The Credit Crunch
Causes, Consequences & Policy

Prof. Dr Casper G. de Vries
Erasmus University Rotterdam
Tinbergen Institute
Duisenberg School of Finance

Contents

- Part I: Origins
- Part II: Systemic Breakdown
- Digression I: Bank Networks
- Digression II: Hedge funds
- Part III: Recession

Part I

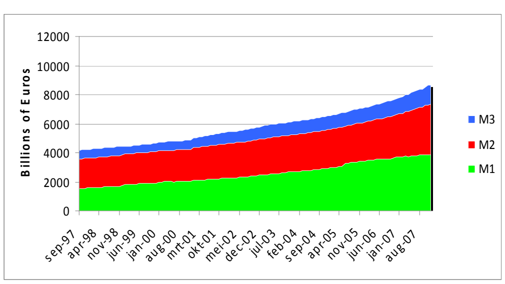
Origins

How it Started

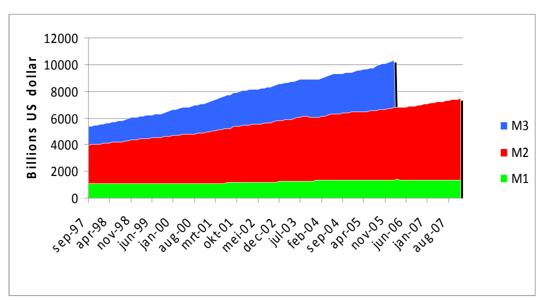
- Easy Money, Low Interest Rate policies
- Savings Deficits USA, Surplus Asia
- Low credit standards
- Permissive Basel Silo Approach

EMU Money Supply

Official growth rate until nov. 2007 4.5%; actual rate 8.3%!



US Money Supply



Ostrich Monetary Policy: Inflation Targeting

- Monetary Policy focused on consumer inflation: don’t notice asset inflation
- Asians build up official reserves
- Subsequently money went into subprime mortgages
- Opaque bundles, kept off-balance, with on balance obligation
- Condoned by rating agents and accountants
- Concentration of CDS with few insurers

Part II

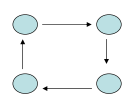
Systemic Breakdown

Three Crucial Crisis Features

- I/ **Asymmetric Information**
- II/ **Interconnectedness of Banks and other Vehicles**
- III/ **Lack of Capital (leverage)**

I/ **The Asymmetric Information Problem**

- The Old Lady meets the Old Maid, or Schwartze Peter, …



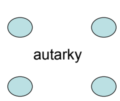
Payoff if win: W Probability to win: 3/4

Payoff if loose: -L Probability to loose: 1/4

Willingness to play if not dealt the old maid if: 3/4W-1/4L>0

Thus play if: W/L>1/3

The Old Lady meets the Old Maid



Payoff if win: W Probability to win: 3/4

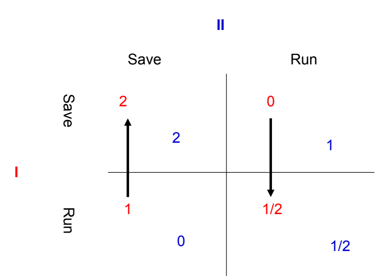
Payoff if loose: -L Probability to loose: 1/4

Willingness to play if not dealt the old maid if: 3/4W-1/4L>0

Subprime woes lead to risk reassessment such that L increased and: W/L<1/3

Fragility of banks

Strategic Choice of Depositors I & II: Two Nash equilibria



Suppose long investment yields 2 per project
canceling project & early withdrawal yields only 1/2

pR+(1-p)aR=B

p = survival probability
R = unsecured interbank rate (euribor)
a = 'recovery' rate
B = gross secured rate (eurepo)

Solve for p: p = {B/R-a}/{1-a}

S'pose
R = 1.04
a = ½
B = 1.01

Hence: p = 0.94

Market expected failure rate of 1 out of 16 banks!

Prevent Instability

- Deposit Guaranties
- Credit Guaranties
- Lower Interest Rates
- Loan conditions at ECB (quality of paper)
- Capital Injections (Fiscal or Monetary)

Special case of EMU (only Fiscal)

- Accounting standards: interpretation

II/ **Bank Network System**

Banks are highly interconnected:

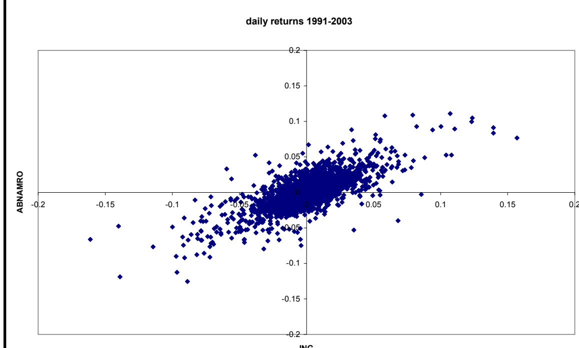
directly

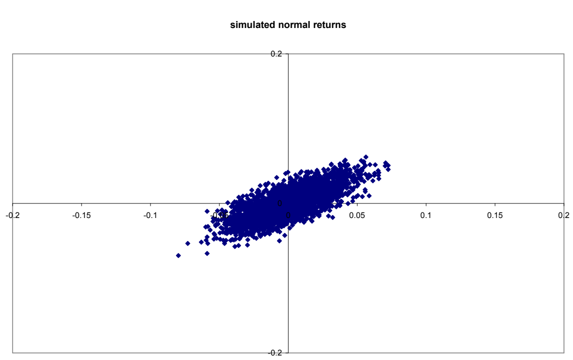
- Syndicated Loans
- Conduits
- Interbank Money Market

indirectly

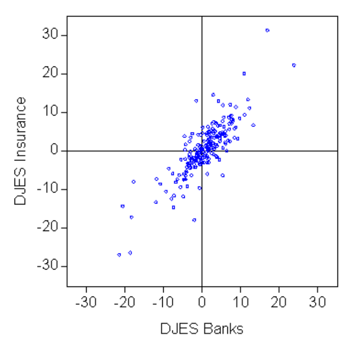
- Macro interest rate risk
- Macro GDP risk

Systemic Risk





Cross plot Insurers versus Banks



Fat versus Normal: 2 Features

- **Univariate**: More than normal outliers along the axes
- **Multivariate**: Extremes occur jointly along the diagonal, systemic risk is of higher order than if normal (*market speak: market stress increases correlation)*

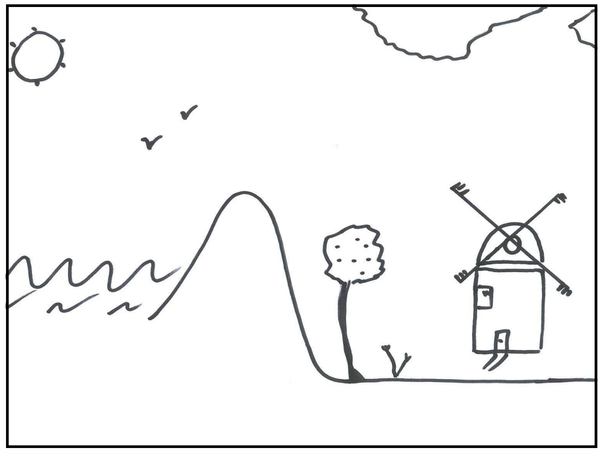


Figure 2: S&P 500 1929—2003 Returns

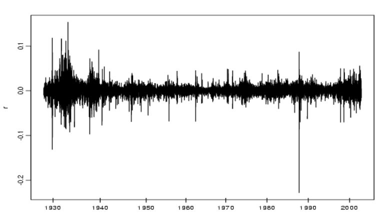


Figure 3: S&P Distribution and the Normal

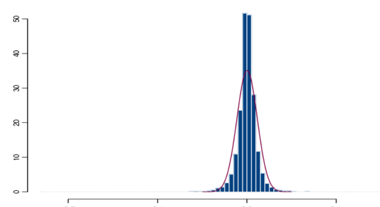
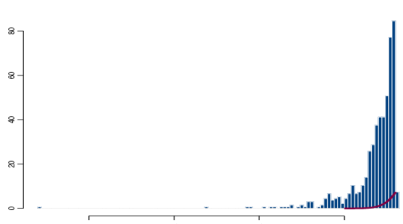


Figure 4: S&P Distribution and the Normal : Left Tail



Normal versus Fat Tail

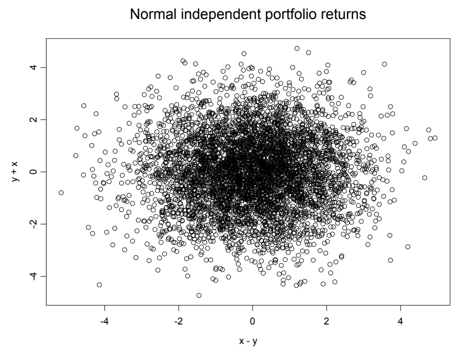
Normal $\Pr\{Y > s\} \approx \frac{1}{s}\frac{1}{2\pi} e^{-s^2/2}$

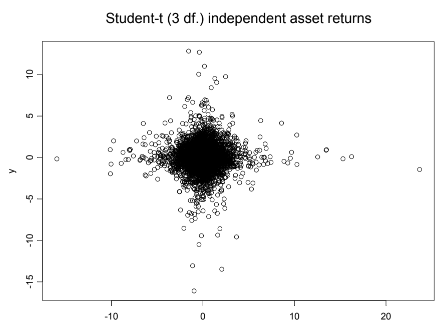
Fat $\Pr\{X > s\} = s^{-\alpha}$ (Pareto)

Ratios $\frac{e^{-s^2/2}}{s^{1-\alpha}} \to 0$ $\frac{s^{1-\alpha}}{e^{-s^2/2}} \to \infty$

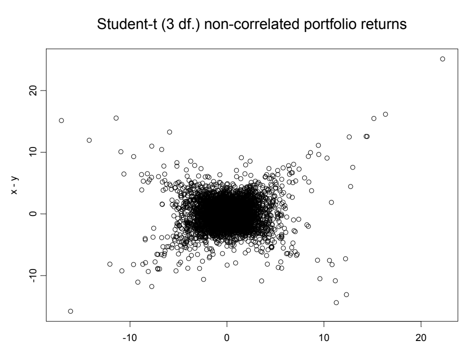
Multivariate

- Consider Bank versus Market Neutral Hedge Fund
- Bank is Long in both X and Y
- Bank portfolio return X+Y
- Hedge fund is long in X, short in Y
- Hedge fund portfolio return X-Y





- Note Plus Shape + is due to the Outliers
- Under normal, just get a Circular cloud



Normal

Normal $\Pr\{Y > s\} \approx \frac{1}{s}\frac{1}{2\pi}e^{-s^2/2}$

Sum / Fractal Nature (square root rule)

$$\Pr\{Y_1 + Y_2 > s\} = \Pr\{\sqrt{2}Y > s\} = \Pr\{Y > \frac{s}{\sqrt{2}}\} \approx \frac{\sqrt{2}}{s}\frac{1}{2\pi}e^{-s^2/4}$$

with n

$$\Pr\{\sum_{i=1}^{n} Y_i > s\} \approx \frac{\sqrt{n}}{s}\frac{1}{2\pi}e^{-s^2/2n}$$

Rate Declines with Sum

$$d\log\Pr\{\sum_{i=1}^{n} Y_i > s\} / d\log n \approx \frac{d[\frac{1}{2}\log n - \log s - \log 2\pi - \frac{s^2}{2n}]}{d\log n} = \frac{1}{2} + \frac{s^2}{2n}$$

Portfolio X+Y composed of indepedent normal returns X and Y
Portfolio failure probability is of lower order than marginal failure probabilities

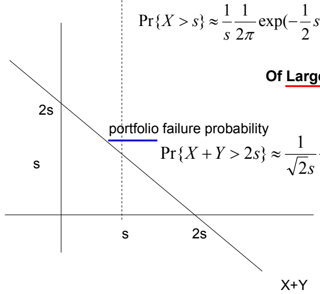
marginal failure probability

$$\Pr\{X > s\} \approx \frac{1}{s}\frac{1}{2\pi}\exp(-\frac{1}{2}s^2)$$

Of Larger Order Than

portfolio failure probability

$$\Pr\{X + Y > 2s\} \approx \frac{1}{\sqrt{2}s}\frac{1}{2\pi}\exp(-s^2)$$



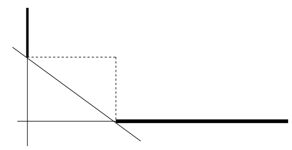
Feller Theorem

Consider two independent Pareto distributed random variables X and Y

$P\{X \le s\} = 1 - s^{-\alpha}$ $\qquad$ $P\{Y \le s\} = 1 - s^{-\alpha}$

Their joint probability is

$$P\{X \le s, Y \le s\} = (1 - s^{-\alpha})(1 - s^{-\alpha}) = 1 - 2s^{-\alpha} + s^{-2\alpha} \approx 1 - 2s^{-\alpha}$$



$\Pr\{X > s\} \approx s^{-\alpha}$

Fat Tail

Pareto $\qquad \Pr\{X > s\} = s^{-\alpha}$

Sum / Fractal Nature $\qquad \Pr\{X_1 + X_2 > s\} \approx 2s^{-\alpha}$

with n

$$\Pr\{\sum_{i=1}^{n} X_i > s\} \approx ns^{-\alpha}$$

Rate Independent of Summation

$$d\log\Pr\{\sum_{i=1}^{n} X_i > s\} / d\log n \approx \frac{d[\log n - \alpha \log s]}{d\log n} = 1$$

Portfolio X+Y composed of independent fat tailed returns X and Y
Marginal and portfolio failure probabilities are of the same order

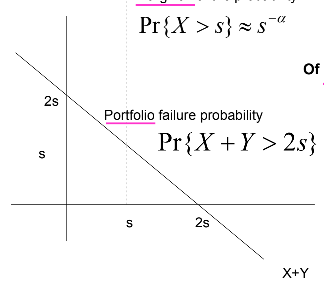
Marginal failure probability

$$\Pr\{X > s\} \approx s^{-\alpha}$$

Of Equal Order as

Portfolio failure probability

$$\Pr\{X + Y > 2s\} \approx 2^{1-\alpha} s^{-\alpha}$$



Effects of Diversification

- Normal Diversification Reduces the Order of Magnitude
- As the Rate is affected

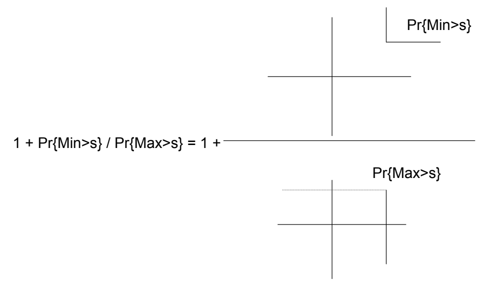
- Fat Tail Diversification leaves the order of magnitude unaffected
- Fat Tail Diversification only Reduces the Scale

Conclude

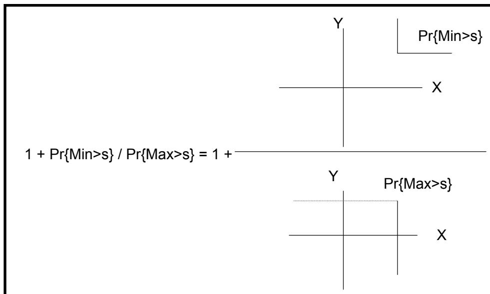
- With **linear dependence**, as between portfolios and balance sheets, the probability of a *joint failure* is:
- Of **smaller order** than the individual failure probabilities in case of the **normal**; Systemic risk is relatively unimportant
- Of the **same order** in case of **fat** tails; Systemic risk is important

Systemic Risk Measure

- Like marginal risk measure VaR
- Desire a scale for measuring the potential **Systemic Risk**



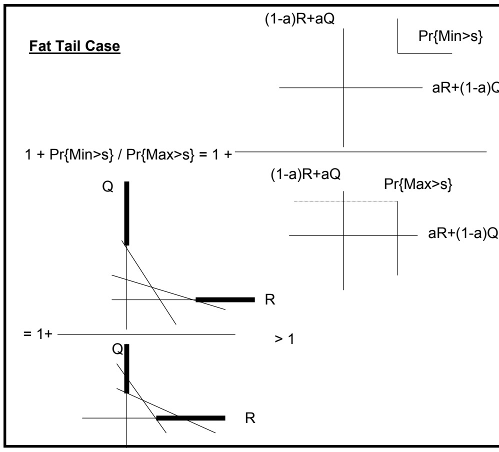
Given that there is a bank failing, what is the probability the other bank fails as well?



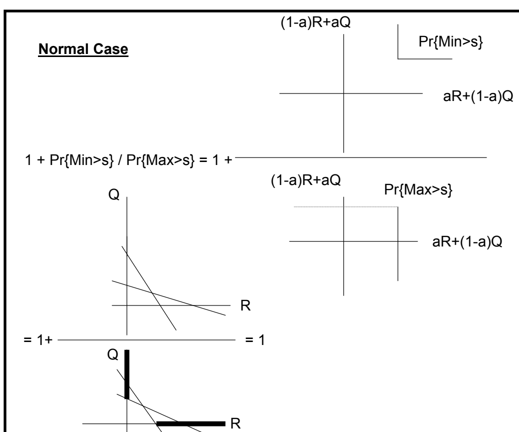
Systemic Risk Measure:

$$\frac{\Pr\{X>s\}+\Pr\{Y>s\}}{1-\Pr\{X\le s, Y\le s\}}=1+\frac{\Pr\{Min(X,Y)>s\}}{\Pr\{Max(X,Y)>s\}}$$

Fat Tail Case



Normal Case



Ledford-Tawn measure

Need finer measure in case of normality since

$$\frac{\Pr\{X>s\}+\Pr\{Y>s\}}{1-\Pr\{X\le s, Y\le s\}}=1+\frac{\Pr\{Min(X,Y)>s\}}{\Pr\{Max(X,Y)>s\}}\to 1$$

Use instead

$$\frac{1}{2}\lim_{s\to\infty}\frac{\log\Pr\{X>s\}+\log\Pr\{Y>s\}}{\log\Pr\{X>s, Y>s\}}$$

Systemic Risk Measure

- Where does systemic failure set in?
- Multiple equilibria, liquidity risk
- Take limits
- Evaluate in limit and extrapolate back
- Construct Multivariate VaR, in terms of Failure Probability, rather than loss quantile
- Conditional Failure Measure

Answers Differ Radically

Question: If bank exposures are linear in the risk factors, and banks have some of these factors in common, then what is the expected number of extra failures given that there is a failure?

• Normal	• Fat Tails
• Zero	• Positive

Note: to see something under normality, we need a finer risk measure like the Trace of the covariance matrix / the Tawn measure

Bank Networks

Digression I

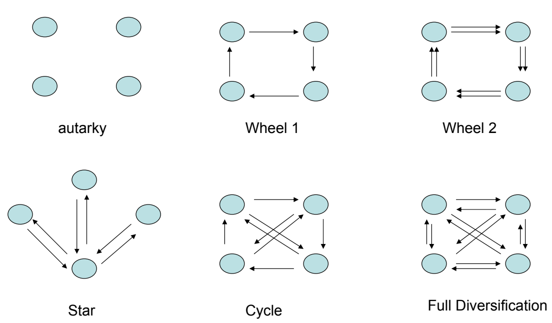
Bank Network System

- Syndicated Loans
- Conduits
- Interbank Money Market

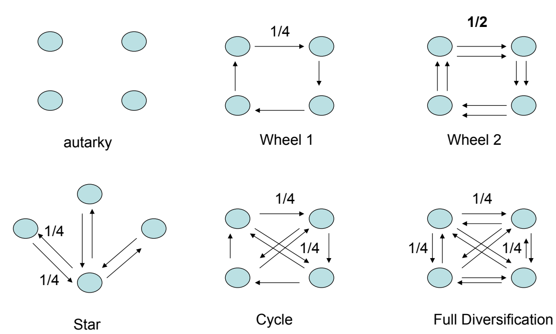
- 4 Banks with 4 Projects
- Each Project Divisible into 4 Parts

Bank Networks

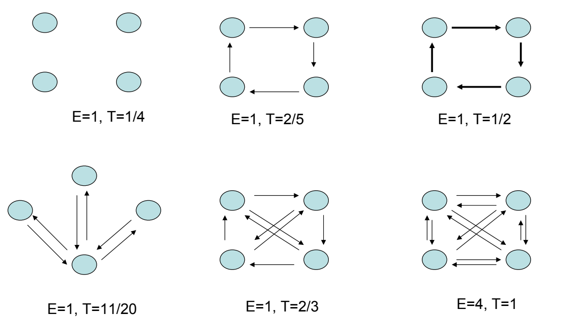
Banks are circles. Arrows indicate transfer of –part of- project, loan etc.



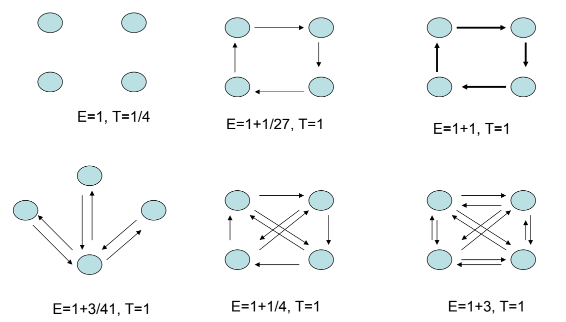
Bank Networks



Systemic Risk, normal



Systemic Risk, fat tails, α =3



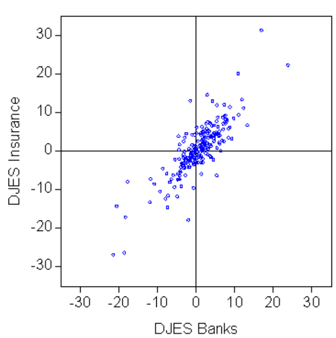
Conclude

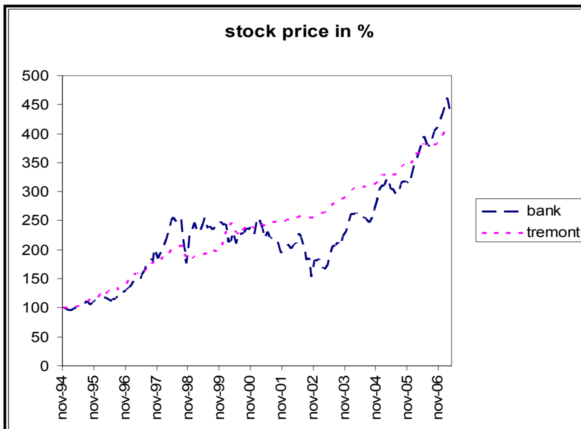
- **Pattern** of Systemic Risk under fat tails differs from normal based covariance intuition
- Too much Diversification **hurts** Systemic Risk (*slicing and dicing convexifies the exposures*)

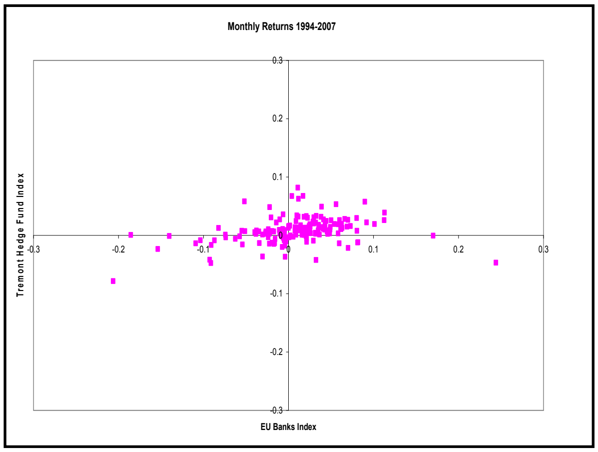
Banks & Hedge Funds

A digression into false positives

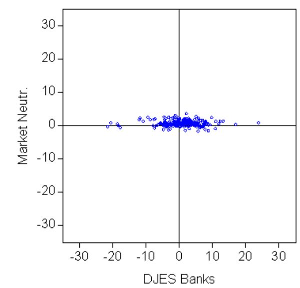
Cross plot Insurers versus Banks

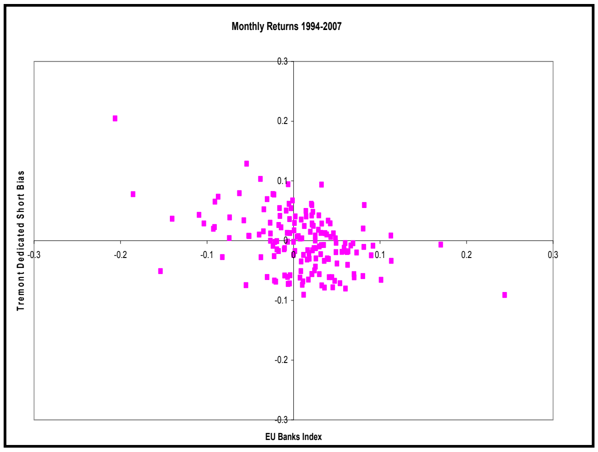


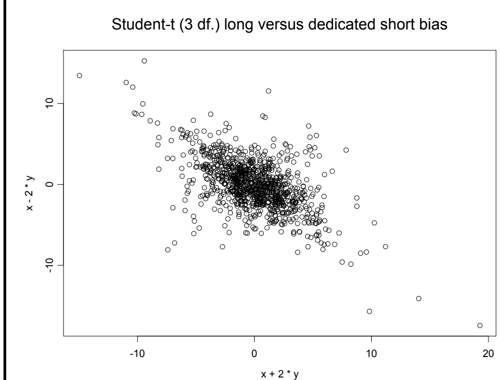


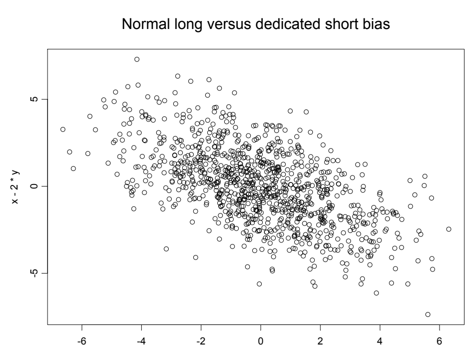


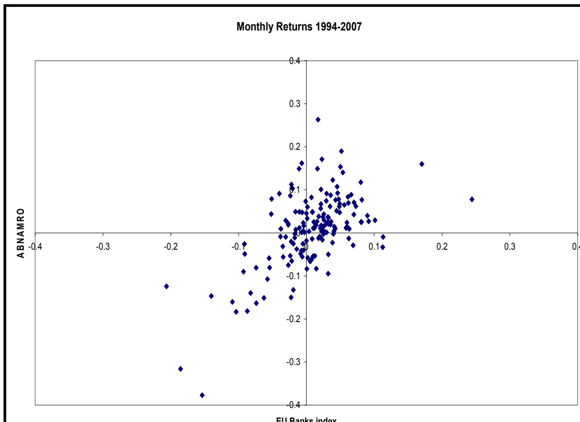
Cross plot Banks versus HFR Equity Market Neutral



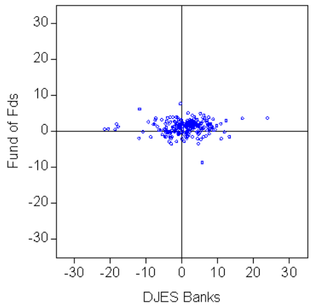




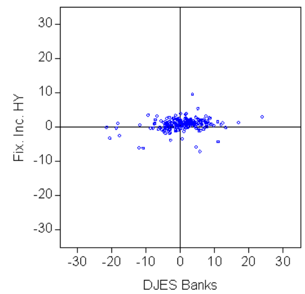




Cross plot Hedge Funds vs. Banks



Cross plot Banks vs. HFR Fixed Income High Yield Index



CAPM Explanation

Banks $B_1 = bR + \varepsilon_1$ $B_2 = bR + \varepsilon_2$

$B_1 + B_2 = 2bR + \varepsilon_1 + \varepsilon_2$ $\Pr\{B_1 + B_2 > s\} = (2 + 2^{\alpha} b^{\alpha}) s^{-\alpha}$

Hedge Funds

$B_1 - B_2 = \varepsilon_1 - \varepsilon_2$ $\Pr\{B_1 - B_2 > s\} = 2s^{-\alpha}$

Corr(B1+B2,B1-B2)=0 $\Pr\{B_1 + B_2 > s, B_1 - B_2 > s\} = s^{-\alpha}$

Banks &Hedge Funds

- Banks are *MORE* Risky than Hedge Funds
- Low Systemic Risk effects of hedge funds for the Banking Sector
- If anything, hedge funds are grasshoppers wearing the bolder hat that provides the protection

Regulation

- Resist call for undirected regulation
- Target systemic features
- Remuneration structured at stability
- Stimulate information provision (creation of organized exchanges for derivatives like cds, cdo, etc.)

Basel Motivation

- Systemic Risk of banks is important due to the externality to the entire economy
- Motive for Basle Accords & why banks are stronger regulated than insurers (Solvency)
- Surprise is micro orientation of Basle II, rather than macro systemic approach

Four Conclusions

- Asymmetric Information, market trade or OTC
- Linear dependence and normal risk cannot produce systemic risk
- Linear dependence and fat tails imply that systemic risk is always there
- Need for systemic risk scale like Richter scale, in order to impute correct capital requirements and signal potential stress

III/ Recapitalization of Banks

- Infusion of capital?

(Japan 90's, Brown/Sarkozy)

- Creation of good bank and bad bank?

(Lloyds debacle, Sweden 91, Paulson initial plan)

Return of Trust

- Healthy banks
- Deposit insurance
- Government guarantees for credit
- Public information

Part III

Recession

Recession

- Banks scramble for capital (2nd round)
- Hedge funds de-leverage big time
- Refinancing collapses, lower investments
- Deflation (but not 1930 or 1880)
- Negative growth, Unemployment
- Strong currency movements
- Biggest danger is overreaction by authorities (pensions, trade and protection, industry bail outs)
- Unity of union? (Solvency II in shambles)

Analogies

- EU economy better prepared than 1920's
- 1987, -20% on a single day, due to information asymmetry
- 1998, Asian (currency) crisis, collapse LTCM
- 1982-87 S&L crisis
- Iceland & IMF, old recipes to kill the patient

Endogenous Risk

- London Millennium Bridge
- Pro-cyclical Policies
- Pro-cyclical Expectations
- Multiple Equilibria
- How to coordinate on positive expectations?
- Inflation in the making?

Anti Recessive Drugs?

- Monetary Policy: Lower interest rates
- But Liquidity trap at r%=0
- Fiscal Policies & Coordination
- ECB currently unable to inflate away national debt, should we worry?

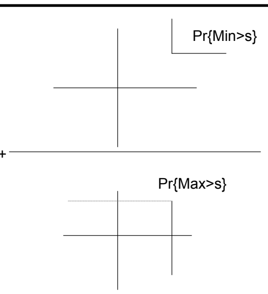
Thank You, Until the next Crisis!

This will be in about 25 years!

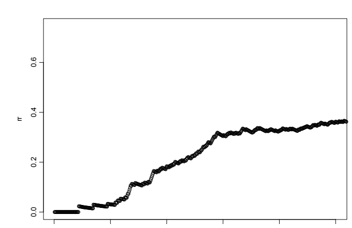
Appendix Multivariate Estimation

Count Measure

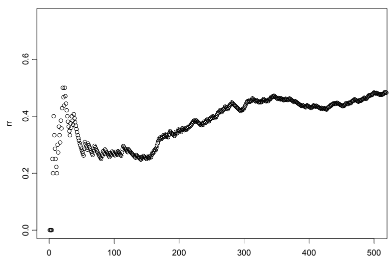
1 + Pr{Min>s} / Pr{Max>s} = 1 +



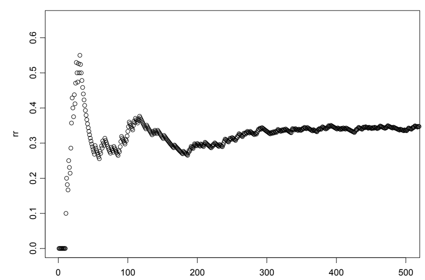
Correlated Normal



Correlated Student-t



Bank Data: ABNAMRO & ING



Interpretation

1 in **3** times one bank ‘fails’, the other bank fails as well

Estimated failure measure

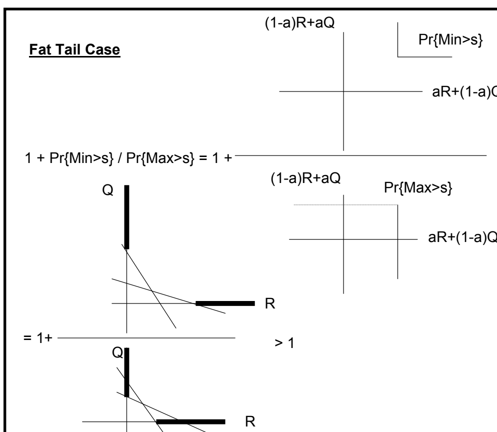
Banks and Insurers (bivariate normal)

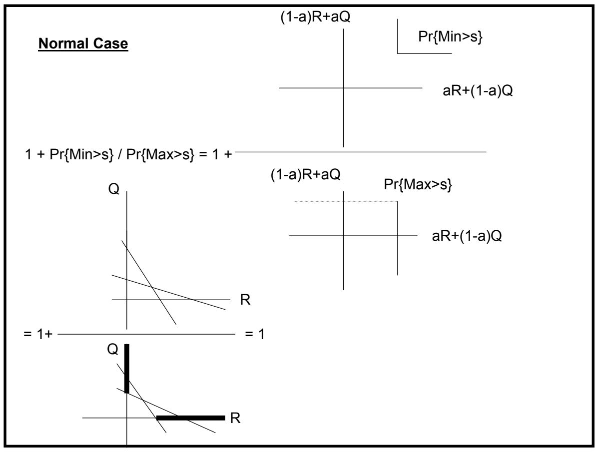
	Mean	
	Bank	Insurer
Bank	0.0082	0.0063
Insurer	0.0063	0.0133

Estimated failure measure

Banks and Insurers across EU

	Mean		Median	
	Bank	Insurer	Bank	Insurer
Bank	0.1038	0.0744	0.095	0.069
Insurer	0.0744	0.1170	0.069	0.107





Normal Details

$$P\{Min[X,Y]>s\}<P\{X+Y>2s\}$$
$$=P\{R+Q>2s\}=P\{\sqrt{1/2}R>s\}\approx\frac{\sqrt{1/2}}{s}\frac{1}{\sqrt{2\pi}}\exp(-s^2)$$

$$P\{Max[X,Y]>s\}>P\{X>S\}$$
$$=P\{aR+(1-a)Q>s\}=P\{\sqrt{a^2+(1-a)^2}R>s\}\approx\frac{\sqrt{a^2+(1-a)^2}}{s}\frac{1}{\sqrt{2\pi}}\exp(-\frac{1}{2}\frac{s^2}{a^2+(1-a)^2})$$

$$\therefore\frac{P\{Min[X,Y]>s\}}{P\{X>s\}}\le\sqrt{\frac{a^2+(1-a)^2}{2}}\exp\left(-\frac{1}{2}\left[\frac{1}{1/2}-\frac{1}{a^2+(1-a)^2}\right]\right)\to 0$$

Fat Tail Details

$$P\{Max[X,Y]>s\}\approx 2\left(\frac{s}{a}\right)^{-\alpha}$$

$$P\{Min[X,Y]>s\}\approx 2\left(\frac{s}{1-a}\right)^{-\alpha}$$

$$1+\frac{P\{Min>s\}}{P\{Max>s\}}=1+\left(\frac{1-a}{a}\right)^{\alpha}>1$$

Conduit Runs

- Bank Return X;
  Market Risk M;
  Interest Rate Risk R;
  Idiosyncratic Risk E;
- Bank 1: $X_1=\beta_1 M+\gamma_1 R+E_1$
- Bank 2: $X_2=\beta_2 M+\gamma_2 R+E_2$
- If: $P\{M>s\}\approx P\{R>s\}\approx P\{E>s\}\approx s^{-\alpha}$
- Systemic Risk
  (expected number of
  joint failures): $E\{k\mid k\ge 1\}=1+\frac{(\beta_1\wedge\beta_2)+(\gamma_1\wedge\gamma_2)}{(\beta_1\vee\beta_2)+(\gamma_1\vee\gamma_2)+2}$