

Detering, Nils; Weber, Andreas; Wystup, Uwe

**Working Paper**

## Return distributions of equity-linked retirement plans

CPQF Working Paper Series, No. 27

**Provided in Cooperation with:**

Frankfurt School of Finance and Management

*Suggested Citation:* Detering, Nils; Weber, Andreas; Wystup, Uwe (2010) : Return distributions of equity-linked retirement plans, CPQF Working Paper Series, No. 27, Frankfurt School of Finance & Management, Centre for Practical Quantitative Finance (CPQF), Frankfurt a. M.

This Version is available at:

<https://hdl.handle.net/10419/43887>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

CPOF Working Paper Series  
No. 27

Return distributions of equity-linked retirement plans

Nils Detering, Andreas Weber and Uwe Wystup

December 2010

Authors:

*Nils Detering*  
PhD Student CPOF  
Frankfurt School of Finance & Management  
Frankfurt/Main  
[nils.detering@mathfinance.com](mailto:nils.detering@mathfinance.com)

*Andreas Weber*  
MathFinance AG  
Frankfurt/Main  
[andreas.weber@mathfinance.com](mailto:andreas.weber@mathfinance.com)

*Uwe Wystup*  
MathFinance AG /  
Professor of Quantitative Finance  
Frankfurt School of Finance & Management  
Frankfurt/Main  
[uwe.wystup@mathfinance.com](mailto:uwe.wystup@mathfinance.com)

Publisher:

Frankfurt School of Finance & Management  
Phone: +49 (0) 69 154 008-0 ■ Fax: +49 (0) 69 154 008-728  
Sonnemannstr. 9-11 ■ D-60314 Frankfurt/M. ■ Germany

# Return distributions of equity-linked retirement plans

Nils Detering, Andreas Weber, Uwe Wystup

December 6, 2010

Nils Detering

[nils.detering@mathfinance.com](mailto:nils.detering@mathfinance.com)

MathFinance AG  
Mainluststraße 4  
60329 Frankfurt am Main

Frankfurt School of Finance & Management  
Sonnemannstraße 9 - 11  
60314 Frankfurt am Main

Andreas Weber

[andreas.weber@mathfinance.com](mailto:andreas.weber@mathfinance.com)

MathFinance AG  
Mainluststraße 4  
60329 Frankfurt am Main

Uwe Wystup

[uwe.wystup@mathfinance.com](mailto:uwe.wystup@mathfinance.com)

MathFinance AG  
Mainluststraße 4  
60329 Frankfurt am Main

Professor of Quantitative Finance  
Frankfurt School of Finance & Management  
Sonnemannstraße 9 - 11  
60314 Frankfurt am Main

**Keywords:** CPPI, stop loss, capital guarantee mechanisms, retirement provision plan, Riester-Rente

**JEL classification:** C15, G11, J26

## Contents

<b>1</b>	<b>Introduction</b>	<b>3</b>
<b>2</b>	<b>DDE model</b>	<b>4</b>
2.1	Model equation . . . . .	4
2.2	Drift adjustment . . . . .	6
2.3	Moments . . . . .	7
<b>3</b>	<b>Parameter estimation</b>	<b>8</b>
3.1	Estimating parameters from financial data . . . . .	8
<b>4</b>	<b>Interest rate curve</b>	<b>9</b>
<b>5</b>	<b>Products</b>	<b>9</b>
5.1	Classical insurance strategy . . . . .	9
5.2	Constant proportion portfolio insurance (CPPI) . . . . .	9
5.3	Stop loss strategy . . . . .	11
<b>6</b>	<b>Payments to the contract</b>	<b>12</b>
<b>7</b>	<b>Cost structures</b>	<b>13</b>
<b>8</b>	<b>Results without costs</b>	<b>14</b>
<b>9</b>	<b>Impact of costs</b>	<b>14</b>
<b>10</b>	<b>Impact of jumps</b>	<b>16</b>
<b>11</b>	<b>Summary</b>	<b>18</b>

## List of Figures

1	Displaced Double-Exponential jump process: simulated paths . . .	5
2	Displaced Double-Exponential density . . . . .	6
3	Simulated path for a classical insurance strategy . . . . .	11
4	Simulated CPPI-path . . . . .	12
5	Simulated stop-loss-path . . . . .	13
6	Return distribution of the different strategies . . . . .	16

## List of Tables

1	Estimated parameters for the DDE-process . . . . .	8
2	Extracted discount factors from money market quotes and swap rates . . . . .	10
3	Model parameters for the different scenarios . . . . .	14
4	Results in the standard scenario . . . . .	15
5	Results in the optimistic scenario . . . . .	15
6	Results in the pessimistic scenario . . . . .	15

7	Results for the actuarial reserve product in the standard scenario with costs . . . . .	17
8	Results in the CPPI strategy with leverage factor 3 with costs . . . . .	17
9	Results in the stop loss strategy with costs . . . . .	17
10	Shortfalls for stop loss and CPPI . . . . .	18

## 1 Introduction

In the recent years an increasing demand for capital guaranteed equity-linked life insurance products and retirement plans has emerged. In Germany, a retirement plan, called Riester-Rente, is supported by the state with cash payments and tax benefits. Those retirement plans have to preserve the invested capital. The company offering a Riester-Rente has to ensure that at the end of the saving period at least all cash inflows are available. Due to the investors demand for high returns, banks and insurance companies are not only offering saving plans investing in riskless bonds but also in products with a high equity proportion. For companies offering an equity-linked Riester-Rente the guarantee to pay out at least the invested capital is a big challenge. Due to the long maturities of the contracts of more than 30 years it is not possible to just buy a protective put. Many different concepts are used by banks and insurance companies to generate this guarantee or to reduce the remaining risk for the company. They vary from simple Stop Loss strategies to complex dynamic hedging strategies. In our work we analyze the return distribution generated by some of these strategies. We consider several examples:

- A classical insurance strategy with investments in the actuarial reserve fund. In this strategy a large proportion of the invested capital is held in the actuarial reserve fund to fully generate the guarantee. Only the remaining capital is invested in products with a higher equity proportion. The actuarial reserve fund is considered riskless. It usually guarantees a minimum yearly interest rate.
- A Constant proportion portfolio insurance strategy (CPPI) which is similar to the traditional reserve fund in that it ensures not to fall below a certain floor in order to generate the guarantee. In contrast to the traditional strategy the amount necessary to generate the guarantee is not fully invested in the riskless products. The amount invested in the more risky equity products is leveraged for a higher equity exposure. Continuous monitoring ensures that the guarantee is not at risk, since the equity proportion is reduced with the portfolio value becoming closer to the floor.
- A stop loss strategy where all the money is invested into pure equity until the floor is reached. If this happens all the invested capital is shifted into the riskless products in order to provide the guarantee at the end.

There are also equity-linked life insurance guarantees sold in Germany. In these products the insurance company promises to pay out the maximum of the invested amount and an investment in an equity fund reduced by a guarantee cost (usually yearly as a percentage of the fund value). The return distribution of these products highly depends on the guarantee cost. Due to the long maturities

of the contracts, the pricing of this guarantee cost is not straightforward and the price is extremely dependent on the model which is chosen. For this reason they are not included in this comparative study. An introduction to equity-linked guarantees and their pricing can be found in (Hardy 2003).

We simulate the return distribution for the different strategies and for different investment horizons. We analyze how fee structures, often used by insurance companies, affect the return distribution. We also study the impact of the cash payments of the state. Therefore we analyze an investment plan which maximizes the federal support.

To model the distribution we extend the jump diffusion model by Kou (Kou 2002) by allowing the jumps to be displaced. Therefore, we go beyond the classical Black-Scholes model (Black & Scholes 1973) and explicitly allow for jumps in the market as we could observe them within the last two years. One reason for using a jump diffusion model is that it better represents reality and therefore the rebalancing between equity and fixed income funds in the strategies under consideration is more realistic. The second reason is that Stop Loss and CPPI both only generate a sure guarantee in a market without jumps. Therefore, we analyze how often a CPPI and a Stop Loss strategy fail if we allow for jumps.

We find out that one of the driving factors of the return distribution is the fee structure of the contract. For some contracts only 85% of the invested capital is actually invested in the strategy. The remaining 15% is taken by the insurance or bank as sales and maintenance fees. With the yearly management fees of the underlying funds the return distribution is additionally weakened. Another very important factor of the return distribution is the guarantee concepts. Due to an equity exposure ranging from 36% to 100% percent the return distributions vary significantly.

## 2 The displaced double-exponential jump diffusion model

### 2.1 Model equation

As mentioned in Section 1, we would like to go beyond the classical Black-Scholes Model and allow for exponentially distributed jumps in the market. We extend the model by Kou (Kou 2002) by allowing the jumps to be displaced.

The governing equation for the displaced jump diffusion model (DDE) is

$$\frac{dS_t}{S_{t-}} = \mu dt + \sigma dW_t + d \left( \sum_{j=1}^{N_t} (V_j - 1) \right), \quad (1)$$

$$S_T = S_t \exp \left[ \left( \mu - \frac{\sigma^2}{2} - \delta \right) \tau + \sigma W_{T-t} \right] \prod_{j=1}^{N_{T-t}} V_j, \quad (2)$$

where

$(W_t)$  is a standard Brownian motion,

$(N_t)$  a Poisson process with intensity  $\lambda > 0$  and

$V_j$  independent identically distributed random variables  $V_j \sim e^Y$ , where  $Y$  represents the relative jump size with a minimal jump of  $\kappa$ , therefore leading to jumps of  $Y$  in the range  $(-\infty, -\kappa] \cup [\kappa, +\infty)$ ,

with parameters

- $\mu$  denoting the expected drift,
- $\sigma$  denoting the volatility,
- $\lambda$  denoting the expected number of jumps per year,
- $\delta$  the drift adjustment which is chosen such that the process  $S_t$  has the desired drift  $\mu$ .

The processes  $(W_t)$ ,  $(N_t)$ , and the random variables  $V_j$  are all independent. We illustrate sample paths drawn from this distribution for a period of 35 years in Figure 1.

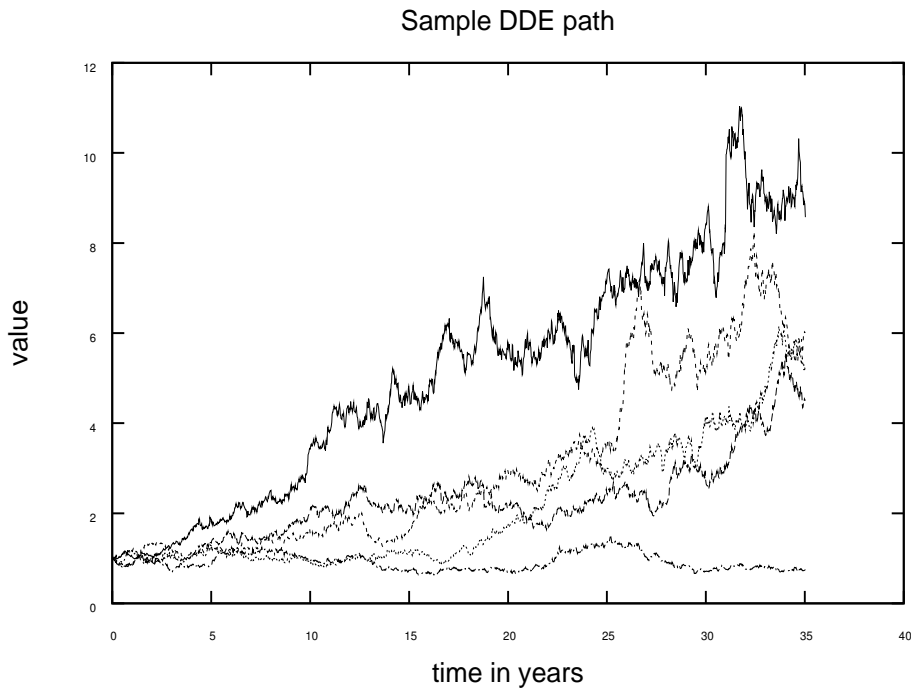


Figure 1: Displaced Double-Exponential jump process: simulated paths with parameters  $T = 35$  years,  $\mu = 6\%$ ,  $\sigma = 14.3\%$ ,  $\lambda = 5.209$ ,  $\kappa = 2.31\%$ ,  $\eta_1 = \eta_2 = \eta = 1/1.121\%$ ,  $p = 0.5$ ,  $S_0 = 1$ .

Except for the drift, the parameters are estimated to resemble the daily log returns of the MSCI World index for the last thirty years. For the drift we simulate different scenarios. We do not intend to simulate actively managed funds.

We assume a minimal jump size in order to distinguish between jumps arising from the Poisson process and the Brownian motion. The minimum jump size

is chosen in order to qualify the 1% lowest and 1% highest daily log returns as jumps.

We chose the jumps  $Y$  to be exponentially distributed assuming only values outside the interval  $(-\kappa, +\kappa)$ .

Therefore, the jump part of the process has the density

$$f_Y(y) = \begin{cases} p\eta_1 e^{-(y-\kappa)\eta_1} & \text{if } y \geq \kappa, \\ 0 & \text{if } |y| < \kappa, \\ (1-p)\eta_2 e^{(y+\kappa)\eta_2} & \text{if } y \leq -\kappa, \end{cases} \quad (3)$$

with  $\eta_1 > 1$ ,  $\eta_2 > 0$  and  $0 \leq p \leq 1$ .

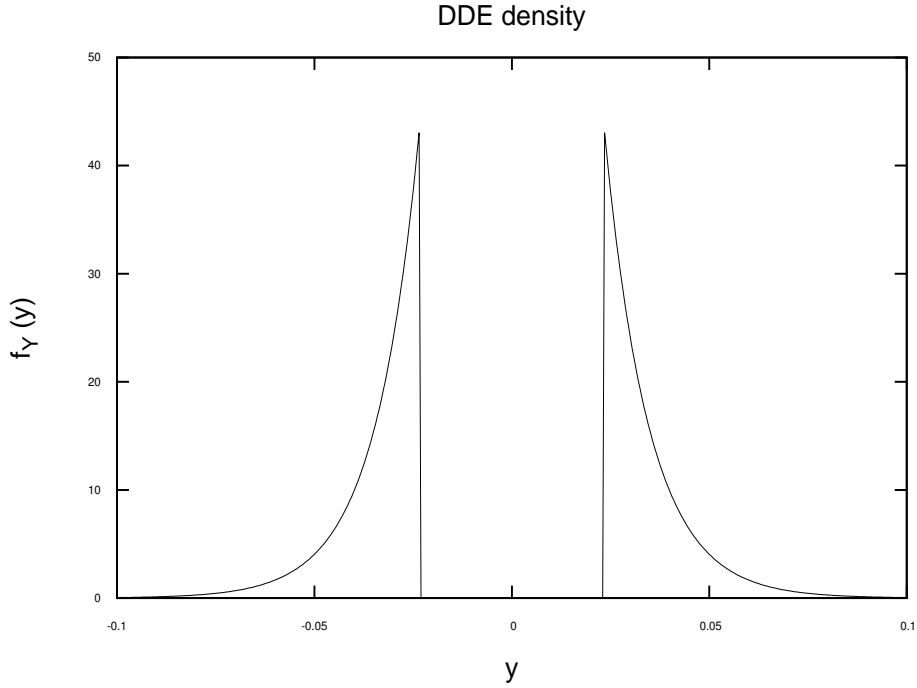


Figure 2: Displaced Double-Exponential density of  $Y$  with parameters  $\kappa = 2.31\%$ ,  $\eta_1 = \eta_2 = \eta = 1/1.121\%$ ,  $p = 0.5$

## 2.2 Drift adjustment

Similar to the work of Kou (Kou 2002) we calculate the drift adjustment for the jump process by

$$\begin{aligned} \delta &= \mathbb{E}[e^Y - 1] \\ &= \lambda \left( p\eta_1 \frac{e^{+\kappa}}{\eta_1 - 1} + (1-p)\eta_2 \frac{e^{-\kappa}}{\eta_2 + 1} - 1 \right). \end{aligned} \quad (4)$$

In this paper we use  $\eta = \eta_1 = \eta_2$  and  $p = 0.5$ .



### 2.3 Moments, variance and volatility

The variance of the random number  $\ln \frac{S_t}{S_0}$  of the process (2) can be written as

$$\begin{aligned} \text{Var} \left[ \ln \frac{S_t}{S_0} \right] &= \sigma^2 t + \text{Var} \left[ \sum_{k=1}^{N_t} U_k(\kappa + H_k) \right] \\ &= \sigma^2 t + \lambda t ((\kappa + h)^2 + h^2), \end{aligned}$$

where the  $H_k$  are independent exponentially distributed random numbers with expectation  $h = \frac{1}{\eta}$ .  $U_k$  is a random variable which takes the value of +1 and -1 with probability  $\frac{1}{2}$ . We calculate the first two moments

$$\begin{aligned} &\mathbb{E} \left[ \sum_{k=1}^{N_t} U_k(\kappa + H_k) \right] \\ &= \sum_{n=0}^{\infty} \mathbb{E} \left[ \sum_{k=1}^n U_k(\kappa + H_k) \right] \cdot \text{P}[N_t = n] \\ &= \sum_{n=0}^{\infty} n \cdot 0 \cdot \text{P}[N_t = n] \\ &= 0, \end{aligned}$$

$$\begin{aligned} &\mathbb{E} \left[ \sum_{k=1}^{N_t} U_k(\kappa + H_k) \right]^2 \\ &= \sum_{n=0}^{\infty} \mathbb{E} \left[ \sum_{k=1}^n U_k(\kappa + H_k) \right]^2 \cdot \text{P}[N_t = n] \\ &= \lambda t ((\kappa + h)^2 + h^2). \end{aligned}$$

For the variance we obtain

$$\begin{aligned} &\text{Var} \left[ \sum_{k=1}^{N_t} U_k(\kappa + H_k) \right] \\ &= \mathbb{E} \left[ \sum_{k=1}^{N_t} U_k(\kappa + H_k) \right]^2 - \left( \mathbb{E} \left[ \sum_{k=1}^{N_t} U_k(\kappa + H_k) \right] \right)^2 \\ &= \lambda t ((\kappa + h)^2 + h^2). \end{aligned}$$

Finally, the volatility of the DDE-process is

$$\sqrt{\frac{1}{t} \text{Var} \left[ \ln \frac{S_t}{S_0} \right]} = \sqrt{\sigma^2 + \lambda((\kappa + h)^2 + h^2)}. \quad (5)$$

Parameter	Value
Total volatility $\hat{\sigma}_{tot}$	14.3%
Volatility of the diffusion part $\hat{\sigma}$	11.69%
Jump intensity $\lambda$	5.209
Minimum jump size $\kappa$	2.31%
Expected jump size above minimum jump size $h$	1.121%
Drift adjustment $\delta$	0.339%

Table 1: Estimated parameters for the DDE-process.

### 3 Parameter estimation

#### 3.1 Estimating parameters from financial data

We estimate the parameters based on the historical data of the **MSCI Daily TR (Total Return) Gross (gross dividends reinvested) in USD** for the period between January 1 1980 and October 2 2009. We denote these prices with  $x_0, x_1, \dots, x_N$  and the log-returns by

$$r_i \triangleq \ln \frac{x_i}{x_{i-1}}, \quad i = 0, 1, \dots, N. \quad (6)$$

The estimate for the daily log return is

$$\bar{r} = \frac{1}{N} \sum_{i=1}^N r_i. \quad (7)$$

The estimate for the total volatility  $\hat{\sigma}_{tot}$  is

$$\hat{\sigma}_{tot}^2 = \frac{\#Prices \text{ per year}}{N-1} \left( \sum_{i=1}^N r_i^2 - N\bar{r}^2 \right). \quad (8)$$

To determine the parameters for the jump process we have to define a level  $\kappa$  such that  $r_i$  with  $\|r_i\| \geq \kappa$  is considered to be a jump. To determine this  $\kappa$  we define for a given level  $u \in [0, 1]$  the  $u\%$  smallest and  $u\%$  biggest daily log returns. The level  $u$  should be chosen such that the resulting returns are intuitively considered as jumps. If  $u$  is chosen too high, even small log-returns are considered jumps, and if  $u$  is too low, almost no jumps occur. Of course, this level is subjective. We have chosen  $u = 1\%$  because in this case only daily changes of more than 2% are considered to be a jump. Changes of less than 2% can be explained with the diffusion part with sufficiently high probability. It turns out that for the analyzed MSCI World Index, the smallest up-jump and the smallest down-jump is almost equal. The absolute values of the relative jump size is on average 2.31%. We use this minimal jump size as an estimator

for  $\kappa$ . The value  $\eta$  of the single parameter exponential distribution is chosen such that  $\eta$  fits the mean of the observed jumps. From the financial data and the already fixed parameters we obtain  $h = 1/\eta$  with  $\eta = 1.21\%$ . The number of jumps divided by the total number of observations yields an estimate for the jump frequency. Annualizing this frequency we can estimate  $\lambda$  to be 5.21. Finally we have to correct the estimator for the volatility according to Equation (5) since the volatility consists of the jump part and the diffusion part. We summarize the estimated parameters in Table 1.

## 4 Interest rate curve

To calculate the current value of the future liability (floor) and the performance of the riskless investments, we use the zero bond curve as of October 1 2009. The curve is extracted from the money market and swap rate quotes on Reuters. This curve is static and not simulated. Interpolation is done linear in the rates. See Table 2 for the calculated discount factors and the market quotes as seen on Reuters.

## 5 Products

In this section we describe the analyzed products and the assumptions we made.

### 5.1 Classical insurance strategy with investment in the actuarial reserve fund

The current value of the future liability is calculated and a sufficient amount to meet this liability in the future is invested in the actuarial reserve fund. The actuarial reserve fund is assumed to be riskless and accrues the interest implied by the current zero bond curve but at least the currently guaranteed interest of 2.25%. The return participation is added to the contract once a year. Only the excess amount which is not needed for the guarantee is invested in the risky asset. We assume that the calculation of the amount needed to meet the future liability is based on the guaranteed interest rate of 2.25%. See Figure 3 for a picture of the exposure distribution in the classical insurance case.

### 5.2 Constant proportion portfolio insurance (CPPI)

The Constant proportion portfolio insurance structure (CPPI) works similar to the classical strategy of investments in the actuarial reserve fund. The difference is that instead of investing only the excess amount into the risky asset the excess amount is leveraged in order to allow for a higher equity participation. The investment is monitored on a continuous basis to guarantee that the investment doesn't fall below the floor. With  $F$  being the floor of the future obligations,  $NAV$  the net asset value of the fund and  $a$  the leverage factor, the rebalancing equation for the risky asset  $R$  is

$$R = \max(a(NAV - F), NAV). \quad (9)$$

The leverage factor determines the participation on the equity returns. The higher the leverage factor  $a$ , the higher the participation on positive return but

Date	Instrument	Rate	Discount factor
11/3/2009	Money market	0.43%	99.96%
12/3/2009	Money market	0.59%	99.89%
1/4/2010	Money market	0.75%	99.80%
2/3/2010	Money market	0.84%	99.71%
3/3/2010	Money market	0.92%	99.61%
4/5/2010	Money market	1.01%	99.48%
5/3/2010	Money market	1.06%	99.37%
6/3/2010	Money market	1.10%	99.26%
7/5/2010	Money market	1.14%	99.13%
8/3/2010	Money market	1.18%	99.01%
9/3/2010	Money market	1.20%	98.88%
10/4/2010	swap	1.20%	98.80%
10/3/2011	swap	1.71%	96.64%
10/3/2012	swap	2.15%	93.76%
10/3/2013	swap	2.46%	90.64%
10/3/2014	swap	2.71%	87.30%
10/5/2015	swap	2.92%	83.85%
10/3/2016	swap	3.15%	80.11%
10/3/2017	swap	3.24%	77.01%
10/3/2018	swap	3.36%	73.71%
10/3/2019	swap	3.46%	70.47%
10/5/2020	swap	3.55%	67.25%
10/4/2021	swap	3.64%	64.09%
10/3/2022	swap	3.72%	61.07%
10/3/2023	swap	3.79%	58.18%
10/3/2024	swap	3.84%	55.43%
10/3/2029	swap	3.99%	44.76%

Table 2: Extracted discount factors from money market quotes and swap rates.

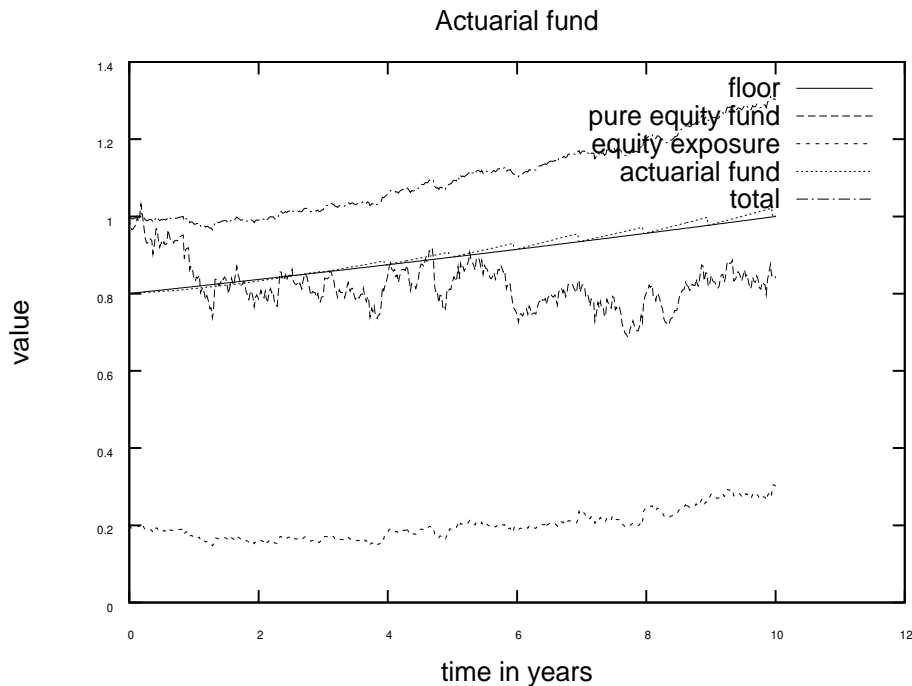


Figure 3: Simulated path for a classical insurance strategy and 10 year investment horizon

also the risk to reach the floor. For a leverage factor of  $a = 1$  the structure becomes static when assuming constant interest rates. A commonly used value for  $a$  in the industry is 3. For a sample path of a CPPI and the equity and fixed income distribution structure with leverage factor 3 see Figure 4. This strategy guarantees 100% capital protection in a continuous model. In a model with jumps this is not the case anymore. The strategy is subject to gap risk, the risk that due to a jump in the market, rebalancing is not possible and the fund value drops below the floor. We neglect liquidity issues here which would cause an additional risk. However due to the continuous reduction of the equity exposure this risk is rather small. See for example (Black & Perold 1992) for the general theory of constant proportion portfolio insurance.

### 5.3 Stop loss strategy

In the stop loss strategy 100% of the equity amount is held in the risky fund until the floor is reached. In this case all the investment is moved to the fixed income fund to generate the guarantee at maturity. See Figure 5 for a path where the stop loss barrier is reached and all the investment is shifted into the fixed income fund. This strategy is riskless as the CPPI strategy in a continuous model. In a model with jumps again we are imposed to gap risk. We neglect liquidity issues here which actually forces the insurer to liquidate the risky asset before it reaches the floor level. This issue becomes especially important for large funds, which is often the case for retirement plans or life insurance products since the amount to liquidate is so big that it actually influences the market.

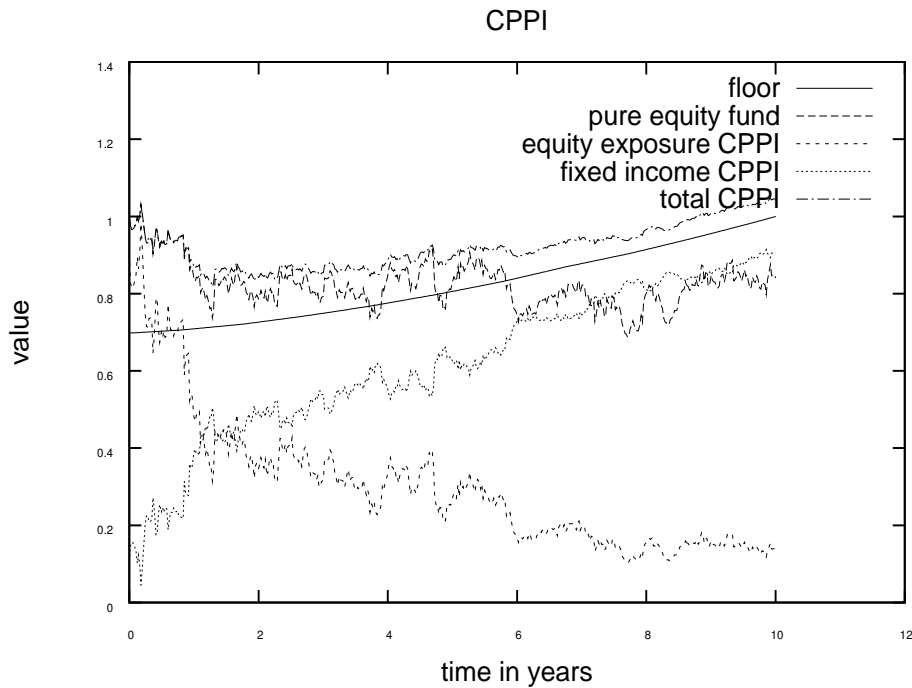


Figure 4: Simulated CPPI path with leverage factor 3 and 10 years investment horizon

## 6 Payments to the contract and simulation horizon

Since capital guaranteed life insurance products are especially popular in Germany under the master agreement of the Riester-Rente, we consider a typical payment plan with an horizon of 20 years. To be eligible for the maximal amount of cash payments and tax benefits the insured has to spend at least 4% of his yearly gross income for the insurance product, including the payments from the state but no more than 2,100 Euro. In this case he receives cash payments of 154 Euro per year, and additional 185 Euro for each child born before January 1 2008 and 300 Euro for each child born on or after this date. Even though this is not the focus of this paper, we assume a saving plan that allows for these benefits in order to compare typical cost structure against the state benefits. We consider the situation of a person being 45 years old when entering the contract and earning 30,000 Euro a year. We further assume that he has one child born after January 1 2008 but before entering the contract. In this case the insured receives 454 Euro from the state, so he actually only has to pay 746 Euro per year to reach 1,200 per year (4% of his income). This is a very high support rate of 37%. For comparison, if we take an investor without children, earning 52,500 Euro per year, the support rate would only be maximal 7.3%. We assume a monthly payment of 100 Euro and do not distinguish between payments made by the state and by the insured. The total nominal amount is  $20 \times 1,200 = 24,000$  Euro. This is the amount the issuer of the plan

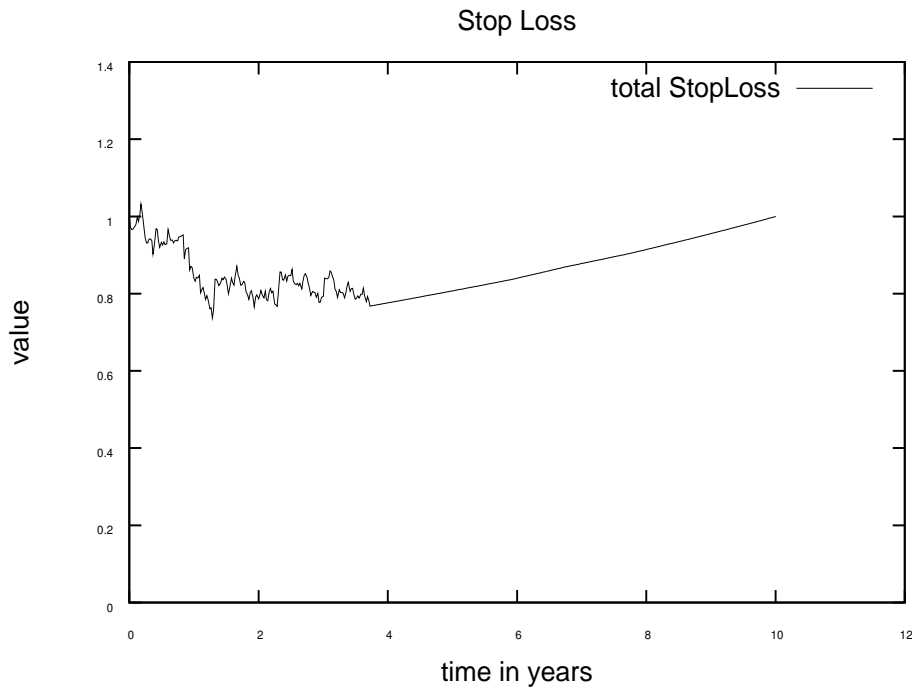


Figure 5: Simulated stop-loss path with 10 years investment horizon

needs to guarantee at retirement. There is no guarantee during the lifetime of the contract. Especially in the case that the insured dies before retirement, the payments to the contract are not guaranteed and only the current account value can be transferred to another contract or payed out. In case the contract is payed out, payments from the state will be claimed back.

## 7 Cost structures

We study the impact of different cost structures which are often seen in insurance products. Often the fee structure of these products is rather complex and consists of a combination of various fees.

- Sales and Distribution cost: These costs are usually charged to pay a sales fee for the agent who closed the deal with the insured. These fees are usually dependent on the total cash contracted to pay into the contract until maturity. However they are usually charged uniformly distributed over the first 5 years of the contract. In insurance business they are called  $\alpha$ -cost.
- Administration cost: These costs are usually charged on the cash payments to the contract during the entire lifetime of the contract. They are usually charged to cover administrative costs of the contract. In insurance business they are called  $\beta$ -cost.
- Capital management cost: These costs are charged based on the sum of

Scenario	drift $\mu$	volatility $\sigma_{tot}$
Standard	6%	14.3%
Optimistic	8%	14.3%
Pessimistic	4%	14.3%

Table 3: Model parameters for the different scenarios. The other model parameters are taken from the estimates in Table 1

the payments up to the effective date. They are usually charged for capital management.

To compare the impact of these different cost structures we analyze costs that are equivalent in terms of the current value. We assume a total fee of 4% of all payments to the contract, i.e. 960 Euro. The current value of these fees with the applied zero bond curve is 681 Euro. Since the typical costs in insurance products are usually a combination of all these fees we also simulate the impact of the sum of these single fees which is a commonly used cost charge.

## 8 Results without costs

We present the simulation results for different scenarios. Since the drift is hardly estimated from the past realization, we calculate the results for three different drift assumptions.

In Figure 6 it can be seen how the distribution varies between the different strategies.

The stop loss strategy has an expected distribution very close to the pure equity investment since it has the highest equity participation as can be seen in Table 4, Table 5 and Table 6. So, for the bullish investor this might be the optimal investment for his Riester-Rente. A similar return profile is provided by a CPPI structure with a high leverage factor. The advantage of the CPPI product in practice is that due to the continuous reduction of the exposure if the market is performing badly, the liquidity issue is smaller than for the stop loss strategy. However, as can be seen in Figure 6, the risk of returns close to zero is rather high for both, the stop loss and the CPPI with a high leverage factor. For the bearish investor a classical product with an investment mainly in the actuarial fund or a CPPI product with a small leverage factor could be the better choice.

## 9 Impact of costs

It can be seen that the fees have a high impact on the return distribution. Even if the fees have actually the same current value, the impact on the return distribution is different. The alpha cost weakens the expected return most since it decreases the exposure at the beginning of the saving period. This impact is very high for the actuarial reserve product which even without fees only has an average equity participation of 36.54%. The alpha fee reduces this further



Strategy	mean	median	exposure
Actuarial	40945	39393	36.54%
CPPI Leverage 1.5	43636	38826	73.48%
CPPI Leverage 2	44731	38129	87.83%
CPPI Leverage 3	45211	39726	94.03%
CPPI Leverage 4	45326	40489	95.56%
Stop Loss	45443	40867	96.65%

Table 4: Results in the standard scenario.

Strategy	mean	median	exposure
Actuarial	45055	42991	38.91%
CPPI Leverage 1.5	53074	45937	79.01%
CPPI Leverage 2	55850	48409	92.66%
CPPI Leverage 3	56765	50825	97.14%
CPPI Leverage 4	56942	51126	98.06%
Stop Loss	57059	51252	98.69%

Table 5: Results in the optimistic scenario.

Strategy	mean	median	exposure
Actuarial	37706	36541	34.25%
CPPI Leverage 1.5	37160	34041	67.81%
CPPI Leverage 2	36892	32332	81.77%
CPPI Leverage 3	36698	30838	89.19%
CPPI Leverage 4	36640	30751	91.32%
Stop Loss	36693	32118	92.96%

Table 6: Results in the pessimistic scenario.

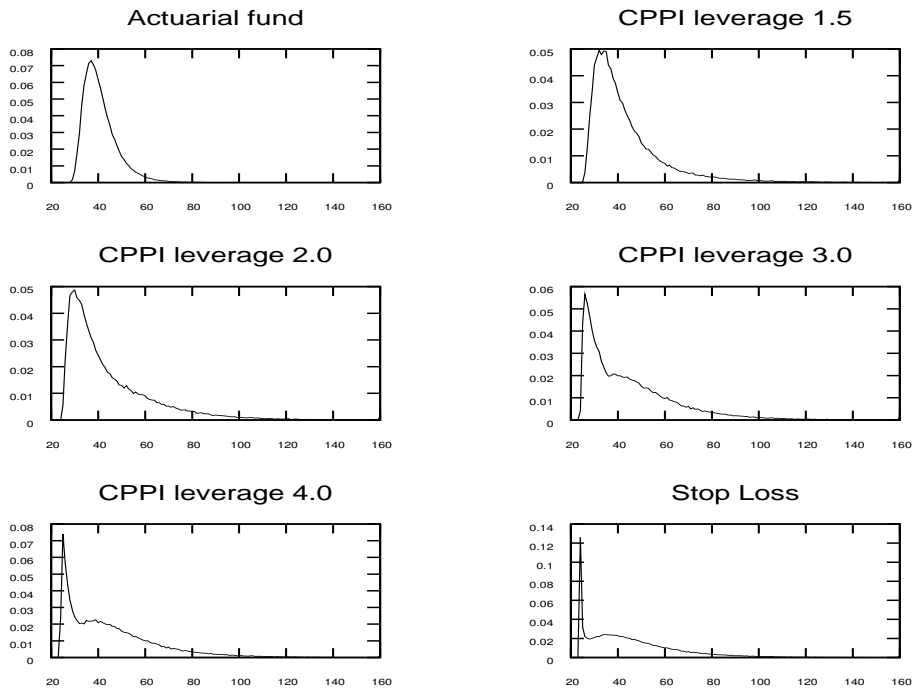


Figure 6: Return distribution of the different strategies. We list the capital available at retirement (in units of 1,000 EUR) on the  $x$ -axes.

to 30.9% as can be seen in Table 7. The fees on the accumulated payments has the least impact since these are mainly charged at the end of the saving period and therefore the impact on the equity exposure is smaller. The insured has to carefully study whether the negative impact of the fee structure is actually fully compensated by the federal cash payments. This highly depends on the cost structure which varies massively between the different products and on the income and family situation of the insured, which in turn determines the amount of cash benefits from the state. In many cases it may be advisable to choose a product outside the class of Riester-Rente that has a smaller cost ratio. In this case the investor can buy less costly products and can freely choose a product without capital protection, which has a higher expected return. A more detailed analysis of the different cost structures can be found in (Detering, Weber & Wystup 2009).

## 10 Impact of jumps

The CPPI and the Stop Loss strategy are risk free in a continuous equity model. However, in a model with jumps, we are exposed to *gap risk*, which means that the value of portfolio of risky assets can fall below the floor. In this case the strategy fails to generate the guarantee. In practice the leverage factor is chosen such that even a very big jump in the market still maintains the guarantee. For example, a 20% jump in the market doesn't cause a loss for a rebalanced portfolio if the leverage factor is below 5. In this case all the equity

Cost	mean	median	exposure
No cost	40945	39393	36.54%
Alpha cost	38923	37678	30.89%
Beta cost	39120	37747	33.83%
Cost on accumulated payments	39231	37782	35.17%
Sum of all fees	35387	34422	25.93%

Table 7: Results for the actuarial reserve product in the standard scenario with costs.

Cost	mean	median	exposure
No cost	45326	40486	95.56%
Alpha cost	43236	38423	94.36%
Beta cost	43433	38496	94.42%
Cost on accumulated payments	43546	38566	94.51%
Sum of all fees	39506	33966	91.13%

Table 8: Results in the CPPI strategy with leverage factor 3 with costs in the standard scenario.

Cost	mean	median	exposure
No cost	45443	40869	96.65%
Alpha cost	43376	38918	95.62%
Beta cost	43577	39044	95.67%
Cost on accumulated payments	43706	39139	95.75%
Sum of all fees	39747	35141	92.83%

Table 9: Results in the stop loss strategy with costs in the standard scenario.

Product	number of paths with gap	average realized gap
CPPI, factor 3, no fees	0	0
CPPI, factor 3, with fees	265	50
Stop loss, no fees	18804	219
Stop loss, with fees	31317	354

Table 10: Shortfalls for stop loss and CPPI for 100,000 simulations.

exposure would be lost, but the guarantee could exactly be generated. So, with a moderate leverage factor the remaining gap risk is negligible. This is also reflected in our jump diffusion model. For the stop loss strategy the situation is different since the equity exposure does not decrease when approaching the floor level. We calculate how often the strategy fails in case of a jump on average. The expected number of guarantee shortfalls is shown in Table 10. We assume that after the stop loss level is reached and all money is invested in the risk free fund it stays there until maturity. Only new cash flows are again invested in the risky fund. Therefore, it might happen that there are several guarantee shortfalls in one path. The shortfall number is the accumulated sum of shortfalls over one path. We show the number of shortfalls for a contract without fees and for a contract with fees. The fees increase the risk of a shortfall since the insurance company has to guarantee the cash payments made by the insured. Table 10 shows that in the CPPI strategy the guarantee is never at risk. The shortfalls in the situation with fees are actually not caused by large jumps, but are caused by high fees close to maturity. At this time the fee charge on the incoming cash flow is so high compared to the difference between invested amount and its present value that the cash contribution does not suffice to ensure the guarantee. In case of a low performing path history the investments done earlier are not able to compensate for this.

## 11 Summary

We have compared the performance of savings plans within the class of difference capital guarantee mechanisms: from the stop loss to classic investments in actuarial reserve funds. CPPI strategies with different leverage factors can be viewed as a compromises between these two extremes. In bullish markets savings plans with a high equity ratio perform the best, in bearish markets the classic insurance concept shows better returns. A stop loss strategy suffers from gap risk, whence a CPPI strategy combines the strength of both gap risk minimization and equity ratio maximization. The effect of fees on the savings plans dominates the performance, especially in typical fee structures found in the German Riester-Rente. The private investor is advised to check carefully if the federal cash payments can compensate the fees taking into account his own salary and tax situation.

## References

- Black, F. & Scholes, M. (1973). *The pricing of Options and Corporate Liabilities*, Journal of Political Economy **81** (3): 637-654.
- Black, F. & Perold, A.R. (1992). *Theory of constant proportion portfolio insurance*, Journal of Economic Dynamics and Control **16** : 403-426.
- Detering, N., Weber, A. & Wystup, U. (2009). *Riesterrente im Vergleich - Eine Simulationsstudie zur Verteilung der Rendite im Auftrag von Euro-Magazin*, MathFinance Research Paper.
- Hardy, M. (2003). *Investment Guarantees: Modelling and Risk Management for Equity-Linked Life Insurance*, Wiley Finance.
- Kou, S.G. (2002). *A Jump-Diffusion-Model for option pricing*, Management Science **48** (8): 1086-1101.

**FRANKFURT SCHOOL / HfB – WORKING PAPER SERIES**

<b>No.</b>	<b>Author/Title</b>	<b>Year</b>
155	Libman Alexander / Vinokurov, Evgeny Is it really different? Patterns of Regionalisation in the Post-Soviet Central Asia	2010
154	Libman, Alexander Subnational Resource Curse: Do Economic or Political Institutions Matter?	2010
153	Herrmann-Pillath, Carsten Meaning and Function in the Theory of Consumer Choice: Dual Selves in Evolving Networks	2010
152	Kostka, Genia / Hobbs, William Embedded Interests and the Managerial Local State: Methanol Fuel-Switching in China	2010
151.	Kostka, Genia / Hobbs, William Energy Efficiency in China: The Local Bundling of Interests and Policies	2010
150.	Umber, Marc P. / Grote, Michael H. / Frey, Rainer Europe Integrates Less Than You Think. Evidence from the Market for Corporate Control in Europe and the US	2010
149.	Vogel, Ursula / Winkler, Adalbert Foreign banks and financial stability in emerging markets: evidence from the global financial crisis	2010
148.	Libman, Alexander Words or Deeds – What Matters? Experience of Decentralization in Russian Security Agencies	2010
147.	Kostka, Genia / Zhou, Jianghua Chinese firms entering China's low-income market: Gaining competitive advantage by partnering governments	2010
146.	Herrmann-Pillath, Carsten Rethinking Evolution, Entropy and Economics: A triadic conceptual framework for the Maximum Entropy Principle as applied to the growth of knowledge	2010
145.	Heidorn, Thomas / Kahlert, Dennis Implied Correlations of iTraxx Tranches during the Financial Crisis	2010
144	Fritz-Morgenthal, Sebastian G. / Hach, Sebastian T. / Schalast, Christoph M&A im Bereich Erneuerbarer Energien	2010
143.	Birkmeyer, Jörg / Heidorn, Thomas / Rogalski, André Determinanten von Banken-Spreads während der Finanzmarktkrise	2010
142.	Bannier, Christina E. / Metz, Sabrina Are SMEs large firms en miniature? Evidence from a growth analysis	2010
141.	Heidorn, Thomas / Kaiser, Dieter G. / Voinea, André The Value-Added of Investable Hedge Fund Indices	2010
140.	Herrmann-Pillath, Carsten The Evolutionary Approach to Entropy: Reconciling Georgescu-Roegen's Natural Philosophy with the Maximum Entropy Framework	2010
139.	Heidorn, Thomas / Löw, Christian / Winker, Michael Funktionsweise und Replikationstil europäischer Exchange Traded Funds auf Aktienindices	2010
138.	Libman, Alexander Constitutions, Regulations, and Taxes: Contradictions of Different Aspects of Decentralization	2010
137.	Herrmann-Pillath, Carsten / Libman, Alexander / Yu, Xiaofan State and market integration in China: A spatial econometrics approach to 'local protectionism'	2010
136.	Lang, Michael / Cremers, Heinz / Hentze, Rainald Ratingmodell zur Quantifizierung des Ausfallrisikos von LBO-Finanzierungen	2010
135.	Bannier, Christina / Feess, Eberhard When high-powered incentive contracts reduce performance: Choking under pressure as a screening device	2010
134.	Herrmann-Pillath, Carsten Entropy, Function and Evolution: Naturalizing Peircian Semiosis	2010
133.	Bannier, Christina E. / Behr, Patrick / Güttler, Andre Rating opaque borrowers: why are unsolicited ratings lower?	2009
132.	Herrmann-Pillath, Carsten Social Capital, Chinese Style: Individualism, Relational Collectivism and the Cultural Embeddedness of the Institutions-Performance Link	2009
131.	Schäffler, Christian / Schmaltz, Christian Market Liquidity: An Introduction for Practitioners	2009
130.	Herrmann-Pillath, Carsten Dimensionen des Wissens: Ein kognitiv-evolutionärer Ansatz auf der Grundlage von F.A. von Hayeks Theorie der „Sensory Order“	2009

129.	Hankir, Yassin / Rauch, Christian / Ueber, Marc It's the Market Power, Stupid! – Stock Return Patterns in International Bank M&A	2009
128.	Herrmann-Pillath, Carsten Outline of a Darwinian Theory of Money	2009
127.	Cremers, Heinz / Walzner, Jens Modellierung des Kreditrisikos im Portfoliofall	2009
126.	Cremers, Heinz / Walzner, Jens Modellierung des Kreditrisikos im Einwertpapierfall	2009
125.	Heidorn, Thomas / Schmaltz, Christian Interne Transferpreise für Liquidität	2009
124.	Bannier, Christina E. / Hirsch, Christian The economic function of credit rating agencies - What does the watchlist tell us?	2009
123.	Herrmann-Pillath, Carsten A Neurolinguistic Approach to Performativity in Economics	2009
122.	Winkler, Adalbert / Vogel, Ursula Finanzierungsstrukturen und makroökonomische Stabilität in den Ländern Südosteuropas, der Türkei und in den GUS-Staaten	2009
121.	Heidorn, Thomas / Rupprecht, Stephan Einführung in das Kapitalstrukturmanagement bei Banken	2009
120.	Rosbach, Peter Die Rolle des Internets als Informationsbeschaffungsmedium in Banken	2009
119.	Herrmann-Pillath, Carsten Diversity Management und diversitätsbasiertes Controlling: Von der „Diversity Scorecard“ zur „Open Balanced Scorecard“	2009
118.	Hölscher, Luise / Clasen, Sven Erfolgsfaktoren von Private Equity Fonds	2009
117.	Bannier, Christina E. Is there a hold-up benefit in heterogeneous multiple bank financing?	2009
116.	Roßbach, Peter / Gießamer, Dirk Ein eLearning-System zur Unterstützung der Wissensvermittlung von Web-Entwicklern in Sicherheitsthemen	2009
115.	Herrmann-Pillath, Carsten Kulturelle Hybridisierung und Wirtschaftstransformation in China	2009
114.	Schalast, Christoph: Staatsfonds – „neue“ Akteure an den Finanzmärkten?	2009
113.	Schalast, Christoph / Alram, Johannes Konstruktion einer Anleihe mit hypothekarischer Besicherung	2009
112.	Schalast, Christoph / Bolder, Markus / Radünz, Claus / Siepmann, Stephanie / Weber, Thorsten Transaktionen und Servicing in der Finanzkrise: Berichte und Referate des Frankfurt School NPL Forums 2008	2009
111.	Werner, Karl / Moormann, Jürgen Efficiency and Profitability of European Banks – How Important Is Operational Efficiency?	2009
110.	Herrmann-Pillath, Carsten Moralische Gefühle als Grundlage einer wohlstandschaffenden Wettbewerbsordnung: Ein neuer Ansatz zur erforschung von Sozialkapital und seine Anwendung auf China	2009
109.	Heidorn, Thomas / Kaiser, Dieter G. / Roder, Christoph Empirische Analyse der Drawdowns von Dach-Hedgefonds	2009
108.	Herrmann-Pillath, Carsten Neuroeconomics, Naturalism and Language	2008
107.	Schalast, Christoph / Benita, Barten Private Equity und Familienunternehmen – eine Untersuchung unter besonderer Berücksichtigung deutscher Maschinen- und Anlagenbauunternehmen	2008
106.	Bannier, Christina E. / Grote, Michael H. Equity Gap? – Which Equity Gap? On the Financing Structure of Germany's Mittelstand	2008
105.	Herrmann-Pillath, Carsten The Naturalistic Turn in Economics: Implications for the Theory of Finance	2008
104.	Schalast, Christoph (Hrsg.) / Schanz, Kay-Michael / Scholl, Wolfgang Aktionärsschutz in der AG falsch verstanden? Die Leica-Entscheidung des LG Frankfurt am Main	2008
103.	Bannier, Christina E./ Müsch, Stefan Die Auswirkungen der Subprime-Krise auf den deutschen LBO-Markt für Small- und MidCaps	2008
102.	Cremers, Heinz / Vetter, Michael Das IRB-Modell des Kreditrisikos im Vergleich zum Modell einer logarithmisch normalverteilten Verlustfunktion	2008

101.	Heidorn, Thomas / Pleißner, Mathias Determinanten Europäischer CMBS Spreads. Ein empirisches Modell zur Bestimmung der Risikoaufschläge von Commercial Mortgage-Backed Securities (CMBS)	2008
100.	Schalast, Christoph (Hrsg.) / Schanz, Kay-Michael Schaeffler KG/Continental AG im Lichte der CSX Corp.-Entscheidung des US District Court for the Southern District of New York	2008
99.	Hölscher, Luise / Haug, Michael / Schweinberger, Andreas Analyse von Steueramnestiedaten	2008
98.	Heimer, Thomas / Arend, Sebastian The Genesis of the Black-Scholes Option Pricing Formula	2008
97.	Heimer, Thomas / Hölscher, Luise / Werner, Matthias Ralf Access to Finance and Venture Capital for Industrial SMEs	2008
96.	Böttger, Marc / Guthoff, Anja / Heidorn, Thomas Loss Given Default Modelle zur Schätzung von Recovery Rates	2008
95.	Almer, Thomas / Heidorn, Thomas / Schmaltz, Christian The Dynamics of Short- and Long-Term CDS-spreads of Banks	2008
94.	Barthel, Erich / Wollersheim, Jutta Kulturunterschiede bei Mergers & Acquisitions: Entwicklung eines Konzeptes zur Durchführung einer Cultural Due Diligence	2008
93.	Heidorn, Thomas / Kunze, Wolfgang / Schmaltz, Christian Liquiditätsmodellierung von Kreditzusagen (Term Facilities and Revolver)	2008
92.	Burger, Andreas Produktivität und Effizienz in Banken – Terminologie, Methoden und Status quo	2008
91.	Löchel, Horst / Pecher, Florian The Strategic Value of Investments in Chinese Banks by Foreign Financial Institutions	2008
90.	Schalast, Christoph / Morgenschweis, Bernd / Sprengel, Hans Otto / Ockens, Klaas / Stachuletz, Rainer / Safran, Robert Der deutsche NPL Markt 2007: Aktuelle Entwicklungen, Verkauf und Bewertung – Berichte und Referate des NPL Forums 2007	2008
89.	Schalast, Christoph / Stralkowski, Ingo 10 Jahre deutsche Buyouts	2008
88.	Bannier, Christina E./ Hirsch, Christian The Economics of Rating Watchlists: Evidence from Rating Changes	2007
87.	Demidova-Menzel, Nadeshda / Heidorn, Thomas Gold in the Investment Portfolio	2007
86.	Hölscher, Luise / Rosenthal, Johannes Leistungsmessung der Internen Revision	2007
85.	Bannier, Christina / Hänsel, Dennis Determinants of banks' engagement in loan securitization	2007
84.	Bannier, Christina "Smoothing" versus "Timeliness" - Wann sind stabile Ratings optimal und welche Anforderungen sind an optimale Berichtsregeln zu stellen?	2007
83.	Bannier, Christina E. Heterogeneous Multiple Bank Financing: Does it Reduce Inefficient Credit-Renegotiation Incidences?	2007
82.	Cremers, Heinz / Lühr, Andreas Deskription und Bewertung strukturierter Produkte unter besonderer Berücksichtigung verschiedener Marktszenarien	2007
81.	Demidova-Menzel, Nadeshda / Heidorn, Thomas Commodities in Asset Management	2007
80.	Cremers, Heinz / Walzner, Jens Risikosteuerung mit Kreditderivaten unter besonderer Berücksichtigung von Credit Default Swaps	2007
79.	Cremers, Heinz / Traugber, Patrick Handlungsalternativen einer Genossenschaftsbank im Investmentprozess unter Berücksichtigung der Risikotragfähigkeit	2007
78.	Gerdesmeier, Dieter / Roffia, Barbara Monetary Analysis: A VAR Perspective	2007
77.	Heidorn, Thomas / Kaiser, Dieter G. / Muschiol, Andrea Portfoliooptimierung mit Hedgefonds unter Berücksichtigung höherer Momente der Verteilung	2007
76.	Jobe, Clemens J. / Ockens, Klaas / Safran, Robert / Schalast, Christoph Work-Out und Servicing von notleidenden Krediten – Berichte und Referate des HfB-NPL Servicing Forums 2006	2006
75.	Abrar, Kamyar / Schalast, Christoph Fusionskontrolle in dynamischen Netzsektoren am Beispiel des Breitbandkabelsektors	2006



74.	Schalast, Christoph / Schanz, Kay-Michael Wertpapierprospekte: Markteinführungspublizität nach EU-Prospektverordnung und Wertpapierprospektgesetz 2005	2006
73.	Dickler, Robert A. / Schalast, Christoph Distressed Debt in Germany: What's Next? Possible Innovative Exit Strategies	2006
72.	Belke, Ansgar / Polleit, Thorsten How the ECB and the US Fed set interest rates	2006
71.	Heidorn, Thomas / Hoppe, Christian / Kaiser, Dieter G. Heterogenität von Hedgefondsindizes	2006
70.	Baumann, Stefan / Löchel, Horst The Endogeneity Approach of the Theory of Optimum Currency Areas - What does it mean for ASEAN + 3?	2006
69.	Heidorn, Thomas / Trautmann, Alexandra Niederschlagsderivate	2005
68.	Heidorn, Thomas / Hoppe, Christian / Kaiser, Dieter G. Möglichkeiten der Strukturierung von Hedgefondsportfolios	2005
67.	Belke, Ansgar / Polleit, Thorsten (How) Do Stock Market Returns React to Monetary Policy ? An ARDL Cointegration Analysis for Germany	2005
66.	Daynes, Christian / Schalast, Christoph Aktuelle Rechtsfragen des Bank- und Kapitalmarktsrechts II: Distressed Debt - Investing in Deutschland	2005
65.	Gerdesmeier, Dieter / Polleit, Thorsten Measures of excess liquidity	2005
64.	Becker, Gernot M. / Harding, Perham / Hölscher, Luise Financing the Embedded Value of Life Insurance Portfolios	2005
63.	Schalast, Christoph Modernisierung der Wasserwirtschaft im Spannungsfeld von Umweltschutz und Wettbewerb – Braucht Deutschland eine Rechtsgrundlage für die Vergabe von Wasserversorgungskonzessionen? –	2005
62.	Bayer, Marcus / Cremers, Heinz / Kluß, Norbert Wertsicherungsstrategien für das Asset Management	2005
61.	Löchel, Horst / Polleit, Thorsten A case for money in the ECB monetary policy strategy	2005
60.	Richard, Jörg / Schalast, Christoph / Schanz, Kay-Michael Unternehmen im Prime Standard - „Staying Public“ oder „Going Private“? - Nutzenanalyse der Börsennotiz -	2004
59.	Heun, Michael / Schlink, Torsten Early Warning Systems of Financial Crises - Implementation of a currency crisis model for Uganda	2004
58.	Heimer, Thomas / Köhler, Thomas Auswirkungen des Basel II Akkords auf österreichische KMU	2004
57.	Heidorn, Thomas / Meyer, Bernd / Pietrowiak, Alexander Performanceeffekte nach Directors Dealings in Deutschland, Italien und den Niederlanden	2004
56.	Gerdesmeier, Dieter / Roffia, Barbara The Relevance of real-time data in estimating reaction functions for the euro area	2004
55.	Barthel, Erich / Gierig, Rauno / Kühn, Ilmhart-Wolfram Unterschiedliche Ansätze zur Messung des Humankapitals	2004
54.	Anders, Dietmar / Binder, Andreas / Hesdahl, Ralf / Schalast, Christoph / Thöne, Thomas Aktuelle Rechtsfragen des Bank- und Kapitalmarktsrechts I : Non-Performing-Loans / Faule Kredite - Handel, Work-Out, Outsourcing und Securitisation	2004
53.	Polleit, Thorsten The Slowdown in German Bank Lending – Revisited	2004
52.	Heidorn, Thomas / Siragusano, Tindaro Die Anwendbarkeit der Behavioral Finance im Devisenmarkt	2004
51.	Schütze, Daniel / Schalast, Christoph (Hrsg.) Wider die Verschleuderung von Unternehmen durch Pfandversteigerung	2004
50.	Gerhold, Mirko / Heidorn, Thomas Investitionen und Emissionen von Convertible Bonds (Wandelanleihen)	2004
49.	Chevalier, Pierre / Heidorn, Thomas / Krieger, Christian Temperaturderivate zur strategischen Absicherung von Beschaffungs- und Absatzrisiken	2003
48.	Becker, Gernot M. / Seeger, Norbert Internationale Cash Flow-Rechnungen aus Eigner- und Gläubigersicht	2003
47.	Boenkost, Wolfram / Schmidt, Wolfgang M. Notes on convexity and quanto adjustments for interest rates and related options	2003
46.	Hess, Dieter Determinants of the relative price impact of unanticipated Information in U.S. macroeconomic releases	2003

45.	Cremers, Heinz / Kluß, Norbert / König, Markus Incentive Fees. Erfolgsabhängige Vergütungsmodelle deutscher Publikumsfonds	2003
44.	Heidorn, Thomas / König, Lars Investitionen in Collateralized Debt Obligations	2003
43.	Kahlert, Holger / Seeger, Norbert Bilanzierung von Unternehmenszusammenschlüssen nach US-GAAP	2003
42.	Beiträge von Studierenden des Studiengangs BBA 012 unter Begleitung von Prof. Dr. Norbert Seeger Rechnungslegung im Umbruch - HGB-Bilanzierung im Wettbewerb mit den internationalen Standards nach IAS und US-GAAP	2003
41.	Overbeck, Ludger / Schmidt, Wolfgang Modeling Default Dependence with Threshold Models	2003
40.	Balthasar, Daniel / Cremers, Heinz / Schmidt, Michael Portfoliooptimierung mit Hedge Fonds unter besonderer Berücksichtigung der Risikokomponente	2002
39.	Heidorn, Thomas / Kantwill, Jens Eine empirische Analyse der Spreadunterschiede von Festsatzanleihen zu Floatern im Euroraum und deren Zusammenhang zum Preis eines Credit Default Swaps	2002
38.	Böttcher, Henner / Seeger, Norbert Bilanzierung von Finanzderivaten nach HGB, EstG, IAS und US-GAAP	2003
37.	Moormann, Jürgen Terminologie und Glossar der Bankinformatik	2002
36.	Heidorn, Thomas Bewertung von Kreditprodukten und Credit Default Swaps	2001
35.	Heidorn, Thomas / Weier, Sven Einführung in die fundamentale Aktienanalyse	2001
34.	Seeger, Norbert International Accounting Standards (IAS)	2001
33.	Moormann, Jürgen / Stehling, Frank Strategic Positioning of E-Commerce Business Models in the Portfolio of Corporate Banking	2001
32.	Sokolovsky, Zbynek / Strohhecker, Jürgen Fit für den Euro, Simulationsbasierte Euro-Maßnahmenplanung für Dresdner-Bank-Geschäftsstellen	2001
31.	Roßbach, Peter Behavioral Finance - Eine Alternative zur vorherrschenden Kapitalmarkttheorie?	2001
30.	Heidorn, Thomas / Jaster, Oliver / Willeitner, Ulrich Event Risk Covenants	2001
29.	Biswas, Rita / Löchel, Horst Recent Trends in U.S. and German Banking: Convergence or Divergence?	2001
28.	Eberle, Günter Georg / Löchel, Horst Die Auswirkungen des Übergangs zum Kapitaldeckungsverfahren in der Rentenversicherung auf die Kapitalmärkte	2001
27.	Heidorn, Thomas / Klein, Hans-Dieter / Siebrecht, Frank Economic Value Added zur Prognose der Performance europäischer Aktien	2000
26.	Cremers, Heinz Konvergenz der binomialen Optionspreismodelle gegen das Modell von Black/Scholes/Merton	2000
25.	Löchel, Horst Die ökonomischen Dimensionen der ‚New Economy‘	2000
24.	Frank, Axel / Moormann, Jürgen Grenzen des Outsourcing: Eine Exploration am Beispiel von Direktbanken	2000
23.	Heidorn, Thomas / Schmidt, Peter / Seiler, Stefan Neue Möglichkeiten durch die Namensaktie	2000
22.	Böger, Andreas / Heidorn, Thomas / Graf Waldstein, Philipp Hybrides Kernkapital für Kreditinstitute	2000
21.	Heidorn, Thomas Entscheidungsorientierte Mindestmargenkalkulation	2000
20.	Wolf, Birgit Die Eigenmittelkonzeption des § 10 KWG	2000
19.	Cremers, Heinz / Robé, Sophie / Thiele, Dirk Beta als Risikomaß - Eine Untersuchung am europäischen Aktienmarkt	2000
18.	Cremers, Heinz Optionspreisbestimmung	1999
17.	Cremers, Heinz Value at Risk-Konzepte für Marktrisiken	1999

16.	Chevalier, Pierre / Heidorn, Thomas / Rütze, Merle Gründung einer deutschen Strombörse für Elektrizitätsderivate	1999
15.	Deister, Daniel / Ehrlicher, Sven / Heidorn, Thomas CatBonds	1999
14.	Jochum, Eduard Hoshin Kanri / Management by Policy (MbP)	1999
13.	Heidorn, Thomas Kreditderivate	1999
12.	Heidorn, Thomas Kreditrisiko (CreditMetrics)	1999
11.	Moormann, Jürgen Terminologie und Glossar der Bankinformatik	1999
10.	Löchel, Horst The EMU and the Theory of Optimum Currency Areas	1998
09.	Löchel, Horst Die Geldpolitik im Währungsraum des Euro	1998
08.	Heidorn, Thomas / Hund, Jürgen Die Umstellung auf die Stückaktie für deutsche Aktiengesellschaften	1998
07.	Moormann, Jürgen Stand und Perspektiven der Informationsverarbeitung in Banken	1998
06.	Heidorn, Thomas / Schmidt, Wolfgang LIBOR in Arrears	1998
05.	Jahresbericht 1997	1998
04.	Ecker, Thomas / Moormann, Jürgen Die Bank als Betreiberin einer elektronischen Shopping-Mall	1997
03.	Jahresbericht 1996	1997
02.	Cremers, Heinz / Schwarz, Willi Interpolation of Discount Factors	1996
01.	Moormann, Jürgen Lean Reporting und Führungsinformationssysteme bei deutschen Finanzdienstleistern	1995

**FRANKFURT SCHOOL / HFB – WORKING PAPER SERIES  
CENTRE FOR PRACTICAL QUANTITATIVE FINANCE**

<b>No.</b>	<b>Author/Title</b>	<b>Year</b>
26.	Veiga, Carlos / Wystup, Uwe Ratings of Structured Products and Issuers' Commitments	2010
25.	Beyna, Ingo / Wystup, Uwe On the Calibration of the Cheyette. Interest Rate Model	2010
24.	Scholz, Peter / Walther, Ursula Investment Certificates under German Taxation. Benefit or Burden for Structured Products' Performance	2010
23.	Esquivel, Manuel L. / Veiga, Carlos / Wystup, Uwe Unifying Exotic Option Closed Formulas	2010
22.	Packham, Natalie / Schlögl, Lutz / Schmidt, Wolfgang M. Credit gap risk in a first passage time model with jumps	2009
21.	Packham, Natalie / Schlögl, Lutz / Schmidt, Wolfgang M. Credit dynamics in a first passage time model with jumps	2009
20.	Reiswich, Dimitri / Wystup, Uwe FX Volatility Smile Construction	2009
19.	Reiswich, Dimitri / Tompkins, Robert Potential PCA Interpretation Problems for Volatility Smile Dynamics	2009
18.	Keller-Ressel, Martin / Kilin, Fiodar Forward-Start Options in the Barndorff-Nielsen-Shephard Model	2008
17.	Griebsch, Susanne / Wystup, Uwe On the Valuation of Fader and Discrete Barrier Options in Heston's Stochastic Volatility Model	2008
16.	Veiga, Carlos / Wystup, Uwe Closed Formula for Options with Discrete Dividends and its Derivatives	2008

15.	Packham, Natalie / Schmidt, Wolfgang Latin hypercube sampling with dependence and applications in finance	2008
14.	Hakala, Jürgen / Wystup, Uwe FX Basket Options	2008
13.	Weber, Andreas / Wystup, Uwe Vergleich von Anlagestrategien bei Riesterrenten ohne Berücksichtigung von Gebühren. Eine Simulationsstudie zur Verteilung der Renditen	2008
12.	Weber, Andreas / Wystup, Uwe Riesterrente im Vergleich. Eine Simulationsstudie zur Verteilung der Renditen	2008
11.	Wystup, Uwe Vanna-Volga Pricing	2008
10.	Wystup, Uwe Foreign Exchange Quanto Options	2008
09.	Wystup, Uwe Foreign Exchange Symmetries	2008
08.	Becker, Christoph / Wystup, Uwe Was kostet eine Garantie? Ein statistischer Vergleich der Rendite von langfristigen Anlagen	2008
07.	Schmidt, Wolfgang Default Swaps and Hedging Credit Baskets	2007
06.	Kilin, Fiodar Accelerating the Calibration of Stochastic Volatility Models	2007
05.	Gribsch, Susanne/ Kühn, Christoph / Wystup, Uwe Instalment Options: A Closed-Form Solution and the Limiting Case	2007
04.	Boenkost, Wolfram / Schmidt, Wolfgang M. Interest Rate Convexity and the Volatility Smile	2006
03.	Becker, Christoph/ Wystup, Uwe On the Cost of Delayed Currency Fixing Announcements	2005
02.	Boenkost, Wolfram / Schmidt, Wolfgang M. Cross currency swap valuation	2004
01.	Wallner, Christian / Wystup, Uwe Efficient Computation of Option Price Sensitivities for Options of American Style	2004

## **HFB – SONDERARBEITSBERICHTE DER HFB - BUSINESS SCHOOL OF FINANCE & MANAGEMENT**

<b>No.</b>	<b>Author/Title</b>	<b>Year</b>
01.	Nicole Kahmer / Jürgen Moormann Studie zur Ausrichtung von Banken an Kundenprozessen am Beispiel des Internet (Preis: € 120,--)	2003

Printed edition: €25.00 + €2.50 shipping

Download:

Working Paper: [http://www.frankfurt-school.de/content/de/research/publications/list\\_of\\_publication/list\\_of\\_publication](http://www.frankfurt-school.de/content/de/research/publications/list_of_publication/list_of_publication)  
CPQF: [http://www.frankfurt-school.de/content/de/cpqf/research\\_publications.html](http://www.frankfurt-school.de/content/de/cpqf/research_publications.html)

**Order address / contact**

Frankfurt School of Finance & Management  
Sonnemannstr. 9–11 ▪ D–60314 Frankfurt/M. ▪ Germany  
Phone: +49 (0) 69 154 008–734 ▪ Fax: +49 (0) 69 154 008–728  
eMail: [e.lahdensuu@fs.de](mailto:e.lahdensuu@fs.de)

Further information about Frankfurt School of Finance & Management  
may be obtained at: <http://www.fs.de>