ABSA
Technical Valuations Session

JSE Trading Division

July 2010

Presented by:

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Some members are lost…..

… some think Safex talks in “tongues”….

Transactions of JSCES, Paper No.20010048

Black-Scholes方程式の流体力学的解釈による拡張

The Expansion for Black-Scholes equation on Hydrodynamics Interpretation

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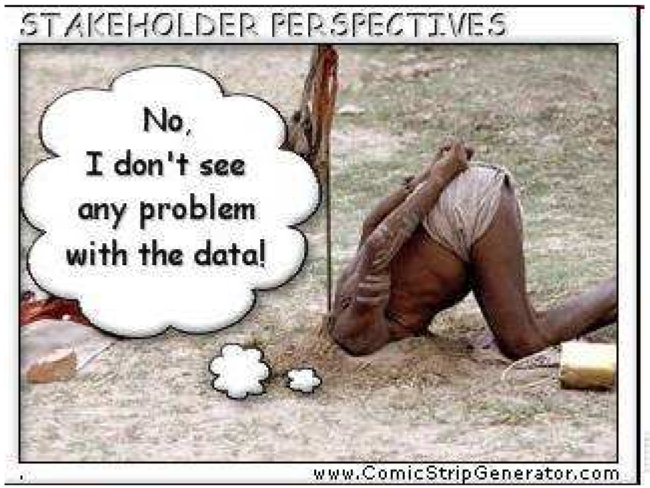
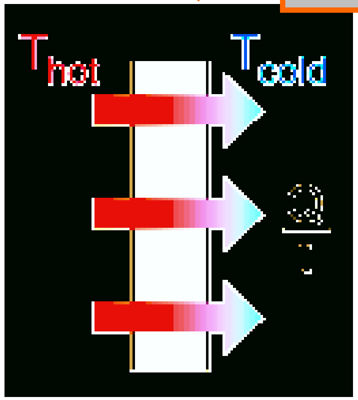
- A derivatives market is far more complex than a vanilla market
- This is especially the case if the market is illiquid
- Safex sometimes **Mark-to-Model** certain instruments and sometimes apply a **Mark-to-Market** methodology
- Safex is continuously engaging with the market to improve fair value calculations to get as close as possible to the correct market values
- Interestingly, after Safex's processes and methodologies are outlined to market participants, most feel that these values are almost as fair as we can reasonably expect them to be.

- **How do we deal with technical/mathematical problems?**
- Safex tries to follow scientific rules and best practice when solving problems!
- We work closely with the sell and buy side



- **Background**: Around 1900, Louis Bachelier first proposed that financial markets follow a 'random walk'.
- In the simplest terms, a "**random walk**" is essentially a Brownian motion: the previous change in the value of a variable is unrelated to future or past changes. This implies that stock price movements are totally random.
- The assumption is that stock prices diffuse through time like heat diffuses through a window or wall – scientific theory is sound.

Resistance – can be modeled mathematically



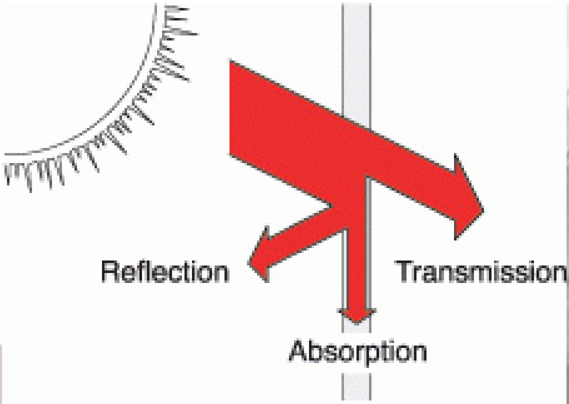
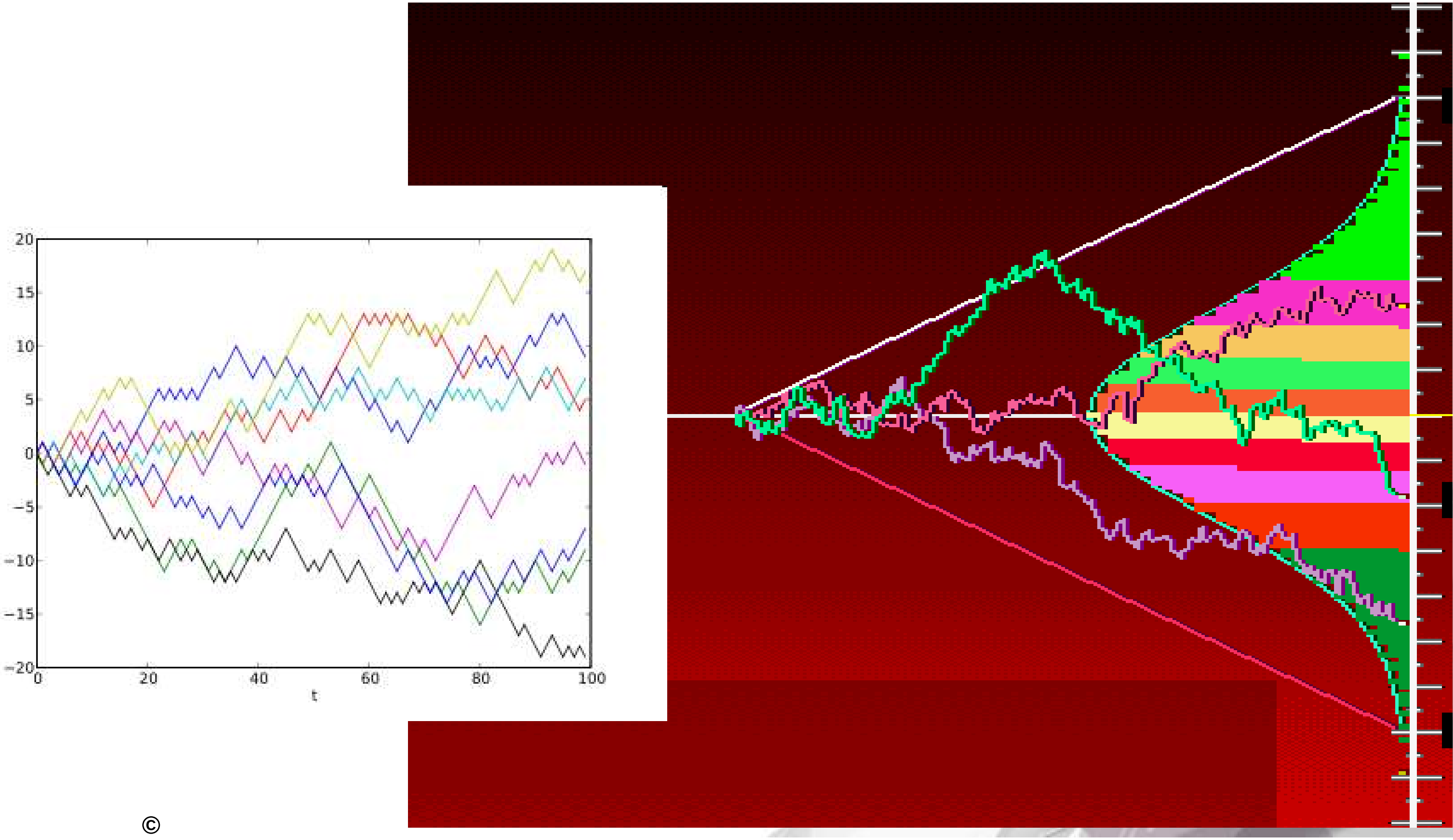
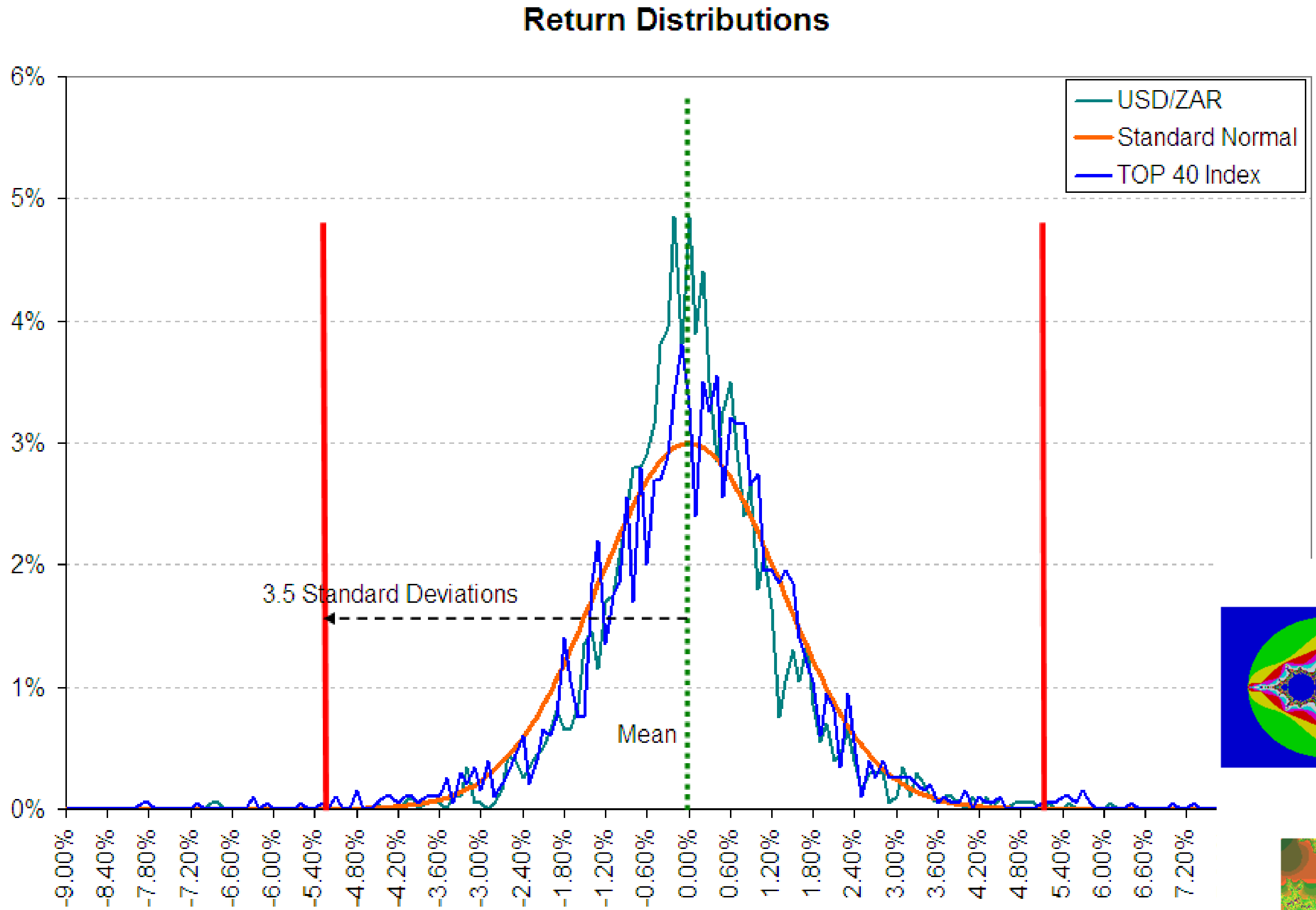


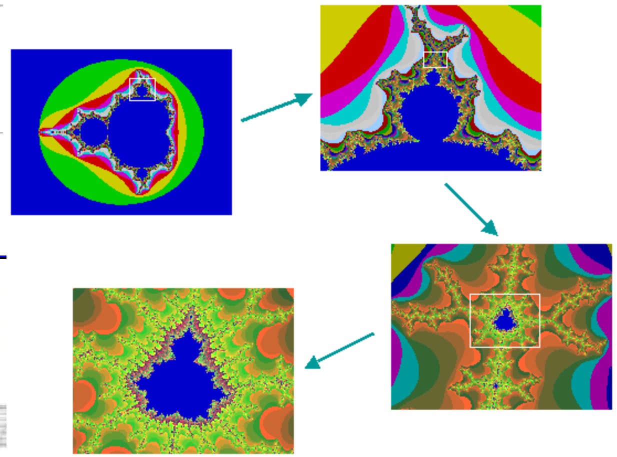
Figure 2-2. Solar radiation through a glazing material is either reflected, transmitted or absorbed

• Brownian motion – **logarithmic returns are normally distributed**

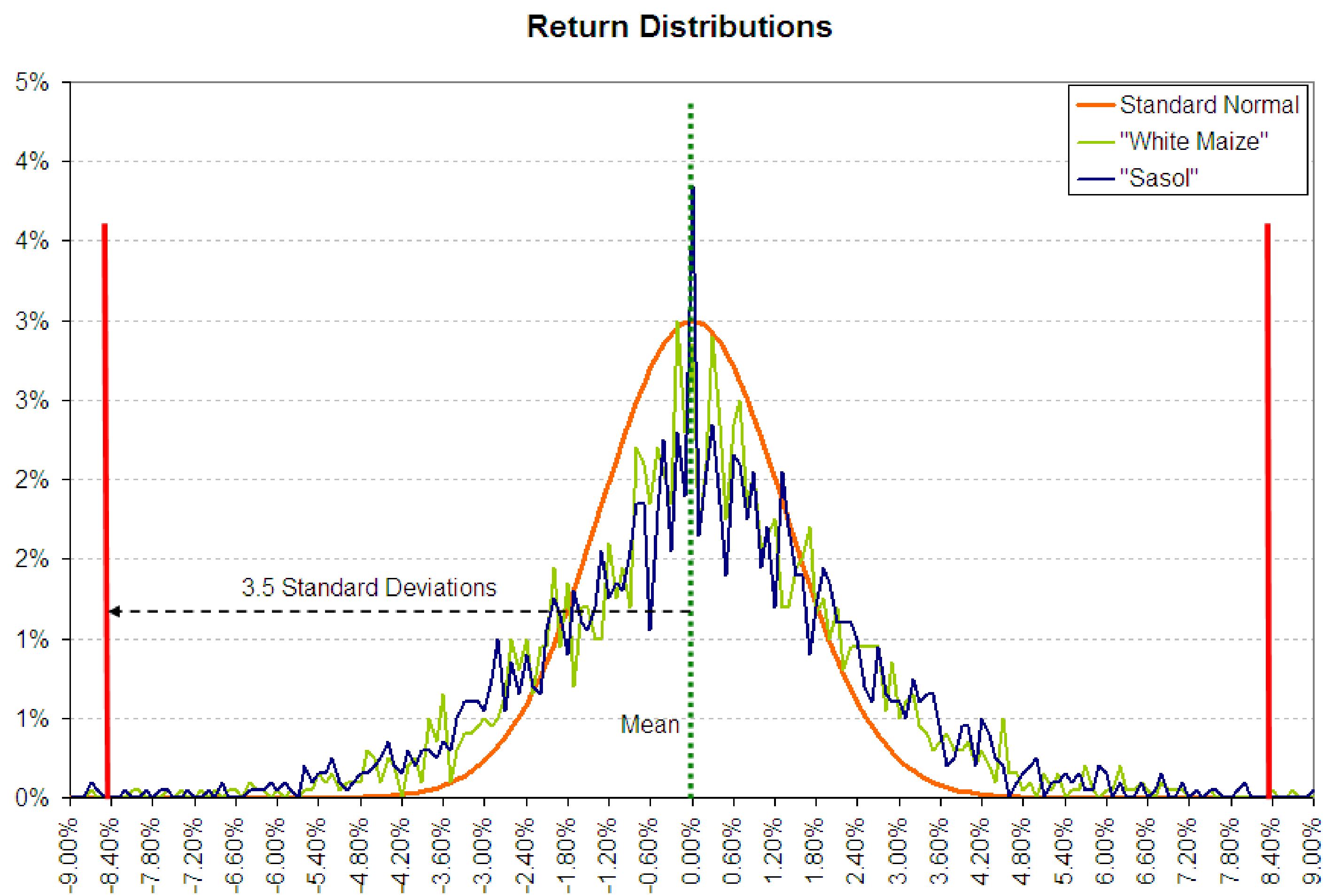


- Does the real world behave like this? We look at DAILY returns



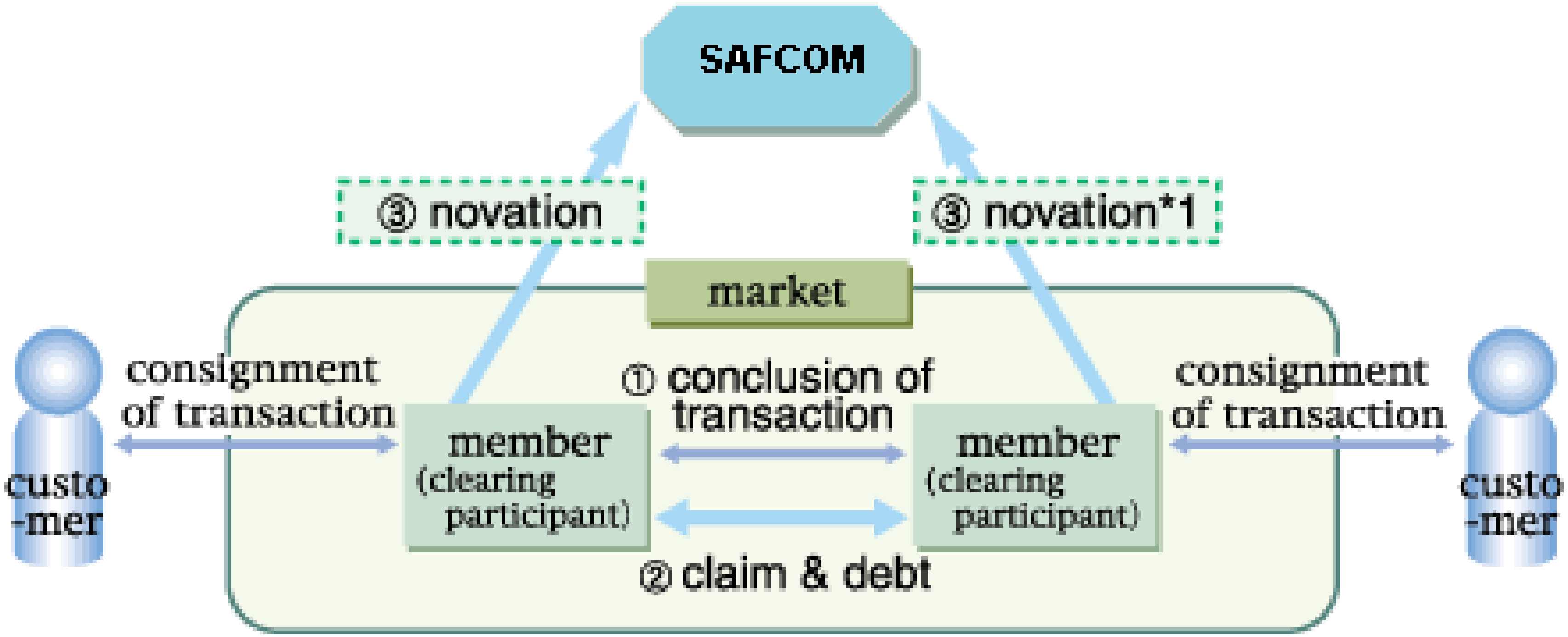


- More SA data



Return Distributions
5%
4%
4%
3%
3%
2%
2%
1%
1%
0%
Standard Normal
"White Maize"
"Sasol"
3.5 Standard Deviations
Mean
-9.00%
-8.40%
-7.80%
-7.20%
-6.60%
-6.00%
-5.40%
-4.80%
-4.20%
-3.60%
-3.00%
-2.40%
-1.80%
-1.20%
-0.60%
0.00%
0.60%
1.20%
1.80%
2.40%
3.00%
3.60%
4.20%
4.80%
5.40%
6.00%
6.60%
7.20%
7.80%
8.40%
9.00%

- Clearing Houses



SAFCOM bears the credit risk

- 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 – also called the FIXED MARGIN) 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.
- The current IMRs are found at http://www.jse.co.za/DownloadFiles.aspx?RequestedNode=DownloadableDocuments/Safex/Margin_Requirements/2010
- This is the current initial margin sheet….

Margin Requirements as at 13 July 2010

NoteF4366B

Contract Code	Expiry Date	Fixed Margin	Spread Margin	VSR	Series Spread Margin
ALMI	16/09/2010	1,700	235	2.00	
ALMI	15/12/2010	1,700	240	2.00	
ALSI	16/09/2010	17,000	2,350	2.00	9500
ALSI	15/12/2010	17,000	2,400	2.00	9500
ALSI	17/03/2011	17,500	2,400	2.00	9500
ALSI	15/06/2011	17,500	2,450	2.00	9500
ALSI	15/12/2011	18,000	2,500	2.00	9500
ALSI	15/03/2012	18,000	2,500	2.00	9500
ALSI	20/12/2012	19,000	2,650	2.00	9500
ALSI	20/03/2013	19,000	2,700	2.00	9500
ALSI	18/12/2014	21,000	3,000	2.00	9500
BANK	16/09/2010	26000	3,500	3.00	
CTOP	16/09/2010	8,400	400	2.00	4250
DIVI	16/09/2010	200	50	4.50	
DTOP	16/09/2010	3,600	350	2.00	2000
DTOP	15/12/2010	3,700	350	2.00	2000
DTOP	17/03/2011	3,700	350	2.00	2000
DTOP	15/06/2011	3,700	350	2.00	2000
ETOP	16/09/2010	8,400	400	2.00	4250
ETOP	15/12/2010	8,400	400	2.00	4250
FINI	16/09/2010	6,100	1,900	2.50	1500
FNDI	16/09/2010	16,500	950	2.00	8250
FNDI	15/12/2010	16,500	950	2.00	8250

- The fixed margin is statistically estimated as follows:
- Use 751 daily closing values to obtain 750 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

- IMR the worst case in looking backwards AND forwards in time….
- See the documents at http://www.safex.co.za/ed/risk_management.asp
- Let's make it real and look at some numbers in Excel ……

- Let's discuss the headings:
- Fixed Margin – dealt with

OFFSETS

- **Spread Margin** – also known as calendar spread margin. Trading the same underlying with different expiry dates e.g. long ALSU0 and short ALSZ0
- A "discount" is thus given for such trades
- Calculation similar to that for fixed margin. Use spreads instead of futures levels. Conservative: use maximum margin over different expiries
- **Series Spread Margin** – trading in different underlyings e.g. long ALSU0 and short FNDU0.
- Offset only applicable to certain indices
- Calculation similar to that for fixed margin using the spreads

- The credit crises showed that we had to enhance the model for illiquid instruments and concentrated positions
- **Concentration** risk lies in the fact that a single or few parties may hold large positions relative to the issued share capital.

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

- 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

Concentration risk = Position / Shares in Issue

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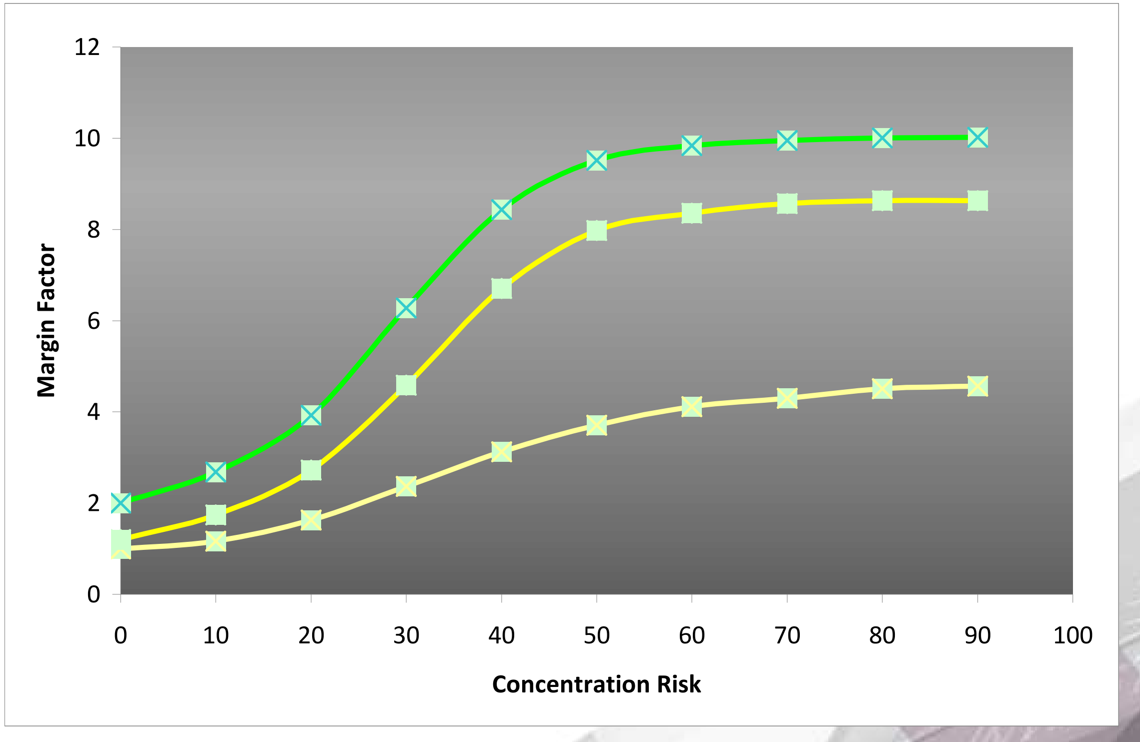
Initial Margin Calculations for Illiquids

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



- Indices and SSFs with nonstandard expiry dates: use IMR for similar standard contract (nearest expiry date)
- Baskets: calculate IMR for each share from IMR for standardised SSF. **Calculate total weighted IMR for basket.**
- Currently there is no offset between different Can-Dos or Can-Dos and standard derivatives e.g. if you trade a basket of shares against a standard Alsi future, no offset will be given

- We have shown how to calculate the IMR for a futures contract – this is a 1 dimensional problem
- The risk of an option is 2 dimensional: we need to assess the influence of changes in the underlying market AND changes in volatility
- This is done via Risk Array’s and VSR’s
- Let’s explain this through a practical example…..
- Spreadsheet can be downloaded from http://www.jse.co.za/Markets/Equity-Derivatives-Market/Margining-methodology.aspx#IMR

OPTION DESCRIPTION	Input Parameters
Index Futures Level	**24,859.00**
Strike Level	**25,000.00**
Current Date/Valuation Date	**14-Jul-10**
T+1	**15-Jul-10**
Maturity/Expiry Date	**17-Mar-11**
ATM Volatility	**27.50%**
Volatility from Skew and Moneyness	**27.29%**
Call/Put	**call**
Time till Expiry	**0.6740**
Volatility Scanning Range (VSR)	2.00%
Risk Parameter (S)	3.50
Fixed Initial Margin per Futures Contract	17,500.00

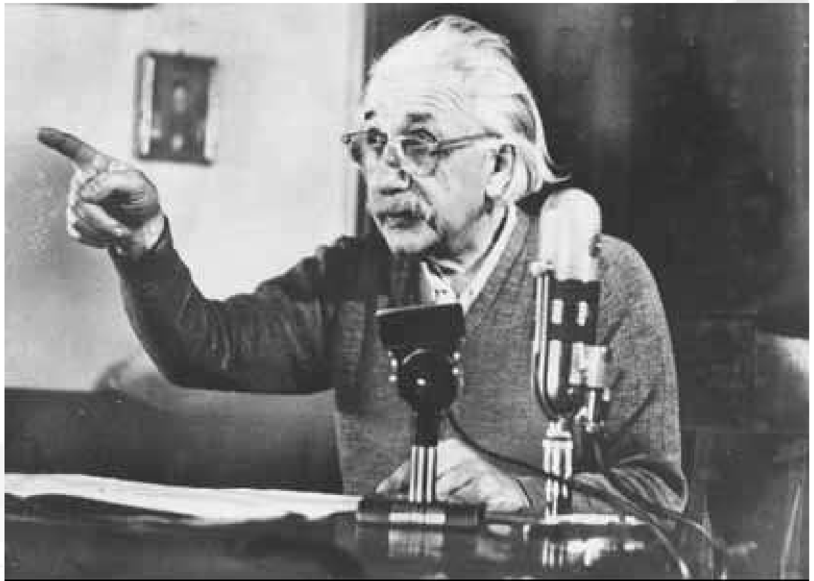
Margin Requirement per Contract	
IMR - sell option	**12,522.00**
IMR - buy option	**9,262.00**

Scenario Analysis

Volatility Scenario Set (VSS)	1.00	(1.00)							
Price Scenario Set (PSS)	(1.00)	(0.75)	(0.50)	(0.25)	-	0.25	0.50	0.75	1.00
Range Price Volatility Effect (RPVE -> N_E)	225.00								
ATM Option Value Today	21,537.00								
Index Future's Scenario Values (SV)	23,109.00	23,546.50	23,984.00	24,421.50	24,859.00	25,296.50	25,734.00	26,171.50	26,609.00
IMR including Volatility Scenario									
Volatility Scenario SELL	30.176%	29.856%	29.625%	29.485%	29.439%	29.485%	29.625%	29.856%	30.176%
Option Scenario Values going SHORT	15,390.00	17,061.00	18,920.00	20,975.00	23,231.00	25,688.00	28,345.00	31,196.00	34,230.00
Difference with ATM	6,318.00	4,647.00	2,788.00	733.00	(1,523.00)	(3,980.00)	(6,637.00)	(9,488.00)	(12,522.00)
Volatility Scenario BUY	26.176%	25.856%	25.625%	25.485%	25.439%	25.485%	25.625%	25.856%	26.176%
Option Scenario Values going LONG	12,446.00	14,017.00	15,793.00	17,783.00	19,993.00	22,426.00	25,077.00	27,940.00	31,001.00
Difference with ATM	(9,262.00)	(7,691.00)	(5,915.00)	(3,925.00)	(1,715.00)	718.00	3,369.00	6,232.00	9,293.00

- Can-Do Options: listed derivatives with the flexibility of OTC contracts
- Current drivers are
  - counter-party risk
  - disclosure
  - mandate issues
  - balance sheet management – liquidity costs
- The exchange acts as the central counter-party to all trades
- JSE acts as calculation agent and provides a “market value”
- Trades margined daily

- Listed so far: Asian's, barrier's, Variance Swaps, cliquets, lookbacks, lookbacks with Asian features, digitals and binary barriers, ladders with time partiality (also called Timers)
- Philosophy: if we can value it and risk manage it, we can list it
- Safex is the only exchange in the world that offers such flexibility and such a wide range of listed exotics


Scan ©American Institute of Physics

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Can-Do Options

- Pricing models are independently created by the exchange

- This can entail either closed-form solutions, binomial trees, trinomial trees or Monte Carlo simulations

- All models are validated by running parallel tests between the exchange, the market maker and institutional investor before the derivative is listed

"I fed all the data in to the computer. The print-out reads 'How the hell should I know!'"

Exotic Option Margins

- Use the same methodology as vanilla options
- Use risk arrays but with the exotic option pricer in place of the vanilla pricer
- Be aware of the dynamics of exotic options:
  - **Vanilla option becomes more expensive the higher the volatility**
  - **Knock-Out option becomes cheaper the higher the volatility**
- There are no offsets between different Can-Dos and/or Can-Dos and standard derivatives.
- Offset is achieved if ALL instruments form part of a single Can-Do

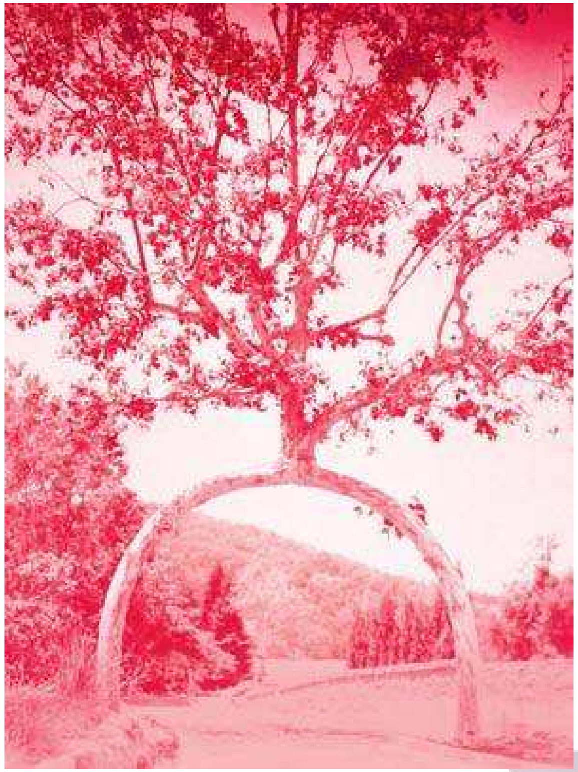
- Quite a few Var Swaps listed under the Can-Do banner
- There are also standardised Var Futures – Savi Squared

$$VNA\left[\min\left(cap, \sigma_R^2\right) - K_{del}\right]$$

- Realised Variance is defined as $\sigma_R^2 = \frac{252}{n}\sum_{i=1}^{n}\left[\ln\left(\frac{S_i}{S_{i-1}}\right)\right]^2$
- Daily MtM is given by $V_{mtm} = \frac{t}{T}\sigma_R^2 + \frac{T-t}{T}K_{var}(t,T)$
- With K the implied variance at t calculated using the Derman-Kani model
- Lastly

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

- Questions?



- Volatility is a measure of risk or uncertainty
- Volatility is defined as the variation of an asset's returns – it indicates the range of a return's movement. **Large values of volatility mean that returns fluctuate in a wide range** – in statistical terms, the standard deviation is such a measure and offers an indication of the dispersion or spread of the data
- Volatility has peculiar dynamics:
  - It increases when uncertainty increases
  - Volatility is mean reverting - high volatilities eventually decrease and low ones will likely rise to some long term mean
  - Volatility is often negatively correlated to the stock or index level
  - Volatility clusters - it is statistically persistent, i.e., if it is volatile today, it should continue to be volatile tomorrow

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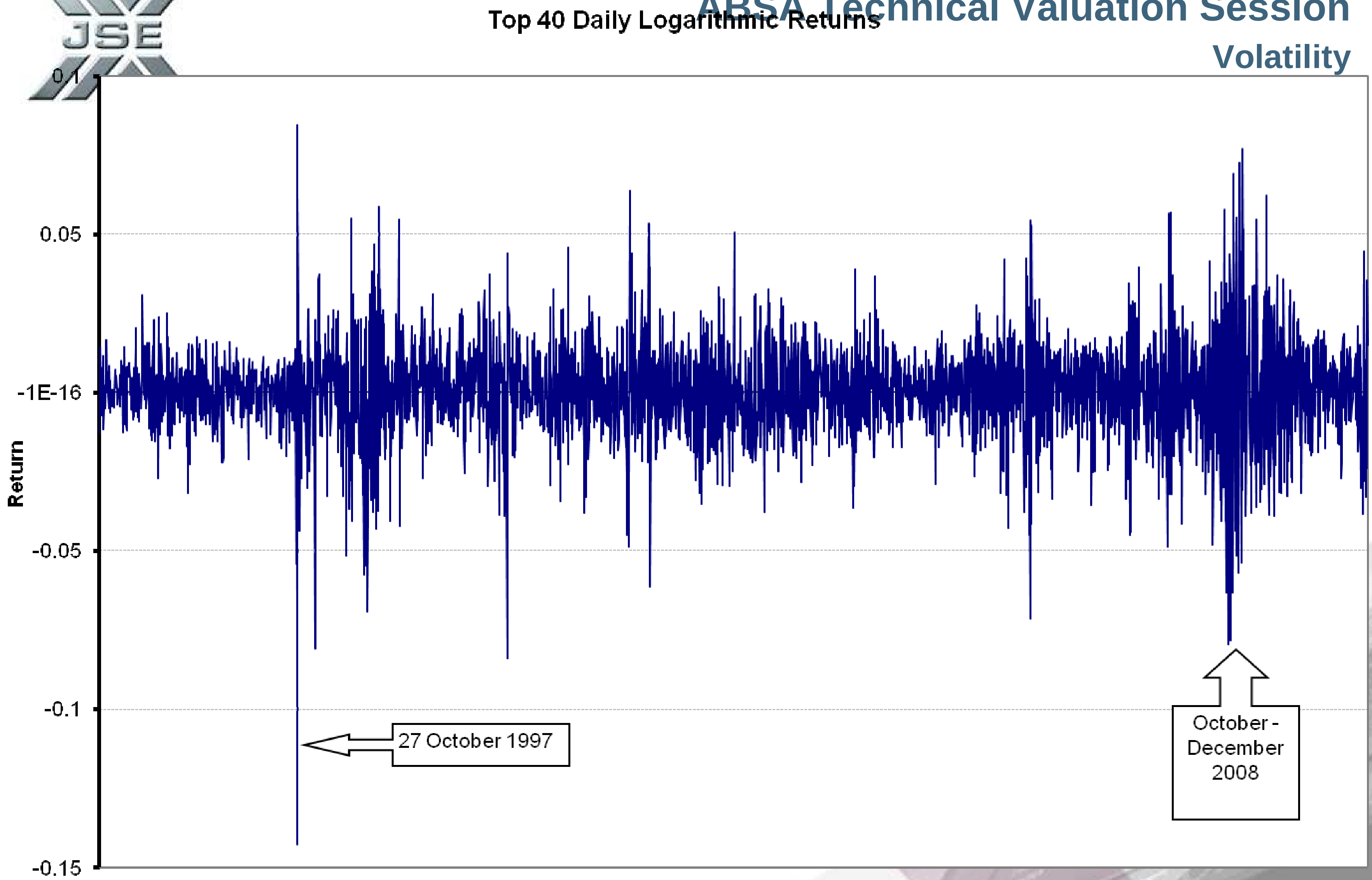
Volatility



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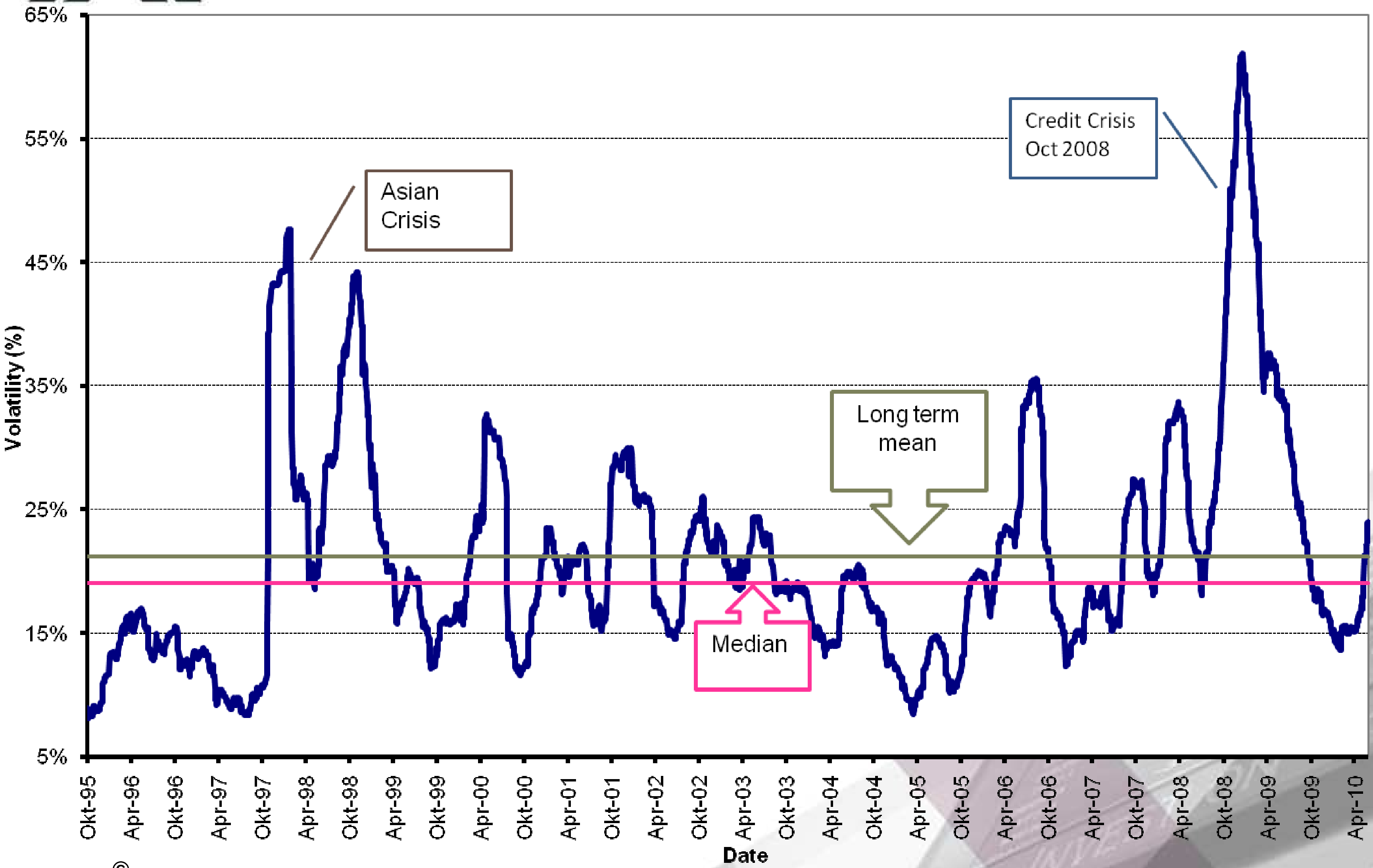
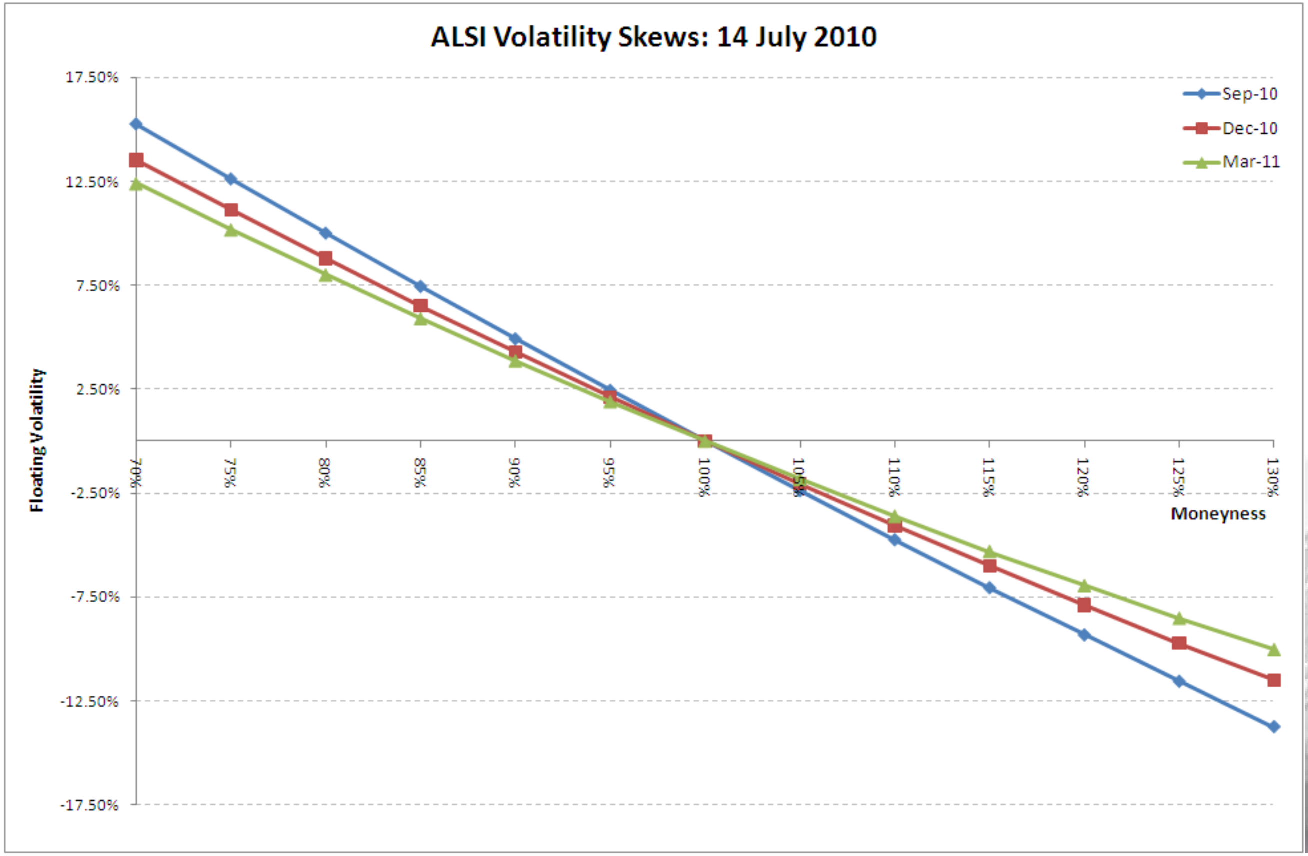
Volatility

Top 40 Volatiliy: 3 Month Rolling: Mean Reversion



- Options (on the **same underlying** with the **same expiry date**) with different strike prices trade at different volatilities - traders say volatilities are skewed when options of a given asset trade at increasing or decreasing levels of implied volatility as you move through the strikes.



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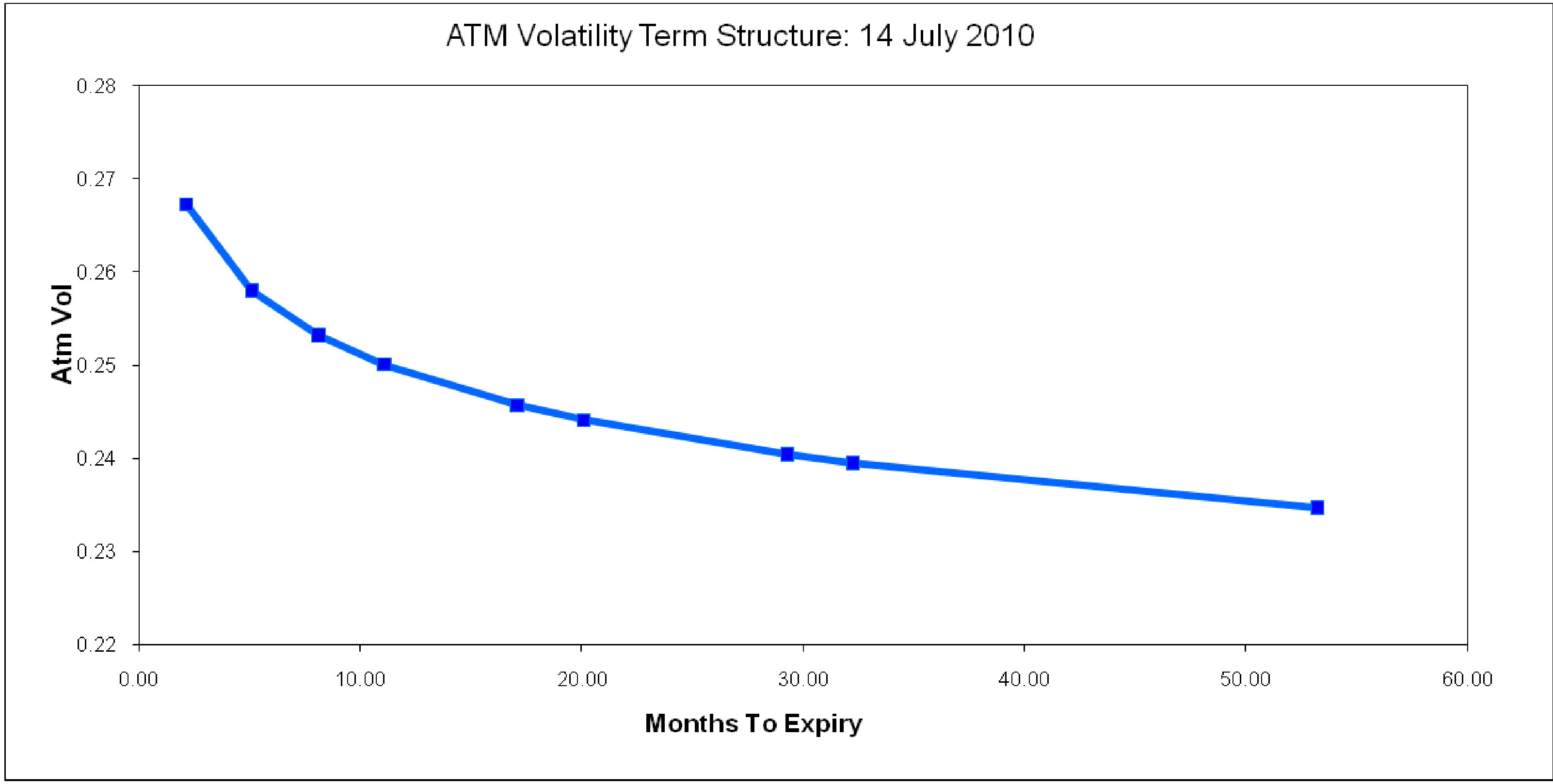
Term Structure of ATM volatilities

- The at-the-money volatilities for **different expiry dates** are decreasing in time ⟶

$$\frac{a}{t^b}$$



Volatility Surface: Admin

- Safex currently updates the volatility surface twice per month – second and last Tuesday
- How does the JSE obtain the volatility surface?
- Used to poll the market monthly

- If the trade data is available, can the skew be modelled?
- Yes. Many models have been proposed
- Surface Dynamic = Tilt (ρ) + Curvature/Vol of vol (υ) + Shift (γ) + Vertex Smoothness (ξ) (smile) +…….
- Three types of models: local vol models, stochastic vol models and deterministic model
- Two factor **stochastic** vol model: Stochastic Alpha Beta Rho (Sabr)
  - Assumes vol. is stochastic, Sabr (ρ, υ); Beta fixes the underlying volatility process and is fixed at 80% for equities, 0 for IR (vols Gaussian) and 1 for currencies (vols lognormal)
- Three factor **deterministic** vol model: Quadratic (Quad)
  - Quad(ρ, υ, γ) – no assumption on the dynamics of the volatility process
- Four factor **deterministic** vol model: Stochastic Volatility Inspired (SVI)
  - SVI(ρ, υ, γ, ξ) - no assumption on the dynamics of the volatility process
- Most banks seem to use deterministic models – up to 6 factors

- Use trade data to calibrate models
- Essentially, need to find model parameters that minimize the distance between the model volatilities, and the traded volatilities.
- Finding model with **stable parameters**, non-trivial, mainly due to sparse trade data
- Parameterise models using **minimal user adjustments** – let the data show the way

- Empirical tests show that the quadratic model is best suited to SA equities market – SVI for commodities and currencies
- Safex implemented the following model during October 2010

$$\sigma_{model}(\beta_0, \beta_1, \beta_2) = \beta_0 + \beta_1 K + \beta_2 K^2.$$

- With K the moneyness NOT the strike
- The volatility term structure is modeled by

$$\sigma_{atm}(\tau) = \frac{\theta}{\tau^\lambda}.$$

- Optimisation is performed using TRADED DATA only in obtaining the 5 parameters.
- One condition to take care of is to ensure that calendar-spread arbitrage is minimised
- Currently testing a volatility model for White Maize

- The parameters are

$\beta_0 =$ Constant volatility (shift or trend) parameter. $\beta_0 > 0$

$\beta_1 =$ correlation (slope) term. This parameter accounts for the negative correlation between the underlying index and volatility. The no-spread-arbitrage condition requires that

$$-1 < \beta_1 < 0$$

$\beta_2 =$ is the volatility of volatility (`vol of vol' or curvature/convexity) parameter. The no-calendar-spread arbitrage convexity condition requires that

$$\beta_2 > 0$$

- τ is the months to expiry,
- λ controls the overall slope of the ATM term structure
- θ controls the short term ATM curvature.

The document "*Constructing a South African Index Volatility Surface from Exchange Traded Data*" can be downloaded from http://www.jse.co.za/Products/Equity-Derivatives-Market/Equity-Derivatives-Product-Detail/Equity_Options.aspx

or

http://www.quantonline.co.za/publications_and_research.html

ATM Model Volatility

- One of the BIG advantages of the current implementation is that we can calculate the ATM volatilities as well
- This is obtained by noting that if $K = 100\,\%$

$$\sigma_{atm}^{model}(\beta_0, \beta_1, \beta_2, \tau) = \beta_0 + \beta_1 + \beta_2.$$

- If we work with floating skews alone we note that

$$\begin{aligned} \sigma_{float}^{model}(\tau) &= \sigma_{model} - \sigma_{atm}^{model} \\ &= \beta_1 (K - 1) + \beta_2 (K^2 - 1). \end{aligned}$$

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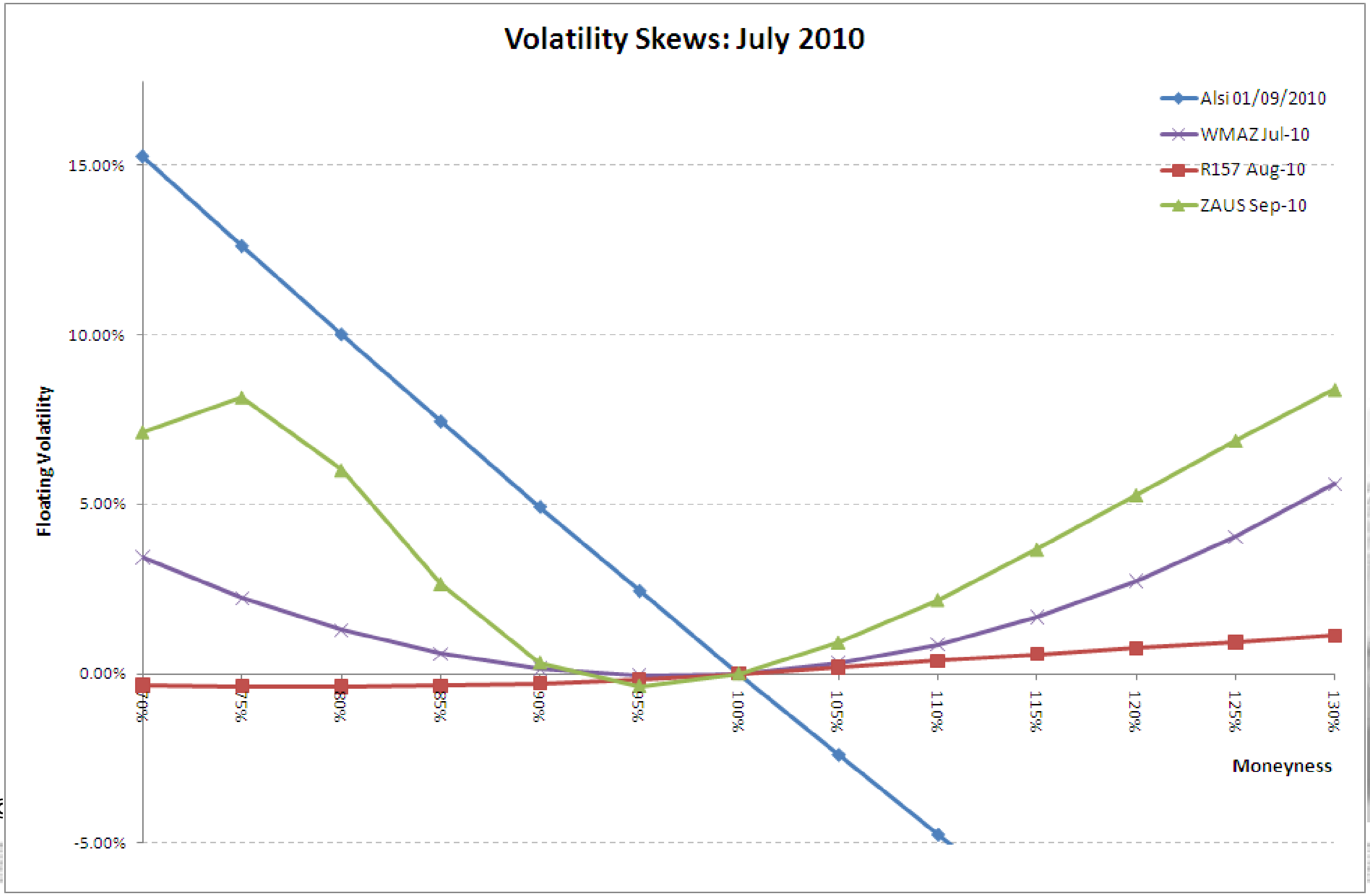
Different Markets

- With the Global Derivatives Market now operational, one needs to know that different markets have different skew shapes and thus different volatility dynamics



- Questions?

Contact Details

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