



University of Zurich
Institute for Empirical Research in Economics



Advanced Portfolio Theory

NHH-Bergen

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IEW

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9. Choosing a Portfolio on a GARCH process: Risk Management

- Give Evidence
- Investing on a GARCH process
- Risk Management
- Crash Measures



GARCH-processes

Stochastic Processes $AR(1)$:

$$y_{t+1} = \mu + \rho y_t + \varepsilon_t$$

where ε_t is white noise:

$$E(\varepsilon_t) = 0$$

$$E(\varepsilon_t^2) = \sigma^2$$

$$E(\varepsilon_t, \varepsilon_{t+1}) = 0$$

Gaussian white noise if

$$\varepsilon_t \sim N(0, \sigma^2)$$

For $\rho = 1$ we get a unit root process = random walk

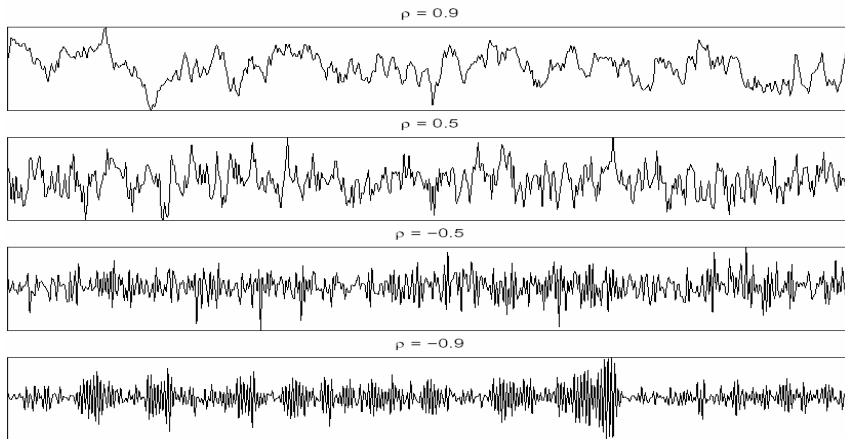
$\rho < 1$ we get a mean reverting process.

If $E(\varepsilon_t^2) = \sigma_t^2$ and σ_t^2 is stochastic then GARCH.

Chan (2002): Time Series Applications to Finance, Wiley.



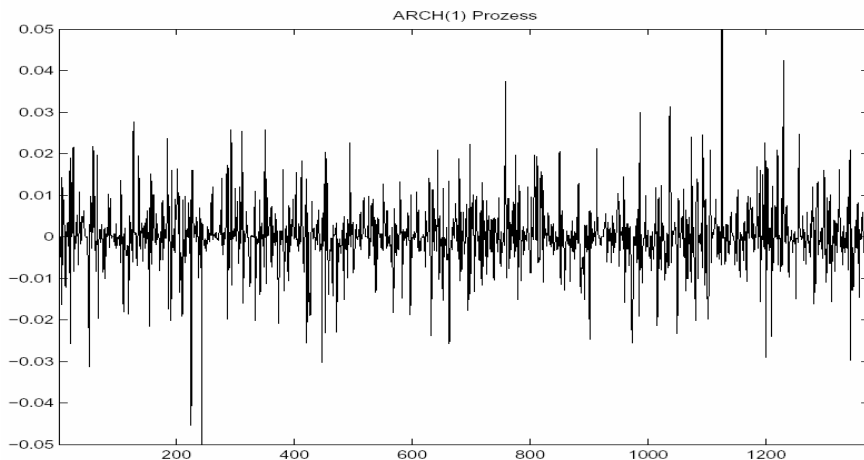
Visualizing Stochastic Processes (I)



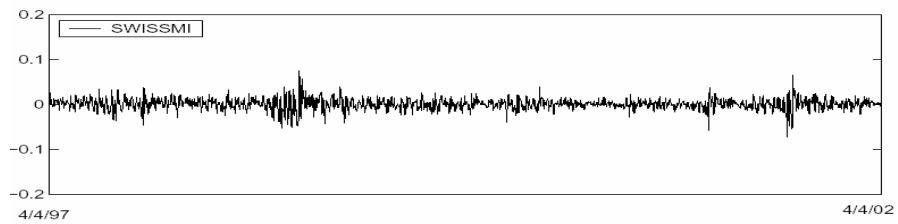
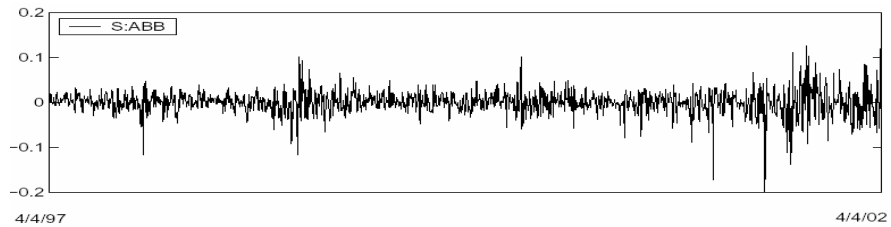
$$y_{t+1} = \mu + \rho y_t + \varepsilon_t$$



Visualizing Stochastic Processes (II)



Returns of ABB and SMI



Stock Market Anomalies

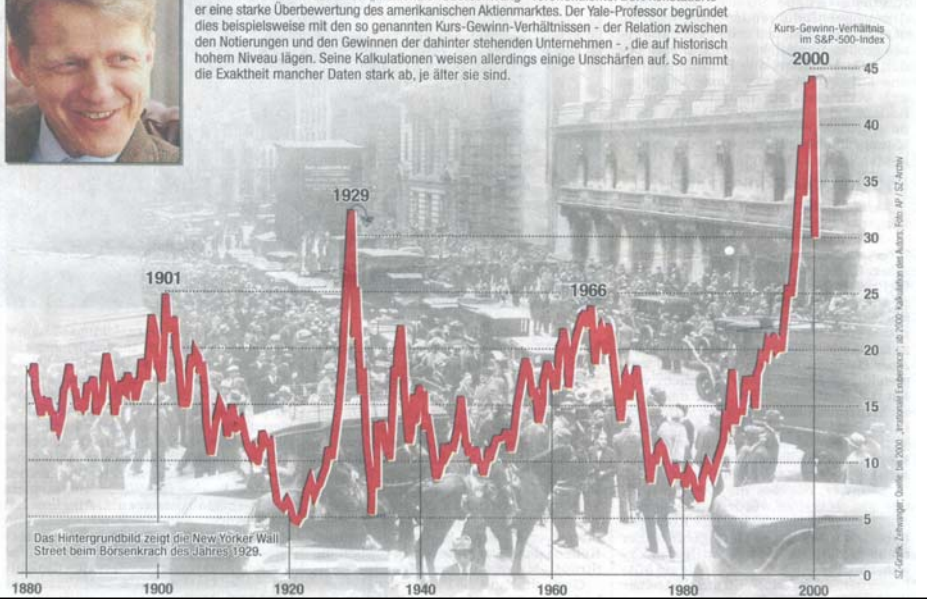
- Irrational Exuberance and Crashes
- Autocorrelation
- Clustered Volatility
- Etc.



Irrational Exuberance



Einen internationalen Bestseller landete der Wirtschaftswissenschaftler Rober J. Shiller (Foto), als er im Jahr 2000 das Buch „Irrationaler Überschwang“ veröffentlichte. Dort konstatierte er eine starke Überbewertung des amerikanischen Aktienmarktes. Der Yale-Professor begründet dies beispielsweise mit den so genannten Kurs-Gewinn-Verhältnissen - der Relation zwischen den Notierungen und den Gewinnen der dahinter stehenden Unternehmen - , die auf historisch hohem Niveau lägen. Seine Kalkulationen weisen allerdings einige Unschärfen auf. So nimmt die Exaktheit mancher Daten stark ab, je älter sie sind.



South Sea Bubble

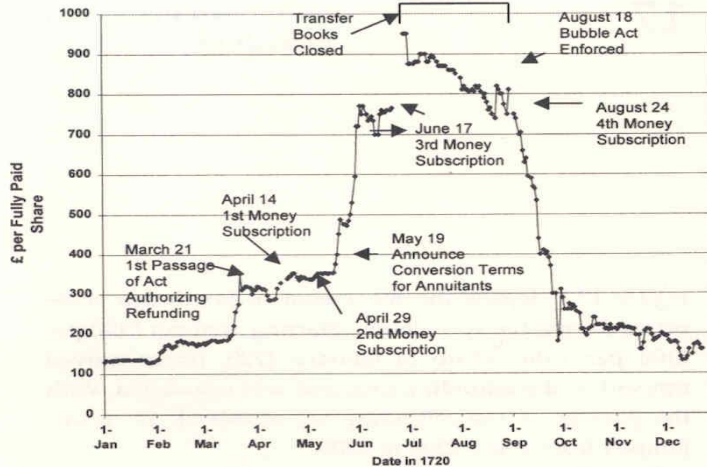
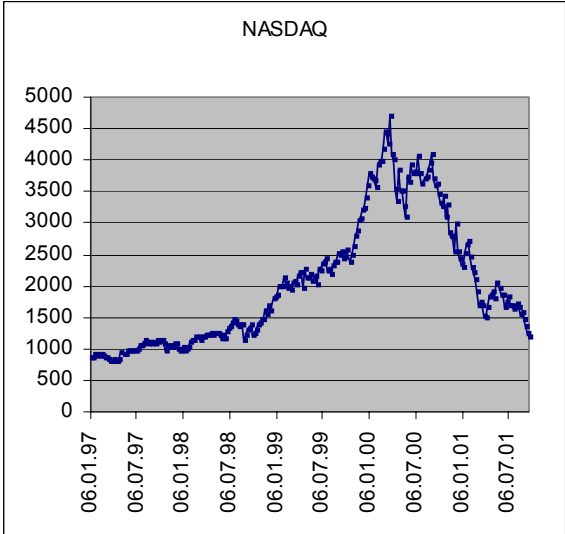


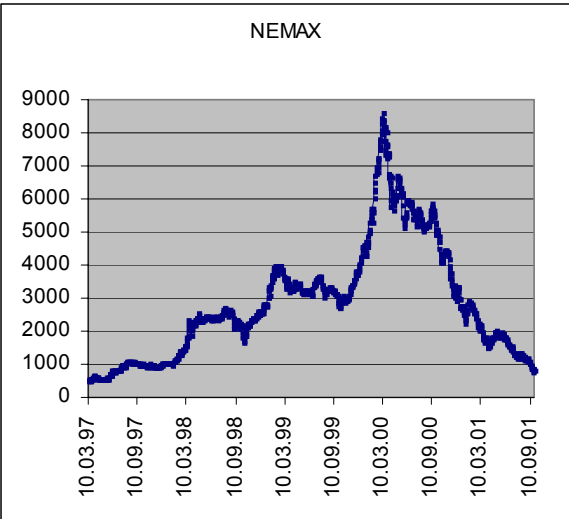
Figure 17.1
Daily South Sea Share Prices, 1720. Data courtesy of Larry Neal.



Nasdaq Bubble



Nemax Bubble



Famous Bubbles (1)

Table 6.2 Famous Bubbles

Bubble	Initial displacement	Smart-money response	Sustaining the bubble	Authoritative blessing	Crash	Political reaction
Dutch Tulipmania (1630s)	Mosaic viruses produce interesting looking tulips; prosperity of Holland	Selective breeding of tulips; purchase by 'insiders' of broken tulips that can only reproduce slowly and asexually	Development of tulip speculation contracts, which can be signed before notaries; appearance of trading	??	1637	??
South Sea Bubble (1710-20)	Profits from conversion of government debt; supposed monopoly on trade with Spanish ruled parts of America	Insiders buy up debt in advance of the conversion scheme, then profit by presenting debt for full conversion	Development of coffee house network for speculation; new subscriptions	Government approval; royal involvement	1720	ex post facto punishing directors; restrictions on use of the corporate form
Mississippi Bubble (1717-20)	Rapidly growing trade with the New World; Law's success as a financial organizer	Law's plan to make money and acquire power by securitizing the French debt	Government support; large expansion of credit by Law's bank to support further purchases	Official government support. Duke of Orleans imprisons critics of Law – the president of the Parlement de Paris and others	1720	Fall of Law; end of efforts to reform French finances until 1787
British first railway boom (1845-6)	End of depression; excitement over the new means of transportation	Many new railroad projects	Ponzi schemes by George Hudson (i.e. use this railroad's capital to pay the last railroads dividends)	Parliamentary bills passed for every railroad suggesting government approval; close links between George Hudson and London Society	No crash, gradual decline	Reform of accounting standards; requirement that dividends be paid only out of earnings, not out of capital

Famous Bubbles (2)

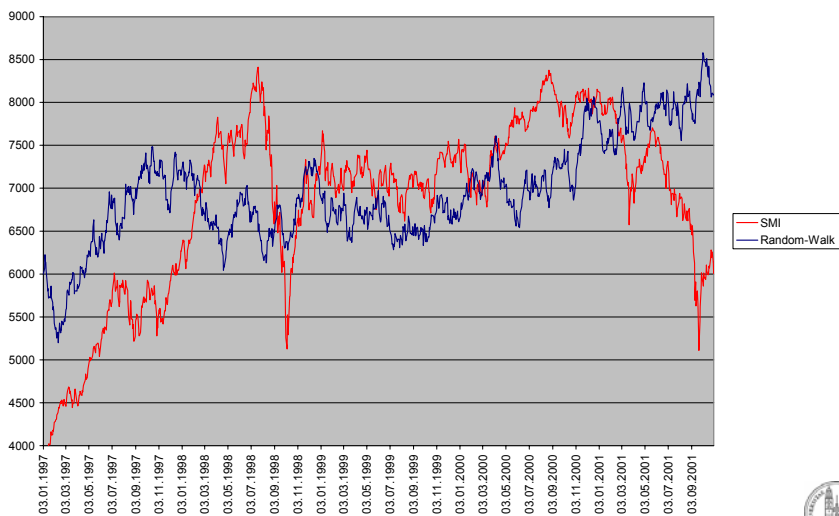
U.S. 1873 railway boom and crash	End of the Civil War; settlement of the American west	Construction of government subsidized railroads	Additional railroad charters; expectation that subsidies would continue	Henry Varnum Poor and Charles Frances Adams	1873 – Bankruptcy of Jay Cooke & Co., beginning of mid-1870s depression	??
Argentine loans (1880s)	Strong demand on world markets for the staple products of Argentinian agriculture; large profits made by early investors	Investment flows from Britain to Argentina; expansion of railway network; construction of social overhead capital	New issues on the London exchange; creation of joint-stock companies to speculate in Argentinian land	Foreign investors 'grossly misled... by Argentinian president' Barings' express optimism that the situation might improve (hoping to avoid bankruptcy)	Baring Bros. bankruptcy November 1890	Coup d'etat in Argentina; laws discriminating against foreign investment
1920s Florida land boom	Great winter climate; closeness to centers of American population; prosperity of the 1920s	Building of railroads; development of Miami; land development projects	Subdivisions; creation of a network of real estate offices selling Florida land	William Jennings Bryan boosts Florida land; close connections between mayors and developers	1926	Fraud prosecutions
1920s U.S. Stock Market boom	Decade of fast growth in the 1920s; end of fears of post WWI deflation; rapid expansion of mass production	Expansion of supply of shares; creation of new closed end funds	Regional exchanges; growth of margin accounts and brokers' loans	Blessings from Coolidge, Hoover, Mellon and Irving Fisher	October 1929 and following	Glass-Steagall Act; creation of SEC; public utility holding company act; election of FDR
1920s U.S. utility stocks boom	Expansion of demand for power; economies of scale	High leverage; expansion of scale to capture economies	Creation of public utility holding companies with cascades of control	??	October 1929 and following	Breakup of large utilities; TVA a byproduct; substantial government regulation of utility industries
1960s conglomerate mergers in the US	Two decades of a rising stock market during which investing in growth stocks had been profitable	Emergence of professional conglomerates; Harold Geczen's ITT, Textron, Teledyne, etc.	Stock swaps to create apparent earnings growth	Harvard endowment takes large positions in National Student Marketing; McGeorge Bundy urges institutions to invest aggressively	1970-1971	Reform of accounting practices; Williams Act



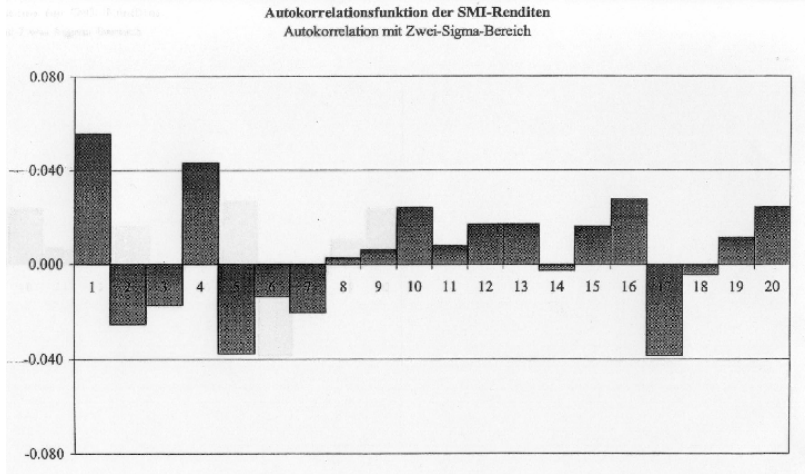
Show Bachelier again



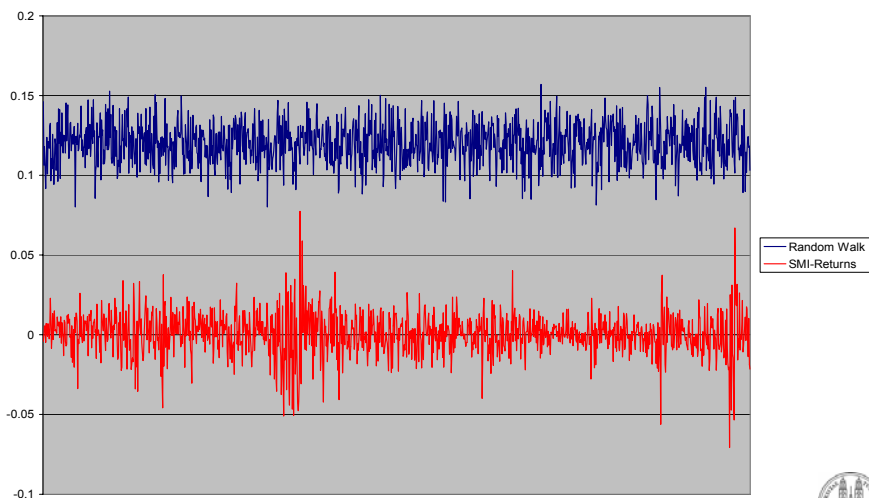
SMI vs. Random Walk



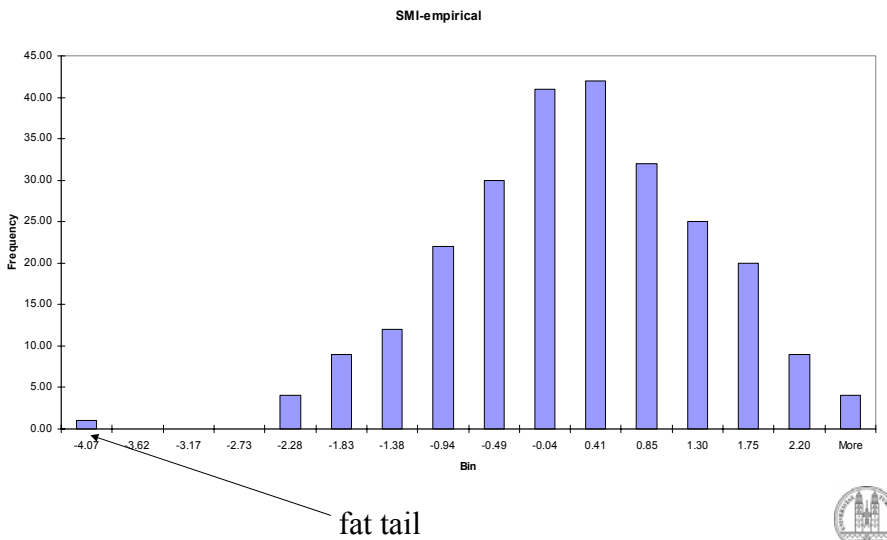
Random Walk Hypothesis: Autocorrelation



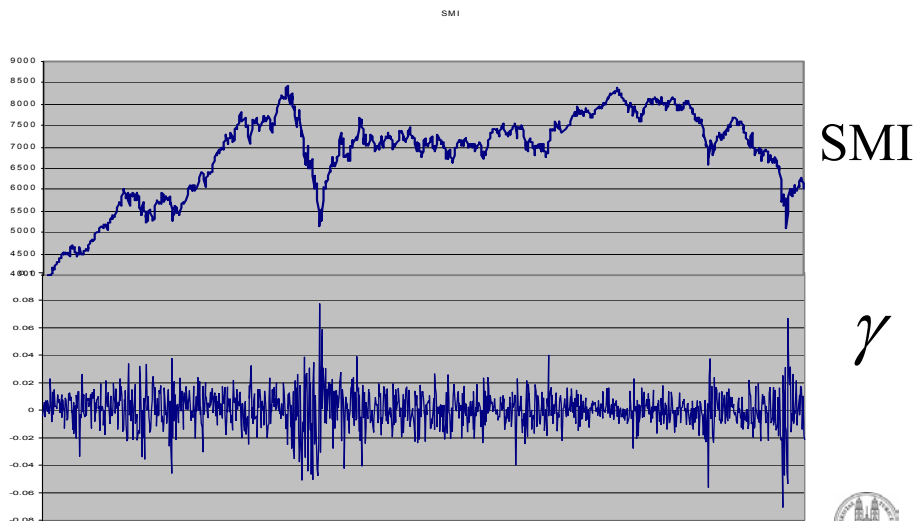
Random Walk Hypothesis: Clustered Volatility



Random Walk Hypothesis: Fat Tails



Loss Aversion and Volatility



VaR Efficient Frontier

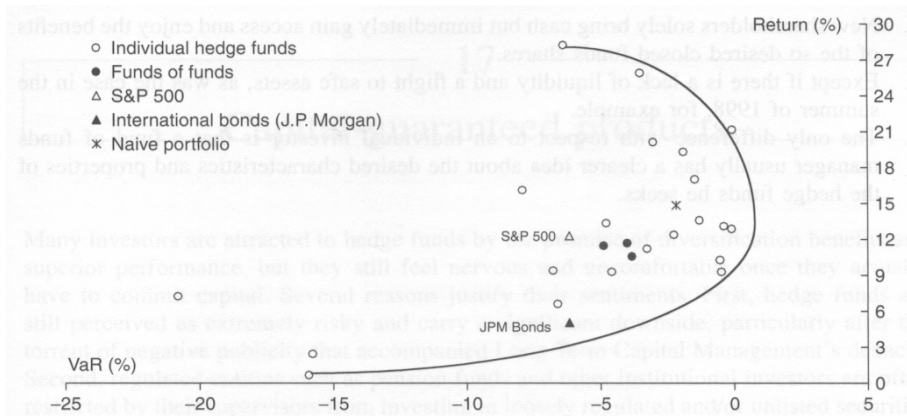


Figure 16.2 The VaR efficient frontier



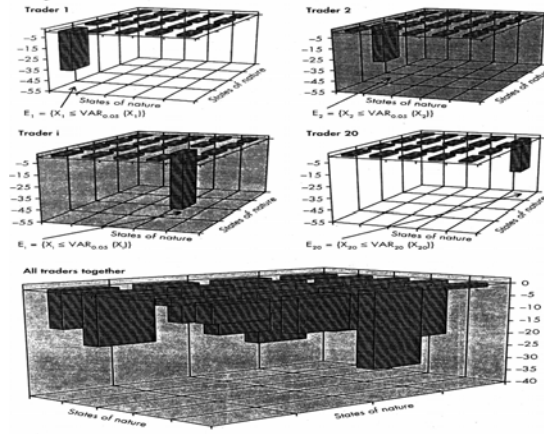
Critique on VaR

- Portfolio theory
- Spike the Firm
- CVaR as a better alternative



Portfolio Theory

2. Individual risk under "control", global risk out of control



Arzner, Delbaen, Eber and Heath (1997): Thinking Coherently, Risk Vol 10/ No 11 November 1997



To Spike the Firm

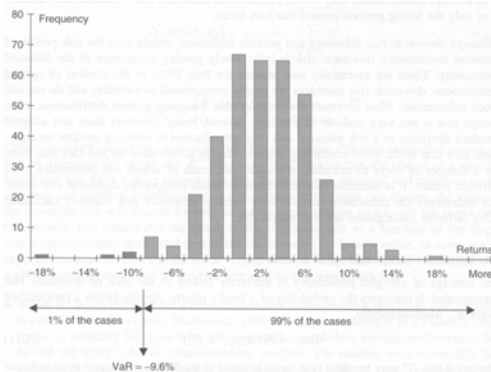


Figure A.3 Graphical interpretation of value at risk

VaR is insensitive to a strategy that with a very small risk results in a catastrophic loss.



Better Alternative: $CVaR = E(x | x \leq VaR(\alpha))$

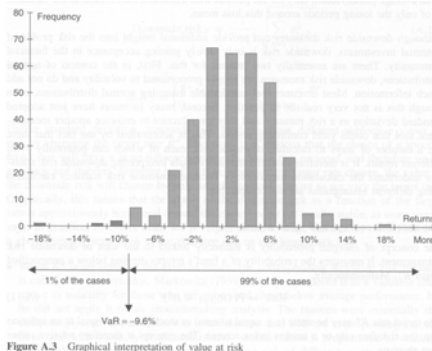
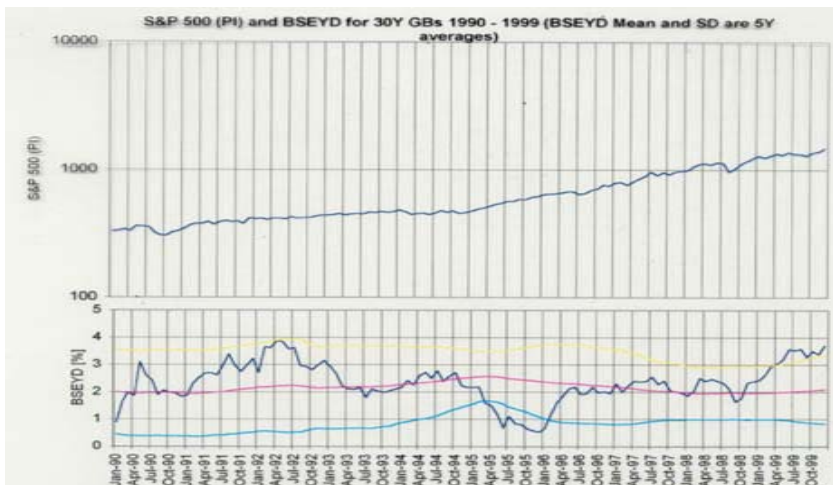


Figure A.3 Graphical interpretation of value at risk

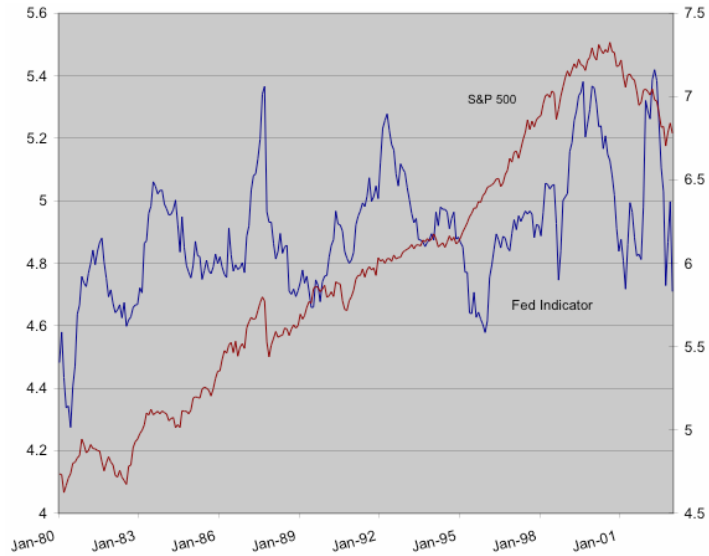
- CVaR is sensitive to spiking
- Is good for portfolio building



Indicators for Crashes



Indicators for Crashes



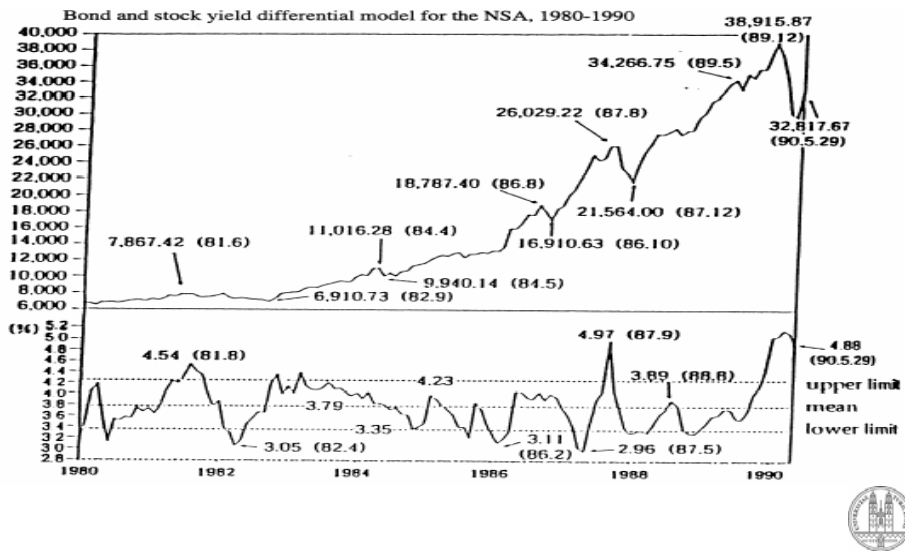
Crash Indicator Measure

		S&P Index	PER	(a) 30 Yr G b/d	(b) I/pe,%	(a)-(b)
1986	Jan	208.19	14.63	9.32	6.84	2.48
	Feb	219.37	15.67	8.28	6.38	1.90
	Mar	232.33	16.50	7.59	6.06	1.53
	Apr	237.98	16.27	7.58	6.15	1.43
	May	238.46	17.03	7.76	5.87	1.89
	Jun	245.30	17.32	7.27	5.77	1.50
	Jul	240.18	16.31	7.42	6.13	1.29
	Aug	245.00	17.47	7.26	5.72	1.54
	Sep	238.27	15.98	7.64	6.26	1.38
	Oct	237.36	16.85	7.61	5.93	1.68
	Nov	245.09	16.99	7.40	5.89	1.51
	Dec	248.60	16.72	7.33	5.98	1.35
1987	Jan	264.51	15.42	7.47	6.49	0.98
	Feb	280.93	15.98	7.46	6.26	1.20
	Mar	292.47	16.41	7.65	6.09	1.56
	Apr	289.32	16.22	9.56	6.17	3.39
	May	289.12	16.32	8.63	6.13	2.50
	Jun	301.38	17.10	8.40	5.85	2.55
	Jul	310.09	17.92	8.89	5.58	3.31
	Aug	329.36	18.55	9.17	5.39	3.78
	Sep	318.66	18.10	9.66	5.52	4.14
	Oct	280.16	14.16	9.03	7.06	1.97
	Nov	245.01	13.78	8.90	7.26	1.64
	Dec	240.96	13.55	9.10	7.38	1.72
1988	Jan	250.48	12.81	8.40	7.81	0.59
	Feb	258.10	13.02	8.33	7.68	0.65
	Mar	265.74	13.42	8.74	7.45	1.29
	Apr	262.61	13.24	9.10	7.55	1.55
	May	256.20	12.92	9.24	7.74	1.50
	Jun	270.68	13.65	8.85	7.33	1.52
	Jul	269.44	13.59	9.18	7.36	1.82
	Aug	263.73	13.30	9.30	7.52	1.78

Table 3.3: S&P500 index, PE ratios, government bond yields and the yield premium over stocks, January 1984 to August 1988. Source: Zienba and Schwartz (1991)



Crash Measure

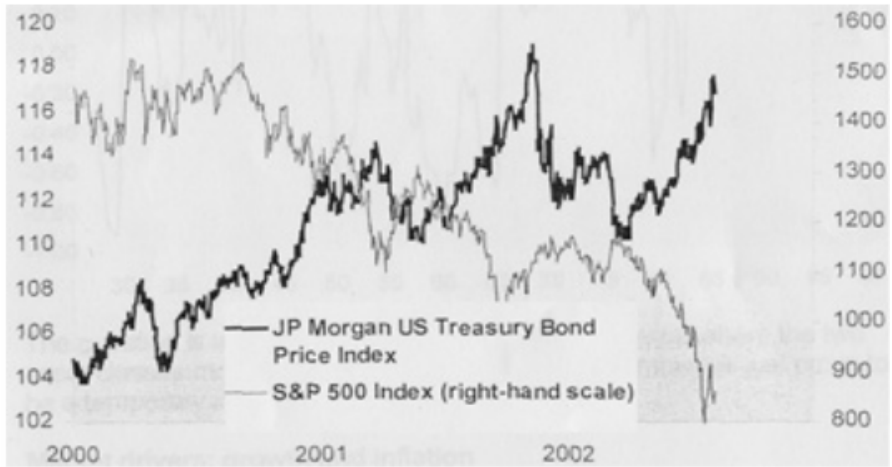


Stochastic Programming Approach

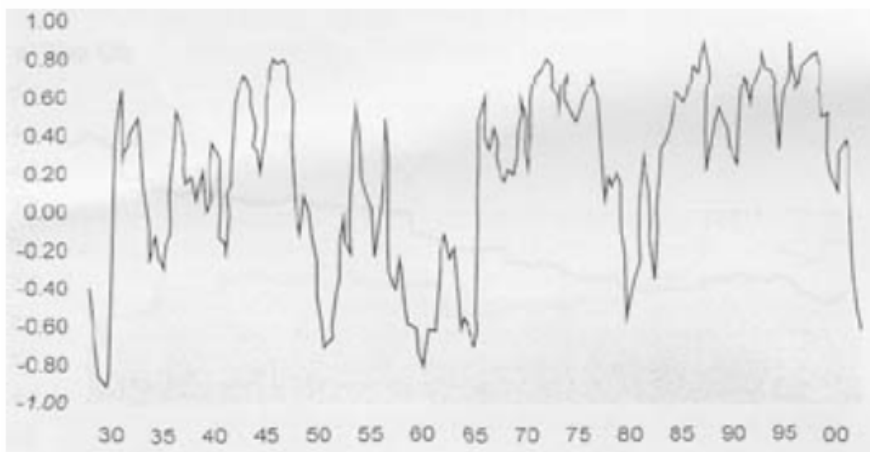
- Two scenarios
- Mean-Variance Tage ausbauen



The Greenspan Hedge



Correlation US Bond Stocks



Changing Expected Equity Returns

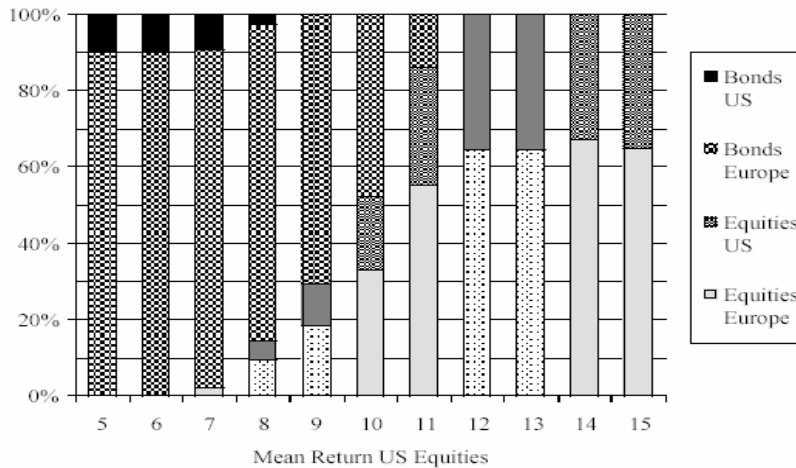


Figure 5.3: Optimal asset weights at stage 1 for varying levels of US equity means. Source: Geyer et al (2002)



Changing Risk Aversion

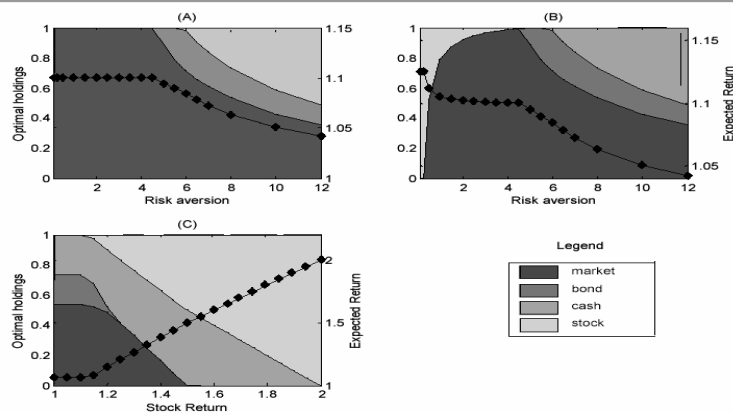


Figure 5.6: Mean-variance model. The optimal portfolios as a function of risk aversion (a,b) and expected return on company stock (c). Shaded regions indicate portfolio weights (left scale). The line represents the expected return on the optimal portfolio (right scale). Diamonds indicate values of independent variable for which calculations were made. Results for the three asset case, with no own-company stock, are in (a). Results for the four asset case are in (b) and (c). Source: Douglass, Wu and Ziemba (2003)

