

HOME TO THE LARGEST MULTI-BILLION DOLLAR CORPORATE ACCOUNTING FRAUD IN THE HISTORY OF OUR NATION

CLINTON, MISSISSIPPI -- FORMER CORPORATE WORLD HEADQUARTERS FOR WORLDCOM

my cube was approximately there

Kevin's office was right there

# As the WORLDCOM turns.

CORPORATE CRIME, FBI INVESTIGATIONS, MASS LAYOFFS, LOSSES, MERGERS AND MORE.

**BITTER:** Well, we lost it all! Kevin got laid off after working there for over 8 years!!! We had just bought a house, and had a baby!! Not to mention I had just quit my job (at WorldCom) to be a stay-at-home-mom! We both lost our ENTIRE 401K's and Kevin also lost hundreds of thousands of dollars in vested stock options. Times were tough!

**SWEET:** This is where we MET!!! This is where we worked when we got married and had our first child! This is where our life together began. So even though we lost all of our money, we gained ALL of those things that money just CANNOT BUY!! Like true love, a best friend, and family! I wouldn't trade this WorldCom experience for anything!!!!

**MY JOB DESCRIPTION:** I started working at WorldCom in September of 1999. While I was there, I was the designer for their Corporate Intranet, which happened to be the busiest intranet site in the world. I also did graphics for the internet site as well. I quit my job soon after Quinn was born in February of 2002.

**KEVIN'S JOB DESCRIPTION:** Kevin started working at WorldCom when it was actually still LDDS. It's hard to just sum up ALL of what he did for them. He was there through over 60 mergers and acquisitions and played a major part in integrating the systems of all of the new companies. He was also over all of their Corporate Internet and Intranet Systems. Kevin was laid off from WorldCom in April of 2002, which was 2 months after I quit.

WORLDCOM  
KIMBERLY SMITH  
10/21/2002

WORLDCOM  
Corporate  
KEVIN CROTHERS

# Financial Risk

## 4-rd quarter

## 2018/19

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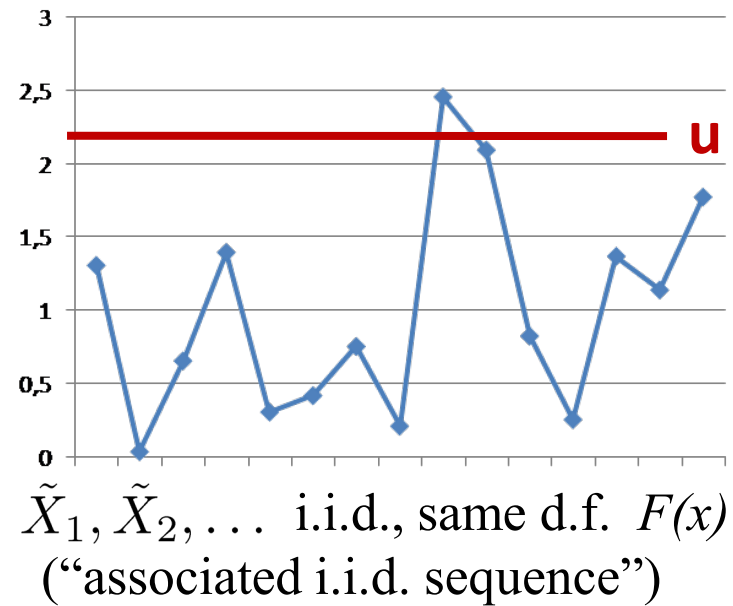
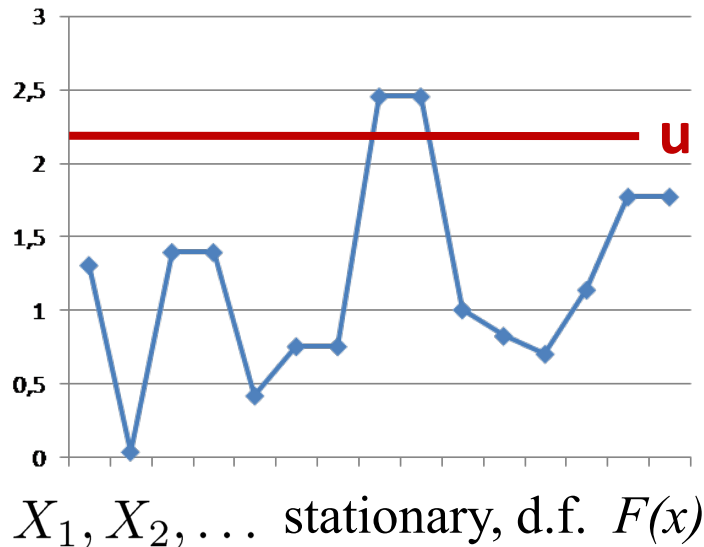
“As an alternative to the traditional 30-year mortgage, we also offer an interest-only mortgage, balloon mortgage, reverse mortgage, upside down mortgage, inside out mortgage, loop-de-loop mortgage, and the spinning double axel mortgage with a triple lutz.”



Gudrun January 2005  
326 MEuro loss  
72 % due to forest losses  
4 times larger than second largest

# Dependence: Extreme Value Statistics for stationary time series

(Coles p. 92-104)



Dependence  $\rightarrow$  extremes typically come in small “clusters”

$\theta$  = “**Extremal index**” = 1/”asymptotic mean cluster length”

- typically  $P(M_n \leq x) \approx F(x)^{\theta n}$  for  $n$  large
- typically clusters asymptotically i.i.d., dependence within clusters
- typically tail of cluster maxima asymptotically same as  $\bar{F}(x)$  !!
- typically the EV distributions the only possible limit distributions

## The block maxima method for stationary time series

If blocks are sufficiently long, then block maxima (typically) are approximately independent, and one can use Extreme Value Statistics in precisely the same way as for i.i.d. sequences

# The PoT method for stationary time series

- 1. Decluster:** identify approximately i.i.d clusters of large values by
  - a) Block method:* divide observations up into blocks of a fixed length  $r$ , all values in a block which exceed the level  $u$  is a cluster
  - b) Blocks-runs method:* the first cluster starts at first exceedance of  $u$  and contains all excesses of  $u$  within a fixed length  $r$  thereafter. The second cluster starts at the next exceedance of  $u$  and contains all excesses of  $u$  within  $r$  thereafter, and so on. . .
  - c) Runs method:* the first cluster starts with the first exceedance of  $u$  and stops as soon as there is a value below  $u$ , the second cluster starts with the next exceedance of  $u$ , and so on ...
- 2.**  $\hat{\theta} = \frac{\text{no. of clusters}}{\text{no. of exceedances}}$  estimate of the *extremal index*
- 3. PoT:** Use standard i.i.d. PoT model, but with excesses replaced by cluster maxima, and exceedance times replaced by the times when cluster maxima occur.
- 4.** Use  $P(M_n \leq x) \approx F(x)^{\theta n}$  to switch between block maxima and PoT

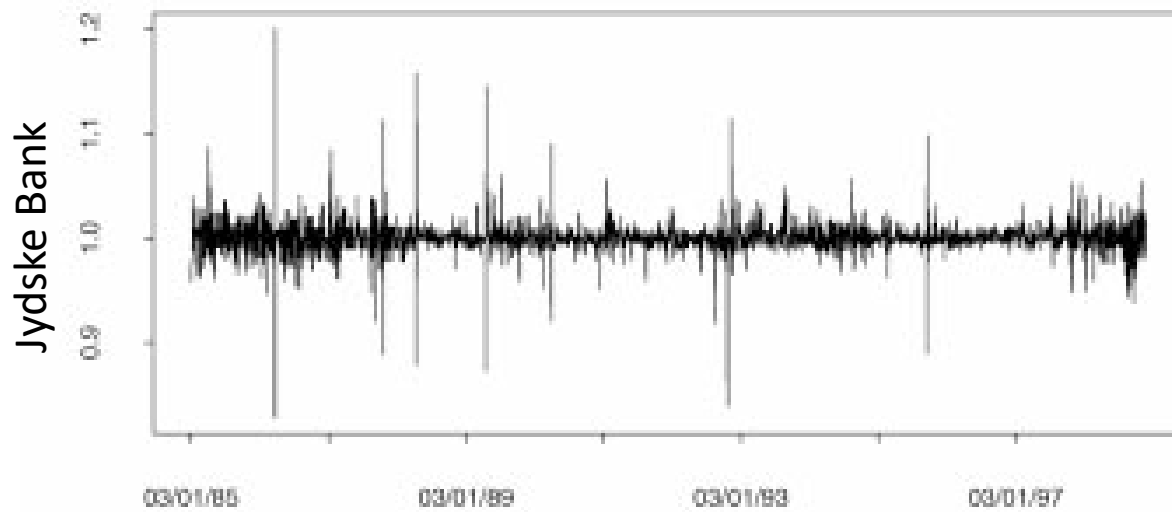
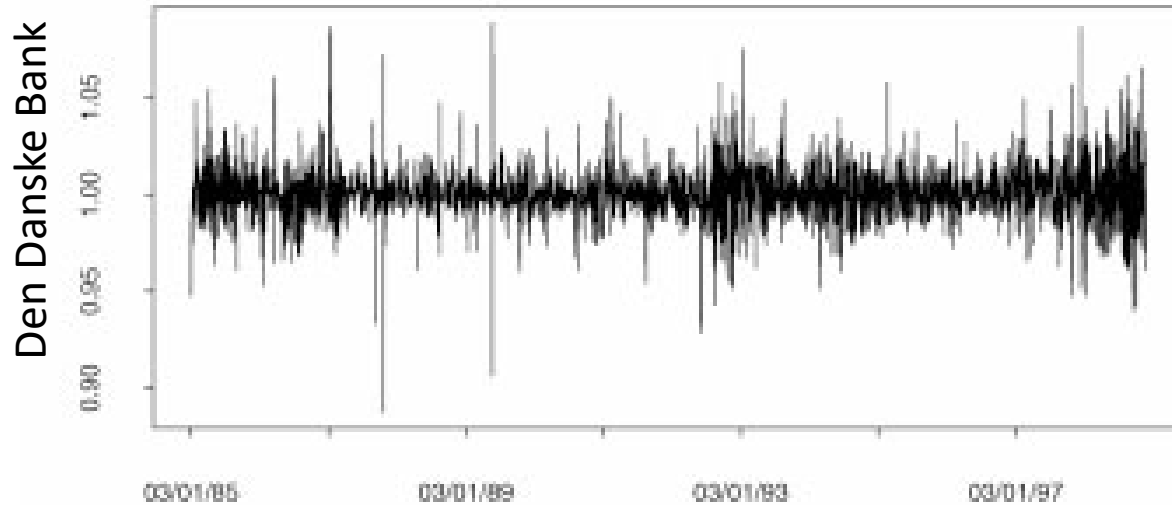
# Estimating value at risk by extreme value methods;

*(Sarah Lauridsen, Extremes 3, 107-144, 2000)*

*VaR = high quantiles of the loss-profits distribution*

- empirical quantiles
- unconditional Gaussian method
- conditional Gaussian method
- GEV + different extremal index estimators
- GP pretending independence
- GP with declustering
- GARCH + GP residuals, conditional
- GARCH + GP residuals, unconditional

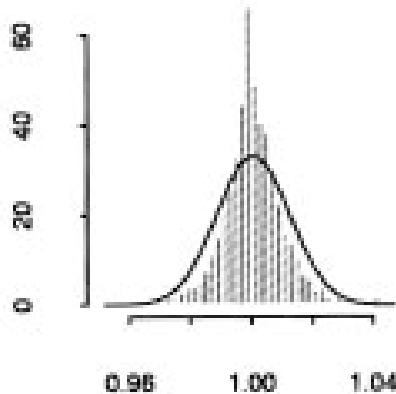
***Compared, and evaluated via backtesting***



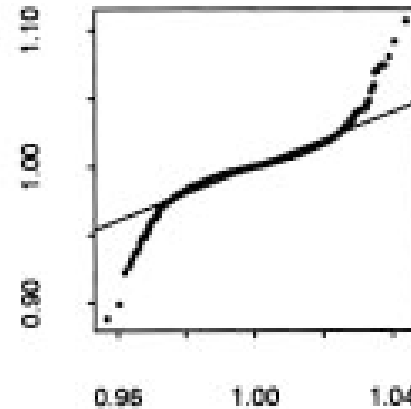
Daily returns from Jan. 1, 1985 to Nov. 27, 1998

***Synthetic portfolio: 50 MDKK Danske Bank + 50 MDKK Jydske Bank***

# Empirical and Normal



histogram with estimated normal density  
(13 left values and 10 right values not shown)



normal qq-plot

VaR in mDKr estimated by Gaussian and empirical method

1-day VaR	95%	96%	97%	98%	99%	99.9%	99.99%
Gaussian method	- 1.93	- 2.05	- 2.21	- 2.42	- 2.75	- 3.67	- 4.42
Empirical method	- 1.66	- 1.85	- 2.07	- 2.43	- 3.10	- 7.55	—

To assume returns normally distributed and i.i.d. gives easy calculations, also for complex portfolios

- **but, distribution doesn't fit in the tails, independence not OK**
- **the empirical method gives no estimates for extreme quantiles**

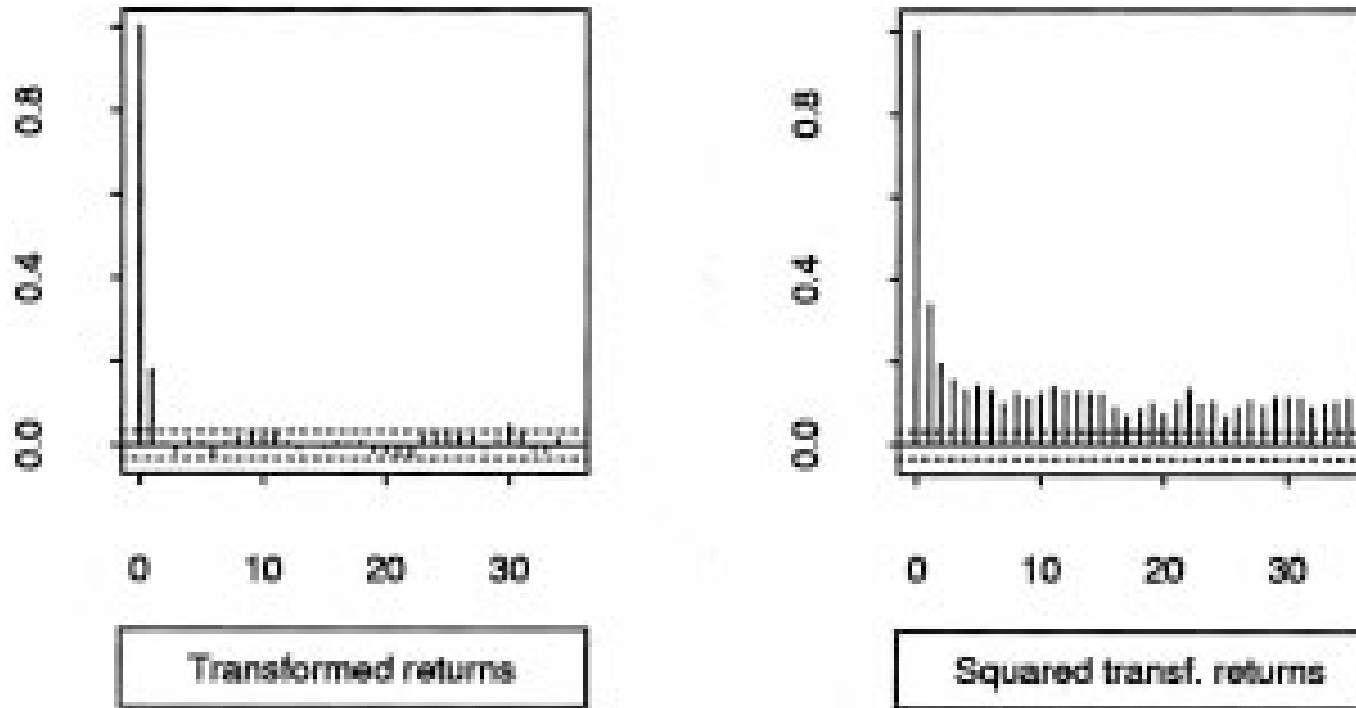


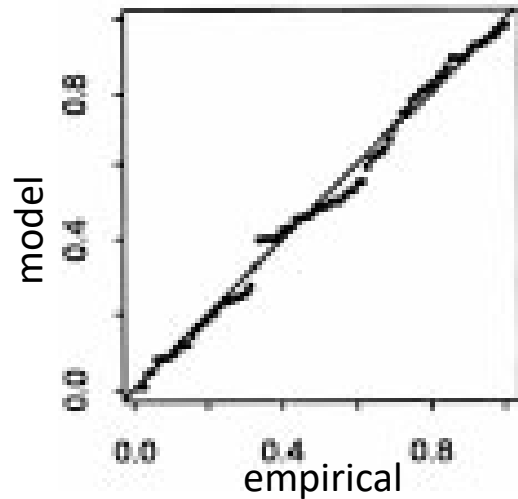
Figure 3. Auto correlograms for the series of daily returns on the bank portfolio. The returns have been transformed to have Gaussian marginals.

checked dependence by transforming to normal marginal distribution and computing correlations → clear and strong dependence

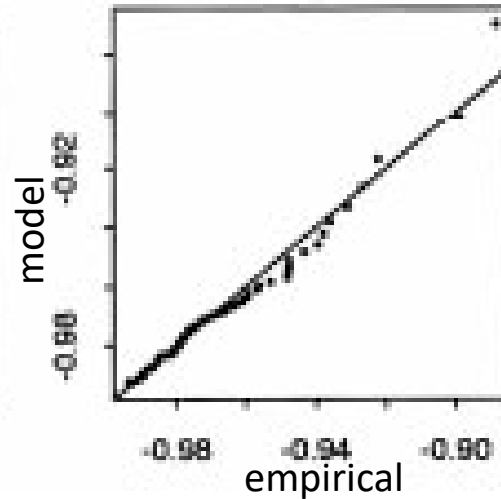
Block Maxima for 42 days approximately independent (figure not shown)



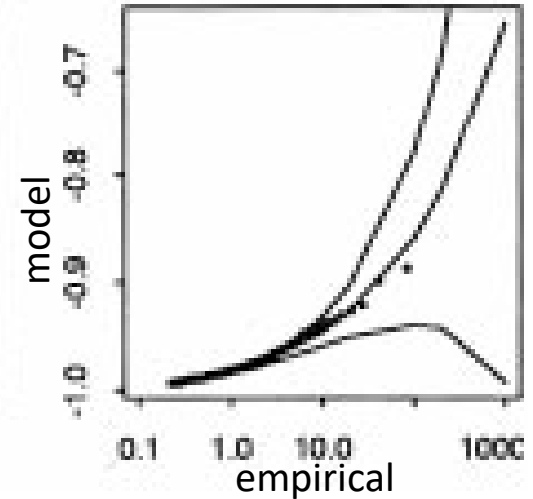
## Block Maxima



pp-plot against EV,  
42 day Block Maxima



qq-plot against EV,  
42 day Block Maxima



return level plot assuming EV,  
42 day Block Maxima

EV distribution fits the data well, and 42 days maxima interesting for firm survival, but how can one get from there to overnight VaR?

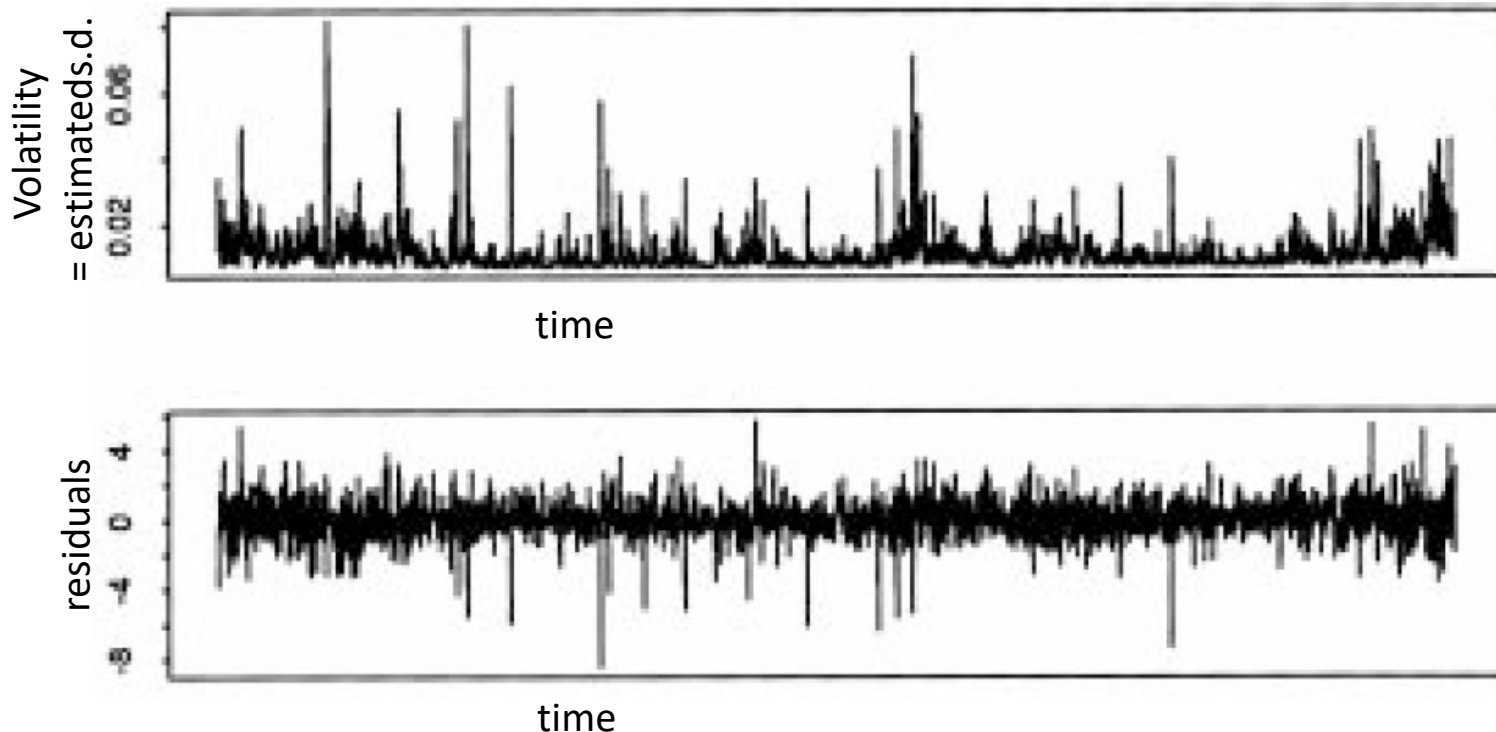
$\alpha$ -quantile of overnight P&L-distribution estimated by  $\alpha^{n\theta}$ -quantile of n-day maxima

**- But  $\theta$  difficult to estimate**

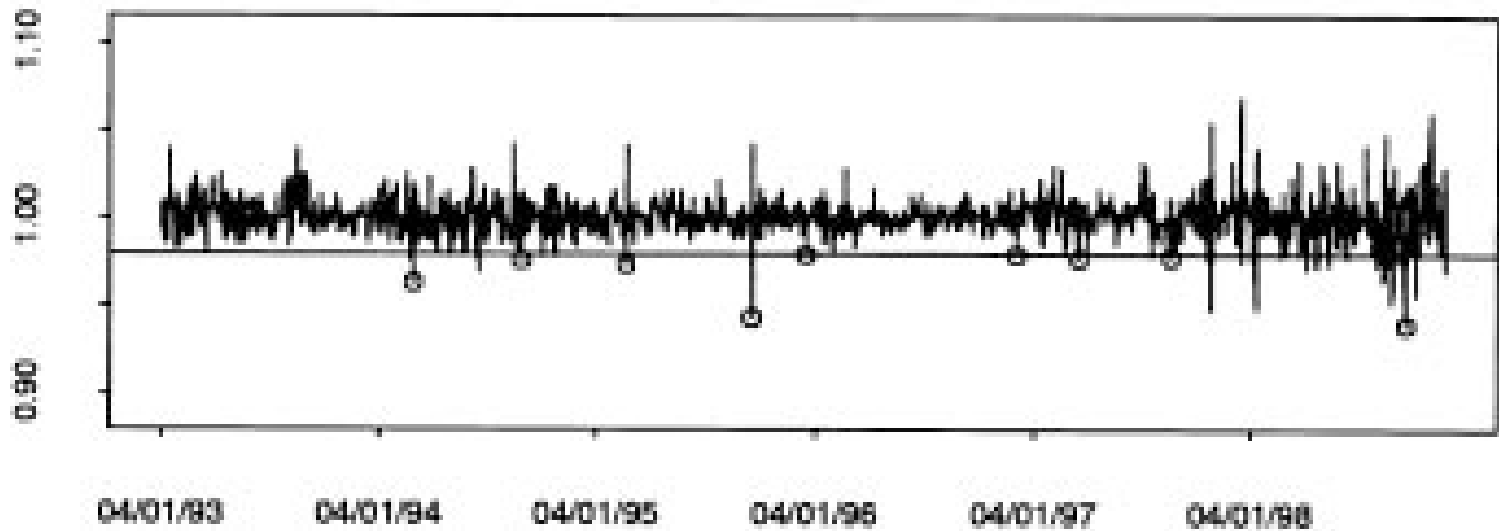
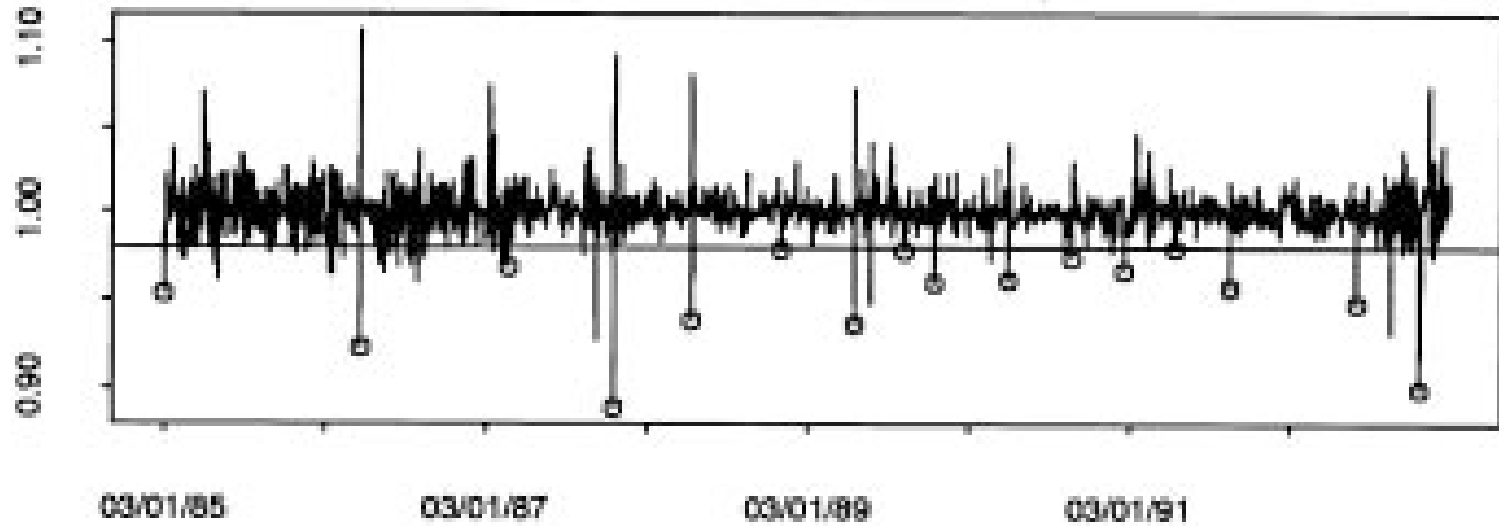
# Garch

fit Garch model, compute residuals, fit GP distribution to residuals, compute quantiles of the resulting estimated distribution of returns (computation done by simulation).

Can be done **conditionally**, using volatility today to compute quantiles for the portfolio tomorrow or **unconditionally** – for longtime behavior of portfolio



# PoT



Cluster minima: level  $u = 0.98$ , separation length  $r = 40$

Backtesting results, violations of 1-day VaR

Empirical method

	95%	96%	97%	98%	99%	99.9%	99.99%
Portfolio	119 (99.3)	100 (79.4)	74 (59.6)	56 (39.7)	30 (19.9)	1 (2.0)	– (0.2)
S&P 500	101 (159.9)	77 (127.9)	55 (95.9)	35 (64.0)	20 (32.0)	3 (3.2)	– (0.3)
B&O	90 (99.3)	72 (79.4)	53 (59.6)	35 (39.7)	19 (19.9)	0 (2.0)	– (0.2)
Carlsberg	81 (99.3)	68 (79.4)	56 (59.6)	39 (39.7)	17 (19.9)	0 (2.0)	– (0.2)
DS 1912	117 (99.3)	93 (79.4)	73 (59.6)	52 (39.7)	27 (19.9)	3 (2.0)	– (0.2)
ISS	148 (99.3)	126 (79.4)	93 (59.6)	63 (39.7)	23 (19.9)	1 (2.0)	– (0.2)
Novo B	113 (99.3)	90 (79.4)	70 (59.6)	49 (39.7)	26 (19.9)	2 (2.0)	– (0.2)
Svendborg	122 (99.3)	96 (79.4)	77 (59.6)	55 (39.7)	30 (19.9)	4 (2.0)	– (0.2)

Unconditional Gaussian method

	95%	96%	97%	98%	99%	99.9%	99.99%
Portfolio	76 (99.3)	66 (79.4)	62 (59.6)	47 (39.7)	30 (19.9)	16 (2.0)	10 (0.2)
S&P 500	101 (159.9)	79 (127.9)	59 (95.9)	36 (64.0)	22 (32.0)	5 (3.2)	3 (0.3)
B&O	61 (99.3)	56 (79.4)	49 (59.6)	40 (39.7)	28 (19.9)	13 (2.0)	9 (0.2)
Carlsberg	63 (99.3)	55 (79.4)	48 (59.6)	39 (39.7)	27 (19.9)	11 (2.0)	5 (0.2)
DS 1912	105 (99.3)	95 (79.4)	85 (59.6)	67 (39.7)	48 (19.9)	19 (2.0)	8 (0.2)
ISS	81 (99.3)	67 (79.4)	57 (59.6)	41 (39.7)	29 (19.9)	19 (2.0)	11 (0.2)
Novo B	88 (99.3)	72 (79.4)	61 (59.6)	54 (39.7)	41 (19.9)	16 (2.0)	7 (0.2)
Svendborg	108 (99.3)	98 (79.4)	84 (59.6)	73 (39.7)	57 (19.9)	22 (2.0)	9 (0.2)

Conditional Gaussian

	95%	96%	97%	98%	99%	99.9%	99.99%
Portfolio	77 (99.3)	64 (79.4)	51 (59.6)	41 (39.7)	27 (19.9)	10 (2.0)	6 (0.2)
S&P 500	151 (159.9)	127 (127.9)	88 (95.9)	61 (64.0)	33 (32.0)	7 (3.2)	4 (0.3)
B&O	71 (99.3)	61 (79.4)	53 (59.6)	42 (39.7)	27 (19.9)	11 (2.0)	7 (0.2)
Carlsberg	60 (99.3)	53 (79.4)	44 (59.6)	36 (39.7)	26 (19.9)	11 (2.0)	5 (0.2)
DS 1912	90 (99.3)	71 (79.4)	57 (59.6)	45 (39.7)	23 (19.9)	9 (2.0)	4 (0.2)
ISS	90 (98.2)	80 (78.6)	70 (58.9)	53 (39.3)	37 (19.6)	18 (2.0)	14 (0.2)
Novo B	72 (99.3)	61 (79.4)	46 (59.6)	37 (39.7)	24 (19.9)	8 (2.0)	3 (0.2)
Svendborg	97 (99.3)	87 (79.4)	72 (59.6)	52 (39.7)	31 (19.9)	10 (2.0)	4 (0.2)

GEV and simple blocks estimator (95% threshold)

	95%	96%	97%	98%	99%	99.9%	99.99%
Portfolio	71 (99.3)	57 (79.4)	36 (59.6)	19 (39.7)	11 (19.9)	0 (2.0)	0 (0.2)
S&P	43 (159.9)	37 (127.9)	25 (95.9)	15 (64.0)	8 (32.0)	2 (3.2)	1 (0.3)
B&O	54 (99.3)	46 (79.4)	34 (59.6)	23 (39.7)	8 (19.9)	0 (2.0)	0 (0.2)
Carlsberg	40 (99.3)	33 (79.4)	24 (59.6)	16 (39.7)	7 (19.9)	0 (2.0)	0 (0.2)
DS 1912	66 (99.3)	55 (79.4)	44 (59.6)	28 (39.7)	14 (19.9)	1 (2.0)	0 (0.2)
ISS	79 (99.1)	60 (79.3)	36 (59.5)	20 (39.6)	11 (19.8)	0 (2.0)	0 (0.2)
Novo B	62 (99.3)	54 (79.4)	40 (59.6)	26 (39.7)	11 (19.9)	1 (2.0)	0 (0.2)
Svendborg	77 (99.3)	67 (79.4)	54 (59.6)	34 (39.7)	12 (19.9)	1 (2.0)	0 (0.2)

# Backtesting

- compute VaR from the first six years of data, see if it “is violated”, i.e. if next days return is lower than VaR, repeat again using six years of data but starting one day later, two days later, ...
- count number of violations
- expected no. of violations in parentheses

Backtesting results, violations of 1-day VaR  
 GEV and simple blocks estimator (99% threshold)

	95%	96%	97%	98%	99%	99.9%	99.99%
Portfolio	140 (99.3)	106 (79.4)	78 (59.6)	56 (39.7)	17 (19.9)	1 (2.0)	0 (0.2)
S&P500	79 (159.9)	56 (127.9)	36 (95.9)	25 (64.0)	13 (32.0)	2 (3.2)	2 (0.3)
B&O	80 (99.3)	63 (79.4)	51 (59.6)	38 (39.7)	15 (19.9)	0 (2.0)	0 (0.2)
Carlsberg	80 (99.3)	70 (79.4)	51 (59.6)	33 (39.7)	16 (19.9)	0 (2.0)	0 (0.2)
DS 1912	108 (99.3)	94 (79.4)	75 (59.6)	48 (39.7)	23 (19.9)	4 (2.0)	0 (0.2)
ISS	157 (99.1)	129 (79.3)	97 (59.5)	61 (39.6)	23 (19.8)	2 (2.0)	0 (0.2)
Novo B	115 (99.3)	93 (79.4)	71 (59.6)	49 (39.7)	25 (19.9)	2 (2.0)	0 (0.2)
Svendborg	125 (99.3)	106 (79.4)	82 (59.6)	60 (39.7)	26 (19.9)	3 (2.0)	0 (0.2)

GEV and blocks estimator (95% threshold)

	95%	96%	97%	98%	99%	99.9%	99.99%
Portfolio	139 (99.3)	107 (79.4)	78 (59.6)	54 (39.7)	18 (19.9)	1 (2.0)	0 (0.2)
S&P500	97 (159.9)	75 (127.9)	57 (95.9)	34 (64.0)	15 (32.0)	3 (3.2)	2 (0.3)
B&O	89 (99.3)	73 (79.4)	58 (59.6)	44 (39.7)	17 (19.9)	1 (2.0)	0 (0.2)
Carlsberg	77 (99.3)	65 (79.4)	46 (59.6)	33 (39.7)	14 (19.9)	0 (2.0)	0 (0.2)
DS 1912	112 (99.3)	90 (79.4)	70 (59.6)	49 (39.7)	21 (19.9)	3 (2.0)	0 (0.2)
ISS	147 (99.1)	129 (79.3)	94 (59.5)	46 (39.6)	20 (19.8)	1 (2.0)	0 (0.2)
Novo B	109 (99.3)	88 (79.4)	65 (59.6)	45 (39.7)	21 (19.9)	2 (2.0)	0 (0.2)
Svendborg	118 (99.3)	100 (79.4)	80 (59.6)	58 (39.7)	29 (19.9)	2 (2.0)	0 (0.2)

GEV and blocks estimator (99% threshold)

	95%	96%	97%	98%	99%	99.9%	99.99%
Portfolio	166 (99.3)	133 (79.4)	99 (59.6)	62 (39.7)	23 (19.9)	1 (2.0)	0 (0.2)
S&P500	88 (159.9)	66 (127.9)	45 (95.9)	31 (64.0)	14 (32.0)	3 (3.2)	2 (0.3)
B&O	86 (99.3)	75 (79.4)	59 (59.6)	45 (39.7)	18 (19.9)	1 (2.0)	0 (0.2)
Carlsberg	102 (99.3)	78 (79.4)	61 (59.6)	42 (39.7)	20 (19.9)	0 (2.0)	0 (0.2)
DS 1912	126 (99.3)	104 (79.4)	87 (59.6)	55 (39.7)	27 (19.9)	5 (2.0)	1 (0.2)
ISS	187 (99.1)	156 (79.3)	114 (59.5)	75 (39.6)	27 (19.8)	2 (2.0)	0 (0.2)
Novo B	133 (99.3)	109 (79.4)	81 (59.6)	58 (39.7)	30 (19.9)	4 (2.0)	0 (0.2)
Svendborg	144 (99.3)	121 (79.4)	99 (59.6)				

GPD

	95%	96%	97%	98%	99%	99.9%	99.99%
Portfolio	118 (99.3)	98 (79.4)	78 (59.6)	57 (39.7)	20 (19.9)	1 (2.0)	0 (0.2)
S&P500	26 (20.8)	26 (16.6)	21 (12.5)	16 (8.32)	5 (4.1)	2 (0.4)	1 (0.04)
B&O	89 (98.9)	74 (79.1)	54 (59.3)	38 (39.5)	16 (19.8)	2 (2.0)	0 (0.2)
Carlsberg	69 (95.6)	56 (76.8)	46 (57.6)	33 (38.4)	16 (19.2)	1 (2.0)	0 (0.2)
DS 1912	98 (74.3)	76 (59.4)	65 (44.6)	41 (29.7)	24 (14.9)	4 (1.5)	1 (0.1)
ISS	151 (99.3)	128 (79.4)	95 (59.6)	61 (39.7)	26 (19.9)	3 (2.0)	0 (0.2)
Novo B	116 (99.2)	89 (79.4)	70 (59.5)	50 (39.7)	27 (19.8)	4 (2.0)	1 (0.2)
Svendborg	110 (88.9)	96 (71.1)	68 (53.3)	52 (35.5)	25 (17.8)	4 (1.8)	0 (0.2)

# Backtesting

- compute VaR from the first six years of data, see if it “is violated”, i.e. if next days return is lower than VaR, repeat again using six years of data but starting one day later, two days later, ... count number of violations

- expected no. of violations in parentheses

# Backtesting

Backtesting results, violations of 1-day VaR GARCH based extreme value method, conditional							
	95%	96%	97%	98%	99%	99.9%	99.99%
Portfolio	109 (99.3)	91 (79.4)	64 (59.6)	44 (39.7)	18 (19.9)	1 (2.0)	0 (0.2)
S&P 500	145 (157.8)	123 (126.2)	88 (94.7)	60 (63.1)	34 (31.6)	6 (3.2)	2 (0.3)
B&O	95 (99.3)	73 (79.4)	53 (59.6)	33 (39.7)	12 (19.9)	2 (2.0)	0 (0.2)
Carlsberg	75 (99.3)	61 (79.4)	45 (59.6)	32 (39.7)	20 (19.9)	0 (2.0)	0 (0.2)
DS 1912	94 (98.3)	66 (78.6)	48 (59.0)	26 (39.3)	11 (19.6)	2 (2.0)	1 (0.2)
ISS	144 (98.2)	117 (78.5)	87 (58.9)	57 (39.3)	22 (19.6)	5 (2.0)	0 (0.2)
Novo B	93 (99.3)	75 (79.4)	52 (59.6)	36 (39.7)	18 (19.9)	2 (2.0)	0 (0.2)
Svendborg	102 (99.3)	87 (79.4)	60 (59.6)	34 (39.7)	14 (19.9)	3 (2.0)	1 (0.2)
GARCH based extreme value method, unconditional							
	95%	96%	97%	98%	99%	99.9%	99.99%
Portfolio	107 (98.1)	90 (78.4)	66 (58.8)	44 (39.2)	16 (19.6)	0 (2.0)	0 (0.2)
S&P500	98 (143.8)	77 (115.1)	55 (86.3)	30 (57.5)	14 (28.8.0)	2 (2.9)	0 (0.3)
B&O	82 (99.3)	65 (79.4)	52 (59.6)	34 (39.7)	14 (19.9)	0 (2.0)	0 (0.2)
Carlsberg	88 (98.8)	77 (79.0)	62 (59.3)	37 (39.5)	22 (19.8)	0 (2.0)	0 (0.2)
DS 1912	108 (94.8)	87 (75.8)	69 (56.9)	43 (37.9)	20 (19.0)	1 (2.0)	0 (0.2)
ISS	114 (81.7)	100 (65.3)	70 (49.0)	41 (32.7)	16 (16.3)	1 (1.6)	0 (0.2)
Novo B	106 (99.2)	87 (79.4)	62 (59.5)	49 (39.7)	25 (19.8)	2 (2.0)	0 (0.2)
Svendborg	115 (98.6)	100 (78.8)	76 (59.1)	56 (39.4)	27 (19.7)	2 (2.0)	0 (0.2)

- compute VaR from the first six years of data, see if it “is violated”, i.e. if next days return is lower than VaR, repeat again using six years of data but starting one day later, two days later, ... count number of violations

- expected no. of violations in parentheses