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PERFORMANCE OF STRUCTURED FINANCE: CAPITAL MARKET PERCEPTION OF STRUCTURED FINANCE IN THE FINANCIAL CRISIS

vorgelegt von

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Overview

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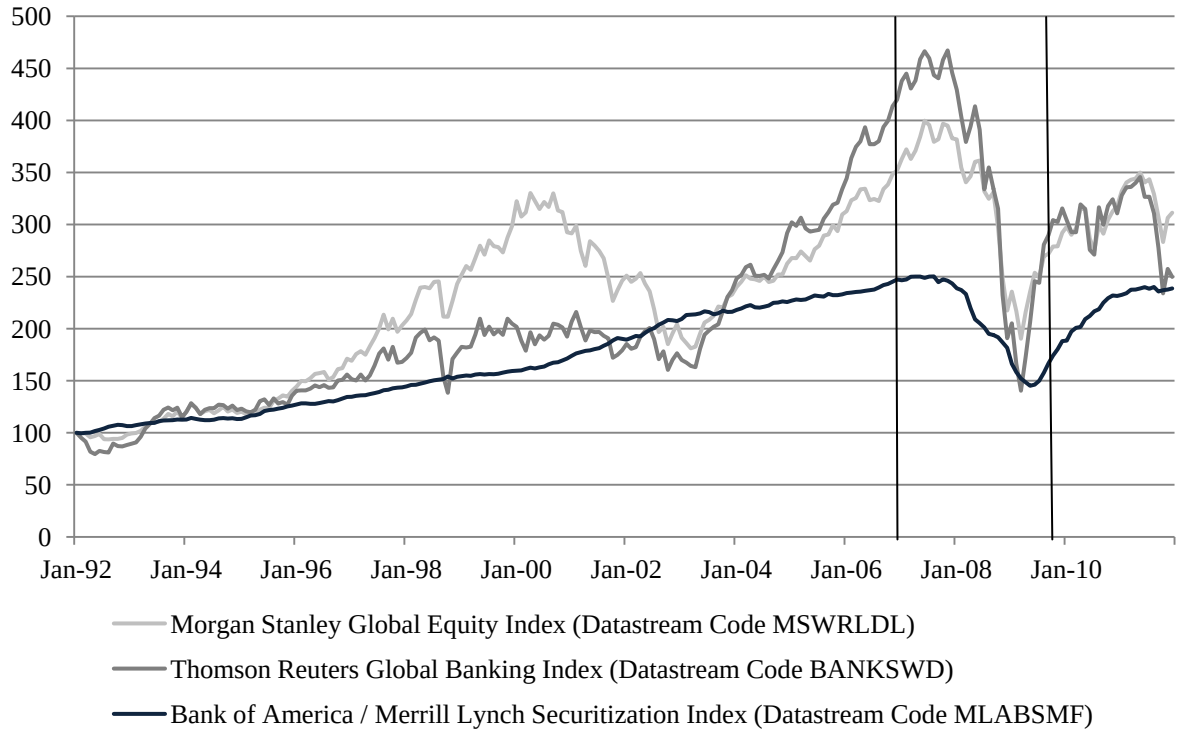
List of Abbreviations

ABI	Association of British Insurers
ABS	Asset Backed Securities
CAAR	Cumulative Abnormal Average Return
CAPM	Capital Asset Pricing Model
CAR	Cumulative Abnormal Return
CDO	Collateralized Debt Obligations
DS	Thomson Reuters Datastream Code
ERISA	Employee Retirement Security Act
FSA	Financial Services Authority
IRC	Internal Revenue Code
MSCI	Morgan Stanley Commodity Index
NAIC	National Association of Insurance Commissioners
NAV	Net Asset Value
OECD	Organisation for Economic Co-operation and Development
S&P	Standard and Poor's
SEC	Securities and Exchange Commission
SPV	Special Purpose Vehicle
VaR	Value at Risk

1 Introduction

The financial services industry has faced one of the hardest challenges in history during the financial crisis. Although there is no consensus about the beginning of the financial crisis, global financial market indicators began to decline in 2007. I will consider the time period from 01/2007-12/2009 as the time period of the financial crisis.

Figure 1.1: Global Financial Market Indicators (index 1992=100)



Supervisory authorities, politicians and international organizations were forced to oppose a spillover effect on the economy with unprecedented measures. Huge amounts of government bailouts and state guarantees were necessary in order to calm down the hysterics on the financial markets. Not only did the financial crisis lead to slurping market prices but also the awareness of commonly accepted low risk investments like government bonds was challenged. As a consequence, the exploding state deficits prior to the financial crisis and the

enormous bailouts during the financial crisis have resulted in general mistrust from capital market participants.

One aspect that is widely expressed of causing this development is linked to an increase in risky investments along with complex structures. Structured finance is one of the heavily criticized forms of complex investments. There exist many sub-forms of structured finance but securitizations are a key aspect in the financial crisis and the focus of this dissertation.

Despite the fact that the origin of securitization is traced back to the early 1970's (Loutskina 2011), the impressive growth rate in terms of outstanding volume was promoted by favorable legislation. Financial institutions are obliged to hold a certain amount of equity for its risk positions. In this context, rating grades are supposed to express the riskiness or debt quality so that high rating grades determine less equity to be held by the financial institution. Securitization deals are commonly structured in several tranches ranging from the senior tranche to the equity tranche. As repayments follow the waterfall principle meaning that the senior tranche is first repaid and then mezzanine and equity tranches, it is conclusive that senior tranches benefit from the best rating grade of a securitization deal.

Astonishing is the fact that the senior tranches were oftentimes given the best possible rating grade, commonly understood as triple-A tranches (He et al. 2011). This implicates that defaults of the senior tranches should occur as a very unlikely event. When investigating the validity of this assumption, it needs to be explained that securitization deals are constructed as bankruptcy-remote structured finance products and its quality is determined by the reference assets. The construction assumes that the securitization deal should be treated as an isolated investment opportunity. Given this assumption, securitization (more

specifically senior tranches with high rating grades) could be an interesting investment opportunity for capital market participants.

As such, institutional investors are dominant capital market participants who invest large sums on capital markets (Davis and Steil 2001). Due to this fact, supervisory authorities pose restrictions to their investment practices. Institutional investors are primarily life insurers, pension funds, mutual funds, hedge funds, university endowments, private equity investors, etc. When analyzing the investment practices of institutional investors in several countries, it becomes apparent that there are distinctive differences. Bringing this into context with structured finance, it is of interest which portfolio structure is best under the constraints of the investment principles and whether securitization adds value to the portfolio. In order to respond to this issue it is necessary to analyze the investment principles of institutional investors and then evaluate the portfolio risk and return characteristics. Since institutional investors are long term investors with a rather low risk affinity, it is consistent that financial products are eligible in the portfolio when these are profitable at low risk.

Despite of the impressive growth rate of structured finance, the sudden loss of investor confidence in the aftermath of the sub-prime crisis resulted in a substantial sell-off. This investor behavior is rather intuitive because investors are more conscious of risk in turbulent market conditions and may evade complex financial products like structured finance. Along with imperfect market conditions comes the challenge of fair valuation. The more complex a financial product is structured, the more assumptions with regard to market environment are generally in force. Callable bonds are a financial product consisting of a standard bond and an embedded option that is rather complex to price (Acharya and Carpenter 2002). Consequently, in the absence of transparent pricing, financial products become less interesting for investors.

This dissertation explores three research questions in order to better understand capital market perceptions during the financial crisis:

1. Do rating announcements of securitized products affect the financial institution?
2. Can institutional investors benefit from securitization?
3. Do valuation models of the option premium in callable bonds reflect market prices under stress?

First research question:

In an empirical analysis investigating rating announcements on collateralized debt obligations (CDO) as a sub-form of securitization, I illustrate that rating announcements of CDO are not considered as isolated events with regard to the originating financial institution. Applying an event study methodology, I show that the impact stemming from CDO rating announcements is intense around the event day but quickly absorbed by the market. The sample consists of 238 events covering financial institutions from USA, UK and Germany. The sub-sample analyses present that time and regime differences exist. The intensity of rating announcements is most pronounced prior to the financial crisis when the reliance on high rating grades of CDO was distinctive. Market perception has changed during the financial crisis when rating downgrades were expected resulting in less significant findings. The analysis provides evidence of a switch in terms of investor behavior. While the trusting investor was dominant prior to the financial crisis, a transition towards the sophisticated investor has taken place where possible downgrades were already expected and so less surprising.

Second research question:

The second research question is two-fold. At first, I present that investment principles of institutional investors have a tendency either following the prudent person rule or quantitative portfolio restrictions. The prudent person rule suggests that decisions should be taken to the best of one's knowledge and judgment whereas quantitative portfolio restrictions determine the maximum share of each portfolio component. In this context, securitization is not explicitly restricted from being included in the portfolio of institutional investors. At second, I present that the prudent person rule is superior to the quantitative portfolio restriction approach but exposed to higher volatility at the same time. Additionally, covering a time span from 1992-2011 the performance of securitization was very volatile in the financial crisis with a sharp decline. Given this outcome, I show that securitization is only favorable for institutional investors prior to the financial crisis. The study explains the plummeting market prices of securitization since primarily institutional investors were forced to sell securitization in order to minimize total portfolio risk.

Third research question:

The pricing of the option premium in callable bonds is derived from the valuation models of Black (1976) for single-callable bonds and Ho and Lee (1986) and the extension of Bühler and Schulze (1993) for multi-callable bonds. Callable bonds consist of a standard bond and an embedded option. Applying a case study approach with a dataset of Commerzbank, I detect an intense deviation between market quotes and model-conform prices during the financial crisis. This stands in contrast to the findings in the pre-crisis period where model-conform prices converge with market quotes. Interestingly, the mismatch of model prices from market prices is triggered by the announcement of government support for Commerzbank in November 2008. This outcome is

quite surprising since the failure of Lehman Brothers in September 2008 was expected to cause a contagion effect on the financial services industry. The study provides evidence that concerns in terms of credit quality of the financial institution is the key driver of valuation mismatches and not contagion effects from other defaulted financial institutions.

After presenting the motivation and key findings in chapter 1, the aforementioned studies are presented in chapter 2 to 4. Chapter 5 summarizes the overall dissertation and gives suggestions for future research. Each study is composed of an introductory part, literature review, data and methodology section, presentation of results and a summary.

2 Impact of CDO Rating Announcements on the Share Price[1]

In the recent financial crisis, banks have suffered from a lack of credibility and the exposure to elevated risk. A number of banks have called for government bailouts or were forced to merge with other financial institutions (Veronesi and Zingales 2010). The involvement in securitization transactions was one of the reasons why banks faced severe turbulences. In this context, rating grades are an instrument to express credibility to the market. The direction of credit ratings was dominated by downgrade announcements in the banking industry during the financial crisis.

Our motivation is to explore the impact of rating announcements in relation to the bank's shareholder value. While most studies examine the long term debt quality or the bank's issuer rating, we enhance research by including the impact of structured finance products, namely rating implications of collateralized debt obligations (CDO). We infer share price response from negative rating outlooks and rating downgrades applying event study methodology and differentiate between CDO and the bank's issuer rating announcements.

To understand capital market reactions regarding CDO rating announcements, we consider the often bemoaned behavioral patterns:

1. *Rating shopping and rating grade inflation*: structured finance became a considerable profit contributor for rating agencies. As rating agencies are paid by the issuer, conflicts of interest may arise when inflated rating grades are given (Sangiorgi et al. 2009). The phenomenon of inflated rating grades is also emphasized for complex products (Skreta and Veldkamp 2009).

[1] I am grateful to Prof. Dr. Dirk Schiereck and Dr. Frank Lehrbass for helpful insights and comments.

2. *Reputation of rating agencies*: a rating grade is supposed to reflect an approximate assessment of the credit quality of an entity or a financial product. When there are many adjustments in a short period of time, the market may question the competence of rating agencies. While rating agencies claim that reputation is a key element for their business, Mathis et al. (2009) show that if the major source of income comes from complex products, ratings become too lax. This implies that reputation concerns are not taken serious.
3. *Sophisticated or trusting investor*: investor behavior can be differentiated between sophisticated investors who put additional efforts to better understand their investments and trusting investors who rely on available information like rating grades. The trusting investor may dominate in economic boom times but underestimate the actual level of risk in times of low default rates. In contrary, the sophisticated investor may dominate when the quality of CDO deals is questioned and downgrades are expected. Adelino (2009) analyzes under what conditions investors rely on rating grades. He provides evidence that information at origination other than rating grades contain information with predictive power.
4. *Informational asymmetry*: information about banks and its products are brought to public attention in various ways. Information about the bank is widely available, whereas information about a particular CDO deal is scarce. Therefore, we expect differing observations about when new information is incorporated.

Taking these aspects into consideration, we show under what circumstances rating announcements have an impact on the bank's shareholder value. We apply event study methodology with short term and long term equity price effects from CDO and the bank's issuer rating announcements. The short term event study includes equity price response of up to 20 days before and 20 days

after the actual announcement day. In the long term performance study we analyze the interdependence between equity and rating announcements with a three months anticipation and post announcement observation. The stock-listed banks considered in this sample are headquartered in Europe and the USA with a strong activity in CDO.

The most important finding is informational asymmetry. We observe highly negative equity price response from CDO rating announcements around the announcement day but no lead and lag effect. This stands in contrast to the findings referring to the bank's issuer rating. In this case we do not detect any significant share price reaction around the announcement day, but a highly significant lead and lag effect. We explain this outcome with widely available information about the issuing bank but little information about the specific characteristics of a given CDO deal.

Furthermore, we find evidence of regime and time dependency when considering the sophisticated or trusting investor theorem. In the observation period from January 1999 until December 2006 the trusting investor dominates. The results highlight strong negative share price response. This finding supports the investor's overconfidence idea referring to Statman et al. (2006). When the issuance volume of CDO grew constantly, most CDO deals benefited from high rating grades. Oftentimes, senior tranches of CDO deals were given the highest rating grades. Due to the complexity of CDO, many investors might not have been cautious enough to correctly interpret the risk exposure they were facing. Instead, they could have taken rating grades as a means of quality measurement. This perception has changed once the market noticed that the high rating grades of CDO were not justified. In this case, we notice a switch towards the sophisticated investor. Rating grade adjustments were expected and this would imply no abnormal returns. Instead, there are still negative abnormal returns

observed in the time period from January 2007 until June 2011. The same perception is found when controlling for regime dependency. Rating announcements from US banks experience a strong tendency towards the sophisticated investor behavior as the low quality of securitizations was rather linked to US banks. This result is quite striking as CDO - or securitized products in general - should have a limited feedback channel to the bank in case of defaults (Benveniste and Berger (1987); Carlstrom and Samolyk (1995)).[2] So the question arises why the sophisticated investor takes downgrade announcements as an indicator of potential risk.

In theory, risk associated with CDO deals is transferred to a special purpose vehicle (SPV) that issues bonds to investors in different tranches ranging from the senior tranche to the equity tranche that is mostly held by the originating bank. With this process, risk is supposedly transferred from the originator to the investor via the bankruptcy-remote SPV. As a result, losses from CDO deals should hardly affect the originating bank above the equity tranche. More precisely, banks need to make impairments for just the equity tranche. If the equity tranche is already written down, there is no need for further impairments.

Nevertheless, the reality of the CDO market showed much more complexity. Some forms of CDO can be constructed in a way that the originating bank is a broker - rather than an originator - with no first loss piece at all. These single tranche CDO have no feedback channel to the originating bank. Still, the sophisticated investor might be concerned about the general reputation of the bank if other investors do not distinguish to what extent a bank is exposed to risk. Even though activity in the CDO market may be considered as a secondary business, the bank's reputation can still be impacted. A further aspect that is still rarely addressed is linked to lawsuits. Banks or prosecutors sued originators - or

[2] At times of growing market share, research highlights the low risk nature of securitized deals. This perception has change after the financial crisis.

brokers - that they consciously sold low quality assets to investors.[3] These lawsuits shed a bad light on the bank's reputation. So concerns arising from secondary businesses can indeed impact the bank. Additionally, a characteristic of a synthetic CDO deal is that banks held not only the first loss piece but as well the super senior tranches which ranked superior to the senior tranches. Due to their size, the impairments were considerably high and put a severe threat to the involved bank.

Summarizing, we deliver proof that rating announcements have a material impact on the bank's equity. The remainder of this study is organized as follows. We summarize the relevant literature in section 1, section 2 proposes the applied data and methodology, section 3 presents the results and section 4 finally concludes the research.

2.1 Literature review

Rating grades are an established credit quality indicator in the financial industry and became even more important with the Basel II framework by determining the regulatory capital requirement based on external ratings. We expect significant market response from rating announcements given the high relevance of rating grades.

Implications of rating announcements have been researched in various ways. One study related to our analysis refers to Higgins et al. (2009) who document that rating downgrades of asset backed securities (ABS) induce significant negative share price reactions and lengthen future securitization issuing. While past research concentrated on the implications of long term rating grades for bonds, research has extended to examine derivative products like credit default

[3] Financial Times from Nov. 10, 2010: "Goldman Sachs junk CDO trouble – again".

swaps (CDS) as well. A comprehensive overview of rating implications exists in Norden and Weber (2004) and Trutwein and Schiereck (2011).

Referring to the theoretical building blocks of our analysis, there is evidence of the rating shopping and inflated rating grade phenomenon. Bongaerts et al. (2012) and Becker and Milbourn (2011) highlight that the more rating agencies issue rating grades on the same entity, the less efficient they become. If there are two rating agencies, one providing investment grade and the other non-investment grade status, then the third rating agency comes up as a tiebreaker. The study presents that it is more likely that the tiebreaker tends towards the investment grade status. This perception is supported by Bolton et al. (2012). The importance of multiple rating grades is also emphasized by Kisgen and Strahan (2010) resulting in lower costs of capital.

Bolton et al. (2012) and Faltin-Traeger (2009) document that it is more likely that rating agencies issue better rating grades for repeated or large issuers. The results are in line with He et al. (2011) who show that large issuers with less tranches have larger triple-A senior tranches. Interestingly, prices for triple-A senior tranches from large issuers dropped significantly in the financial crisis.

Reputation is an issue for rating agencies who argue that a lax rating approval would impact the reputation. However, Mathis et al. (2009) outline that there are indications that reputation concerns are not taken serious. They discover that rating agencies first build up reputation in order to generate fees for inflated ratings later on. The probability of inflated ratings and, hence, reputation concerns raises when the major source of income comes from rating complex products.

According to the sophisticated or trusting investor theorem, Bolton et al. (2012) perceive that in booms the investor does not scrutinize inflated ratings and so

making the investor vulnerable to high risk and forced selling when the performance strongly declines (Ambrose et al. 2008). Securitizations have been regarded as a means of risk transfer. Instefjord (2005) examined the impact of derivative structures that are used particularly in synthetic securitizations. These techniques favor risk-taking that could destabilize banks.

Generally, given the high relevance of rating grades, Rajan et al. (2010) demonstrate that certain information, other than what is reported to the investor, may be neglected and favor informational asymmetry. This is underlined by the results of Ivashina (2009) who shows that risk premiums are generally higher for less transparent products. Since we differentiate between CDO and the bank's issuer rating, we argue that information about CDO is less available and so it is conclusive that market participants ask for higher yields.

2.2 Data and methodology

2.2.1 Data

We extract data from several sources. For equity market prices we use Thomson Reuters and for rating announcements Bloomberg. We select the total return prices that take stock splits and dividend payments into account. In order to select data for CDO as our first proxy to represent the debt quality, we narrow the search for rating announcements by selecting CDO as issue type. In terms of linking the issuer of the CDO deal to the originator, we identify the SPV as the investment vehicle of the bank.

Rating agencies evaluate each tranche of a CDO deal independently. In common practice, rating agencies publish rating announcements on a number of tranches belonging to the same CDO deal simultaneously. As long as rating announcements occur for the same CDO deal in the largest event window [-20; 20], we consider the first announcement as our event date. This seems justified

because the downgrade of a CDO tranche can imply the downgrade of the subordinated tranches due to the loss allocation scheme inherent in CDO deals. Due to this fact rating announcements include negative rating outlooks and rating downgrades in this study. We consider confounding events when there are rating announcements on more than one CDO deal from the same bank in our largest event window [-20; 20]. We try to relate only one rating event as the indicator of abnormal returns in our observation. With this approach we considerably reduce our sample size.

The sample consists of CDO rating announcements from banks headquartered in Europe and the USA. We select all downgrade announcements in the time period from January 1999 until June 2011. From 6002 rating announcements for US banks and 2007 rating announcements for European banks, we consolidate the list by filtering CDO from stock-listed banks. We get 1227 rating announcements for US banks and 1743 announcements for European banks. After that we select banks with a considerable activity in CDO. This refers to banks with high total outstanding volume and several years of activity in securitization or CDO.[4] This leaves us with 513 rating announcements for US banks and 765 rating announcements for European banks. We consolidate rating announcements of CDO tranches belonging to the same CDO deal as one event if they occur in the event window [-20; 20]. The remaining events consist of 83 events from US banks and 176 events from European banks. Now we identify confounding events by disallowing major events that are disclosed during the event window [-20; 20] in order to diminish bias.[5] Exemplarily, on the day Lehman Brothers claimed for bankruptcy, a wave of CDO rating downgrades corresponding to Lehman Brothers and other banks were disclosed. As a bank failure is obviously a major confounding event, we exclude such an event from

[4] Outstanding volume in securitization / CDO > $ 100 million and years of activity in securitization> 10 years.
[5] Here we selected corporate news published in newspaper or journals such as the Financial Times and Wall Street Journal.

our sample. Our final sample size of 238 events consists of 72 events from US banks and 166 events from European banks.

CDO started to receive investor attention in the past decade. We take this into account and limit our time horizon from January 1999 until June 2011. We define a subsample from January 1999 until December 2006 and a subsample from January 2007 until June 2011 in order to control for time dependency with the rise and fall of the CDO market.

Table 2.1: Sample characterization, CDO rating announcements

	Events per year													
Country	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Total**
France			2	3						2	1	1	1	10
Germany		1	1	6	8	8	11	20	27	20	12		3	117
Netherlands							2	2		2	1			7
Spain								2		1			1	4
Switzerland								4	4	2	1	4		15
UK								3	4		2	3	1	13
USA	1						37	2		3	7	13	9	72
Total	**1**	**1**	**3**	**9**	**8**	**8**	**50**	**33**	**35**	**30**	**24**	**21**	**15**	**238**

After identifying CDO rating announcements as a first proxy for the debt quality, we select the bank's issuer rating as a second proxy. The rating methodology differs between the three largest rating agencies Standard & Poor's, Moody's and Fitch. Nonetheless, market participants have a common understanding of the rating methodologies and the adaptations of each rating agency (Holthausen and Leftwich (1986), Livingston and Jewell (1998)). Given this assumption, we retrieve the bank's issuer rating announcements only from Moody's.

We notice that negative rating outlooks and downgrades took place at the end of the 1990s with several financial crises and during the financial crisis 2007-2009 and in 2011. Rating upgrades or positive rating outlooks took place mostly during the new economy boom and prior to the financial crisis. In order to obtain consistent findings of the impact of rating grades, only negative rating outlooks and rating downgrades of banks involved in the CDO market are taken into account. With this approach we come to a sample size of 52 events in the period from January 1999 until June 2011. Due to the limited number of events, we do not run subsample analysis.

Table 2.2: Sample characterization, bank's issuer rating announcements

	Events per year													
Country	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Total**
France										1	1	1	4	7
Germany	2		3	2	1	1					5	1	2	17
Spain													2	2
Switzerland	3												1	4
UK										1	1		2	4
USA									1	5	4	2	6	18
Total	**5**	**0**	**3**	**2**	**1**	**1**	**0**	**0**	**1**	**7**	**11**	**4**	**17**	**52**

2.2.2 Methodology

We measure stock price reactions implicated by rating announcements. For that purpose, we apply an event study approach that is designed to quantify abnormal returns within a specified event period. We apply the adjusted market model approach by calculating the cumulative abnormal return (CAR) according to (MacKinlay 1997):

$$CAR_{i,[t_0-\tau,t_0+\tau]} = \sum_{t=t_0-\tau}^{t_0+\tau} (R_{i,t} - \widehat{\alpha}_i - \widehat{\beta}_i R_{m,t})$$

Where $R_{i,t}$ is the return of the originating bank at time t, $R_{m,t}$ is the security's market return at time t, $\hat{\alpha}_i$ and $\hat{\beta}_i$ are parameters derived from the ordinary least square regression with the estimation period beginning 200 days before the event and a lag time of 30 days in order to avoid leakage effects. We evaluate statistical significance for the different event window cumulative average abnormal returns (CAAR). The largest event window in our observation is set equal to 41 days, starting 20 business days before and ending 20 business days after a rating announcement. We subdivide our analysis in 9 time intervals and repeat them for all subsamples. In addition to standard t-test statistics, we test event-induced increases in variance (Boehmer et al. 1991). The non-parametric test is conducted by applying the Wilcoxon test.

In order to control for anticipation and post announcement effects, we calculate the buy-and-hold abnormal returns (BHAR) according to Loughran and Ritter (1995) with monthly returns three months before and after the event:

$$BHAR_{i,t} = BHR_{i,t} - BHR_{m,t}$$

Where $BHR_{i,t}$ is the stock's return at time t and $BHR_{m,t}$ is the market's return at time t. In addition, we conduct a multivariate regression analysis and control for heteroskedasticity (White 1980).

2.3 Results

2.3.1 Short term analysis: CDO vs. bank's issuer rating announcements

In a first analysis referring to CDO rating announcements we investigate whether the market considers rating announcements of CDO deals to affect the bank. The results in the overall 238 event sample indicate highly significant abnormal returns with CAAR= -0.59% (t-value = -4.175) right on the event day [0; 0]. The results suggest that CDO rating announcements are a valid indicator in terms of enhanced risk for the bank's shareholders. The wealth effects are not

lagged and absorbed very quickly by the market. In the event windows [0; 0], [-1; 2], [-1; 1] and [0; 2] we get significantly negative abnormal returns. The results highlight that the market assesses that risk still resides with the bank, either in form of reputation risk or possible impairments on the assets. On a longer period of event windows, the results turn insignificant. Once the rating announcements are absorbed, there are no abnormal returns noticed in larger event windows [-5; 5] or [-10; 10]. With a total sample of 238 events it appears that investors do not consider CDO rating announcements to be a prime driver in their investment decision.

In order to provide more evidence to our findings, we control for regime and time dependency as well. First market distortions in the subprime credit business were noticed in 2006. In this context, subprime credit business was rather linked to US banks than to European banks. These low quality assets have accounted for a great share of the reference assets in CDO deals. Upon the knowledge of activity in securitization, the investor may have anticipated rating downgrades specifically for US banks. So the reaction of a rating event would imply an indifferent market response. In a subsample covering 72 rating events corresponding to US banks we deliver proof that the expected weak performance of CDO deals from US banks were expected to some extent as we obtain little significant negative abnormal returns around the announcement day [-1;+1], [0;+0], [-1;+2] and [0;+2]. However, the expectation of fully indifferent market response was not validated.

We argue that the existence of feedback channels elevate the risk of the bank since reputation concerns arise as well as impairment requirements. A different finding is perceived when analyzing rating announcements corresponding to European banks. Here, we find support for the overall results table with strong negative abnormal returns around the event day in the event windows [-1; 1], [0;

0], [-1; 2] and [0; 2]. The highly significant abnormal return at event day with CAAR=-0.65% (t-value=-4,275) illustrates the differing market response in terms of regime dependency.

To further analyze the impact of CDO rating grades, we pursue with a time dependency analysis as illustrated in Panel C. Over the last decade CDO have gained market attention due to beneficial aspects such as regulatory capital relief and credit risk transfer as long as the underlying assets are of low default rates (Thomas 1999). We split our analysis into a time period from January 1999 until December 2006 and a time period from January 2007 until June 2011 separating the growth and sudden fall period of CDO.

As first market distortions in the credit business were noticed in 2006 and the awareness of high default rates became apparent, the assumption that securitization / CDO were a low risk investment was questioned. Once the weak performance of many subprime credits came to public attention, investors' confidence suffered and rating announcements were widely expected with a detrimental effect on the bank's reputation. We hypothesize that the sophisticated investor has already expected rating downgrades resulting in indifferent market response especially for rating events after 2007. In the first time period from 1999 until 2006 wealth effects are highly significant with negative abnormal returns of CAAR= -1.27% (t-value=-4.172) at announcement day [0; 0] and CAAR= -0.41% (t-value=-2.674) for the event window [-1; 1]. In accordance with our findings from the overall sample and CDO originated from European banks, we only obtain significant results in the shortest event windows and confirm that CDO rating announcements are quickly incorporated.

Table 2.3: Stock price response to CDO rating announcements

The table reports cumulative abnormal returns (CARs) for the CDO originating banks that are affected by a rating event (downgrade announcement or negative rating outlook of CDO) over the period 1999 to 2011 in our final sample. We first aggregate the portfolio of equally weighted equity returns for each rating event. Then, we average these returns across events. CAR is the cumulative abnormal return of the bank, defined from the market model estimated over the period (-200, -30). The market model consists of the corresponding local index as provided by Thomson Reuters Datastream (DS Code LI). t-statistics are computed from the portfolio time-series standard deviation to account for any possible event clustering. Boehmer z-score takes event-induced increases in variance into account. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. The total sample (Panel A) contains 238 rating events. Panel B breaks down the sample across CDO originated from European and US banks. Panel C breaks down the sample across rating events from 1999-2006 and 2007-2011.

Panel A: Abnormal Equity Returns, Total Sample

	All events (N=238)		
Day	Mean	t-Statistic	Boehmer z-score
-10,1	-0.64%	-1,146	-1,509
-5,1	-0.48%	-1,039	-1,313
-1,1	-0.72%	-2.854***	-2.913***
-5,5	-0.62%	-1,248	-1,299
-10,10	-0.74%	-1,244	-1,281
-20,20	-0.63%	-1,316	-0,769
0,0	-0.59%	-4.175***	-4.321***
-1,2	-0.74%	-2.596***	-2.741***
0,2	-0.64%	-2.513***	-2.662***

Panel B: Abnormal Equity Returns by Region

	US Banks (N=72)			European Banks (N=166)		
Day	Mean	t-Statistic	Boehmer z-score	Mean	t-Statistic	Boehmer z-score
-10,1	-1.65%	-0.816	-1.061	-0.23%	-0,343	-0,460
-5,1	-1.03%	-1,083	-1,149	-0.26%	-0,516	-0,709
-1,1	-0.62%	-1.945*	-2.190*	-0.75%	-2,958***	-3,246***
-5,5	-0.71%	-0,553	-0,625	-0.59%	-1,130	-1,188
-10,10	-1.28%	-1,138	-1,126	-0.52%	-0,799	-0,775
-20,20	0.66%	-0,343	0,360	-1.16%	-1,338	-1,302
0,0	-0.49%	-2.191**	-2.364**	-0.65%	-4,275***	-4,289***
-1,2	-0.56%	-1.985**	-2,136**	-0.87%	-2,993***	-3,070***
0,2	-0.48%	-1,495	-1.600	-0.77%	-3,197***	-3,123***

Panel C: Abnormal Equity Returns by Time Period

	1999-2006 (N=127)			2007-2011 (N=111)		
Day	Mean	t-Statistic	Boehmer z-score	Mean	t-Statistic	Boehmer z-score
-10,1	0.08%	0,066	0,247	-0.92%	-1.355	-1.494
-5,1	0.02%	0,021	0,085	-0.50%	-1.237	-1.308
-1,1	-0.41%	-2,674***	-2,522**	-1.09%	-1.652*	-1.734*
-5,5	0.20%	0,592	0,652	-1.15%	-0.742	-1.174
-10,10	0.52%	0,848	1,152	-0.28%	-0.890	-0.771
-20,20	0.36%	0,391	0,536	0.42%	-0.414	0.265
0,0	-1.27%	-4.172***	-4.029***	-0.35%	-2.069**	-2.015**
-1,2	-0.92%	-3.747***	-3.643***	-0.40%	-1.782*	-1.792*
0,2	-0.81%	-3.112***	-3.244***	-0.53%	-1.945*	-1.880*

After controlling for the time period from 1999-2006 we investigate the effect of rating implications from 2007-2011 as this time period stands for the weak performance of CDO and little issuance volume. We project that the weak performance was expected so that market response should have a limited impact on the bank's share price. Nonetheless, we get little significant negative abnormal returns for rating events after 2007. This result is quite striking as expected rating announcements should not result in a substantial wealth effect. We argue that a shift towards the sophisticated investor has occurred. The sophisticated investor does not only incorporate rating announcements, but as well other concerns that may arise. The rating grades express the creditworthiness of a product and thus are a proxy for reputation risk.

In contrary to the strong impact of CDO rating grades, we do not observe significant abnormal returns around the event day in any of the event windows for downgrades referring to the bank's issuer rating. This is surprising as the bank's issuer rating is of significant importance for a bank's creditworthiness. Due to the few events we do not conduct further subsample analysis with regional and time dependency as conducted with CDO rating announcements. In addition, we focus on non parametric test statistics due to the few events. In lack of significant findings in the short term observation we rather argue that there is a distinctive characteristic between the bank's issuer and CDO rating announcement. In contrast to CDO, information about the bank is widely available. If investors have already incorporated publicly available information about the bank, equity price effects might have taken place well in advance and rating announcements are lagged. This would support the informational asymmetry theorem. In order to examine lead and lag effects we continue the analysis by observing anticipation and post announcement effects.

Table 2.4: Stock price response to bank's issuer rating announcements

The table reports cumulative abnormal returns (CARs) for the CDO originating banks that are affected by a rating event (downgrade announcement or negative rating outlook of the bank's issuer rating) over the period 1999 to 2011 in our final sample. We first aggregate the portfolio of equally weighted equity returns for each rating event. Then, we average these returns across events. CAR is the cumulative abnormal return of the bank, defined from the market model estimated over the period (-200, -30). The market model consists of the corresponding local index as provided by Thomson Reuters Datastream (DS Code LI). t-statistics are computed from the portfolio time-series standard deviation to account for any possible event clustering. Boehmer z-score takes event-induced increases in variance into account. The Wilcoxon test is included due to the small sample size. ∗∗∗, ∗∗, and ∗ indicate significance at the 1%, 5%, and 10% level, respectively. The total sample contains 52 rating events.

Abnormal Equity Returns, Bank's issuer rating total sample				
	All events (N=52)			
Day	Mean	t-Statistic	Boehmer z-score	Wilcoxon test
-10,1	-1.29%	-0,378	-0,798	-0,070
-5,1	-1.28%	-1,221	-1,352	-0,726
-1,1	-1.64%	-0,482	-0,908	-0,126
-5,5	-1.26%	-0,516	-0,960	-0,279
-10,10	-0.38%	0,412	-0,148	0,000
-20,20	-0.78%	0,035	-0,248	-0,154
0,0	-0.72%	-0,739	-1,034	-0,223
-1,2	-0.52%	0,131	-0,368	-0,502
0,2	-0.60%	0,063	-0,335	-0,307

2.3.2 Long term analysis: CDO vs. bank's issuer rating announcements

Our main findings correspond to the informational asymmetry and sophisticated or trusting investor theorem. Now, we observe lead and lag effects by calculating a long term performance study with monthly BHAR calculation.

If rating downgrades were expected and already priced, we would expect significant abnormal returns to take place before the actual event. The long term effect of CDO rating announcements is different. Referring to our above mentioned note we pointed out that CDO rating announcements had a wealth effect only around the announcement day but no significant findings in the largest event window [-20; 20]. The long term BHAR emphasizes the results of the short term event study that CDO rating implications are limited to the event day since neither anticipation nor post announcement effects are noticed.

Table 2.5: Pre-announcement and post-announcement effect

The table reports Buy-and-Hold abnormal returns (BHARs) for the CDO originating banks that are affected by a rating event (downgrade announcement or negative rating outlook of the bank's issuer rating) over the period 1999 to 2011 in our final sample. The BHAR is calculated on a monthly basis. The market index consists of the corresponding local index as provided by Thomson Reuters Datastream (DS Code LI). t-statistics are computed from the portfolio time-series standard deviation to account for any possible event clustering. The Wilcoxon signed rank test is included as a non-parametric test statistics. ∗∗∗, ∗∗, and ∗ indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: BHAR, Pre-announcement period

	CDO (N=238)			Issuer Rating (N=52)		
Months	Mean	t-Statistic	Wilcoxon	Mean	t-Statistic	Wilcoxon
-3,2	-0.22%	-0.256	-0.114	-8.15%	-3.545***	-3.531***
-3,1	0.27%	0.261	-0.061	-11.89%	-5.372***	-4.215***
-3,0	0.21%	0.163	-0.471	-14.17%	-5.901***	-4.410***

Panel B: BHAR, Post-announcement period

	CDO (N=238)			Issuer Rating (N=52)		
Months	Mean	t-Statistic	Wilcoxon	Mean	t-Statistic	Wilcoxon
0,1	-0.34%	-0.391	-0.700	-4.78%	-1.603	-0.740
0,2	-0.09%	-0.079	-0.236	-10.68%	-2.860***	-2.604***
0,3	0.68%	0.482	-0.174	-13.59%	-3.715***	-3.178***

Derived from the theoretical building blocks, we expect to deliver support for informational asymmetry and sophisticated or trusting investor theorem. We argue that rating downgrades are just a logical reaction if the bank performance is weak. Additionally, investors may foresee the weak development and incorporate this in their investment decision. We obtain negative monthly BHAR at the 1% significance level in the months prior to the announcement day [-3; -2], [-3; -1] and [-3; 0]. In line with the findings of the short term event study, the BHAR in the period [0; 1] does not show significant abnormal returns for the bank’s issuer rating. Surprisingly, the post announcement effect shows significantly negative abnormal returns starting one month after the event day in the period [0; 2] and [0; 3]. We conclude that the sophisticated investor acknowledges the importance of the bank’s issuer rating and reacts with delayed selling.

2.3.3 Multivariate regression analysis

This section reports regression analysis of the bank's return on explanatory variables designed to identify the drivers of abnormal returns. The dependent variable is the CAR derived from the event window [0; 0]. We use bank characteristics, risk categories and binary variables for regional and time dependencies. The bank characteristics are the market value (log market value) and the market-to-book ratio. The dummy characteristics are consistent with the subsamples. The time dummy separates events that took place before 2006 and after 2007. The regional dummy differentiates between CDO from European and US banks. We include the correlation 250 days preceding the event. Another important dummy variable is whether the bank received a downgrade on the bank's issuer rating three months prior to the event day. Literature suggests that the bank's issuer downgrade is essential in terms of explaining abnormal returns for securitized products (Higgins et al. 2009). Our data sample suggests that there is no need to control for the strength of rating downgrades since most CDO deals were sharply downgraded. The t-statistics of the coefficient estimates are based on White's heteroskedasticity-consistent standard errors (White 1980).

All our models outline that there is a highly significant negative impact with the intercept in model 1=-0.027 (t-value=-2.715). Interestingly, size characteristics have a positive impact. The log market size is in model 1 = 0.005 (t-value=1.957) that supports the "too big to fail" assumption. Large banks may suffer less from rating announcements since the market may recognize that they are more capable to withstand possible losses from rating downgrades on CDO deals. In line with the corresponding literature, the issuer downgrade prior to the event is of core importance with a strong impact of -0.011 (t-value= -2.066) in model 1. All models indicate a suitable regression model with an adjusted r-

squared of more than 0.1. Overall, the multivariate regression analysis supports the findings for the abnormal returns as identified in the event study.

Table 2.6: Multivariate regression for CDO rating announcements

Model	**1**	**2**	**3**
Intercept	-0.027	-0.032	-0.026
t-value	*-2.715****	*-2.762****	*-2.597****
Bank characteristics			
Log Market Size	0.005	0.005	0.005
t-value	*1.957**	*1.999***	*1.999***
Market to Book Ratio	0.002	0.002	0.002
t-value	*1.475*	*1.005*	*0.725*
Region			
Europe (Dummy=1)		-0.003	
t-value		*-1.784**	
US (Dummy=1)			0.003
t-value			*0.924*
Time			
before 2006 (Dummy=1)		-0.003	
t-value		*-2.016***	
after 2007 (Dummy=1)			-0.004
t-value			*-1.806**
Risk characteristics			
Downgrade issuer rating (Dummy=1)	-0.011	-0.010	-0.010
t-value	*-2.066***	*-1.840**	*-1.832**
Correlation	0.020	0.001	0.002
t-value	*-1.316*	*-1.147*	*-1.127*
Model parameters			
adjusted r-squared	0.116	0.120	0.120
F-statistics	8.770***	5.562***	5.570***
N	238	238	238

2.4 Summary and conclusion

Rating grades have become an integral part in the banking industry. We intend to quantify the impact of rating announcements on the bank's share price. We examine rating implications from CDO and cross check the implications by including the bank's issuer rating. The basic building blocks in our analysis are

1) rating shopping and rating grade inflation, 2) reputation of rating agencies, 3) sophisticated or trusting investor behavior and 4) informational asymmetry.

Our results indicate that informational asymmetry is very distinct. Furthermore, the other dominating theory that we find support for is the sophisticated or trusting investor theorem. We observe a switch from the trusting to the sophisticated investor over time.

We explain our results with the growing market impact of CDO and securitization in general. Rating agencies recognized that structured finance products like CDO became a considerable profit contributor for their business. Nonetheless, neither the rating agencies nor the market participants were cautious enough to assess the risk CDO were bearing. The assumed risk transfer did not hold true since the complex construction of CDO permitted feedback channels to the bank. Beginning with the subprime credit crisis, the high rating grades were questioned by the market seeing a rapid drop in confidence to complex products. In the wake of the financial crisis CDO were blamed to bear incalculable risk. However, the results highlight that risk from rating announcements on CDO deals is actually limited to a very narrow time frame.

3 Benefits from Securitization for Institutional Investors

This study investigates investment charters and the performance of institutional investors in the US, UK and Germany. Investment charters for institutional investors are supposed to prevent high risk taking and to establish stable financial markets. Institutional investors are dominant market actors with essential market power. Exemplarily, the importance of institutional investors is highlighted by Campbell and Taksler (2003) who observe that about 60% of all US corporate bonds are held by institutional investors.[6] In addition, Binay (2005) finds that institutional ownership in the equity market grew from 35% in 1981 to 58% in 2002. The dominance of institutional investors is supported by a more recent study from Lewellen (2011). Given their influence on the financial market, individuals might consider institutional investors as "safe haven" especially during times of heightened uncertainty and economic downturns.

According to the investment practices of institutional investors, there are two dominating strategies, the prudent person rule and quantitative portfolio restrictions. The prudent person rule suggests that decisions should be taken to the best of one's knowledge and judgment whereas quantitative portfolio restrictions determine the maximum share of each portfolio component. However, both investment strategies could not fully withstand the market turbulences in the financial crisis.

Institutional investors have experienced stress during the financial crisis in terms of generating stable returns and evading risk. Hence, they were forced to review their portfolio allocation strategy and to evaluate the suitability of financial products that were underrepresented so far. Generally, financial products qualify to be considered in the portfolio of institutional investors when there is a low

[6] This is composed of 15% by pension funds, 5% to 10% by mutual funds, 5% by commercial banks and one third by insurance firms.

correlation to other assets and steady return rates. In this context, we investigate whether an increased investment in securitization is beneficial. Early research on securitization from Benveniste and Berger (1987) proposed that risk mitigation techniques existed and moral hazard issues were offset. Securitization has become a success story with an impressive growth rate. According to Loutskina (2011), securitization accounts for approximately 40% of outstanding loans in the US. Loutskina and Strahan (2009) provide evidence that 60% of outstanding mortgage loans in the US are already securitized. More impressively, the authors present that the amount of securitization has already surpassed the amount of US corporate bonds. One aspect of the rapid market growth is related to high rating grades. As institutional investors are restricted to the investment grade universe by their charters, highly rated securitization tranches became interesting investment opportunities. Nonetheless, recent literature found evidence that the complex construction of securitizations permitted feedback channels that destabilized the banking system (Nijskens and Wagner (2011); Instefjord (2005) and Shleifer and Vishny (2010)).

The motivation of this study is to conduct global research on investment practices in the US, UK and Germany covering the largest institutional investors. The most prominent institutional investors are life insurers, pension funds, mutual funds, banks, hedge funds and university endowments. We run portfolio optimization methodology for institutional investors where homogeneous portfolio allocations can be identified. The 2009 OECD survey discloses homogeneous portfolio compositions for life insurers, pension funds and open-end mutual funds.

The framework of this study consists of the following research questions:

- Is the prudent person rule superior to the quantitative portfolio restriction approach?
- Can small shifts in the portfolio allocation achieve higher risk-adjusted returns?
- Do institutional investors possess outperformance skills?
- Can securitization add value to the portfolio of institutional investors?

First, we investigate whether institutional investors are exposed to the prudent person rule or to quantitative portfolio restrictions and whether securitization is permitted by the investment charters. Second, we calculate the risk-return characteristics of the actual portfolios and evaluate whether small shifts in the portfolio composition add value. Third, we examine whether securitization increases the risk-adjusted return of institutional investors. Lewellen (2011) shows that the portfolios of institutional investors replicate the value-weighted market index almost perfectly. Additionally, Gompers and Metrick (2001) highlight that institutional investors prefer large and liquid stocks that are mostly the components of major indices. Derived from these findings we argue that index-based portfolio optimization is suitable in our analysis. In addition to deterministic risk-return characteristics, we incorporate stochastic statistics by applying Monte Carlo simulations.

Summarizing our results, we start with the descriptive findings. We observe a general tendency to centralized supervision of the financial services industry in all three countries. This pays tribute to the fact that banks, insurance firms, etc. offer a broad range of products and services. Furthermore, we notice a long history of financial regulation especially in the US and track this back to the aftermaths of the Great Depression with the creation of the Securities and Exchange Commission (SEC) (Blum 1938). We discover that the prudent person

rule applies to institutional investors in the UK and US, whereas quantitative portfolio restrictions apply to German investors. We encounter a more domestic approach in the US and a more international approach in Europe.

Table 3.1: Characteristics of financial regulation

Regulation characteristics	USA	UK	Germany
centralized financial regulation	+	+	+
prudent person rule	+	+	-
quantitative portfolio restrictions	-	-	+
securitization explicitly allowed	o	o	+
investments in foreign markets	o	+	+

+ = strong impact, o = neutral, - = low impact

Proceeding to the empirical results, our findings suggest that the prudent person rule is superior to the quantitative portfolio restriction approach. Further on, securitization was favorable for institutional investors prior to the financial crisis. As institutional investors are forced to provide stable returns at low risk, the deterioration of securitization was catalyzed by forced selling from institutional investors. When including the recent financial crisis we do not perceive additional value from securitization.

We see indications of outperformance skills of institutional investors but not at high significance levels over all observations. Interestingly, the outperformance skills are most pronounced during the financial crisis meaning that institutional investors could be regarded as “safe haven” in times of stress. The independent variables in the multifactor models according to Fama and French (1993) and Carhart (1997) reveal interesting findings. The size factor is highly significant with a negative sign meaning that large firms perform better than small firms in an extended observation period. More impressively, the momentum factor referring to Carhart (1997) does not deliver significant findings.

The remainder of section 1 presents the necessity of regulation and the lack thereof. We continue in section 2 with the relevant literature review, section 3 describes the data and methodology, section 4 presents the results and section 5 finally concludes the analysis.

3.1 Regulation of institutional investors

3.1.1 Necessity of investment charters and financial regulation

In general, institutional investors are exposed to strict regulation since contributions made to them are mostly long term savings. We summarize the necessity and possible shortcomings of regulation as proposed by Davis (2001).

- *Informational asymmetry:* the existence of informational asymmetry between purchasers of financial services and their providers makes the purchaser vulnerable to exploitation. This, in particular, holds true for securitization where the buyer may face risk from low quality assets ("lemons").
- *Externalities:* the reduction of government-provided pensions results in more contributions to private institutional investors with adequate low risk investments.
- *Market power:* due to their high investment volume, institutional investors possess a distinctive market power.

While these arguments have positive implications, the following arguments are negatively influenced.

- *Portfolio immunization techniques:* regulation hinders the usage of immunization techniques for the asset-liability management.
- *Portfolio hedging:* limitations in the use of derivatives force investors to invest in low-yield instruments to the disadvantage of clients and policy holders.

- *Flexibility:* strict regulation puts a burden on institutional investors who might not respond rapidly enough to cyclical or structural changes in the market.
- *Diversification:* restrictions of diversification can increase overall portfolio risk.

3.1.2 History of financial regulation and specifics for securitization

The SEC as the main institution in charge of regulation in the US was established after the Great Depression following the 1929 financial market crash. With the passing of the Securities Act in 1933 and the Securities Exchange Act in 1934, both the primary and the secondary market were covered. Since its founding, the SEC has proposed and enacted several amendments in order to adapt regulation to new developments on financial markets.

We observe that financial regulation is centralized in Europe as well. The Financial Services Authority (FSA) is in charge of financial market regulation in the UK with broad competence in terms of establishing market confidence, public awareness and the protection of consumers. The counterpart in Germany is the Federal Financial Services Authority (BaFin) that was formed in 2002 as a merger of three institutions:

- Banking: Federal Banking Supervisory Office *(Bundesaufsichtsamt für das Kreditwesen, BAKred)*
- Insurance: Federal Insurance Supervisory Office *(Bundesaufsichtsamt für das Versicherungswesen, BAV)*
- Securities: Federal Supervisory Office for the Securities Trading *(Bundesaufsichtsamt für den Wertpapierhandel, BAWe)*

Securitization is a rather young investment opportunity. Nevertheless, regulation has extended to cover securitization as well. We outline the specifics for securitization exemplarily in the US not neglecting European regulation. Regulation of securitization is based on the Securities Exchange Act that prohibits trading in a security unless it has been registered with the SEC. Exempt from this regulation are private placements of securities. These securities are regarded as “restricted securities” when there is a one-year holding period on securities issued in a private placement. If these securities are resold in another private placement, longer periods apply meaning that private placements basically fall out of regulation by the SEC. In addition, the resale of securities to institutional investors is permitted without registration.

Hence, the lack of regulation of financial products designed for institutional investors becomes apparent. This is valid for securitization as these are mostly addressed to institutional investors. Along with these shortcomings and growing importance of securitization, new regulation for securitization came into force. The full details of requirements are listed in Kothari (2006). Although there is plenty of information, investors need to invest time and effort to cautiously evaluate the quality of the securitization and its underlying reference assets (Downing et al. 2009).

3.1.3 Prudent person rule or quantitative portfolio restrictions

There is mixed evidence whether the prudent person rule or quantitative portfolio restrictions is superior. We account for this issue by summarizing the regulatory requirements. We discover that there is mostly a mix of the prudent person rule and quantitative restrictions. Hence, we show that institutional investors in the US and UK are more exposed to the prudent person rule and German institutional investors to quantitative portfolio restrictions. The

regulation is rather federal responsibility in the US, whereas German and UK investors are centrally regulated.[7]

Table 3.2: Investment restrictions for institutional investors[8]

Investor	Characteristics	USA	UK	Germany
Life Insurers	Prudent Person rule (PPR)	PPR, limit of 3-5% other than US Government	PPR, maturity matching	no PPR, diversification rules apply
	Quantitative portfolio restrictions (QR)	state responsibility	3% cash	30% shares, 10% unquoted shares, 25% real estate, 50% loans, 30% mutual funds, 50% bonds
	Concentration and own investment	n/a	n/a	no own investment
	Foreign Asset restrictions	limit max 10%, state responsibility	80% currency matching	80% currency matching
Pension funds	Prudent Person rule	PPR, diversification	PPR, concentration limit to DC funds	no PPR, single institution 2%
	Quantitative restrictions	n/a	10% in a single mutual fund, 25% in funds run by one manager	20-25% equity, 15-25% real estate
	Concentration and own investment	own investment of 10% for defined benefit funds	own investment 5%	own investment 10%
	Foreign Asset restrictions	n/a	n/a	80% currency matching

3.2 Literature review

The term institutional investor is defined by Davis and Steil (2001) as "specialized financial institutions that manage savings collectively on behalf of small investors towards a specific objective in terms of acceptable risk, return

[7] We do not consider the portfolio limitations for mutual funds as different types would bias a general statement. There are security funds, real estate funds, money market funds, funds-of-funds, etc. with different regulation.
[8] (Davis 2001), pp. 43-45

maximization and maturity of claims". Institutional investors act as capital allocation points by aggregating large numbers of small investments from their clients making them potent actors on the financial market. The high investment volume permits institutional investors to benefit from economies of scale and to invest in assets that are inaccessible to private investors due to limitations like minimum investment or holding period. So corporate governance and shareholder activism as investigated by Del Guercio et al. (2008) are important issues for institutional investors.

Generally, the investment strategy is characterized by investments in large and liquid stocks. Gompers and Metrick (2001) analyze that large institutional investors doubled their share in the stock market from 1980 to 1996 by investing preferably in large companies. Del Guercio (1996) explains the investment in large and liquid assets with the prudent person rule and fears of lawsuits.

There are various observations whether the prudent person rule or quantitative portfolio restrictions is superior. Davis (2001) detects that the prudent person rule is generally superior to quantitative portfolio restrictions. Analyzing European life insurers, Bijapur et al. (2007) emphasize the findings.

Investment charters stipulate that rating grades are considered as regulatory certifications since institutional investors are restricted to the investment grade universe. Bongaerts et al. (2012) find that Standard and Poor's and Moody's dominate the market.[9] The importance of rating-based constraints is most pronounced at the threshold of the investment grade and non investment grade universe. The paper presents that Fitch Rating serves as a tiebreaker in order to determine whether an asset falls into the investment grade universe and thus can be included in the portfolio of institutional investors. This suggests that rating

[9] Rating agencies are licensed as Nationally Recognized Statistical Rating Organizations by the SEC in the US. Similar regulation is valid in Europe, too.

grades are essential for marketing a product to institutional investors. In this context, the downgrade from the investment grade to the non investment grade universe may implicate forced selling and further catalyze the deterioration of products (Ambrose et al. 2008). Regarding securitization, Moody's downgraded more than 400 deals on July 10, 2007 and Standard & Poor's announced 612 downgrades two days later (Higgins et al. 2009). Given these numbers, the question arises whether securitization can serve as a suitable investment for institutional investors that seek stable returns at low risk.

Summarizing the literature with regard to the performance of institutional investors there are distinctive findings. Referring to Lewellen (2011), institutional investors have little stock-picking skills. Instead, they closely reproduce the market portfolio with almost perfect correlation with the value-weighted market index. He finds a correlation of 99.8% and a beta of 1.01 in the observation period from 1980 to 2007. More specifically, the study presents that the largest institutions have the highest correlation and smallest excess returns. A closely related paper from Cohen et al. (2002) questions the ability of institutional investors to outperform the trading skills of individual investors. They find evidence that institutional investors outperform individuals by 1.44% due to their extremely conservative deviations from the market portfolio. Binay (2005) finds that institutional investors do possess stock-picking skills. The selection skills are supported by Daniel et al. (1997) who detect excess returns for mutual fund managers.

Given the importance of institutional investors, we summarize their trading behavior. Herding and feedback trading is existing as the large investment volumes, especially in less liquid stocks, can influence price movements (Wermers 1999). Sias (2004) observes herding of institutional investors since the investment decisions are based on the investments of other institutional

investors. This is supported by the results of Nofsinger and Sias (1999) who analyze more herding and feedback trading for institutional investors than for individual investors.

3.3 Data and methodology

3.3.1 Life insurers

Life insurers in the US are one of the largest investors with total assets of $5 trillion at the end of 2009 (ACLI 2010). A comparable situation can be found in the UK which provides the biggest insurance industry in Europe and the third largest in the world following the US and Japan. According to the Association of British Insurers (ABI), the investment volume accumulates to £560 billion in 2009 (ABI 2010). The German Federation of Insurance Industry (*Gesamtverband Deutscher Versicherungswirtschaft, GDV*) administrates 95% of the German insurance market. With €700 billion assets under management in 2009, the German life insurance industry is amongst the largest institutional investors in Germany (GDV 2009).

Federal states are in charge of insurance regulation in the US. The regulation commissions of each state are voluntarily associated in the National Association of Insurance Commissioners (NAIC). The NAIC had originally advisory functions but expanded its competencies towards a federal agency. Each state has an insurance regulation department in its executive branch with “broad, legislatively delegated powers to enforce state insurance laws, promulgate rules and regulations, and conduct hearings to resolve disputed matters” (Randall 1999). The prudent person rule shall prevent life insurers from exposure to high risk.

The supervising institution in the UK is the FSA legitimated by the Financial Services and Markets Act 2000. The FSA is in charge of controlling and

regulating the financial industry. The FSA is rather liberal concerning quantitative portfolio restrictions. Hence, British insurers are also called “stock share insurances” due to their high stakes in the stock market (Bijapur et al. 2007). In Germany, the financial stability of life insurers is set out in the Insurance Supervision Act (*Versicherungsaufsichtsgesetz, VAG*) and the investment act (*Anlageverordnung, AnlV*) which are supervised by the BaFin. The most significant tasks of the BaFin concerning life insurers are monitoring the financial soundness and the compliance with regulatory requirements.

Table 3.3: Portfolio allocation of life insurers, 2009 OECD survey

Life insurers	USA	UK	Germany
Currency and deposits	1.1%	6.5%	40.0%
Securities	56.7%	52.7%	10.2%
Loans	10.7%	2.1%	19.0%
Shares	31.5%	38.8%	30.8%
Shares issued by residents	*0.0%*	*22.4%*	
Shares issued by non residents	*0.0%*	*16.4%*	
Total	100.0%	100.0%	100.0%

3.3.2 Pension funds

Life insurances and pension funds are similar concepts, although there are some key differences (Davis 2001). The objective of pension funds is to achieve stable earnings whereas life insurers have to match a nominal return in order to provide the guaranteed return. Furthermore, life insurers are subject to high liquidity risk due to early surrender values or the death of the client. There are several ways of categorizing pension funds:

- By ownership: pension funds fall either under private or public regulation. Private pension funds traditionally play an important role in the US as state provided pensions are less funded than, for example, in many central European countries.

- By benefits: a *defined contribution plan* provides benefits solely based on the contributions made to the individual beneficiary's account plus any investment earnings, if applicable. The amount of the annual or monthly contribution is predefined and usually paid by the employer. Upon retirement, the pension scheme works like a mutual fund trying to reach the best investment return possible at a given risk (Queisser 1998). Due to the individual accounts, funds can be transferred from one plan to another. In contrary, in a *defined benefit plan* the beneficiary receives a specific monthly pension based on a formula that incorporates the individual's earnings history, tenure and age. Here, the issue of funding arises since the plan guarantees future and current benefits. In addition, transferring from one plan to another is more difficult since no individual funds are accrued.

One of the most popular pension plans in the USA is the 401(k) plan, indicating the corresponding Internal Revenue Code (IRC). The 401(k) is a defined contribution plan that is mostly employer-sponsored and allows the participant to choose whether and how much to contribute, how to invest and when to withdraw the funds. Furthermore, participants have the option of paying taxes when the funds are withdrawn.[10] Due to delayed taxation, pre-tax payment can be an attractive option for employees (Bodie (1990); Munnell and Sundén (2006)). In the UK pension funds are mostly structured as trusts while German pension funds are predominantly constituted by captive insurance companies. In Germany as well as in the UK the defined contribution plan is the more common pension scheme. This study focuses on public funds. Private funds are not regulated by an official institution and can differ significantly in their investment policies so that they are unsuitable in this analysis.

[10] usually upon retirement

Regulation of pension funds is fragmented with many distributed responsibilities (Queisser 1998). The Employee Retirement Income Security Act (ERISA), passed in 1974, regulates employee benefit plans in the USA. It establishes basic rules for pension plans, such as pension vesting (the employee attains a non-forfeitable right to receive benefits after a certain number of years of participation in the plan). The Pension Protection Act of 2006 made important enhancements to the existing regulation in terms of disclosure and reporting issues (Lansberg 2008). In general, investment regulation is based on the prudent person rule (Queisser 1998). Pension fund trustees establish their own, more specific investment regulation based on this guideline. In the UK pension funds are subject to the prudent person rule monitored by the FSA who establishes principles for financial services provider. Pension funds in Germany are supervised by the BaFin. Additionally, the regulating institutions in the European Union are the International Organization of Pension Supervisors and the European Insurance and Occupational Pensions Authority.

A study referring to the performance of US pension funds was conducted by Bauer et al. (2010) on 463 defined benefit pension funds from 1990-2006 and 248 defined contribution pension funds from 1997-2006. The authors find that cost levels for pension funds are substantially lower than for mutual funds, mainly because of economies of scale. Furthermore, they find a negative correlation between the size of the pension fund and its performance, as well as between the liquidity of investments and their performance. When comparing the performance of defined benefit vs. defined contribution plans, they come to the conclusion that defined benefit plans generally seem to accomplish better returns than defined contribution plans due to better performing small cap investments and lower cost levels. There seems to be no consensus on the general performance of pension funds. While the study on 6,260 portfolios of defined benefit pension fund accounts shows that the average fund manages to

outperform the market by 124 basis points (Busse et al. 2010), others find that pension funds lag the S&P 500 by 260 basis points annually (Lakonishok et al. 1992).

The UK pension funds market is the second largest to the US pension funds market. Pension funds in the UK have experienced a considerable growth rate with a continuously positive trend (Blake et al. 1997). From 2000-2009, UK pension funds generated an average return of 3.7% while the benchmark FTSE All-Share index rose by 1.2%. In the recent financial crisis it was perceived that UK pension funds shifted more towards secure investments like low yield bonds rather than equity (IMA 2008). In Germany due to lower government provided pensions, pension funds have attracted more attention with a constant growth rate (Maurer 2003). The portfolio of pension funds differs for the respective countries.

Table 3.4: Portfolio allocation of pension funds, 2009 OECD survey

Pension funds	USA	UK	Germany
Currency and deposits	1.2%	6.2%	44.7%
Securities	34.3%	46.0%	9.9%
Loans	0.9%	0.3%	8.5%
Shares	63.6%	47.5%	37.0%
Shares issued by residents		*20.4%*	
Shares issued by non residents		*27.1%*	
Total	100.0%	100.0%	100.0%

3.3.3 Mutual funds

Given their size, mutual funds can benefit from investment opportunities that require significant minimum investments, achieve better trading terms or spread fixed costs over a large base of assets (Buti 2005). According to data provided by the Investment Company Institute (ICI), a national association of US investment companies, mutual funds serve as important investment channels in

the stock, bond and money markets by holding 28% of US corporate equity, 12% of US treasury and government securities and 51% of all commercial paper as at the end of 2009 (ICI 2010).

According to the SEC's official definition, a mutual fund is an investment company that pools money from investors in order to invest in stocks, bonds and other securities. The investors purchase shares of the fund at a price relative to the fund's net asset value (NAV) and any charges that may apply. These shares are usually not traded in a secondary market (between investors), instead they are redeemable meaning that they can be sold back to the fund at their current NAV minus redemption fees (Frankel and Cunningham 2006).

The Investment Company Act of 1940 contains regulation on disclosure and the pricing of redeemable securities as well as the valuation of the portfolio holdings. Portfolio holdings for which market quotations are readily available have to be priced at market value, while other securities are priced at fair value by the fund's board. No single standard exists for this process of fair valuation, but the SEC provides extensive guidance and supervision (ICI 2009). Furthermore, the Investment Company Act contains income tax regulation for investment companies. Investment companies are generally exempt from paying federal income tax on net income and realized gains, as long as these are redistributed to the shareholders. The investment objectives of a specific fund are stated in the fund's prospectus, disclosing information about the fund and its fund managers.

An important regulation valid for all countries is the rule that mutual funds, i.e. open-end funds that issue redeemable securities, must be prepared to redeem shares daily and repay redeeming shareholders within seven days after receiving a redemption request. This means a need for liquidity on the one hand and a need for exact calculation of the NAV on the other (ICI 2009).

The mutual funds industry has experienced a strong growth in the past years with total funds amounting to $12.2 trillion at year-end 2009 (ICI 2010). The performance of mutual funds is strongly correlated with the performance of the underlying assets. Net flows to equity funds generally tend to rise with stock prices. Similar to equity funds, demand and performance of fixed-income funds show a strong correlation with bond performance and, accordingly, the US yield curve. Due to the good performance of corporate bonds in 2009 and the low short term interest rates that provoked a shift of investor demand away from money market funds towards bond funds, mutual funds achieved a record net inflow of $376 billion in 2009. Several academic studies over an extended time horizon dealing with the performance of mutual funds come to the result that mutual funds can rarely generate an excess risk-adjusted return (Jensen (1967); Malkiel (1995); Gruber (1996) and Nitzsche et al. (2008)).

Table 3.5: Portfolio allocation of mutual funds, 2009 OECD survey

Mutual funds	USA	UK	Germany
Currency and deposits	6.3%	3.5%	11.0%
Securities	43.0%	26.3%	52.4%
Loans	6.7%	0.0%	0.2%
Shares	44.0%	70.1%	36.4%
Shares issued by residents		*36.6%*	*18.9%*
Shares issued by non residents		*33.5%*	*17.4%*
Total	100.0%	100.0%	100.0%

In order to consider the allocation of “other” we relocate its share to the remaining asset classes according to the portfolio allocation for all institutional investors.

3.3.4 Sample characterization

For simulation purposes we conduct the data gathering by using major indices and weight them according to the portfolio allocation. The data source is Thomson Reuters Datastream. We argue that the usage of market indices is justified since academics found that institutional investors prefer to invest in large cap assets (Gompers and Metrick 2001). Historically, large cap assets have a strong correlation with the major index and determine its performance (Banz 1981). Exemplarily, the S&P 500 refers to the US domestic equity position.

We analyze portfolio performance of institutional investors and examine aggregated average portfolios for each institutional investor. In order to prevent bias from economic booms and downturns we consider a time horizon from 06/1992-06/2011. We retrieve monthly data and upscale them to yearly risk-return statistics. We take total return prices into account that include stock splits, dividend payments, etc. The following list illustrates the indices and provides risk and return characteristics over the time period 06/1992-06/2011. We take the securitization index for countries and consider denomination in local currency.

Table 3.6: Index-base positions with Datastream code

Asset class	Country	Indices (Code)	Return p.a. 06/1992-06/2010	Volatility p.a. 06/1992-06/2010
Shares	Germany	DAX 30 PERFORMANCE - DAXINDX(RI)	10.4%	21.7%
	UK	FTSE 100 - FTSE100(RI)	9.2%	15.3%
	USA	S&P 500 COMPOSITE - S&PCOMP(RI)	9.2%	15.6%
	Foreign	MSCI WORLD U$ - MSWRLD$(RI)	8.2%	15.9%
Securities	Germany	REX GENERAL BOND - REXINDX(RI)	6.2%	3.5%
	UK	BOFA ML UK GILTS 10+Y (£) - MLUK10£(RI)	8.4%	8.6%
	USA	JPM UNITED STATES GOVT.BOND US$ - JPMUSU$(RI)	6.2%	4.8%
Loans	Germany	BOFA ML US CRP/GVT 10+Y (E) - MLGCTPE(RI)	7.8%	12.0%
	UK	BOFA ML US CRP/GVT 1-10Y (£) - MLUG1T£(RI)	7.1%	9.9%
	USA	BOFA ML CORP & GVT. MSTR ($) - MLCORGM(RI)	6.3%	4.4%
Currency and Deposits	Germany	JPM GERMANY CASH 6M - JPBD6ML(RI)	4.1%	0.6%
	UK	JPM UK CASH 6M - JPUK6ML(RI)	5.5%	0.8%
	USA	JPM US CASH 6M - JPUS6ML(RI)	4.2%	0.7%
Securitization	Germany	BOFA ML US ABS HM EQTY LOANS(E) - MLAHELE(RI)	4.7%	11.3%
	UK	BOFA ML US ABS HM EQTY LOANS(£) - MLAHEL£(RI)	5.8%	10.3%
	USA	BOFA ML US ABS HM EQTY LOANS($) - MLASHEL(RI)	4.6%	5.0%

3.3.5 Methodology

We apply mean-variance efficient portfolios with optimal risk and return characteristics. We calculate the expected return for each institutional investor with the actual portfolio allocation and under constraints.

As constraints we take the portfolio allocation as derived in the data section and permit flexible shifts of -10% or +10% per asset. Furthermore, the minimum asset allocation is set equal to zero meaning that we do not consider short selling of portfolio positions. The maximum asset allocation is restricted to the maximum share as outlined in the investment charters. Our objective is to

determine the risk-adjusted return of the portfolio. The optimization process is divided as follows and presented in the output tables:

- Optimized portfolio with actual asset allocation
- Optimized portfolio with flexible asset allocation, *no securitization*
- Optimized portfolio with flexible asset allocation, *with securitization*

We maximize the risk-return statistics derived from the Sharpe Ratio that determines where the tangency line hits the efficient portfolio:

$$Sharpe\ Ratio_p = \frac{E(r_p) - r_{free}}{\sigma_p}$$

Where $E(r_p)$ is the expected return, σ_p is the volatility of the portfolio and r_{free} is the risk-free return rate. $E(r_p)$ is calculated by the average of the returns r_i on the investments in the portfolio given the portfolio weights x_i.

$$E(r_p) = \sum_i x_i r_i$$

We first calculate the variance of the portfolio and then derive the volatility. The variance of the portfolio is equal to the sum of the covariances of the returns r_i and r_j of all pairs in the portfolio multiplied by the portfolio weights x_i and x_j.

$$\sigma_p{}^2 = \sum_i \sum_j x_i\, x_j\, Cov(r_i, r_j)$$

And so the volatility is:

$$\sigma_p = \sqrt{\sigma_p{}^2}$$

The optimal portfolio allocation is subject to the constraints from the investment charters. We allow shifts in the portfolio of -10% and +10% for each asset in order to permit flexibility:

$$0 \leq [x_i - 10\%; x_i + 10\%] \leq restriction\ from\ investment\ charters$$

The limitation in portfolio shifts is justified since only small deviations in the share of each portfolio position is observed as presented in the historical portfolio allocation over a time period of 20 years.

In addition to the determination of the portfolio return and volatility, we calculate more sophisticated risk indicators. The Value-at-Risk (VaR) is a measurement of the maximum portfolio loss at a given probability and a certain holding period. The VaR is an established risk measurement indicator in the financial industry according to Berkowitz and O'Brien (2002) and Pérignon et al. (2008). We consider the maximum portfolio loss in a holding period of one year (252 trading days) with a probability of 99%. In other words, the VaR assumes that losses beyond the VaR occur at a probability of 1%.

There are basically three approaches to calculate the VaR (Linsmeier and Pearson 2000). The historical simulation is a non-parametric approach that calculates the VaR from past records. It is easy to implement but has shortcomings since it does not assume any distribution. Pérignon and Smith (2010) find that it is the most popular VaR approach of commercial banks but with little information about future volatility. The variance-covariance approach assumes normal distribution whereas the Monte Carlo Simulation is a stochastic approach in order to estimate a VaR. It generates random numbers that are transformed to price changes even in case of non-linearity.

The VaR from the Monte Carlo Simulation describes that the periodic return on a continuously compounded frequency is approximately normally distributed and the price levels are therefore log normally distributed:

$$ln\left(\frac{S_t}{S_{t-1}}\right) \sim \phi\left[\left(\mu - \frac{\sigma^2}{2}\right) * T, \sigma\sqrt{T}\right]$$

where T is scaled from monthly to yearly numbers. We conclude that there is a log normal diffusion process and set up the link to the Geometric Brownian Motion (GBM) that takes a deterministic and stochastic part into account. We run 5000 simulations to derive the Monte Carlo VaR.

$$ln\left(\frac{S_t}{S_{t-1}}\right) = \alpha + z_t\sigma$$

With α as the deterministic and z_t as the stochastic part. α is calculated by the expected return from our observation and z_t is the random shock scaled by the volatility. So the price change is.

$$\left(\frac{S_t}{S_{t-1}}\right) = e^{\alpha + z_t\sigma}$$

Additionally, we analyze the portfolio performance by calculating the outperformance of the portfolio in comparison to the market with commonly applied performance measures:

CAPM measures the market outperformance of the portfolio and sensitivity in the form (Sharpe 1964):

$$R_p - R_f = \alpha + \beta_1\left(R_m - R_f\right) + \varepsilon$$

Three factor model of Fama and French (1993) measures the outperformance with a size (small minus big) and value (high minus low) factor in the form:

$$R_p - R_f = \alpha + \beta_1(R_m - R_f) + \beta_2 SMB + \beta_3 HML + \varepsilon$$

The four factor model of Carhart (1997) adds a momentum factor (winner minus loser) in the form:

$$R_p - R_f = \alpha + \beta_1(R_m - R_f) + \beta_2 SMB + \beta_3 HML + \beta_4 WML + \varepsilon$$

The momentum factor signals the herding effect to some extent. The multi factor models are supposed to improve the explanatory power R^2 of the CAPM.

3.4 Results

3.4.1 Portfolio allocation Life insurers

The results table for life insurers highlights that securitization has been beneficial prior to the financial crisis for US and UK life insurers with 10% and 6.8%, respectively. In contrary, German life insurers could not benefit from securitization. Furthermore, the risk-adjusted portfolio return is higher for US and UK life insurers suggesting that the prudent person rule is superior to quantitative portfolio restrictions. Nonetheless, the prudent person rule has higher risk characteristics in terms of volatility and Monte Carlo VaR.

The motivation of this study is to explain the rapid decline of securitization in the aftermath of the financial crisis. When considering the time period 1992-2011, there is no additional value from including securitization in the portfolio of life insurers. The share of securitization for US life insurers has dropped from 10% to 0%. As US life insurers invested a significant amount in securitization, the forced selling is one of the reasons of the intense decline. Interestingly, the share of securitization for UK life insurers is still above 0% despite of the financial crisis.

Table 3.7: Portfolio allocation life insurers, 1992-2006

Life insurers 1992-2006	USA			UK			Germany		
Asset allocation	Actual	Opt. w/o sec	Opt. w/ sec	Actual	Opt. w/o sec	Opt. w/ sec	Actual	Opt. w/o sec	Opt. w/ sec
Currency and deposits	1.1%	11.0%	10.2%	6.5%	16.5%	16.5%	40.0%	31.2%	31.2%
Securities	56.7%	46.7%	46.7%	52.7%	58.7%	54.0%	10.2%	20.2%	20.2%
Loans	10.7%	20.0%	11.3%	2.1%	1.5%	0.0%	19.0%	22.3%	22.3%
Shares	31.5%	22.4%	21.9%	38.8%	23.3%	22.8%	30.8%	26.3%	26.3%
Shares issued by residents				22.4%	12.4%	12.4%			
Shares issued by non residents				16.4%	10.9%	10.4%			
Securitization			10.0%			6.8%			0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Return	7.6%	7.0%	7.0%	9.3%	8.9%	8.8%	7.5%	7.4%	7.4%
Risk	5.1%	4.2%	4.0%	7.2%	6.1%	5.9%	7.5%	6.2%	6.2%
VaR	8.3%	7.8%	7.7%	8.4%	8.2%	7.9%	9.9%	7.0%	7.0%
Sharpe Ratio	0.60	0.60	0.62	0.67	0.73	0.73	0.40	0.47	0.47

Table 3.8: Portfolio allocation life insurers, 1992-2011

Life insurers 1992-2011	USA			UK			Germany		
Asset allocation	Actual	Opt. w/o sec	Opt. w/ sec	Actual	Opt. w/o sec	Opt. w/ sec	Actual	Opt. w/o sec	Opt. w/ sec
Currency and deposits	1.1%	0.2%	0.2%	6.5%	11.5%	11.5%	40.0%	35.2%	35.2%
Securities	56.7%	59.0%	59.1%	52.7%	52.7%	52.1%	10.2%	15.2%	15.2%
Loans	10.7%	14.3%	14.1%	2.1%	7.1%	7.1%	19.0%	23.8%	23.8%
Shares	31.5%	26.5%	26.5%	38.8%	28.8%	28.8%	30.8%	25.8%	25.8%
Shares issued by residents				*22.4%*	*17.4%*	*17.4%*			
Shares issued by non residents				*16.4%*	*11.4%*	*11.4%*			
Securitization			0.0%			0.6%			0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Return	7.1%	7.0%	7.0%	8.3%	8.1%	8.1%	6.9%	6.9%	6.9%
Risk	5.6%	5.1%	5.1%	7.7%	6.7%	6.7%	7.1%	6.4%	6.4%
VaR	9.8%	8.9%	8.9%	9.5%	7.4%	7.4%	9.7%	8.0%	8.0%
Sharpe Ratio	0.56	0.59	0.59	0.57	0.61	0.61	0.41	0.45	0.45

3.4.2 Portfolio allocation Pension funds

As US and UK pension funds are exposed to the prudential person rule while German pension funds rather to quantitative portfolio restrictions, the results support the findings as presented for life insurers. Securitization is beneficial for US and UK pension funds prior to the financial crisis with 10% and 6.5%, respectively. When including the financial crisis, only UK pension funds can benefit from securitization to a little extent.

An interesting finding is that the share of securities, primarily government bonds, is significantly higher when including the financial crisis. This outcome is intuitive since in times of stress the investor should be more risk averse with more investments in large and liquid assets.

Despite having higher levels of volatility, the return statistics of US and UK pension compensate the higher level of risk in terms of risk-adjusted returns. However, due to higher volatility, the risk-adjusted returns are lower than for life insurers.

Table 3.9: Portfolio allocation pension funds, 1992-2006

Pension funds 1992-2006	USA			UK			Germany		
Asset allocation	Actual	Opt. w/o sec	Opt. w/ sec	Actual	Opt. w/o sec	Opt. w/ sec	Actual	Opt. w/o sec	Opt. w/ sec
Currency and deposits	1.2%	0.1%	0.2%	6.2%	16.2%	16.2%	44.7%	35.0%	35.0%
Securities	34.3%	35.9%	26.5%	46.0%	54.9%	49.8%	9.9%	19.9%	19.9%
Loans	0.9%	10.4%	9.7%	0.3%	1.3%	0.0%	8.5%	18.2%	18.2%
Shares	63.6%	53.6%	53.7%	47.5%	27.5%	27.5%	37.0%	27.0%	27.0%
Shares issued by residents				*20.4%*	*10.4%*	*10.4%*			
Shares issued by non residents				*27.1%*	*17.1%*	*17.1%*			
Securitization			10.0%			6.5%			0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Return	8.9%	8.5%	8.5%	9.3%	8.9%	8.8%	7.4%	7.4%	7.4%
Risk	8.5%	7.3%	7.3%	7.6%	6.1%	5.9%	8.3%	6.7%	6.7%
VaR	10.8%	8.5%	8.4%	8.2%	7.2%	7.2%	11.8%	8.2%	8.2%
Sharpe Ratio	0.52	0.55	0.55	0.64	0.73	0.73	0.35	0.43	0.43

Table 3.10: Portfolio allocation pension funds, 1992-2011

Pension funds 1992-2011	USA			UK			Germany		
Asset allocation	Actual	Opt. w/o sec	Opt. w/ sec	Actual	Opt. w/o sec	Opt. w/ sec	Actual	Opt. w/o sec	Opt. w/ sec
Currency and deposits	1.2%	0.2%	0.2%	6.2%	11.2%	11.0%	44.7%	39.8%	39.8%
Securities	34.3%	36.7%	36.7%	46.0%	46.0%	46.0%	9.9%	14.9%	14.9%
Loans	0.9%	4.5%	4.5%	0.3%	5.3%	5.3%	8.5%	13.4%	13.4%
Shares	63.6%	58.6%	58.6%	47.5%	37.5%	37.5%	37.0%	32.0%	32.0%
Shares issued by residents				*20.4%*	*15.4%*	*15.4%*			
Shares issued by non residents				*27.1%*	*22.1%*	*22.1%*			
Securitization			0.0%			0.3%			0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Return	8.1%	8.0%	8.0%	8.3%	8.1%	8.1%	6.9%	6.9%	6.9%
Risk	9.8%	9.1%	9.1%	8.3%	7.1%	7.1%	8.1%	7.1%	7.1%
VaR	14.8%	13.2%	13.2%	11.0%	8.5%	8.5%	11.8%	9.7%	9.7%
Sharpe Ratio	0.42	0.44	0.44	0.52	0.58	0.58	0.36	0.41	0.41

3.4.3 Portfolio allocation Mutual funds

Due to the great variety of mutual funds, the classification into prudent person rule or quantitative portfolio restrictions does not apply in this analysis. The findings for life insurers and pension funds are supported in the sense that US mutual funds could benefit from securitization prior to the financial crisis. Here, German mutual funds benefit from securitization both prior to the financial crisis and over the time period 1992-2011.

Putting together, the strong decline of securitization in the aftermath of the financial crisis is caused by the forced selling of institutional investors, primarily from US and UK. Institutional investors consider long term stable assets as preferred investments. The strong decline of securitization in the wake of the financial crisis resulted in volatile performance and expulsion from the portfolio of institutional investors.

Table 3.11: Portfolio allocation mutual funds, 1992-2006

Mutual funds 1992-2006	USA			UK			Germany		
Asset allocation	Actual	Opt. w/o sec	Opt. w/ sec	Actual	Opt. w/o sec	Opt. w/ sec	Actual	Opt. w/o sec	Opt. w/ sec
Currency and deposits	6.3%	1.2%	1.0%	3.5%	13.5%	13.5%	11.0%	20.6%	20.1%
Securities	43.0%	48.1%	38.3%	26.3%	35.9%	35.8%	52.4%	62.4%	62.4%
Loans	6.7%	16.7%	16.7%	0.0%	0.5%	0.0%	0.2%	0.6%	0.4%
Shares	44.0%	34.0%	34.0%	70.1%	50.2%		36.4%	16.4%	16.4%
Shares issued by residents				*36.6%*	*26.7%*	*26.6%*	*18.9%*	*8.9%*	*8.9%*
Shares issued by non residents				*33.5%*	*23.5%*	*23.5%*	*17.4%*	*7.4%*	*7.4%*
Securitization			10.0%			0.6%			0.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Return	8.0%	7.7%	7.7%	9.6%	9.2%	9.1%	7.7%	6.8%	6.8%
Risk	6.2%	5.3%	5.2%	9.6%	7.5%	7.5%	6.0%	3.3%	3.3%
VaR	11.9%	11.7%	11.4%	12.7%	10.3%	10.3%	11.3%	10.9%	10.9%
Sharpe Ratio	0.55	0.58	0.59	0.52	0.61	0.61	0.51	0.66	0.66

Table 3.12: Portfolio allocation mutual funds, 1992-2011

Mutual funds 1992-2011	USA			UK			Germany		
Asset allocation	Actual	Opt. w/o sec	Opt. w/ sec	Actual	Opt. w/o sec	Opt. w/ sec	Actual	Opt. w/o sec	Opt. w/ sec
Currency and deposits	6.3%	1.5%	1.8%	3.5%	3.6%	3.6%	11.0%	11.3%	10.5%
Securities	43.0%	47.9%	48.0%	26.3%	31.3%	31.3%	52.4%	57.4%	57.4%
Loans	6.7%	11.5%	11.2%	0.0%	5.0%	5.0%	0.2%	4.8%	4.9%
Shares	44.0%	39.1%	39.1%	70.1%	60.1%	60.1%	36.4%	26.4%	26.5%
Shares issued by residents				*36.6%*	*31.6%*	*31.6%*	*18.9%*	*14.0%*	*13.9%*
Shares issued by non residents				*33.5%*	*28.5%*	*28.5%*	*17.4%*	*12.5%*	*12.6%*
Securitization			0.0%			0.0%			0.6%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Return	7.4%	7.4%	7.4%	8.5%	8.4%	8.4%	7.1%	6.8%	6.9%
Risk	7.0%	6.4%	6.4%	10.8%	9.5%	9.5%	6.3%	4.8%	4.8%
VaR	14.9%	13.6%	12.6%	16.5%	13.7%	13.7%	12.6%	11.3%	11.3%
Sharpe Ratio	0.49	0.52	0.52	0.42	0.47	0.47	0.49	0.59	0.59

3.4.4 Portfolio performance of life insurers

We investigate the outperformance skills of life insurers and differentiate between pre crisis, crisis and a post crisis period. Literature suggests mixed evidence that institutional investors are capable of outperforming the market. More concretely, it is of interest whether institutional investors are capable of outperforming the market in times as stress so that the “safe haven” assumption is emphasized. Applying CAPM and the multi-factor models of Fama French and Carhart, we detect that US life insurers outperform the market with a significant alpha. As presented, US life insurers could improve their risk-adjusted return prior to the financial crisis with securitization. Since the share of securitization vanished after the outbreak of the financial crisis, US and UK life insurers are still capable of achieving an alpha in relation to the market. This means that the immediate shift in the portfolio allocation is essential in order to achieve outperformance returns. We do not discover significant outperformance skills for German life insurers.

Furthermore, the results show that the multi factor models have higher explanatory power than the CAPM. Interesting is the fact that the size factor in the multi factor model is significantly negative. This emphasizes that in volatile markets institutional investors prefer investments in larger firms. The momentum effect does not deliver significant findings implying that there comes no benefit from herding and feedback trading.

Summarizing the results for life insurers, the prudent person rule delivers higher risk-adjusted returns than the quantitative portfolio restriction approach. Life insurers show indications of outperformance skills but not at high significance levels.

Table 3.13: Portfolio performance life insurers, pre crisis

Life insurances, 1992-2006

CAPM

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	2.01%**	3.38%	3.15%**	4.00%	1.44%	37.5%
R_m-R_f	0.26 ***	0.00%	0.29***	0.00%	0.29***	0.0%
R^2	48.9%		52.7%		50.3%	

Fama French 3 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	2.17%**	2.12%	4.02%***	0.96%	2.50%	12.98%
R_m-R_f	0.27***	0.00%	0.25***	0.00%	0.25***	0.0%
SMB	-0.10***	0.01%	-0.23***	0.00%	-0.22***	0.01%
HML	-0.01	72.6%	-0.06	20.9%	-0.08	11.9%
R^2	53.4%		58.8%		65.6%	

Carhart 4 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.94%**	4.37%	4.03%**	1.39%	3.32%*	5.55%
R_m-R_f	0.27***	0.00%	0.25***	0.00%	0.24***	0.00%
SMB	-0.10***	0.00%	-0.23***	0.00%	-0.21***	0.03%
HML	0.00	84.8%	-0.06	21.4%	-0.10*	7.5%
WML	0.02	24.4%	0.00	98.2%	-0.05	13.1%
R^2	53.5%		58.5%		66.1%	

Table 3.14: Portfolio performance life insurers, crisis

Life insurances, 1992-2008

CAPM

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	2.23%**	1.45%	2.93%**	4.42%	1.43%	35.3%
R_m-R_f	0.25***	0.00%	0.28***	0.00%	0.28***	0.0%
R^2	49.5%		51.6%		49.8%	

Fama French 3 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	2.34%***	0.96%	3.60%**	1.40%	2.23%	15.05%
R_m-R_f	0.27***	0.00%	0.25***	0.00%	0.25***	0.0%
SMB	-0.09***	0.02%	-0.22***	0.00%	-0.21***	0.01%
HML	-0.01	80.9%	-0.06	22.3%	-0.08	14.6%
R^2	62.7%		68.0%		65.1%	

Carhart 4 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	2.32%**	1.23%	3.64%**	1.91%	3.12%*	5.74%
R_m-R_f	0.27***	0.00%	0.25***	0.00%	0.24***	0.00%
SMB	-0.09***	0.03%	-0.22***	0.00%	-0.20***	0.02%
HML	-0.01	82.6%	-0.06	22.6%	-0.09*	8.8%
WML	0.00	92.4%	0.00	93.6%	-0.05	10.1%
R^2	62.5%		67.6%		65.7%	

Table 3.15: Portfolio performance life insurers, post crisis

Life insurances, 1992-2011

CAPM

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	2.17%**	1.38%	3.22%**	1.86%	2.12%	12.2%
R_m-R_f	0.27***	0.00%	0.28***	0.00%	0.23***	0.0%
R^2	52.6%		49.7%		49.9%	

Fama French 3 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	2.28%***	0.81%	3.50%***	0.91%	2.05%	3.51%
R_m-R_f	0.28***	0.00%	0.27***	0.00%	0.22***	0.00%
SMB	-0.10***	0.00%	-0.22***	0.00%	-0.23***	0.00%
HML	0.00	82.7%	-0.03	51.2%	-0.09	3.4%
R^2	56.1%		54.6%		56.9%	

Carhart 4 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	2.23%**	1.07%	3.74%***	0.80%	2.08%***	0.62%
R_m-R_f	0.28***	0.00%	0.26***	0.00%	0.20***	0.00%
SMB	-0.10***	0.01%	-0.22***	0.00%	-0.22***	0.00%
HML	0.01	77.4%	-0.04	44.3%	-0.12***	0.9%
WML	0.01	71.4%	-0.02	56.8%	-0.06**	1.8%
R^2	55.9%		54.4%		58.2%	

3.4.5 Portfolio performance of pension funds

The outperformance skills of UK pension funds are in all three performance measures statistically significant. In contrary, there are signs of outperformance skills for US and German pension funds but not at high significance levels. In line with the findings for life insurers, the size factor in the multifactor models is significant with a negative sign whereas the growth and momentum factors are insignificant.

Putting together, there is more evidence of outperformance skills for life insurers than for pension funds. Especially in the time period 1992-2008, the intercept of life insurers is higher than for pension funds.

Table 3.16: Portfolio performance pension funds, pre crisis

Pension funds, 1992-2006

CAPM

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.27%	19.7%	2.60%*	7.1%	0.71%	66.2%
R_m-R_f	0.55***	0.00%	0.36***	0.00%	0.37***	0.00%
R^2	69.9%		66.4%		61.8%	

Fama French 3 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.71%*	6.9%	3.58%**	1.3%	1.89%	25.5%
R_m-R_f	0.55***	0.00%	0.32***	0.00%	0.34***	0.00%
SMB	-0.14***	0.00%	-0.23***	0.00%	-0.22***	0.01%
HML	-0.03	19.1%	-0.07	11.4%	-0.10*	7.7%
R^2	73.1%		72.2%		66.3%	

Carhart 4 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.86%*	5.4%	3.71%**	1.5%	2.97%*	8.8%
R_m-R_f	0.55***	0.00%	0.32***	0.00%	0.33***	0.00%
SMB	-0.13***	0.00%	-0.23***	0.00%	-0.20***	0.03%
HML	-0.03	16.4%	-0.08	11.0%	-0.11*	3.9%
WML	-0.01	45.3%	-0.01	78.1%	-0.07*	5.0%
R^2	73.0%		72.0%		67.2%	

Table 3.17: Portfolio performance pension funds, crisis

Pension funds, 1992-2008

CAPM

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.25%	18.9%	2.40%*	7.9%	0.82%	59.8%
R_m-R_f	0.54***	0.00%	0.35***	0.00%	0.37***	0.00%
R^2	59.1%		55.6%		51.8%	

Fama French 3 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.57%*	8.2%	3.15%**	2.0%	1.74%	26.7%
R_m-R_f	0.55***	0.00%	0.32***	0.00%	0.33***	0.00%
SMB	-0.14***	0.00%	-0.22***	0.00%	-0.22***	0.01%
HML	-0.03	19.9%	-0.07	12.8%	-0.09*	9.4%
R^2	72.5%		71.7%		66.3%	

Carhart 4 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.75%*	5.8%	3.32%**	2.2%	2.88%*	8.1%
R_m-R_f	0.55***	0.00%	0.32***	0.00%	0.32***	0.00%
SMB	-0.13***	0.00%	-0.22***	0.00%	-0.20***	0.02%
HML	-0.03	16.3%	-0.07	12.0%	-0.11**	4.5%
WML	-0.01	37.7%	-0.01	73.0%	-0.07**	3.7%
R^2	72.4%		71.4%		67.2%	

Table 3.18: Portfolio performance pension funds, post crisis

Pension funds, 1992-2011

CAPM

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.00%	33.3%	2.65%**	4.0%	1.50%	28.0%
R_m-R_f	0.57***	0.00%	0.36***	0.00%	0.31***	0.00%
R^2	58.8%		54.5%		53.2%	

Fama French 3 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.12%	26.5%	2.96%**	1.8%	2.25%*	9.5%
R_m-R_f	0.60***	0.00%	0.34***	0.00%	0.30***	0.00%
SMB	-0.12***	0.00%	-0.23***	0.00%	-0.24***	0.00%
HML	0.01	67.8%	-0.03	41.3%	-0.10**	2.3%
R^2	70.7%		69.0%		69.4%	

Carhart 4 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.36%	18.1%	3.30%**	1.2%	2.06%**	1.6%
R_m-R_f	0.59***	0.00%	0.34***	0.00%	0.28***	0.00%
SMB	-0.11***	0.01%	-0.23***	0.00%	-0.24***	0.00%
HML	0.00	90.6%	-0.04	32.2%	-0.13***	0.5%
WML	-0.02	14.8%	-0.02	39.4%	-0.07***	0.8%
R^2	70.8%		68.9%		70.7%	

3.4.6 Portfolio performance of mutual funds

Academic studies have research the outperformance skills of mutual fund managers (Jensen (1967); Malkiel (1995); Gruber (1996) and Nitzsche et al. (2008)). Our results are in line with the findings of the relevant research that indications of outperformance skills are present but not highly significant. Nonetheless, we discover that US mutual funds have the highest outperformance skills since test statistics are significant in all three observations. Vice versa, UK mutual funds show the lowest outperformance test statistics.

The assumption in the multi factor models that small firms perform better than big firms is not supported in our analysis. The size coefficient is negative for all institutional investors and in line with the results for life insurers and pension funds. The growth and momentum effect are of no significance in our analysis.

Summarizing the performance of institutional investor, there is to some extent support for the “safe haven” theory of institutional investors in times of stress.

Table 3.19: Portfolio performance mutual funds, pre crisis

Mutual funds, 1992-2006

CAPM

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.62%*	6.62%	1.58%	31.6%	1.35%	18.0%
R_m-R_f	0.37***	0.00%	0.51***	0.00%	0.32***	0.00%
R^2	69.7%		59.5%		58.7%	

Fama French 3 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.89%**	2.73%	2.94%*	5.6%	2.18%**	2.8%
R_m-R_f	0.38***	0.00%	0.47***	0.00%	0.29***	0.00%
SMB	-0.11***	0.00%	-0.30***	0.00%	-0.17***	0.00%
HML	-0.02	40.8%	-0.11**	3.6%	-0.07**	4.3%
R^2	73.6%		66.0%		64.3%	

Carhart 4 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.84%**	3.62%	3.32%**	4.05%	2.73%***	0.88%
R_m-R_f	0.38***	0.00%	0.46***	0.00%	0.29***	0.00%
SMB	-0.11***	0.00%	-0.29***	0.00%	-0.17***	0.00%
HML	-0.02	43.6%	-0.11**	2.9%	-0.07**	2.3%
WML	0.00	77.4%	-0.02	45.2%	-0.03	8.9%
R^2	73.5%		65.9%		64.6%	

Table 3.20: Portfolio performance mutual funds, crisis

Mutual funds, 1992-2008

CAPM

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.64%*	5.30%	1.40%	35.3%	1.30%	17.6%
R_m-R_f	0.37***	0.00%	0.51***	0.00%	0.32***	0.00%
R^2	68.8%		59.1%		58.0%	

Fama French 3 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.85%	2.27%	2.42%*	9.5%	1.95%**	3.7%
R_m-R_f	0.38***	0.00%	0.46***	0.00%	0.29***	0.00%
SMB	-0.11***	0.00%	-0.29***	0.00%	-0.17***	0.00%
HML	-0.02	34.9%	-0.10*	5.1%	-0.06*	5.1%
R^2	73.0%		65.7%		63.9%	

Carhart 4 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.83%**	2.91%	2.84%*	6.53%	2.55%***	0.99%
R_m-R_f	0.38***	0.00%	0.46***	0.00%	0.28***	0.00%
SMB	-0.11***	0.00%	-0.29***	0.00%	-0.17***	0.00%
HML	-0.02	36.7%	-0.10**	4.0%	-0.07**	2.5%
WML	0.00	87.9%	-0.02	41.2%	-0.04**	6.5%
R^2	72.8%		65.6%		64.3%	

Table 3.21: Portfolio performance mutual funds, post crisis

Mutual funds, 1992-2011

CAPM

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.59%*	6.66%	1.71%	22.7%	1.82%**	4.3%
R_m-R_f	0.39***	0.00%	0.51***	0.00%	0.29***	0.00%
R^2	65.9%		67.2%		61.3%	

Fama French 3 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.70%**	4.33%	2.15%	11.0%	2.31%***	0.6%
R_m-R_f	0.41***	0.00%	0.50***	0.00%	0.28***	0.00%
SMB	-0.10***	0.00%	-0.29***	0.00%	-0.19***	0.00%
HML	0.01	73.9%	-0.05	25.4%	-0.07**	2.1%
R^2	73.5%		71.8%		67.4%	

Carhart 4 Factor Model

	USA		UK		Germany	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.78%**	3.70%	2.75%*	5.12%	2.90%***	0.06%
R_m-R_f	0.40***	0.00%	0.49***	0.00%	0.27***	0.00%
SMB	-0.10***	0.00%	-0.29***	0.00%	-0.19***	0.00%
HML	0.00	83.4%	-0.07	15.2%	-0.08***	0.4%
WML	-0.01	55.6%	-0.04	16.0%	-0.05***	0.8%
R^2	73.4%		71.9%		68.3%	

3.5 Summary and conclusions

This research study investigates the performance of institutional investors. We first research the historical background of financial regulation and the investment charters of institutional investors. Investment charters are mandatory guidelines for large institutional investors with the objective to minimize risk. To this end, there is a tendency towards the prudent person rule for US and UK institutional investors and a quantitative portfolio restriction approach for German institutional investors. The results exhibit that the prudent person rule is superior to the quantitative portfolio restriction approach in terms of risk-adjusted returns.

In general, financial assets with a persisting and stable return profile serve as suitable investments for institutional investors. The decline of securitization during the financial crisis revealed that these do not optimize the portfolio structure of large institutional investors. This explains that the performance of securitization declined since institutional investors were forced to sell in order to achieve the targeted returns for their clients. The outperformance skills of institutional investors are a widely addressed research issue. We detect indications of outperformance skills but with no highly significant statistical evidence.

4 Valuation of Callable Bonds in the Financial Crisis[11]

The appropriateness of valuation models to price financial products is of high importance specifically in the presence of complex products and rather illiquid capital markets. Especially stress conditions put a severe challenge to the effectiveness of models. We enhance research by investigating the appropriateness of valuation models to determine the option premium in callable bonds.

Callable bonds recently experienced an increase in issuance. In the time period from 2005 to 2010, 9.5% of all issued corporate bonds in Germany possessed a call option.[12] The numbers for the US corporate bond market are even more striking with 58.8% possessing a call option in the same time period. This ratio even increased during the financial crisis. The numbers of callable bonds rose to 11.1% for German corporate bonds and 71.7% for US corporate bonds in the time period from July 2007 to March 2010.

We question the model-conform valuation of callable bonds and the circumstances where the early termination is more likely. A sign of growing uncertainty is related to the term structure of interest rates and thus makes the modeling of the term structure more challenging under stress. As investors and issuers are concerned about the term structure, flexibility becomes a key asset. Callable bonds permit the issuer to terminate a bond earlier than maturity at predefined call dates. In order to compensate the investor for the possible early redemption, an option premium is paid that stands for the price difference of the callable bond and the non-callable bond. By exercising the option, an issuer can - given a favorable market condition - terminate the bond and refinance at better

[11] I am grateful to Niko Hatziiosifidis for his contributions to this section when conducting the Bachelor Thesis "Bewertung kündbarer Anleihen – Eine empirische Untersuchung am deutschen Rentenmarkt" at the chair of Corporate Finance under my supervision.

[12] The aggregate number stands for bonds with a single-call or multi-call option. Numbers are taken from Thomson One Banker.

conditions. The timing of the termination is of interest in our analysis. We analyze callable bonds in a case study approach due to the constraints callable bonds are exposed to. We run the analysis applying the option premium pricing for single-callable bonds according to Black (1976) and for multi-callable bonds according to Ho and Lee (1986) and Bühler and Schulze (1993). For the determination of the discount function we use the spline approach of McCulloch (1971) and the extension in McCulloch (1975).

In general, the pricing of financial assets is of key importance in accounting and financial regulation. The mark-to-market approach is suitable in liquid markets where the fair value is equal to the market quote. It becomes more challenging to price financial assets in case of complex products and in less liquid markets. Complex products rely on specific assumptions that rather prevail in normal market conditions. These assumptions permit a pricing in a mark-to-model approach. During the financial crisis the pricing of complex assets was a concern for financial institutions and supervisory authorities. Persisting deviations from previous market prices can result in impairments on these assets that may affect the profit and loss accounts and finally the equity basis. The financial crisis revealed that a strong activity in complex assets could result in sizeable impairments and finally to an increase of systemic risk. In light of these concerns, regulators issued new legislation referring to fair value accounting in illiquid markets. Products, for instance illiquid structured finance products, were classified as Level 3 assets. The impairments on these Level 3 assets were given high priority in terms of cautious accounting rules. So, regulatory foresight may become necessary in order to prevent a systemic shock.

We examine the pricing of callable bonds as the determination of the embedded option under stress has not been research to the best of our knowledge. Acharya and Carpenter (2002) emphasize the complexity of embedded options in callable

bonds. Our findings highlight that the pricing of the fair option premium in callable bonds is challenging under stress since models signal prices that are not in line with the option premium in market quotes. Prior to the financial crisis, we do not detect significant deviations from the valuation model. This perception is challenged in the wake of the financial crisis. Surprisingly, the deviation of market quotes from the valuation model is not related to the bank failure of Lehman Brothers that ignited a contagion effect on the banking industry. We find, however, evidence that the government bailout is the driver of the mismatch between model-conform valuation and market quotes. We document a persisting deviation of the model-based option premium over a period of one year. Intuition suggests that deviations from model-conform valuation is more likely in times of stress. Additionally, we show that exercising the call option is more likely when the yield of the multi-callable bond is above the covered bonds yield curve.

4.1 Literature review

Academic research focuses on valuation principles preferably for equity where accounting and non-accounting figures serve as determinants to explain equity prices (Collins et al. (1997), Francis and Schipper (1999), Aggarwal et al. (2009), Balachandran and Mohanram (2011), and Zhang (2000)). In times of hypes and stress there is broad research about equity pricing (Core et al. (2003), Aharon et al. (2010), Kothari and Shanken (2003), Gavious and Schwartz (2011), Demers and Lev (2001) and Perkins and Perkins (1999).

However, academic studies referring to the option pricing in callable bonds are underrepresented. The option premium in a callable bond can be understood as a contingent claim in addition to a straight bond. The mispricing of contingent claims is analyzed by Longstaff et al. (2001) and Ibáñez and Paraskevopoulos (2010). Contingent claims in the context of callable bonds have been

investigated by Acharya and Carpenter (2002) in a stochastic interest rates environment. Nonetheless, we discover that valuing contingent claims under stress is underrepresented in the relevant literature.

4.2 Data

4.2.1 Dataset for Single-callable bonds

Due to the complexity of callable bonds and the specific requirements, we will process with a case study analysis of a single issuer. Especially bank bailouts would bias our findings if we had considered a broader sample. We found that callable bonds from Eurohypo, at that time a subsidiary of Commerzbank, fulfill the following constraints. At first, a homogenous market segment is needed where callable bonds are regular investments. Historically, the banking sector is a regular issuer of callable bonds. Other factors such as default risk, market liquidity, agency costs and taxation should have similar characteristics. There have to be sufficient prices of callable and non-callable bonds during the observation period. The option premium should only depend on the forward interest rate.

4.2.2 Dataset for Multi-callable bonds

Our data sample includes callable and non-callable bonds from Eurohypo in the observation period from January 2004 to September 2009 in order to include a pre-crisis and post-crisis period. The final sample consists of multi-callable bonds with 349 price observations. The face value is 100 Euro for all bonds and the notice period is between 1 and 10 bank days. The termination is only possible at one specific day for each call date.

4.3 Methodology

The analysis is processed as follows differentiating between single-callable and multi-callable bonds.

- Estimation of the discount functions at the beginning and the middle of each month from January 2005 to September 2010 for smooth discount functions.
- *Single-callable bonds:* estimation of the option premium with the model of Black (1976).
- *Multi-callable bonds:* estimation of the term structure movement according to the model of Ho and Lee (1986) and Bühler and Schulze (1993) and recursive evaluation of the option premium.

4.3.1 Discount function

The discount function is "the most fundamental curve describing the term structure of interest rates, the one from which all others must be derived" (McCulloch 1971). It describes the present value of 1 repayable in m years. In order to estimate the discount function, the following requirements have to be fulfilled:

- The present value at time 0 is unity
- The discount function is monotonically decreasing from 1 (=unity)
- There are only positive values
- The discount function is continuously differentiable

The estimation of the discount function is a long discussed research field. Practitioners use parametric and non-parametric approaches. Since all approaches are exposed to certain requirements and no approach is best under all circumstances, we select the non-parametric spline approach of McCulloch (1971). This decision is based on our given conditions with differing maturities and the number of bonds.

The approach of McCulloch (1971) infers a discount function from observed bond prices in the form:

$$P(T) = a_0 + \sum_{j=1}^{k} a_j f_j(T)$$

Based on the requirement that at point 0 the discount function is unity we conclude that $a_0 = 1$ and $f_j(0) = 0$.

$$P(T) = 1 + \sum_{j=1}^{k} a_j\, f_j(T)$$

Further on, the price of a bond with maturity T and coupon rate c is determined by the face value multiplied by the discount function at time T_0 and added by the accrued interests.

$$p = 100P(T_0) + c\int_0^{T_0} P(T)dT$$

After rearranging the formula, we can estimate an ordinary least square (OLS) regression in the form:

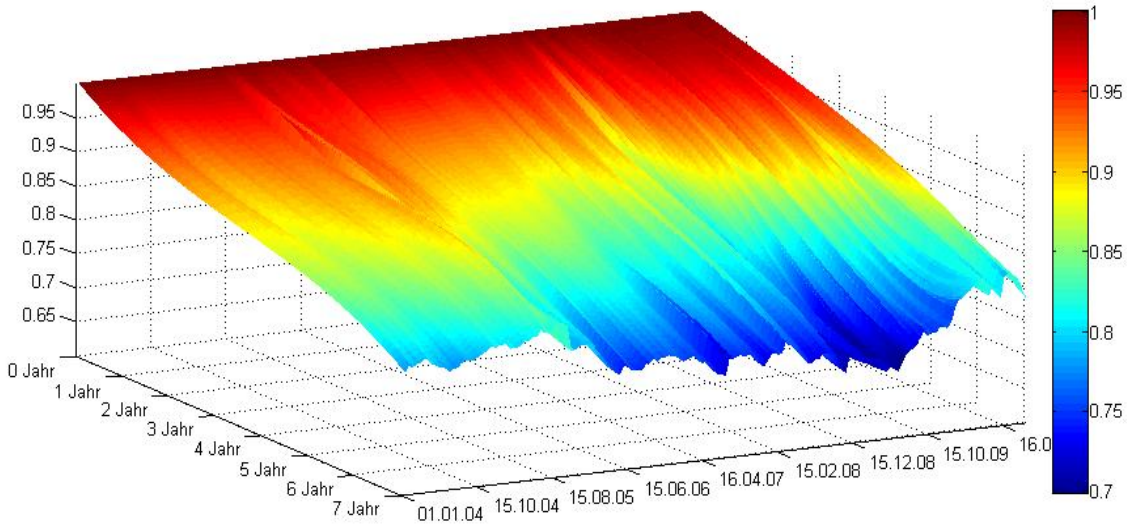
$$\hat{P}(T) = 1 + \sum_{j=1}^{k} \hat{a}_j\, f_j(T)$$

McCulloch (1975) extended the methodology for calculating $f_j(T)$ with cubic splines that has an improved explanatory power of the discount function. Given the discount functions, we get the yield curve $r(T)$ for maturity T.

$$r(T) = -\frac{1}{T}\ln\left(P(T)\right)$$

This can be understood as the internal rate of return of a zero-coupon bond with maturity T and permits a clear relation of the interest rate $r(T)$ and the discount function $P(T)$.

Figure 4.1: Discount function, 3 D plot



4.3.2 Methodology single-callable bonds

The model of Black (1976) is an extension of the option pricing model of Black and Scholes (1973). It allows the assessment of European options that are options with a single call date.

The model assumes the following model environment:

- The future bond price follows a Brownian bridge.
- Call date of an European option is at maturity.
- No transaction costs or taxes are in place.
- No risk-free arbitrage is possible.

Given the assumptions, the valuation model is presented by:

$$c = e^{-rT} * \left(F_T * N(d_1) - K * N(d_2)\right)$$

$$p = e^{-rT} * \left(K * N(-d_2) - F_T * N(-d_1)\right)$$

With

$$d_1 = \frac{\ln\left({F_T}/{K}\right) + \left(r + {\sigma_F}^2/2\right) * T}{\sigma_F\sqrt{T}}$$

$$d_2 = \frac{\ln\left({F_T}/{K}\right) + \left(r - {\sigma_F}^2/2\right) * T}{\sigma_F\sqrt{T}} = d_1 - \sigma_F\sqrt{T}$$

The variables c and p stand for the call and put prices and e^{-rT} is the discount with maturity T and interest rate r. The future price at time 0 with maturity T is presented by F_T and volatility σ_F. The strike price is K and $N(x)$ stands for the cumulative distribution function of a standard normal distribution function $\Phi(0,1)$ that is less than or equal to x.

- The payoff of a European call option with strike price K and future spot price B_T at maturity is:

$$\max\,(B_T - K; 0)$$

- The payoff of a European call option with the same strike price K und future price F_T at maturity is:

$$\max\,(F_T - K; 0)$$

- With decreasing maturity, spot price and future price converge. If spot price and future price possess the same maturity, then is F_T=S_T.

Hence, the model of Black (1976) permits the valuation of the future spot price for any asset. Applying this to the Black and Scholes (1973) model, we get the equations:

$$c = P(0,T) * \left(F_B * N(d_1) - K * N(d_2)\right)$$

$$p = P(0,T) * \left(K * N(-d_2) - F_B * N(-d_1)\right)$$

with:

$$d_1 = \frac{\ln\left({F_B}/{K}\right) + {\sigma_B}^2/2 * T}{\sigma_B\sqrt{T}}$$

$$d_2 = \frac{\ln\left({F_B}/{K}\right) - {\sigma_B}^2/2 * T}{\sigma_B\sqrt{T}} = d_1 - \sigma_B\sqrt{T}$$

Where $P(0,T)$ stands for the discount factor with maturity T and ${\sigma_B}^2$ is the variance of the forward price.

4.3.3 Methodology multi-callable bonds

4.3.3.1 Term structure movement in a two-state environment

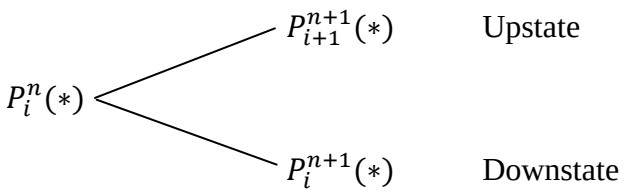
We determine the term structure with the model of Ho and Lee (1986) using the binomial lattice approach. The following assumptions referring to the term structure movements are valid in a perfect capital market within a discrete state-time framework:

- There is a frictionless market with no taxes or transaction costs and all securities are divisible.
- Discrete points in time exist where every period can be expressed as a time unit.
- Discount bonds exist for each maturity so that the bond market is complete.
- For every point in time there is a limited amount of states i. The discount function $P_{i=state}^{n=maturity}$ describes the term structure of interest rates of state i and time n.

As the discount function needs to be positive and has the value 1 at time 0 and 0 at the distant future, we get:

$$P_i^n(0) = 1 \text{ and } \lim_{T\to\infty} P_i^n(T) = 0 \text{ , for all i, n}$$

We extend the discount function with dynamic term structure movements. By convention, the discount function at initiation has state 0 and is $P_0^0(*)$. As the model of Ho and Lee (1986) considers two states, we get at time 1 either $P_0^1(*)$ or $P_1^1(*)$. We define $P_1^1(*)$ as an upstate, while $P_0^1(*)$ is defined as a downstate. When there is an upstate at time 1, we get $P_2^2(*)$ for an upstate at time 2 and $P_1^2(*)$ for a downstate, respectively. It is worth mentioning that the term structure is path-independent. This means that an upstate followed by a downstate is equal to a downstate followed by an upstate. The general form $P_i^n(*)$ describes the discount function at time n for the interval [n; n+1] with i upstate and n-i downstate movements.



Given the discount function P(T), we can derive the yield curve as a function of the term structure movement.

$$r(T) = -\frac{1}{T}\ln\left(P(T)\right)$$

The model suggests that we have great certainty at two extreme points. Certainty is great at the immediate future and at the distant future. Apart from this, uncertainty about the term structure is great. We introduce the perturbation

function for the term structure movement in order to obtain an arbitrage-free environment.

4.3.3.2 Perturbation functions h(T) and h*(T)

The discount function at the n-th period and state i is expressed as $P_i^n(T)$. In case there is no interest rate risk, the term structure has to be equal for an upstate and downstate and becomes the implied forward interest rate in an arbitrage-free environment.

$$F_i^n(T) = P_i^{n+1}(T) = P_{i+1}^{n+1}(T) = \frac{P_i^n(\mathrm{T}+1)}{P_i^n(1)}$$

When the discount function deviates from the implied forward function, we need to quantify the perturbation. We separate this with a perturbation for both the upstate $h(T)$ and the downstate $h^*(T)$.

$$P_i^n(\mathrm{T}) \begin{cases} P_{i+1}^{n+1}(\mathrm{T}) = \frac{P_i^n(\mathrm{T}+1)}{P_i^n(1)}\, h(T) & \text{Upstate (U)} \\ P_i^{n+1}(T) = \frac{P_i^n(\mathrm{T}+1)}{P_i^n(1)}\, h^*(T) & \text{Downstate (D)} \end{cases}$$

Based on the requirements for the discount function, the perturbation function is expressed as 1 for the immediate future.

$$h(0) = h^*(0) = 1$$

All we need in order to estimate the term structure is the initial discount function $P(T)$ and the perturbation function that can be defined as an implied binomial probability π in the form:

$$\pi\, h(T) + (1-\pi)h^*(T) = 1 \;\; \text{for n, i} > 0$$

So we include the implied binomial probability into a binomial option pricing model in accordance with Cox et al. (1979):

$$P_i^n(T) = [\pi\, P_{i+1}^{n+1}(T-1) + (1-\pi)\, P_i^{n+1}(T-1)]\, P_i^n(1)$$

Path-independency implies that a downstate followed by an upstate equals an upstate followed by a downstate:

$$h(T+1)h^*(T)h^*(1) = h^*(T+1)h(T)h(1)$$

Since $h^*(T)$ can be expressed as a function of $h(T)$, we simplify the equation and obtain:

$$h(1) = \frac{1}{\pi + (1-\pi)\delta}$$

where δ is some constant. The first-order linear difference equation $h(T)$ has a general solution in the form:

$$h(T) = \frac{1}{\pi\ +\ \mathrm{c}\,\delta^{\mathrm{T}}}$$

where c is some constant. As we know that at the immediate future $h(0) = 1$, we obtain the unique solution:

$$h(T) = \frac{1}{\pi\ +\ (1-\pi)\delta^{\mathrm{T}}}$$

We transform $h(T)$ to $h^*(T)$ and get:

$$h^*(T) = \frac{\delta^{\mathrm{T}}}{\pi\ +\ (1-\pi)\delta^{\mathrm{T}}}$$

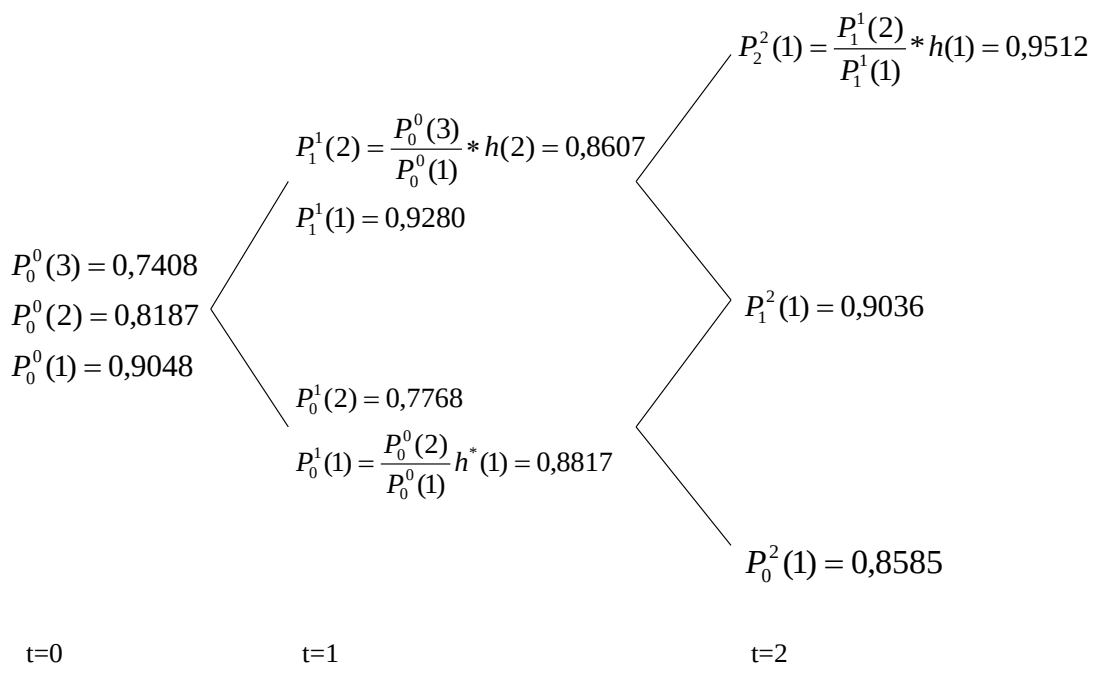
Knowing π and δ permits the determination of the arbitrage-free model of the term structure in a dynamic environment.

Exemplarily, we get the discount factors for the maturities T=0, 1, 2, 3. The binomial probability π is 0.5, the constant δ is 0.95 and $P_0^0(T) = e^{(-0,1*T)}$.

Table 4.1: Perturbation function in a two-state framework, exemplarily

$\boldsymbol{T}$	0	1	2
$\boldsymbol{h(T)}$	1,0000	1,0256	1,0512
$\boldsymbol{h^*(T)}$	1,0000	0,9744	0,9488

Figure 4.2: Ho/Lee process



After adjusting the term structure with the perturbation function, we can derive the yield curve (internal rate of return) as conducted with the estimation of the discount function.

$$r(T) = -\frac{1}{T} \ln\left(P(T)\right)$$

4.3.3.3 Term structure movement with a three-state environment

Bühler and Schulze (1993) extended the binomial model of Ho and Lee (1986) by introducing a third state in the estimation of the term structure movement. This third state refers to a "no change" of the discount function. Bühler and Schulze (1993) observe that a no change state is common when considering monthly data. They follow the proposal of Bliss and Ronn (1989) who detect similar findings for US government bonds.

The assumptions as outlined in the model of Ho and Lee (1986) are valid with the following additions:

- The transition of the discount function is enhanced by a third state that refers to a no change of the discount function with the respective perturbation functions:

$$P_i^n(T) \begin{cases} P_{i+2}^{n+1}(T) = \frac{P_i^n(T+1)}{P_i^n(1)} h^u(T) & \text{Upstate (U)} \\ P_{i+1}^{n+1}(T) = \frac{P_i^n(T+1)}{P_i^n(1)} h^n(T) & \text{No change (N)} \\ P_i^{n+1}(T) = \frac{P_i^n(T+1)}{P_i^n(1)} h^d(T) & \text{Downstate (D)} \end{cases}$$

- Path-independency eases calculation in the sense that we have at time n only 2n+1 states instead of 3^n states.

According to Bühler and Schulze (1993), there are the following perturbation functions that fulfill the arbitrage-free model:

$$h^u(T) = \frac{1}{\pi^2 + 2\pi(1-\pi)\delta^{\mathrm{T}} + (1-\pi)^2\delta^{2\mathrm{T}}}, \; h^n(T) = \delta^{\mathrm{T}} h^u(T), \; h^d(T) = \delta^{2\mathrm{T}} h^u(T)$$

with $0<\pi$, $\delta<1$

Where π^2 refers to the risk-neutral probability for an upstate, $2\pi(1-\pi)$ for a no change and $(1-\pi)^2$ for a downstate of the discount function. According to

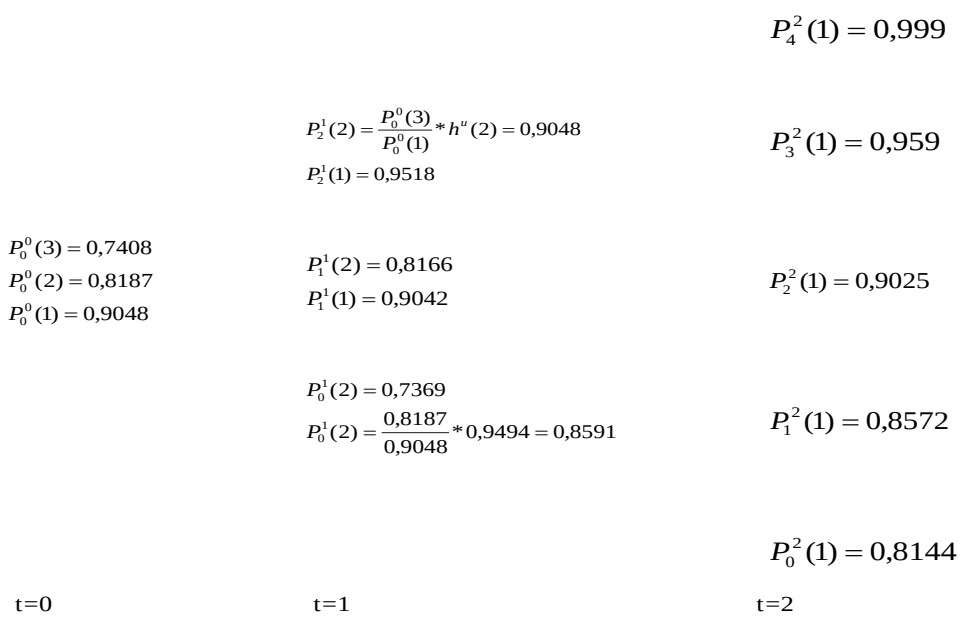
the model of Ho and Lee (1986), we can derive the term structure by just knowing the parameters π and δ and the initial discount function.

Applying the same parameters as used for the binomial approach, we obtain with π=0.5, δ=0.95, $P_0^0(T) = e^{(-0,1*T)}$ and maturities T=0, 1, 2, 3 the following discount function:

Table 4.2: Perturbation function in a three-state framework, exemplarily

$\boldsymbol{T}$	0	1	2
$\boldsymbol{h^u(T)}$	1,0000	1,0519	1,1051
$\boldsymbol{h^n(T)}$	1,0000	0,9993	0,9974
$\boldsymbol{h^d(T)}$	1,0000	0,9494	0,9001

Figure 4.3: Bühler/Schulze process



Hence, we can determine the term structure by estimating the parameters π, δ and $P_0^0(T)$. More precisely, δ explains the spread between the perturbation functions. A large spread refers to great interest rate volatility. Vice versa, for δ=1 we have certainty about the term structure movement.

4.3.3.4 Pricing of the option premium in multi-callable bonds

The specifications for the option pricing of multi-callable bonds are outlined in Bühler and Schulze (1993). We highlight some important specifications:

- The option premium is the difference between the non-callable bond and the callable bond. In other words, if the inner value is higher than the option premium, then the termination is favorable.
- The typical call option can be exercised at certain points in time with a specified notice period. The termination may not be economically beneficial if the interest rate is increased during the notice period. However, the terms of the contract outline that the termination cannot be withdrawn. So the cost for refinancing the bond has to be taken into account.
- The termination can imply transaction costs TC that occur for the issuance of a new bond.

The option premium is determined by applying the trinomial model with a recursive valuation from the last call date in a three step approach.

Step 1: call premium from the last call date N_c

The option premium $C(N_{c,i})$ depends on the price of the non-callable bond $B(N_{c,i})$:

- Minus the exercise price E_{Nc}.
- Minus the present value of the accrued interests in the notice period $c \cdot NP$, where c stands for the coupon rate.
- Plus the present value of the short term interest rate $r(N_{c,i})$ for refinancing the bond.

The correction terms consist of the accrued interest and refinance risk so that the inner value $C(N_{c,i})$ is calculated by:

$$C\left(N_{c,i}\right) = B\left(N_{c,i}\right) - E_{N_c} - c * KF * \left(1 + r\left(N_{c,i}\right)\right)^{-NP} + E_{N_c} * (1 - \left(1 + r\left(N_{c,i}\right)\right)^{-NP})$$

This can be rearranged in the form:

$$C(N_c, i) = B(N_c, i) - (c * NP + E_{N_c}) * \left(1 + r(N_c, i)\right)^{-NP} \text{ for } C(N_c, i) \geq TC$$

$$C(N_c, i) = 0 \quad \text{otherwise.}$$

More precisely, the option premium levies an inner value when transaction costs are exceeded.

Step 2: Call premium at any time when termination is not possible

Similar to the model of Ho and Lee (1986) in the case of a two-state model, the option premium can be calculated in a three-state model as:

$$C(n, i) = \left(\pi^2 * C(n+1, i+2) + 2\pi(1-\pi) * C(n+1, i+1) + (1-\pi)^2 * C(n+1, i)\right) * P_i^n(1)$$

Step 3: optimal exercise strategy and option premium when exercising the option is possible

When exercising the option is possible, we calculate the relation between the call price $\phi(n, i)$ and the option premium $C^*(n, i)$ as derived from the trinomial model.

$$\phi(n, i) = B(n, i) - E_n - c * NP * \left(1 + r(n, i)\right)^{-NP} + E_n * \left(1 - \left(1 + r(n, i)\right)^{-NP}\right) = B(n, i) - (c * NP + E_n) * \left(1 + r(n, i)\right)^{-NP}$$

for $\phi(n,i) \geq TC \; and \; \phi(n,i) = 0$ otherweise

The exercise price E_n and $r(n,i)$ refers to the interest rate of the notice period NP. So the option premium is calculated by:

$$C(n,i) = \max\big(C^*(n,i); \Phi(n,i)\big)$$

The optimal exercise strategy is given when the call price $\phi(n,i)$ is greater than the calculated option premium $C^*(n,i)$. Given this assumption, the optimal exercise strategy can be recursively derived for all states and time (n,i). We begin with the current call price $C(0,0)$ and the price of the callable bond $B_c(0,0)$.

Finally, the price of the non-callable bond in the immediate future is given by:

$$B_C(0,0) = B(0,0) - C(0,0)$$

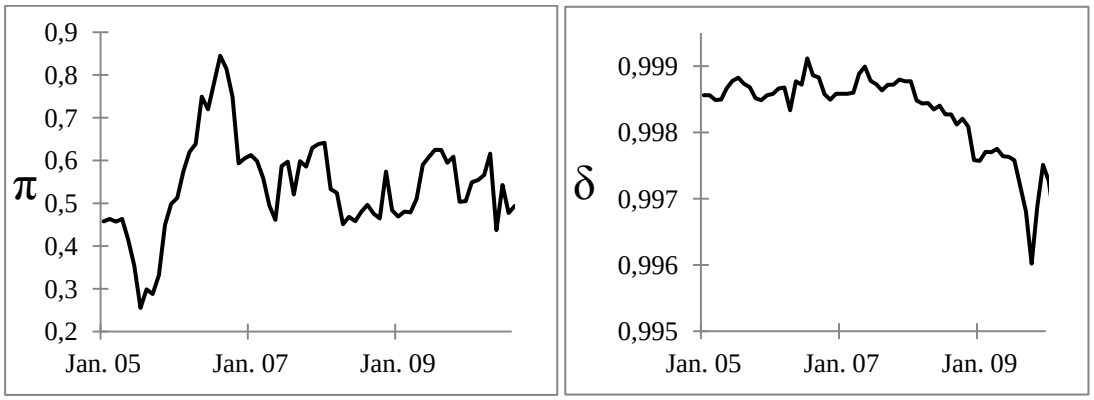
Where $B(0,0)$ is the price of the non-callable bond derived from the term structure movement.

4.4 Results

4.4.1 Discount function

We estimate the parameters π and δ for the discount function at the beginning and the middle of each month. As the estimation of the parameters π and δ is possible 12 months from the observation period, we consider here the time period from January 2005 to September 2010. With this approach, we obtain 68 parameters for the transition from the beginning to the beginning and middle to middle of the following month, respectively. We optimize the parameters by applying the Newton-Raphonson method.

Figure 4.4: Parameter estimation for the transition of a month's beginning



Comparing the parameter estimation, we observe for both transitions that the implied probability π is exposed to greater volatility than the spread of the perturbation function δ. This is caused by the sensitivity of δ. We interpret this outcome with a great uncertainty in modeling the term structure during the financial crisis. The spread of the perturbation function sharply declines during the financial crisis for both transitions.

Figure 4.5: Parameter estimation for the transition of a month's middle

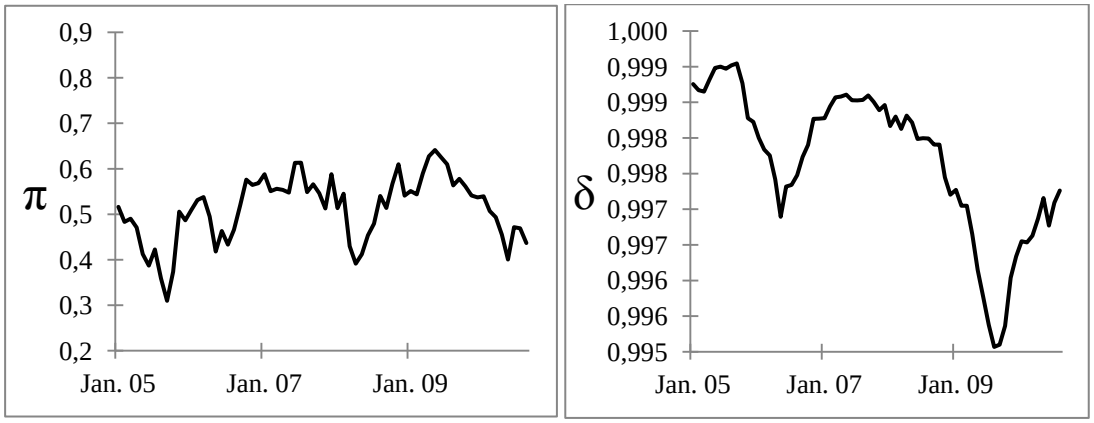


Table 4.3: Estimation of the discount function parameters

Discount function estimation	Transition beginning to beginning		Transition middle to middle	
	π	δ	π	δ
Number of estimations	68	68	68	68
Mean	0.5397	0.9981726	0.5121226	0.9976919
Std.	0.1138	0.0007053	0.0716881	0.0010214
Min	0.2553	0.9960210	0.3098087	0.9950685
Max	0.8445	0.9989937	0.6410514	0.9990463
Median	0.5288	0.9984909	0.5255841	0.9979885

The implied probabilities $\pi^2, 2\pi(1-\pi)$ and $(1-\pi)^2$ serve as risk-neutral probabilities in the context of Cox et al. (1979). This means that the bond price equals the expected bond price at the end of the period discounted by the one-period bond rate:

$$P_i^n(T) = [\pi^2 * P_{i+2}^{n+1}(T-1) + 2\pi(1-\pi) * P_{i+1}^{n+1}(T-1) + (1-\pi)^2 * P_i^{n+1}(T-1)] * P_i^n(1)$$

Controlling for the disturbance term, the parameter δ determines the volatility of the term structure. If δ is near 1 and the spread between the perturbation function is small, then there should be only one possible state. Vice versa, if δ decreases, the difference of the future term structure deviates more significantly from the observed term structure.

4.4.2 Results option premium

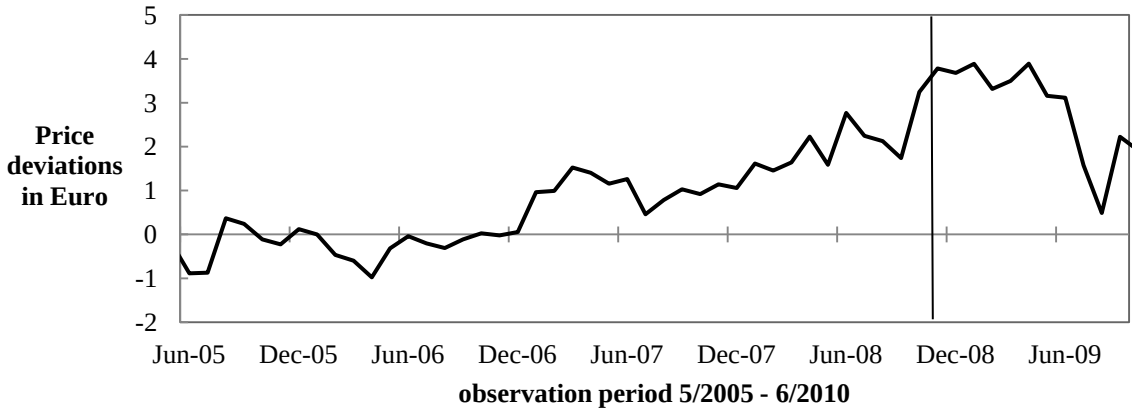
4.4.2.1 Single-callable bonds

The price deviation is most pronounced for the sub sample from July 2007 to September 2009. Prior to the financial crisis, price deviations are small indicating that market quotes and model-conform valuation converge. The results support the hypothesis that the market is more cautious under stress that puts a challenge to accounting complex financial products. From November 2008, there is a persisting price deviation that is linked to the government bailout of Commerzbank on November 2, 2008.

Table 4.4: Price deviation single-callable bonds

Deviation (x=EUR)	Number of observations					
	2/2005 – 5/2010		2/2005 – 6/2007		7/2007 – 9/2009	
12≥x> 11	-		-		-	
11≥x> 10	-		-		-	
10≥ x > 9	-		-		-	
9 ≥ x > 8	-		-		-	
8 ≥ x > 7	-		-		-	
7 ≥ x > 6	-		-		-	
6 ≥ x > 5	3	*1.4%*	-		3	*3.7%*
5 ≥ x > 4	3	*1.4%*	-		3	*3.7%*
4 ≥ x > 3	6	*2.7%*	-		6	*7.3%*
3 ≥ x > 2	21	*9.5%*	3	*2.2%*	18	*22.0%*
2 ≥ x > 1	68	*30.9%*	46	*33.3%*	22	*26.8%*
1 ≥ x > 0	64	*29.1%*	38	*27.5%*	26	*31.7%*
0 ≥ x >-1	22	*10.0%*	18	*13.0%*	4	*4.9%*
-1 ≥x > -2	11	*5.0%*	11	*8.0%*	-	
-2 ≥ x >-3	21	*9.5%*	21	*15.2%*	-	
-3 ≥ x > 4	1	*0.5%*	1	*0.7%*	-	
Total	220	*100%*	138	*100%*	82	*100%*

Figure 4.6: Option premium mispricing in Euro, single-callable bonds



4.4.2.2 Multi-callable bonds

Given our hypothesis that the market is more cautious under stress, we expect deviations of the option premium in relation to the model-conform valuation of multi-callable bonds as well. Observing the option premium over the time period from January 2005 to September 2009, the outcome is two-fold. Prior to the financial crisis, the deviations are rather small although not negligible. Pricing, however, becomes critical in times of stress. There is a persisting underestimation of the option premium with deviations in the excess of up to 6 Euros in Q4 2008. By Q3 2009 the option premium returns close to the model-conform valuation. So the most significant deviation occurs in Q4 2008 and lasts for one year until Q3 2009.

As we detect strong support for the pricing problem hypothesis, we intend to relate the outcome to a certain time period. Table 4.5 presents the overall results with a frequency distribution of the deviations. As such, there is a strong frequency cluster for deviations in the excess of up to 2 Euros in the overall observation period. Breaking down the results in a narrower time frame, we divide the table in a pre-crisis and a crisis period. We define the time period from June 2005 to June 2007 as the pre-crisis period and the time period from July 2007 to September 2009 as the crisis period. There is apparently a strong

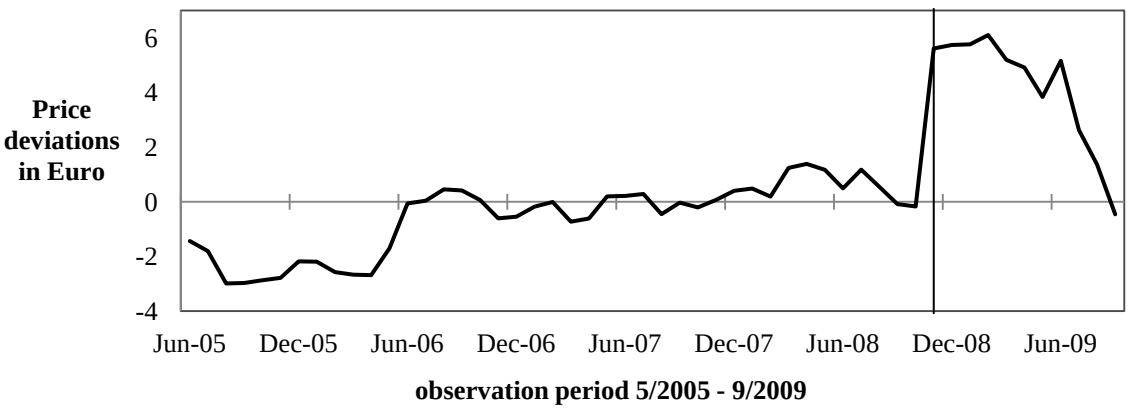
mismatch in the sub-periods. During the financial crisis, there is a persisting underestimation meaning that market prices are higher than the model-conform valuation. The most intense pricing gap of the option premium occurs in an extended period from November 2008 to June 2009. We bring this outcome into the context of the financial services industry. We do not explicitly relate our findings to the bank failure of Lehman Brothers since the mispricing of the option premium occurs two months after Lehman Brothers filed for bankruptcy. However, we could relate the mispricing in terms of a lagged price effect with concerns about the financial sector. Moreover, the option premium mispricing is most pronounced by the fact of government support.

Eurohypo was a subsidiary of Commerzbank that struggled in the financial crisis. Finally, Commerzbank had to claim for government bailout in order to operate its business. On November 2, 2008, Commerzbank was granted government support via the Special Financial Market Stabilization Fund (Finanzmarktstabilisierungsgesetz, FMStG). Due to this fact, we can relate the significantly higher option premium to this event. Even emphasized, we provide evidence that in times of increasing default risk, the mispricing of model-conform valuation is most pronounced.

Table 4.5: Price deviation multi-callable bonds

Deviation (x=EUR)	Number of observations					
	6/2007 -9/2009		6/2005 – 6/2007		7/2007 – 9/2009	
13 ≥ x > 12	1	*0.3%*	-		1	*0.6%*
12 ≥ x > 11	0	*0.0%*	-		0	*0.0%*
11 ≥ x > 10	2	*0.6%*	-		2	*1.1%*
10 ≥ x > 9	3	*0.9%*	-		3	*1.7%*
9 ≥ x > 8	4	*1.1%*	-		4	*2.2%*
8 ≥ x > 7	6	*1.7%*	-		6	*3.3%*
7 ≥ x > 6	8	*2.3%*	-		8	*4.4%*
6 ≥ x > 5	4	*1.1%*	-		4	*2.2%*
5 ≥ x > 4	5	*1.4%*	-		5	*2.8%*
4 ≥ x > 3	13	*3.7%*	6	*3.5%*	7	*3.9%*
3 ≥ x > 2	31	*8.9%*	15	*8.8%*	16	*8.9%*
2 ≥ x > 1	39	*11.1%*	5	*2.9%*	34	*18.9%*
1 ≥ x > 0	73	*20.9%*	33	*19.4%*	40	*22.2%*
0 ≥ x > -1	56	*16.0%*	28	*16.5%*	28	*15.6%*
-1 ≥ x > -2	42	*12.0%*	24	*14.1%*	18	*10.0%*
-2 ≥ x > -3	21	*6.0%*	18	*10.6%*	3	*1.7%*
-3 ≥ x > -4	28	*8.0%*	27	*15.9%*	1	*0.6%*
-4 ≥ x > -5	10	*2.9%*	10	*5.9%*	0	*0.0%*
-5 ≥ x > -4	4	*1.1%*	4	*2.4%*	0	*0.0%*
Total	350	*100%*	170	*100%*	180	*100%*

Figure 4.7: Option premium mispricing in Euro, multi-callable bonds



The mispricing hypothesis is emphasized when employing test statistics. We test whether the difference between model-conform valuation and market prices in the financial crisis is significantly different than prior to the financial crisis. The time period is cut off in July 2007. We reject the null hypothesis with highly significant test statistics.

Table 4.6: Test statistics option price deviation

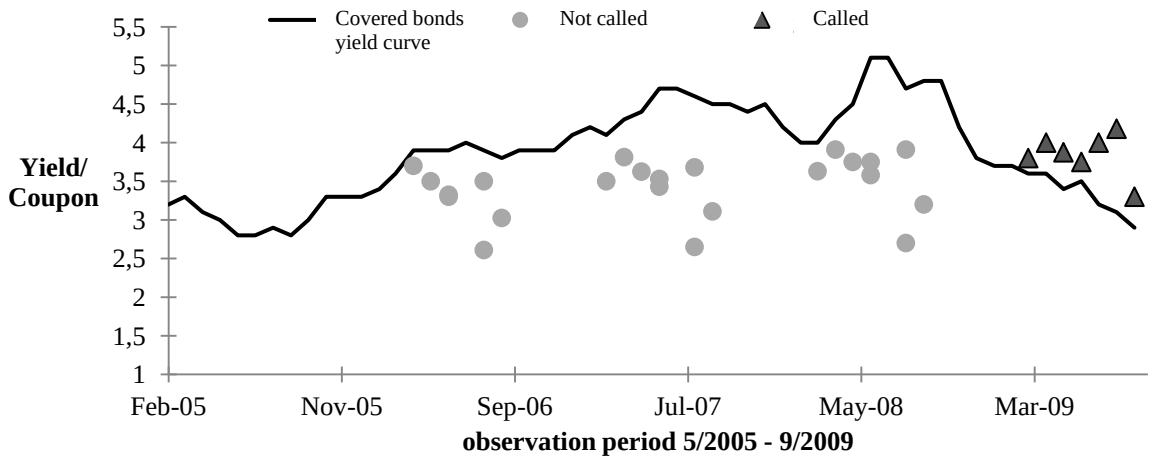
Indicators	Single-callable bonds	Multi-callable bonds
t-statistics	-3,6912***	-3.1012***
$x_{\text{until July 2007}}$	0,6802	1.2586
$x_{\text{after July 2007}}$	1,2571	2.3399

*** indicate highly statistical results at the 1% significance level

4.4.3 Optimal exercise strategy

After presenting the significant mispricing of the option premium during the financial crisis, we investigate under what conditions the early termination of multi-callable bonds is most likely. Figure 4.8 exhibits all possible call dates and the covered bonds yield curve. We detect that the current covered bonds yield curve is a good indicator for the termination of callable bonds. More precisely, when the yield of the multi-callable bond is higher than the covered bonds yield curve, the early termination of the callable bond is most likely. Vice versa, when the yield of the multi-callable bond trades at a discount to the yield curve, then the termination is less probable.

Figure 4.8: Exercise of call option



4.5 Summary and conclusion

In this study, we question the appropriateness of models to price the option premium in multi-callable bonds. As such, we apply a case study analysis for multi-callable bonds from Eurohypo. We differentiate the deviation of market prices and model-conform valuation between a time period prior to the financial crisis and a crisis period. We hypothesize that models are suitable in regular markets since most models rely on idealized conditions. However, the assumptions may be violated in times of stress so that there is a persisting deviation from the market value.

Our results highlight that there is a significant deviation of market prices from model-conform valuation. This may seem rather intuitive since stress periods ignite a more volatile market environment and the reliance on idealized market conditions suffer. However, we discover that an increase of default risk causes the mispricing and not contagion effects in the financial services industry. Furthermore, we present that the covered bonds yield curve serves as a suitable indicator for determining the early termination. The results show that in the presence of an inner value, exercising the call option is more likely. While this finding is in line with the option pricing theory, it is still astonishing since the

termination of a bond usually triggers the issuance a new bond particularly in the financial crisis. This is surprising since refinancing via the bond market was expected to be tense.

5 Concluding Remarks

The motivation of this doctoral thesis is to improve our understanding of the interconnection of structured finance and the financial crisis. While media coverage on structured finance and its sub-forms like securitization was mainly negative, the presented studies show that generalization is not justified.

Three research questions are the building blocks of this doctoral thesis that were of relevance in the financial crisis. In chapter 2, I investigate the impact of rating announcements of securitizations. In chapter 3, I examine the investment practices of institutional investors and determine the risk and return characteristics by including securitization. In chapter 4, I examine the appropriateness of option pricing models in structured finance products during times of stress.

In Chapter 2, I find strong evidence that rating announcements of securitization have a strong impact. However, the impact is limited to the announcement day. This indicates that activity in structured finance or securitization is not in general negative. When cross-checking the effect with rating announcements on the long-term outlook of a financial institution, the impact of rating announcements is much more pronounced. Given this outcome, the bank wide overall risk is the key determinant in the investor's perspective. Suggestion for future research is to examine the impact of rating announcements on government bonds as this is an up-to-date issue.

In chapter 3, the investment practices of institutional investors show distinctive differences with regard to the investment policies they are exposed to. I detect that institutional investors following the prudent person rule achieve higher risk-adjusted returns than those following the quantitative portfolio restriction approach. In addition to that, securitization is not suitable in the portfolio of

institutional investors after the outbreak of the financial crisis due to the weak performance. I explain the rapid decline of securitization in the financial crisis since primarily institutional investors sold securitization in the financial crisis. Suggestion for future research is to explore the outperformance skills of institutional investors for other countries than USA, UK and Germany.

In chapter 4, the option pricing in callable bonds is explored. Since valuation methodology is quite complex, I show that in normal times model-conform valuation and market prices converge. Nevertheless, this becomes more challenging in times of stress resulting in strong deviations from valuation principles. Suggestion for future research is to quantify the price deviation since this is caused from increased default risk.

Taken together, structured finance and securitization have become an established investment opportunity. Due to the predominant opinion that risk is coated with structured finance, market participants are obliged to restore investor confidence with high quality products. If this target is pursued, the continuation of structured finance as a success story in the financial service industry may seem likely.

Declaration of Honor

I declare upon my word of honor that the doctoral thesis submitted is entirely my research. Co-authors, sources, references or quotations in any form and their use have been clearly identified. The dissertation has not been submitted for examination purposes to any institution before.

Ich erkläre hiermit ehrenwörtlich, dass ich die vorliegende Arbeit selbständig angefertigt habe. Mitarbeit durch weitere Autoren und sämtliche aus fremden Quellen direkt oder indirekt übernommenen Gedanken sind als solche kenntlich gemacht. Die Arbeit wurde bisher keiner anderen Prüfungsbehörde vorgelegt und noch nicht veröffentlicht.

Anit Deb

Groß-Gerau, 25.06.2012

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