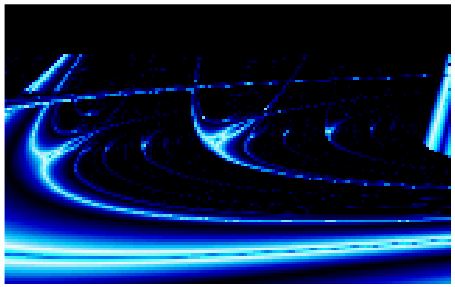
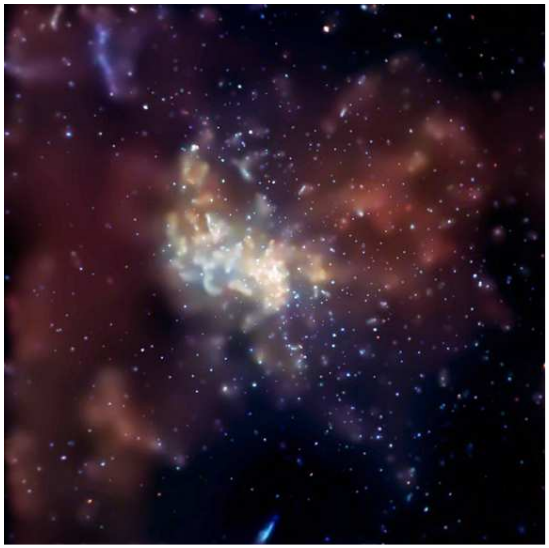


SOLVING PROBLEMS?

Dr A. A. Kotzé
Financial Chaos Theory
March 2010



Saggitarius A*: supermassive black hole at the Milky Way's center

Niels Bohr
and
Albert Einstein

Before I came here I was confused about the subject. Having listened to your lecture I am still confused. But on a higher level.

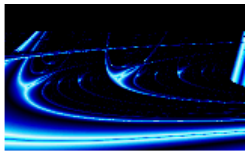
Enrico Fermi (1901-1954)

FINANCIAL CHAOS THEORY

Safex Margins

- Safex
- http://www.jse.co.za/DownloadFiles.aspx?RequestedNode=DownloadableDocuments/Safex/Margin_Requirements/2010
- Currencies

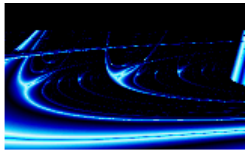
Contract Code	Expiry Date	Initial Margin Requirement	Spread Margin Requirement	VSR
Dollar/Rand ($/R)	15 March 2010	R 350.00	R 25.00	2.5
Dollar/Rand ($/R)	14 June 2010	R 360.00	R 25.00	2.5
Dollar/Rand ($/R)	13 September 2010	R 370.00	R 25.00	2.5
Dollar/Rand ($/R)	13 December 2010	R 375.00	R 25.00	2.5
Dollar/Rand ($/R)	14 March 2011	R 380.00	R 25.00	2.5
Dollar/Rand ($/R)	13 June 2011	R 385.00	R 30.00	2.5



FINANCIAL CHAOS THEORY

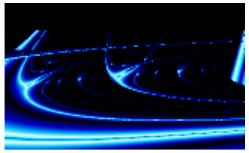
Freaking Out on Risk

- Super Freakonomics explains what I do
- **Chapter 4: The fix is in – and it's cheap and simple**
- In the USA in 1952, 40 million cars
- Rate of death per mile driven was 5 times higher than today. Why?
- Enter Robert McNamara who believed in statistical analysis



Car Accidents Freaking me Out

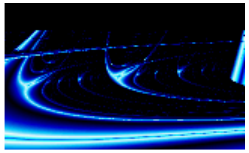
- Worked for Ford Motor Company after WWII
- Started testing with dummies
- Humans were no match for hard materials used in car interiors
- Drivers were often impaled on steering wheel
- Passengers hit the windshield or header bar of instrument panel



FINANCIAL CHAOS THEORY

First Freaking Solution

- Soften up the interior
- Worked but one can soften the steering wheel only up to point



FINANCIAL CHAOS THEORY

Better Freaking Solution

- Fit seat belts!
- Cars did not have seat belts before the mid fifties
- McNamara knew airplanes had seat belts
- Started to fit them to Ford cars – not a new solution
- Seat belts reduce the risk of death by as much as 70%

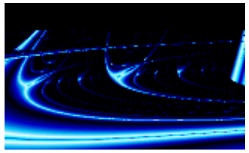
FINANCIAL CHAOS THEORY

Most Cost-Effective Freaking Solution

- Enter the air bag
- Cost: $1.8 million per life saved

- What about seat belts?
- Cost: $30,000 per life saved!

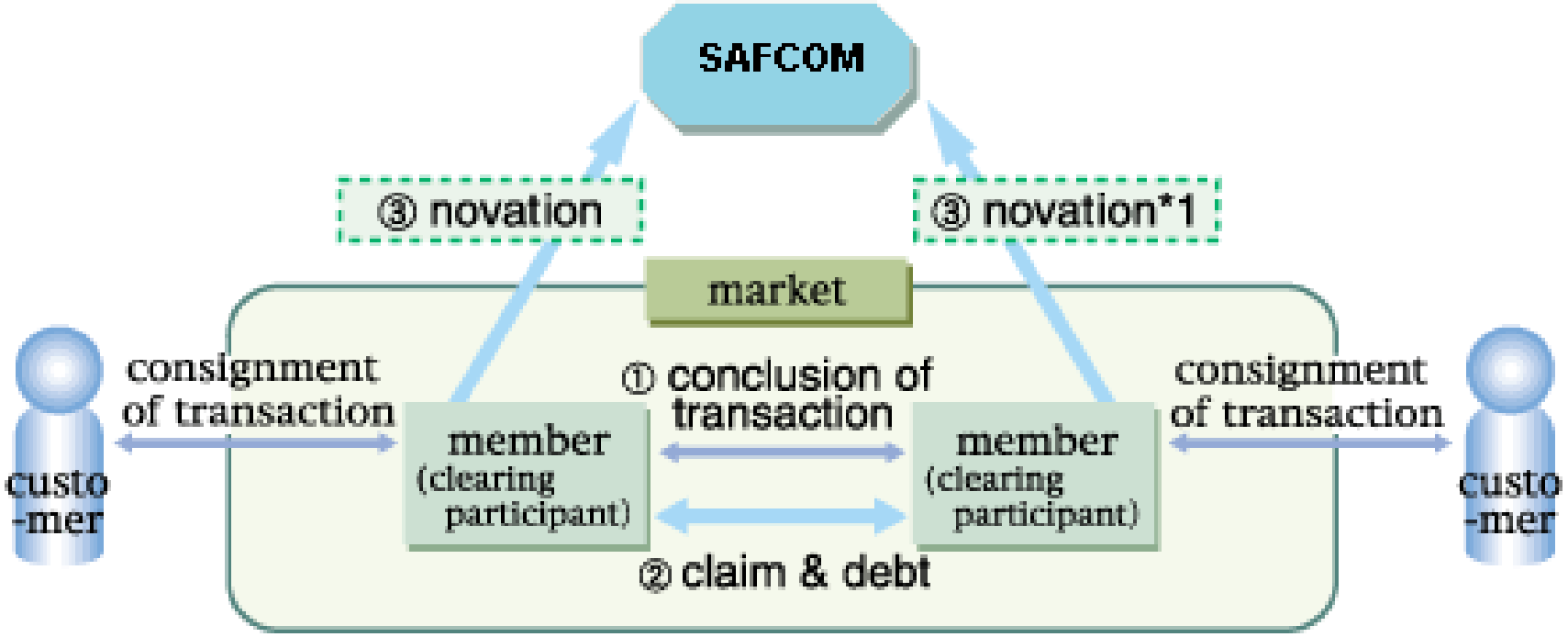
- Which solution is the best?



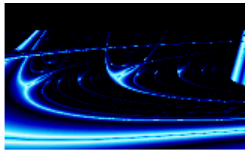
FINANCIAL CHAOS THEORY

Who Bears the Risk in a Derivatives Market?

- Clearing Houses



SAFCOM bears credit risk

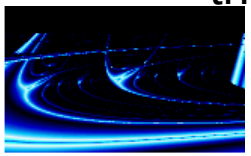


FINANCIAL CHAOS THEORY

Initial Margin

- Exchanges employ a system of margining. Accordingly, a counterparty to a transaction on an exchange is required to pay a sum over to it at the inception of the derivative transaction to cover any potential losses arising from a default – initial margin

- **Risk management** may be defined as identifying the risk of loss in a portfolio and ensuring that the **losses can be borne**.
- A futures contract's Initial Margin Requirement (IMR) is equal to the profit or loss arising from the **maximum anticipated** up or down move in its price **from one day to the next**
- It is in essence a 1 day Value at Risk (VAR) measure. It is given in Rands per futures contract.
- Should the losses eventuate and the participant be unable to bear them, the margin is available to the exchange to meet the shortfall.



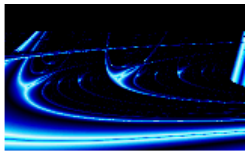
FINANCIAL CHAOS THEORY

The Risk Parameter

- The exchange estimates this possible 1 day loss through a statistical analysis of historical market returns
- Use 751/2001 daily closing values to obtain 750/2000 daily returns
- The risk parameter is set at **3.5** Standard Deviations confidence level of 99.95%.
- Meaning? 99.95% of all possible daily changes in the market will be covered by the IMR

OR

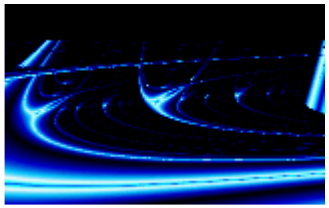
- The IMR will be enough to cover any 1 day loss 99.95% of the time
- 99.95% confidence => one loss in 2000



FINANCIAL CHAOS THEORY

The Risk Parameters

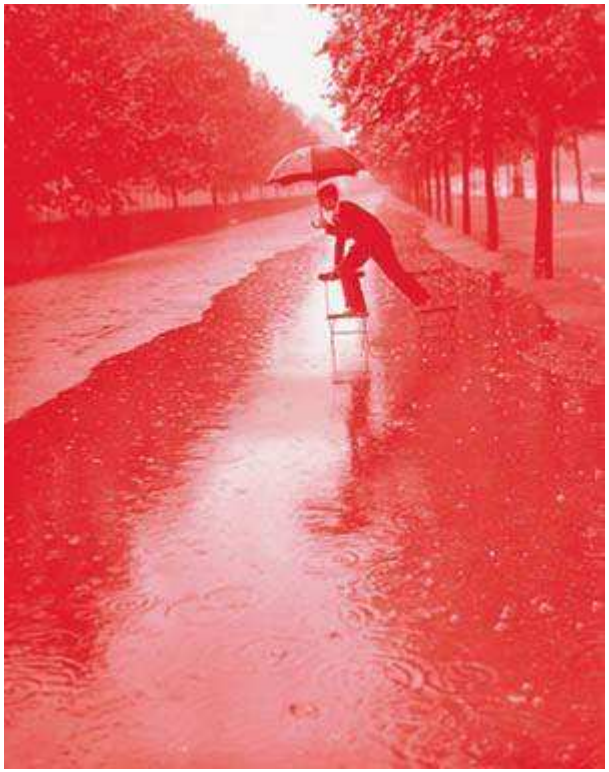
Standard Deviations	Confidence Level
σ	68.2689492137%
1.645σ	90.0000000000%
1.96σ	95.0000000000%
2σ	95.4499736104%
2.33σ	98.0000000000%
2.576σ	99.0000000000%
3σ	99.7300203937%
3.5σ	99.9500000000%
4σ	99.9936657516%
5σ	99.9999426697%
6σ	99.9999998027%
7σ	99.9999999997%



FINANCIAL CHAOS THEORY

Currency Futures

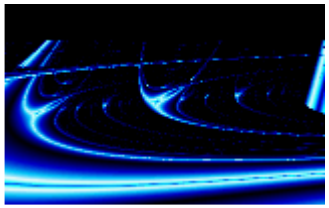
- Started trading in June 2007
- Standard Bank and Investec were liquidity providers
- New instruments – they were “weary”
- Asked YieldX to calculate margins using **6** standard deviations
- Let’s untie the risks……excel



FINANCIAL CHAOS THEORY

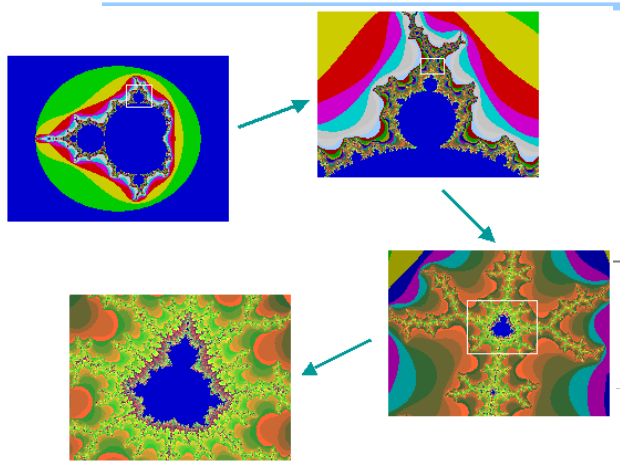
Global Exchanges

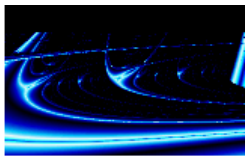
Exchange/Clearing House	Confidence Level	Standard Deviations
Natural Gas Exchange (NGX)	99.70%	3.0
Australia Securities Exchange	99.00%	2.576
LCH.Clearnet	99.70%	3.0
Bombay Stock Exchange	99.00%	2.576
X-Clear (Swiss)	99.00%	2.576
Safex ED	**99.95%**	**3.5**
Yield-X (interest rate futures)	**99.95%**	**3.5**
Yield-X (currency futures)	**9.999999%**	**6**



FINANCIAL CHAOS THEORY

Standard Deviation



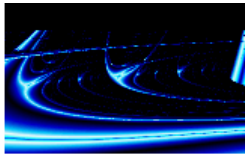


FINANCIAL CHAOS THEORY

Problem 1

- **At 6 STDEVs, margins too high and traders traded single stock futures instead**

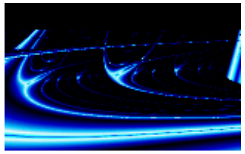
- Let's unpack risks further….. and compare against what we are comfortable with….. and we'll also get closer to the market's view on risk….excel
- Solution: Market did not understand the risk. A simple analysis was enough to solve this problem



FINANCIAL CHAOS THEORY

Single Stocks and Crises of October 2008: Problem 2

- Lehmans – no problems with SA book
- Dealstream and Cortex – SSF undermargined
- The credit crises showed that we had to enhance the model for **illiquid instruments** and **concentrated positions**
- Let's see the effect of liquidity - excel
- Concentration risk lies in the fact that a single or few parties may hold large positions relative to the issued share capital.
- Ratings of 1 & 2 are considered as Liquid Contracts – SSF will be listed
- Ratings of 3 are considered as Illiquid Contracts – SSF will not be listed

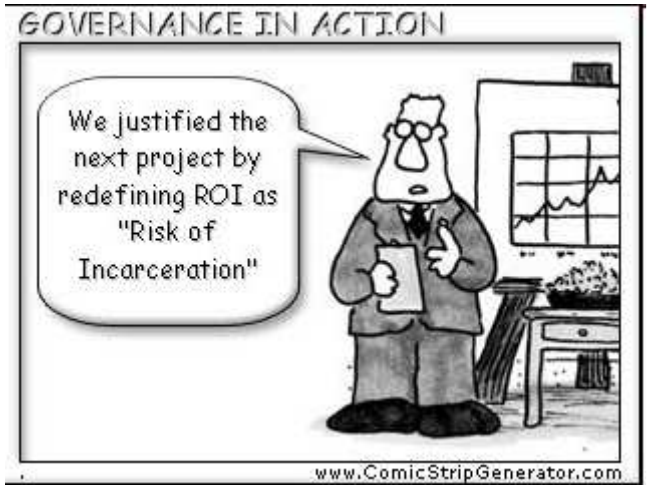


FINANCIAL CHAOS THEORY

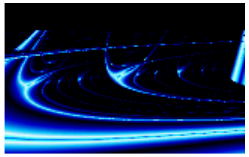
Liquidity

LIQUIDITY PROGRAMMING PARAMETERS

RATING	AVE VALUE TRADED PER MONTH (CALCULATED OVER 6 MONTHS)	PARAMETER	% DAYS TRADE	Liquidity Level
1	> R100 000 000	AND	>75%	High
2	> R30 000 000	AND	>75%	Normal
3	< R30 000 000	OR	<75%	Illiquid



Liquidity and volatility…….



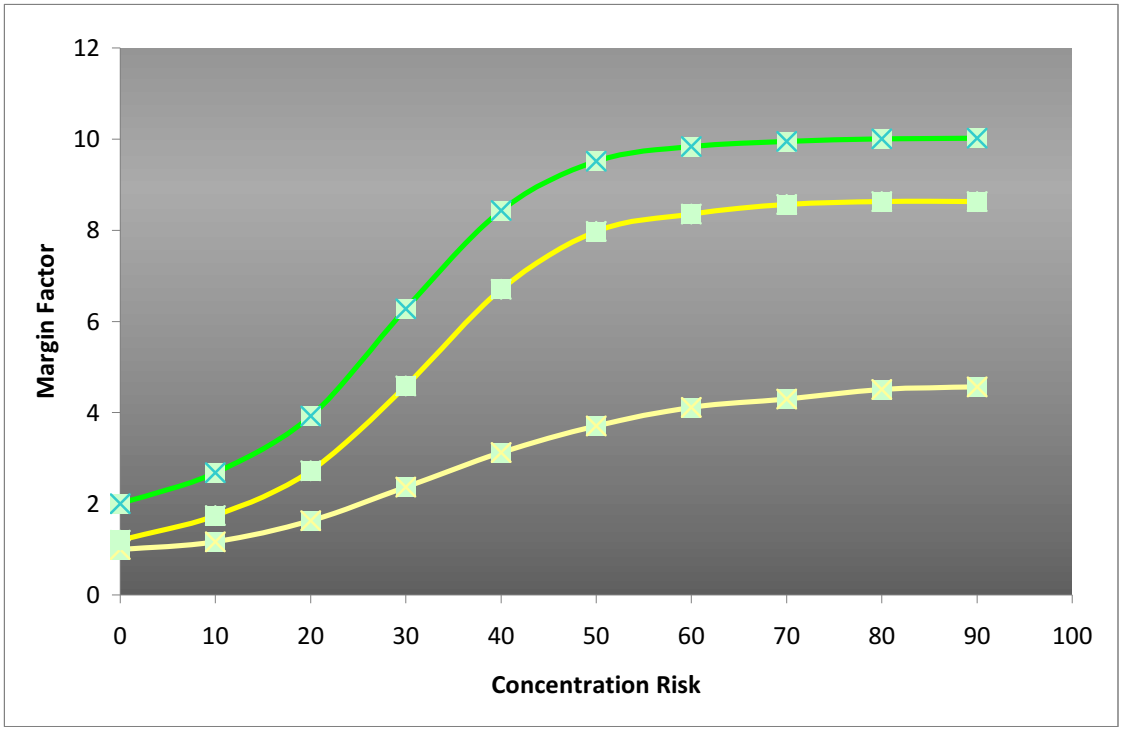
FINANCIAL CHAOS THEORY

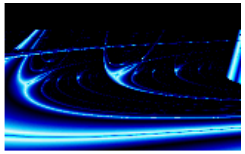
Concentration Risk

Liquidity Rating	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
3	2	2.684521	3.928324	6.274398	8.433277	9.511071	9.835002	9.949161	10.00589	10.02
2	1.2	1.742451	2.724644	4.584617	6.703902	7.974339	8.35733	8.567661	8.632931	8.63
1	1	1.167901	1.628874	2.369143	3.125875	3.704345	4.114506	4.294166	4.507414	4.565

Concentration risk

Concentration risk = Position / Shares in Issue

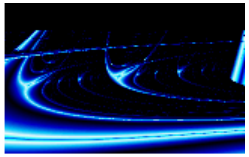




FINANCIAL CHAOS THEORY

SUCCESS

- This solution was a quick AND very cheap one
- It did not require ANY IT system changes
- It works….why
- Due to higher margin requirements the volumes in the illiquids almost dried up…why
- Every trader is very cash sensitive… remember the currency futures….
- Solution: If one understands how the market operates and what is important, one might not need a complex highly involved solution!



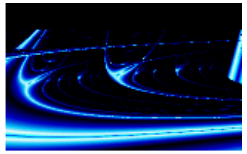
FINANCIAL CHAOS THEORY

Interest Rate Derivatives - Margins

The Initial margin requirements (IMR) for the interest rate contracts are as follows and are effective, 8th March 2010.

Contract Code	Expiry Date	Fixed Margin	Spread Margin	VSR	Series Spread Margin
R155	06/05/2010	600	50	1.00	140
R157	06/05/2010	1370	70	1.00	100
R157	05/08/2010	1390	70	1.00	100
R157	04/11/2010	1390	70	1.00	100
R186	06/05/2010	2800	140	1.00	230
R186	05/08/2010	2850	140	1.00	230
R186	04/11/2010	2850	140	1.00	230

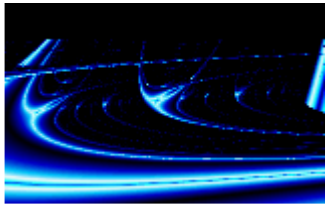
- Let's calculate margins…..



FINANCIAL CHAOS THEORY

Data Input: Problem 3

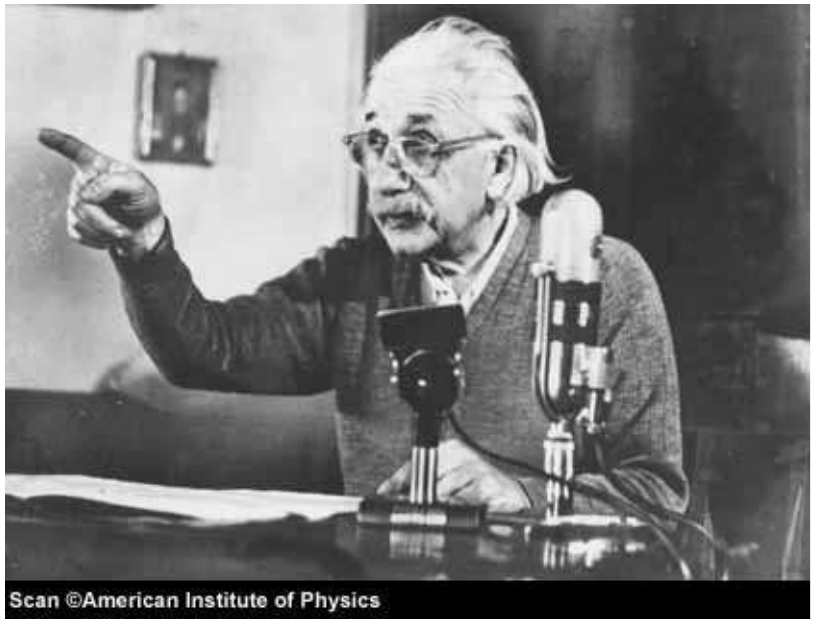
- Problem: what data should one use?
- NB: Bonds (and the futures) trade on YIELD but settle on ALL-IN-PRICE – AIP determines cash flows….
- Let's use the YTMs and AIPs….. - excel



FINANCIAL CHAOS THEORY

Bond Duration

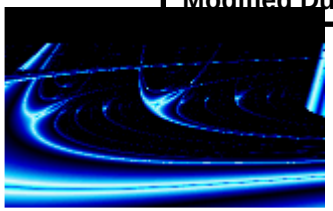
- What's the problem with this method (if any)?



- R157 matures on 15 Sep 2015
- Let's test something:

	Spot	Spot
Bond	r157	r157
Value date	15-Mar-10	15-Mar-05
YTM	8.180%	8.180%
Settlement date	18-Mar-10	18-Mar-05
All-in Price	123.270710	137.099730
Rand per Point	-497.6517586471	-864.9031999481
Rand per Point per Point	0.25895576	0.75339854
Duration	4.202180178279	6.566590098461
Modified Duration	4.037064250437	6.308569601750

- As time progresses the dynamics of a bond changes due to the changes in Rpp and duration

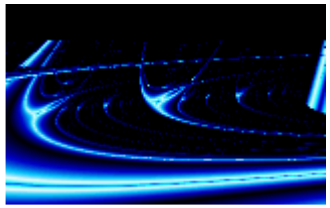


FINANCIAL CHAOS THEORY

Historical Time Series

- Can we really use time series as we did in the calculation of standard deviations?
- Let's look at this problem from a different angle…
- There are two fundamental building blocks in the financial markets where resources are necessary to ensure they are implemented correctly

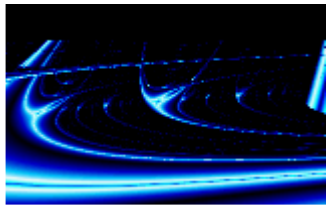
Yield Curve and **Volatility Surface**



FINANCIAL CHAOS THEORY

Using the Yield Curve for Bond Futures

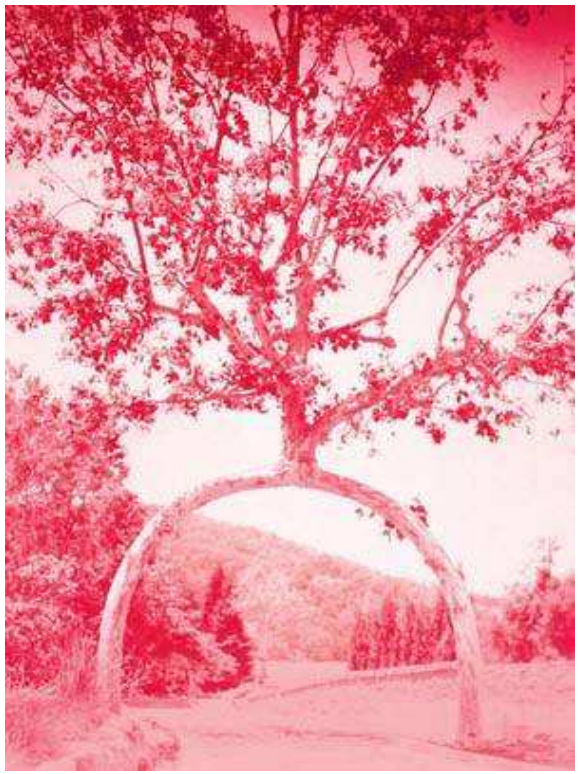
- Example: calculate a time series of R157 bond prices using the series of yield curves
- Use BESA's perfect fit bond yield curves from 28 Feb 2002…
- On 11 March the R157's MtM was 8.245% and an AIP of 122.89381
- Let's see what we can do with our yield curves…
- Using the yield curve gives a price of 122.69701
- Now we can calculate the margins using these "generated" time series… excel
- Problem solved!

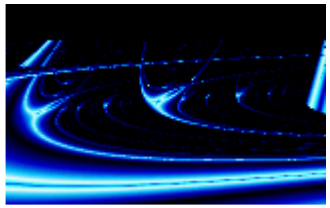


FINANCIAL CHAOS THEORY

Using the Yield Curve with the Top 40 index: Problem 4

- Extension to equities: We can do exactly the same BUT using the Top 40 and relevant dividend yields to generate theoretical forward values… excel
- Most banks use the theoretical forward prices in their own mark-to-market calculations
- Safex currently mark-to-market near Alsi future, everything else is marked-to-model
- Not implemented yet, still in test phase

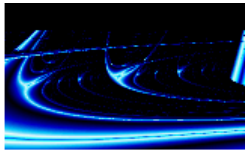




FINANCIAL CHAOS THEORY

Offsets: Problem 5

- If a portfolio contains instruments that is correlated, a “rebate” is given to reflect the correlation
- Two types of offsets
  - Series spreads or calendar spread offsets e.g. going long a June Alsi and shorting a Sep Alsi
  - Group series offsets e.g. going long a May R157 futures and shorting a May R186 future
- Using correlation and covariance matrices….excel
- Implemented for all interest rate futures
- Will extend later on to incorporate the Top 40 SSFs



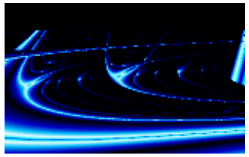
FINANCIAL CHAOS THEORY

Options

- One extra source of risk: volatility
- We have the fixed margin and volatility surface so let's do some scenario analysis….excel

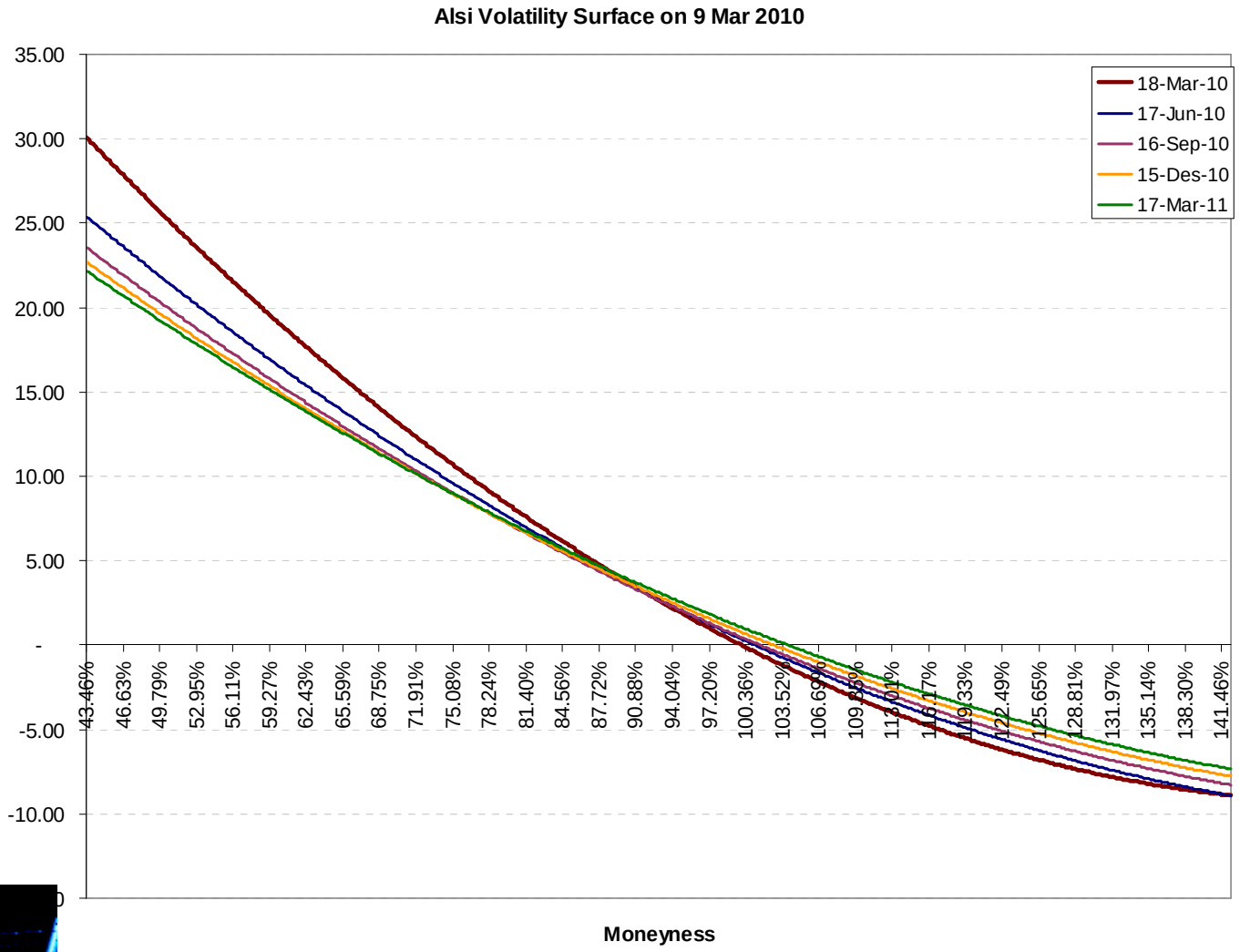
$$\frac{dS}{S} = \mu(t)\,dt + \sigma(t, S/K)\,dW$$

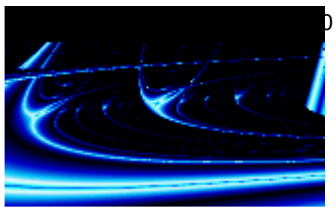
"Nurse, get on the internet, go to SURGERY.COM, scroll down and click on the 'Are you totally lost?' icon."



FINANCIAL CHAOS THEORY

Options: Current Alsi vol Surface

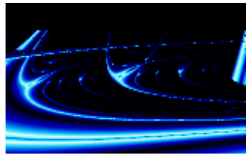




FINANCIAL CHAOS THEORY

Options - Can-Dos: Problem 6

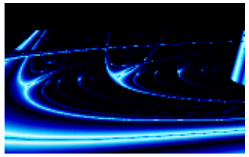
- How do we calculate the initial margin for exotic options?
- Use exactly the same method to calculate margins for exotic options
- Instead of calling BS model, call relevant exotic option model….excel digital
- Biggest issue is how does one incorporate the volatility surface into the pricing equations?
- Most exotics discrete in time
- Even for options where closed form solutions exist, one needs to use numerical procedures
- Can now explain to any market player how the margins are calculated



FINANCIAL CHAOS THEORY

Options – VSR: Problem 7

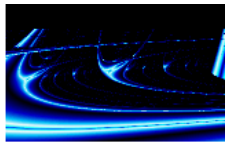
- VSR = volatility scanning range
- Better to call it the volatility of volatility
- How much can the volatility change from today to tomorrow?
- Most volatility models has the vol of vol as input or it is calculated as part of the optimisation process when the volatility surface is generated
- It is in essence the curvature of the skew
- Can we use the **sticky strike** vol skew?
- Yes, it gives a much better reflection of the market's view on volatility the risk
- Safex uses it since September 2009 to update ATM vols



FINANCIAL CHAOS THEORY

Options: VSR

Expiry Date	MtM	Current ATM Vol	VolVol (ν)	Max Volatility Change	Fixed Margin	Vol from Sticky Strike	Vol Change or VSR
18-Mar-10	25,308	23.00	32.539%	**7.48**	16500	25.409	2.41
17-Jun-10	25,594	23.00	23.143%	**5.32**	17000	25.184	2.18
16-Sep-10	25,718	23.00	21.053%	**4.84**	17000	25.018	2.02
15-Des-10	26,014	23.50	19.893%	**4.67**	17000	25.407	1.91
17-Mar-11	26,322	23.50	19.083%	**4.48**	17500	25.379	1.88
15-Jun-11	26,658	23.50	18.486%	**4.34**	17500	25.308	1.81
15-Des-11	27,314	23.75	17.602%	**4.18**	18000	25.496	1.75
15-Mar-12	27,568	23.75	17.264%	**4.10**	18000	25.453	1.70
20-Des-12	28,808	24.25	16.465%	**3.99**	18500	25.862	1.61
18-Des-14	32,308	24.25	15.207%	**3.69**	19000	25.631	1.38



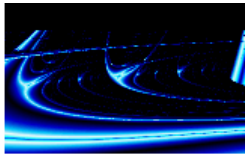
FINANCIAL CHAOS THEORY

Options: VSR Statistics

- Can we calculate the “volatility change” for every fixed margin using historical skews to obtain a statistical VSR?
- Ja, but do not have that many skews – monthly skews from July 2008 and daily skews from July 2009
- What about Variance Swaps?
- Trading implied variance

$$Payoff_T = NumberContracts \times VPV \times [\text{Realised Variance} - K]$$

$$IMR = NumberContracts \times VPV \times [2\lambda\sqrt{K} + \lambda^2]$$



FINANCIAL CHAOS THEORY

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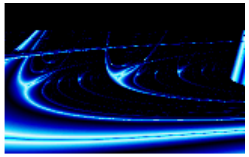

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