Last but certainly not least I thank my family, friends and Charlotte for supporting me during this research and my time as student, which means a lot to me.

Joey Grashuis

Contents

Chapter 1: Introduction

ABN AMRO N.V. (hereafter ABN AMRO) is a Dutch state-owned bank that offers a full range of products and services to retail, private, commercial and merchant banking clients with a strong position in all business activities in the Netherlands. The bank has a stable client basis, provided by 5 million households, 365,000 business banking clients and 2,500 corporate clients. The bank is a product of a long history of mergers and acquisitions and is owned by the Dutch state[1].

This research is done within the Energy, Commodities & Transportation (ECT) department. This department is a part of the Large Corporates & Merchant Banking division, which falls under the Commercial & Merchant Banking division. The ECT department acts as the financial partner of its clients by offering financial services (such as loans) and advice, covering their clients' whole industry value chains. The clients of ECT are international mid-sized to large corporates active in the energy, commodities and transportation businesses. Clients which are active in energy, are active in the oil or gas industries or offshore services. Clients active in commodities are trading companies which trade agricultural, metals and energy commodities. Transportation involves shipping and other transportation industries. For the Energy, Commodities and Transportation industries, the ECT department also complements the debt services with equity solutions by co-investing with clients in assets in projects and companies within these industries. This is done by the Principle Finance Team.

As financial partner of its clients, ECT offers a variety of credit facilities to the clients. These credit facilities vary from letters of credit to long-term bullet loans. This research focuses on monitoring the market value of outstanding credit facilities of ECT, taking current market circumstances into account. It is valuable to the ECT department to compare how the market value of its credit facilities actually developed over time with the market expectations which were determined at origination. This comparison shows whether markets of counterparties develop better or worse than expected, which is useful information for the bank for example in order to determine how to maintain relationships with clients. Furthermore having insight in the market value of credit facilities can be useful for portfolio management actions, for instance in case when credit facilities are considered to be sold.

In the next chapter the context and goal of the research will be described more extensive. Further the research questions will be defined.

[1] (ABN AMRO Group N.V., 2012).

Chapter 2: Research design

In this chapter the research design will be described. At first, the context of the research and its corresponding goal will be explained in section 2.1. In the second section, the research proposal will be given including the research questions.

2.1 Context and goal

As described in the introduction, the Energy, Commodities & Transportation department offers a variety of credit facilities to their clients. The terms and margins of these credit facilities are set during the origination of the loan process partially based on the market expectations at that time. Based on this, credit facilities are valued. However, over time (market) circumstances logically can differ from expectations, giving the bank a lack of clarity whether the terms and margins of that credit facility (and thus its valuation) set at the beginning, still apply in the changed market situation and at the same time how the market situation actually developed in comparison with what was expected.
For example when the bank has a loan outstanding to a certain counterparty and due to unexpected negative market changes the counterparty might have difficulties to repay the loan, the bank is exposed to more risk. More unexpected risk for the bank should normally correspond to higher margins of the loan and consequently a change in value for the bank.

The ECT department wants to know where it stands in terms of the market value of its credit facilities. This gives the department insight in how the counterparties and their risk profiles develop. This can be useful for determining how to maintain the relationship with a customer and for creating insight in the market value of credit facilities in the ECT portfolio separately and combined. This is especially useful for portfolio management actions.

Currently a method, that was recently developed, is applied to compare the fixed commercial margin of a loan (which is set at the beginning of a term, based on the market expectations at that time) with a relevant corresponding CDS spread (which can be seen as the current external risk premium in the current market).

A statement of the composition of the margins of loans is left out, since this is considered to be confidential.

In case that the CDS spread in the market is higher than the commercial margin of the loan, more is earned on the current market for similar risks, implicating that there are higher margins (and thus more risk) in the current market than there were in the bank's market expectations at the time of origination. Therefore it is plausible that the market has developed worse than expected in terms of risk. The other way around the reverse way of reasoning applies.

This method is presented as a method to mark-to-market (approaching the fair value of) loans in the portfolio and gives a percentage which shows whether there are higher or lower margins on the current market than expected at the beginning of the term. Simply stated, this percentage represents the difference between the commercial margin of the loan and the CDS spread and is used as the fraction of the exposure which can be earned more or less on the current market than on the market as it was expected to be[2]. This can also be seen as the change in earnings, which is interpreted by the method as the change in market value. However, this value does not represent the market value itself (although there is a relation between the outcomes and the actual market value). Therefore it can be said that further research on this topic is desirable.

This research focuses on properly estimating and monitoring the market value of credit facilities within the ECT portfolio and in addition creating insight in the (development over time of the) market values of outstanding credit facilities. The corresponding key question of this research will be as follows.

- *How can the market value of loans in the Energy, Commodities & Transportation portfolio be monitored?*

The goal of this research is to acquire more insight in properly monitoring the market value of a credit facility and insight in the development of the market values of outstanding credit facilities over time in addition.

2.2 Research proposal

In order to calculate market values of outstanding credit facilities, a theoretical foundation will be created, providing a good context and an alternative method for calculating market values. This will be done in the first research question. It is important to evaluate the existing method and to find potential flaws. This will be done in the second research question. After that, the existing method can be improved based on these potential flaws by marginal improvement or even by replacement of the method by the alternative method. The improved or alternative method will then be compared to the current method in the third research question to come up with the method which preferably should be used to monitor market values of outstanding loan facilities.

2.2.1 First research question

It is first important to understand the context. Therefore a research question will treat how the market value of a loan should be approached theoretically in the situation where all data is available, where needed illustrated with an example. This gives an introduction to the theory of market values and how to calculate it according to literature, providing an alternative method with a theoretical foundation. This theoretical method can later be compared to the current method. This corresponds to the following first research question.

1. *How should the market value of a loan theoretically be measured?*

2.2.2 Second research question

This part of the research will evaluate the existing method. Depending on the outcomes, potential shortcomings of the current method will come forward. This is needed as a basis to improve the way market values of outstanding loan facilities are calculated further in the research. This corresponds to the second research question, which is as follows.

2. *What characteristics and potential deficiencies does the existing method have?*

[2] (Jiang, 2012).

In order to evaluate the existing method it is important to understand it. An extensive description of the method will be given as a basis. This will explain in detail and step by step how the method works and will use the handbook for this method as source. This corresponds to the first sub question which is as follows.

a. *How does the existing method for approaching the change in market value of loans work?*

Now that the existing method is extensively explained and a theoretical way of calculating market values is described, the focus can move to the differences between the two. Out of these differences, it must be identified which ones might be problematic for the method. This will be done by logical reasoning, conducting interviews and using literature where needed as basis. This is treated in the following sub question.

b. *What differences between the existing method and the theoretical method are problematic?*

Answering these sub questions will make clear what deficiencies the existing method has, by comparing it with the theoretical method described in the first research question.

2.2.3 Third research question

Now that the existing method is evaluated, the way of calculating market values of outstanding loans possibly can be improved by using the theoretical method instead of the existing method. For that reason both methods are properly compared to each other, focusing on the deficiencies of the existing method identified in the second research question. When this is done it can be said that more insight is given in properly estimating the market value of a credit facility, which is the goal of this method and this research. This leads to the following research question.

3. *Which method should preferably be used in order to calculate the market values of outstanding loan facilities in the ECT portfolio?*

It is valuable to give an overview of the advantages and disadvantages of both methods at first in order to give additional insight in the differences between both methods. This will build on the problematic differences between both methods outlined in sub question 2b. This will be treated in the sub question showed below.

a. *What are the advantages and disadvantages of both methods?*

To compare the methods properly it is desirable to know what influence applying both methods has on the actual results and on the use. Therefore a part is added where this will be tested. Depending on the time available a selection of loans will be made for which the method will be applied, for example the five loans with the largest exposures. Firstly, the original method will be applied on this selection of loans. After that, the theoretical method will be applied. With these results comparisons can be made to see what influence applying either one of the methods has on the results and on the use. These influences show which method actually leads to other (possibly more precise) outcomes. If there is no or little influence, it may be possible that the alternative method cannot be seen as an improvement of the existing method at all. This can strengthen of weaken the reasons to use either one of both methods or not and thus it is a relevant addition to this research. This will answer the following research question.

b. *What are the differences between both methods in terms of their use and results when both are applied?*

Answering these sub questions gives more insight in how the market value of outstanding credit facilities properly can be monitored. This corresponds to the goal of the research.

Chapter 3: Calculating the market value of outstanding loans in theory

In this chapter will be described how the market value of a loan would theoretically be calculated in the ideal situation where all data is available and simplified. Firstly it is important to understand what market value is. This will be the starting point for this section, which will be treated below in section 3.1. After that the hierarchy to calculate fair values is given in section 3.2. The theory behind discounted cash flow methods is given in section 3.3, where the extensions of discounted cash flow methods are described in section 3.4. The inputs of the extended discounted cash flow method that is used in this research are discussed in section 3.5.

3.1 Definitions

This section will start with the definition of market value. According to both the International Valuation Standards and the European Valuation Standards, market value is defined as: "the estimated amount for which an asset or liability should exchange on the valuation date between a willing buyer and a willing seller in an arm's length transaction, after proper marketing and where the parties had each acted knowledgeably, prudently and without compulsion."[3] This is a recent, extensive and accepted definition of market value. Morris & Sellon Jr. state that obtaining market values is relatively easy for some bank assets and liabilities which are actively traded, but more difficult for others. For instruments that are not actively traded in liquid markets, including most bank loans and deposits, market values must be estimated.[4]

In practice, market values are approached by calculating fair values. Fair value is defined in IFRS 13 Fair Value Measurement as: "the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date"[5]. The International Valuation Standards Board considers the definition of fair value according to IFRS 13 and the definition of market value to be generally consistent[6]. The difference is that market value is determined by the interaction of demand and supply on the open market, whereas fair value is estimated by fundamental models including (current) financial and economic data, trying to determine what a hypothetical market participant might pay.[7] As stated by Matherat, the objective of fair value accounting is to replicate market prices and is based on the availability of market inputs for valuation.[8] For loans, quoted market prices are generally not available, and because many loans have unique characteristics, market prices for similar instruments are also unavailable.[9] Prices for distressed loans are only exchanged occasionally between banks. Therefore it can be said that for approaching the market value of a loan, the fair value can be approximated. How fair value should be approached is described in the next section.

[3] (International Valuation Standards Council, 2011); (The European Group of Valuers' Associations, 2012).
[4] (Morris & Sellon Jr., 1991).
[5] (International Valuation Standards Council, 2011).
[6] (International Valuation Standards Council, 2011).
[7] (King, 2010).
[8] (Matherat, 2008).
[9] (Nissim, 2003).

3.2 Fair value hierarchy

When quoted market values are available, these should be used to measure fair value. When market values are not available, the estimations should be based either on market prices of instruments with similar characteristics or on valuation techniques.[10] This is also described in the Fair Value hierarchy under both the International Financial Reporting Standards (IFRS) and the US Generally Accepted Accounting Principles (US GAAP). This hierarchy shows how fair value preferably should be assessed depending on the available data according to both standards and is presented in the table below.

IFRS	US GAAP
Level 1: quoted prices in an active market Level 2: more recent quoted price	Level 1: market prices
Level 3: estimation of fair value by reference to similar financial instruments Level 4: valuation techniques incorporating a maximum of observable data	Level 2: model prices with observable inputs
Level 5: valuation techniques incorporating non observable data	Level 3: model prices with no observable inputs

Table 3 – Fair value hierarchy under IFRS and US GAAP
Source: (Matherat, 2008)

The levels of the hierarchy are determined by the inputs that should be used depending on their availability. This table shows that financial instruments could be valued using market prices (if available), using the market of a similar instrument if there is no market for this specific instrument or using model-based valuation techniques (with or without market inputs depending on their availability).

The hierarchy shows that in order to estimate the fair value, prices observable from earlier transactions on markets should be used if available. IFRS makes the distinction between observable prices in active markets and more recent quoted prices in less active markets. Since, as stated before, the objective of fair value accounting is to replicate market prices, these observable prices will have preference. These prices can be seen as the actual market values. Financial instruments could also be decomposed into and replicated by different standard products giving the same expected cash flows. In this case one can add the market prices of these standard products to come up with the total price, which should be equal to the market price of the financial instrument.
In case these prices are not available, the prices must be modeled or estimated (corresponding to the definition of fair value). US GAAP describes its second level as valuation allowing the use of prices on nearby dates, or the use of arbitrage-type valuation models that use the observable prices of other similar financial instruments or available indices.[11] This level is split in the IFRS hierarchy into estimating the fair value by reference to similar instruments as level 3 and valuation techniques incorporating a maximum of observable data in terms of prices of similar financial instruments as level 4.
When the valuations described before are not possible, valuations allow the use of theoretical valuation

[10] (Nissim, 2003).
[11] (Caruana & Pazarbasioglu, 2008).

models that use as inputs various relevant fundamental parameters.[12] These inputs should reflect the current market expectations when possible.

As stated earlier, quoted market prices for loans are generally not available, and because of the unique characteristics different loans might have, market prices for similar instruments are generally also unavailable. This makes level 1 to level 3 valuations according to the IFRS hierarchy and level 1 and 2 valuations according to the US GAAP hierarchy generally not possible for loans. This means that for loans in general theoretical valuation models must be used. Shin confirms this by stating: “Finding the fair value of a loan is a very different exercise from simply reading off the competitive price in a liquid market. Instead, one has to find the hypothetical price that would prevail were frictionless markets to exist for such assets.”[13] What theoretical valuation model should be used and how it works is described in the next section.

3.3 Discounted cash flow method

For many assets and liabilities, market values can be estimated using a present value model. In general, the price an investor will pay for a financial instrument depends on the return he will receive from this investment relative to the return on competing investments, as stated by Morris & Sellon Jr.[14] To support this, Nissim states that the value of any asset depends on the expected cash flows from the asset and the riskiness of those cash flows. In the context of loans, the expected cash flows consist generally of interest and principal repayments.[15] Research done by Tschirhart et al. on the use and measurement of loan fair values at seven large internationally-active banks confirms that banks take expected cash flows into account using discounted cash flows (DCF) methods as valuation technique in order to measure fair values of loans. They state: “Applying a DCF model to estimate the fair values of loans generally involves discounting the contractual or expected cash flows using a secondary market interest rate for the same or similarly categorized loans.”[16]

One might instinctively argue that credit value adjustment techniques can be used as well to estimate market values. However, credit value adjustment is the difference between the risk-free value and the true value of a financial instrument or portfolio, taking the possibility of a counterparty’s default into account. This implicates that the credit value adjustment can be seen as the market value of the counterparty credit risk.[17] However calculating the adjustment does not give the actual market value of the instrument. For that reason the DCF method is used from this point in the research.

DCF is an investment appraisal technique which takes into account both the time value of money and also total cash flows over a project’s life. In case of discounting, the present value of an investment is calculated. Loans are customarily valued using present value techniques.[18] The present value can be defined as: “the cash equivalent now of a sum of money receivable or payable at the stated future date,

[12] (Allen & Carletti, 2008); (Caruana & Pazarbasioglu, 2008).
[13] (Shin, 2007).
[14] (Morris & Sellon Jr., 1991).
[15] (Nissim, 2003).
[16] (Tschirhart, O'Brien, Moise, & Yang, 2007).
[17] (Hull, Options, Futures, And Other Derivatives, 2012).
[18] (Nissim, 2003).

discounted at a specified rate of return"[19]. The discounting formula to calculate the present value of a future sum of money at the end of n time periods is as follows assuming a flat yield curve.[20]

$$\mathrm{PV} = \frac{\mathrm{FV}}{(1+\mathrm{r})^{\mathrm{n}}}$$

with PV = the present value of the investment
FV = the future value of the investment with interest
r = the rate of return per time period
n = the number of time periods

For a stream of expected cash flows associated with a certain investment, asset or liability, the present value formula can be written as follows. In reality, the discount rate varies per time period. Therefore in the formula below the discount rate is specified per time period.[21]

$$\mathrm{PV} = \sum_{\mathrm{k}=0}^{\mathrm{n}} \frac{\mathrm{x_k}}{(1+\mathrm{r}_k)^{\mathrm{k}}}$$

with n = the number of time periods
x_k = the expected cash flow in time period k
r_k = the discount rate expected for time period k

Morris & Sellon Jr. confirm that this formula can be used to estimate the market value of a financial instrument by stating that the market value of a financial instrument with maturity of T years is equal to the future interest cash flows plus principal repayment, discounted by a market interest rate I.[22] The DCF model can be extended and used in different ways. This will be discussed in the next section, next to how the DCF model should be used in the context of this research.

3.4 Extensions of the DCF model

There are three methods to use DCF models for valuation purposes. The three methods differ in the way they take risks into account. The first one uses the contractual (promised) cash flows. These cash flows are fixed, implicating that unexpected cash flows are not identified. Therefore the full risk effect is included in the discount rate. The second one uses expected cash flows rather than the contractual cash flows. Expected cash flows due to risks, such as the losses given a possible default are taken into account, even though this is no contractual cash flow. Unexpected risks are in this method included in the discount rate. The third method also uses expected cash flows. The difference with the second method is that possible cash flows have a probability (such as the probability of default) and all risk effects are represented by these probabilities. These probabilities are risk-neutral and the discount free is the risk-free rate. This method is also called risk-neutral valuation.[23]

[19] (Berry & Jarvis, 2006).
[20] (Berry & Jarvis, 2006).
[21] (Luenberger, 2009).
[22] (Morris & Sellon Jr., 1991).
[23] (Luenberger, 2009).

Risk-neutral valuation implicates that when valuing the assumption is made that all individuals live in a risk-neutral world and are indifferent to risk. In such a world investors require no compensation for risk and the expected return on all securities is the risk-free rate.[24] The probability of default (PD) in the formula is a risk-neutral probability. The difference between a real world PD and a risk-neutral PD is that the real world PD is derived from historical PD data, where the risk-neutral PD is derived from bond or CDS prices/spreads. Therefore the real world PD is the actual probability of default, where the risk-neutral PD also partly consists of a risk premium since a compensation is desired and included in the price/spread in the real world for bearing the systematic credit risks. This automatically implicates that the risk-neutral PD is higher than the real world PD.
For example when the real world PD is 1% and the risk-neutral PD is 5%, this means that the actual probability of default is 1%. In this case the wanted compensation in the risk-neutral world is 5%, of which the actual probability of default is only 1%. This implicates that the risk neutral 'probability' of default is not an actual probability but a compensation per euro or dollar exposure. In this case the risk premium thus is 4%.

Tschirhart et al. come up with a risk-neutral valuation to calculate the fair value of a financial instrument. It is based on in-depth discussions with seven internationally-active banks on their use of fair value measuring. The idea of their valuation framework is summarized below in a simplified formula.[25]

$$\mathrm{FV_i} = \sum_{\mathrm{t=i}}^{\mathrm{N}} \mathrm{E[loan\ facility\ payments_t | survival_t] * p[survival_t] * discount_t}$$
$$+ \sum_{\mathrm{t=i}}^{\mathrm{N}} \mathrm{E[loan\ recovery_t - commit\ drawdown_t | default_t] * p[default_t] * discount_t}$$

with E[…] = the expected value (in principal a risk-neutral value)

E[loan facility payments$_t$|survival$_t$] = the expected payments at time t, given survival until time t

p[survival$_t$] = the unconditional risk-neutral probability of survival at time t

discount$_t$ = the present value of one dollar paid with certainty at time t (risk-free)

E[loan recovery$_t$|default$_t$] = the expected amount that the bank recovers after a loan defaults at time t

E[commit drawdown$_t$|default$_t$] = the expected commitment drawdown at time t at default

p[default$_t$] = the unconditional risk-neutral probability that default will occur at time t

The discount factor in this formula equal to $\frac{1}{(1+\mathrm{dr})^{\mathrm{t}}}$, which is the discount part from the standard DCF model. The top line in the formula represents the sum of the discounted expected payments to be made in each period t, given the fact that the obligor has survived through t. The bottom line of the formula is the sum of the discounted expected payments for each period t, given the fact that a default occurred at time t multiplied by the unconditional probability of default at time t.

Tschirhart et al. define what could be included as expected payments in more detail. They define these as typical payments of a loan facility. Possible payments by the bank are preceded by a minus sign. Since

[24] (Hull, Options, Futures, And Other Derivatives, 2012).
[25] (Tschirhart, O'Brien, Moise, & Yang, 2007).

the payments are uncertain, the bank should estimate their expected values. It depends on the loan which expected payments should be taken into account. The payments are summarized in the tables below.[26]

Payments given survival	Description
LIBOR interest rate (floating)	Paid on outstanding loan balance
Loan margin	Spread over LIBOR paid on loan balance; margin may be changed based on measure of obligor credit condition
Loan prepayment/refinancing	Loans can be prepaid or refinanced, possibly with a prepayment penalty
Loan repayment at maturity	If no default, the outstanding balance is paid at maturity
Commitment facility fee	Fixed periodic fee paid for a loan commitment
Commitment fee	Periodic fee based on unused commitment
- Commitment drawdown	Drawdown on the unused commitment
- Term-out exercise	Loan commitment can be converted to a fixed term loan at maturity at obligor's discretion

Table 4 – Loan Facility Payments given survival
Source: (Tschirhart, O'Brien, Moise, & Yang, 2007)

Payments given default	Description
- Commitment drawdown	The obligor may drawdown on the unused commitment when default is imminent
Recovery of loan balance	The amount that the bank recovers after a loan defaults (including any commitment drawdown at default)

Table 5 – Loan Facility Payments given default
Source: (Tschirhart, O'Brien, Moise, & Yang, 2007)

The simplified formula can be extended with inclusion of the expected payments as defined in the tables. The complete formula with explanation should be used and can be seen in Appendix 1. How the needed data should be obtained is described in the following section.

[26] (Tschirhart, O'Brien, Moise, & Yang, 2007).

3.5 Inputs of the extended DCF model

As stated in section 3.4, the expected cash flows should be estimated by the bank. The probability of default (PD) must be estimated as well. When the PD is estimated, the probability of survival is also known, since the probability of survival is equal to 1 minus PD. Tschirhart et al. come up with a hierarchy of market price sources which preferably should be used to measure fair value in general.[27] This hierarchy can be used to see which market price source preferably should be used. This hierarchy is summarized in the table below.

Market Price Sources	Relation to Facility/Obligor	Use
Secondary loan market price	1. Same facility 2. Obligor in same or related legal entity	Used directly as fair value
Obligor credit default swap curve (CDS)	1. Same obligor 2. Obligor in same or related legal entity 3. Possibly independent but highly correlated entity	Used to estimate default/survival probabilities
Obligor bond credit curve		
Generic credit curve; firm equity value		

Table 6 – Hierarchy of market price sources for fair value estimations
Source: (Tschirhart, O'Brien, Moise, & Yang, 2007)

The price sources higher in the hierarchy are believed to provide more reliable fair values. As with the fair value hierarchy in section 3.2, quoted market prices preferably should be used directly as fair value. In this case, where this is not possible, other market price sources should be used. As can be seen, all these market price sources should be used to estimate default/survival probabilities to eventually estimate the fair value using the previously described valuation framework. This shows that in order to estimate default/survival probabilities using obligor credit default swap (CDS) curves should be used if possible. Focusing on CDSs, when possible a CDS of the same obligor should be used. When this is not possible, a CDS of an obligor in the same or related legal entity should be used. When this also is not possible, CDSs of independent but highly correlated entities must be used. Otherwise, generic credit spread curves must be estimated to represent spread curves for loan facility obligors in generic categories based on firm credit ratings, industry, country/region and/or possibly currency. In practice this is done by finding CDS spread curves of borrowers with the same rating within the same industry.

The spread on a bond CDS reflects the risk-neutral expected loss from default on the reference bond over the remaining term of the contract per dollar of bond face value. Under artificial risk-neutral assumptions, this equals to the probability of surviving up to that period and defaulting in that same period multiplied by the expected loss given default for each period. This requires a separate estimation of the reference bond's expected recovery rate in default.[28]

[27] (Tschirhart, O'Brien, Moise, & Yang, 2007).
[28] (Tschirhart, O'Brien, Moise, & Yang, 2007).

For example, considering a CDS with a contractual term of 5 years, a probability of default during a year conditional on no earlier default of 0.02 and an estimated loss given default of 0.6 (and thus a recovery rate of 1 – 0.6 = 0.4), the spread is calculated to be as follows.

$$\mathrm{s} = (1 - 0.02)^4 * 0.02 * 0.6 = 0.01106 = 110.6\ \mathrm{bps}$$

In this case, each period is one year long and the defaults are assumed to happen at the end of a year. In a general form this can be written as below.

$$\mathrm{s} = (1 - \mathrm{PD})^{\mathrm{N}-1} * \mathrm{PD} * \mathrm{LGD}$$

with PD = the probability of default during a period conditional on no earlier default
N = the maturity in terms of the amount of the assumed time periods
LGD = the loss given default

This calculation can be reverse-engineered using for instance the Solver within Excel to calculate the PD for a given spread. With this probability of default during a period conditional on no earlier default, the unconditional (that is as seen at time zero) default and survival probabilities for each point in time can be calculated to use in the valuation framework.

A similar approximation calculation is suggested by Hull. He comes up with the following formula to approximate the same average probability of default per year conditional on no earlier default, resulting in what he calls the default intensity (also known as the hazard rate) from credit spreads.[29]

$$\mathrm{PD} = \frac{\mathrm{s}}{1 - \mathrm{R}}$$

with PD = the average probability of default per year conditional on no earlier default
s = the CDS spread over the risk-free rate
R = the expected recovery rate

Hull states that this calculation works well for CDS spreads.[30] Using the previously described example, a spread of 110.6 bps and a recovery rate of 0.4 leads to the following average probability of default per year conditional on no earlier default.

$$\mathrm{PD} = \frac{0.01106}{1 - 0.4} = 0.01843 \approx 0.02$$

This corresponds to the probability of default which was assumed to be 0.02 in the example. This method is slightly easier to use than the one before where the formula must be reverse-engineered.

If credit spreads are known for a number of different maturities, the term structure of the default intensity can be (approximately) bootstrapped using Hull's method. This results in a different probability of default for different periods, which matches better to the practice as the average PD conditional on no earlier default is by definition not equal for each period. How bootstrapping works will be illustrated using the following example where the expected recovery rate is 40% and the CDS spreads for 3-year, 5-

[29] (Hull, Risk Management and Financial Institutions, 2010).
[30] (Hull, Risk Management and Financial Institutions, 2010).

year and 10-year instruments are respectively 50, 60 and 100 basis points. The average PDs per year over 3, 5 and 10 years are calculated as follows.

$$\mathrm{PD}_{3\text{ years}} = \frac{0.0050}{1-0.4} = 0.0083$$
$$\mathrm{PD}_{5\text{ years}} = \frac{0.0060}{1-0.4} = 0.01$$
$$\mathrm{PD}_{10\text{ years}} = \frac{0.0100}{1-0.4} = 0.017$$

From this can be estimated that both the average PD per year between year 3 and year 5 and the average PD per year between year 5 and year 10 are as follows.

$$\mathrm{PD}_{\text{between year 3 and 5}} = \frac{(5 * 0.01 - 3 * 0.0083)}{2} = 0.01255$$
$$\mathrm{PD}_{\text{between year 5 and 10}} = \frac{(10 * 0.017 - 5 * 0.01)}{5} = 0.024$$

Tschirhart et al. also refer to a slightly more complex method of Hull, where discounting is taken into account by calculating the spread of a CDS. This is done by firstly calculating the expected loss from default on a bond in terms of the default probabilities per year, using the recovery rate and the discount rate. This is set equal to the present value of the CDS spread payments and then the unconditional default probability per year can be calculated. This method requires more work than the previously described approximation and assumptions must be made concerning the discount rate and the expected losses and payments. Further Hull states that the approximation formula especially works well for CDS spreads. The approximation formula gives similar results, which is extensively described in Hull (2010).[31] Therefore the approximation formula can be seen as a more practical way of estimating PDs out of CDS spreads.

The default/survival probabilities obtained from market price sources include investor premiums for bearing systematic credit risk. Because these risk premiums are included in the measurement of the default/survival probabilities, future payments should be discounted using a risk-free rate.[32]

Concluding can be said that in order to estimate the market value of loans, fair value approximations can be used. When there are no market prices available from earlier transactions, other observable inputs should be used to model the prices. Out of these inputs CDSs have preference. These can be used to derive probabilities of default and survival. Using these, the expected cash flows and the risk-neutral discount rate, the fair value framework from Appendix 1 can be used to calculate the fair value of the loan at time t.

The next chapter will evaluate the existing method.

[31] (Hull, Risk Management and Financial Institutions, 2010).
[32] (Tschirhart, O'Brien, Moise, & Yang, 2007).

Chapter 4: Evaluating the existing method

In this chapter the existing method will be evaluated. Firstly will be described in section 4.1 how the existing method works. After that the existing method will briefly be compared to the theoretical alternative in section 4.2 to find potential deficiencies of the existing method.

4.1 Explanation of the existing method

This section will describe the currently applied method to approach the market value of loans. The method is introduced as a method to mark loans to market. Marking-to-market financial instruments corresponds to measuring the fair value of these instruments. The first subsection will describe which steps are taken when applying the method, which assumptions are made and which inputs are used. The second subsection will describe how the results should be interpreted and how they relate to the outcomes of the method of the first research question.

4.1.1 Applying the existing method

As starting point of this subsection the main idea of the method will be sketched. The main idea of the existing method is to compare the internal risk premium which is determined at origination with the external risk premium in the current market at a certain point in time. The method uses a relevant quoted CDS spread for this purpose. It can be used for both loans (bullet and amortizing) and revolving credit facilities. A revolving credit facility (RCF) is in essence an agreement between a bank and a company or an individual to provide a certain amount in loans on demand from the borrower. The borrower is under no obligation to actually take out a loan at any particular time, but may take part of the funds at any time over a period of several years. A commitment fee is generally paid over the undrawn portion of the amount.[33]

An example will be used to give an illustration of how the method is applied in practice. The example concerns a loan with a maturity of 5 years. In this example is assumed that one wants to estimate the market value of the loan one year after origination. The data concerning the example are shown in the table below.

Characteristics of the loan example			
Principal (million EUR)	100	Repayment Scheme	
Maturity (years)	5	Year	Repayment (million EUR)
Annually Paid Margin (bps)	260	1	40
Upfront fee (bps)	125	2	30
Liquidity premium (bps)	143	3	10
Loss Given Default	16%	4	10
Expected Payout CDS	60%	5	10

Table 7 – Data of the loan example

The first step of the method is to calculate the expected revenues of the facility for the bank. As explained briefly in section 2.1 on the context of this research, the existing method assumes that the

[33] (Gupton, Finger, & Bhatia, 1997).

cash flows of the loans to large corporates can be divided. The margin is set at origination and consists of the so-called 'liquidity premium' and commercial margin, based on the market expectations at the beginning of the term. This commercial margin is seen as the internal risk premium and is compared with the relevant quoted CDS spread. As stated earlier, the CDS spread is assumed to be the external risk premium in the current market.[34]

A part about the composition of the payments of loans is declared confidential and therefore left out.

The liquidity premium is seen as an annual negative cash flow for the bank needed to fund itself in the market. The liquidity spread is expressed as a mark-up or discount on the base rate in bps. The liquidity spread for various maturities is determined by the amount ABN AMRO should pay in the financial markets for funding with the same maturity. This spread is updated monthly.[35]

The liquidity premium is found in the liquidity spread for different maturities. In case there is no amortization the maturity used for determining the liquidity spread is equal to the contractual tenor at origination. For example when a loan has a contractual tenor of 5 years with no amortization (bullet loan), a liquidity premium corresponding to a maturity of 5 years must be found in the liquidity spread curve. In case the loan amortizes, the weighted average lifetime (WAL) of the loan must be calculated as approximation of the time each dollar of unpaid principal remains outstanding. The liquidity premium corresponding to the WAL at origination must be derived from the liquidity spread curve in this case. Linear interpolation is used when points lie between the points in the spread curve.[36]

Weighted average life, also known as average life or weighted average maturity, is the average number of years for which each dollar of unpaid principal on for example a loan or mortgage remains outstanding. This is calculated using the following formula.

$$\mathrm{WAL} = \sum_{\mathrm{i}=1}^{\mathrm{n}} \frac{\mathrm{P_i}}{\mathrm{P}}\mathrm{i}$$

with P_i = the principal repayment in year i

P = the total principal

i = the time in years

n = the maturity in years

This is a similar principle as duration, with the difference that discounting is not taken into account and WAL only focuses on principal payments. For the example illustrated in before in this subsection, the weighted average life will be calculated as follows.

$$\mathrm{WAL} = \frac{40}{100} * 1 + \frac{30}{100} * 2 + \frac{10}{100} * 3 + \frac{10}{100} * 4 + \frac{10}{100} * 5 = 2.2 \text{ years}$$

[34] (Jiang, 2012).

[35] (De Stigter, 2012).

[36] (ABN AMRO Group N.V., 2013).

With the liquidity premium derived as a cash flow, consisting of a fraction of the principal in bps, the other cash flows need to be estimated. All cash flows are presented and used in bps, which is as fraction of the principal. For term loans, the fixed margin of the loan (including the liquidity premium and the commercial margin), upfront fees and the liquidity premium are identified as cash flows. These are used to calculate the annual margin & fees as a portion of the principal using the formula as shown below.

$$\text{Annual Margin \& Fees} = \text{margin} + \frac{\text{upfront fees}}{\text{original WAL}} - \text{liquidity premium}$$

As explained before, revolving credit facilities are partly used and an additional commitment fee must be paid over the unused portion of the facility. Therefore the annual margins and fees are according to the method calculated for revolving credit facilities as follows.

$$\begin{aligned}\text{Annual Margin \& Fees} \\ &= \text{expected utilization} * \text{margin} + (1 - \text{expected utilization}) * \text{commitment fees} \\ &+ \frac{\text{upfront fees}}{\text{original WAL}} - \text{expected utilization} * \text{liquidity premium}\end{aligned}$$

This calculation will be as follows for the example (utilization = 100%).

$$\text{Annual Margin \& Fees} = 260 + \frac{125}{2.2} - 143 = 173 \text{ bps}$$

These annual margin and fees are seen as the commercial margin or the risk premium and are based on expectations at origination. The idea is to compare this premium with the premium at the current market, using CDS spreads as benchmarks. A CDS spread must preferably be found for the same company and with a maturity equal to the remaining WAL at the valuation point. In case there is no CDS of the same company, CDS spreads are derived from companies with similar ratings and industries. When this is not possible, an estimate of the CDS spread must be derived from bond yield signals.

In the example is assumed that the current valuation point is one year after origination. The remaining WAL is calculated as follows.

$$\text{Remaining WAL} = \frac{30}{60} * 1 + \frac{10}{60} * 2 + \frac{10}{60} * 3 + \frac{10}{60} * 4 = 2 \text{ years}$$

Therefore in this example the CDS spread must be found with a maturity of 2 years. A CDS spread of the same company with a maturity of 2 years is assumed to be 703 bps.

To use the CDS spread properly, a hedge ratio is incorporated in the method. The idea of incorporating this ratio is that there might be a difference between the expected loss given default on the bank's asset and the payout of the CDS. In the example the expected payout of the CDS (and thus the recovery rate for the underlying bond) is 60% and the loss given default of the outstanding loan with a certain principal is estimated by internal models to be 16%, using a CDS for protection of the same principal would result in overprotection and thus miscalculations when the CDS spread is used as a whole. Therefore, in order to compare the annual margin & fees with the CDS spread, the CDS spread needs to be adjusted according to the method. The hedge ratio within this context is the percentage of the CDS protection that actually should be bought in order to protect the loss given default of the loan, so that the risk premium on the market (CDS spread) of the CDS can be compared with the risk premium of the bank. Consequently the fraction of the CDS spread equal to the hedge ratio should be used. The hedge ratio is calculated as follows.[37]

$$\text{Hedge ratio} = \frac{\text{LGD}_{\text{loan}}}{\text{Expected payout}_{\text{CDS}}}$$

In the example the hedge ratio will be calculated as follows.

$$\text{Hedge ratio} = \frac{16\%}{60\%} = 27\%$$

In case of revolving credit facilities, an assumption must be made for the portion of the facility that is drawn in default. This also has influence on the fraction of the CDS spread that should be taken into account. In practice borrowers might draw a portion of the limit in case it defaults, which differs from the expected utilization mentioned before. Currently a usage given default (UGD) of 100% is assumed. In case of revolving credit facilities the CDS spread should also be multiplied by the UGD next to the hedge ratio, but as the UGD is assumed to be 100% this factor can be ignored.

The formulas for the so-called total hedge premiums (external risk premium or CDS spreads) for respectively loans and revolving credit facilities are presented below.[38]

$$\text{Total hedge premium}_{\text{loan}} = \text{CDS spread} * \text{hedge ratio}$$
$$\text{Total hedge premium}_{\text{RCF}} = \text{CDS spread} * \text{hedge ratio} * \text{UGD}$$

The total hedge premium in the example would become as shown below.

$$\text{Total hedge premium} = 703 * 27\% = 190 \text{ bps}$$

The annual margin & fees (the internal risk premium) now can be compared with the total hedge premium (the external risk premium). Both are fractions (in bps), of which the margin and fees are annual. This leads to the annual change in earnings. This change is then multiplied by the remaining WAL, which is the average time in years until a dollar of principal is repaid. This comparison results in a so-called mark-to-market result which is calculated using the formula below.[39]

$$\text{MTM result} = (\text{Annual margin and fees} - \text{Total hedge premium}) * \text{remaining WAL}$$

Following the example, the calculation will be as follows.

$$\text{MTM result} = (173 - 190) * 2 = -34 \text{ bps} = -0.34\%$$

[37] (Jiang, 2012).
[38] (Jiang, 2012).
[39] (Jiang, 2012).

This percentage is in practice multiplied by the exposure, which is in the example 100 million EUR. The mark-to-market result can thus also be given in an actual amount which is exemplified below.

$$\text{MTM result} = -0.34\% * 100 \text{ million} = -0.34 \text{ million EUR}$$

The calculations done in the existing method are in essence similar to the calculations for the Macaulay duration for bonds. Macaulay duration is a widely used simplified measure of a portfolio's exposure to yield curve movements.[40] The existing method can also be interpreted within this context as a measure of the influence of market movements on the market value. To illustrate this, the formula of Macaulay duration is given below.[41]

$$\frac{\Delta \text{PV}}{\text{PV}} = -\Delta \text{r} * \text{Duration}$$

with PV = present value
r = the interest rate

The formula can be rewritten as follows.

$$\Delta \text{PV} = -\Delta \text{r} * \text{Duration} * \text{PV}$$

Looking back on the formulas of the existing method, a similar structure clearly can be seen as the ΔPV corresponds to the MTM result. The term Duration in the Macaulay duration formula equals to the remaining WAL in the existing method formula when an interest rate of 0 is assumed, as was explained earlier in this subsection. The term PV corresponds to the outstanding exposure in the existing method, which is the amount outstanding and still to be received. However according to the duration theory, this should be equal to what the amount is worth at maturity. In the existing method this equal to the exposure, which is not discounted. This can be seen as a simplification.

The term –Δr in the formula above can be seen as similar to the term (Annual margins and fees – Total hedge premium) in the existing method. This is because this term represents in Macaulay duration the change in the bond's yield and the bond yield is defined as the discount rate that equates the bond's theoretical price to its market price.[42] This theory is based on the discounted cash flow method with contractual cash flows, implicating that the full risk effect is included in the discount rate, as explained in section 3.4.

The term (Annual margins and fees – Total hedge premium) of the existing method corresponds to the difference between the risk premium set at origination and the risk premium in the market. Therefore it can be interpreted as the change in risk effect between what was expected and the market developments and thus corresponds to the term –Δr in the Macaulay duration formula. From the above described similarities can be concluded that the existing method is in essence a simplified Macaulay duration calculation, where Macaulay duration itself is already a simplified ΔPV calculation. It calculates

[40] (Hull, Risk Management and Financial Institutions, 2010).
[41] (Hull, Risk Management and Financial Institutions, 2010).
[42] (Hull, Risk Management and Financial Institutions, 2010).

Δr and eventually ΔPV, whereas the theoretical method calculates the actual PV. How the results of the existing method should be interpreted is explained in the following subsection.

4.1.2 Interpretation of the results

In the previous subsection is described how the internal risk premium set at origination is compared with the external risk premium, resulting in the so-called mark-to-market result.

Focusing on the percentage as result, in case the result of the method is 0, the return on the loan based on the fixed margin which is set at origination built on the expected risk, is equal to the return that is currently demanded in the market for similar risks.

If the result is positive, the bank earns more than is earned on the current market for similar risks. This implicates that the margins in the current market are lower than expected at origination. Lower margins in the current market correspond to less risk than expected. This makes it plausible that the counterparty's market has developed better than expected in terms of risk. This shows that the terms and margins of the loan are favourable for the bank. Since more is earned by the bank than on the market for a similar loan, one is prepared to pay more for the same loan if the loan would be sold on the market. Therefore this development of the market might indicate a higher market value than expected.

In case the result is negative, the earnings on the market are higher than what the bank earns for similar risks based on expectations at origination. Higher earnings on the current market than expected beforehand implicate more risk in the current market than expected at origination and thus a worse development of the counterparty's market. This means that for the same risk, higher margins are asked on the market. Hence the bank does not earn sufficiently enough for these risks. Lower earnings on a certain similar loan for the bank than on the current market results in the fact that one would pay less for the bank's loan (if the loan is considered to be sold) than for another loan on the current market with similar risks and thus higher earnings. Therefore this development indicates that the market value of the loan would possibly be lower than expected at origination.

Concluding can be said that this approach intends to compare the earnings on the loan with the earnings in the current market and is seen as a mark-to-market approach. In practice, the result (which is a percentage) is multiplied by the exposure. This results in the amount that the method interprets as what could be earned more or less on the current market than what is earned now based on the fixed margins. This is seen as an indication of whether the market value might lie above or under what was expected. Even though this might be a good indication of where the actual market value stands in comparison with the expected market value, the mark-to-market result is no actual market value estimation. It is questionable whether this result actually is the additional amount that could be earned on a certain loan.

For reporting purposes, in practice this method is applied to calculate the result for a client with more than one facility or a group of clients. This is done by weighing the results by their limits and remaining WAL. Whether this leads to a representative result seems debatable. It gives an indication of how much can be earned more or less on a specific client with more facilities or a certain group of clients. However this is not relevant for calculating the actual market value, which is the goal of this research.

Neither the expected market value at a certain point in time, nor the current market value is calculated. Only an indication is given whether the actual market value might lie above or under the (unknown) expected market value. This proves that additional steps must be taken with this method as basis and certain issues of the theoretical method should be incorporated in the existing method to actually calculate fair values. Firstly the differences between both methods must be recognized to identify potential problematic differences and shortcomings of the existing method. This will be done in the next section.

4.2 Differences between the existing method and the theoretical method

This section will give an overview of the differences between the theoretical method to calculate fair values of loans from chapter 3 and the existing method described in the previous section to find deficiencies of the existing method.

The most important difference between the methods is the interpretation of the results. The theoretical method gives an actual market value estimation, while the existing method only comes up with an indication of the change in earnings, interpreted as the change in market value. How the results of the existing method should be interpreted is explained in subsection 4.1.2. Due to the difference in the interpretation of results certain steps and inputs used when applying the method are also different from the theoretical method.

The mark-to-market result is calculated by comparing the expected annual cash flows with the hedge premium for a relevant corresponding CDS. In the theoretical method the expected cash flows given a default of the counterparty are estimated and multiplied by the risk-neutral probability of default derived from a relevant corresponding CDS spread. The existing method thus does not take the actual cash flows given default directly into account. It uses the hedge ratio and usage given default to come up with the external risk premium. However, in order to calculate fair values using expected cash flows, the expected cash flows given default should directly be taken into account, which is shown in section 3.3.

A significant difference concerning the expected cash flows is that in the theoretical method the cash flows are identified for all time points, where in the existing method the cash flows are represented by one yearly value which is a percentage of the principal. Consequently the cash flows are fixed in the existing method, where in the theoretical method the cash flows can be different per year based on the information available at different points in time. The same applies for other inputs, such as the expected utilization. Therefore for the existing method an average needs to be calculated to come up with one average yearly value for these inputs. Next to that, the cash flows are not discounted using the existing method, where this is done using the theoretical method. Discounting is needed to know what certain cash flows in the future are worth at a certain time point, which is according to the theory necessary for a proper fair value calculation.

One of the most important expected cash flows regarding a loan commitment are payments concerning repaying the loan. Repaying can be done at maturity in case of a bullet loan or with a certain amortization scheme. Next to that, loan prepayment/refinancing cash flows (including possible prepayment penalties) are frequently occurring cash flows. Further, in case of a revolving credit facility, the option to draw down on the unutilized commitment should also be taken into account. These expected payments have a big influence on what one wants to pay for the loan and thus on the market value of the loan. These cash flows are not taken into account in the existing method, which is logical given the fact that the internal risk premium is compared with the external risk premium and these cash flows do not directly have influence on the risk premiums. In the theoretical method these cash flows are included. Amortization is indirectly taken into account in the existing method when the weighted average life is calculated. As explained before, this will give an indication of the average time until a dollar of principal is repaid and is used for the comparison between both risk premiums. Ignoring these additional cash flows, which is done in the existing method, might lead to less accurate results.

Comparing the other expected cash flows which are taken into account in both methods, it turns out that there are some cash flows in the theoretical method which are missing in the existing method. These cash flows are the fixed periodic fee for a loan commitment and the payment in case of a term-out option exercise. In practice both are not reported for the loans in the ECT portfolio. It is plausible that the fixed periodic fee is already incorporated in the margin or in the upfront fee. As for the term-out option exercise, the fact that this cash flow is not reported implicates that this difference between both methods does not have an effect on the results when the methods are applied to loans within the ECT portfolio.

Another difference between the methods concerns the liquidity premium. The liquidity premium is included in the existing method, while this is excluded in the theoretical method. As described earlier, the liquidity premium is the premium that the bank has to pay in order to fund itself on the market. The liquidity premium is part of the Funds Transfer Price. However both the liquidity premium and the Funds Transfer Price are internal rates paid by the bank. In case a loan is brought on the market to be sold, another party might have its own internal premiums or even no internal premiums for funding at all. These are no expected cash flows that change what one is prepared to pay for a specific loan commitment. Therefore these rates are irrelevant for a market value estimation and thus should not be included. This explains why these are not included in the theoretical method.

Even though the existing method only gives an indication of the market value in comparison with the (unidentified) expected market value at a certain point in time, less data is needed for the calculations when using this method. Fewer assumptions have to be made regarding the expected cash flows than when using the theoretical method. Whether this is actually the case will be found out when both methods are applied.

The described differences are summarized in the table on the next page.

Theoretical method	Existing method
Market value as result	Mark-to-market result on the earnings on a loan as result, giving an indication the change in earnings, which is interpreted as the change in market value
Expected cash flows given default are included	Expected cash flows given default are not directly included
Inputs are identified per year and can differ at each time point	Cash flows are set annually and cannot differ in different years
Cash flows are actual amounts	Cash flows are fractions of the principal given in bps
Cash flows are discounted	Cash flows are not discounted
Cash flows concerning repaying the principal or drawing down on unused commitment are included	Cash flows concerning repaying the principal or drawing down on unused commitment are not included
Amortization is taken into account using expected cash flows	Amortization is indirectly taken into account by doing WAL calculations
Commitment facility fee and term-out options cash flows are included	Commitment facility fee and term-out options cash flows are not included
Liquidity premium is not included	Liquidity premium is included
More data needed	Less data needed
More assumptions must be made	Less assumptions must be made

Table 8 – Differences between the theoretical method and the existing method

In this chapter the existing method is evaluated and an alternative method is presented in chapter 3. The way of calculating market values of outstanding loans possibly can be improved by using the theoretical method instead of the existing method. For that reason both methods will be compared to each other in the following chapter.

Chapter 5: Comparing both methods

With both methods explained and the differences between both methods described the methods can be compared to find out which method should preferably be used in order to monitor the market value of outstanding loan facilities. The first section will give an overview of the advantages and disadvantages of both models, using the differences between both as starting point. After that both methods will be applied in the second section to analyse the differences between both in terms of their results and practical use.

5.1 Advantages and disadvantages of both methods

In section 4.2 the differences between both models are described. These differences can be seen as an advantage for one method and a disadvantage of the other method. This section will describe whether and to what extent the differences can be seen as advantages or disadvantages for both methods.

The first difference described is the interpretation of the results. The fact that the theoretical method results in an actual fair value and thus a market value estimation can be considered as an advantage for the theoretical method. The indication as result of applying the existing method can thus be considered as a disadvantage for this method.

Looking at the cash flows which are incorporated, the advantage of the theoretical method is that several cash flows are incorporated, while these are ignored in the existing method. As described in section 4.2, the cash flows concerning a possible default, repaying the principle, interest payments, drawing down on unused commitment, facility fees and term-out options are included in the theoretical method, but are ignored in the existing method. Amortization is directly taken into account in the theoretical method as cash flows while it is indirectly taken into account in the existing method by doing the WAL calculations. These issues can be seen as disadvantages of using the existing method and hence as advantage of the theoretical method. Another advantage of the theoretical method in comparison with the existing method is that the inputs can differ each year. In the existing method one annual value is assumed for these inputs. In case the inputs differ, averages must be calculated leading to additional calculations, being a disadvantage of the existing method. The lack of discounting is a disadvantage for the existing method as well, for the reason that discounting is required for a proper fair value calculation as explained in section 3.3, making it an advantage for the theoretical method.

The difference that in the theoretical method the cash flows are taken into account as actual amounts and in the existing method as fractions of the principle is logical given the fact that in both methods the cash flows are used differently and for another calculation. Therefore this difference cannot be seen as either an advantage or as disadvantage. The same applies for including the liquidity premium. As explained in section 4.2, this should not be included as this is irrelevant for market prices using the theoretical method. In the existing method this is included to calculate and ultimately compare the risk premiums, which is another purpose. Therefore this difference also cannot be seen as either an advantage or a disadvantage for both methods. One difference regarding the calculations made that is an advantage for the existing method is that when the calculations are done less data is needed and assumptions need to be made.

The above described advantages and disadvantages are summarized in the tables below.

Advantages	Disadvantages
Easier to automate	Indication of the change in market value as result
Less data needed	Not all cash flows are included
Less assumptions to be made	Amortization is by approximation taken into account
	One annual fixed value for inputs, leading to possible additional calculations
	No discounting

Table 9 – Advantages and disadvantages of the existing method

Advantages	Disadvantages
Market value as result	More difficult to automate
More types of cash flows are identified	More data needed
Amortization is directly taken into account	More assumptions to be made
Inputs can differ each year	
Cash flows are discounted	

Table 10 – Advantages and disadvantages of the theoretical method

The next section will assess the influence of applying the different methods on the results and will compare the use of both methods. Even though the advantages of the existing method are not considered as important within the context of the research, they will be taken into account.

5.2 Differences in terms of the results and use of both methods

The influence of applying both the existing method and the theoretical method on the results will be assessed in this section. A certain selection of loans must be made on which both methods are applied. In the first subsection will be described how the comparison will be made. This is important since the results of both methods differ in terms of their meaning and ultimately they must be compared to each other. How the CDS spreads are obtained and the restrictions and assumptions coming from obtaining the CDS spreads are described in the second subsection. How the selection of loans is made is described in the third subsection. The fourth subsection describes how and where the data to use can be collected. After that the comparison is made in the fifth subsection, giving an assessment of the influence of both methods on the results and a comparison of the use of both methods. The results of the comparison will be discussed in the sixth subsection.

5.2.1 Main idea of the comparison

As explained in section 4.2 the results of both methods differ in their interpretation. The theoretical method gives an actual market value estimation, while the existing method comes up with an indication of whether the market value might lie above or under the market value that was expected, interpreted as the change in market value. These results can thus not directly be compared to each other. Below is explained how these can be compared.

In subsection 4.1.2 is described that the existing method gives an indication of whether and how much the market value might lie above or under the market value that would have been expected at origination by calculating the amount that could be earned more or less on the current market than on the market expected at origination. The problem is that even though an indication is given how much the market value might lie above or under the market value as expected at origination (t = 0) given changing market circumstances, the actual market value expected at t = 0 is not calculated. This implicates that the existing method can only estimate the difference in market values between what would have been expected at t = 0 and the market value calculated using the market situation at a certain time point t = x. This corresponds to what is explained in subsection 4.1.1 using the Macaulay duration formula that has been rewritten as follows.

$$\Delta \mathrm{PV} = -\Delta \mathrm{r} * \mathrm{Duration} * \mathrm{PV}$$

This formula illustrated that the existing method calculates ΔPV, which is the difference in market value between two time points, where the theoretical method calculates PV, being the market value at a certain time point itself.

The theoretical method thus is able to calculate the market value at each time point t. In order to compare the results of both methods, both must represent the same. As explained above the existing method calculates the difference between the market values that would have been calculated using the market situation at t = 0 and at t = x (ΔPV). The actual market value (PV) for all time points can be calculated with the theoretical method. This is illustrated in the figure below.

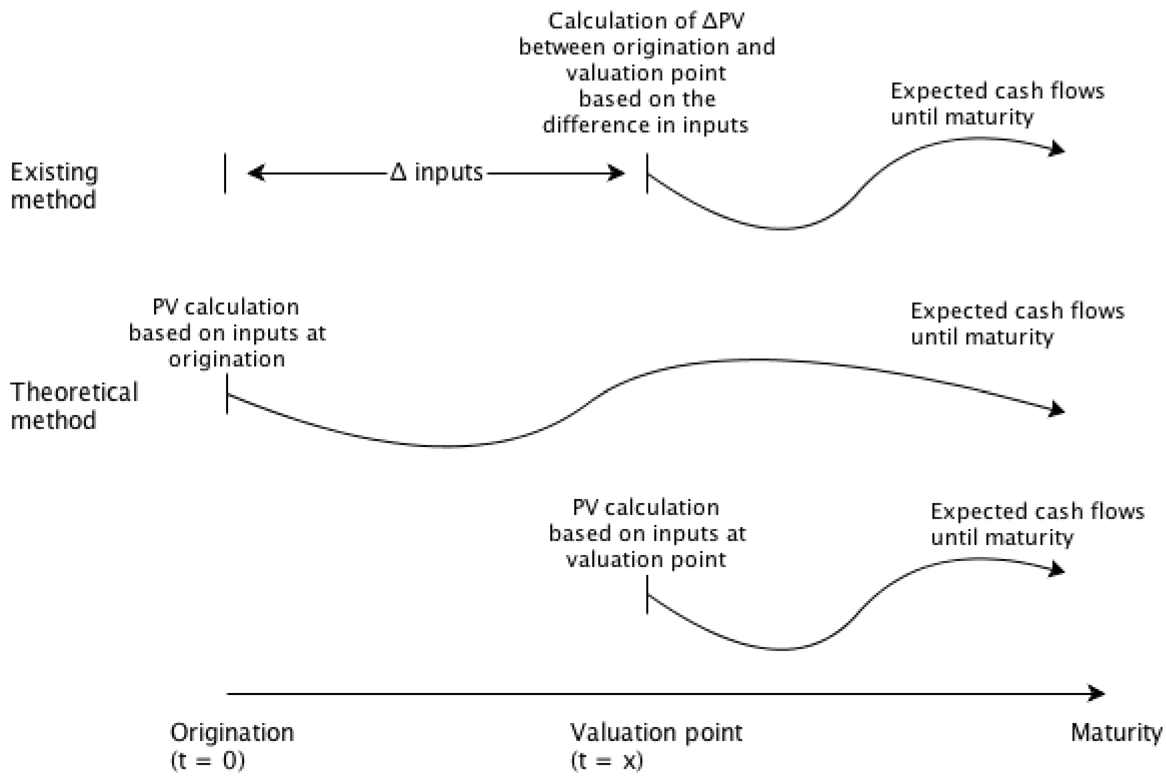

Figure 1 – Overview of both methods

The curved arrows show that for the calculations, the expected cash flows from the calculation point until maturity are taken into account. This implicates that when the theoretical method is applied at t = 0, the expected cash flows between origination and the (other) valuation point are taken into account, where they are not taken into account when the theoretical method is applied at t = x.

The market value at a certain time point calculated with the theoretical method depends on the upcoming expected cash flows. The cash flows which are paid in the past are not relevant anymore. The same applies for the probability that the loan has not defaulted until the valuation date, since it is given that the borrower has survived. When the market value is calculated before the valuation date, these cash flows and probabilities are taken into account. Therefore market values logically can vary significantly at different time points due to reasons which are no result of changing market developments. For example when a loan with a principal of 100 has an amortization scheme in which 90 is repaid in the first year and 10 at maturity, the market value will become much lower after one year since the highest cash flow is already paid. Concerning the probabilities of default and survival, at origination the unconditional probability of survival at maturity and thus the expected maturity payment is significantly lower than it would be after for example 3 years. This is due to the fact that the counterparty has not defaulted until the valuation date and thus the unconditional probability of survival at maturity will be higher using the later valuation date, since the probability that the borrower has survived until the valuation date is not taken into account. The existing method does not take these issues into account, as it compares the risk premiums in the current market with the market expectations from the past.

This implicates that the result of the existing method cannot be directly compared to the difference of the results of the theoretical method applied at both t = 0 and t = x, since the theoretical method applied at t = 0 takes the cash flows from t = 0 to maturity into account and the theoretical method applied at t = x and the existing method only take the cash flows from t = x to maturity into account. The fact remains that in order to compare both methods the theoretical method must be applied at both t = 0 and t = x, as the existing method gives an indication of ΔPV between t = 0 and t = x. Both methods can be compared properly when the theoretical method is applied twice at either t = 0 or t = x, using the inputs of both time points. This way it can be calculated how the market value changes seen from either t = 0 or t = x (with the expected cash flows from that point to maturity) when the changed inputs from the other time point are used. When this is done the same cash flows are taken into account when using the theoretical method.

There are two ways doing this comparison. The first option is to choose the perspective of t = x. The theoretical method is then applied at t = x. After that the same calculations are done, using the inputs of t = 0. When both results are subtracted from each other, the change in market value is calculated as seen from t = x, using the cash flows from t = x to maturity. This follows the same principle as the theoretical method does. It calculates the change in inputs between t = 0 and t = x, calculating an annual difference in earnings. This annual difference is then multiplied by the remaining WAL, which is the average time the amount is outstanding seen from t = x, representing the cash flows from t = x to maturity.

The other option is to use the perspective of t = 0. When this is done the theoretical method is applied twice at t = 0, using the changed inputs of t = x the second time. The difference between the results represent the change in market value as seen from t = 0, taking all cash flows into account. The existing method needs to be slightly adjusted when this is done. As explained in subsection 4.1.1 and above the existing method calculates the annual change in earnings. Normally this would be multiplied by the remaining WAL. However when the perspective of t = 0 is chosen, this annual change must be multiplied by the original WAL, representing how long the amount is outstanding as seen from t = 0.

For this research and the comparison in this section, both options above could be used. The perspective of t = 0 takes the whole period the loan is outstanding into account, in contrast to the perspective of t = x. For proper comparisons, it is desirable to take the whole maturity of loans and thus all cash flows into account. This gives an indication of the change in market value of the whole loan, rather than a part of the loan. For this reason this option is chosen in the research.

Concluding can be said that both methods can properly be compared when the market circumstances (and corresponding data) at the later t = x are used as inputs for applying the theoretical method at origination. Then the market value can be calculated for both the expected market developments and the actual market developments to come up with the difference between the two. This difference can then be compared to the adjusted outcome of the existing method.

Several inputs of the theoretical method are changing between the two time points. These are the 3-month LIBOR rate, the internally calculated LGD, the risk-free rates which are used as discount rates and naturally the CDS spread for the risk-neutral PD estimations. Except for the CDS spread, the changing variables mainly represent general market trends. General market trends have influence on the CDS spread, but as was explained in section 3.5. CDS spreads must be used as market price source in order to reflect market prices corresponding to the borrower's industry and rating[43]. Next to that the CDS spread is used to calculate the risk-neutral PD's, implicating that these risk-neutral PDs and thus the CDS spreads represent all risk effects, as explained in section 3.4. Since the CDS spreads represent both industry specific and general market trends and all risk effects are assumed to be represented by the risk-neutral PDs derived from the CDS spread, the CDS spread is for the comparison assumed to be the only changing variable between both time points.

With the way of comparing explained, it will be described in the following subsection how the CDS spread data must be gathered. Further the subsequent assumptions and restrictions will be described.

5.2.2 CDS spread data gathering and the subsequent assumptions and restrictions

This subsection will firstly explain how the CDS spreads are obtained and what assumptions need to be made in order to do so. Further the restrictions of the availability of the data and their result on comparing the methods are described.

CDS spreads are one of the most important aspects of the needed data as they reflect the current market circumstances. For that reason they have big influence on the results. Consequently it is of importance to use proper CDS spread data. CDS spreads are generally not available for all companies. As explained in section 3.5, if possible a CDS of the same obligor should be used. When this is not possible a CDS of an obligor in the same or related entity or CDSs of independent highly correlated entities should be used. Otherwise generic credit spread curves must be estimated to represent spread curves for loan facility obligors in generic categories based on firm credit ratings, industry, country/region and/or possible currency. In practice this is done by finding CDS spread curves of borrowers with the same rating within the same industry according to the ICB (Industry Classification Benchmark) supersectors. This is consistent with the theory, which said: "Generic curves are estimated to represent the spread curves for typical loan facility obligors in each generic category. The categories are based on firm credit ratings and can also include industry, country/region or possibly currency."[44]

A statement about how many borrowers in the ECT portfolio have CDSs outstanding is left out.

Therefore the need to estimate generic credit spread curves for obligors within the same industry and with the same rating is inevitable.

The CDS spreads are to be found in Bloomberg. For the existing method, the spread corresponding to the calculated WAL can be calculated by interpolating or extrapolating the CDS spreads for the maturities of which data is available. CDS spread data is generally not recorded, resulting in relatively little data on this subject. As the goal is to find CDS spreads for a certain industry for as much ratings as possible, as much data should be collected as possible. Indices of CDS spreads illustrating a general trend in the market specific for certain industries and/or ratings are not recorded, in contrast to indices for CDS spreads representing the trends of the general market. Therefore during earlier research on this topic as much as

[43] (Tschirhart, O'Brien, Moise, & Yang, 2007).
[44] (Tschirhart, O'Brien, Moise, & Yang, 2007).

possible CDS spreads from all industries are found in Bloomberg, resulting in a selection of CDS spreads from a wide range of industries and ratings.[45] Whether the searching and selection procedure is correct is beyond the scope of this research because of time restrictions. As for the research it is assumed that this selection of CDS spreads is representative, even though it is recommended for the bank to reconsider which CDSs are representative for the corresponding market activities.

A part about how the CDS spreads are obtained and grouped in practice is left out because of confidentiality. The conclusion of this part was that insufficient data regarding CDS spreads were available.

An alternative way of obtaining CDS spread data is to use indices illustrating the trends in the general CDS spread market. However when doing this CDS spread curves for specific industries or ratings cannot be estimated. Only a general CDS spread curve is estimated. This results in the fact that there is no difference in terms of CDS spreads and thus industry specific risks between different firms. This implicates that only general market developments would be taken into account, providing the same probabilities of default for all facilities in the theoretical method at a specific date. Because market data (CDS spreads) are needed in order to come up with risk-neutral PDs, the use of CDS indices is inevitable.

There are two main groups of CDS indices, namely CDX and iTraxx, which are both owned by Markit Group Limited, an international market data vendor. Out of these groups preferably the iTraxx LEVX index should be used. This index consists of 40 European 1st Lien Loan CDSs. However in Bloomberg there is no historical data available for this index. The second choice as index is the CDX.NA.IG index, consisting of 125 investment grade CDSs. Even though these are CDSs of investment grade and North American, this is the only index with available historical data that consists of general CDS spreads. The other indices with available historical data all consist of CDS spreads of a certain rating. Therefore in the theoretical method calculations historical data of the CDS index CDX.NA.IG is used as CDS spread. This CDS spread index has a maturity of 5 years. Spreads corresponding to other maturities are not available.

For these reasons it is more practical in this research to assume a changed variable CDS spread at the valuation point and a CDS spread at origination equal to the index. In this manner for a small selection of loans different values can be filled in as changed CDS spread to see how the results of both methods are using a variety of different CDS spreads and thus different market developments. This creates a useful additional insight since the CDS spreads reflect the current market circumstances and consequently are one of the main inputs for both methods. For the comparison the CDS spread at time point $t = x$ is assumed to be variable where the CDS spread at $t = 0$ is set at the index value.

Even though the results under different market circumstances can be evaluated using a variable CDS spread at $t = x$, the CDS spread is assumed to be one value. In practice one CDS spread is interpolated using the remaining WAL in the existing method and the CDS spreads of different maturities as explained in subsection 4.1.1. As for the theoretical method, conditional PD's are bootstrapped from a CDS spread corresponding to the time until maturity, which is explained in section 3.5. As CDS spreads of other maturities than 5 years for the calculations at origination are not available and the CDS spread at $t = x$ is

[45] (Jiang, 2012).

variable, the calculations described above are not done and one CDS spread value corresponding to one maturity is used. In this case the CDS spread values might not always correspond to certain actual market conditions, since these are represented by the whole set of CDS spreads. However an indication of the market circumstances is given and both methods can be compared under the similar conditions at both time points.

How the loans are selected on which the methods are applied and compared is explained in the next subsection.

5.2.3 Selection of loans

Due to time restrictions a selection must be made of loans on which both methods can be applied. Since the aim is to evaluate both models, the most important issue is that both models can be compared properly. Therefore both methods must be applicable on the selection of loans. This means that the needed data should be available for the time periods t = 0 and t = x, as explained in subsection 5.2.1. Especially since both methods are compared to each other, it is important that as much proper data is available as possible so that preferably as little as possible assumptions need to be made which may have influence on the results. Hence the selection of loans which are taken into account depend mostly on the availability of data.

Different portfolio managers suggested to use only loans within the Energy and Transportation portfolio for the reason that loan facilities within the Commodities portfolio generally are uncommitted and short-term oriented. Therefore the usage of revolving facilities hardly can be anticipated. Further the part that is outstanding is generally is significantly lower than the limit and is outstanding for a relatively shorter time period. This means that data of these loans are generally not up to date and for this reason the selection is restricted to loans in the Energy and Transportation portfolio.

Next to loans and revolvers, the portfolio also includes other types of facilities, such as letters of credit and guarantees. Out of the overview of loan facilities these other types are filtered out so that term loans and revolving loans are left, as the inputs are hard to estimate for the other types. Then the facilities can be sorted on their limit (in euros) to come up with the loan facilities with the highest limits. Because of the high limits the facilities selected do have relatively more relevance for portfolio management and it is more likely that more and more correct data is reported. It must be noted that in the data dump the limits are corrected with the (re)payments that are done. For this reason sorting on the limit might not always provide the loan facilities with the highest limits. The data of these payments however are not available and therefore cannot be taken into account. Lastly it will be checked whether these facilities have all needed data reported. It turned out that this is not always the case. Next to that reports of loans are regularly reported, with changes of limits included in the new reports. For the comparison the report is used in which the original terms and conditions are described as the calculations are done from the perspective of t = 0, which is explained in subsection 5.2.1. Further it turned out that loans in the Transportation portfolio generally have complicated constructions, with the result that these loans cannot always be used for the existing method. Out of the remaining loans the selection will be made.

The loan characteristics cannot be given and are therefore left out, as these are confidential.

For some of the above illustrated loans the repayments are done quarterly. This would implicate that all cash flows should be identified each quarter of a year. The problem with this is that the theoretical method uses annual cash flows, implicating that the (both conditional and ultimately unconditional) probabilities of default and survival (derived from CDS spreads) and discount rates are also identified on a yearly basis. When using quarterly cash flows assumptions need to be made about how to convert the probabilities and discount rates. Next to that applying the theoretical method on quarterly cash flows is much more time consuming due to additional calculations that need to be made, for example regarding the unconditional probabilities of default and survival. An alternative is to assume that the quarterly amortization payments are done yearly and thus are discounted each year. This might result in slightly different (negligible) results concerning the discounting of the amortization payments, but especially since most loans are bullet loans and this alternative is less time consuming this is assumed for this stage in the research.

The next subsection will be about how and from where the inputs of both methods must be obtained.

5.2.4 Inputs of both methods

In chapter 3 and subsection 4.1.1 is broadly described how both methods work and how they should be applied. However which data should be used and how and where this data can be obtained is not precisely explained. This subsection explains these issues, so that both methods can be applied in subsection 5.2.5.

This subsection will start with the existing method. How the method works is already explained in subsection 4.1.1. Where the data for the existing method needs to be obtained, is defined in the method's handbook.

A part is left out about the source of the data.

The amortization scheme combined with the maturity and principal are used to calculate the weighted average lifetime (WAL). As explained in subsection 4.1.1, the WAL is used to obtain the correct liquidity premium out of the monthly updated liquidity spread, possibly by interpolating and extrapolating.

The loss given default and the expected payout of the CDS combined are used to calculate the so-called hedge ratio. The expected payout of the CDS is currently assumed to be xx, because of the fact that bondholders lose on historical average xx% on a senior unsecured bond. Further the usage given default is currently assumed to be 100% of the limit.[46] These assumptions are debatable, however these assumptions are currently in use and therefore they might be plausible. The debate of whether both assumptions are plausible lies beyond the scope of this research due to time restrictions.

The discount factor is calculated with the formula $1 / (1+r_t)^i$. The discount rate r_t corresponds to the risk-free rate as explained in section 3.4. The risk-free rate depends on the currency which is used for the loan facility and on the maturity of the rate. The cash flows are for a relatively long-term identified per year. Since the risk-free rate implicates what a dollar or euro is worth at the maturity of the rate, risk-free rates with maturities in terms of years are needed. For banks LIBOR or EURIBOR rates are generally

[46] (Jiang, 2012).

used as risk-free rate. The problem is that these rates have maturities equal to and shorter than 1 year. For a cash flow which is for example identified to be paid in 2 years, a risk-free rate with a maturity of 2 years should be used. For that reason LIBOR and EURIBOR rates are not recommended to be used as risk-free discount rates. As alternative government bonds yield curves are also used in practice as risk-free rates.[47] For loans paid in dollars US Government Bond yields can be used. These have maturities of 1, 2, 3, 5, 7 and 10 years. Points lying in between these maturities can be calculated by interpolating. As for loans paid in euros, a yield curve from European AAA bonds can be used, as these are assumed to be risk-free.

All data that is used for both methods is as expected at the time point for which the calculation is intended to be. In the next subsection both methods will be applied to see what influence the theoretical method has on the results of the existing method. Further will become clear what differences both methods have in their use when applying.

5.2.5 Comparison by applying both methods

Both methods are modeled in an Excel sheet so that as little calculations as possible need to be made. The Excel sheet consists of applications of the formulas of both methods as they are explained in chapter 3 and subsection 4.1.1. The sheet is attached to this report, which can be seen in Appendix 2. The sheet is created to compare both methods in the way that is explained in subsection 5.2.1, but can also be used to calculate market values of current outstanding loans at any time point by taking the valuation date as t = 0 and filling in all inputs from that perspective.

Even though all data is available for the loans selected in subsection 5.2.3, the inputs of some loans, such as the margin, can depend on different circumstances which cannot be predicted and are not recorded. Therefore in this research assumptions are made in in order to use the data. The calculations and assumptions of the first loan in the selection will be treated in this subsection to illustrate which calculations are made. For the other loans in the selection the inputs are given in Appendix 3. The results for all loans in the selection are illustrated in this subsection.

The calculations are illustrated using the first loan in the selection as example. As the characteristics of the loan are confidential, the calculations and assumptions made are left out in this subsection from this point.

Both methods are applied using a range of CDS spreads as input. In the current market, CDS spreads of different maturities roughly lie between 10 and 700 bps, depending on the maturity. Therefore both methods will be applied for CDS spreads in the range of 0 to 1000 bps using steps of 50 bps. Steps are used to reduce the amount of calculations need to be made and using 20 steps is sufficient enough to show the relation between the CDS spread and the results of both methods.

Normally the change in annual earnings of the existing method (Annual margins & fees – Total hedge premium) would be multiplied by the remaining WAL, representing the time the amount is outstanding from the valuation point. As was explained in subsection 5.2.1, for the comparison the perspective of t =

[47] (Hull, Risk Management and Financial Institutions, 2010).

0 is chosen, meaning that the remaining WAL should be replaced with the WAL at origination. This is because the original WAL represents the time the amount is outstanding as seen from origination.

The theoretical method is applied twice, using data at origination and a changed CDS spread of t = x.

The conditional probabilities of default are then used to calculate the unconditional probabilities of survival and default per year for the time the loan facility is outstanding. This is firstly illustrated for the calculations using the data of t = 0.

For year 1, the unconditional probability of default is equal to the conditional probability of default, which is xx. The unconditional probability that the borrower has survived is then obviously $1 - \mathrm{xx} = \mathrm{xx}$. For year 2 the unconditional probability of default is the conditional probability of default multiplied by the unconditional probability of survival of the year before. The unconditional probability of survival of year 2 is calculated by multiplying the unconditional probability of survival of the year before with the conditional survival rate. This gives an unconditional probability of survival of year. For years 3, 4 and 5 and the data of t = x the same calculations can be done. This leads to the following unconditional probabilities.

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Table 11 – Unconditional probabilities of survival and default

The discount rate is calculated using the risk-free rates with the following formula. The results are given in the table below.

$$\text{Discount rate} = \frac{1}{(1 + \text{risk–free rate})^{\text{year}}}$$

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Table 12 – Discount rates

The present values of cash flows can be divided into three parts, namely the present value of the expected survival payments per year from year 1 to year N-1 (N is the maturity in years), the present value of the expected default payments per year and the present value of the expected payment at maturity, following the formula given in Appendix 1. As explained in section 3.4, all expectations are based on risk-neutral probabilities.

The expected default payment between year 0 and year 1 is equal to the recovery rate multiplied by the loan balance of the year before, since this is what the bank is paid if the borrower defaults. This is then multiplied by the discount rate and the unconditional probability of default.

The expected maturity payment taking the fact that the borrower has survived until maturity into account, still needs to be calculated. The payment at maturity consists of the repayment, margin and 3-month LIBOR rate in the last year, as can be seen in Appendix 1. In this particular example the expected maturity payment would be equal to the expected survival payment in year 5, however this is not always the case and therefore the expected maturity payment is calculated separately.

The market value of the loan is then equal to the three cash flows added up. This leads to a market value of t = 0 of xx and a market value using the CDS spread of t = x of xx million USD. The difference between both is equal to xx million. This can be compared to the result of the existing method, which is xx million. This shows that for both methods the market value has become higher with an amount equal to the calculated difference when the CDS spread at t = x would be 50 bps. However in the existing method the change in bps is multiplied by the exposure. As illustrated in subsection 4.1.1, this step is a simplification, since according to Macaulay duration theory this should be multiplied by the present value at maturity of the amount outstanding. Therefore as alternative to work around this simplification, the relative change is calculated as percentage of the market value calculated with the theoretical method, using the following formula.

$$\text{Relative change} = \frac{\mathrm{PV}_0(\mathrm{t}) - \mathrm{PV}_0(0)}{\mathrm{PV}_0(0)}$$

with $PV_x(y)$ = the present value calculated with the theoretical method at time x given the information available at time y

This change in percentage can then be compared with the result of the existing method in bps, before it would be multiplied by the exposure. This has the advantage that the debatable simplification of multiplying by the exposure instead of the present value of the exposure is not taken into account. In this case the relative change would be 1.1954%, where the change calculated with the existing method was 375 bps, which is equal to 3.75%. Just as before this shows that the market value has become higher, namely with 1.1954% using the theoretical method and with 3.75% using the existing method. The difference between the results will be discussed in subsection 5.2.6.

The results are calculated using the Excel sheet in Appendix 2 for a range of CDS spreads of t = x from 0 to 1000 in steps of 50 to see how the results hold under different circumstances. The results of applying both methods on the first loan facility, which has “Marine contractor in the offshore oil and gas industry” as borrower, are shown in the table below.

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Table 13 – Results first loan facility (Marine contractor in the offshore oil and gas industry)

As described before, the results of the existing method (%) and the relative change of the theoretical method are to be compared. In addition the results of the theoretical method using the different inputs are also given, as well as the difference between both in million USD. This difference can also be compared to the result of the existing method in million, representing the same as the comparison of the values as percentage. The comparisons of the results of the existing method (%) and the relative change of the theoretical method for all CDS spreads in the range are illustrated in a graph. The results will be analyzed and discussed in subsection 5.2.6. For the first loan in the selection the graph can be seen below.

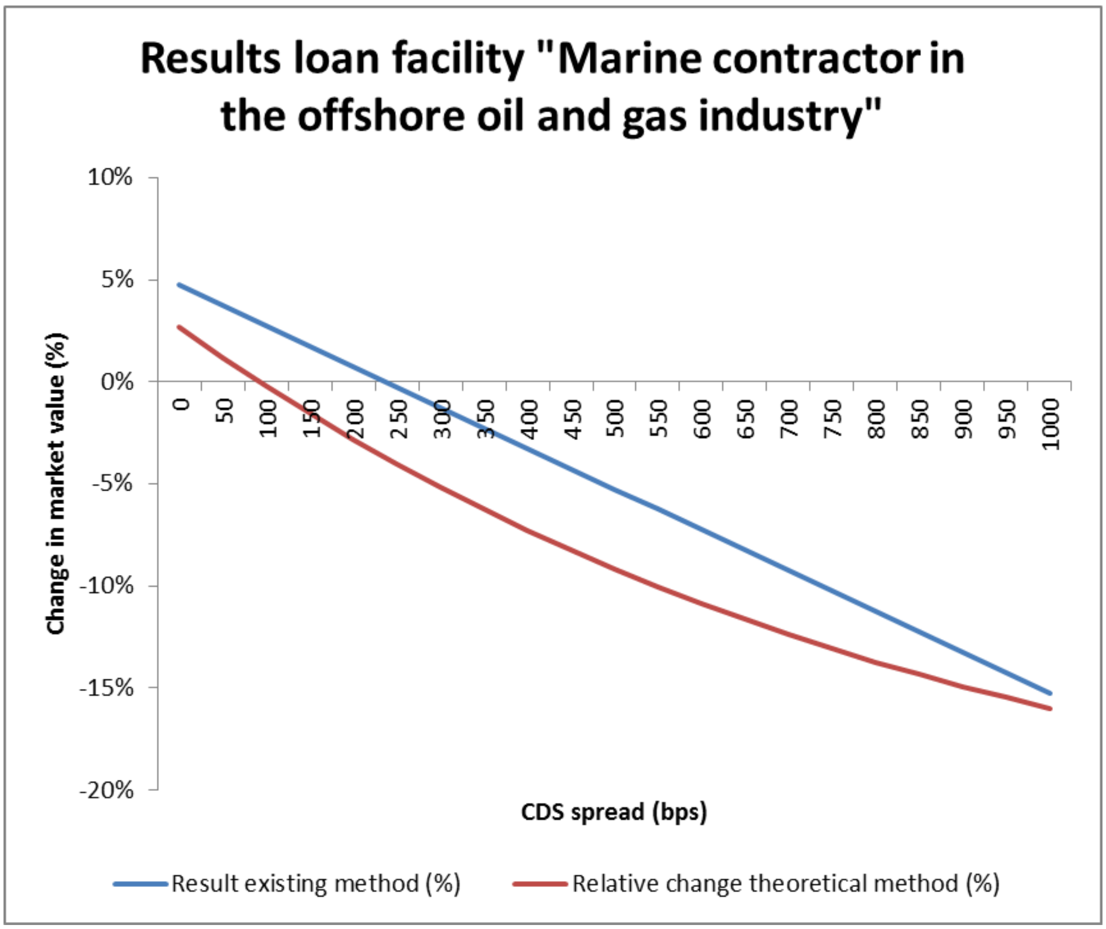

Figure 2 – Results “Marine contractor in the offshore oil and gas industry” loan facility

The first issue that can be noticed is that the result of the theoretical method is lower for all CDS spreads in comparison with the result of the existing method. A higher CDS spread corresponds to a negatively changing market and hence a lower market value, implicating that a downward trend in the graph is correct. Next to that a noticeable point is from which CDS spread the difference becomes negative. A negative result means that the market value reflecting the current market circumstances is lower than the market value that would be expected at origination. As for the theoretical method the difference becomes negative from a CDS spread of approximately 90 bps, being equal to the CDS spread at origination. The result of the existing method becomes negative from a CDS spread of approximately 250 bps. This implicates that the market situation has become worse from these CDS spreads according to both methods.

As for the other loans in the selection of subsection 5.2.3, the results are presented in this subsection illustrated with graphs. The inputs (also showing what values are assumed as inputs) and the tables illustrating the results are given in Appendix 3 for all loans within the selection.

The graph illustrating the results of the second loan in the selection can be seen below.

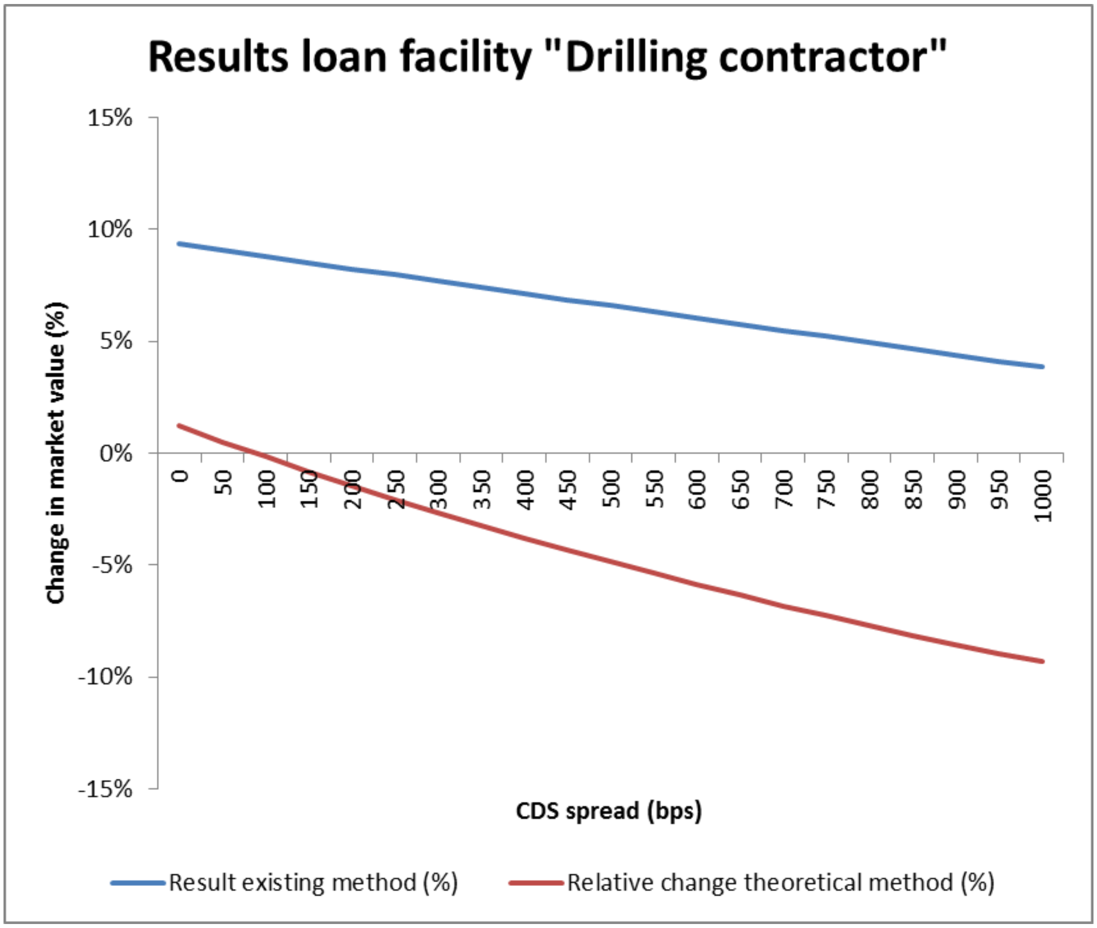

Figure 3 – Results "Drilling contractor" loan facility

This shows a more extreme pattern. Again can be seen that the change calculated with the theoretical method, is significantly lower than the result of the existing method under all CDS spreads. Notable in this case is that the result of the existing method is always positive, implicating that under all CDS spreads at t = x the market value of the loan has become higher, where the change of the theoretical method becomes negative from a CDS spread approximately 90 bps, which is equal to the CDS spread at origination. This will further be analyzed in subsection 5.2.6.

The results of the third loan facility can be seen below.

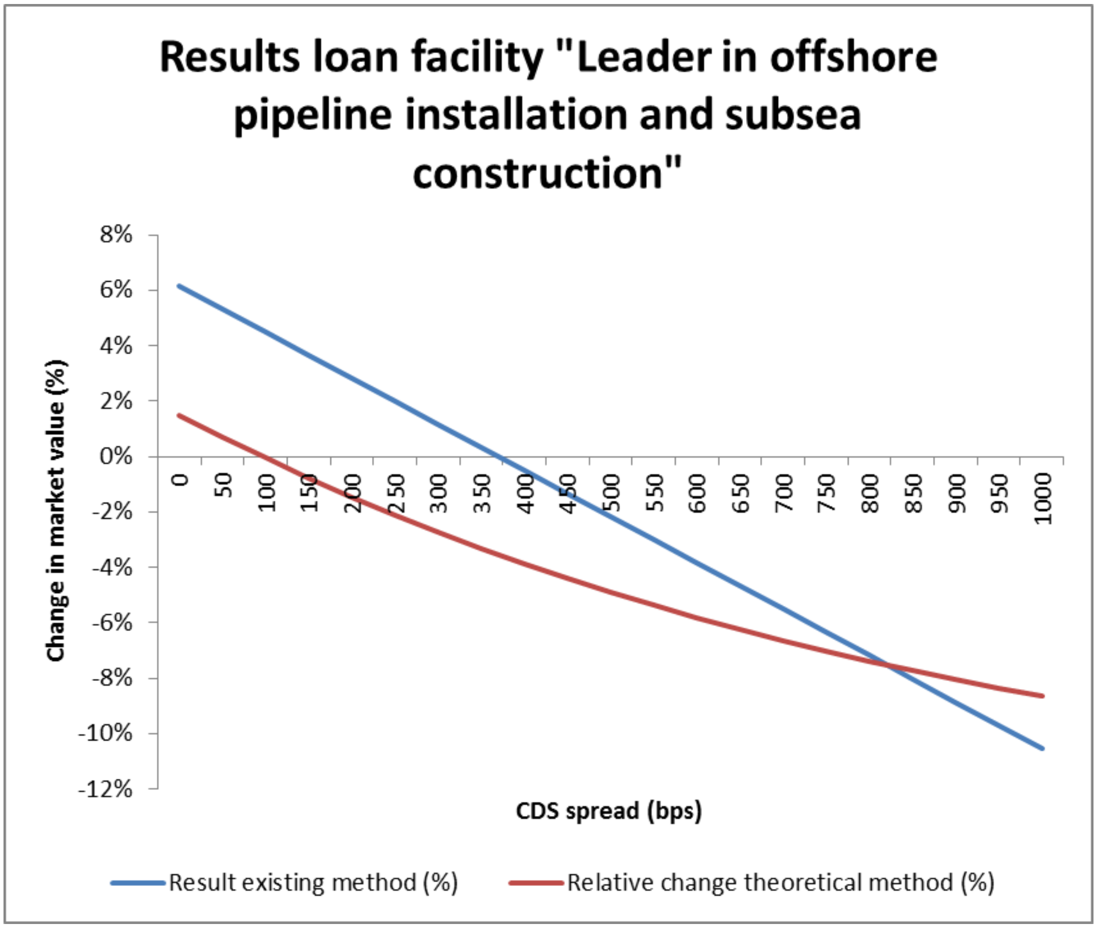

Figure 4 – Results "Leader in offshore pipeline installation and subsea construction" loan facility

Again there is a significant difference in the turning point from which CDS spread the results become negative. The point where the change in market value becomes negative is approximately 95 bps for the theoretical method (CDS spread at origination) and approximately 375 bps for the existing method. A noticeable issue is in this case that the lines cross at a CDS spread of approximately 825 bps. The line of the result of the existing method goes from approximately 6% to -10%. For the loan facilities the line was more flat, implicating that the slope of the line representing the result of the existing method differs for each loan facility. The reason for this will be discussed in subsection 5.2.6.

The fourth loan has similar results as the second loan facility, as is illustrated below.

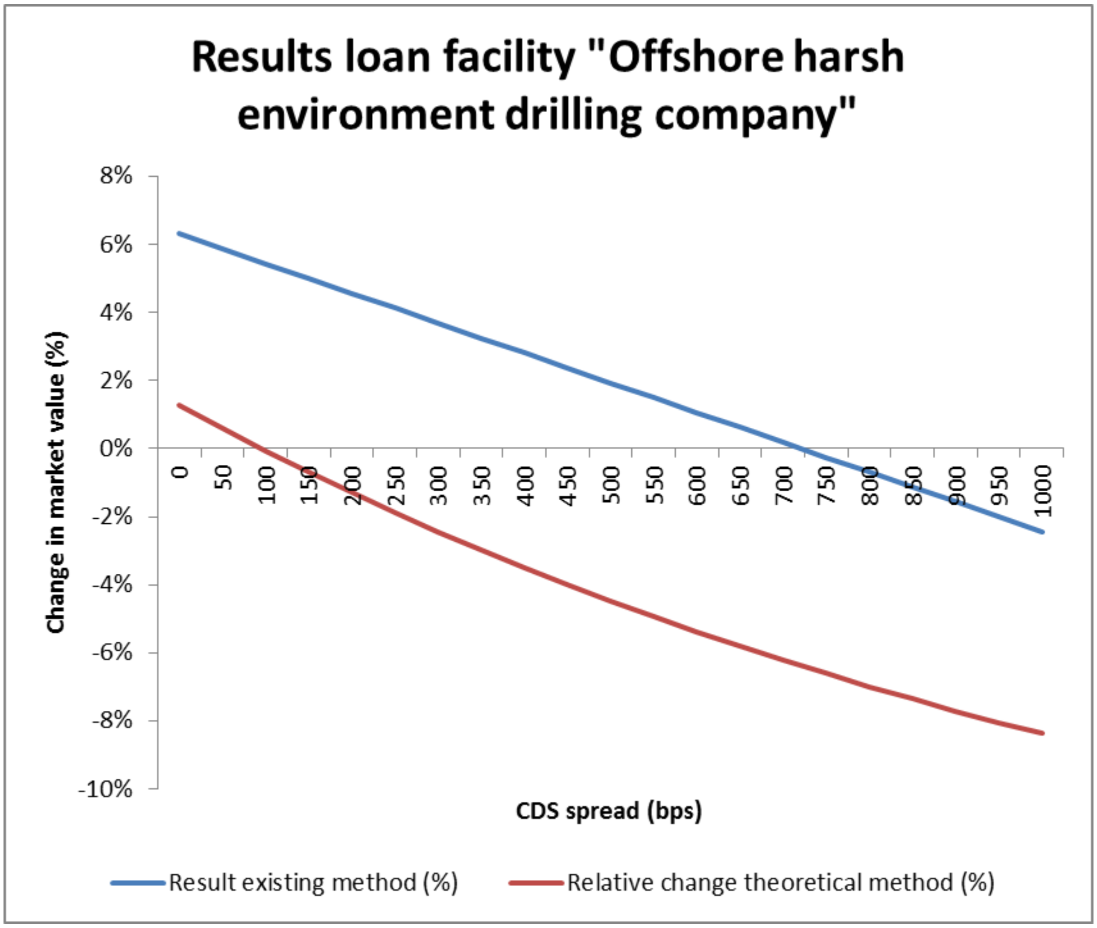

Figure 5 – Results “Offshore harsh environment drilling company” loan facility

These results show similarities with the results of the (second) “Drilling contractor” loan facility, where the result of the existing method also lies significantly above the change of the theoretical method. The result of the existing method becomes negative from approximately 730 bps, where the change of the theoretical method becomes negative from the CDS spread at origination. This is a big difference, especially in comparison with the other loans (first, third, fourth and sixth) except for the second loan where the result of the existing method never gets negative. This will be further discussed in subsection 5.2.6.

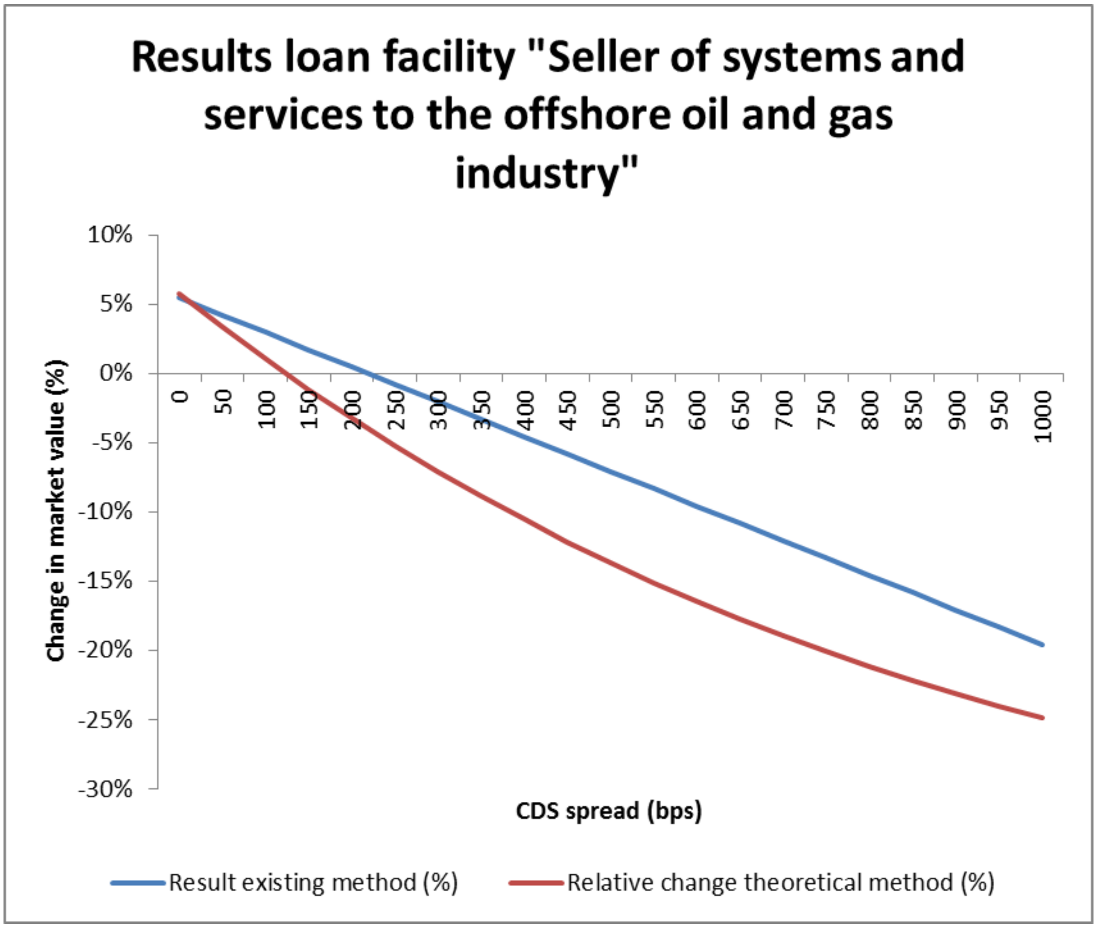

Figure 6 – Results "Seller of systems and services to the offshore oil and gas industry" loan facility

The graph of the results of the fifth loan facility shows that the change of the theoretical method is slightly higher than the result of the existing method for extremely low CDS spreads. The figure shows a pattern similar to the results of the first loan facility. The last loan shows a different pattern, which can be seen on the next page.

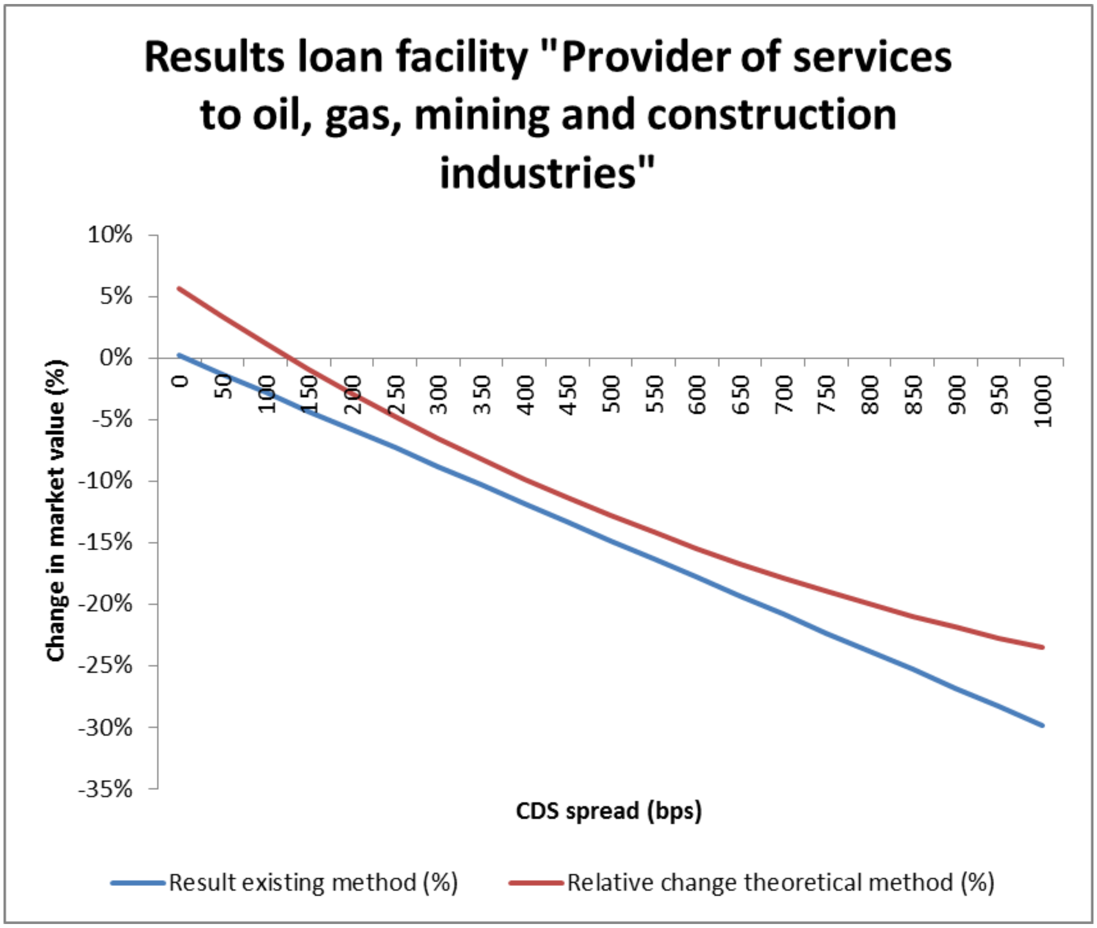

Figure 7 – Results "Provider of services to oil, gas, mining and construction industries" loan facility

As for the sixth loan facility, it is noticeable that the result of the existing method is lower than the change of the theoretical method for all CDS spreads. Next to that the result of the existing method is (almost) under all CDS spreads negative, where for the second loan the result was always positive. The line of the change of the theoretical method shows the same pattern as before, being positive for CDS spreads lower than the CDS spread at origination and negative for higher CDS spreads.

From these examples can be concluded that the results of both methods show a similar downward trend as the CDS spread gets higher. This is in accordance to what would be expected in theory, since a higher CDS spread implicates that there is more risk in the market, which leads to a lower market value. The difference between the results of both methods varies per loan facility, due to different input variables. Another interesting issue is the CDS spread from which the change in market value becomes negative. The theoretical method shows a similar pattern for all cases. The change is positive when the CDS spread is lower than it was at origination, where a negative change corresponds to a higher CDS spread than at origination. The turning point is thus equal to the CDS spread at origination, which is instinctively right. As for the existing method, the turning point is different for each loan. Next to that, the slope of the line of the results of the existing method also differs per loan facility. This shows that the result of the existing method might vary depending on the inputs, possibly leading to extreme instinctively strange results. The results of the theoretical method are instinctively explainable and show patterns which one would expect from the theory. These issues will be discussed further in subsection 5.2.6.

The theoretical method uses more inputs, which are not used or simplified in the existing method. Hence the theoretical method represents the practice more, making the results of the theoretical method more substantiated. The method calculates actual market values, but changes of market values over time can also be estimated following an approach such as was described in subsection 5.2.1. The existing method can only estimate the change in market value, of which the results are debatable. More data is needed to apply the theoretical method, for which assumptions need to be made. When using for example the attached Excel sheet the calculations are automated and thus are not more time consuming than the calculations of the existing method.

Another difference between both methods concerning the use of both is that the existing method uses annual margins and fees, so that a value per year should be calculated. In practice, inputs such as the margin paid per year can change, which is commonly the case for loan facilities which are used to finance for example the production of a ship. The margin (among other inputs) might differ between the pre-production and the post-production state. When the existing method is applied, an average value must be calculated, for which in practice some sort of weighted average is used as the average, using the time until the margins are received as weights. Using these kinds of averages has influence on the results and requires additional calculations. As for the theoretical method, different values can be used per year, which is more practical to use and more accurate.

From the arguments described above can be concluded that regarding the use of both methods, the theoretical method should be used instead of the existing method. The next subsection will discuss the differences between the results of both models.

5.2.6 Discussion

This subsection will discuss the results of comparing both methods. The discussion is divided into a part regarding the results, the assumptions and simplifications made and the data that is used.

Results

One of the most interesting issues is from which CDS spread the change in market value becomes negative. As can be seen in the results of the previous subsection, both methods have a different turning point, which also differ depending on the input variables. This turning point is in case of the theoretical method equal to the CDS spread at origination. Instinctively this makes sense, as the CDS spread is assumed to be the only changing variable and the changed CDS spread is compared to the CDS spread at origination. As for the existing method the turning point is different. This difference can also be seen in the results of the previous subsection. It can be seen from the result of the existing method using the CDS spread at origination as “changed” CDS spread. It turns out that the calculated result of the existing method is not equal to 0% in all cases. The reason for this is that the CDS spread is simply stated compared to the margin which is set at the beginning of the term. The assumption is made in this case that the margin can be used directly as a benchmark for the market circumstances at origination. In practice this is not necessarily the case, as the margin might also be determined based on factors such as the relation with the borrower, which explains why the turning point of the existing method differs from the turning point of the theoretical method. This might give a good indication of the change in earnings of the loan facility, but it does not necessarily give a good indication of the change in market value, which is explained in subsection 4.1.2.

The difference between the result of the existing method and the change of the theoretical method differs per loan facility. As stated before the existing method calculates the change in earnings. This is calculated by taking the annual margins and fees directly into account. As for the theoretical method the annual margins and fees determine the expected cash flows, which are discounted and multiplied by the unconditional probability of the state of the borrower, and thus having relatively less direct influence on the results. This explains why the line representing the result of the existing method in moves up or down as a whole depending on the inputs of the loan facility, which can be seen in the graphs, explaining why the differences between the results of both methods vary per loan facility.

This is illustrated by the most extreme cases, starting with the second "Drilling contractor" loan. The corresponding margin is xx bps per year, which is significantly higher than the margins of the other loans. Next to that this loan also has a relatively low liquidity premium and LGD in comparison with the other loans. For the existing method a low liquidity premium leads to higher annual margin & fees and a lower LGD leads to a lower hedge ratio and thus a lower hedge premium. This leads to a higher result of the existing method. This explains why the result of the existing method is always positive in this case. This indicates that the earnings are higher than on the market, however this does not necessarily say the same about the change in market value.

On the other hand for the sixth loan facility of "Provider of services to oil, gas, mining and construction industries" a relatively low margin of xx bps per year is assumed. The liquidity premium of xx bps is relatively high and even higher than the assumed annual margin. This leads in the calculations of the existing method automatically to a relatively low value for "Annual margin & fees". Next to that this loan has a relatively high LGD in comparison with the other loans, which is xx%, leading to a relatively higher total hedge premium. Therefore the result of the existing method is significantly lower for this loan, which can be seen in the graph representing the results. The result of the existing method is negative from a CDS spread of approximately 10 bps and is lower than the change of the theoretical method for all CDS spreads. The relative change of the theoretical method still follows the earlier explained pattern, being positive for a CDS spread lower than the CDS spread at origination and being negative for a CDS spread higher than the CDS spread at origination.

Another notable point is that the slope of the lines of the results of the existing method differs per case. The reason for this is that the CDS spread is multiplied by the hedge ratio, which is the LGD divided by a fixed factor. Therefore the LGD has a direct effect on the slope of the line representing the results of the existing method. Further the result is the existing method under different CDS spreads is a straight line, where the change of the theoretical method is a curve. This can be explained by the fact that in the existing method the CDS spread is multiplied by the so-called hedge ratio, as described in subsection 4.1.1. This hedge ratio consists of the internally calculated loss given default and the expected payment of the CDS spread, which is assumed to be xx by the bank since bondholders lose on historical average xx% for senior unsecured bonds. The most recent (seen at t = x) internally calculated LGD is derived by xx and this hedge ratio is multiplied by the CDS spread. This would result in a fixed hedge ratio, which has direct influence as a factor on the CDS spread in the calculations of the existing method. For the first loan facility for example the CDS spread is multiplied by xx. As for the theoretical method the CDS spread is derived by xx to come up with the unconditional PD rate. This PD rate is used to identifying the expected cash flows further on in the calculations. This illustrates that the CDS spread has a different relation to the results under both methods. This explains why there is no similar relation between the CDS spread and the results under both methods. Next to that both the xx and the xx are assumed values. Using different values might completely change the results and the relation of the CDS spread with the results under both methods.

From this can be concluded that the result of the existing method is heavily and directly dependent on the inputs of the loan facility, making extreme results (always positive or always negative) possible. Again this is not necessarily wrong, but this says something about the annual change in earnings (simplifying the calculations) and not about the actual change in market value, which is the goal of the research.

Assumptions and simplifications

As for this research an approximation formula from Hull is used to approximate the conditional PD from a CDS spread, following by possible bootstrapping.[48] More accurate conditional PDs can be calculated with a more complex method of Hull, taking discounting into account. The effect on the results might be negligible, but it is recommended to further analyze this.

In order to compare both methods, the assumption is made that the only changing variable between t = 0 and t = x is the CDS spread to make a proper comparison possible. As explained in subsection 5.2.1, the theoretical method calculates the market value at t = 0 using the CDS spread at t = x. When the theoretical method would be applied properly, the market value is calculated at a certain point in time by estimating the upcoming cash flows seen from that point in time. Any cash flows paid before that point in time are not taken into account. Therefore when for a certain loan most of the loan is being repaid for example in the first year and the market value is calculated with the theoretical method in the second year, the actual market value of the loan would be much lower than at origination because the (highest) cash flow is already paid. Calculating proper market values by taking this into account would create more insight in the actual market values of loan facilities and the portfolio, which can easily be done with the theoretical method. The Excel sheet in Appendix 2 could be used for this when the valuation date is seen as t = 0.

Next to that the unconditional probabilities of default and survival also change when the market value is calculated with the theoretical method at a different point in time, due to a possibly changing conditional PD and the fact that it is given that the borrower has survived until that point in time. The changing unconditional probabilities combined with the fact that cash flows in the past are not taken into account make it impossible to track the development of the borrower by simply comparing the market values calculated at different time points. This can be done by using the changed CDS spread as market benchmark in the calculation of the market value at origination, which is done in the comparison

[48] (Hull, Risk Management and Financial Institutions, 2010).

in the previous subsection, even though this does not calculate the actual market value (the estimated amount for which an asset or liability should exchange on the valuation date between a willing buyer and a willing seller in an arm's length transaction[49]).

The existing method makes simplifications regarding when the repayments are paid. In the theoretical method these cash flows are discounted and multiplied by the probability that the borrower is in a corresponding state at the time the cash flow is expected to be paid. The existing method approximates how long the loan is outstanding from the valuation point by calculating the remaining WAL. The idea behind this is that the difference between the annual margin & fees and the annual hedge premium is multiplied by this remaining WAL, to calculate the change in earnings over the time the loan is expected to be outstanding. This way of reasoning is instinctively right, however as described above, the expected cash flows are estimated depending on when they are expected to be paid. Another issue is that cash flows might depend on circumstances, such as the margin which can be varying over time since it is multiplied by the amount outstanding. Hence it is not recommended to use the existing method with these simplifications since these kind of issues are not taken into account, leading to less substantiated results.

When the theoretical method is applied, assumptions must be made regarding the cash flows, base rate, risk-free rate and the discount rate. These assumptions have influence on the results, which is usual for discounted cash flow models. As for the existing method these assumptions are not made and the calculations are simplified by disregarding discounting and interest payments. The possible influence of the assumptions on the results and the fact that the assumptions need to be made might be the reason that these are not taken into account in the existing method. As the theoretical method incorporates more variables, which are ignored or simplified in the existing method, the results of the theoretical method are more substantiated.

In section 4.2 the issue regarding the use of the liquidity premium was identified as difference between the results. In the existing method the liquidity premium is subtracted from the margin to calculate the part of the margin that can be attributed to what is paid for the risk. This part is then compared to the CDS spread. By making this comparison the assumption is made that this part can be compared directly to the CDS spread, implicating that this part represents the amount that is paid for the risk of the underlying financial instrument. One can also debate whether there is some funding cost part in the CDS spread as well. In practice the comparison made might give a slightly different difference between the annual margins and fees and the total hedge costs, which might have influence on the results of the existing method. The theoretical method uses expected cash flows. In section 4.2 was argued that the liquidity should not be taken into account, because this is the premium the bank has to pay to fund itself on the market. This is an internal rate paid by the bank and therefore it has no relevance for the expected payments in the future, which determine the market value. When a loan is sold on the market, the other party might have its own liquidity premium or even no liquidity premium at all. Therefore it can be supposed that the liquidity premium has no influence on what one is prepared to pay for that loan, explaining why the liquidity premium is not taken into account in the theoretical method. When

[49] (International Valuation Standards Council, 2011); (The European Group of Valuers' Associations, 2012).

the theoretical method is used, no assumptions need to be made regarding whether and how the liquidity premium should be taken into account. If the liquidity premium would not be taken into account in the existing method, the overall result of the existing method is higher, since the liquidity premium is subtracted from the change in annual earnings.

Data

Not all data needed was available in the systems of ABN AMRO. The consequence was that both methods could not be properly applied on all loan facilities. Loan facilities with as much data available as possible were found in subsection 5.2.3. The only relevant missing data was the (expected) utilization of the loan facility (in case of a revolver) at relevant time points. For some of the loan facilities within the selection a commitment fee was reported, which is the fee paid over the unused commitment of the facility. For this research a utilization of 100% is assumed in all cases due to the lack of data. The utilization of a loan facility is used differently in the calculations of both methods, implicating that the results of both methods might be closer to each other or might differ even more. Due to time restrictions only a quick check is done by changing the utilization of the first loan in the selection into 0.75. This resulted in a decrease of approximately 0.2% of the result of the existing method for all CDS spreads. The whole line representing the results of the existing method moves down. The change in market value calculated with the theoretical method increases slightly for the CDS spreads with a positive change, but decreases slightly for the CDS spreads with a negative change. This is what would be expected, since the change in cash flows (due to a changing utilization) are discounted and multiplied by a different unconditional probability of survival which is derived from the variable CDS spread. This again shows that the result of the existing method is directly influenced by the inputs.

Both methods can only be used for calculations of longer-term oriented loan facilities, since the payments are identified per year. Because of this a part of the loans within the ECT portfolio were filtered out in the selection process in subsection 5.2.3. The methods can only be applied to committed loan facilities. Looking at the portfolio of ECT, both methods cannot be properly applied for loan facilities in the Commodities portfolio. As said earlier in this subsection, the theoretical method allows the use of changing inputs. Further when an input is changed, the consequence on the market value can easily be seen. Since the ECT business is a rather complex business with possibly rapidly changing market conditions, using the theoretical method instead of the more static existing method is desirable in the more dynamic ECT business. The theoretical method could also be extended to use a shorter interval than one year between the payments, so that the method can be applied to shorter-term oriented facilities.

The theoretical method calculates the market value of a loan facility using a theoretical foundation. By changing the CDS spread in the original calculation at $t = 0$, the change in market value seen from origination can be calculated, which corresponds to what the existing method tries to calculate. Instead of only looking at the what could be earned more or less on the market, it is calculated what the influence of market changes are on the actual market value of loans. This is also done by making fewer simplifications, leading to more substantiated results. Therefore the theoretical method preferably should be used to calculate market values. This leads to more insight in what the market value of loan facilities within the ECT portfolio are and how they can be monitored, matching the goal of the research.

Chapter 6: Conclusions & Recommendations

In this chapter the most important conclusions from the research will be summarized in the first section. Recommendations for the ECT department and the bank as a whole are described in the second section.

6.1 Conclusions

The goal of this research is to create more insight in how the market value of loan facilities can be monitored over time. In chapter 3 was concluded that in order to calculate market values, an extended risk-neutral discounted cash flow model needs to be used (see Appendix 1), in which all risk effects are represented by the risk-neutral probabilities of default and survival. These probabilities are to be derived from CDS spreads, reflecting the state of the relevant market.

The method that is currently applied, calculates an indication of the change in annual earnings by comparing the internal risk premium with the CDS spread, which is seen as market price benchmark. This change is calculated by making several simplifications and is interpreted as the change in market value. Looking at the goal of the research, it is desirable to be able to calculate actual market values, rather than only indications of changes of market values.

Both methods are compared to each other. The advantages and disadvantages of both methods are shown in the tables below, which are copied from section 5.1.

Advantages	Disadvantages
Easier to automate	Indication of the change in market value as result
Less data needed	Not all cash flows are included
Less assumptions to be made	Amortization is by approximation taken into account
	One annual fixed value for inputs, leading to possible additional calculations
	No discounting

Table 14 – Advantages and disadvantages of the existing method

Advantages	Disadvantages
Market value as result	More difficult to automate
More types of cash flows are identified	More data needed
Amortization is directly taken into account	More assumptions to be made
Inputs can differ each year	
Cash flows are discounted	

Table 15 – Advantages and disadvantages of the theoretical method

When both methods are compared by applying them on a certain selection of loans it turned out that there are significant differences between both methods in terms of their results and use. In order to compare the results of both methods the theoretical method is applied twice at origination, using a recent (variable) CDS spread the second time. After that the relative difference is calculated, which is compared to the result of the existing method.

Concluding can be said that the theoretical method makes fewer simplifications in the calculations. Assumptions need to be made, but even with these assumptions the theoretical method leads to more substantiated results than the existing method. Regarding the use of both methods, different values can be used for all years, where for applying the existing method averages must be calculated. The existing method gives an indication of whether more or less can be earned than was expected at origination, but it remains dubious whether the commercial margin (which is the margin minus the liquidity premium) can be compared directly to the CDS spread, implicating that these represent the same. It is proven that the existing method however does not give a proper indication of the change in market value of the loan facility.

The most important conclusions following from the comparison are listed below.

- Both methods come with lower market values as the CDS spread gets higher, which is theoretically a correct relation.
- The theoretical method uses more inputs, which are disregarded or simplified in the existing method. The consequence is that the theoretical method represents the practice relatively more, leading to better substantiated results.
- The turning point from which CDS spread the change becomes negative is different for both methods. As for the theoretical method, the change is positive when the recent CDS spread is lower than the CDS spread at origination and vice versa. As for the existing method, this turning point depends mainly on the commercial margin of the loan facility, assuming that this margin directly represents the market conditions at origination, which is not necessarily the case. Therefore the existing method does not give a proper indication of the change in market value.
- The results of the existing method depend directly on the margin and fees and other inputs. Different inputs make the line representing the results of the existing method move up or down, changing the turning point from which the market value change becomes negative. This might lead to extreme results.
- Relatively more assumptions need to be made with the theoretical method, but even with these assumptions the theoretical method leads to more substantiated results.
- Both methods are automated in an Excel sheet (see Appendix 2). Additional calculations need to be done in the existing method, since weighted averages need to be calculated to come up with annual values for the existing method.

6.2 Recommendations

From the conclusions described in the previous section and the research follow some recommendations for the ECT department.

The first and most important recommendation is that the theoretical method is recommended to be used instead of the existing method, because of the reasons described in the conclusions section. Next to that it is recommended to apply the theoretical method regularly to monitor the market value of loan facilities in the portfolio. The theoretical method and the additional insights created might be valuable for other departments next to ECT as well. Even though this is not possible to apply the theoretical method on all loans, it creates insight in the market value of the (partial) portfolio and in the market value of loan facilities on individual level, which is valuable for possible portfolio management actions.

In order to apply the theoretical method, CDS spreads are needed. CDS spreads are currently obtained on a way that could be improved to come up with more accurate CDS spreads, as was described in subsection 5.2.2. It is recommended for the bank to reconsider how the CDS spreads corresponding to certain industries are obtained and categorized. Further it is recommended to keep obtaining these regularly to be able to calculate market values using the theoretical method.

An important point which could be improved is the amount of data that is reported. Issues such as the outstanding amount and the utilization (expected) at certain points in time are not directly reported. Yet these are important for when both methods are applied. Therefore it is a recommendation to report more data.

Hull's approximation formula is used for the estimation of the conditional probability of survival and default from the CDS spreads. As discussed in subsection 5.2.6, a more complex method can be used, leading to more accurate PDs. Further research is recommended on this topic.

A restriction of the theoretical method is that in its current state the steps between the time points are years. In practice several loans have a quarterly repayment schedule. Further in case of revolvers, utilizations might change on a daily basis. Especially for loan facilities within the Commodities portfolio, which are short-term oriented and regularly have a maturity of 30, 60 or 90 days, it is recommended to extend the theoretical method to be able to estimate expected cash flows on a monthly or daily basis. This has the consequence that significantly more calculations need to be done and more data is needed. Since it would be valuable especially for facilities within the Commodities business, it is highly recommended to do further research in this area.

As can be read in subsection 5.2.4, assumptions need to be made regarding which data should be obtained and where these data is obtained. These assumptions are about the risk-free rate and the base rate that should be used. It is a recommendation to reconsider which rates should be used, as other rates might lead to slightly different results.

As the most important recommendation is to use the theoretical method regularly, it would be desirable to identify on which loans the method can be applied. When new facilities are added to the portfolio, it can be identified once if the theoretical method can be applied on these loan facilities. In that case for these loan facilities, the most recent data can be used as inputs in an Excel sheet so that the market values of these loan facilities can regularly and easily be monitored.

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Appendix 1: Extended loan facility fair value framework of Tschirhart et al.

As can be seen in section 3.4, the simplified formula of the loan facility fair value framework is as follows.[50]

$$FV_i = \sum_{t=i}^{N} E[\text{loan facility payments}_t|\text{survival}_t] * p[\text{survival}_t] * \text{discount}_t$$

$$+ \sum_{t=i}^{N} E[\text{loan recovery}_t - \text{commit drawdown}_t|\text{default}_t] * p[\text{default}_t] * \text{discount}_t$$

with E[...] = the expected value (in principal a risk-neutral value)

$E[\text{loan facility payments}_t|\text{survival}_t]$ = the expected payments at time t, given survival until time t

$p[\text{survival}_t]$ = the unconditional risk-neutral probability of survival at time t

discount_t = the present value of one dollar paid with certainty at time t

$E[\text{loan recovery}_t|\text{default}_t]$ = the expected amount that the bank recovers after a loan defaults at time t

$E[\text{commit drawdown}_t|\text{default}_t]$ = the expected commitment drawdown at time t at default

$p[\text{default}_t]$ = the unconditional risk-neutral probability that default will at time t

The expected payments that should be included in the simplified formula are depicted in the tables below. These are copies of the tables from section 3.4.

Payments given survival	Description
LIBOR interest rate (floating)	Paid on outstanding loan balance
Loan margin	Spread over LIBOR paid on loan balance; margin may be changed based on measure of obligor credit condition
Loan prepayment/refinancing	Loans can be prepaid or refinanced, possibly with a prepayment penalty
Loan repayment at maturity	If no default, the outstanding balance is paid at maturity
Commitment facility fee	Fixed periodic fee paid for a loan commitment
Commitment fee	Periodic fee based on unused commitment
- Commitment drawdown	Drawdown on the unused commitment
- Term-out exercise	Loan commitment can be converted to a fixed term loan at maturity at obligor's discretion

Table 16 – Loan Facility Payments given survival
Source: (Tschirhart, O'Brien, Moise, & Yang, 2007)

[50] (Tschirhart, O'Brien, Moise, & Yang, 2007).

Payments given default	Description
- Commitment drawdown	The obligor may drawdown on the unused commitment when default is imminent
Recovery of loan balance	The amount that the bank recovers after a loan defaults (including any commitment drawdown at default)

Table 17 – Loan Facility Payments given default
Source: (Tschirhart, O'Brien, Moise, & Yang, 2007)

Including these payments in the simplified formula leads to the following formula.[51]

$$
\begin{aligned}
\mathrm{FV_i} = \sum_{t=i+1}^{N-1} & \mathrm{E}[(\mathrm{libor}_{t-1} + \mathrm{margin}_{t-1}) * \mathrm{loan\ bal}_{t-1} + \mathrm{commit\ fee}_{t-1} * \mathrm{unused\ commit}_{t-1} \\
& + \mathrm{facility\ fee}_{t-1} * \mathrm{P} + \mathrm{prepay}_t + \mathrm{prepay\ penalty}_t - \mathrm{commit\ drawdown}_t | \mathrm{survival}_t] \\
& * \mathrm{p}[\mathrm{survival}_t] * \mathrm{discount}_t \\
& + \sum_{t=i+1}^{N} \mathrm{E}[\mathrm{recovery\ rate}_t * (\mathrm{loan\ bal}_{t-1} + \mathrm{commit\ drawdown}_t) \\
& - \mathrm{commit\ drawdown}_t | \mathrm{default}_t] * \mathrm{p}[\mathrm{default}_t] * \mathrm{discount}_t \\
& + \mathrm{E}[(\mathrm{libor}_{N-1} + \mathrm{margin}_{N-1} + 1) * \mathrm{loan\ bal}_{N-1} - \mathrm{term\ out\ opt}_N | \mathrm{survival}_N\ ] \\
& * \mathrm{p}[\mathrm{survival}_N] * \mathrm{disc}_N
\end{aligned}
$$

with E[…] = the expected value (in principal a risk-neutral value)
libor_t = the LIBOR rate at time t
margin_t = the loan margin at time t
$\mathrm{loan\ bal}_t$ = the loan balance at time t
$\mathrm{commit\ fee}_t$ = the commitment fee at time t
$\mathrm{unused\ commit}_t$ = the unused commitment at time t
$\mathrm{facility\ fee}_t$ = the commitment facility fee at time t
P = the principal value of the loan
prepay_t = the amount that is prepaid or refinanced at time t
$\mathrm{prepay\ penalty}_t$ = the possible penalty with regard to the prepayment at time t
$\mathrm{commit\ drawdown}_t$ = the commitment drawdown on the unused commitment at time t
$\mathrm{recovery\ rate}_t$ = the recovery rate on the loan facility at time t
$\mathrm{term\ out\ opt}_N$ = the value of the option to extend loan value for a fixed term at time T
I = {1,2,3,…,N}
$\mathrm{unused\ commit}_0 = P$
$\mathrm{loan\ bal}_t \geq 0$
$0 \leq \mathrm{prepay}_t \leq \mathrm{loan\ bal}_{t-1}$
$0 \leq \mathrm{commit\ drawdown}_t \leq \mathrm{unused\ commit}_{t-1}$

[51] (Tschirhart, O'Brien, Moise, & Yang, 2007).

Appendix 2: Market value calculation sheet

This Appendix refers to the attached Excel sheet, in which the orange cells are input cells. The gray cells are calculation cells. The calculations made are explained in subsection 5.2.5.

Deleted

Figure 8 – Screenshot of the market value calculation sheet

The sheet can also be used to apply the theoretical method at any time point. The valuation point is in that case seen as t = 0 and inputs are used from the perspective of the valuation point, meaning that they are estimated using the information at the valuation point. The cash flows paid before the valuation point and the probability that the borrower has survived until the valuation point are not taken into account. When this is done the result of the theoretical method is shown at the results.

Appendix 3: Input & results loan facilities

In this Appendix both the inputs and the results of applying the methods on the selection of loan facilities are illustrated. The input sheet and result table of the first loan facility in the selection are already given in subsection 5.2.5. For completeness these are given in this Appendix again.

Because the loan characteristics and the actual market values of the loans are confidential, all figures and tables in this Appendix are removed.