Im FinanzVerbund der Volksbanken Raiffeisenbanken

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Using @RISK to Develop Financial Products

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London
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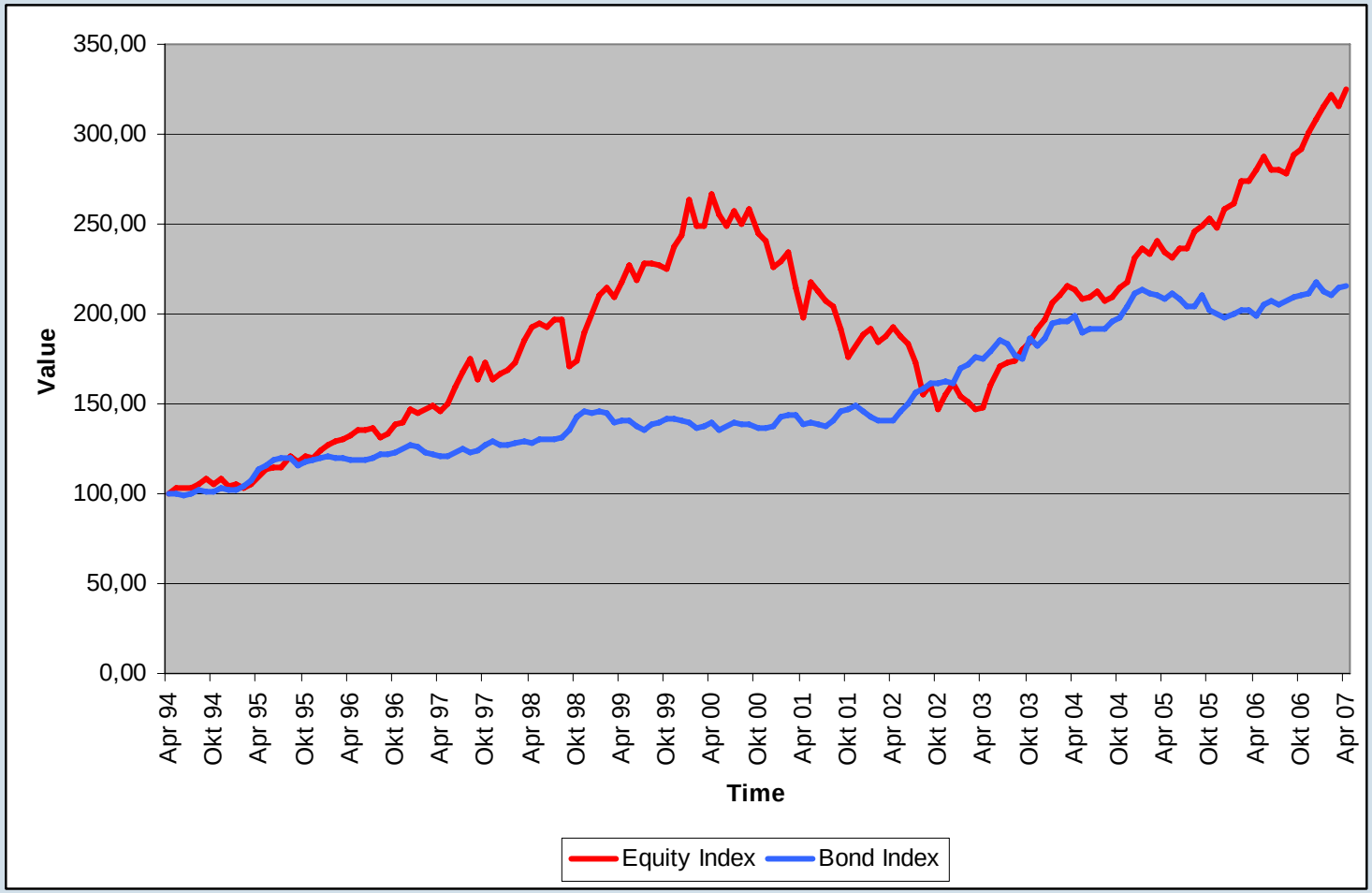
Union Investment

„Equities are better than bonds“

Comparison of a 100$ investment into equities or government bonds* (13 years)



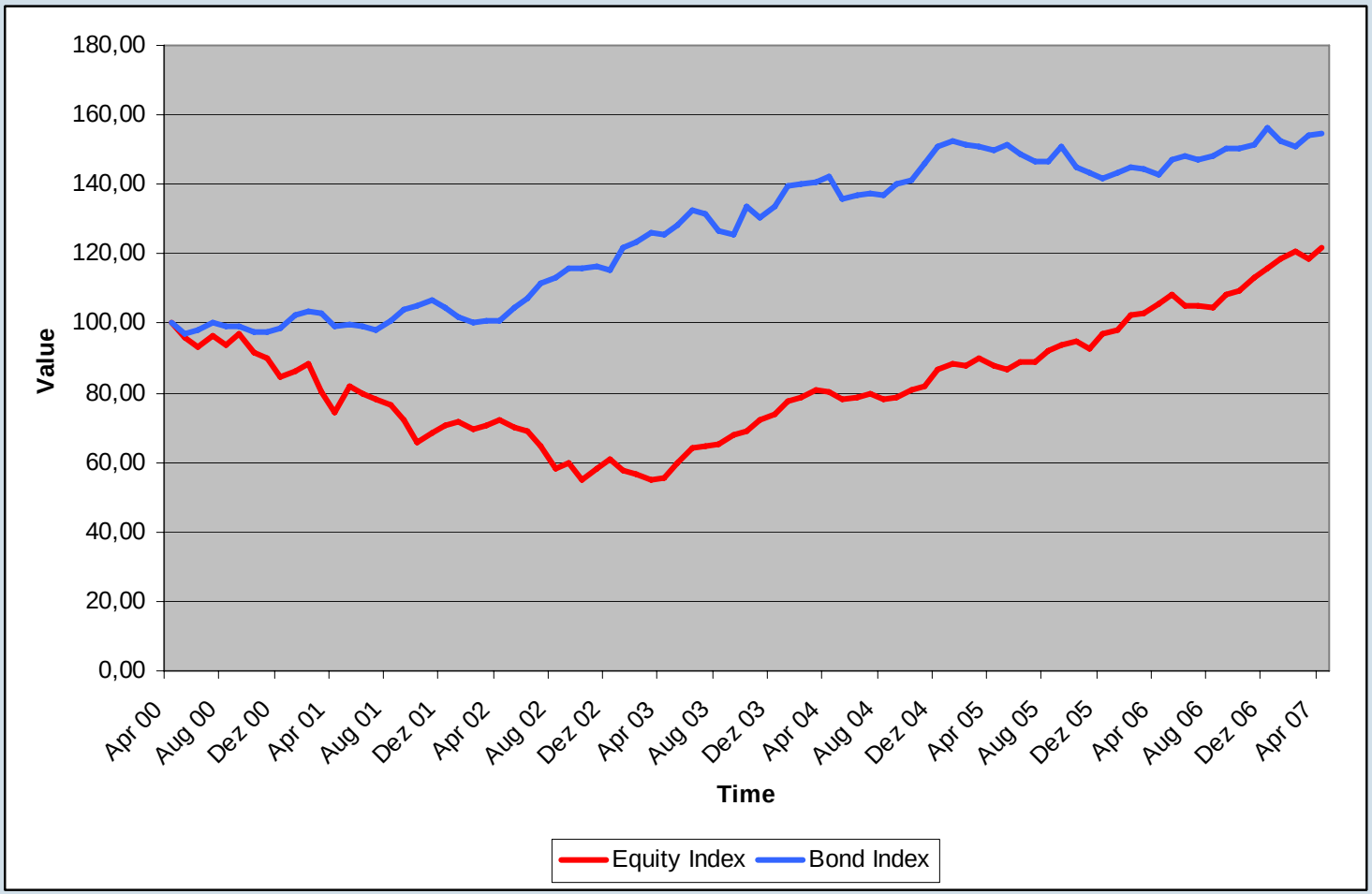
Equity investment is worth 324.49$

Bond investment is worth 216.11$

*Equities represented by MSCI World index and bonds by the ML Global Government Bond Index II

„Nonsense, bonds are better than equities“

Comparison of a 100$ investment into equities or government bonds* (7 years)



Bond investment is worth 154.84$

Equity investment is worth 121.79$

*Equities represented by MSCI World index and bonds by the ML Global Government Bond Index II

Advantages and Disadvantages of both Methods

Historical Simulation	Monte Carlo Simulation
Based on “hard facts“ Easy to explain Easy to perform	Distribution of results gives much more information Less dependent on historical data (but still: garbage in – garbage out)
“Tell me which result you want to see and I‘ll find an appropriate period“ Result is only one figure Assumption: history will repeat itself	More difficult to explain More time and effort

Product Requirements

- Investment for 10 years
- Invested capital guaranteed at maturity
- Own capital needed not more than 1% on a 99.9% confidence level
- Yield at least 6%

Assumptions

- Equities earn 9% p.a. with a volatility (stddev) of 17%
- Money Market earns 3% p.a. with a volatility (stddev) of 0,5%
- Both yields follow a normal distribution

1st Approach with different static Asset Allocations

Description

- A certain and static percentage of the money will be invested into equities
- The remainder will be invested into a “safe” asset class, e.g. into money market papers
- In order to find the optimal mix between risky assets (equities) and “safe“ assets several combinations will be evaluated using Monte Carlo Simulation:
  - 100% equities, 0% money market
  - 75% equities, 25% money market
  - 50% equities, 50% money market
  - 25% equities, 75% money market
  - 0% equities, 100% money market

Evaluation of different static Asset Allocations

Simulation model

$$fund_{t+1}=fund_t*(1+ep*ey_{t+1}+mmp*mmy_{t+1})$$

			p.a.	p.m.
	Equities	mu	9,00%	0,72%
		sigma	17,00%	4,91%
	percentage equities		50%	
	correlation		10,00%	
	Money Market	mu	3,00%	0,25%
		sigma	0,50%	0,14%
	percentage mm		50%	

	maturity (years)	10,00
	maturity (month)	120,00
final value:		157,95 €
yield:		4,68%
max drawdown:		29,63 €

			Yield				
month	Z1	Z2	equity	bond	equity	bond	fund
0	-0,59	0,64	-2,16%	0,33%	100,00 €	100,00 €	100,00 €
1	0,00	-0,95	0,72%	0,11%	100,72 €	100,11 €	100,41 €
2	-1,28	1,40	-5,58%	0,43%	95,10 €	100,54 €	97,83 €
3	-0,90	-0,59	-3,71%	0,15%	91,57 €	100,69 €	96,09 €
4	0,71	1,11	4,23%	0,42%	95,45 €	101,11 €	98,32 €
5	-1,57	0,10	-7,00%				95,00 €

$$equity_{t+1}=equity_t*(1+equity\_yield_{t+1})$$

$$equity\_yield=\mu_E+Z1*\sigma_E$$

$$bond\_yield=\mu_B+Z1*\sigma_B*\rho+Z2*\sigma_B*\sqrt{(1-\rho^2)}$$

$$Z1,\ Z2\ \sim N(0,1)$$

Evaluation of different static Asset Allocations

Using a VBA macro different combinations of input parameters can be run in batch

5	Runs	maturity (years)	percentage equities
1	10000	10,00	100%
2	10000	10,00	75%
3	10000	10,00	50%
4	10000	10,00	25%
5	10000	10,00	0%

```
Sub Makro1()
' Makro1 Makro
                                                    het
                                                    uswählen!!
    Selection.Copy
    Columns("C:IV").Select
    Selection.PasteSpecial Paste:=xlPasteFormats, Operation:=xlNone, _
        SkipBlanks:=False, Transpose:=False
    Application.CutCopyMode = False

    For i = 2 To Sheets("Input").Range("A1").Value + 1

' Hier werden die INPUTs eingelese:
' Linke Seite: Zelle der Simulation anpassen
' rechte Seite: Spalte der Inputgrößen anpassen

       'In der zweiten Spalte steht immer die Zahl der Runs
        Sheets("Ergebnisse").Range("B2").Value = Sheets("Input").Cells(i, 2).Value

        Sheets("Simulation").Range("J1").Value = Sheets("Input").Cells(i, 3).Value
        Sheets("Simulation").Range("D4").Value = Sheets("Input").Cells(i, 4).Value

'       Sheets("Simulation").Range( HIER: "SIMUZELLE angeben").Value = Sheets("Input").Cells(i, HIER:#INPUTSPALTE angeben).Value

    rc = RiskGetSettingsDefaults(MeineEinstellungen)
    MeineEinstellungen.ShowRiskWindowAtEndOfSimulation = False
    MeineEinstellungen.numIterations = Sheets("Input").Cells(i, 2).Value
    MeineEinstellungen.CollectDistributionSamples = RiskCollectNone
'

    rc = RiskSetSettings(MeineEinstellungen)

    rc = RiskSimulate()

    'Hier werden die Outputdaten in der "TEMP"-Lasche rüberkopiert:

        For z = 1 To 150
        Sheets("Ergebnisse").Cells(z, i + 2).Value = Sheets("Ergebnisse").Cells(z, 2).Value
        Next

    ActiveWorkbook.Save
```

Static Asset Allocations don‘t help us

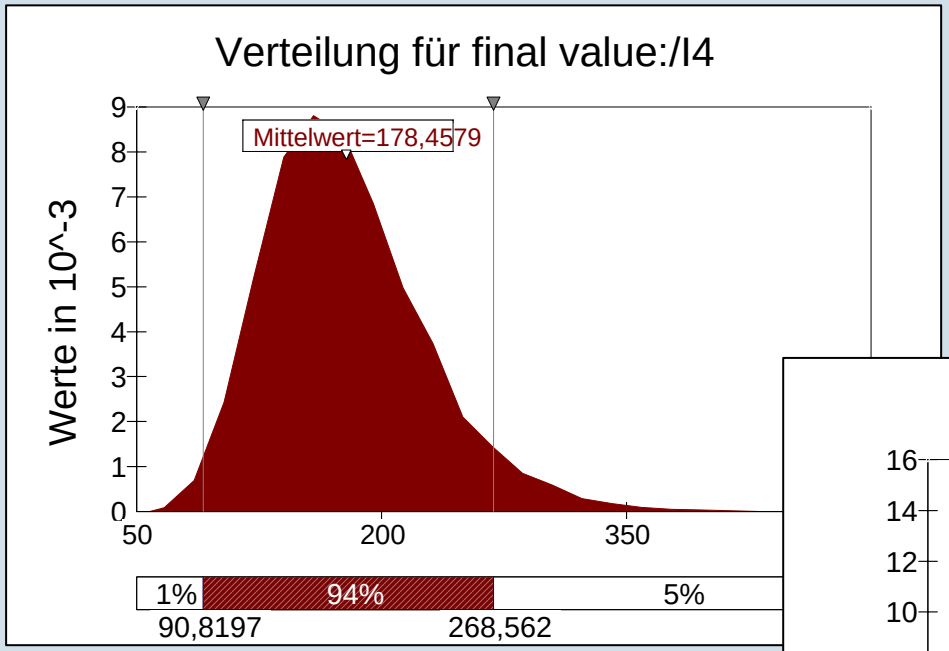
date	19.4.07 18:55	19.4.07 18:57	19.4.07 19:01	19.4.07 19:05	19.4.07 19:06
runs	10.000	10.000	10.000	10.000	10.000
maturity (years)	10,00	10,00	10,00	10,00	10,00
percentage equities	100%	75%	50%	25%	0%
final value:	236,74 €	206,10 €			
Mean	236,82 €	205,60 €	178,46 €	154,87 €	134,39 €
Stddev	135,38 €	85,80 €	48,81 €	21,15 €	2,14 €
Probability	9,21%	5,65%	2,23%	0,09%	0,00%
Min	23,30 €	37,13 €	57,88 €	88,29 €	126,47 €
Max	1.468,41 €	829,16 €	459,94 €	250,53 €	142,79 €
1% Quantil	57,33 €	72,97 €	90,82 €	111,03 €	129,38 €
50% Quantil	205,82 €	190,13 €	172,35 €	153,54 €	134,40 €
99% Quantil	714,82 €	484,78 €	320,74 €	209,75 €	139,47 €
yield:	9,00%	7,47%	5,96%	4,47%	3,00%
Mean	7,61%	6,69%	5,62%	4,38%	3,00%
Stddev	5,78%	4,30%	2,85%	1,42%	0,16%
Min	-13,56%	-9,43%	-5,32%	-1,24%	2,38%
Max	30,82%	23,56%	16,49%	9,62%	3,63%
1% Quantil	-5,41%	-3,10%	-0,96%	1,05%	2,61%
50% Quantil	7,48%	6,64%	5,59%	4,38%	3,00%
99% Quantil	21,74%	17,10%	12,36%	7,69%	3,38%
max drawdown:					
Mean	98,71 €	75,53 €	61,19 €	59,74 €	128,19 €
Stddev	123,22 €	97,80 €	82,83 €	75,41 €	28,30 €
Min	0,02 €	0,01 €	0,02 €	0,00 €	0,00 €
Max	1.468,41 €	829,16 €	459,94 €	250,53 €	142,79 €
1% Quantil	1,45 €	0,81 €	0,44 €	0,13 €	0,02 €
50% Quantil	57,67 €	37,83 €	20,77 €	7,78 €	134,30 €
99% Quantil	599,75 €	429,92 €	300,47 €	205,16 €	139,47 €

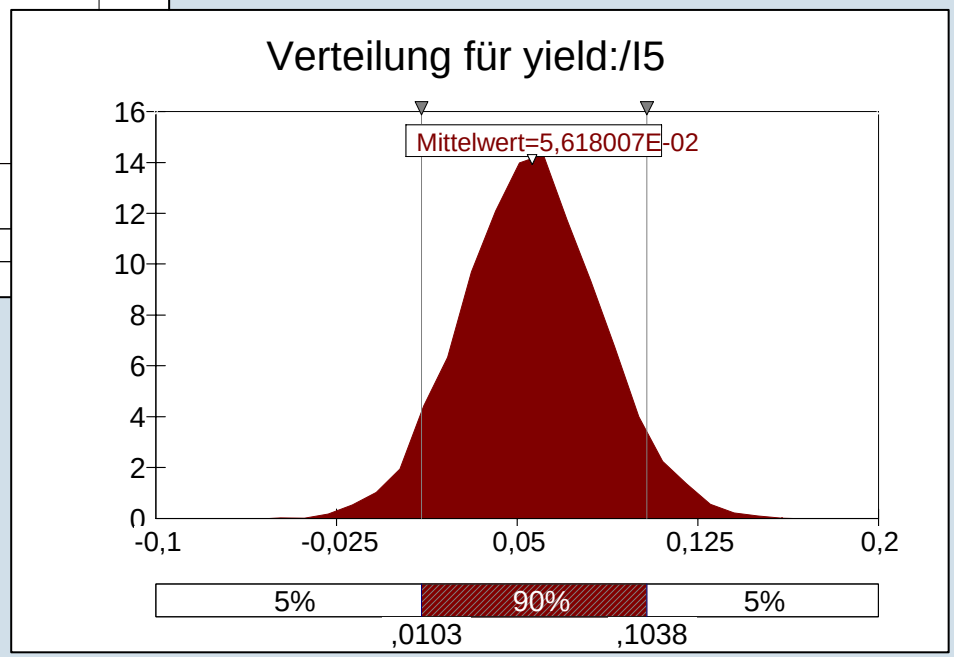
Own capital for guarantee to high
(VaR $_{99\%}$ >1%=1€)

Yield to low (< 6%)

Properties of different static Asset Allocations

Final value and yield are quite symmetric when using a static asset allocation





What is Constant Proportion Portfolio Insurance (CPPI)?

Definition

Constant proportion portfolio insurance

From Wikipedia, the free encyclopaedia

(Redirected from CPPI)

Constant proportion portfolio insurance (CPPI) is a capital guarantee derivative security that embeds a dynamic trading strategy in order to provide participation to the performance of a certain underlying. See also dynamic asset allocation. Note that the intuition behind CPPI was adopted from the interest rate universe.

How does CPPI work?

Explanation

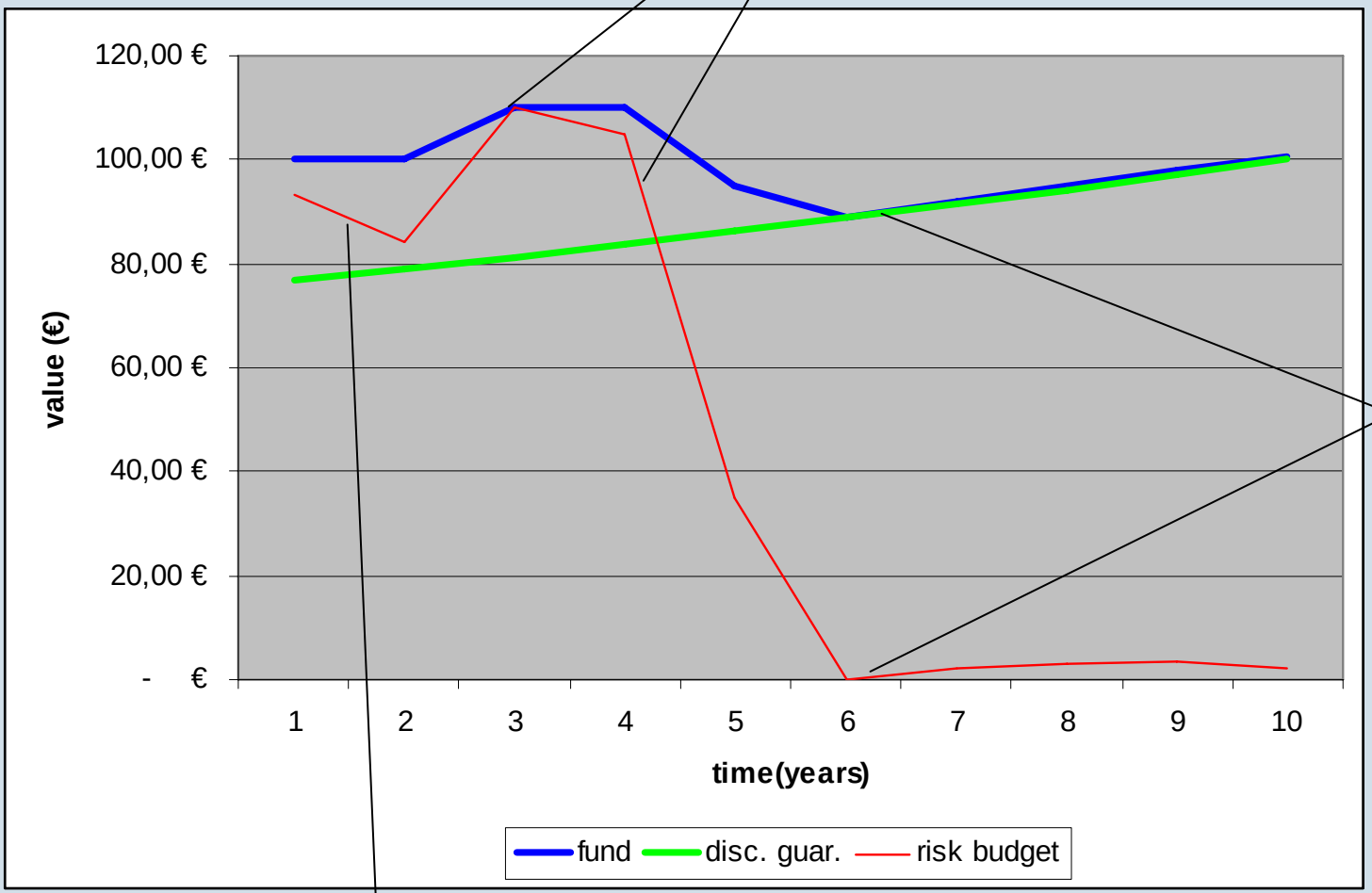
- Investment strategy based on two assets (asset classes), one risky, one “safe”
- Calculation of a risk budget based on the difference between the current portfolio value and the discounted value of the guarantee (using the yield of a “safe” asset). This risk budget is multiplied with a factor reflecting the risk of the “risky” asset (the riskier the asset the lower the factor).
- The result is invested into the risky asset, the rest into the safe asset
- Changes of the portfolio value and the discounted value of the guarantee will change the exposure of the risky asset
- Formula:

$$exposure_{RISK} = \left(value_{portfolio} - \frac{guarantee}{(1 + yield_{SAFE})^{maturity}} \right) \times factor_{RISK}$$

How does CPPI work?

Example

risk budget in-/decreases with fund value



„lock-in“

risk budget decreases with time

Simulation of a CPPI model

Simulation model

risk budget according to formula

	maturity (years)	10,00						
	maturity (month)	120,00						
					CPPI			
	final value:	263,26 €			y		min equities:	55,65%
	yield:	10,16%						
	max drawdown:	80,18 €						
				guarantee	100,00 €			
				riskfree rate	3,00%			
				multiplicator	4			
price								
equity	bond	fund		DF	CPPI-fund	risk budget	% equities	
100,00 €	100,00 €	100,00 €		74,41%	100,00 €	100,00 €	100,00%	
97,03 €	100,13 €	100,13 €		74,59%	97,03 €	89,76 €	92,50%	
95,97 €	100,34 €	100,34 €		74,78%	96,06 €	85,15 €	88,72%	
89,08 €	100,90 €	100,90 €		74,96%	90,00 €	60,16 €	67,54%	
87,18 €	101,10 €	101,10 €		75,15%	88,77 €	54,49 €	62,51%	
91,81 €	101,49 €	101,49 €		75,33%	91,84 €	66,03 €	71,93%	

DF: discounted guarantee value

$$\text{CPPI-fund}_{t+1}=\text{fund}_t*(1+\text{ep}_t*\text{ey}_{t+1}+\text{mmp}_t*\text{mmy}_{t+1})$$

Our CPPI Product fulfils the Requirements

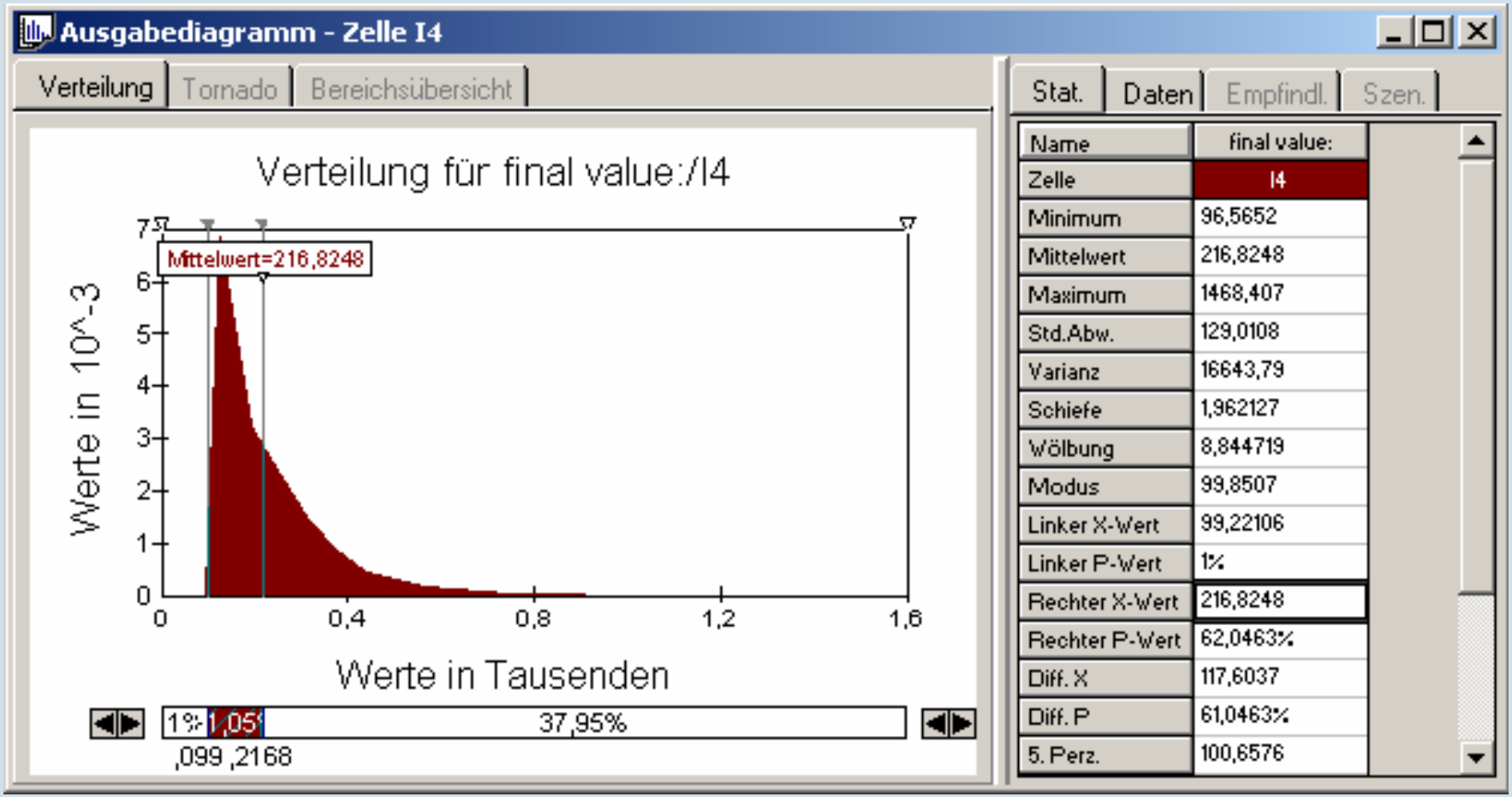
final value:	134,39 €
Mean	216,82 €
Stddev	129,01 €
Probability	2,99%
Min	96,57 €
Max	1.468,41 €
1% Quantil	99,22 €
50% Quantil	179,12 €
99% Quantil	678,91 €
yield:	8,05%
Mean	6,70%
Stddev	5,48%
Min	-0,35%
Max	30,82%
1% Quantil	-0,08%
50% Quantil	6,00%
99% Quantil	21,11%
max drawdown:	
Mean	84,11 €
Stddev	115,98 €
Min	0,00 €
Max	1.468,41 €
1% Quantil	0,64 €
50% Quantil	43,65 €
99% Quantil	574,82 €
min equities:	
Mean	52,30%
Stddev	34,65%
Min	0,00%
Max	100,00%
1% Quantil	0,00%
50% Quantil	51,35%
99% Quantil	100,00%

Own capital for guarantee ok
($VaR_{99\%}$ <1%=1€)

Yield above 6%
(even median is ok)

A CPPI produces right skewed Results for the Final Value

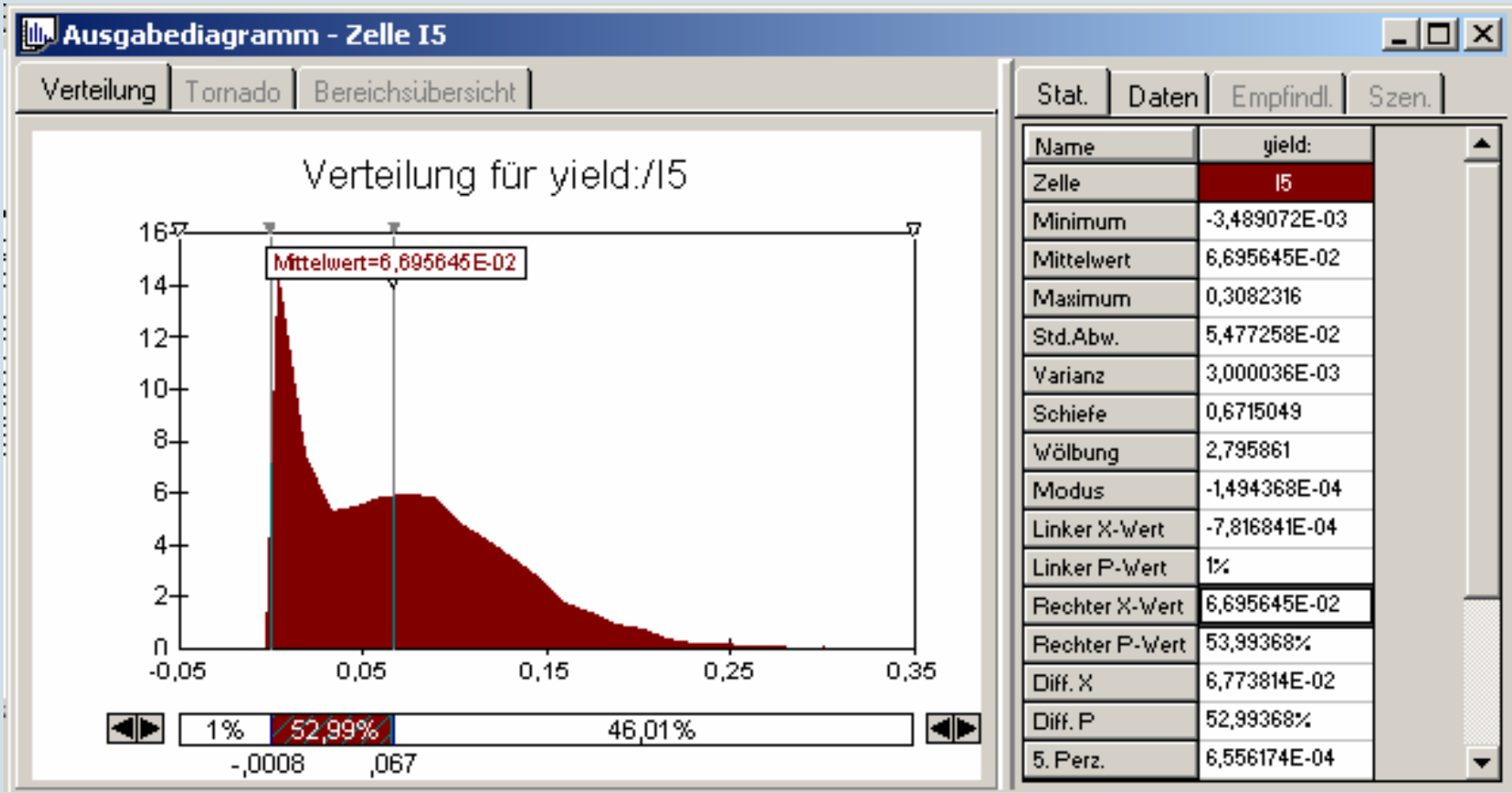
For the final value the skewness is 1,96, and there is only a approx. 38% chance to reach the mean value



Name	final value:
Zelle	I4
Minimum	96,5652
Mittelwert	216,8248
Maximum	1468,407
Std.Abw.	129,0108
Varianz	16643,79
Schiefe	1,962127
Wölbung	8,844719
Modus	99,8507
Linker X-Wert	99,22106
Linker P-Wert	1%
Rechter X-Wert	216,8248
Rechter P-Wert	62,0463%
Diff. X	117,6037
Diff. P	61,0463%
5. Perz.	100,6576

The yield of a CPPI Product is rather asymmetric

The chance to earn the mean yield is only 46%



What did we learn?

- Historical simulation is not as objective as it seems
- It is easy to apply “Trial-and-Error” development methodes using Excel and @Risk, esp. with VBA batches
- Static Asset Allocations produce usually symmetric results (when assets are distributed symmetrically)
- Constant proportion portfolio insurance (CPPI) is a mechanism to reach a given value with a high confidence
- CPPI produces rather asymmetric results for final value and yield with the mean higher than the median