

NORGES HANDELSHØYSKOLE

Bergen, spring 2010

Master thesis within the main profile of Financial Economics

Thesis Advisor: Prof. Dr. Thorsten Hens

# Utility evaluation of structured products

*Was it a sound decision to practically ban  
structured products in Norway?*

by Ragnar Kjos

This thesis was written as a part of the Master of Science in Economics and Business Administration at NHH. Neither the institution, the advisor, nor the sensors are - through the approval of this thesis - responsible for neither the theories and methods used, nor results and conclusions drawn in this work.

## Executive summary

This master thesis in behavioral finance investigates whether it was a sound decision to practically ban structured products from the Norwegian markets. The thesis also discusses the relationship between culture and investment behavior.

The prospect theory analysis shows that an irrational investor can increase his utility by investing in structured products compared to the alternative investments. Contrarily, a rational investor will halve his utility by doing the same. The main conclusion is that investing in structured products is irrational, and that it was a sound decision to practically ban structured products from the Norwegian market.

An investigation of the potential link between cultural dimensions and investment choices and behavior concludes that a Swiss investor has more than 50 percent greater utility from the access to structured products than a Norwegian investor, which strengthens the hypothesis of a close relationship between cultural dimensions and investment choices.

# Preface

I have been honored to have Prof. Dr. Thorsten Hens, Director of Swiss Banking Institute, and Professor of Financial Economics at the University of Zurich, to supervise this thesis. I am grateful to him for patiently answering my numerous questions and for giving me precious advices and fruitful comments throughout the working process of this thesis.

I would also like to address my regards to Geir Magne Bøe, PhD student at the Norwegian School of Economics and Business Administration, for sharing his datasets as well as generating new sets on request. Likewise I would like to express my thankfulness to Assistant Professor Valeri Zakamouline at the University of Agder. He has provided complete datasets that have been valuable for this thesis.

Finally, I am thankful to all other contributors to this thesis.

Bergen, 16 June 2010

---

Ragnar Kjos

# Contents

1	Introduction .....	10
1.1	Introduction .....	10
1.2	Problem set .....	11
1.3	Structure of the paper .....	12
2	Structured products .....	13
2.1	What is a structured product? .....	13
2.2	Structured products in Norway .....	18
3	Decision theory .....	26
3.1	Introduction to decision theory .....	26
3.2	Mean-variance analysis .....	26
3.3	Expected utility theory .....	28
3.4	Prospect theory .....	33
3.5	The behavioral investor .....	43
3.6	Cultural dimensions and investors' behavior .....	46
4	Utility calculations of structured products .....	51
4.1	Introduction to the analysis .....	51
4.2	Generic assumptions and criteria .....	60
4.3	DnB Global 2000/2006 .....	62
4.4	DnB Sektor 2000/2006 .....	64
4.5	Orkla Finans Absolutt Europa II .....	65
4.6	Fokus Bank Råvareindeksobligasjon olje 2007-2008 .....	67
4.7	Acta Japansk Eiendom 2007-2010 .....	69
4.8	DnB Nor Kraft 2007/2009 .....	71
4.9	Nordea Lock-in Basket 2006-2010 .....	73
4.10	Storebrand Spread Aksjeindeksobligasjon 2006-2010 .....	75

4.11	Discussion .....	77
5	Cultural background and its influence on investment choices .....	92
5.1	Assumptions and parameters .....	92
5.2	Utility analysis .....	92
5.3	Discussion.....	95
6	Conclusions and final comments.....	100
6.1	Conclusions .....	100
6.2	Weaknesses of the report and future research .....	101
7	References .....	103
8	Appendices .....	110
	A - Calibration of dataset .....	110

## List of figures

Figure 1 - The different players in the market for structured products .....	14
Figure 2 - Risk-return ranking of different asset classes.....	15
Figure 3 – The composition of a capital protection product .....	16
Figure 4 – Invested amount in structured products from 2003-2009, and the distribution between AIO and BMA.....	19
Figure 5 - Mean-variance utility function .....	27
Figure 6 - Analytical representation of the preference order .....	29
Figure 7 - Analytical representation of the expected utility theory.....	30
Figure 8 - Representation of risk aversion, risk premium, and certainty equivalent (Bachmann & Hens, 2008) .....	31
Figure 9 - Analytical representation of prospect theory.....	35
Figure 10 - A graphical presentation of Kahneman and Tversky’s value function (Bachmann & Hens, 2008) .....	37
Figure 11 - Kahneman and Tversky’s piecewise power function .....	38
Figure 12 – Certainty equivalent expression of the power value function.....	38
Figure 13 - Presentation of a hypothetical weighting function .....	40
Figure 14 – Analytical representation of the probability weighting function .....	41
Figure 15 – Normalized prospect theory (NPT).....	42
Figure 16 – Desired payoff by a behavioral client (Bachmann & Hens, 2008).....	44
Figure 17 – Payoff diagram of a possible optimal structured product (Bachmann & Hens, 2008).....	45
Figure 18 – Hofstede’s five dimensions of culture .....	47
Figure 20 - Cultural differences based on Hofstede’s cultural dimension score .....	49
Figure 21 – The different steps of the analysis process .....	53
Figure 22 – The quality of the datasets for each product .....	60
Figure 23 – Payoff diagram of DnB Global 2000/2006.....	63
Figure 24 – Utility calculations of DnB Global 2000/2006 and the respective alternative investments.....	63
Figure 25 – Payoff diagram of DnB Sektor 2000/2006 .....	64
Figure 26 - Utility calculations of DnB Sektor 2000/2006 and the respective alternative investments.....	65

Figure 27 – Payoff diagram of Orkla Finans Absolutt Europa II.....	66
Figure 28 - Utility calculations of Orkla Finans Absolutt Europa II and the respective alternative investments .....	67
Figure 29 – Payoff diagram of Fokus Bank RIO olje 2007-2008 .....	68
Figure 30 - Utility calculations of Fokus Bank RIO olje 2007-2008 and the respective alternative investments .....	69
Figure 31 – Payoff diagram of Acta Japansk Eiendom 2007-2010 .....	70
Figure 32 - Utility calculations of Acta Japansk Eiendom 2007-2010 and the respective alternative investments .....	71
Figure 33 – Payoff diagram of DnB Nor Kraft 2007/2009 .....	72
Figure 34 - Utility calculations of DnB Nor Kraft 2007/2009 and the respective alternative investments.....	73
Figure 35 – Payoff diagram of Nordea Lock-in Basket 2006-2010.....	74
Figure 36 - Utility calculation of Nordea Lock-in Basket 2006-2010 .....	75
Figure 37 - Payoff diagram of Storebrand spread 2006-2010.....	76
Figure 38 - Utility calculation of Storebrand spread 2006-2010.....	76

## List of tables

Table 3.1– Prospect theory parameter values of Norwegian and Swiss investors .....	50
Table 4.1 - Overview of the sample of structured products .....	55
Table 4.2 – Summary of findings .....	77
Table 4.3 – The difference between the structured product and the adjusted classical investment .....	78
Table 4.4 – The differences between the structured product and the two alternative investments.....	80
Table 4.5 – The differences in utility between the structured product and the alternative investments for the Norwegian investor and the K-T investor .....	83
Table 4.6 – Utilities of structured products when the reference point is equal to zero compared to reference point equal to the risk-free rate of return.....	84
Table 4.7 - Utilities of the $C_R$ investments when the reference point is equal to zero and the risk-free rate of return .....	85
Table 4.8 – The free design effect of the structured products for reference points equal to zero and to the risk-free rate of return.....	85
Table 4.9 - Utilities of the structured products for $\gamma$ equal to one and $\gamma$ equal to 0.65 .....	86
Table 4.10 – Utilities of the structured products for $\gamma$ equal to one compared to the risk-free rate of return .....	87
Table 4.11 – Utilities of the structured product and the classical investments for $\gamma$ equal to one .....	88
Table 5.1 – Comparison of structured product utilities between the K-T and the Norwegian investor .....	93
Table 5.2 - Comparison of structured product utilities between the K-T and the Swiss investor .....	94
Table 5.3 - Comparison of structured product utilities between the Norwegian and the Swiss investor .....	94
Table 5.4 – Utility comparison of the $C_F$ investment between a Norwegian and a Swiss investor .....	97
Table 5.5 – Differences in utility from the structured products between a Norwegian and a Swiss investor.....	97
Table 5.6 – The free design effect for the Norwegian and the Swiss investor.....	98
Table 8.1 – Original input data from Bøe .....	111



Table 8.2 – Calibrated dataset ..... 112

# 1 Introduction

## 1.1 Introduction

Do you wish to profit from the return potential of stock markets without the risk of losing your money? Does not the idea of an investment where you cannot lose any money, just win, sound compelling? In that case you are certainly not alone! In spring 2006 Norwegians had invested close to NOK50bn in products apparently offering such a deal.

A general term for these products is structured products. By combining two or more securities a structured product allows for a variety of risk-return combinations that classical investments such as stocks and bonds do not allow for. They are offered by financial institutions, most commonly banks, and the typical buyer is a small private investor.

A search for “structured products” on the Norwegian version of Google immediately returns the following newspaper headlines: “Interdiction of structured products” and “Academia slaughters the banks”. These headlines give a good indication on the ruling sentiment for structured products in Norway. Through articles, papers, and reports media and academia have heavily criticized structured products and blamed the banks for being greedy. This has placed structured products in an unfavorable light.

However, there are clearly some bright sides of structured products. Indeed, the products could be good investment alternatives for smaller investors. The products allow small private investors to invest in commodities and indices that would otherwise be inaccessible. Further, the risk-return profiles of the structured products are more complex than investments in stocks. Finally, the payoff structure is tailored to fit the investor’s feelings and needs. In this way we can say that structured products could be more personal than other investments.

One reason for the heavy criticism against structured products in Norway could be that the vast majority of analyses so far have been limited to classical financial valuations. In this paper I will not conduct such an approach. Instead I will apply behavioral finance theory.

The world of behavioral finance is a world in which human emotions rule, logic has its place, but markets are moved as much by psychological factors as by information from corporate balance sheets (Montier, 2002). Empirically, behavioral finance both explains the evidence that appears anomalous from the efficient markets perspective, and generates new predictions that have been confirmed in the data (Shleifer, 2000).

The best known theory within the field of behavioral finance is prospect theory. Prospect theory is a descriptive framework of choice in the face of risk, and it is a psychologically based theory. It emerged as an alternative to the expected utility theory as the inconsistency between the theory and real life experiments became clearer.

I will use prospect theory to analyze structured products. This allows me to combine psychological perspectives of the investor's mindset with financial theory and still have a quantitative result. Further, the prospect theory approach allows me to take the investor's perspective. Instead of saying what price the financial institution should have charged for the products, I look at what utility the investor achieves from the products.

As mentioned, structured products in Norway have been heavily criticized. The reputation of the products has become horrible during the last five to ten years. Some even claim the banks, by selling structured products, have sacrificed their clients on the altar of greed. Eventually, regulations tightened, and structured products were practically banned from the Norwegian markets in 2008.

Looking across borders the situation is different, and structured products have a stronger reputation. For instance, in Switzerland they are immensely popular. In 2007 more than 20,000 products were listed on the Swiss stock exchange, and around seven percent of invested assets were held in structured products!

Naturally, the question rises; was it a sound decision to practically ban these products in Norway while they are so popular in other countries?

## **1.2 Problem set**

Indeed, the main research aim of this master thesis is to answer the question I just asked. More precisely, it is to analyze whether the banning of structured products in Norway was a sound decision. In order to conclude upon this, I will perform utility calculations of structured product investments and the related alternative investments, and compare the utilities from each investment. I will also use my findings to investigate how cultural dimensions can influence investment choices.

### 1.3 Structure of the paper

In chapter two I give an introduction to structured products, with emphasis on structured products in Norway. I also define the generics of the structured products offered in the Norwegian market.

Next, in chapter three, I briefly present the evolution within the field of decision theory from the mean-variance theory via expected utility theory to prospect theory. I elaborate on the elements of prospect theory, as well as on the link between cultural dimensions and investors' behavior.

Chapter four presents my findings on the utility of structured products offered in Norway based upon the classical Kahneman and Tversky prospect theory parameters with variations, compared to relevant alternative investments.

In chapter five I use Norwegian and Swiss prospect theory parameters on the product sample to see how cultural differences affect the utility of structured products, and thereby investment behavior.

Chapter six summarizes the elements and findings of the thesis. It also suggests topics for further research, and I discuss weaknesses of the thesis.

## 2 Structured products

In this chapter I will elaborate on the characteristics of structured products, and I will present the development of the market for structured products in Norway. Towards the end of the chapter I will define the generic characteristics of the products offered in Norway.

### 2.1 What is a structured product?

In this part I will go through the basics of structured products. I will define what a structured product is. Further I will explain how they are constructed and who the main market players are, and why they are attractive.

#### 2.1.1 Definition

There is no uniform or consistently embraced definition of structured products. The US Structured Products Association, SPA, define structured products as “a security or other instrument (e.g., a bank deposit, commercial paper, senior or subordinated debt security or note, warrant, etc.), the return on which is based on the performance of one or more reference assets, which may include stocks, indices, funds, commodities, exchange rates, etc.” (SPA, 2008).

Another definition explains the product as a “combination of classical assets such as stocks, bonds, and indices with at least one derivative, into a bundle that shall have specific interesting features for investors, like capital protection or increased participation” (Hens & Rieger, 2009).

A third explanation of structured products is given by the Financial Supervisory Authority of Norway, or Finanstilsynet. This institution will hereby be referred to as the FSA. They describe structured products as investment products that consist of a deposit or a zero coupon bond, and a derivative where the deposit is the safe element of the structured products assuring the investor to get back at least his initial investment at maturity whereas the derivative is supposed to generate return above the guaranteed payoff (Kredittilsynet, 2008).

It is interesting to notice that when the FSA describes structured products, they define them as capital protection products.

### 2.1.2 The market players

According to FSA there are three players in the market for structured products (Finanstilsynet, (2), 2008). These are the buyer, the manufacturer, and the distributor. Figure 1 explains the role of these players in the market.

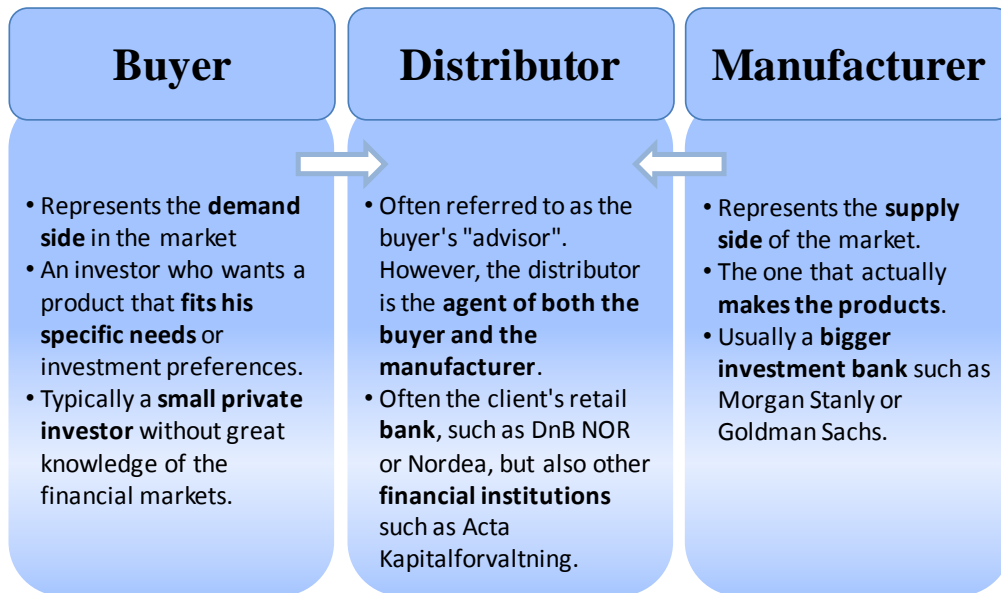


Figure 1 - The different players in the market for structured products

From the illustration we notice the double role of the distributor. This can create conflicts. On the one hand the distributor is serving the needs of the buyer and giving investment advices. On the other hand the distributor serves as a sales person of the manufacturer.

In the rest of the paper, when referring to the distributor of structured products, I will use the terms bank and financial institution reciprocally although they in reality are different players and have different roles. For instance, Acta Kapitalforvaltning is not a bank, but a company providing investment services. However, when it comes to structured products they share the same role in Norway; they distribute them. Therefore this reciprocal use of terms is acceptable.

### 2.1.3 Risk-return positioning of structured products

In terms of risk and return structured products are situated somewhere in between an investment in stocks and a risk-free investment, also referred to as a bank deposit. This is illustrated in Figure 2.

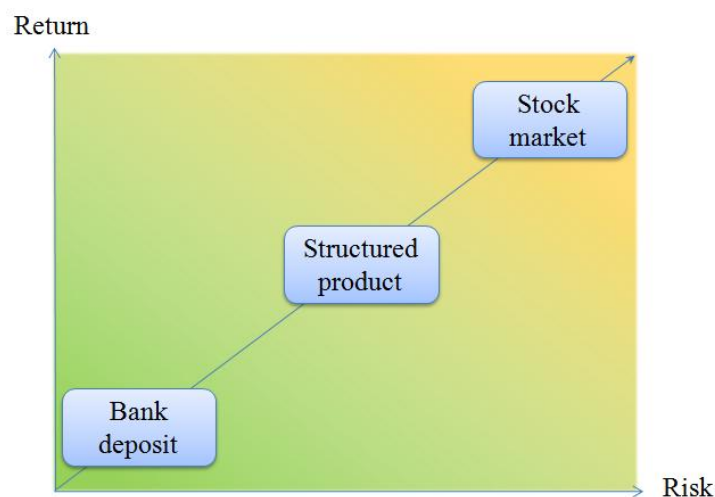


Figure 2 - Risk-return ranking of different asset classes

This figure is meant to illustrate the risk-return ranking of different asset classes to provide a clearer understanding of the properties of structured products. It is an illustrative sketch, and should not be understood as a precise prediction of the risk and return of different asset classes.

Assuming the bank runs no default risk, or at least that the deposits in the bank are guaranteed by a third party, bank deposit is typically regarded as a risk-free investment. Since there is no risk, the return is low. In the other end of the scale we find the stock market. Here the investor faces downside risks as well as upside risks. This means that in the same way the investor risks to lose his money, he also risks to make a profit on his money. The expected return from the stock market is superior to what the investor could expect from a bank deposit. In between the stock market and a bank deposit we find the typical structured product. The risk is lower than for an investment in the stock market, but so is the return. However, the return is higher than what a bank deposit yields, but so is the risk.

#### 2.1.4 Different types of structured products

There are many types of structured products. They may differ from bank to bank and country to country. Still there are some similarities in the global markets. Comparing the German, Swiss and US market for structured products, we can find that three of the same product types are in the top list of the three countries. These are discount certificates, bonus certificates and reverse convertibles (Hens & Rieger, 2009).

When it comes to the Norwegian market, there were two main categories of structured products offered; AIOs and BMAs. AIO is the abbreviation for “Aksjeindeksobligasjoner” or

protected equity note, whereas BMA is the abbreviation for “Banksparing med aksjeavkastning” or market-linked certificate of deposit (Quinn, 2009). The dominating structure of these products has been capital protection products, constructed on a call-option (Klype, 2006).

### 2.1.5 The construction of a typical structured product in Norway

A typical structured product offered in the Norwegian market consists of three elements; a certificate of deposit or a zero coupon bond to create the capital protection, an investment in a derivative to generate a return, and fees.

Figure 3 illustrates how a capital protection product constructed on a call-option is constructed, and includes a numerical example as well.

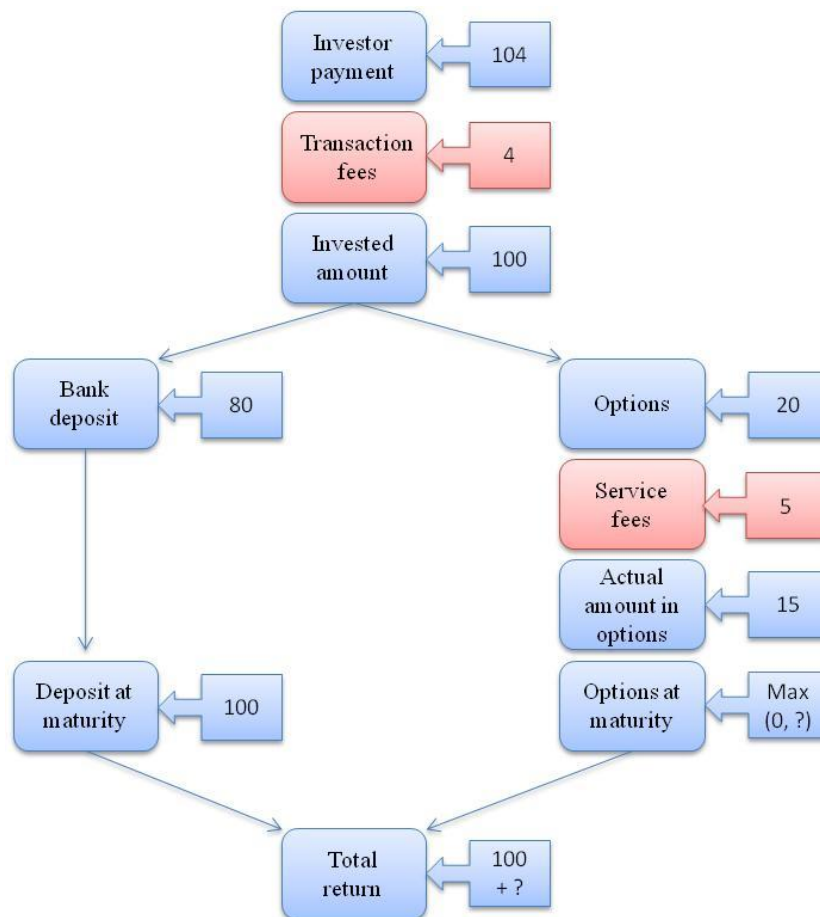


Figure 3 – The composition of a capital protection product

In this capital protection product the investor is guaranteed to get his invested amount (100) back at maturity. However, what he pays is slightly higher (104) due to transaction fees (4) charged by the bank. To secure the invested amount the bank invests a sum equaling the present value of a five year bank deposit in a certificate of deposit (80). How big this risk-free



investment is depends on the risk-free rate of return. Normally the risk-free investment is somewhere from 80 to 90 percent (Bøe, 2007).

The remaining amount is invested in some kind of derivative (20). The underlying of the derivative is one or more indices related to stock markets, exchange rate markets, commodities market, interest rate market and so forth. The return on the structured products is therefore somewhat related to one of these indices.

The amount invested in the derivative, in our case an option, is not the real investment, because the bank charges a service fee. This fee partly goes to the bank, and partly to the manufacturer of the product (Johnsen, 2008).

The investment in the option (15) serves as the return generator of the product. Even though this investment fails, meaning that the option at maturity has a value of zero, the bank still has the deposit which at maturity is equal to the invested amount (100). This is what will be paid back to the investor. Therefore the investor cannot lose his invested amount, and his capital is protected.

However, the investor does not break even on the investment by having the invested amount back at maturity. To break even he must realize a return of the product that is equal to the return of the alternative investment which is 104 times the risk-free rate. I use the risk-free rate because I assume that the real alternative of the investor is to put his money on the savings account.

If the product is debt financed, which has been frequent in Norway, the expected return that is necessary for the investor to break even must naturally be higher since there is an interest margin related to the debt financing, as well as some extra fees.

### **2.1.6 The attractiveness of structured products**

In the Norwegian market the typical investors in structured products are smaller private investors who are looking for a higher return than what a risk-free deposit generates (Bøe 2007). Why are these private investors attracted by structured products? And why do financial institutions sell them? One reason is the different risk-return profile the product offers compared to a direct investment in the underlying (Klype, 2006). However, one may ask why the investor could not hold the same positions as the structured product by investing directly in the derivatives market himself. This would be more profitable for the investor since he would not have to pay the fees to the financial institution and thereby increase his actual

return. In case of a professional investor with a considerable capital base it is hard to find the reasons why not. However, in the case of a small private investor there are at least three main reasons (Hens & Rieger, 2009). Firstly the private investor has inferior knowledge compared to the bank. Secondly he has inferior access to the derivatives market and markets in general. For instance, a small private investor would normally not have access to indices linked to the Japanese real estate or indices linked to the spread between two indices. Thirdly, complex SPs require dynamic hedging methods that are out of reach for the private investor.

In other words it is a question of competency, market access and technology. And there is also a question of size. By selling the same product to thousands of customers the bank can achieve economies of scale and push margins down.

From the bank's point of view structured products are profitable for at least two reasons. Firstly the bank can charge fees to the investors, as we have seen. Secondly the investments provide the bank with relatively cheap funding through deposits or bond issues. If the investor leverages his position through the same bank it can charge an interest rate margin as well. In both cases the bank has no risk exposure.

## **2.2 Structured products in Norway**

In this part I will elaborate on the development of the market for structured products in Norway. Firstly I will look at the history. Thereafter I will go through the regulations of structured products and see how they have developed. I will also present the main critical arguments towards structured products in Norway. In the last part I will define the generic characteristics of structured products offered in the Norwegian market.

### **2.2.1 History**

In 1992 structured products were introduced to professional investors in Norway (Bøe, 2007). In the mid 90s the products were offered to private investors. The market for structured products developed rapidly during the following decade (Klype, 2006). It peaked in summer 2006 with NOK48.8bn invested (SSB, 2010). More than 90 percent of this amount was held by private investors (Almklov, Tørum, & Skjæveland, 2006). At this time the majority of banks marketed structured products (Klype, 2006). The magazine *Dine Penger* claims that structured products have been sold to as many as 150,000 clients in Norway (Ormseth, 2009). By the end of 2009 there was about NOK19.9bn invested in structured products in Norway (SSB, 2010).

Figure 4 shows the development of total amount invested in structured products in Norway from 2003-2009 based on figures from SSB (SSB, 2010).

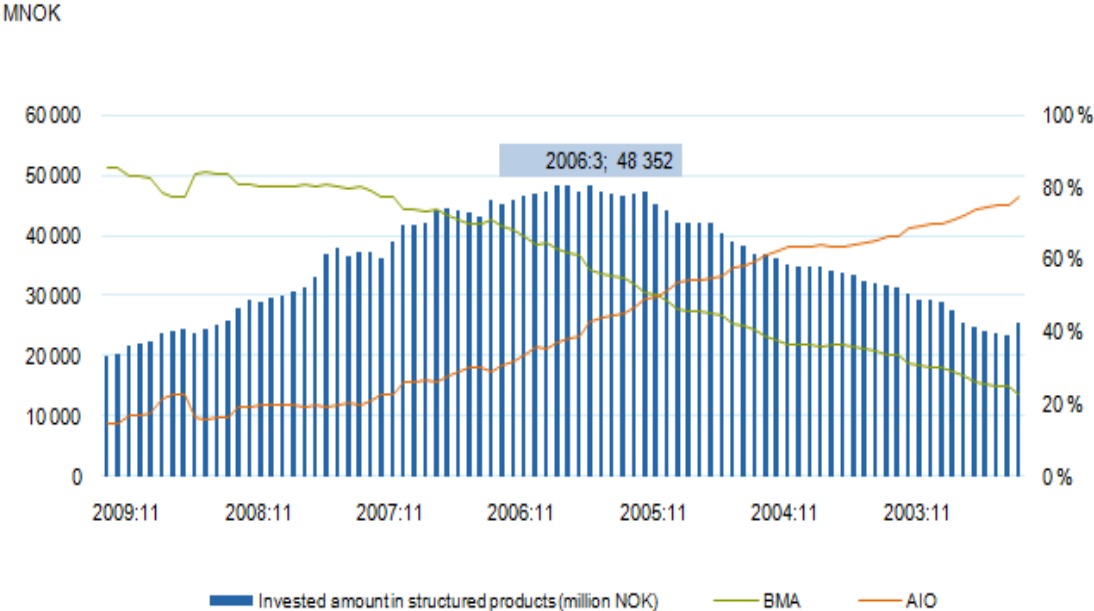


Figure 4 – Invested amount in structured products from 2003-2009, and the distribution between AIO and BMA

We see that the investments peaked in March 2006 with NOK48.4bn. AIOs dominate until the end of 2005. From 2006 BMAs take over as the most popular category of structured products and by November 2009 85.2 percent is invested in BMAs. In general we see that the investments have declined steadily since the peak. This declining trend could be explained by bad publicity in the media, and new regulations (Kredittilsynet, 2008). As a matter of fact, since 2008 structured products were practically banned from the market as a consequence of new regulations.

The financial institutions can allow for debt financing of the structured products, and they can provide the credit themselves. This was especially the case for Norway (Quinn, 2009). Indeed, the debt financing of the products soared over the period. By year end 2006, NOK34bn of the total investments of NOK45.8bn in structured products in Norway were financed by debt. To put in more clearly, about three out of four kroner invested in structured products were financed by debt (SSB, 2010). The debt financing peaked in October 2007 with 83.3 percent of the amount invested financed by debt (SSB, 2010). The Norwegian Ministry of Finance practically banned debt financing of structured products in 2008 (Forbrukerrådet, 2009).

## 2.2.2 Criticism and regulations

Criticism and regulations are closely linked. When the critical voices become loud enough, regulators have to react. In this part I will give a chronological presentation of the development of regulations of structured products in Norway. I will also present the main arguments against the products.

### 2.2.2.1 Regulations

Throughout the 2000s there has been a development from very soft regulations towards firm regulations and indeed to what is called a complete stop to the purchase of structured products in Norway (Finanstilsynet, 2008).

The first circular from the Financial Supervisory Authority of Norway concerning structured products is dated 16 February 2004. It gives guidelines about the disclosure of information required from providers of structured products in Norway (Finanstilsynet, 2004). Its purpose is to make sure the clients could assess, compare and choose among different structured products. In order to do so the clients need to be properly informed about the price, fees and margins charged by the provider (Finanstilsynet, 2004).

A second circular is dated 25 September 2006. This circular replaces the circular from 2004, and gives further and more detailed guidelines about the requirements to the information disclosed in relation to the structured products, and also to the advisory process related to the sale of structured products (Finanstilsynet, 2006).

MiFID (Markets for financial instruments directive), applying to all banks and financial institutions in Europe and their clients, is introduced in Norway in 2007 with effect from 1 November 2007 (Nordea, 2007). It is a codification of existing law and implies stronger consumer protection (Forbrukerrådet, 2009). In relation to compliance to this directive is the introduction of a new law regarding securities trading, introduced 29 June 2007. A circular of 10 July 2007 related to the new law explains that banks and financial institutions from now on need to obtain a concession if financial advisory services related to *specific financial instruments* are to be offered to its customers (Finanstilsynet, 2007). In my understanding financial institutions now needed concession to sell equity-indexed bonds (AIOs). However, sale of index-linked bank deposits (BMAs) did not need concession since BMAs were not considered a financial instrument.

This situation lasted until the changes in Regulation of 25 September 2006 nr. 1317 on the duty of disclosure in relation to structured products offered for purchase took effect on 1 March 2008. From now on many of the regulations related to investor protection were to apply to the sale of BMAs. As a consequence of these changes, the regulations for the sale of BMAs become identical to the regulations for the sale of AIOs (Finanstilsynet, 2008), meaning increased investor protection.

In relation to the changed regulation mentioned above, the FSA wrote a circular (4/2008) that to a large extent put an end to structured products in Norway. In the circular the FSA presupposed that institutions should not sell structured products to customers who could not be regarded as professional investors. Moreover, the FSA advised institutions against offering debt financing when selling structured products (Finanstilsynet, 2008). The FSA emphasized that the financial institutions have a duty to do an assessment of the client, and have a duty to inform about all costs related to the investment.

The purpose of the assessment was to make the financial institution capable of assessing which specific financial instruments or investment services are in line with the investment goals of the client (Kleven, 2008). It must reveal the client's financial situation, investment goal and knowledge (Forbrukerrådet, 2009). The financial advisors have to document that such a test of the client has been done. The information obtained in the test is to be used to assess which investment solutions serve the client the best, and thereby should be recommended. The financial institution must make sure that the products offered are compatible with the client's investment goal, that the client is financially capable of bearing the risks and that the client has sufficient and necessary knowledge and experience to understand the risks (Kleven, 2008).

Moreover, the circular states that expensive investment products cannot be recommended if the client's investment goal can be reached by investing in a cheaper product (Kleven, 2008).

In a press release related to the circular, the Director General (at that time) Bjørn Skogstad Aamo at the FSA stated (Finanstilsynet, 2008):

*"The new regulations mean in practice a complete stop to the purchase of structured products financed by loans. Further, the regulations mean that banks and other financial institutions will normally not be selling such products to normal savers, who cannot be regarded as professionals in this context."*

After the introduction of the new regulations, the invested amount has surged dramatically (Finanstilsynet, (2), 2008). Indeed, it has practically stopped (Finanstilsynet, 2009).

### *2.2.2.2 Criticism*

Structured products existed for many years before critical voices started to be heard<sup>1</sup>. As we have seen, the products are now practically forbidden in Norway. According to professor Bjerksund at NHH the estimated aggregated losses of the investors are about NOK10bn (Ormseth, 2009).

According to Bøe (2007) there are three major areas of criticism; debt-financing, misleading prospects, and a complicated structure of the products hiding high fees (Bøe, 2007). From my observations of media, academia and authorities, including Bøe's work, I have deduced the following three areas of criticism; debt financing, the complexity of the products, and the advisory and marketing process.

#### *2.2.2.2.1 Debt financing*

Let us start with the debt financing of structured products. According to the Norwegian Consumer Council, Forbrukerrådet, debt financing of structured products is a Norwegian phenomenon (Forbrukerrådet, 2009). The debt financing of structured products made it possible even for clients without any savings or in a mediocre financial situation to make big investments in the products. This was because the default risk of a debt financed structured product was limited to interest payments since the majority of the invested amount was placed in risk-free assets (Quinn, 2009).

One cannot reject the hypothesis that it was the easy access to debt financing that ultimately banned the products in Norway. The debt financing was to a large extent motivated by the banks' hunts for profits. About  $\frac{3}{4}$  of the investments in structured products have been financed by debt. In a study by NHH professor Thore Johnsen, he concludes that investment in 100 percent debt financed structured products had lower return than the risk free rate. The products he investigated had a yearly loss of 2.2-2.3% compared to a risk-free return (Johnsen, 2008).

Professor Bjerksund is harsh in his critics (Tørring & Hansen, 2008). He says that the debt financing is just a cunning way to wrap in an extra cost. He claims the banks would never

---

<sup>1</sup> The exception is Geir Ormseth in the magazine *Dine Penger*, who for a long time fought alone to put focus on the very limited return potential of structured products.

have succeeded in selling this product to professional investors and that they would have laughed of the products.

#### 2.2.2.2.2 Product complexity

A second area of criticism is related to the complexity of the products. The complexity of the products made it very hard for non-professional clients to understand the costs, margins and fees of the products, as well as the risks and return possibilities (Finanstilsynet, (2), 2008). According to Bjerksund no ordinary bank client could fully understand the products without financial expertise (Tørring & Hansen, 2008).

Moreover, construction and distribution of structured products may have been highly motivated by the fact that the income of the middle men was hidden to the investors (Kleven, 2008). Yield calculations of 350 structured products with maturity before third quarter 2007 and issue date from 1997 illustrate that most of the equity financed and debt financed structured products do not generate additional yields compared to an investment without risk (Aamo, 2008). In a study by NHH professor Thore Johnsen, he concludes that the banks charged 25 percent of the invested amount in costs and hidden fees in case of a 100 percent debt financed product. For equity financed products the number is 20 percent (Johnsen, 2008)<sup>2</sup>.

The FSA concludes that it is reason to believe that increased focus on the return possibilities of structured products has contributed to the decrease in sale of structured products (Finanstilsynet, (3) 2008). From this it is natural to conclude that as soon as the clients understood the actual fees charged on the structured product investments, they did not find them very attractive anymore.

#### 2.2.2.2.3 Advisory service and marketing process

A third area of criticism is the advisory process and the marketing of the products. In the advisory process there is reason to believe that sales personal, advisors, and marketers did not have good enough understanding of the products (Finanstilsynet, (2), 2008). Another report by FSA concludes that the banks did not separate between advisory services and sales (Finanstilsynet, (3) 2008).

---

<sup>2</sup> Even though this report was written on two specific products from one specific bank, the findings can be generalized to apply on the vast majority of all debt financed structured products in the market. Indeed, in a comment to Dine Penger Professor Koekebakker says that the two specific products are among the better products in the market, and that the majority of products are worse (Ormseth, Bankklagenemda latterliggjør DnB Nor, 2009).

Further, the sale force, distributors and advisors are accused of disguising the risks related to the products by labeling the product from a random characteristic and not its specific and most important characteristics (Kleven, 2008). The common inaccuracy in the description of the products could serve to disguise the specific risks related to each instrument.

In the marketing of the products misleading words like “guaranteed” and “stock market return” have been used and sold with false promises of “stock market return without risk” and “bank deposits with stock market return” (Omseth, 2008). In the previous mentioned study by professor Johnsen he claims the banks’ marketing has been irresponsible (Johnsen, 2008).

The marketing has been aggressive and the banks have manipulated their clients to invest in structured products (Omseth, 2008). According to professor Johnsen, the biggest bank in Norway, DnB Nor, have been telling untruths to its customers that would have failed any student in a basic finance class (Ormseth, 2009). Johnsen further claims that DnB Nor Markets apparently has limited knowledge of fundamental issues in investment management.

We see that the advisory process and the marketing of the structured products have been accused of being unprofessional and little serious.

The reputation of the banks has definitely suffered from the blast over structured products. 20 January 2009 the Complaints Boards of the Norwegian banking industry, Bankklagenemda, ruled that a client had been tricked by his bank to invest in structured product. They advised the bank to refund the investment (Omseth, 2008). This case is currently ongoing in the legal system. Dine Penger called the day of this announcement “*perhaps the blackest day in the history of Norwegian banking...this is namely a scam without parallel in the history of Norwegian banking*” (Staavi, 2009). Geir Ormseth in Dine Penger was even harsher in his judgment. He claimed “*the banks have sacrificed their credibility on the altar of greed*” (Ormseth, 2009).

### **2.2.3 Product trends in the Norwegian market**

In this section I will present the product trends typical for the Norwegian market. I will also look at the generic properties of the products offered in the Norwegian market.

As I mentioned in the beginning of this chapter, it is interesting to notice that the FSA describes structured products as capital protection products (Finanstilsynet, (2), 2008). Moreover, according to Klype (2006) the dominating structured products are capital



protection products. I therefore conclude that capital protection products have been the most typical product in Norway.

There is only one register for structured products, and this is in the data base of Norsk Tillittsmann, Trustee. The database only provides information on AIO volumes, since AIOs are bond-backed securities. However, there are no statistics available for BMAs.

The difference between an AIO and a BMA is according to DnB NOR very small. In terms of the underlying structure, there is in principle no difference. The difference lies in the liquidity of the paper, in the recognition on the bank's balance sheets, and the risk related to complete capital insurance. Since the products are generally the same, I conclude that the statistics from Trustee could be applied on the market as a whole.

According to data from Stamdata, the database of Trustee, among the ten biggest issues ever done, DNB Nor has six of them, including the two biggest, which are both six billion NOK each. In comparison, the third place is an issue of two billion NOK. The other banks among in the top ten are Nordea Bank Norge ASA, Sparebanken Hedmark, and Nordea Bank Finland Abp.

The product that has sold the most is DnB Global 00/06, is one of two products involved in what has become known as the Røeggen case. The Røeggen case is a legal law suit in which the small private investor Røeggen sues DnB Nor for advising him to invest in DnB Global 00/06 and DnB Sektor 00/06.

Returning to the generic product, based on interviews and other reports, it has the following properties:

- Lifetime is typically three to five years. Products issued in the beginning of 2000s had longer lifetime than products issued later in the decade
- The average volume is NOK120m, whereas the median volume is NOK60m
- The underlying is shares indices, typically three to four international indices
- Structure is Asiatic quanto option, often with Asiatic tale and no exchange rate exposure. The majority of the products are capital protection products

## 3 Decision theory

The domain of decision theory is more than 200 years old. It is about choice under uncertainty, and concerns how people ideally should make decisions, and how they actually do it. In this chapter I will present the mean-variance theorem, the expected utility framework and finally the prospect theory. I will present all the three theories because we need a general understanding of the evolution of decision theory to understand the rise of prospect theory. However, the majority of this chapter will be dedicated to prospect theory.

The text is to an extent and unless otherwise is explicitly stated, based upon chapter two in “Behavioral finance for private banking” by Hens and Bachmann (Bachmann & Hens, 2008).

### 3.1 Introduction to decision theory

We have at least two different approaches to decision theory; the prescriptive approach and the descriptive approach. The difference lies within the views of human behavior. The prescriptive approach focuses on how people *should* make decisions. It assumes an ideal decision-maker who is fully informed, able to compute with perfect accuracy and full rationality. Contrarily, the descriptive approach tries to describe how people *actually* make decisions. It includes the psychological aspects of people and assumes that people behave irrationally. The latter approach is becoming increasingly popular (Montier, 2002).

Daniel Bernoulli first defined the concept of expected utility. Almost two hundred years later the theory was made acceptable on the basis of some generally acceptable axioms by von Neumann and Morgenstern. However, during the 20<sup>th</sup> century it became clear that humans do not behave rationally, especially through the work of Allais and Ellsberg. Kahneman and Tversky founded a mathematical base to the behavioral approach with their prospect theory (Kahneman & Tversky, 1992).

### 3.2 Mean-variance analysis

The mean-variance theory focuses on how we should make choices. It is in other words a prescriptive approach. Fundamentally investors face a very basic choice; should they put their money in a savings account, or should they invest in other asset classes? The determining factors are risk and return. Whereas there is no risk related to the bank deposit, assuming no bankruptcy costs, there could be a substantial amount of risk related to investments in other asset classes. However, the return of the bank deposit is usually lower than for the other asset

classes. For instance, historically for long periods it can be found that stocks have a higher return than riskless investments.

In his ground-breaking portfolio theory from 1952, Markowitz proves the link between risk and return and recommends the investment rule of expected return versus variance of return (Markowitz, 1952). Since higher return is linked to higher risk, the highest return may not be the preferable choice for all investors.

Based on the investors' risk preferences, the mean-variance framework uses the utility function presented in Figure 5 to calculate each investor's position on the efficient frontier:

$$u^i(\mu, \sigma^2) = \mu - \frac{\alpha^i}{2} \sigma^2$$

**Figure 5 - Mean-variance utility function**

We see that the utility for the investor is determined by two factors; the risk-return opportunities in the market,  $\mu$  and  $\sigma^2$ , and the investor's risk aversion  $\alpha^i$ . The risk-return opportunities in the market determine a set of efficient portfolios, i.e. the portfolios of risky assets with minimum risk for any given expected return level. This set of portfolios forms the efficient frontier. The risk preference of each investor determines his location on the frontier.

The market opportunities are available and similar for all investors. What differentiates the investors is therefore the risk aversion. Each investor can have different attitudes towards risk. Some are risk seeking whereas some are risk averse. Thus, the risk aversion parameter may vary, and by consequence the investors may have different utilities.

James Tobin introduced in 1958 the two-fund-separation theorem which reduces the efficient frontier to one optimal point within a market. By consequence, the only element differentiating the investors is the amount invested in the optimal portfolio compared to the amount invested in risk-free assets (Tobin, 1958).

Today it is well-known that investors do not follow the two-fund-separation theorem. Nevertheless, it is interesting to notice that the mean-variance theory still holds a very strong position in portfolio choice (Campbell & Viceira, 2002).

We have so far looked at the basic principles of portfolio choices. Let us further continue with a model that can determine how we make rational decisions when there is a risk.

### 3.3 Expected utility theory

The expected utility theory is widely accepted as a normative model of rational choice and moreover as a descriptive model of economic behavior (Kahneman & Tversky, 1979). It provides a valuable guide for action and helps people think systematically about risky alternatives.

A common approach to expected utility theory is the lottery approach. This approach will be used when it is convenient throughout this paper.

#### 3.3.1 The fundamental tenets of expected theory

Kahneman and Tversky state that the application of expected utility theory to choices between prospects is based on three tenets, namely expectation, asset integration, and risk aversion (Kahneman & Tversky, 1979).

**Expectation:** The overall utility of a prospect is the expected utility of its outcomes.

**Asset integration:** A prospect is acceptable if the utility resulting from integrating the prospect with one's assets exceeds the utility of those assets alone. This means that the domain of expected utility is defined by final states, and not over gains or losses.

**Risk aversion:** A person is risk averse if he prefers the certain prospect  $x$  to any risky prospect with expected value  $x$ . In expected utility theory, risk aversion is equivalent to the concavity of the utility function. The practice of risk aversion is among the best known generalizations concerning risky choices. It led to the idea that utility is a concave function of money. This idea has been applied since the eighteenth century.

#### 3.3.2 Axioms of rationality

Before we have a closer look into the representation of the expected utility, it is time to look at the concept of rationality. There are at least four axioms that everyone agrees to and that everyone should follow and hence *tries* to follow if they want to make rational decisions. These axioms are called the axioms of rationality. We need them to define the concept of preference, which in turn is needed to define a choice or a behavior as rational. The four axioms of rationality are assumptions on completeness, continuousness, transitivity, and independence.

**Completeness** is about defining a preference of A over B, B over A, or that we are indifferent towards them. **Transitivity** is related to the consistency of the preferences, meaning that if

you prefer A over B, and B over C, then you prefer A over C as well. If not, you will systematically lose money. **Continuosity** of the preferences is a prerequisite when applying the utility function. We need this property to create a link between the decision-maker's preferences and the numerical values. With continuous preferences minor changes in the data will not lead to sudden jumps in the portfolio. Finally, the **independence** axiom says that you can mix two lotteries with the same third one without changing the preference order.

In addition to the four axioms, we introduce the axiom of state dominance, also called the "Axiom 0". This axiom is more basic than the four others. This axiom defines that if lottery A in each state pays off the same as lottery B, the investor should consider the two lotteries as equal. If additionally lottery A in at least one state pays off more than lottery B, lottery A should be considered as superior. If axiom 0 is violated, the investor acts irrationally.

### 3.3.3 Representation

We can state that the preferences defined over pairs of alternative outcomes can be represented by a utility function if and only if the preference relation is continuous, complete and transitive. More precisely, the expected utility is founded on the representation theorem that goes back to von Neumann and Morgenstern. Let  $\geq$  be a preference order that is complete, transitive and continuous, then  $\geq$  can be represented by an expected utility function if and only if  $\geq$  satisfies the independence axiom (Von Neumann & Morgenstern, 1944).

The first three axioms are needed to assign numerical values to the outcomes of lotteries to compare them. If the fourth axiom is satisfied, the preference order can be represented by an expected utility function. This representation states that if a decision-maker prefers lottery A to lottery B, then lottery A yields a greater expected utility to the decision-maker than lottery B, and vice versa. Mathematically this link is presented in Figure 6.

$$A > B \Leftrightarrow E_u(A) > E_u(B)$$

Figure 6 - Analytical representation of the preference order

A key advantage of the expected utility representation is that it separates beliefs from risk attitudes. This makes it a valuable guide for decision-making.

A very basic definition of expected utility can be found in textbooks on microeconomics. For instance Pindyck and Rubinfeld define it as "*the sum of the utilities associated with all*

possible outcomes, weighted by the probability that each outcome will occur” (Pindyck & Rubinfeld, 2009). Mathematically this can be expressed according to Figure 7.

$$E_u(x) = p_1u(c_1) + p_2u(c_2) + \dots + p_nu(c_n) = \sum_{i=1}^n p_iu(c_i)$$

Figure 7 - Analytical representation of the expected utility theory

$c_i$  represents each consequence that may occur, whereas  $p_i$  represents the probability that consequence  $i$  occur.

### 3.3.4 Certainty equivalent, risk premium, and risk preference

Related to the expected utility function there are some terms that should be defined. Firstly, the certainty equivalent payoff is a payoff that is regarded as good as playing the lottery. The certainty equivalent rate is the rate that risk-free investments must return to provide the same utility score as the risky lottery. In other words, it is the rate that, if earned with certainty, would provide a utility score equivalent to that of the lottery in question. The certainty equivalent rate of return is a natural way to compare the utility values of competing portfolios (Bodie, Kane, & Marcus, 2008). The utility of the certainty equivalent equals the expected utility from playing the lottery.

Secondly, risk premium is defined as the difference between the expected value of the lottery and the certainty equivalent. Thirdly, the concept of risk preference should be elaborated. A risk-averse decision-maker requires a positive risk premium to play the lottery, and his certainty equivalent is lower than the expected value of the lottery. On the other hand, a risk seeking decision-maker is willing to pay a positive risk premium to play, thus the certainty equivalent is higher than the expected value of the lottery. The risk preference of the decision-maker can be understood from the slope of the utility function. If the slope is convex, the decision-maker is risk-seeking. Contrarily, a concave slope represents a risk-averse decision-maker. If the slope is linear, the decision-maker is risk-neutral.

Figure 8 represents these terms graphically.

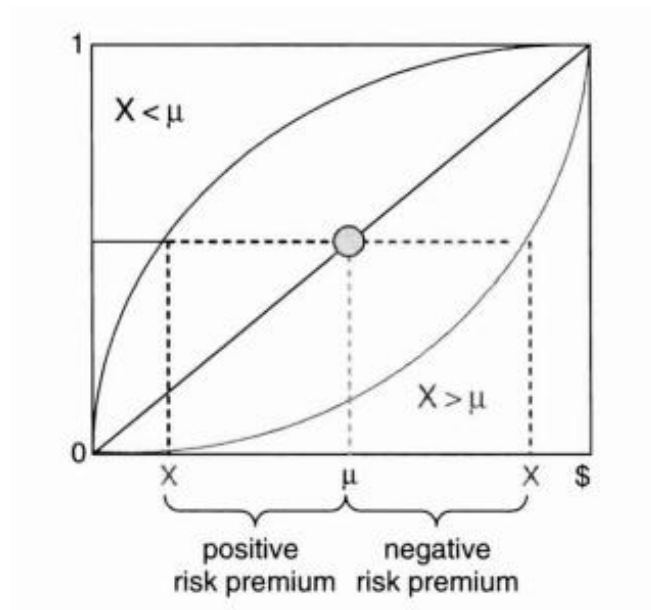


Figure 8 - Representation of risk aversion, risk premium, and certainty equivalent (Bachmann & Hens, 2008)

### 3.3.5 Violations of expected utility theory

In this section I will present some of the critics that rose against expected utility theory. This will give us an understanding of why a new theory was born. The present section is primarily based on the violations observed in experiments by Kahneman and Tversky (Kahneman & Tversky, 1979).

The axioms of rationality presented earlier in this chapter are issue of major criticism. The core of the criticism is that the axioms do not describe the real behavior of decision-makers. Economist Maurice Allais was the first to recognize that expected utility theory is not descriptive of how people generally make choices. This is known as the Allais paradox (Allais, 1953),(Shefrin, 2005). Daniel Ellsberg casted doubts on the basic premise of subjective expected utility theory that subjective probabilities are equivalent to objective probabilities (Ellsberg, 1961).

Through empirical work, Kahneman and Tversky found numerous violations of the tenets of expected utility theory (Kahneman & Tversky, 1979). They organized the violations into four effects; the certainty effect, reflection effect, probabilistic insurance, and the isolation effect.

#### 3.3.5.1 Certainty effect

The certainty effect says that people overweight outcomes that are considered certain, relative to outcomes that are merely probable. Hence, the certainty effect is a violation of the

substitution axiom which states that if B is preferred to A, then any probabilistic mixture (B, p) must be preferred to the mixture (A, p).

In a survey people were asked to choose between having 3000 with 100 percent certainty, or 4000 with 80 percent certainty. Then they were asked to choose between 3000 with 25 percent certainty and 4000 with 20 percent certainty. In the first choice 80 percent of the respondents chose 3000 for certain. However, in the second problem 65 percent of the respondents chose 4000 with 20 percent probability. The example shows that reducing the probability of winning from 100 percent to 25 percent has a greater effect on people's behavior than a reduction from 80 percent to 20 percent.

### *3.3.5.2 Reflection effect*

The reflection effect describes what happens when the signs of the outcomes of a prospect are reversed, so that gains are replaced by losses. Indeed, the reflection of prospects around zero reverses the preference order. By this one can conclude that people are risk seeking in losses, and risk aversion in gains, contrarily to what expected utility would have predicted. This effect was indeed early noticed by Markowitz (Markowitz, 1952). Additionally, the reflection effect eliminates aversion for uncertainty or variability as an explanation of the previously mentioned certainty effect.

Among the previous mentioned respondents (3000,1) was preferred to (4000, .80). However, swapping the signs reveals the opposite preferences, meaning that (-4000, .80) is preferred to -3000 with certainty. Similarly (-3000, .25) is preferred to (-4000, .20).

### *3.3.5.3 Probabilistic insurance*

The prevalence of the purchase of insurance against both small and large losses has been regarded by many as strong evidence for the concavity of the utility function for money. However, a closer look at the insurance programs that people prefer does not support the notion that the utility function for money is concave everywhere. One example is probabilistic insurance.

Probabilistic insurance is an example of an insurance problem where people's responses are inconsistent with the concavity hypothesis. It represents many forms of protective action where one pays a certain cost to reduce the probability of an undesirable event without eliminating it altogether. Empirical results indicate that probabilistic insurance is generally



unattractive. Contrarily, expected utility theory, with a concave utility function, states that that probabilistic insurance is superior to regular insurance.

#### **3.3.5.4 Isolation effect**

In order to simplify the choice between alternatives, people often disregard components that are common, and focus on the components that differentiate them. This approach to choice problems may produce inconsistent preferences, because a pair of prospects can be decomposed in many ways, and this sometimes leads to different preferences. In other words, two prospects that are equivalent in probabilities and outcome could have different values depending on their formulation. This phenomenon is referred to as the isolation effect.

We can conclude that expected utility theory is inappropriate to describe actual behavior. Let us now turn to the new model that arose on the failures of the expected utility theory.

### **3.4 Prospect theory**

So far we have looked at what could be called the traditional approach to risk. In the case of mean-variance analysis, we saw that the volatility was the unique risk factor driving decision-making under uncertainty. In the case of expected utility theory we saw that the variance was used as a risk measure, and we assumed that investors weight negative returns equally to positive returns. When we now turn to prospect theory, this is no longer the case.

#### **3.4.1 Background**

As we have seen earlier, the grandfathers of the expected utility framework, von Neumann and Morgenstern (1944), show that if preferences satisfy a number of plausible axioms - completeness, transitivity, continuity, and independence – then they are rational and can be represented by the expectation of a utility function (Von Neumann & Morgenstern, 1944). However, in the last quarter of the 20<sup>th</sup> century researchers and economists started questioning the expected utility theory (Kahneman & Tversky, 1992). More and more evidence showed that decision makers systematically violated the basic tenets of expected utility theory, and behavioral finance saw its formal beginnings in the 1980s (Thaler, 2005).

In the beginning of the 90s a common agreement took shape stating that the expected utility theory did not provide an adequate description of individual choice (Kahneman & Tversky, 1992). A variety of alternative models have been proposed, such as Camerer, Fishburn and Libby, and Machina. Machina proposes a general framework for describing generalized theories of choice under uncertainty (Machina, 1987). Camerer evaluated a series of

alternative theories of choice under uncertainty (Camerer, 1989). His general finding was that no single theory can account for the average choice patterns that people typically generate (Shefrin, 2005). Fishburn and Libby evaluated alternative descriptive models of individual risk-taking behavior in business decisions based upon a review of experimental studies (Fishburn & Libby, 1977).

However, prospect theory is by far the most well-known descriptive decision theory (Bachmann & Hens, 2008). It has gained much ground the last decade (Montier, 2002). In 2002 the authors were awarded the Nobel laureate. This reflects the importance of the theory. According to Thaler the prospect theory is the most promising theory for financial application and it is the most successful at capturing the experimental results (Thaler, 2005).

Prospect theory brings psychology into the heart of economic analysis. Limited possibilities of quantification are often a challenge when combining economic analysis and psychology. However, prospect theory has a solid mathematical fundament which makes it comfortable for economists to play with (Montier, 2002).

The grandfathers of prospect theory are the two psychologists Daniel Kahneman and Amos Tversky. In a paper from 1979 they presented an alternative decision theory that did take the violations of classical decision theory into account. Further, in 1992 they published an article with several improvements to their original theory, as well as extensions. As mentioned earlier, in 2002 they were awarded the Nobel laureate for their ground-breaking work.

The main difference between expected utility theory and prospect theory is that whereas expected utility theory is about how the world should be, prospect theory focuses on how the world actually is. In other words, it is a descriptive theory instead of a prescriptive approach (Montier, 2002). Prospect theory has its main strength in its descriptive validity. However, it is relatively complicated in deriving applications (Bachmann & Hens, 2008).

### **3.4.2 Theory**

Prospect theory is defined as “*a general psychological approach that describes the way people make choices among risky alternatives*” (Shefrin, 2007). It is best described by two phases. The first phase is the framing and the processing of a decision problem. The second phase is the evaluation (Bachmann & Hens, 2008).

The framing phase concerns psychological biases, heuristics, and how investors and individuals handle information. Due to limited capacity in the processing of a decision

problem, we tend to use heuristics or rules of thumbs as proxies to increase the speed of the processing (Montier, 2007). A bias is a predisposition toward error. A heuristic is a rule of thumb used to make a decision. I will not go deeper into the framing phase in this paper. For interested readers I recommend Shefrin (2007) and Montier (2002, 2007).

The evaluation phase consists of two elements. Firstly, it consists of a utility function defined over changes in wealth rather than over final wealth. This is known as the value function. Secondly, the evaluation phase consists of a probability weighting function allowing for objective probabilities to be replaced by subjective decision weights (Bachmann & Hens, 2008). The evaluation phase is expressed mathematically in Figure 9.

$$\sum w(p_i)v(x_i - r)$$

**Figure 9 - Analytical representation of prospect theory**

Parameter  $w(p_i)$  is a non-linear weighting function, while  $v(x_i - r)$  is the value function evaluated with respect to a reference point  $r$  which is determined by the subjective feelings of the individual.

These two elements in prospect theory are fundamentally different from what we find in the expected utility theory in at least two ways. Firstly, the risk approach in general is fundamentally different from the one in traditional finance. Traditional finance uses variance as the risk measure and suggests that individuals weigh negative returns equally to positive returns. Indeed, in the case of mean-variance theory volatility is the unique risk factor driving decisions under uncertainty. In contrast, prospect theory proposes that individual risk preferences depend significantly on gains and losses with respect to a certain reference point, meaning that risk preferences could not be derived solely from the mean (Bachmann & Hens, 2008).

Secondly, prospect theory allows the investor to have subjective beliefs on the probabilities of a consequence to occur. This means that the perceived probabilities can be different from the stated probability. Consequently, risks associated with particular decisions can be biased (Bachmann & Hens, 2008). The introduction of probability weighting makes the theory more difficult to work with compared to the expected utility theory.

Let us now have a closer look at the two abovementioned elements.

### 3.4.2.1 Value function

The value function is prospect theory's equivalent of classical economics' utility function (Montier, 2002). There are three essential properties that distinguish the value function from the expected utility function:

- It is defined on deviations from the reference point
- It is generally concave for gains and convex for losses
- It is steeper for losses than for gains, implying loss aversion

#### 3.4.2.1.1 The reference point

Shefrin defines reference point as “*a benchmark used to measure gains and losses*” (Shefrin, 2007). When we say that the value function is defined on deviations from the reference point, it implies that people think in terms of gains and losses instead of final wealth. Whether an outcome is a gain or a loss depends on the reference point, which is determined by the subjective feelings of the individual. It is the benchmark against which all comparisons are contrasted (Montier, 2002). For instance, a typical reference point for an investor can be the risk-free rate of return.

However, Kahneman and Tversky stress that the initial position could not be neglected (Kahneman & Tversky, 1979). In monetary terms a loss of 100 can mean a change into poverty for one person, whereas another person does not recognize the loss at all. This is because the two persons have different reference points. Therefore the emphasis on changes as the carriers of value should not be taken to imply that the value of a particular change is independent of the initial position.

A person can have several reference points, and the perception of the gain or loss differs from one reference point to another. The aspiration level is one kind of reference point. It is typically linked to past performance. Let us say you buy a house. The price you pay will be your initial reference point. The aspiration level could be the historical annual increase in house prices. Let us assume you want to sell the house after five years. If you get a price above the price you paid for the house, but below the estimated selling price based on the price performance in the period you owned the house, you may still achieve this as a gain. It depends on your subjective feelings. However, a price below the reference point is always perceived as a loss. A price far below the initial reference point would be considered totally disappointing in a way that further losses would no longer affect your evaluation.

### 3.4.2.1.2 Concave for gains and convex for losses

The value function is generally concave for gains and convex for losses. In other words, the value function predicts risk aversion in gains and risk seeking in losses. This is fundamentally different from the expected utility theory which predicts risk aversion independently of gains and losses. A consequence of different curvature of gains and losses is that the marginal value for both gains and losses generally decreases with their magnitude. Applied to monetary terms, it means that a change from 100 to 200 units has a greater impact on your wealth than a change from 2000 to 2100, although the absolute change is the same. The same effect can be found for losses. Therefore the value function for changes in wealth is normally concave above the reference point, and convex below.

### 3.4.2.1.3 Loss aversion

When we say that the value function is steeper for losses than for gains, this reflects the loss aversion and means that losses loom larger than gains in terms of changes in wealth. The negative aspects related to losing a sum of money dominate the positive aspects related to gaining the same amount. The majority of people find symmetric bets of the form  $(x, .50; -x, .50)$  distinctly unattractive, and this effect increases with the amount of money at risk.

### 3.4.2.1.4 Graphical representation

Based on the properties described above, the value function could be presented graphically as shown in Figure 10.

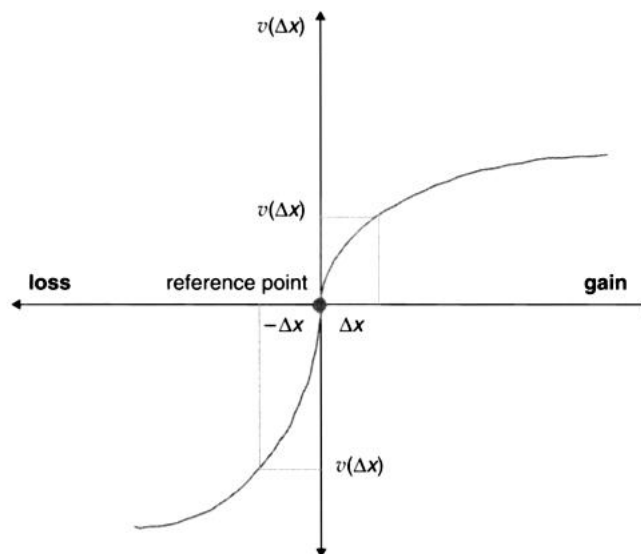


Figure 10 - A graphical presentation of Kahneman and Tversky's value function (Bachmann & Hens, 2008)

We notice that the function is steeper for losses than for gains, and steepest at the reference point.

The main properties ascribed to the value function were thoroughly described by Fishburn and Kochenberger (Fishburn & Kochenberger, 1979). They assessed thirty utility functions on changes in wealth or return on investment with the aim of examining general features and susceptibility to fits by linear, power, and exponential functions. They concluded that the most common composite function for gains and losses was convex-concave, which means risk seeking behavior in losses and risk-averse behavior in gains. Further, below-target losses utility was generally steeper than for gains. They also conclude that power functions give the best fits in the majority of convex below-target and concave above-target cases.

#### 3.4.2.1.5 Mathematical representation

There are many different functions to represent the just mentioned properties. Figure 11 displays Tversky and Kahneman's piecewise power function (Kahneman & Tversky, 1992).

$$v(\Delta x) = \begin{cases} \Delta x^\alpha & \text{for } \Delta x \geq 0 \\ -\beta(-\Delta x)^\alpha & \text{for } \Delta x < 0 \end{cases}$$

**Figure 11 - Kahneman and Tversky's piecewise power function**

Parameter  $\alpha$  represents the median risk aversion of individuals, whereas  $\beta$  represents the loss aversion of individuals. Kahneman and Tversky found that  $\alpha = 0.88$  and  $\beta = 2.25$ , based on experimental evidence. Remember that these parameters are specific for the piecewise power function.

From Figure 11 we clearly see the difference between gains and losses expressed through the piecewise formulation. The loss aversion coefficient  $\beta$  is what distinguishes gains from losses.

For the piecewise power utility function the pertaining certainty equivalent expression is displayed in Figure 12.

$$CE = PT\frac{1}{\alpha} + RP$$

**Figure 12 – Certainty equivalent expression of the power value function**

I leave the discussion about value functions for now, but will return to it later on in this section.

#### 3.4.2.1.6 Choosing the right value function

There are some commonly accepted criteria that the utility function should satisfy (Bachmann & Hens, 2008). Firstly, the utility function for optimal asset allocation should be psychologically sound, meaning that the function is reflecting the real behavior of observed individuals. Secondly, it should be robust to small changes in input data. Thirdly, it is the weight and not the mix of risky assets that should adjust to changes in investor's preferences. In this way it is in line with the two-found separation theorem of Tobin.

De Giorgi and Hens suggest that one should replace the piecewise power value function of Kahneman and Tversky (1979) with a piecewise negative exponential value function. They argue that the piecewise power function has the limitation of unboundedness which makes it difficult in applying to finance (Bui, 2009). However, the piecewise negative exponential value function also has its disadvantages. For instance, for large outcomes it exhibits more curvature and hence the function discourages extreme risk taking (Bui, 2009). For interested readers I suggest exploring the article by De Giorgi and Hens (2006).

In general, one of the problems with the piecewise power function is the lack of robustness to small changes in the parameters. However, when scale is irrelevant, the piece-wise power utility function could be chosen. Moreover, the piece-wise power value function is the most standard and commonly used value function. Indeed, by examining the performance of 27 different model variants of prospect theory, cumulative prospect theory, and normalized prospect theory, on data from an international survey on risk attitude from the Swiss Banking Institute, University of Zurich, Tui finds that the best model in terms of minimum sum of errors among all the participants in the survey, has a power value function (Bui, 2009). I refer to section 3.6.3 for more details about the international risk attitude survey. The choice of power function is also in line with the findings of Fishburn and Kochenberger referred to earlier in the chapter.

#### 3.4.2.2 Probability weighting

Another key difference between prospect theory and utility theory is the concept of perceived probabilities. Kahneman and Tversky noted that people tend to give zero weight to relatively unlikely outcomes, and a weight of one to relatively certain outcomes (Kahneman & Tversky, 1979). For instance, people prefer a lottery ticket with expected value  $x$  to the certain gain  $x$ . Also, people buy insurance, meaning they prefer a certain small loss over a small probability

of a big loss, even though the expected value is the same. Similarly results were also found by Markowitz (Markowitz, 1952).

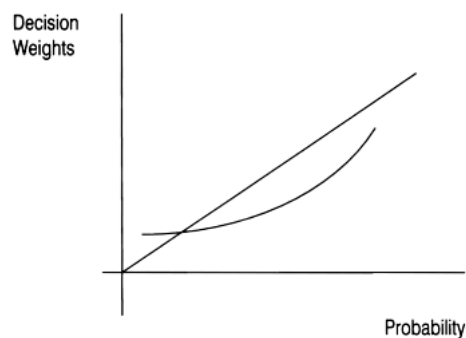
Prospect theory allows for the exaggeration of true probabilities through probability weighting. The objective or stated probabilities are adjusted by a probability weighting function. The result is that the value of each outcome is multiplied by a decision weight. Although similar to stated probabilities for zero and one, probability weights do not obey the probability axioms and they should not be interpreted as measures of degree of belief (Kahneman & Tversky, 1979).

One should remember to discriminate between over-weighting and over-estimation. The latter relates to the assessment of the probability of rare events, whereas the former is a property of decision weights. When the subject is assumed to adopt the stated probability, there exists no over-estimation. However, in real life the two effects may occur simultaneously, increasing the impact of rare events (Kahneman & Tversky, 1979).

The irrationality of probability weighting is discussed in section 3.4.3.

#### 3.4.2.2.1 Graphical representation

Based upon the present presentation of properties of the decision weighting, the function can be presented graphically as in Figure 13.



**Figure 13 - Presentation of a hypothetical weighting function**

As we can see, the function is relatively shallow in the open interval and changes abruptly near the end-points where  $w(0)=0$  and  $w(1)=1$ . We see that there are discontinuities in the function at the endpoints. These represent the notion that there is a limit to how small a decision weight can be attached to an event, if it is given any weight at all. People have restrictions in their ability to understand and assess extreme probabilities. Therefore, highly unlikely events are either ignored or over-weighted, and the difference between high



probability and certainty is either neglected or exaggerated. This explains why the function is not well-behaved near the end-points (Kahneman & Tversky, 1979).

To explain the non-linearity of the decision weighting function, the following example is fruitful. Imagine you play Russian roulette. You are given the opportunity to purchase a removal of one bullet from the gun. Would you pay the same amount to reduce the number of bullets from four to three than from one to zero? Most people would pay more for the latter, since this reduces the probability of death from one sixth to zero.

#### 3.4.2.2.2 Analytical representation

Analytically, the psychological probability weight should be calculated using a probability weighting function. Several functions have been proposed, such as Prelec (1998) and Rieger and Wang (2005). However, the most used is the one defined by Kahneman and Tversky (1992), presented in Figure 14.

$$w(p) = \frac{p^\gamma}{(p^\gamma + (1 - p)^\gamma)^{1/\gamma}}$$

**Figure 14 – Analytical representation of the probability weighting function**

The parameter  $\gamma$  captures the bias in perception of probabilities and has an average value of 0.65 found in experiments, and a range of  $0.27 \leq \gamma \leq 1$ . The lower the value of the parameter is, the stronger the distortion in the perceived probabilities is, and the more distorted is the curvature in Figure 13.

As mentioned earlier, the weighting function is a distortion of the given probability, and not a subjective probability (Bachmann & Hens, 2008). Quoting Hens and Bachmann (2008): “An individual may agree that the probability of a fair coin landing twice on heads is 0.25, but in decision-making the individual acts as if the probability is  $w(0.25)$ .” Again, notice that the distortion occurs when the investor is about to act himself. In other words; what you say you do does not match what you actually will do.

Remember that probability weighting is irrational and should be avoided by separating beliefs from risk attitudes (Bachmann & Hens, 2008).

#### 3.4.2.3 Normalized prospect theory (NPT)

This customized version of prospect theory normalizes the prospect theory value so that the decision weights  $w(p_s)$  add up to one. It is also referred to as smooth prospect theory (Bui,

2009). The normalization avoids some violations that the standard prospect theory is subject to. The approach goes back to Karmakar (1978). I will use this approach in my calculations. Figure 15 displays the normalized prospect theory.

$$PT_v = \frac{\sum_{s=1}^S w(p_s)v(\Delta x_s)}{\sum_{s=1}^S w(p_s)}$$

Figure 15 – Normalized prospect theory (NPT)

We have seen how the need for a new decision theory arose on the failures of the mean-variance analysis and the expected utility to describe actual behavior. Prospect theory is the best quantitative theory we have in decision making when it comes to including psychological aspects.

### 3.4.3 Criticism - Is prospect theory rational?

In classical finance theory one typically perceives that traditional finance defines a rational benchmark, and all behaviorally motivated decisions of the investors are irrational (Bachmann & Hens, 2008). Therefore one can argue that any model based on behavioral aspects generates irrational results.

However, this perception is not necessarily true. While some of the behavioral aspects of investors are irrational, others are not. Put in other words, not all psychologically determined decisions as documented by the behavioral finance research are irrational (Bachmann & Hens, 2008). The discussion of rationality versus irrationality therefore has to be more nuanced.

Hens et al. argue that prospect theory can be made consistent with rational choice and the mean-variance analysis (Bachmann & Hens, 2008). Indeed, there is only one aspect of prospect theory that is clearly irrational, and that is probability weighting. However, assuming a rational investor he separates beliefs and risk attitudes. He does not use his intuition when assessing probabilities, but sticks to the stated probability, hence he has no distortion in his perception of probabilities, and  $\gamma$  is equal to one.

Indeed, when there is no probability weighting, which is the case when  $\gamma$  is equal to one, Hens and Bachmann (2008) show that in the two-period model prospect theory is consistent with rational choice. This is because as in expected utility, prospect theory separates beliefs and risk attitudes and for  $\gamma$  equal to one the objective function is linear in probabilities. Indeed, it has been well known in expected utility theory that any increasing function can serve as a

rational utility from wealth. For instance, Friedman and Savage suggested a double s-shaped function (Friedman & Savage, 1948). In this sense Kahneman and Tversky's point is just to suggest a single s-shaped utility with a kink. Note that mean-variance would however violate the rationality requirement of expected utility because of two reasons; firstly a variance is not linear in probabilities and secondly mean-variance utility functions are not strictly increasing.

In the case of loss aversion, risk aversion, and reference point, they are all aspects of the prospect theory which can be explained by rational behavior. For instance, basing one's decision on reference points is not necessarily irrational. When they are realistic and stable, goals that will be achieved in the future do not contradict rational decision-making (Bachmann & Hens, 2008). However, if reference points are used to justify previous decisions or if they change very often in the course of an investment, then irrational decisions may result. Another example of aspects of prospect theory which can be explained by rational behavior is the loss aversion. One can argue that it is part of the investors' preferences, hence it is not irrational.

Rejecting prospect theory based upon the rationality criteria of decision making is therefore not necessarily right. Prospect theory can very well be rational.

## **3.5 The behavioral investor**

Approaching the analysis of structured products, it is high time to describe the investment needs of the behavioral investor. This section will deal with how products could be designed to feed these needs.

### **3.5.1 The role of the banks**

Banks provide services to their clients. One of these services is to offer investment products that best suit the clients' preferences. Since the bank has superior access to and superior knowledge about financial markets, this service is profitable for the bank. Clients are willing to pay for this knowledge and superior access to markets. In this way they can invest in assets and have risk-return trade-offs that are not otherwise directly available on the market (Bachmann & Hens, 2008). Moreover, the banks realize economies of scales on hedging costs which the client could not achieve as an individual in the market. Further, the banks use their knowledge to structure products the clients lack knowledge to do.

### 3.5.2 Product development

Keeping in mind that behavioral clients are particularly sensitive to losses, fairness of the distribution of profits between the bank and the clients, and finally the relative return related to the reference point, the behavioral investor is willing to pay for a product taking these properties into account. That is to say, the behavioral investor would like a product that protects from returns below the reference point, that allows for a fair participation in the returns above the reference point, and that allows for some gambling to obtain particularly high returns despite the low probability. Remember that the behavioral investor always prefers to pay indirectly in terms of opportunity costs to paying directly by cash.

The preferences of the behavioral investor could be illustrated in a payoff diagram. Such a diagram is displayed in Figure 16.

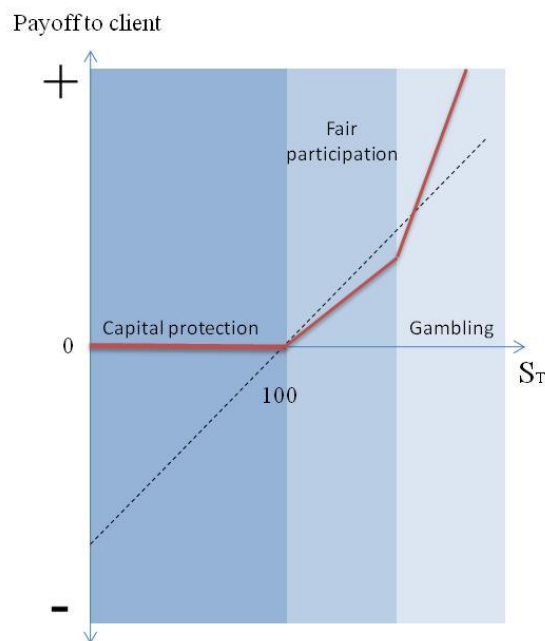


Figure 16 – Desired payoff by a behavioral client (Bachmann & Hens, 2008)

The slope of the payoff of the structured product is red, whereas the slope of the basket of underlying is black and dotted. 100 is the par value of the investment. As we can see, the desired structured product consists of three elements. The first element is the capital protection which protects the client from returns below the reference point. The higher the loss aversion is the stronger is the client's willingness to pay for this protection. The client pays for this protection by reducing the participation in the underlying, hence the upside potential, which is the second element of the product and referred to as fair participation. This is illustrated by a slightly flatter slope of the structured product in this zone than the slope of

the underlying. The third element of the structured product is the gambling. We see that the payoff increases sharply when entering into the gambling zone of the product. Since a behavioral investor tends to overweight unlikely outcomes, a gambling component is likely to be perceived as more attractive compared to an investment in the underlying.

### 3.5.3 The optimal product

Assuming that an investor's portfolio only consists of a structured product, we can look at the design of an optimal product. Assuming a behavioral investor, the value function is the starting point. Moreover, assuming loss aversion and diminishing marginal utility for gains and losses, the investor will prefer to give up some of the upside in order to be protected from small to medium losses. However, above a certain limit, incremental loss or gain do not reduce or add any value. Therefore there is no desire to have a capital protection for big losses. In the same way there is no desire to participate in big gains.

Based on these properties, the optimal product could look like a typical barrier product presented in Figure 17.

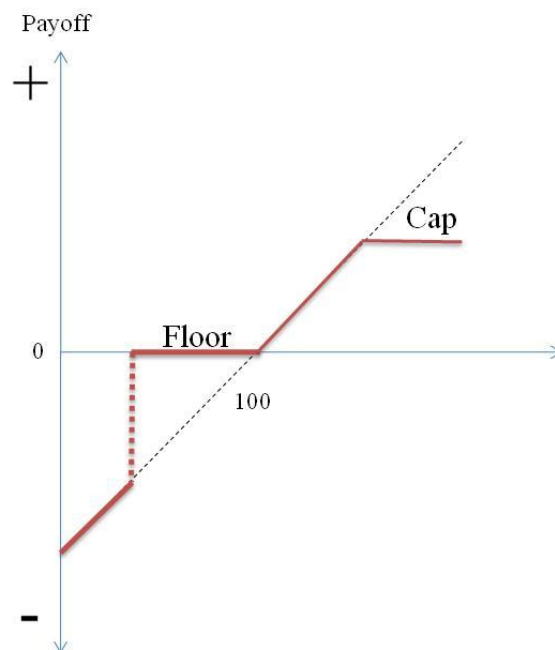


Figure 17 – Payoff diagram of a possible optimal structured product (Bachmann & Hens, 2008)

However, so far probability weighting is not taken into account. The introduction of probability weighting would affect the optimal payoff since the extremes receive more weight. The change in preferences due to subjective perceptions of probabilities would result in different levels of the cap and the floor, depending on each investor's perceptions. We

would need to conduct a numerical analysis to draw any conclusions. I will not do so in this paper. For interested readers I would recommend the article by Hens and Rieger (2008) for a thorough investigation of the optimal structured product.

A structured product that offers a similar payoff to Figure 17 is the bonus certificate. It offers capital protection until a certain limit or barrier. Below this barrier the payoff is equal to the payoff of the underlying and the protection is lost even though the underlying should have a positive development.

The Swiss Design Institute for Finance and Banking conducted a field study where visitors at a public exhibition got to design the structured product they would prefer. More than 600 individuals did participate. The survey revealed that 49 percent of the population preferred a capital protection product with approximately 96 percent capital protection and a slightly reduced participation. Additionally, 18.9 percent preferred a capital protection product with 100 percent capital protection, reduced participation, and a cap. This proves the popularity of capital protection products and explains why the majority of structured products include capital protection. Moreover, it emphasizes the importance of loss aversion in investment decisions of private investors (Bachmann & Hens, 2008).

### **3.6 Cultural dimensions and investors' behavior**

Deviations from the rational choice can be linked to cultural differences. Culture is central to how individuals perceive the world, how they think, and how they make decisions. The importance of cultural differences is acknowledged in many contexts. However, cultural differences have not yet gained proper attention from the finance research community. One reason could be that for a long time finance has been considered a discipline focusing strictly on how rational agents make optimal decisions under perfect or imperfect conditions.

With the rise of behavioral finance and its psychological aspects, it is natural to include cultural factors in the analysis (Hens & Wang, 2007). Indeed, Hens and Wang show that cultural differences do matter for financial decisions (Hens & Wang, 2007). They show that cultural differences lead to systematic deviations from rational decision making, which in turn lead to cultural differences in risk taking, which finally will lead to cultural differences in investment choices among investors. More precisely, they show that culture can influence risk-attitudes, probabilistic thinking, and overconfidence tendency. This may lead to different patterns in investment behavior and market trends across countries and regions.

As the world is globalizing, cultures confront and interact. This has implications for our society, the world of finance included. To understand the culture’s impact on investment decisions and preferences is therefore highly necessary (Hens & Wang, 2007).

### 3.6.1 Understanding the culture’s impact on investment decisions

The academic work on culture is comprehensive. Perhaps the most famous work is the cultural dimensions defined by the Dutch researcher Geert Hofstede (Hofstede, 2001). Despite its key role in social science and economics, his theory is under-researched in finance (Hens & Wang, 2007).

Hofstede’s framework organizes culture into five dimensions. This simplification of a complex subject is convenient because it makes the rather abstract notion of culture more tangible. Further, Hofstede’s framework allows for a numerical comparison of cultures. This quantification of culture facilitates the understanding of where the cultures actually differ. However, one should bear in mind that a simplification of a complex subject has its negative sides, such as the absences of nuances, cultural paradoxes and the risk of stereotyping.

Hofstede synthesizes culture into five dimensions as shown in Figure 18. A short description of each dimension follows.

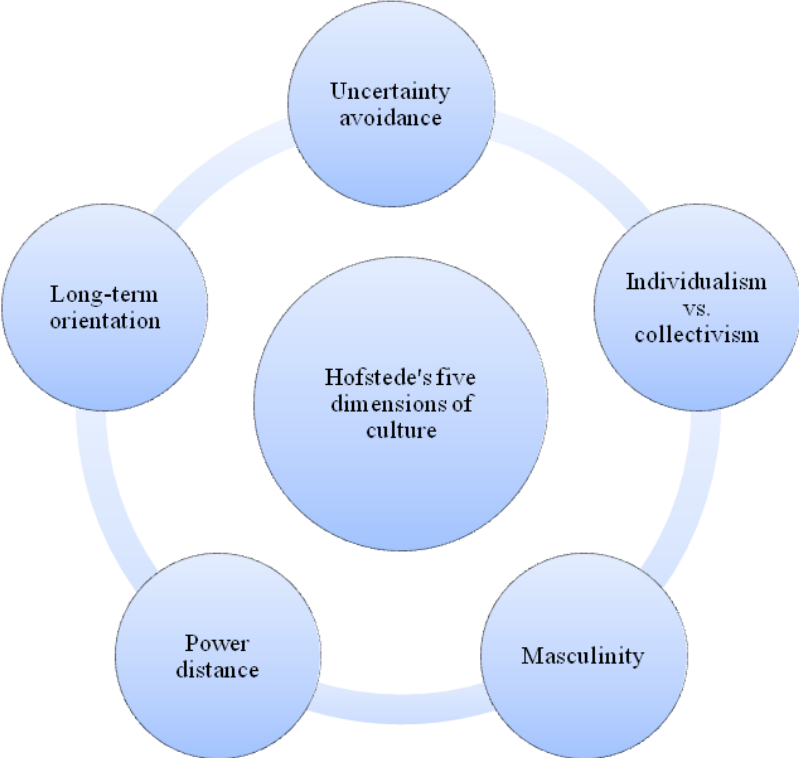


Figure 18 – Hofstede’s five dimensions of culture

**Uncertainty avoidance** is about whether people prefer the predictable (high uncertainty avoidance) or the unpredictable (low uncertainty avoidance). Societies of high uncertainty avoidance are based upon a high degree of regulation. Opposite, an uncertainty loving culture is tolerant towards diverging opinions and the level of formal regulation in society is low. People in this culture are not expected to express feelings.

**Individualism vs. collectivism** looks at how needs or achievements of one person are valued compared to the achievements or needs of the group as a whole. Is everyone expected to take care of themselves, or is one strictly connected to an extended family where loyalty is highly valued?

**Masculinity** deals with how well the gender roles are defined and expressed in the culture. Strictly defined gender roles are found in masculine culture. Here men's and women's values differ significantly. In a feminine culture the roles and values of men and women are quite alike. Here one would expect to find modest and caring men, more or less like women, opposite to the assertive and competitive in the masculine culture.

**Power distance** is about equality versus inequality. A hierarchical culture typically has high power distance while an egalitarian culture has low power distance. Moreover power distance refers to the degree of inequality accepted within the culture.

**Long-term vs. short-term orientation** concerns the importance attached to the past and the present versus the future. In long-term oriented societies, people value actions and attributes that affect the future, such as persistence and perseverance, thrift, and shame. Contrarily, in short-term oriented societies, people value actions and attitudes that are affected by the past or the present such as normative statements, immediate stability, protecting one's own face, respect for tradition, favors, gifts and so forth.

A little warning on the use and relevancy of cultural dimensions should be included. Cultural dimensions were constructed in order to compare cultures and generate understanding. However, one should never interpret and use these dimensions without contingency. Generalizations must never be exploited and defined as the truth for every single group or individual. Subcultures and subgroups exist in every culture, and cultural paradoxes are everywhere. An unanticipated consequence of using the dimensions is the danger of stereotyping entire cultures (Osland, Bird, Delano, & Jacob, 2000).



### 3.6.2 Comparison of Switzerland and Norway

Based on the five dimensions Hofstede made a ranking of all the involved countries. This ranking could be used as a proxy on the property of a culture. Figure 19 shows the results for Switzerland and Norway. The higher the number, the stronger the dimension.

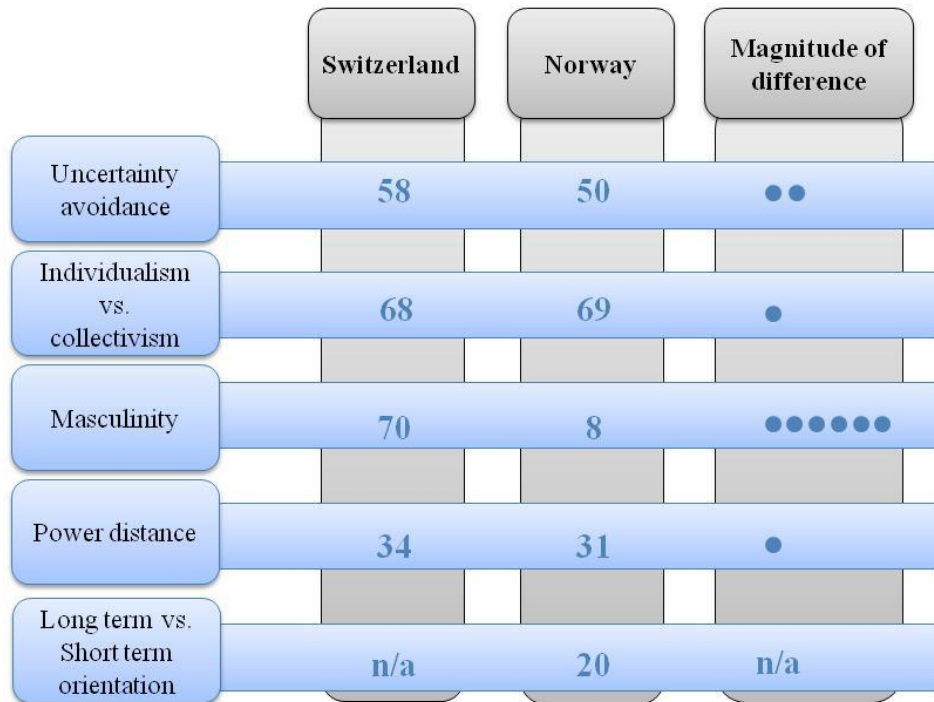


Figure 19 - Cultural differences based on Hofstede's cultural dimension score

As we can see from Figure 19, the main difference between Switzerland and Norway lies within the dimension of masculinity where the difference is very strong. There is also a difference in terms of uncertainty avoidance. The former is hard to discuss from a behavioral point of view. Contrarily, the latter is highly interesting. The dimension captures the attitudes towards ambiguous situations, which is related to general risk attitudes (Bachmann & Hens, 2008). Since Swiss people, therein investors, in general are more uncertainty avoidant, it follows that their risk taking should be limited relative to the Norwegian people, therein investors. Consequently the loss aversion and the risk aversion should be higher. Highly relevant to this are the results of a survey conducted by Swiss Banking Institute.

### 3.6.3 The INTRA study

#### 3.6.3.1 Data

Hans, Rieger, and Wang on behalf of the Swiss Banking Institute at the University of Zurich have conducted one of the most systematic and comprehensive studies on cultural differences in decision-making (Bachmann & Hens, 2008). This international study involves 45 countries

and 5912 participants in different countries around the world. The participants are undergraduate business students. In Zurich answers from business students were compared to answers from students with other specializations as well as practitioners from banks.

The respondents were given a questionnaire including three time-preference questions, one question about ambiguity aversion, ten lottery questions, and 19 questions about happiness. Additionally they were asked to disclose their nationality, culture origin and some other personal information.

The data from the study was used to compute country level parameter values for all possible combinations for three prospect theory models, three probability weighting functions and three value functions.

**3.6.3.2 Comparing Switzerland to Norway**

From the survey we can find data for risk aversion, loss aversion, and decision weighting for normalized prospect theory with a Kahneman and Tversky probability weighting function and a piecewise power value function. Table 3.1 displays these data for Switzerland and Norway.

Country	$\alpha+$	$\alpha-$	$\beta$	$\gamma$
Norway	0,52	0,81	0,96	0,61
Switzerland	0,41	0,74	1,98	0,60
Germany	0,39	0,71	4,43	0,55

**Table 3.1– Prospect theory parameter values of Norwegian and Swiss investors**

We see that the Norwegian investor is more risk averse for gains and for losses, than the Swiss investor. Swiss investors are twice as sensitive to losses as the Norwegians which actually have a lower sensibility to losses than to gains. The two investors have practically the same perception of probabilities.

## 4 Utility calculations of structured products

In this chapter I will investigate how the access to structured products can affect the utility of small, Norwegian private investors. More precisely I will analyze how the enhanced investment opportunities from structured products affect the investor's utility, and whether structured products return higher utility than at one hand bank deposits, and at the other hand the best alternative market investment. Ultimately I will conclude whether it was a sound decision to practically ban structured products in Norway in 2008.

In section 4.1 and 4.2 I go through the necessary explanations, assumptions and parameters one needs to understand the analysis. From section 4.3 to 4.10 I present the products and the respective analysis. Finally, in section 4.11 I discuss my findings, herein how my results are affected when I change the parameters and assumptions.

### 4.1 Introduction to the analysis

Before we go into the utility analysis of each product, it is necessary to have an understanding of the assumptions and parameters used, as well as of the calculation process itself.

#### 4.1.1 The rationale of the analysis

To see how the access to structured products can affect the utility of small, private investors, it would be meaningless to present only the utility achieved from the structured product. We need to compare the utility of the investment in the structured product to the best alternative investments and then analyze the utility improvement.

I assume there are two realistic alternative investments to structured products. One is a classical portfolio investment, and the other is a bank deposit. The typical investor in structured products in Norway is a small, private investor. Structured products are distributed by the banks, which we have seen have been pushing structured products quite aggressively to clients. I assume the clients can roughly be divided into two groups; those that have knowledge or are familiar to market investments and that have invested in stock markets before, and those that have no experience or knowledge about market investments, and that keep all their money in a savings account.

The latter group of clients can chose between a structured product investment and a risk-free investment represented by a bank deposit. The former group of clients can chose between the structured product investment and a classical portfolio investment. This classical portfolio is

the investor's optimal combination of the basket of assets underlying the structured product, and a risk-free asset, referred to as the optimal Markowitz portfolio in chapter three.

The enhanced investment opportunities from structured products are in this paper expressed through having the possibility to do non-linear investments compared to only having access to the optimal Markowitz portfolio. I refer to the utility effect from the non-linear investment as the free design effect. To measure the free design effect I compare the utility of the optimal classical portfolio investment to the utility of the structured product investment. In other words I compare the utility of a linear combination of assets, a classical investment, to the utility of a non-linear combination of the very same assets, a structured product investment.

The non-linear combinations are represented by structured products offered in the Norwegian market. The sample is presented in section 4.1.3. As we saw in chapter two investments in structured products are subject to fees, and the underlying assets do not usually pay any dividends. To isolate the free design effect, these properties have to be embedded in the classical investment alternative. However, such assumptions are not realistic in the real world the classical investor faces. For instance, if the classical investor invests in stocks he can expect to receive dividends, and he pays small or no fees.

I therefore need to define two different classical investments; one to represent the utility change as an effect of the free design, and one to express the utility change between the structured product and a realistic real-world optimal linear investment alternative. I will refer to the realistic real-world alternative as the realistic classical investment,  $C_R$ , and the alternative that represents the free design effect as the adjusted classical investment,  $C_F$ .

#### **4.1.2 Calculation process**

The inputs to the calculations are probability distributions of returns. We need the distributions of both the structured products' returns and the underlying baskets' returns. The input data is crucial for the model and the result, and is thoroughly discussed in section 4.1.4.

We start the process by probability weighting the return probabilities for all return states of both the structured product and the basket of underlying assets. Thereafter we find the normalized prospect theory utility for each of the return states by multiplying the normalized weighted probabilities with the piecewise power function utility.

Next, for the classical portfolios, we optimize the utilities of the portfolios by optimizing the allocation between the risk-free asset and the basket of underlying assets. After this, we

summarize the prospect theory utilities of the structured product and the now optimized classical portfolios, and convert the utilities into certainty equivalents.

Finally, we adjust for dividends and fees to find the certainty equivalent returns of the structured products and the  $C_R$  and  $C_F$  investments. We now have three different utilities expressed in certainty equivalent returns, in addition to the risk-free investment, which we can compare to find the change in utility by investing in structured products compared to classical investments and risk-free investments. Figure 20 shows a summary of the different steps of the analysis process.

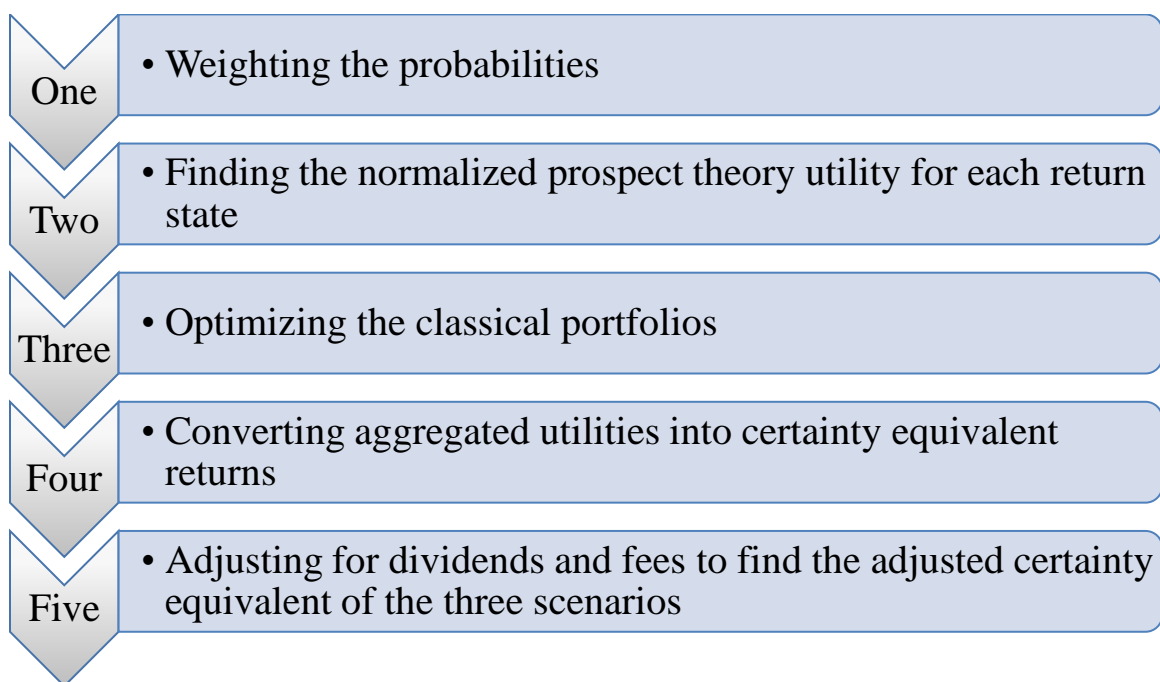


Figure 20 – The different steps of the analysis process

### 4.1.3 Product sample

In this section I present the criteria based on which I have chosen the structured products to be evaluated. I also present the products briefly. A thorough presentation of the products follows as a part of the analysis.

#### 4.1.3.1 Criteria

The sample is based upon two criteria; representativeness and diversity.

Let me first address the representativeness criterion. In order to conclude on the Norwegian market for structured products, the data sample has to be representative. As we can read in chapter two, DnB Global 2000/2006 is the product that has sold the most based upon issued

amount (Trustee, 2010). Based purely upon volume this could be said to be a qualified representative of the Norwegian market.

In an email from DnB NOR dated Tuesday 4 May 2010, they write that “there have been many different types of structured products in the Norwegian market the last decade, but in line with my experience the structure of the Global and Sektor is the one that have been the most frequent. However, a term of six years is probably far above the average. The majority of the [structured] products have had a term of three to five years”. In other words, the structure of DnB Global 2000/2006 and DnB Sektor 2000/2006 is representative although the term is somewhat long.

The very same products have been analyzed in a report about expected return on AIOs (Koekebakker & Zakamouline, 2006). On question about whether he believes that the DnB Global 2000/2006 product is representative for the Norwegian market of structured products, one of the co-authors answers that “I believe that both DnB Global 2000/2006 and DnB Sektor 2000/2006 are fairly representative for the Norwegian market” (Zakamouline, 2010). Further, according to Lindset (2008), DnB Global and DnB Sektor are representative examples of structured products marketed in Norway at the start of the century (Lindset, 2008).

I conclude that DnB Global 2000/2006 and DnB Sektor 2000/2006 could be regarded as representative products offered in the Norwegian market.

Having concluded on the representativeness of my sample, I turn to the diversity criterion. It is important to include products that reflect different properties. More precisely, I want to include products linked to different underlying indices and asset classes, as well as different terms and payoff structures. Also, it is important to investigate products sold by a variety of institutions. To fulfill the criterion, I have included six products in addition to the two representative products.

To conclude on the sample as a whole, we can say that eight products have been chosen which represent both the most popular products in terms of volumes, and the variety of different products offered in the Norwegian market.

#### *4.1.3.2 Presentation of the sample*

Table 4.1 gives an overview of the eight products included in my sample.

Product	Type	Underlying	Dataset provider
• DnB Global 00/06	AIO	<ul style="list-style-type: none"> <li>• Euro STOXX 50</li> <li>• S&amp;P500</li> <li>• Nikkei225</li> </ul>	• Koekebakker and Zakamouline
• DnB Sektor 00/06	AIO	<ul style="list-style-type: none"> <li>• Euro STOXX healthcare</li> <li>• Euro STOXX Telecom</li> <li>• Euro STOXX Bank</li> </ul>	• Koekebakker and Zakamouline
• Orkla Finans Absolutt Europa II 2007-2012	BMA	• Dow Jones Euro Stoxx 50	• Bøe
• Fokus Bank Råvareindeksobligasjon Olje 2007-2008	AIO	• WTI light sweet crude futures	• Bøe
• Acta Japansk Eiendom 2007-2010	BMA	• Tokyo Stock Exchange REIT index	• Bøe
• Nordea Lock-in Basket 2006-2010	AIO	<ul style="list-style-type: none"> <li>• Dow Jones Euro Stoxx 50</li> <li>• Tokyo Stock Price Index</li> <li>• Hang Seng index</li> <li>• S&amp;P BRIC 40 Euro index</li> </ul>	• Bøe
• DnB Nor Kraft 2007/2009	AIO	• Nord Pool electricity price forwards	• Bøe
• Storebrand Spread Aksjeindeksobligasjon 2006-2010	AIO	<ul style="list-style-type: none"> <li>• Dow Jones Euro Stoxx 50</li> <li>• Russell 2000</li> </ul>	• Bøe

**Table 4.1 - Overview of the sample of structured products**

We see that the datasets on the first two products are provided by Koekebakker and Zakamouline, whereas Bøe has produced the sets for the other six products. I will elaborate on the datasets in section 4.1.4. Six products are AIOs whereas two are BMAs. The term of the products varies from 18 months to six years, and the products are issued throughout the 2000s. There are six different institutions involved and 13 different indices.

Despite the diversity there are some generic properties of the sample. Firstly, they all include a capital protection. Secondly, the options employed are quanto options. This means that the underlying indices are price indices only, and not adjusted for dividends. Thirdly, the returns on the indices are calculated in local currency eliminating the currency risk. Fourthly, with the

exception of one product, the options have Asiatic tales meaning that the final value of the product is determined by an arithmetic average over a time period of varying length. The longer period the average is based upon, the lower is the variance and by consequence the expected return. The products may also have their starting value calculated by an arithmetic average.

#### 4.1.4 Dataset

The datasets refer to the input data used in my estimations. As mentioned earlier, the input data used in the analysis is the probability distributions of both the structured products' returns and the underlying baskets' returns.

The return distributions of the structured products cannot be found in any database. They have to be simulated. One way of estimating is Monte Carlo simulation technique which generates simulated returns based upon a set of assumptions and parameters. Indeed, this technique has been employed by Professor Steen Koekebakker and Associate Professor Valeri Zakamouline at the University of Agder to simulate the expected return on DnB Global 2000/2006 and DnB Sektor 2000/2006 (Koekebakker & Zakamouline, 2006). Another analysis of expected returns of structured products in Norway has been conducted by Geir Bøe, a PhD student at the Norwegian School of Economics and Business Administration (NHH). He wrote his master thesis on estimating the expected return on six different structured products sold by six different institutions (Bøe, 2007).

On request I have gotten access to the datasets from the two abovementioned papers. In the following I elaborate on these datasets. I refer to Koekebakker and Zakamouline (2007) and Bøe (2007) page 73 to 89 for thorough explanations of the simulation processes.

##### 4.1.4.1 Datasets from Koekebakker and Zakamouline

As we can see from Table 4.1, Koekebakker and Zakamouline have provided me with the datasets of DnB Global 2000/2006 and DnB Sektor 2000/2006. The datasets include probability distributions of returns of both the structured products and their underlying baskets of assets.

###### 4.1.4.1.1 Key findings

In their report Koekebakker and Zakamouline conclude that the expected returns of the two products in question were only marginally higher than the risk-free rate of return. A gearing



of the products would cause the expected returns to be negative, based on the authors' assumptions.

#### 4.1.4.1.2 Credibility

DnB Markets conducted their own analysis of the products as a response to Koekebakker and Zakamouline's findings where they conclude that the estimated returns are positive for both an equity-based investment and a leveraged investment (Johnsen, 2008). A third analysis on the same products was conducted by NHH professor Thore Johnsen on request by Bankklagenemda in order to have an external, objective expert's view. His findings support the conclusion by Koekebakker and Zakamouline that the expected return on a fully leveraged investment is negative for both products. His annual returns on the equity-financed investments are about 0.75 percent higher than Koekebakker and Zakamouline's. However, Johnsen explains this difference by diverging assumptions on additive log-normality (Johnsen, 2008).

Johnsen concludes that a significant part of the differences between DnB Markets' report and Koekebakker and Zakamouline's report is attributed to the use of different return models. He further concludes that one should trust the two researchers' model, since it is more elaborated (Johnsen, 2008).

Based upon this we can conclude that the datasets from Koekebakker and Zakamouline are reliable. However, we keep in mind that different assumptions and models generate significantly different results.

#### 4.1.4.2 Datasets from Bøe

Bøe have provided me with datasets for six structured products, as we can see from Table 4.1. However, the datasets from Bøe do only include the probability distributions of returns of the structured products, and not of the underlying basket of assets.

##### 4.1.4.2.1 Key findings

From Bøe's valuation and estimation of expected returns on six structured products, Bøe concludes that the criticism of structured products is legitimate and appropriate. He finds that the investor pays from eight to ten percent in fees on a typical product, which is two to four percent higher than what is stated in the prospects. Moreover, the expected return on a fully equity-financed investment in a structured product is on the same level as the risk-free return, whereas the expected return of the fully leverage investment is negative.

#### 4.1.4.2.2 Credibility

Bøe's master thesis attracted attention from media, and is referred to in several articles, such as (Slettan, 2007) and (Moe, 2007). Further, strengthening the credibility of the report is the fact that the supervisor of the report, professor Petter Bjerksund at NHH, has spent a lot of time analyzing structured products (Leirvåg, 2010), has been used as an expert witness on structured products in court (Andersson, 2010), and written papers on the same subject (Bjerksund, 2008).

Based on the abovementioned, and the fact that Bøe's findings are in line with the conclusions of Koekebakker and Zakamouline, and Johnsen, I consider Bøe's data as reliable and objective.

#### 4.1.4.2.3 Finding the distribution of the underlying

As mentioned above, Bøe's datasets do not include the return distributions of the underlying assets, which I need to conduct my analysis. In order to get these data I face several potential solutions. A stringent solution is to use the Monte Carlo simulation technique based upon the same assumptions as Bøe on the underlying baskets of the structured products. However, this paper is not about Monte Carlo simulations and I consider that option out of the scope of the paper.

Another solution is to assume that future distributions are equivalent to historical distributions, and thereby using the historical probability distributions of returns of the underlying baskets. Actually, this is how both Bøe and Koekebakker and Zakamouline find many of their input variables such as the volatility. Unfortunately, the historical data for some of the indices is limited and this decreases the quality of the assumptions.

A third solution is to assume that the returns of the underlying assets are normally distributed. However, we know that the distributions of returns historically are skewed and actually have fat tails. By assuming normal distributions we exclude these tails. Due to the probability weighting in prospect theory, these fat tails are relatively more important than in classical decision theory, and should be reflected in the datasets.

Despite these drawbacks I choose to assume normal distributions of the underlying assets. To find the probability distributions of returns I integrate the normal distribution function over the desired return interval and the number of states. Due to the drawbacks mentioned above, the credibility of the datasets of the underlying baskets of the six products analyzed by Bøe is

limited, and we should be careful about drawing conclusions upon them. The distribution of the underlying basket of assets of Nordea and Storebrand's products were not produced due to the restricted amount of data available.

#### 4.1.4.2.4 Calibration of the structured products' distribution data

In opposition to the limited amount of data on the underlying baskets of assets, I have datasets of the probability distributions of all the structured products' returns. However, there is a problem in Bøe's probability distributions of the structured products' returns. The number of return states is limited so that the range of the return states is only from zero to 25 percent annual return. Probabilities of annual returns above 25 percent are pooled into one state. This is unfortunate due to the probability weighting in prospect theory. I have therefore modified the dataset to include return states up till 45 percent. The calibration is described in detail in appendix A.

#### 4.1.4.3 Quality of the datasets

Based on the discussion above, we understand that the quality of the datasets varies. A summary of the discussion is presented in Figure 21.

Product	Quality of dataset		Comments
	Structured product	Underlying	
DnB Global 00/06	Very good	Very good	Dataset for both structured product and underlying provided by Koekebakker and Zakamouline.
DnB Sektor 00/06	Very good	Very good	Dataset for both structured product and underlying provided by Koekebakker and Zakamouline.
Orkla Finans Absolutt Europa II 2007-2012	Good	Poor	Bøe's dataset for the structured product has been calibrated. Normal distribution assumption on underlying, but results are not quantitatively reliable.
Fokus Bank Råvareindeksobligasjon Olje 2007-2008	Good	Poor	Bøe's dataset for the structured product has been calibrated. Normal distribution assumption on underlying, but results are not quantitatively reliable.
Acta Japansk Eiendom 2007-2010	Good	Poor	Bøe's dataset for the structured product has been calibrated. Normal distribution assumption on underlying, but results are not quantitatively reliable.
DnB Nor Kraft 2007/2009	Good	Poor	Bøe's dataset for the structured product has been calibrated. Normal distribution assumption on underlying, but results are not quantitatively reliable.
Nordea Lock-in Basket 2006-2010	Good	No data	Bøe's dataset for the structured product has been calibrated. No data on underlying.
Storebrand Spread Aksjeindeksobligasjon 2006-2010	Good	No data	Bøe's dataset for the structured product has been calibrated. No data on underlying.

Figure 21 – The quality of the datasets for each product

The products having the datasets with the highest quality are DnB Global and DnB Sektor. I will therefore put most weight on the results from the analysis of these two products when analyzing the findings. Fortunately these two products are representative for the market, as concluded in section 4.1.3.

## 4.2 Generic assumptions and criteria

In this section I discuss the generic assumptions and parameters. For product specific assumptions and parameters, I refer to the analysis of each product.

### **4.2.1 Financing**

We know that debt-financing of structured products was very frequent in the Norwegian market. Hence, it could be interesting to include effects of debt financing in the analysis. As we have seen, this has been done by Bøe and Koekebakker and Zakamouline, and the effect is a decrease in the expected return of the structured products. Indeed, some of the products even have negative expected returns according to the calculations.

I will strictly focus on 100 percent equity financing in this paper. I refer to the other papers for a better understanding of the effects of debt financing, such as Quinn (2009), Bøe (2007), Johnsen (2008), and Koekebakker and Zakamouline (2006) to mention a few.

### **4.2.2 Invested amount**

An assumption on the size of the invested amount is necessary to decide the size of the fees included in the estimations, since the fees are contingent on the invested amount.

I assume that we are dealing with the typical Norwegian investor as defined in chapter two. As we have seen, this is a small, private investor that. I therefore assume that the invested amount is NOK500,000.

### **4.2.3 Risk-free rate of return and the reference point**

The risk-free rate employed on the structured product depends on when the product was issued and the term of the product. The prospects of the structured products normally emphasize that the products are designed for investors who have the intention to hold the investment to maturity. If the products are sold before maturity, the investors are not guaranteed the invested amount back. Based on this, it is reasonable to employ the return rate from a risk-free investment with the same term as the structured product. To keep consistency between parameters and input data, I have chosen to use the same risk-free interest rates as used in the generation of the input data, which is the effective return on Norwegian governmental bond issued for the same period as the structured product.

The reference point, RP, is if not differently stated the risk-free rate of return for each structured product.

### **4.2.4 Prospect theory parameters**

To estimate the prospect theory utility I use the piecewise power value function, Tversky-Kahneman probability weighting and normalized prospect theory. If not explicitly stated, I use the classical prospect theory parameters found by Kahneman and Tversky (1992):

- The risk aversion ( $\alpha$ ) for gains and losses is 0.88
- The loss aversion ( $\beta$ ) is 2.25
- The bias in perception of probabilities, the probability weighting factor ( $\gamma$ ) is 0.65

## 4.3 DnB Global 2000/2006

### 4.3.1 Description of the product

The product is an AIO. It combines a zero-coupon bond issued at par value, with a long position in a call option. At maturity the investor receives the invested amount in addition to a return dependent on the development in three underlying stock indices in Europe, USA, and Japan, namely Euro STOXX50, S&P500 and Nikkei225. The weighting is 50 percent, 25 percent, and 25 percent respectively. The participation is 105 percent and the investment period is six years. The note was issued on 24 November 2000 by DnB with expiration on 24 November 2006.

For investments in the range of NOK10,000 to NOK1,000,000 the fees are 4.5 percent for the ordinary customer. This means that the total amount paid to DnB is the principal plus the fees.

Its payoff diagram is illustrated in Figure 22. The payoff diagram illustrates the payoff of the structured product for any return state of the underlying, denoted  $S_T$  in the diagram. It is critical to emphasize that the underlying in the payoff diagrams does not refer to the underlying baskets of assets applied in the optimal classical investments,  $C_F$  and  $C_R$ . The underlying in the diagrams is not adjusted for fees or dividends. This is because the payoff diagrams are meant to *illustrate* the structured products' payoff in different return states of the underlying assets so that the reader can get a visual impression of how the structured products perform. The diagrams must not be misinterpreted as accurate descriptions of the payoffs of the structured product. However, for illustrative purposes they describe the payoff design of the structured products sufficiently.

The above mentioned properties apply to all payoff diagrams in this chapter.

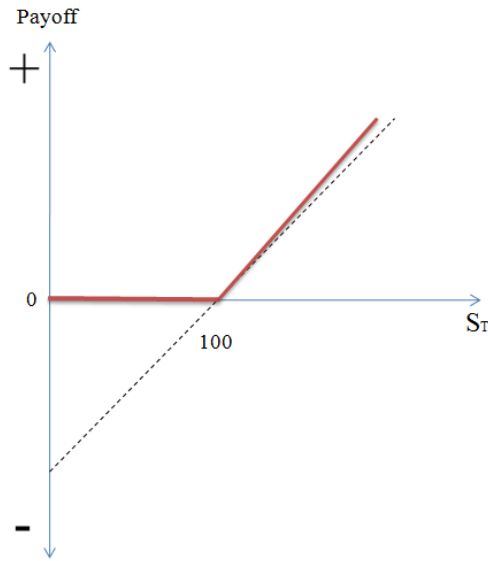


Figure 22 – Payoff diagram of DnB Global 2000/2006

### 4.3.2 Product specific parameters

The annual effective risk-free rate of return is estimated from the effective annual return of the Norwegian governmental bond for the relevant period. It is 6.30 percent.

### 4.3.3 Utility calculations

The results of the utility calculations are summarized in Figure 23. All utilities are expressed in terms of certainty equivalent interest rates.

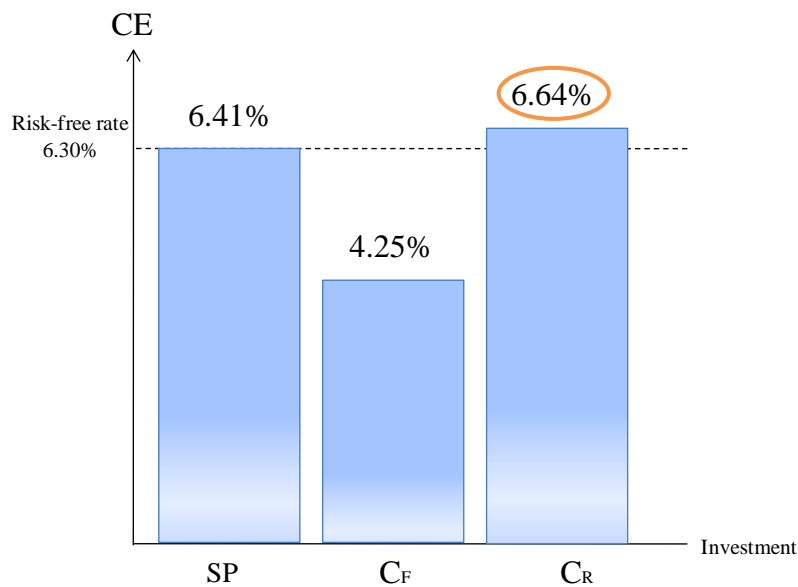


Figure 23 – Utility calculations of DnB Global 2000/2006 and the respective alternative investments

SP is the structured product,  $C_F$  is the adjusted classical investment, whereas  $C_R$  is the realistic classical investment. The utility of the structured product is 6.41 percent. The  $C_F$  investment has a utility of 4.25 percent, and the  $C_R$  investment has a utility of 6.64 percent. The investment that yields the highest utility is the  $C_R$  investment. The optimal portfolio has a proportion of 100 percent invested in the basket of risky assets.

## 4.4 DnB Sektor 2000/2006

### 4.4.1 Description of the product

This is an AIO which combines a zero-coupon bond issued at par value, with a long position in a call option. At maturity the investor receives the invested amount in addition to a return dependent on the development in three underlying industry specific European stock indices. The three indices, STOXX Healthcare, STOXX Telecom, and EURO STOXX Bank, are weighted equally. The participation is 100 percent, and the investment period is six years. The note was issued on 24 November 2000 by DnB with expiration on 24 November 2006.

Fees are 4.5 percent of the invested amount if the latter is between NOK10,000 and NOK1,000,000 and the investor is an ordinary client.

The payoff diagram of the product is illustrated in Figure 24.

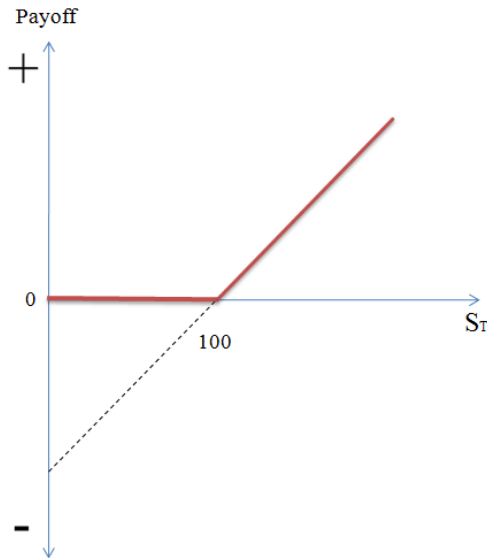


Figure 24 – Payoff diagram of DnB Sektor 2000/2006

### 4.4.2 Product specific parameters

This product has the same term and is issued for the same period as DnB Global 00/06. I therefore use the same effective annual risk-free rate, which is 6.30 percent.



### 4.4.3 Utility calculations

The results of the utility calculations are summarized in Figure 25. All utilities are expressed in terms of certainty equivalent interest rates.

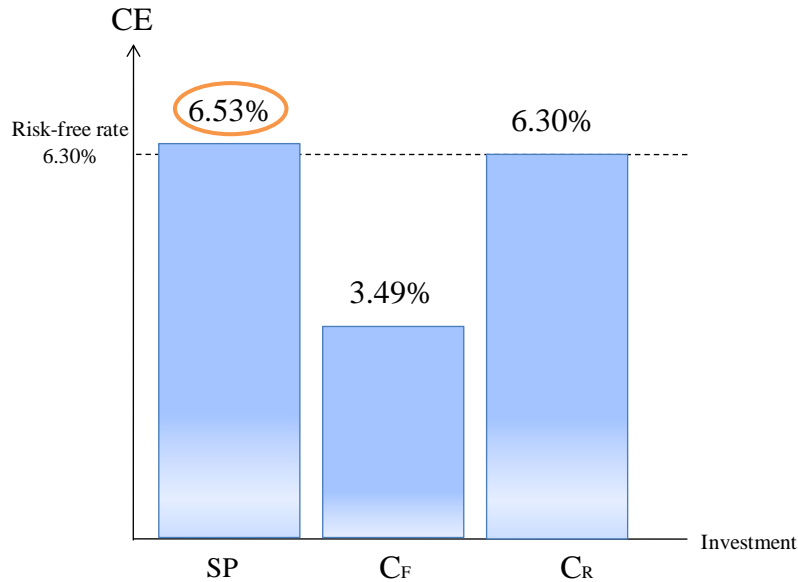


Figure 25 - Utility calculations of DnB Sektor 2000/2006 and the respective alternative investments

The structured product has a utility of 6.53 percent. The utility of the  $C_F$  investment is 3.49 percent whereas an investment in the  $C_R$  has a utility of 6.30 percent. The optimal classical portfolio has an allocation of 100 percent in the risk-free asset. The scenario that yields the highest utility is the investment in the structured product.

## 4.5 Orkla Finans Absolutt Europa II

### 4.5.1 Description of the product

This product is a combination of a bank deposit and a put and a call linked to the Dow Jones Euro Stoxx 50. It has an investment period of just above six years, which runs from 27 March 2007 with maturity on 27 April 2012. While you are guaranteed to have your money back at maturity, your profit increases if the index augments and if it falls. However, the put is limited by a knock-out meaning that if the underlying at any time drops more than 50 percent, the put option becomes worthless.

Fees amount to five percent for investments in the range of NOK100,000 to NOK1,999,999.

The product's payoff diagram is shown in Figure 26.

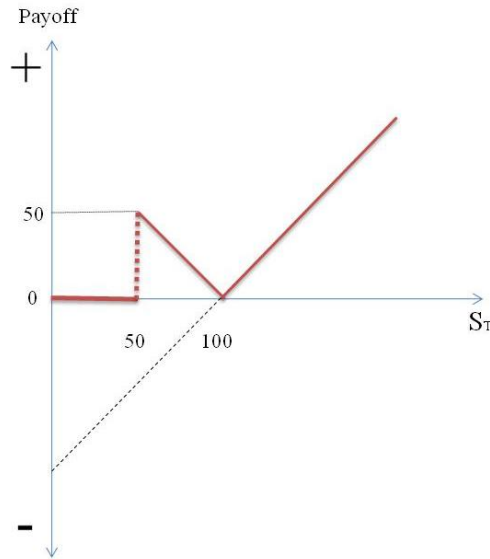


Figure 26 – Payoff diagram of Orkla Finans Absolutt Europa II

#### 4.5.2 Product specific parameters

We need the effective risk-free annual rate of return. We estimate this from the five-year Norwegian governmental bond for the relevant period, which is 4.49 percent.

I need to estimate the probability distribution of the underlying assets on this and the remaining products of my sample, as discussed in section 4.1.4. To estimate the normal distribution I need the volatility and the expected return. I need the dividend rate to find comparable certainty equivalent returns.

As of 3 March 2007 the dividend yield for DJ EuroStoxx 50 the previous year is 2.71 percent. The last five years upon issuance, more precisely 31.12.2001-31.12.2006 the DJ EuroStoxx 50 has had an annual average return of 1.60 percent according to the prospect. The volatility used by Bøe is the average the last four years, since the five-year average is too high. The volatility is based on daily logarithmic return, and is 15.02 percent.

##### 4.5.2.1 Utility calculations

The results of the utility calculations are summarized in Figure 27 below. All utilities are expressed in terms of certainty equivalent interest rates.

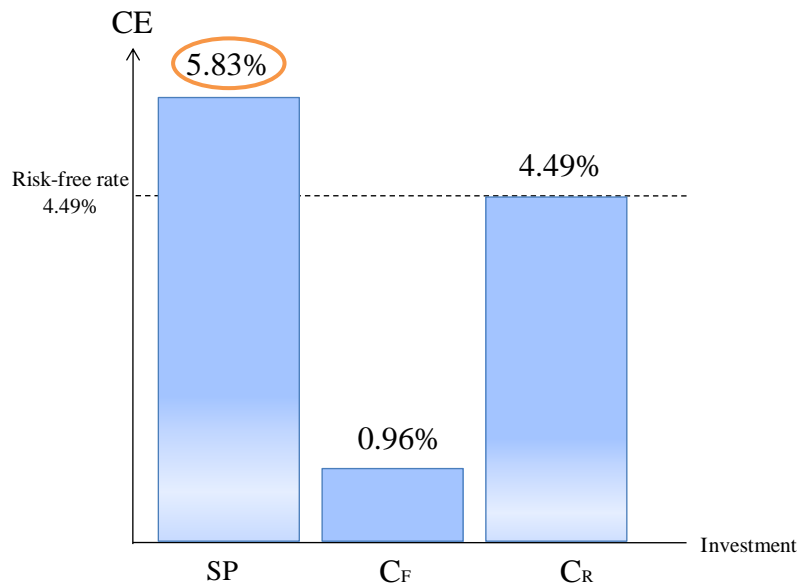


Figure 27 - Utility calculations of Orkla Finans Absolutt Europa II and the respective alternative investments

The  $C_R$  investment has a proportion of 100 percent in the risk-free asset, thus the certainty equivalent is equal to the risk-free return. The  $C_F$  investment has a utility of 0.96 percent, whereas the structured product has a utility of 5.83 percent. The optimal allocation between risk-free and risky assets in the classical portfolios consists of 100 percent invested in the risk-free asset.

## 4.6 Fokus Bank Råvareindeksobligasjon olje 2007-2008

### 4.6.1 Description of the product

This AIO combines a zero-coupon bond issued at par value with one month futures on the WTI light sweet crude in USD. The investment period is 18 months, from 8 June 2007 to 8 December 2008. The return of the product is linked to four scenarios. If the oil price has stayed in a range of 80-125 percent of the benchmark oil price from 8 June 2007 throughout the whole lifetime of the product, the return of the derivative is 21 percent. If it has stayed between 75-135 percent the return is 14 percent. Further, if the return is in the range of 70-145 percent at maturity the investor gains a seven percent return. Outside this range, the return of the structured product is the guaranteed element only.

For investments between NOK100,000 and NOK900,000 the fees are two percent. Figure 28 displays the payoff diagram of the structured product.

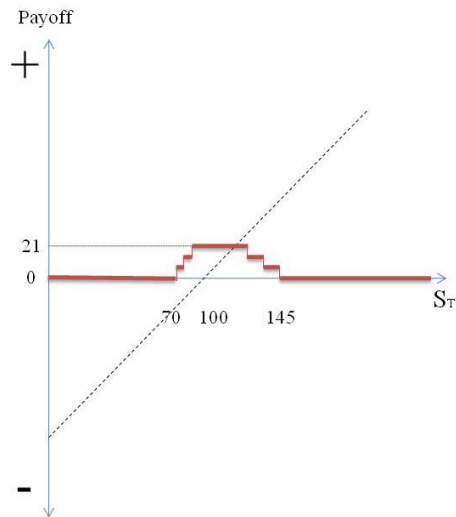


Figure 28 – Payoff diagram of Fokus Bank RIO olje 2007-2008

#### 4.6.2 Product specific parameters

By combining the return of a three-year and five-year Norwegian governmental bond for the relevant period, we find the effective four-year risk-free rate of return. It is 4.93 percent. The annual volatility the last one and a half year upon issuance is 29.52 percent, according to Bøe's estimations. In the prospect Focus refers to the five-year return upon issuance, which is 132 percent, equivalent to an annual rate of 18.33 percent. I assume that there is no dividend paid on this index. This means that any convenience yield is ignored.

#### 4.6.3 Utility calculations

The results of the utility calculations are summarized in Figure 29 below. All utilities are expressed in terms of certainty equivalent interest rates.

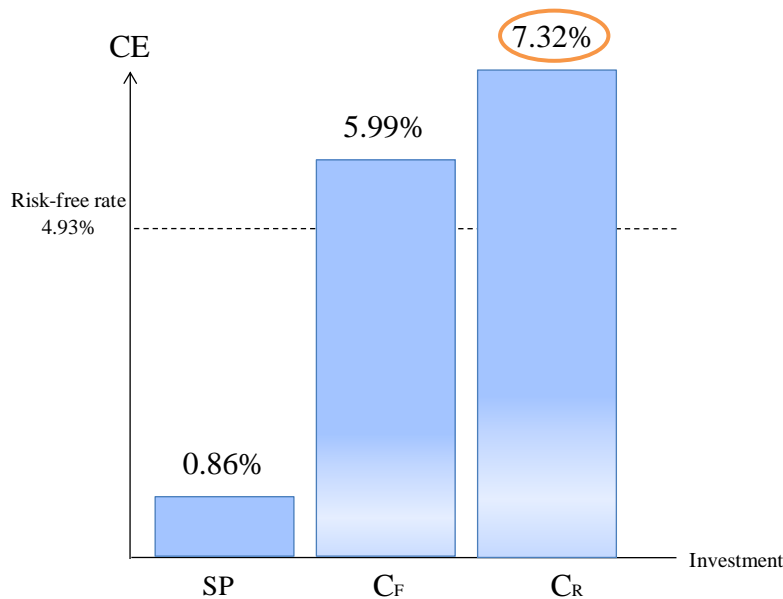


Figure 29 - Utility calculations of Fokus Bank RIO olje 2007-2008 and the respective alternative investments

The utilities of the structured product, the C<sub>F</sub> investment and the C<sub>R</sub> investment are 0.86 percent, 5.99 percent, and 7.32 percent respectively. The allocation of the Markowitz portfolio consists of 100 percent of the investment in risk-free asset. It is the C<sub>R</sub> investment that yields the highest utility.

## 4.7 Acta Japansk Eiendom 2007-2010

### 4.7.1 Description of the product

This BMA product consists of a bank deposit and a call option on the Japanese real estate index Tokyo Stock Exchange REIT index. It runs from 20 March 2007 to 31 March 2010, i.e. the term is three years. The invested amount is guaranteed at maturity of the product.

Fees are contingent on the size of the investment. For investments ranging from NOK50,000 to NOK10,000,000, the fees are five percent of the invested amount. In accordance with the procedure for the other products, I assume that we are dealing with a small investor who could be safely placed within the range of NOK50,000 to NOK10,000,000.

The ex post participation factor was 102% and this factor is being used in the calculations. Figure 30 illustrates the payoff diagram of the product.

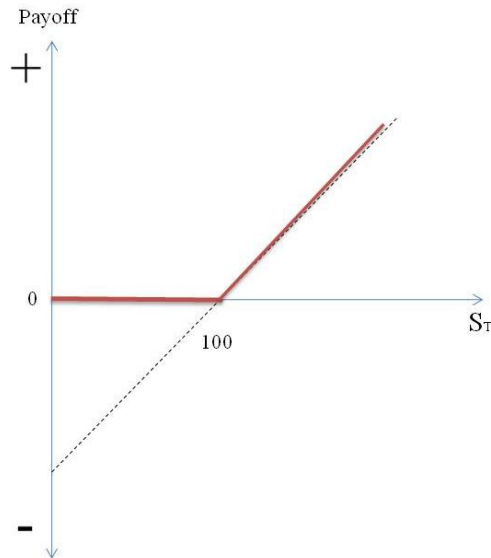


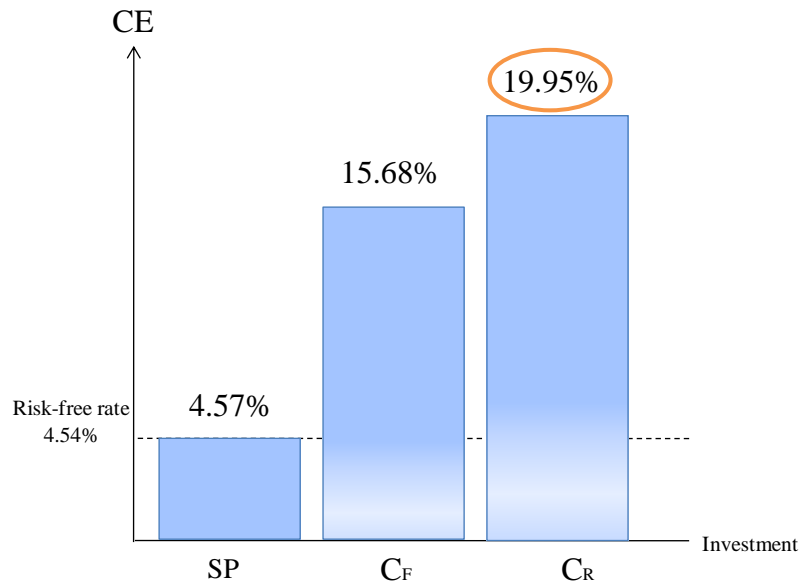
Figure 30 – Payoff diagram of Acta Japansk Eiendom 2007-2010

#### 4.7.2 Product specific parameters

The risk-free effective rate of return is estimated from the effective rate on a three-year Norwegian governmental bond for the relevant period. The rate is 4.54 percent. Three-year volatility on the Japanese real estate index Tokyo Stock Exchange REIT index is 13.82 percent annually, calculated by Bøe. At the time of issue of the product, the REIT index had only existed for three years and ten months. According to the prospect of the structured product, Acta communicate that the price return of the REIT index has been 117.8 percent. This represents an annual return of 22.5 percent, excluding dividends. In the prospect Fokus further communicates that the annual dividend yield is 2.63 percent.

#### 4.7.3 Utility calculations

The results of the utility calculations are summarized in Figure 31 below. All utilities are expressed in terms of certainty equivalent interest rates.



**Figure 31 - Utility calculations of Acta Japansk Eiendom 2007-2010 and the respective alternative investments**

The structured product has a utility of 4.57 percent, which is marginal higher than the risk-free rate of 4.54 percent. The utility of the C<sub>F</sub> is 15.68 percent whereas the C<sub>R</sub> investment has a utility of 19.95 percent. It is the C<sub>R</sub> investment that yields the highest utility. The optimal allocation between risk-free and risky assets in the classical portfolios consists of 100 percent invested in the risky assets. Studying the results, it is important to recall the discussion about the reliability of the datasets from section 4.1.4.

## 4.8 DnB Nor Kraft 2007/2009

### 4.8.1 Description of the product

This AIO was issued by DnB Nor 29 January 2007 with expiration on 30 December 2009 which means that time to maturity is two years. The potential return relates to the price development on three different fixed price contracts on electricity, listed on Nord Pool. More precisely, the product consists of three options with the electricity price in EUR per MWh as underlying. The three contracts are equally weighted.

The participation is 105 percent, and the bond is issued at five percent above par value. The fees vary as usual according to the invested amount. For investments in the range of NOK10,000 to NOK1,490,000 they are three percent of the invested amount for normal customers.

Figure 32 shows the payoff diagram of the product.

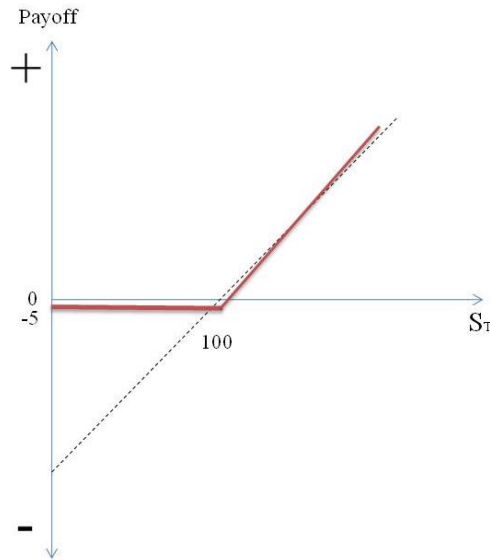


Figure 32 – Payoff diagram of DnB Nor Kraft 2007/2009

#### 4.8.2 Product specific parameters

As before, the effective risk-free rate of return is estimated from the Norwegian governmental bond with the same term and issued for the same period as the structured product. The effective return on a three-year Norwegian governmental bond for the relevant period is 4.35 percent. Three-year annual volatility is estimated by Bøe to 20.0 percent. There is no dividend on power price contracts.

The underlying is forward contracts on power and not the spot price. Therefore it is the expected return on the forward contracts that is relevant. The prospect does not include any historical returns. However, in a prospect on a different structured product based on warrants on similar contracts provided by DnB Nor, the historical annual returns on two-year forward contracts from 2002-2004, 2003-2005, and 2004-2006 constructed by one-year contracts, are on average 20.58 percent, 24.90 percent, and 30.92 percent annually. The overall average is 25.47 percent annually.

#### 4.8.3 Utility calculations

The results of the utility calculations are summarized in Figure 33 below. All utilities are expressed in terms of certainty equivalent interest rates.



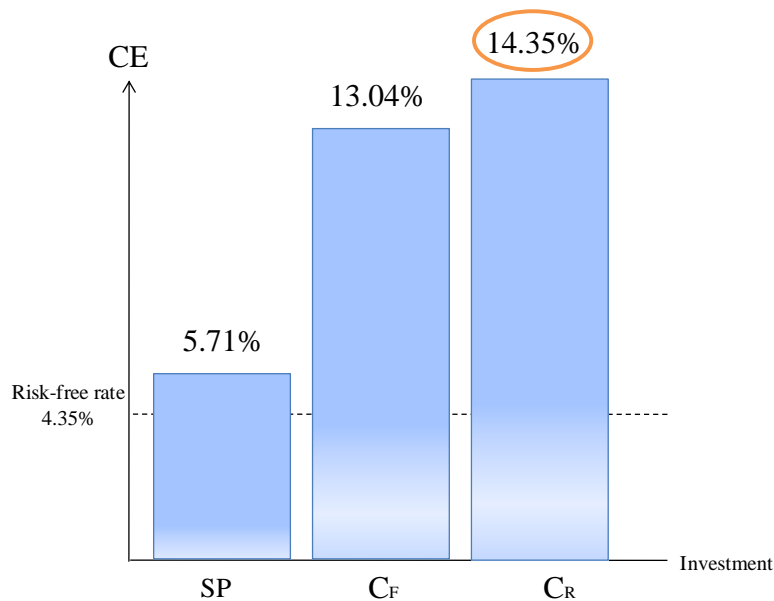


Figure 33 - Utility calculations of DnB Nor Kraft 2007/2009 and the respective alternative investments

The utility of the structured product is 5.71 percent, which is somewhat higher than the risk-free return rate of 4.35 percent. It is the C<sub>R</sub> investment that yields the highest utility of 14.53 percent, while the C<sub>F</sub> investment yields a utility of 13.04 percent. The optimal allocation between risk-free and risky assets in the classical portfolios consists of 100 percent invested in the risky assets. Again I emphasize that when studying the results, it is important to recall the discussion about the reliability of the datasets from section 4.1.4.

## 4.9 Nordea Lock-in Basket 2006-2010

### 4.9.1 Description of the product

The product is an AIO and consists of a zero coupon bond and a call option linked to a basket of four underlying stock indices. The guaranteed amount to be paid back at maturity is 95 percent of the invested amount. The four underlying stock indices are Dow Jones Euro Stoxx 50, Tokyo Stock Price index, the Chinese Hang Seng index, and finally S&P BRIC 40 Euro index. They are weighted 40 percent, 30 percent, 15 percent, and 15 percent respectively.

Additionally, the product includes a lock-in element. This means that if the return of the basket of the four indices increases by at least 20 percent any time during the product's life, the investor is guaranteed at least these 20 percent. Consequently, the return will be minimum 15 percent; 20 percent from the basket of indices, and minus five percent from the invested amount.

The product was issued on 3 November 2006 with expiration on 3 November 2010. This represents an investment period of four years. The fees are contingent on the size of the invested amount. For investments in the range of NOK10,000 to NOK990,000 the fees are four percent. The participation in the underlying is 100 percent. Figure 34 shows the payoff diagram of the product.

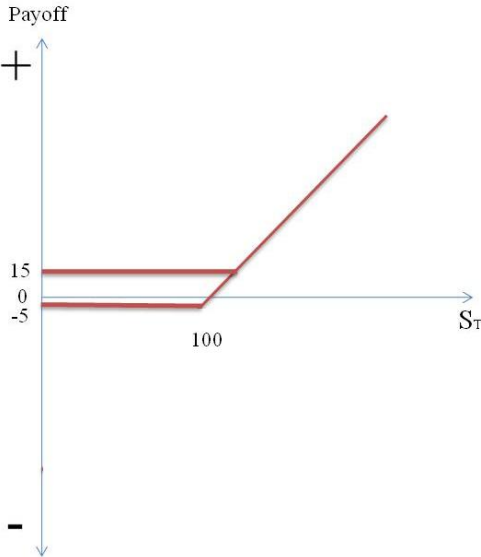


Figure 34 – Payoff diagram of Nordea Lock-in Basket 2006-2010

**4.9.2 Product specific parameters**

The effective risk-free rate is found by combining the three-year and five-year Norwegian governmental bond for the relevant period. It is estimated to be 4.04 percent. Based on an average of the dividend yields employed on each index, the dividend yield for the basket of indices is 1.73 percent annually.

**4.9.3 Utility calculations**

The results of the utility calculations are summarized in Figure 35 below. All utilities are expressed in terms of certainty equivalent interest rates.

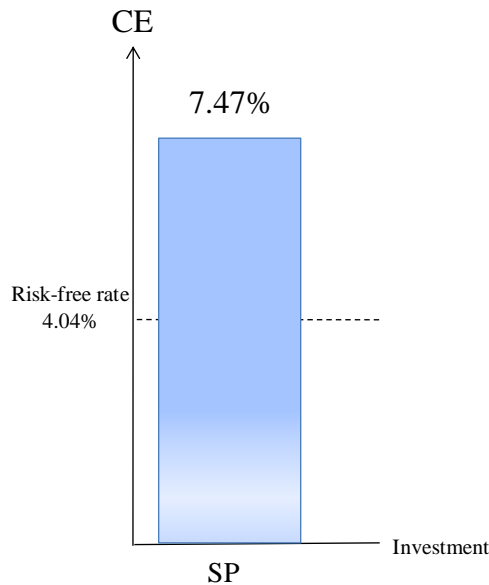


Figure 35 - Utility calculation of Nordea Lock-in Basket 2006-2010

For this product I do not have data on the underlying assets. The utility of the structured product is 7.47 percent compared to the risk-free investment of 4.04 percent.

## 4.10 Storebrand Spread Aksjeindeksobligasjon 2006-2010

### 4.10.1 Description of the product

This AIO product by Storebrand was issued on 29 August 2006 with expiration on 6 September 2010. The term is four years. The return on the derivatives is linked to the difference between the return of Dow Jones Euro Stoxx 50 and the American index Russell 2000. If the difference is positive, the return on the derivative is positive. Otherwise the return is zero on the derivatives, and the investor receives only the invested amount at maturity. The participation is 150 percent and the guaranteed amount is 100 percent of the initial investment. The product can deliver a positive return even if the markets falls during the period, contingent that DJES falls less than Russell 2000.

As usual, the fees depend upon the invested amount. If the invested amount is in the range of NOK10,000 to NOK990,000 the fees are 4.25 percent of the invested amount for normal clients. Figure 36 represents the payoff diagram of the product.

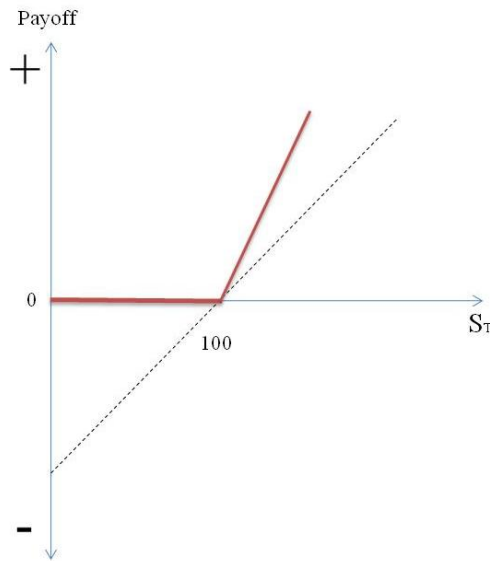


Figure 36 - Payoff diagram of Storebrand spread 2006-2010

The effective annual risk-free rate of return is as before estimated from the Norwegian governmental bond in the relevant period and with the same term as the structured product in question. The effective annual return on the four-year Norwegian governmental bond for the relevant period is found by combining a three-year and a five-year governmental bond. It is 3.88 percent.

#### 4.10.2 Utility calculations

The results of the utility calculations are summarized in Figure 37 below. All utilities are expressed in terms of certainty equivalent interest rates.

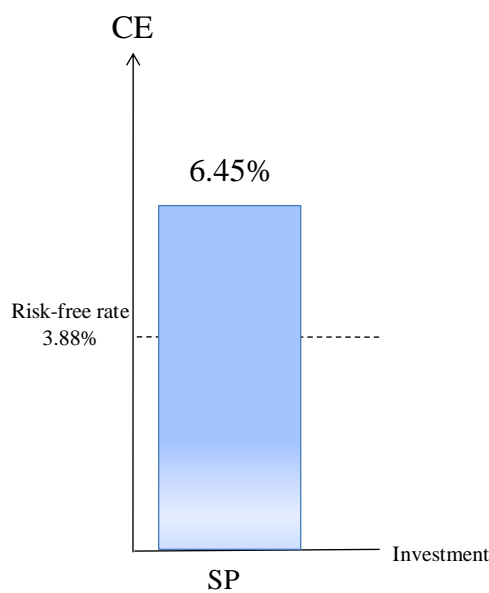


Figure 37 - Utility calculation of Storebrand spread 2006-2010

For this product I do not have data on the underlying assets. The utility of the structured product is 6.45 percent compared to the risk-free investment of 3.88 percent.

## 4.11 Discussion

The results of my analysis are summarized in Table 4.2. The names of the financial institutions represent the structured product of that institution. I will use the names of the financial institutions to refer to the structured product of that institution throughout the discussion.

Product	SP	$C_F$	$C_R$	$R_f$
DnB Global	6,4 %	4,2 %	6,6 %	6,3 %
DnB Sektor	6,5 %	3,5 %	6,3 %	6,3 %
Orkla	5,8 %	1,0 %	4,5 %	4,5 %
Fokus	0,9 %	6,0 %	7,3 %	4,9 %
DnB Kraft	5,7 %	13,0 %	14,5 %	4,4 %
Acta	4,6 %	15,7 %	20,0 %	4,5 %
Nordea	7,5 %	n/a	n/a	4,0 %
Storebrand	6,4 %	n/a	n/a	3,9 %

Table 4.2 – Summary of findings

We see that the utility from the adjusted classical investment,  $C_F$ , is always inferior to the realistic classical investment,  $C_R$ . This is as expected since the only difference between the two investments is that the  $C_R$  investment is subject to no fees but receives dividends on the investment. Further, we see that the utility is higher from the structured product investments than from the  $C_R$  investments for DnB Sektor and Orkla. For the rest of the products the situation is opposite.

The utility of the structured product investments is for three products higher than the utility of the belonging  $C_F$  investment, whereas for three other products the opposite is true. The utility of the structured product investments is superior to the risk-free investments for all products except the Fokus product.

We notice that the  $C_F$  and  $C_R$  investments of the DnB Kraft and Acta have very high utilities compared to the other products. One reason for this could be the assumption related to the

calculations of the underlying basket of assets. As mentioned earlier in the chapter, the return distribution of the underlying basket of assets of these products, as well as four other products, has been calculated assuming normal distribution. The mean returns used to compute the normal distributions of these two products are taken from the respective prospects, where it is stated that Acta’s mean return is 22.5 percent whereas DnB Kraft’s mean return is 25.47 percent. These figures are definitely very high, and this could to a large extent explain the high utility from the  $C_F$  and  $C_R$  investments of these products. This is a strong argument for my choice not to base any quantitative conclusions on these products.

**4.11.1 The effect of free design**

To investigate the free design effect we compare the utility of the structured product investment to the utility of the adjusted classical investment,  $C_F$ . The  $C_F$  investment is subject to the same conditions as the structured product investment in terms of dividends and fees. Therefore, the difference in utility between the two investments could be directly compared and represents to what extent the investor appreciates access to a non-linear investment compared to a strictly linear investment. I refer to section 4.1.1 for a thorough explanation of the rationale behind the comparison. Table 4.3 summarizes the comparison.

Product	SP/ $C_F$
Orkla	504,6 %
DnB Sektor	87,0 %
DnB Global	50,9 %
DnB Kraft	-56,2 %
Acta	-70,8 %
Fokus	-85,7 %
Nordea	n/a
Storebrand	n/a

**Table 4.3 – The difference between the structured product and the adjusted classical investment**

The table expresses the difference in utility, measured in certainty equivalent returns, between the structured product investment and the  $C_F$  investment. We see that three of the products are yielding higher utilities than the  $C_F$  investment, expressed by a positive number, whereas three of the products are yielding lower utilities than the  $C_F$  investment, expressed by a negative number. This means that in three of the cases the free design increases the utility of

the investors, whereas in three other cases it reduces the utility. For two of the products I do not have data. They are presented alphabetically.

Regarding the Fokus product it is interesting to notice that this is the product that performs the poorest in terms of expected return (Bøe, 2007). It has an expected annual return which is 1.7 percent below the risk-free rate. This explains, at least partially, the highly negative percentage of the product.

We should be careful to conclude upon the percentages of all the products. In the lack of simulated probability distribution of the returns of the underlying assets of six of the eight products, their distributions are estimated based on normal distribution. This strongly limits the reliability of the results. I refer to section 4.1.4 for a closer discussion about the quality of the datasets.

However, for DnB Global and DnB Sektor we have simulated distributions for both the structured products and the underlying assets. We can therefore draw conclusions upon these two products without having a reliability issue. The downside is that we are reducing the size of the sample and therefore the sample's representativeness for structured products in Norway as a whole. However, we have seen that the two products in questions are considered to be representative for the Norwegian market. The pros and the cons could therefore be said to neutralize.

Limiting the analysis to include only DnB Global and DnB Sektor we can conclude that enhancing investment opportunities from strictly linear classical investments to structured product investments offering non-linear combinations of the risk-free asset and the risky assets does increase the investors' utility in the range of 51 to 87 percent.

#### **4.11.2 Structured product investments compared to the alternative investments**

To investigate how structured products perform compared to the alternative investments I look at the difference between the utility of the structured product investments and the two alternative investments; the  $C_R$  investment and the risk-free investment. The results are summarized in Table 4.3.

Product	SP/C <sub>R</sub>	SP/R <sub>f</sub>
Orkla	29,7 %	29,7 %
DnB Sektor	3,7 %	3,7 %
DnB Global	-3,6 %	1,7 %
DnB Kraft	-60,7 %	31,3 %
Acta	-77,1 %	0,7 %
Fokus	-88,3 %	-82,6 %
Nordea	n/a	84,9 %
Storebrand	n/a	66,1 %

Table 4.4 – The differences between the structured product and the two alternative investments

#### 4.11.2.1 Structured product investment versus classical C<sub>R</sub> investment

Let us first compare the structured product investment to the C<sub>R</sub> investment. We see that for two of the products the percentages are positive. This means that the investment in the structured product has a superior utility than the C<sub>R</sub> investment. Four of the eight products have negative percentages, meaning the C<sub>R</sub> investment yields a higher utility than the structured product.

Again we should be careful about concluding based upon the results from all the product comparisons due to the reliability of the datasets. However, we can conclude upon the findings from DnB Global and DnB Sektor which are representative for the Norwegian market of structured products. We see that DnB Sektor yields 3.7 percent higher utility than the C<sub>R</sub> investment, whereas DnB Global yields 3.6 percent lower utility than the C<sub>R</sub> investment. We roughly conclude that structured products provide about the same utility as the C<sub>R</sub> investment.

From the findings we can conclude that it seems like the structured product investments are no worse than the C<sub>R</sub> investment. Looking deeper into the assumptions of my calculations we can find arguments that speak in favor of this conclusion.

One of the assumptions of the C<sub>R</sub> investment alternative is that the investor has direct access to the underlying assets involved in the structured products. This is a strong assumption. In chapter two I argue that one of the advantages of structured products is indeed that they gives small private investors access to markets and securities they otherwise would not have access to. The Japanese REIT index embedded in the structured product from Acta is an example of



a security that a small, private investor in Norway most likely would not have access to without the structured product. For this superior access to markets and securities it is reasonable to assume that the small private investor is willing to pay a premium.

It is also highly relevant to question whether a small, private investor has the required knowledge to understand these markets and conclude that he wants to invest in the relevant indices. In chapter two I argue that they have inferior knowledge compared to the financial institutions. It is therefore likely to assume that the investor is willing to pay a premium for having an investment proposal ready on the table, prepared by the bank.

These two effects are difficult to quantify but it is likely to assume that they would improve the position of structured products compared to  $C_R$ . This qualitative conclusion supports the quantitative conclusion that it is likely to say that structured product investments are not worse than the  $C_R$  investments.

#### *4.11.2.2 Structured product investment versus risk-free investment*

Let us now compare the utility of the structured product investment to the utility of the risk-free investment. From Table 4.4 we see that all the structured products, with the exception of one, yield utilities that are higher than the risk-free rate. The exception is the product by Fokus. One reason for this could be the exceptional low expected return from the product.

When comparing the structured products to the risk-free return, I use only the return distribution of the structured products. I have such distributions for all the eight products of my sample. The difference of the utility measured in certainty equivalents of the average product to the average risk-free investment is 17 percent. This means that structured products yield on average a utility that is 17 percent higher than the utility of a bank deposit. From my findings I can therefore conclude that structured products are better investments in terms of utility than bank deposits.

#### *4.11.2.3 Structured products versus alternative investments, conclusion*

I have assumed that when comparing investments in structured product to investments in a risk-free asset the investors have no knowledge or experience from financial markets. Without the alternative of a structured product investment they face only one investment possibility; the risk-free asset, also known as the bank deposit. For these investors we see that structured products deliver increased utility in the range of 17 percent. When comparing a structured product investment to a  $C_R$  investment, I have assumed that the investor has knowledge about

or is familiar to market investments and has invested in stock markets before. I conclude that utility of the structured product investment and the  $C_R$  investment is about the same for the two investments.

### **4.11.3 Changing the input parameters and assumptions**

In my findings so far I have only used classical PT-parameters found by Tversky and Kahneman (1992). Moreover, I have based my calculations on several assumptions presented in section 4.2. Obviously, changing the parameters and assumptions would affect the results of my analysis. In this section I will investigate how the utilities of the structured products and the alternative classical investments change when I change the input parameters and assumptions.

First I will look at the effect of changing the prospect theory parameters from the K-T parameters to the parameters of a Norwegian investor. Thereafter I will investigate the effect of changing the reference point from equaling the risk-free rate of return to zero. Finally I will analyze the effect of changing the probability perception parameter,  $\gamma$ , from 0.65 to 1.0. The latter change is related to the discussion on the rationality of the prospect theory in section 3.4.3.

#### ***4.11.3.1 Introducing the Norwegian investor***

To compare the results of classical PT-parameters, labeled K-T, with the results of Norwegian PT-parameters, labeled Norwegian, I use the parameters found in the INTRA survey, presented in section 3.6.3. I investigate the two products with the most reliable dataset, namely DnB Global and DnB Sektor. I also compare the utility of the structured product investments to the risk-free investment. This is done on all the products in my sample since I have reliable data on all the probability distributions of the structured products.

The comparison between the Norwegian and the K-T investor is summarized in Table 4.5.

Product	SP/R <sub>f</sub>		SP/C <sub>F</sub>		SP/C <sub>R</sub>	
	Norwegian	K-T	Norwegian	K-T	Norwegian	K-T
DnB Global	19,9 %	1,7 %	27,2 %	50,9 %	-9,4 %	-3,6 %
DnB Sektor	23,2 %	3,7 %	36,9 %	87,0 %	-8,4 %	3,7 %
Orkla	36,3 %	29,7 %				
Fokus	-20,5 %	-82,6 %				
DnB Kraft	41,2 %	31,3 %				
Acta	17,0 %	0,7 %				
Nordea	78,6 %	84,9 %				
Storebrand	76,4 %	66,1 %				

**Table 4.5 – The differences in utility between the structured product and the alternative investments for the Norwegian investor and the K-T investor**

Looking at the utility of the structured product compared to the utility of the risk-free investment, we see that all the utilities with the exception of one increase when using Norwegian prospect theory parameters compared to K-T parameters. This means that the utility of the structured products has increased. The difference in utility between the structured product investments and the risk-free investments is on average 34 percent for the Norwegian investor, compared to 17 percent for the K-T investor, as we saw in the previous section.

Comparing the free design effect of the Norwegian investor to the K-T investor, we see that the effect on the Norwegian investor on average is less than half the effect of the K-T investor for the DnB Global and the DnB Sektor products.

Investigating the utility of the structured product investments compared to the utility of C<sub>R</sub> investments for the DnB Global and DnB Sektor products, we notice that the performance of the structured products is poorer when applying Norwegian prospect theory parameters instead of classical K-T parameters. In difference to the K-T investor, we can say that the Norwegian investor clearly prefers the structured product investment to the C<sub>R</sub> investment.

We can conclude that the structured product investments clearly generate lower utility than the C<sub>R</sub> investments when applying Norwegian prospect theory parameters compared to K-T parameters, and that the free design effect is reduce by more than 50 percent on average. However, the difference in utility of the structured product investments compared to the risk-free investments has doubled from 17 percent to 34 percent as a consequence of introducing

Norwegian prospect theory parameters. This means that the utility of the structured products has increased.

In chapter five I adapt the prospect theory parameters to a Norwegian investor and a Swiss investor.

#### *4.11.3.2 Introducing the reference point equal to zero*

So far I have assumed that the reference point is equal to the risk-free rate. However, many private investors have a reference point equal to zero. When the reference point of the investor is zero the structured products with a 100 percent capital protection cannot yield negative utility if we exclude the fees. Hence, intuitively one should expect that the utility of the structured products is higher with the new reference point. The same intuitive expectation is valid for the realistic classical investment,  $C_R$ , because the possibility of returns below the reference point is lower since there is lower probability for return below zero than below the risk-free rate.

Table 4.6 shows the utility of the structured products for reference point equal to zero and reference point equal to the risk-free rate.

Product	SP (RP=0)	SP (RP=Rf)
DnB Global	8,4 %	6,4 %
DnB Sektor	8,7 %	6,5 %
Orkla	7,2 %	5,8 %
Fokus	3,0 %	0,9 %
DnB Kraft	7,5 %	5,7 %
Acta	6,2 %	4,6 %
Nordea	8,4 %	7,5 %
Storebrand	8,4 %	6,4 %
<i>Average</i>	<i>7,2 %</i>	<i>5,5 %</i>

**Table 4.6 – Utilities of structured products when the reference point is equal to zero compared to reference point equal to the risk-free rate of return**

As expected, we see that all the structured products have a higher utility when the reference point equals zero compared to when the reference point equals risk-free rate of return. The average utility of the products has increased by 32 percent. This also means that they have improved their position with respect to the risk-free investment.

Next, we compare the utility of the  $C_R$  investment for the two different reference points. The results are summarized in Table 4.7. I use the DnB Global and DnB Sektor since I have the highest quality datasets on the underlying of these products.

Product	$C_R$ (RP=0)	$C_R$ (RP=Rf)
DnB Global	8,3 %	6,6 %
DnB Sektor	7,9 %	6,3 %
<i>Average</i>	<i>8,1 %</i>	<i>6,5 %</i>

**Table 4.7 - Utilities of the  $C_R$  investments when the reference point is equal to zero and the risk-free rate of return**

We see that the realistic classical investment on average increases its utility by close to 25 percent when introducing reference point equal to zero compared to the standard situation in which the reference point is equal to risk-free rate.

Finally we look at the difference in free design effects when using two different reference points. The results are summarized in Table 4.8.

Product	SP/ $C_F$ (RP=0)	SP/ $C_F$ (RP=Rf)
DnB Global	42,2 %	50,9 %
DnB Sektor	72,0 %	87,0 %
<i>Average</i>	<i>57,1 %</i>	<i>68,9 %</i>

**Table 4.8 – The free design effect of the structured products for reference points equal to zero and to the risk-free rate of return**

The free design effect is on average about 17 percent lower when the reference point is zero compared to when the reference point is equal to the risk-free rate of return.

To summarize the effects of changing the reference point from being the risk-free rate to being zero, we can say that the average utility of the structured products increases by 32 percent, which means that they strengthen their position with respect to the risk-free investment. Further, the utility of the classical realistic investment increases on average by 25 percent. The free design effect is on average 17 percent lower.

For the investor with a reference point which is zero instead of equal to the risk-free return, we can conclude that the structured products improve their position compared to the risk-free investment and compared to the optimal classical realistic investment. The fact that both the

classical investments experience increased utility is in line with what we assumed. However, the free design effect is smaller. This is interesting because it means that investors with a reference point equal to the risk-free return appreciate the availability of structured products more than those with a reference point which is zero.

**4.11.3.3 Making the model rational**

As we saw in chapter three, section 3.4.3, classical finance theory argues that behavioral theories such as prospect theory are irrational. We further saw that the criticism is not necessarily fair because the majority of aspects of prospect theory could be explained by rationality. Indeed, the only irrational element of prospect theory is probability weighting.

Until now we have strictly looked at the utilities of structured products compared to classical investments for an irrational investor. We have used the K-T prospect theory parameters which give  $\gamma$ , the parameter reflecting the bias in perception of probabilities, the value of 0.65. To find the utilities of the structured products and the classical investments of a rational investor, we equal the  $\gamma$ -parameter to one. We will see that this introduction of a rational investor completely changes the results of the analysis so far.

First we investigate how the utility of the structured products changes when we introduce the rational investor. Table 4.9 shows the utilities of the structured products for the rational investor with  $\gamma$  equal to one, and for the K-T investor which is irrational and has  $\gamma$  equal to 0.65.

Product	SP ( $\gamma=1$ )	SP ( $\gamma=0.65$ )
Orkla	4,1 %	5,8 %
DnB Sektor	3,4 %	6,5 %
DnB Global	4,4 %	6,4 %
DnB Kraft	1,2 %	5,7 %
Acta	1,6 %	4,6 %
Fokus	-1,8 %	0,9 %
Nordea	4,3 %	7,5 %
Storebrand	-0,3 %	6,4 %
<i>Average</i>	<i>2,1 %</i>	<i>5,5 %</i>

**Table 4.9 - Utilities of the structured products for  $\gamma$  equal to one and  $\gamma$  equal to 0.65**

We can see that all the structured products yield lower utility when the investor is rational, and that two of the products yield a negative utility. The average utility of the structured products measured in certainty equivalents drops by 3.4 percent, which could be translated into a 61.5 percent decrease in utility. This means that the rational investor appreciates the structured product less than half as much as the irrational investor.

Next, we look at the utility of the structured product investments compared to the risk-free investments for the rational investor. The comparison is shown in Table 4.10.

Product	SP ( $\gamma=1$ )	Rf
Orkla	4,1 %	4,5 %
DnB Sektor	3,4 %	6,3 %
DnB Global	4,4 %	6,3 %
DnB Kraft	1,2 %	4,4 %
Acta	1,6 %	4,5 %
Fokus	-1,8 %	4,9 %
Nordea	4,3 %	4,0 %
Storebrand	-0,3 %	3,9 %
<i>Average</i>	<i>2,1 %</i>	<i>4,9 %</i>

**Table 4.10 – Utilities of the structured products for  $\gamma$  equal to one compared to the risk-free rate of return**

We can see that all products except one have lower utility measured in certainty equivalents than the risk-free rate of return. The exception is the Nordea product which has a slightly higher utility than the risk-free investment. On average the utility of the structured products for the rational investor is 57 percent lower than the utility of the bank deposit.

Finally, we compare the rational investor's utility of the structured products with the utility of the  $C_R$  investment, and we look at the free design effect. The results are presented in Table 4.11.

Product	SP	C <sub>F</sub>	C <sub>R</sub>	R <sub>f</sub>
DnB Global	4,4 %	4,5 %	6,9 %	6,3 %
DnB Sektor	3,4 %	3,5 %	6,3 %	6,3 %
<i>Average</i>	<i>3,9 %</i>	<i>4,0 %</i>	<i>6,6 %</i>	<i>6,3 %</i>

**Table 4.11 – Utilities of the structured product and the classical investments for  $\gamma$  equal to one**

We see that the utility of the structured products for the rational investor on average is 41 percent lower than the utility of the C<sub>R</sub> investment. We also see that the free design effect is negative.

To conclude we can say that when we adapt the K-T prospect theory parameters to a rational investor, the utilities of the structured products compared to the classical investments fall dramatically, and the free design effect vanishes. Roughly speaking we can say that the utilities of the structured products are less than half the utilities of the alternative classical investments. The effect of introducing a rational investor compared to an irrational investor reduces the average utility of the structured products by more than 60 percent.

#### **4.11.4 Was it right to ban structured products in Norway?**

The ultimate question to be answered in this chapter was whether it was a wise decision to practically ban structured products in Norway.

The base case of the analysis has been an irrational investor. The irrationality has been reflected through a biased perception of probabilities, expressed by  $\gamma$  equal to 0.65. We have seen that the investors having the risk-free investment as their alternative investment had 17 percent higher utility from the structured products, whereas the investors having the C<sub>R</sub> investment as their alternative were roughly indifferent between structured products and the C<sub>R</sub> investments. The free design effect was between 51 and 87 percent. In general structured products appeared to be quite good investments. At least we could not conclude that they were bad investments.

However, the results changed dramatically when we modified the assumptions and the parameters. When applying Norwegian prospect theory parameters the utility of the structured products increased and the C<sub>R</sub> investment clearly generated lower utility than the structured product investment. However, the free design effect halved. By applying a reference point equal to zero instead of the risk-free rate the structured products yielded higher utility and



strengthened their position with respect to the classical investments. However, also here the free design effect was reduced compared to when the K-T prospect theory parameters were applied.

The most radical change in the results happened when we assumed that the investor was rational, meaning that he is not subject to any bias in the perception of probabilities. The utility of the structured products was reduced by more than 60 percent compared to the irrational investor. Moreover, both the classical investments yielded by far higher utility than the structured products, and the free design effect was gone. Roughly speaking the classical investments were both twice as good in terms of utility than the structured product investments.

We can conclude that the preferences of the irrational investor and the rational investor tend to be completely different. Whereas irrational investors generally preferred structured products to the classical investments, and profited from a strong free design effect, rational investors preferred the classical investments by large, and did not have any free design effect from structured products.

Based upon this, we can further conclude that investments in the structured products analyzed in this thesis are irrational. I have argued that my sample is representative for the Norwegian market for structured products. Hence, we can conclude that investments in Norwegian structured products can only be good investments if the investor is irrational. However, the banks, in role of financial advisors, should not accept this irrationality of the client. Instead they should help the client to make rational choices, meaning they should correct the client's biased probability perception.

Was it correct to practically ban structured products from the Norwegian market? Based on my findings the answer is yes. What we have seen is that Norwegian banks instead of correcting the client's bias have been aggressively selling the structured products to their clients. This means that the banks have been profiting from their clients' irrationality, which is a weakness of the clients, to sell structured products which are profitable for the banks. I believe this could be compared to selling drugs to drug addicts! Although this metaphor is harsh, I believe it could be a descriptive picture of the banks' behavior.

#### **4.11.5 Personal reflections**

At the end of this chapter I find room for some personal reflections based upon my findings.

#### *4.11.5.1 A comment on the $C_R$ investment*

Implicitly, for the  $C_R$  investment alternative, I have assumed that a small, private investor with knowledge about financial markets can access all the assets or securities that are underlying assets of the structured product. But is this realistic? Would it be possible for the investor to obtain the underlying basket of assets in the markets? If we assume that the investor is a small, private investor, the most likely answer is no. By consequence, we would have to adjust the real-life classical model and find a proxy.

As the world markets globalize it is natural to expect increased investment possibilities, which converge the number of securities available to the small private investor towards the global population of securities. In such a scenario my original assumptions are valid. However, in today's markets, that is not necessarily the case.

#### *4.11.5.2 A comment on the Røeggen case in light of the utility analysis of the involved products*

In chapter two, section 2.2.3, I mention the Røeggen case. In light of the findings in this chapter it could be interesting to give a comment on the case.

Mr Røeggen invested in two structured products sold by DnB Nor; DnB Global and DnB Sektor. Assuming Røeggen wanted to do good rational investments, the investment in the two products offered by DnB Nor was a bad choice. Table 4.11 presented earlier in this chapter summarizes the utility calculations of the two structured products and the classical investments.

Røeggen achieved less utility from the structured products than what he could have achieved from the two classical investment alternatives. Also, he had no free design effect to profit from. Mr Røeggen would have been much better off by investing in the classical alternatives. Assuming that he had no experience or knowledge about market investments, his alternative would have been to do the risk-free investment, in other words investing in his savings account. He would on average have achieved a 65 percent higher utility from this alternative than from investing in the structured products.

In other words, according to my analysis his investment decision could only be irrational. It is hard to understand how DnB Nor could advise him to invest in the products.

Røeggen sued the bank for advising him to invest in the products. The verdict in the case fell from the city court of Oslo Monday 15 June 2010. DnB Nor was judged guilty of providing

too poor information about the products and sentenced to compensate Mr. Røeggen (Bache & Stranden, 2010).

It is expected that the final verdict will fall in the Supreme Court.

## **5 Cultural background and its influence on investment choices**

In chapter four we have seen that introducing other prospect theory parameters changes the utility of structured products. Since different prospect theory parameters return different utilities of the structured products, it seems that investors with different cultural backgrounds have different investment preferences. An interesting question is to what extent I can prove this relationship between cultural backgrounds and investment behavior based upon utility calculations on my sample of structured products.

In this chapter I will investigate this question. I will look at how the structured products presented in chapter four are appreciated by a Norwegian investor and a Swiss investor, compared to the K-T investor applied in the previous chapter. Then I will calculate the free design effect for the Swiss and the Norwegian investor. By free design effect I refer to the increase in utility from the investment in the structured product compared to the adjusted classical investment.

### **5.1 Assumptions and parameters**

I assume that cultural backgrounds are dependent solely on the country to which the investor belongs. This means that a Swiss investor represents the Swiss culture whereas a Norwegian investor represents the Norwegian culture.

In all the utility calculations in this chapter I use the normalized prospect theory with K-T probability weighting function and the piecewise power value function. I further assume that the Swiss investor has the same reference point as the Norwegian investor, in this chapter the risk-free rate of return.

I will use the prospect theory parameters for Norway and Switzerland found in the INTRA survey, and presented in chapter three.

### **5.2 Utility analysis**

Based upon the assumptions and parameters presented above, I conduct the utility analysis in three steps. First I compare the Norwegian investor to the K-T investor. Second I compare the Swiss investor to the K-T investor. Third, I compare the Norwegian to the Swiss investor. The K-T investor can be regarded as the non-culturized investor.

### 5.2.1 Norwegian investor versus K-T investor

By comparing the utility score of the structured products found by classical K-T prospect theory parameters to the score found by Norwegian parameters, we can see how the Norwegian culture affects the utility compared to the non-culturized utility. Referring to the classical K-T prospect theory parameters, I will say the K-T investor, while referring to the Norwegian parameters I will say the Norwegian investor. Table 5.1 summarizes the comparison.

Product	K-T	Norwegian	$\Delta U$
Acta	4,57 %	5,31 %	16 %
DnB Kraft	5,71 %	6,14 %	8 %
DnB Global	6,41 %	7,55 %	18 %
DnB Sektor	6,53 %	7,76 %	19 %
Fokus	0,86 %	3,92 %	356 %
Nordea	7,47 %	7,22 %	-3 %
Orkla	5,83 %	6,12 %	5 %
Storebrand	6,45 %	6,85 %	6 %

Table 5.1 – Comparison of structured product utilities between the K-T and the Norwegian investor

We see that for all products except one the Norwegian investor scores higher than the K-T investor. Fokus' product is subject to the largest utility improvement with a magnitude of 356 percent. In the other end of the scale, Nordea's product is suffering from the change in parameters, and the utility for the Norwegian investor is three percent lower than for the K-T investor. The median improvement is 12 percent. We can conclude that the Norwegian investor realizes about 12 percent higher utility from the structured products than the non-culturized investor.

### 5.2.2 Swiss investor versus K-T investor

Comparing the K-T parameters with the Swiss parameters shows how the Swiss investor evaluates the structured products compared to the non-culturized investor. The results are summarized in Table 5.2.

Product	K-T	Swiss	$\Delta U$
Acta	4,57 %	4,23 %	-8 %
DnB Kraft	5,71 %	4,77 %	-17 %
DnB Global	6,41 %	6,48 %	1 %
DnB Sektor	6,53 %	6,56 %	0 %
Fokus	0,86 %	3,62 %	322 %
Nordea	7,47 %	6,20 %	-17 %
Orkla	5,83 %	5,14 %	-12 %
Storebrand	6,45 %	5,26 %	-18 %

**Table 5.2 - Comparison of structured product utilities between the K-T and the Swiss investor**

From five out of eight products the Swiss investor achieves lower utility than the K-T investor. Again, Fokus' product is subject to the largest utility improvement with a magnitude of 322 percent. The median improvement is minus ten percent. We conclude that the Swiss investor overall achieves ten percent less utility from the structured products than the non-culturized K-T investor.

### 5.2.3 Norwegian investor versus Swiss investor

We have investigated how the utility of the structured products changes as we look at the investments from a Norwegian point of view compared to the K-T perspective, and a Swiss viewpoint to the K-T perspective. However, it is interesting to compare the Norwegian investor to the Swiss investor directly. This comparison is summarized in Table 5.3.

Product	Norwegian	Swiss	$\Delta U$
Acta	5,31 %	4,23 %	-20 %
DnB Kraft	6,14 %	4,77 %	-22 %
DnB Global	7,55 %	6,48 %	-14 %
DnB Sektor	7,76 %	6,56 %	-16 %
Fokus	3,92 %	3,62 %	-8 %
Nordea	7,22 %	6,20 %	-14 %
Orkla	6,12 %	5,14 %	-16 %
Storebrand	6,85 %	5,26 %	-23 %

**Table 5.3 - Comparison of structured product utilities between the Norwegian and the Swiss investor**

For all the products the Swiss investor has a lower utility than the Norwegian investor. The difference is in the magnitude of eight to 23 percent. The Storebrand product has the biggest difference, whereas the Fokus product has the smallest difference. The median difference is 16 percent. We conclude that a Swiss investor generally has 16 percent lower utility from the structured products in my sample than the Norwegian investor.

## 5.3 Discussion

I start by discussing the difference in utility between a Norwegian and a Swiss investor. Thereafter I discuss the link between the cultural background of the investors and their investment preferences.

### 5.3.1 The difference between the Norwegian and Swiss investor

From the numerical analysis we have seen that the Swiss and the Norwegian investors realize different utilities from the structured products. The Norwegian investor has on average higher utility from the structured products than the K-T investor, whereas the Swiss investor has lower average utility from the products than the K-T investor. In numbers the Norwegian investor realizes 12 percent higher utility from the structured products than the K-T investor, whereas the Swiss investor realizes ten percent lower utility.

There is no surprise that the utility changes when we change the parameters of the prospect theory model. However, what at first glance seems surprising is that the Swiss investor has 16 percent less utility from the structured products than his Norwegian colleague. This is despite the fact that the Swiss investor is twice as loss averse as his Norwegian colleague.

However, if we study the numbers more carefully, the results are not that surprising. We have throughout this chapter assumed that the prospect theory investor has the risk-free investment as his reference point. This means that any return below the risk-free rate is achieved as a loss by the investor. Recalling that the structured products have capital protection at zero percent return, we see that the investor can have a negative utility from the products even though they are capital protection products. Indeed, any return between zero and the risk-free rate represents a negative utility to the investor.

The Swiss investor has a loss aversion which is more than twice the Norwegian investor's loss aversion. In other words, when the return of the structured products is between the reference point and zero, the Swiss investor's utility suffers twice as much as the Norwegian investor's utility. Let us look closer at the probability of returns between zero and the risk-free rate. I

look at the DnB Global and the DnB Sektor structured product. I choose these two products because they have the most reliable datasets.

The probability of returns between zero and the reference point, which is 6.3 percent for the two products, is 48.2 percent for DnB Global and 53.9 percent for DnB Sektor. It is in other words as probable that the utility from the products will be positive as negative, meaning that the degree of loss aversion is highly determinant for the utility of the products. Therefore there is no surprise that the Swiss investor has lower utility from the structured products.

We can quantify the loss aversion's effect on the difference in utility between the two investors for the two products. For DnB Global the loss aversion can explain a difference in certainty equivalents of 1.26 percent, whereas for DnB Sektor it explains a difference in certainty equivalents of 1.36 percent.

Notice that from Table 5.3 we see that the differences between the products in terms of certainty equivalents are 1.07 percent for DnB Global and 1.20 percent for DnB Sektor. The effect of the differences in loss aversion is therefore higher than the utility difference between the products. This could be explained by the fact that we have only looked at the loss aversion effect in this section. In reality, the difference in *risk* aversion for losses does also play. However I do not investigate this effect.

Since all the products I investigate are capital protection products, it is reasonable to say that the abovementioned effect could be attributed to all the products in my sample. I therefore conclude that the difference between the utilities of the two investors could to a large extent be explained by the difference in loss aversion between the Norwegian and Swiss investors. The effect is amplified by a high probability of a negative utility from the products, because the capital protection level of the products level is below the reference point.

### **5.3.2 Cultural dimensions and investment behavior**

The key question to be answered in this chapter was to what extent my findings from the analysis of the structured products could prove a relationship between cultural background and investment behavior.

If such a relationship exists, it should be reflected by a difference in the free design effect for investors with different cultural backgrounds. We recall that the free design effect refers to the increase in utility from an investment in a structured product compared to an adjusted classical investment.



From Hofstede’s cultural dimensions we have seen that the Swiss investor is more uncertainty avoidant than the Norwegian investor. The more uncertainty avoiding an investor is, the more he prefers the predictable to the unpredictable.

Structured products have a customized payoff structure. All the products of my sample, which is representative for the Norwegian market, are capital protection products. For these products the predictability is increased because all return combinations of the underlying assets that yield a negative return are eliminated. Therefore, the structured products in my sample are more predictable than a classical investment in the same assets. Hence, the higher uncertainty avoidance of the Swiss investor compared to the Norwegian investor should be reflected through a stronger free design effect.

Table 5.4 shows the comparison of the utilities between the Norwegian and the Swiss investor of the  $C_F$  investments for DnB Global and DnB Sektor of the Norwegian and Swiss investor. Again I choose to look at these two products because they have the most reliable datasets.

CF	Nor	Swiss	$\Delta U$
Global	5,94 %	4,61 %	-22,43 %
Sektor	5,67 %	4,09 %	-27,76 %
<i>Average</i>	<i>5,80 %</i>	<i>4,35 %</i>	<i>-25,10 %</i>

**Table 5.4 – Utility comparison of the  $C_F$  investment between a Norwegian and a Swiss investor**

The Swiss investor has on average 25.1 percent lower utility from the investment than the Norwegian investor. Next, I have to compare the difference in utilities of the investors when they invest in the structured products. This comparison is summarized in Table 5.5.

SP	Nor	Swiss	Swiss/Nor
Global	7,55 %	6,48 %	-14,27 %
Sektor	7,76 %	6,56 %	-15,50 %
<i>Average</i>	<i>7,66 %</i>	<i>6,52 %</i>	<i>-14,88 %</i>

**Table 5.5 – Differences in utility from the structured products between a Norwegian and a Swiss investor**

We see that the difference in utility between the investors falls from 25.1 percent to 14.9 percent when they invest in the structured products compared to a linear portfolio investment. The Swiss investor has a larger relative increase in utility compared to the Norwegian

investor. This speaks in favor of the fact that the Swiss investor benefits the most from structured products.

Table 5.6 compares the free design effect for both investors from each product. If the Swiss investor benefits the most from structured products, as suggested above, one should expect to see that the Swiss investor has the biggest magnitude of change from the linear investments to the non-linear investments. In other words, the Swiss investor should be the one that appreciates the most the free design effect from access to structured products.

	Nor	Swiss	Diff
Global	27,20 %	40,58 %	49,22%
Sektor	36,91 %	60,15 %	62,95%
<i>Average</i>	<i>32,06 %</i>	<i>50,37 %</i>	<i>57,13%</i>

**Table 5.6 – The free design effect for the Norwegian and the Swiss investor**

From the table this is exactly what we see. The Swiss investor has 57,13 percent higher increase in the average utility compared to the Norwegian investor when comparing the utility change from an investment in a structured product to a classical investment. This strengthens the conclusion that the Swiss investor, which is the most uncertainty avoidant, benefits the most from having access to structured products.

We can conclude that my findings from the investigation of two structured products support quantitatively the relation between the cultural background of the investor and his investment behavior and preferences.

**5.3.3 Personal reflections**

Broadening the scope of the discussion, the relation between culture and investment behavior represents a challenge for the manufacturers of structured products as the world globalizes. A successful product on the Swiss market could be an unpopular product on the Norwegian market. To make optimal products, the producers must study the different countries in which they want to distribute their products. In other words, products must be customized to fit to a certain culture. This limits the potential economies of scales that could be achieved from globalization of structured products, and the banks must realize this.

There is also another interesting aspect of the globalization. As cultures interact and blend into each other, the cultural dimensions of Hofstede could be assumed to be less predictive.

For instance, the Norwegian culture is in a continuous evolution which increases in magnitude with the globalization. To make the most popular structured products the manufacturers must go beyond the assumption that cultures are linked to countries, and investigate sub-cultures. This would make the design process of structured products more difficult and costly. Indeed, to the extreme the products must be customized for each and every single investor since. It is hard to imagine that this would ever be the case. Therefore some level of stereotyping is necessary. However, the dangers of stereotyping mentioned towards the end of chapter three must be kept in mind throughout the designing process.

## 6 Conclusions and final comments

### 6.1 Conclusions

Throughout the 2000s the criticism of structured products in Norway amplified. Regulations became increasingly stricter, and in 2008 structured products were practically banned from the Norwegian market.

In this master thesis I have analyzed a representative sample of structured products from the Norwegian market. The main research aim has been to evaluate whether the banning was a sound decision.

In chapter four I have performed prospect theory utility calculations of the structured products in my sample and compared the results to utilities of alternative investments. I have conducted the utility calculations based upon classical K-T prospect theory parameters, and a reference point equal to the risk-free rate of return. Thereafter I have changed the parameters to see how this affected the results of the analysis.

Structured products represent non-linear investments. What are the best alternative investments depend upon the investor. I have looked at small, private investors who have historically been the typical investors in structured products in Norway. Depended upon their knowledge about and access to financial markets their best alternative investment is either to invest in an optimal linear portfolio consisting of the same assets as the structured product or to invest in a risk-free asset, represented by a bank deposit.

The base case of the analysis involves a classical K-T investor, who is an irrational investor. We have seen that the investors having the risk-free investment as their alternative investment had 17 percent higher utility from the structured products, whereas the investors having the  $C_R$  investment as their alternative were roughly indifferent between structured products and the  $C_R$  investments. The effect from free design was between 51 and 87 percent. From this we can conclude that in general structured products appear to be quite good investments for the irrational investor. At least we cannot conclude that they are bad investments.

Changing the assumptions and parameters, the story is different. The most radical change in the results happens when we assume that the investor is rational. We have seen that the utility of the structured products was reduced by more than 60 percent compared to the irrational investor, that there were no free design effects, and that both the  $C_R$  investment and the risk-

free investment yielded twice as high utility compared to the structured products. From this we can conclude that structured product investments are bad investments for rational investors.

Investments in the structured products analyzed are bad for rational investors. Such investments can only be considered good if the investor is irrational. The banks in the role of financial advisors should advise the client to make rational choices. Contrarily, what we have seen in Norway is that banks have been profiting from their clients' irrationality by selling structured products which are profitable for the banks, but bad for the clients. I believe this could be compared to selling drugs to drug addicts! Although this metaphor is harsh, I believe it draws a descriptive picture of the banks' behavior. Ultimately, I therefore conclude that it was a sound decision to practically ban structured products from the Norwegian market.

In the second part of this thesis I have looked into the link between culture and investments. The aim was to investigate how cultural dimensions can influence investment choices. In chapter five I have used my utility estimations of the structured products in my sample to investigate this potential link between cultural dimensions and investment choices and behavior. I have looked at how the difference in uncertainty avoidance between two countries is reflected through the utility gain achieved from having access to structured products.

I conclude that a Swiss investor has about 57 percent greater utility from the access to structured products than a Norwegian investor. This strengthens the hypothesis of a close relationship between cultural dimensions and investment preferences and behavior.

## **6.2 Weaknesses of the report and future research**

My results are highly sensitive to the input datasets I have used. For two of the eight products in my sample I have used datasets on the structured product and the underlying which are consistent. On the remaining six products I have used good datasets on the structured products, but unfortunately I have not gotten good datasets on the underlying basket of assets. To create proxies on the underlying basket of assets I have used normal distribution. This is a strong assumption and one must be careful when interpreting the belonging results. Therefore I have based most of my conclusions on the findings from the two products on which I have reliable datasets for both the return distribution of the structured product and the underlying basket of assets. The fact that my conclusions are mostly based upon the results from two

structured products, although highly representative for the Norwegian market, limits the generalization potential of the findings in this report.

However, it is time consuming to make the simulations. Master thesis are dedicated to such problems alone. This would clearly have been out of the scope of this thesis which after all is about the prospect theory utility approach to structured products.

Having said that, it would have been highly interesting to have consistent datasets on all the products in my sample. Further, it would have been interesting to increase the sample to include more structured products. The bigger the sample, the stronger the conclusions of the findings. If one eventually could have utility estimations based upon consistent datasets of the majority of all structured products offered in Norway, one could conclude with certainty.

Another interesting topic would be how Norwegian investors like the Swiss structured products. In this thesis I have limited the analysis to concern how Swiss investors like Norwegian products. Indeed, the scope could be broadened to include many different countries to check the consistency between the cultural dimensions and the investment behavior.

I would like to comment on the assumption that the K-T prospect theory parameters are non-culturized. This is not necessarily right. When Kahneman and Tversky conducted their surveys they must have chosen a certain group of people. This means that what I used as the standard prospect theory parameters actually are parameters adapted to some specific culture(s).

Finally I would like to come with a last proposal for future master thesis: To what extent do manufacturers of structured products include cultural dimensions when they decide upon the design and the risk profile of the products? My findings implicate that they should do so in order to make successful products. However, are they really doing so?

## 7 References

- Aamo, B. S. (2008, April 8). Kredittilsynets krav til rådgivning om finansielle produkter.
- Allais, M. (1953). Le Comportement de l'Homme Rationnel devant le Risque, Critique des Postulats et Axiomes de l'École Americaine. *Econometrica* , 21, 503-546.
- Almklov, G., Tørum, E., & Skjæveland, M. (2006). Utviklingstrekk i kredittmarkedet - nye utlånstyper og omfanget av fastrentelån i Norge. *Penger og Kreditt* 3/2006 .
- Andersson, J. E. (2010, April 7). *Opp mot DnBNOR i Tingretten*. Retrieved June 4, 2010, from Forbrukerportalen.no:  
[http://forbrukerportalen.no/Artikler/2010/opp\\_mot\\_dnbnor\\_i\\_tingretten](http://forbrukerportalen.no/Artikler/2010/opp_mot_dnbnor_i_tingretten)
- Bache, G., & Stranden, A. L. (2010, June 15). *Rettsaken om sammensatte spareprodukter: Småsparere vant mot DnB NOR, Får tilbake 230.000 fra storbanken*. Retrieved June 15, 2010, from Dine Penger: <http://www.vg.no/dinepenger/artikkel.php?artid=10001589>
- Bachmann, K., & Hens, T. (2008). *Behavioural finance for private banking*. Chichester, England: John Wiley & Sons Ltd.
- Bjerksund, P. (2008). *Hvordan bankene har påført sine kunder skjulte kostnader med lånefinansierte garanterte produkter*. Bergen: NHH.
- Bodie, Z., Kane, A., & Marcus, A. J. (2008). *Investments (seventh edition)*. New York: McGraw-Hill.
- Bui, T. (2009). *Prospect Theory and Functional Choice*. Paris.
- Bøe, G. M. (2007). *Analyse av strukturerte spareprodukter - et kinderegg for banknæringen?* Bergen: Samfunns- og næringslivsforskning AS.
- Camerer, C. (1989). An Experimental Test of Several Generalized Utility Theories. *Journal of Risk and Uncertainty* , 2, 61-104.
- Campbell, J., & Viceira, L. (2002). *Strategic Asset Allocation*. Oxford University Press.
- De Georgi, E., Hens, T., & Levy, H. (2004). *Prospect Theory and the CAPM: A contradiction or Coexistence? NCCR Working Paper No. 85*. University of Zurich.

De Giorgi, E., & Hens, T. (2006). Making Prospect Theory Fit for Finance. *Financial Markets and Portfolio Management* , 20, 339-360.

De Giorgi, E., & Hens, T. (2009). Prospect Theory and Mean-Variance Analysis: Does it make a difference in Wealth Management? *Investment Management and Financial Innovations* , 1, 122-129.

DnB NOR, M. A. (2010, May 4). (R. Kjos, Interviewer)

Ellsberg, D. (1961). Risk, ambiguity, and the Savage Axioms. *Quarterly Journal of Economics* , 75, 643-669.

Finanstilsynet. ( 2), 2008). *Det norske sparemarkedet: Konkurransen og effektiviteten i markedet for verdipapirfond og andre spareprodukter*. Oslo: Finansdepartementet.

Finanstilsynet. (2006, September 26). *Informasjon og retningslinjer ved salg av sammensatte produkter*. Retrieved March 10, 2010, from Finanstilsynet:

<http://finansstilsynet.no/no/Artikkelarkiv/Rundskriv/2006/Informasjon-og-retningslinjer-ved-salg-av-sammensatte-produkter/>

Finanstilsynet. (2004, February 16). *Informasjon ved salg av sammensatte produkter, herunder aksjeindekserte obligasjoner og innskudd*. Retrieved March 10, 2010, from Finanstilsynet: <http://www.finanstilsynet.no/no/Artikkelarkiv/Rundskriv/2005/Informasjon-ved-salg-av-sammensatte-produkter-herunder-aksjeindekserte-obligasjoner-og-innskudd/>

Finanstilsynet. (2009, February 11). *Interessant og nyttig undersøkelse fra Forbrukerrådet*.

Retrieved March 10, 2010, from Finanstilsynet:

<http://www.finanstilsynet.no/no/Artikkelarkiv/Pressemeldinger/2009/1-kvartal/Interessant-og-nyttig-undersokelse-fra-Forbrukerradet/>

Finanstilsynet. (2008, February 12). *Kredittilsynet tightens up on structured products*.

Retrieved March 10, 2010, from Finanstilsynet: <http://finansstilsynet.no/en/Secondary-menu/Documents/Press-releases/Kredittilsynet-tightens-up-on-structured-products/>

Finanstilsynet. (2007, July 10). *Nye konsesjonspliktige tjenester mv. som følge av ny lov om verdipapirhandel*. Retrieved March 10, 2010, from Finanstilsynet:

<http://www.finanstilsynet.no/no/Artikkelarkiv/Rundskriv/2007/Nye-konsesjonspliktige-tjenester-mv-som-folge-av-ny-lov-om-verdipapirhandel/>



- Finanstilsynet. ((3) 2008). *Undersøkelse av sammensatte produkter*. Oslo: Finanstilsynet.
- Fishburn, P. C., & Libby, R. (1977). Behavioral Models of Risk Taking in Business Decisions: A Survey and Evaluation. *15*, 272-292.
- Fishburn, P., & Kochenberger, G. (1979). Two-Piece von Neumann-Morgenstern Utility Functions. *Decision Sciences* , *10*, 503-690.
- Forbrukerrådet. (2009). *Rydd opp - Forbrukerrådets forslag til ryddepakke i sparemarkedet*. Oslo: Forbrukerrådet.
- Friedman, M., & Savage, L. (1948). Utility Analysis of Choices Involving Risk. *Journal of Political Economy* , *56*, 279-304.
- Hens, T., & Rieger, M. O. (2009). The Dark Side of the Moon: Structured Products from the Customer's Perspective. *EFA 2009 Bergen Meetings Paper*. Bergen: Available at SSRN: <http://ssrn.com/abstract=1342360>.
- Hens, T., & Wang, M. (2007). Does finance have a cultural Dimension? National Center of Competence in Research, Financial Valuation, and Risk Management.
- Hirshleifer, D. (2001). Investor psychology and asset pricing. *Journal of Finance* , *56*, 1533-1598.
- Hofstede, G. (2001). *Culture's Consequences: Comparing Values, Behaviors, Institutions and Organizations accross nations*. Sage Publication.
- Hofstede, G. (n.d.). *Geert Hofstede's Cultural Dimensions*. Retrieved May 2010, 2010, from <http://www.geert-hofstede.com/>
- Investorwords*. (2010). Retrieved April 2010, from Investorwords: <http://www.investorwords.com>
- Jensen, M. (1978). Some anomalous evidence regarding market efficiency. *Journal of Financial Economics* , *6*, 95-101.
- Johnsen, T. (2008). *Forventet avkastning på DnB Global 2000/2006 og DnB Sektor 2000/2006*. Bergen: NHH.

- Kahneman, D., & Tversky, A. (1992). Advances in Prospect Theory: Cumulative Representation of Uncertainty. *Journal of Risk and Uncertainty* , 5, 297-323.
- Kahneman, D., & Tversky, A. (1979). Prospect theory: An Analysis of Decision Under Risk. *Econometrica* , 47, 263-291.
- Karmakar, U. (1978). Subjectively Weighted Utility: A Descriptive Extension of the Expected Utility Model. *Organizational Behavior and Human Performance* , 21, 61-72.
- Kleven, E. (2008, April 8). Tilsyn med spareprodukter - Foredrag for Norges Fondsmeglerforbunds generalforsamling. Oslo, Norway: Finanstilsynet.
- Klype, J. (2006). Strukturerte produkter. In E. Reppen, *Alternative investeringer*. Oslo: Gyldendal Norsk Forlag AS.
- Koekebakker, S., & Zakamouline, V. (2006). *Forventet avkastning på aksjeindeksobligasjoner*. Institutt for økonomi, Høgskolen i Agder.
- Koekebakker, S., & Zakamouline, V. (2007). *Realisert avkastning på garanterte spareprodukter*. Høgskolen i Agder, Institutt for Økonomi.
- Kredittilsynet. (2008). *Det norske sparemarkedet: Konkurransen og effektiviteten i markedet for verdipapirfond og andre spareprodukter*. Oslo: Finansdepartementet.
- Leirvåg, A. (2010, January 4). *Føler seg lurt av Orkla Finans- går til sak*. Retrieved June 4, 2010, from TV2Nyheterne.no/Økonomi:  
<http://www.tv2nyhetene.no/innenriks/okonomi/foeler-seg-lurt-av-orkla-finans-gaar-til-sak-3075348.html>
- Lindset, S. (2008). *Finansfaglig vurdering for Forbrukerrådet*. Retrieved May 26, 2010, from dn.no: [http://multimedia.dn.no/archive/00164/Finansfaglig\\_vurder\\_164287a.pdf](http://multimedia.dn.no/archive/00164/Finansfaglig_vurder_164287a.pdf)
- Løland, A., & Steinbakk, G. H. (2009). *Historisk avkastning for garanterte spareprodukter*. Oslo: Norsk Regnesentral.
- Machina, M. (1987). Choice Under Uncertainty: Problems Solved and Unsolved. *Journal of Economic Perspectives* , 1, 121-154.
- Markowitz, H. (1952). Portfolio Selection. *Journal of Finance* , 7, pp. 77-91.

- Markowitz, H. (1952). The Utility of Wealth. *Journal of Political Economy* , 60, 151-158.
- Moe, I. E. (2007, November 8). *Lokkes til minusavkastning*. Retrieved June 4, 2010, from DN.no/Privatøkonomi: <http://www.dn.no/privatokonomi/article1223354.ece>
- Montier, J. (2002). *Behavioural finance: insights into irrational minds and markets*. John Wiley & Sons Ltd.
- Montier, J. (2007). *Behavioural investing: A practitioner's guide to applying behavioural finance*. John Wiley & Sons, Ltd.
- Nordea. (2007). *MiFID - Direktiv om markeder for finansielle instrumenter*. Luxembourg: Nordea Bank S.A. R.C.S.
- Ormseth, G. (2008). *Metoderapport til SKUP 2008 - Garanterte spareprodukter - Småsparere lurt for 13 milliarder*. Oslo.
- Ormseth, G. (2009, January 20). *Bankklagenemnda latterliggjør DnB Nor*. Retrieved March 11, 2010, from Dine Penger: <http://www.vg.no/dinepenger/artikkel.php?artid=536006>
- Ormseth, G. (2009, January 20). *Bankkundene kan få millionerstatning*. Retrieved March 11, 2010, from Dine Penger: <http://www.vg.no/dinepenger/artikkel.php?artid=536008>
- Ormseth, G. (2009, January 20). *En helsvart dag for norske banker*. Retrieved March 11, 2010, from Dine Penger: <http://www.vg.no/dinepenger/artikkel.php?artid=536020>
- Ormseth, G. (2009, January 1). *Prinsippsak i Bankklagenemnda klar: Bankkundene kan få milliarderstatning*. Retrieved from Dine Penger: <http://www.vg.no/dinepenger/artikkel.php?artid=536008>
- Osland, J., Bird, A., Delano, J., & Jacob, M. (2000). Beyond sophisticated stereotyping: cultural sense-making in context. *Academy of Management Executive* .
- Pindyck, R. S., & Rubinfeld, D. L. (2009). *Microeconomics – seventh edition*. New Jersey: Pearson Education.
- Prelec, D. (1998). The Probability Weighting Function. *Econometrica* , 66, 497-527.
- Quinn, L. G. (2009). *Recommending structured products as investment strategy*. Bergen: NHH.

- Raiffa, H. (1968). *Decision Analysis*. Addison-Wesley.
- Rieger, M., & Wang, M. (2005). Cumulative Prospect Theory and the St. Petersburg Paradox. *Economic Theory* , 28, 665-679.
- Ross, S. A. (2005). *Neoclassical Finance*. Princeton and Oxford: Princeton University Press.
- Shefrin, H. (2005). *A Behavioral Approach to Asset Pricing*. Elsevier Academic Press.
- Shefrin, H. (2007). *Behavioral Corporate Finance - Decisions that Create Value*. New York: McGraw-Hill Irwin.
- Shleifer, A. (2000). *Inefficient Markets - An Introduction to Behavioral Finance*. Oxford University Press.
- Slettan, A. (2007, November 12). *Slakter spareprodukter*. Retrieved June 4, 2010, from NA24: <http://arkiv.na24.no/Nyhet/269949/Slakter+spareprodukter.html>
- SPA. (2008, July 25). *Securities and Exchange Commission*. Retrieved May 28, 2010, from sec.gov: <http://www.sec.gov/comments/s7-13-08/s71308-54.pdf>
- SSB. (2010, January 12). *Statistisk Sentralbyrå*. Retrieved June 15, 2010, from <http://www.ssb.no>
- Staavi, T. (2009, January 20). *En helsvart dag for norske banker*. Retrieved March 11, 2010, from Dine Penger: <http://www.vg.no/dinepenger/artikkel.php?artid=536020>
- Thaler, R. H. (2005). *Advances in Behavioral Finance*. New Jersey: Princeton University Press.
- Tobin, J. (1958). Liquidity Preference as Behavior Towards Risk. *Review of Economic Studies* , 67, 65-86.
- Trustee. (2010, May 14). *Norsk Tillittsmann ASA*. Retrieved June 15, 2010, from Stamdata: <http://www.trustee.no/Default.aspx?tabid=756>
- Tørring, C. S., & Hansen, I. A. (2008, September 12). *Nytt håp for dem som har tapt penger: Småsparerne skal få erstatning*. Retrieved March 11, 2010, from Dine Penger: <http://www.vg.no/dinepenger/artikkel.php?artid=526150>

Von Neumann, J., & Morgenstern, O. (1944). *Theory of Games and Economic Behavior*. Princeton University Press.

Zakamouline, V. (2010, May 3). (R. Kjos, Interviewer)

## 8 Appendices

### A - Calibration of dataset

The datasets of probability distributions from Bøe are limited to a return range from zero percent to 25 percent. All probabilities of returns above 25 percent are merged into one row. Due to probability weighting the more extreme outcomes are relatively more important in prospect theory than in classical decision theory.

In the datasets provided by Koekebakker and Zakamouline the range is from minus 20 percent to 50 percent. The ranges of the structured products payoffs are from zero percent to 40 percent and zero percent to 36 percent.

Although there are differences among products and datasets, I find it reasonable to expand the range used in the datasets from Bøe. I choose to set the range of the structured products from zero percent to 40 percent.

I use an exponential function to allocate the merged probabilities of the range above 25 percent into one-percent intervals from 26 percent to 40 percent, assuming that the probability of 40 percent annual return is zero. In other words, the merged or pooled probability of a return above 25 percent is scattered through an exponential function converging to zero over 15 intervals.

I used the goal-seek function in excel to conduct the calibration.

As for the return of the underlying baskets of assets, I will once again use the return state spaces applied by Koekebakker and Zakamouline. For the underlying, this is in the range of minus 20 percent to plus 39 and 50 percent. Based on this I define the space for the products' underlying from minus 20 percent to plus 45 percent, which is the average of the two Koekebakker and Zakamouline products.

I stress that the optimal solution would be to expand the range of the Monte Carlo simulations. However, Bøe could not meet this request. A recommendation for future work on this subject is to apply a larger return space on the input data.

The original input data from Bøe is presented in Table 8.1.

Row	Annual returns	Acta	Orkla	Storebrand	Fokus	Nordea	DnB Kraft
		Probability	Probability	Probability	Probability	Probability	Probability
1	0 %	31,49 %	5,11 %	62,20 %	Discrete outcomes, read in prospect	19,88 %	40,00 %
2	1 %	4,82 %	8,64 %	2,39 %		0,27 %	5,58 %
3	2 %	5,03 %	9,05 %	2,22 %	0,35 %	4,98 %	
4	3 %	5,20 %	8,99 %	2,12 %	0,39 %	4,48 %	
5	4 %	5,27 %	8,93 %	2,08 %	13,63 %	4,11 %	
6	5 %	5,25 %	8,66 %	2,07 %	14,88 %	3,78 %	
7	6 %	5,09 %	8,26 %	2,03 %	9,44 %	3,53 %	
8	7 %	4,94 %	7,31 %	1,97 %	5,61 %	3,29 %	
9	8 %	4,66 %	6,33 %	1,91 %	4,95 %	3,16 %	
10	9 %	4,30 %	5,20 %	1,84 %	4,23 %	2,92 %	
11	10 %	3,91 %	4,42 %	1,74 %	4,04 %	2,72 %	
12	11 %	3,51 %	3,88 %	1,65 %	3,75 %	2,50 %	
13	12 %	3,05 %	3,48 %	1,56 %	3,47 %	2,24 %	
14	13 %	2,66 %	2,77 %	1,45 %	2,82 %	2,02 %	
15	14 %	2,24 %	2,08 %	1,34 %	2,47 %	1,88 %	
16	15 %	1,90 %	1,65 %	1,26 %	2,03 %	1,74 %	
17	16 %	1,56 %	1,36 %	1,17 %	1,63 %	1,49 %	
18	17 %	1,25 %	1,02 %	1,07 %	1,38 %	1,34 %	
19	18 %	0,97 %	0,80 %	0,97 %	1,01 %	1,21 %	
20	19 %	0,77 %	0,62 %	0,87 %	0,78 %	1,08 %	
21	20 %	0,60 %	0,36 %	0,80 %	0,60 %	0,96 %	
22	21 %	0,44 %	0,23 %	0,72 %	0,46 %	0,86 %	
23	22 %	0,33 %	0,19 %	0,64 %	0,35 %	0,77 %	
24	23 %	0,24 %	0,13 %	0,57 %	0,27 %	0,68 %	
25	24 %	0,16 %	0,10 %	0,51 %	0,21 %	0,61 %	
26	25 %	0,11 %	0,09 %	0,45 %	0,16 %	0,54 %	
27	> 25 %	0,24 %	0,33 %	2,40 %	0,93 %	1,52 %	
28	>25%/25%	2,1	3,7	5,3	5,9	2,8	
29	index	36 %	62 %	90 %	100 %	48 %	
30	increased nb. of states	5	9	14	15	7	

Table 8.1 – Original input data from Bøe

In the following I explain the calibration process row by row.

Row 27 is the source of the problem. As we can see, the probabilities for returns above 25 percent are merged in this row.

However, the importance of the mergers varies from product to product. This is expressed in row 28. I have calculated the ratio of row 27 to row 26, which expresses the importance of the pooled probability to the probability of the last 1 percent interval (25 percent return). We see that the ratio varies from two to six.

Based on the ratios in row 28, row 29 indexes the ratios with respect to the highest ratio.

Finally row 30 shows how many extra intervals should be calculated, where 15 is the maximum, as discussed above. The number is based on the index in the row above.

The calibrated dataset is presented in Table 8.2.

Row	Annual returns	Acta	Orkla	Storebrand	Fokus	Nordea	DnB Kraft
		Probability	Probability	Probability	Probability	Probability	Probability
1	0 %	31,49 %	5,11 %	62,20 %	Discrete outcomes, read in prospect	19,88 %	40,00 %
2	1 %	4,82 %	8,64 %	2,39 %		0,27 %	5,58 %
3	2 %	5,03 %	9,05 %	2,22 %		0,35 %	4,98 %
4	3 %	5,20 %	8,99 %	2,12 %		0,39 %	4,48 %
5	4 %	5,27 %	8,93 %	2,08 %		13,63 %	4,11 %
6	5 %	5,25 %	8,66 %	2,07 %		14,88 %	3,78 %
7	6 %	5,09 %	8,26 %	2,03 %		9,44 %	3,53 %
8	7 %	4,94 %	7,31 %	1,97 %		5,61 %	3,29 %
9	8 %	4,66 %	6,33 %	1,91 %		4,95 %	3,16 %
10	9 %	4,30 %	5,20 %	1,84 %		4,23 %	2,92 %
11	10 %	3,91 %	4,42 %	1,74 %		4,04 %	2,72 %
12	11 %	3,51 %	3,88 %	1,65 %		3,75 %	2,50 %
13	12 %	3,05 %	3,48 %	1,56 %		3,47 %	2,24 %
14	13 %	2,66 %	2,77 %	1,45 %		2,82 %	2,02 %
15	14 %	2,24 %	2,08 %	1,34 %		2,47 %	1,88 %
16	15 %	1,90 %	1,65 %	1,26 %		2,03 %	1,74 %
17	16 %	1,56 %	1,36 %	1,17 %		1,63 %	1,49 %
18	17 %	1,25 %	1,02 %	1,07 %		1,38 %	1,34 %
19	18 %	0,97 %	0,80 %	0,97 %		1,01 %	1,21 %
20	19 %	0,77 %	0,62 %	0,87 %		0,78 %	1,08 %
21	20 %	0,60 %	0,36 %	0,80 %		0,60 %	0,96 %
22	21 %	0,44 %	0,23 %	0,72 %		0,46 %	0,86 %
23	22 %	0,33 %	0,19 %	0,64 %		0,35 %	0,77 %
24	23 %	0,24 %	0,13 %	0,57 %		0,27 %	0,68 %
25	24 %	0,16 %	0,10 %	0,51 %		0,21 %	0,61 %
26	25 %	0,11 %	0,09 %	0,45 %		0,16 %	0,54 %
27	26 %	0,08 %	0,10 %	0,57 %		0,25 %	0,42 %
28	27 %	0,06 %	0,07 %	0,45 %		0,19 %	0,33 %
29	28 %	0,04 %	0,05 %	0,35 %		0,14 %	0,25 %
30	29 %	0,03 %	0,04 %	0,27 %		0,10 %	0,19 %
31	30 %	0,02 %	0,03 %	0,21 %		0,08 %	0,14 %
32	31 %		0,02 %	0,16 %		0,06 %	0,11 %
33	32 %		0,01 %	0,12 %		0,04 %	0,08 %
34	33 %		0,01 %	0,09 %		0,03 %	
35	34 %		0,01 %	0,06 %		0,02 %	
36	35 %			0,04 %		0,01 %	
37	36 %			0,03 %		0,01 %	
38	37 %			0,02 %		0,01 %	
39	38 %			0,01 %		0,00 %	
40	39 %			0,01 %		0,00 %	
41	40 %					0,00 %	

Table 8.2 – Calibrated dataset

We see that the probabilities actually *increase* from row 26 to row 27 in some of the cases. This is because the exponential factor is below one in order to fulfill the criteria that the sum of the added probabilities equals the pooled probabilities from before. This affects the value of the structured products, but I will still go for this approximation as a fair way to calibrate the dataset.