Stress testing: Practical Aspects

Alfa-Bank

Market Risk Management Department

Sergey Belousov

PRMIA Risk Management Conference

Moscow, 19 June 2007

Agenda

1. Importance of stress testing

2. Definition of stress testing

3. Types of stress testing

4. Uses of stress testing

5. Practical aspects of stress testing:

5.1 Scenarios
5.2 Macro stress testing
5.3 Bottom-up approaches:
- Linear positions
- Derivatives positions

6. Questions

1). Importance of stress testing

Shanghai stock index

In standard *"conditional-normal"* GARCH framework probability of a fall on *27-Feb-07* was **0.009%**

1). Importance of stress testing

Dow Jones stock index

In standard *“conditional-normal”* GARCH framework probability of a fall on 19-Oct-87 was a **14** standard deviation event *(almost **0** probability)*

2). Definition of stress testing

Stress testing is a risk management technique used to evaluate the potential effects on an institution's financial condition of a specific event and/or movement in a set of financial variables. The traditional focus of stress testing relates to exceptional but plausible events

3). Types of stress testing

1. **Sensitivity analysis:**
- focus on a move in one particular risk driver
- source of shock not identified

2. **Scenario analysis:**
- focus on simultaneous moves in a number of risk-drivers
- definition of stress events

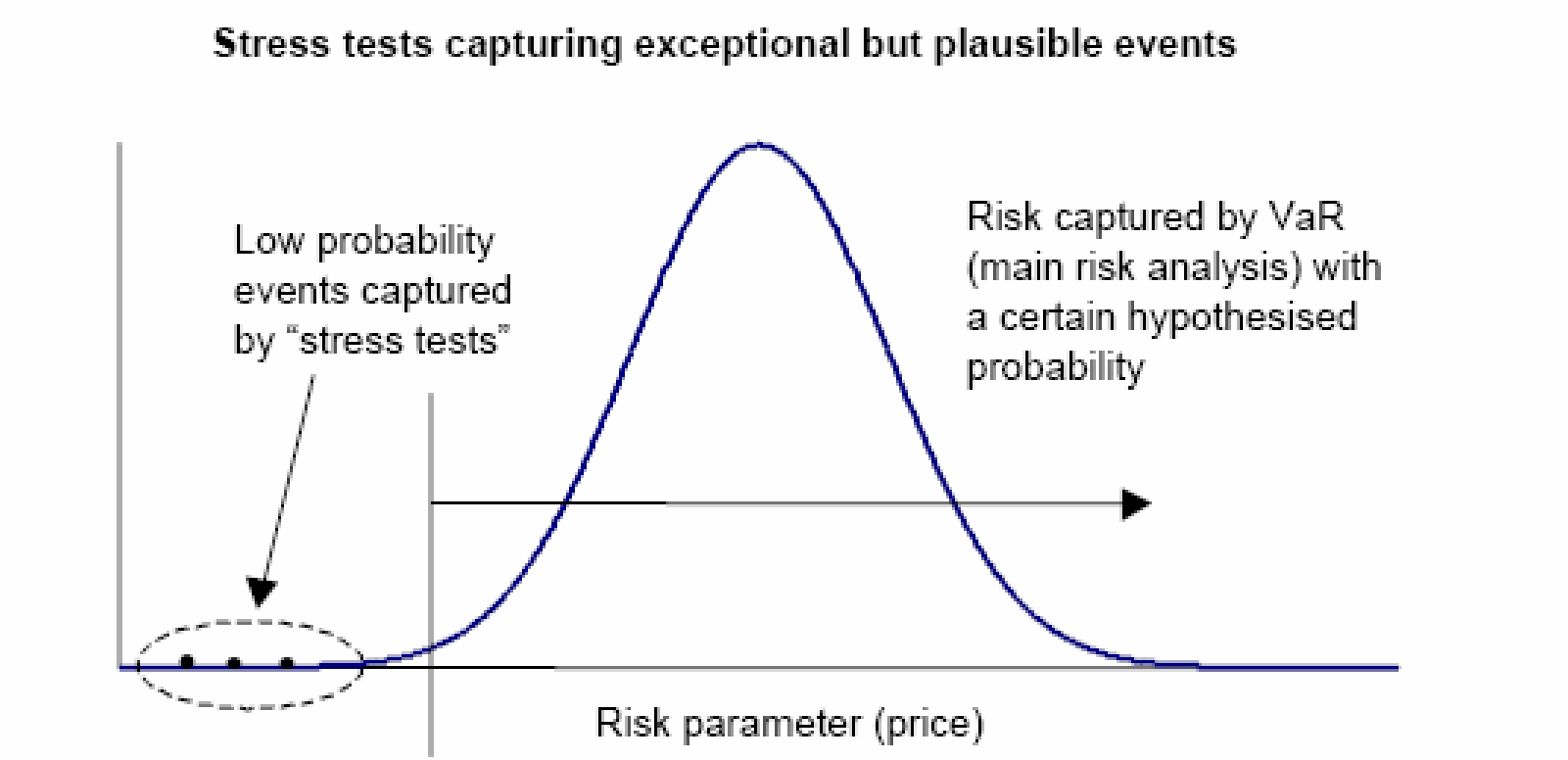
3). Types of stress testing (cont.)

1. **Macro stress testing** (top-down approach)

2. **Micro stress testing** (bottom-up approach)

4). Uses of stress testing

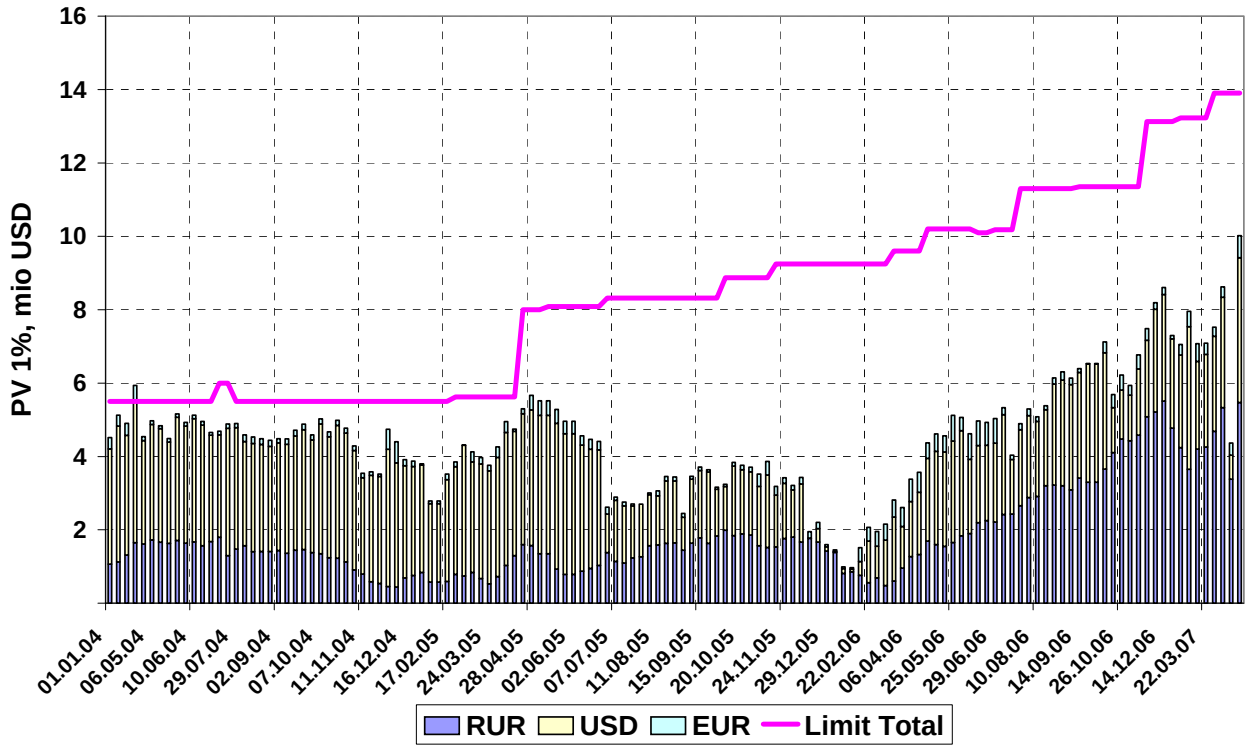
1. Capturing the impact of “low probability/high impact” events



4). Uses of stress testing (cont.)

2. Understanding the risk profile

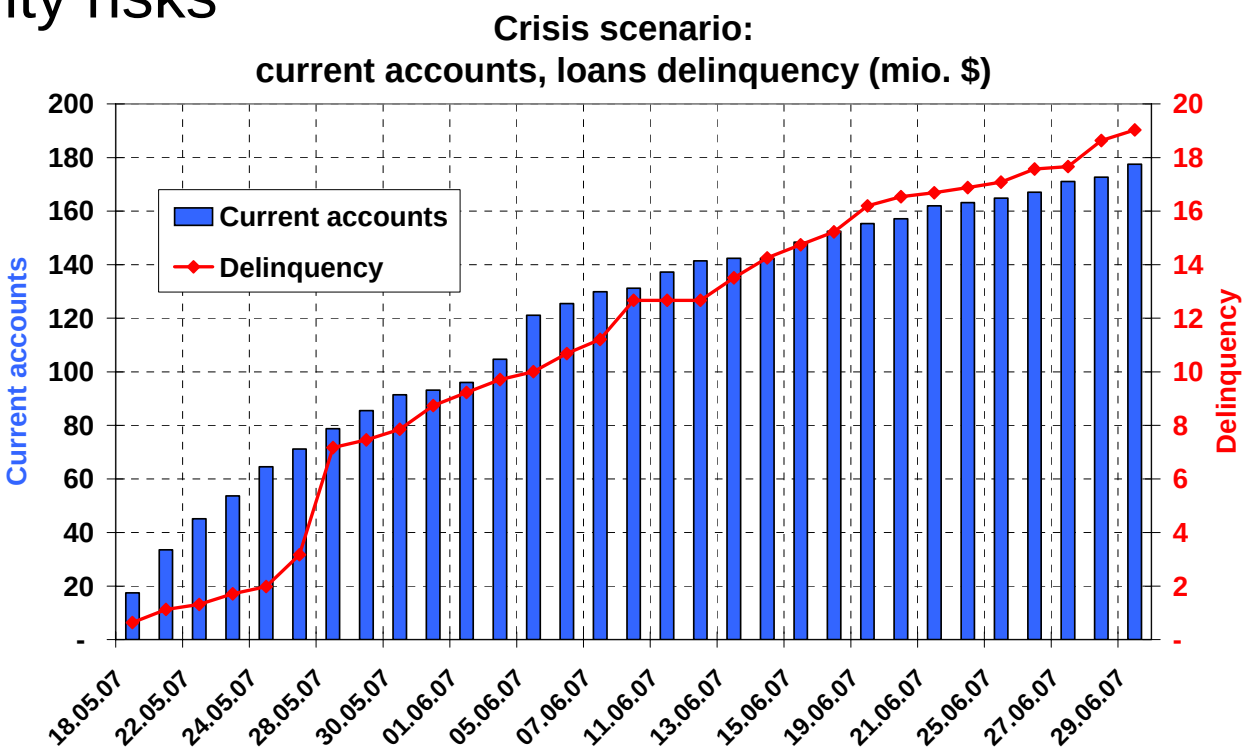
- sensitivity analysis
- where can't rely on VaR *(e.g., options positions; markets with low historical volatility or with limited history)*
- liquidity risks



4). Uses of stress testing (cont.)

2. Understanding the risk profile

- sensitivity analysis
- where can't rely on VaR *(e.g., options positions; markets with low historical volatility or with limited history)*
- liquidity risks



4). Uses of stress testing (cont.)

3. Limit/capital allocation

Position	Position, USD	Position value, USD	VAR (1% ql), USD	Stress Testing (One Day), USD	Period VAR (1%ql), USD
Equity	5,892,704	5,461,487	295,395	1,299,425	342,975
Limit	10,000,000		1,000,000	2,500,000	4,000,000
Fixed Income	19,214,397	19,214,397	127,259	417,740	369,378
Limit	30,000,000		300,000	800,000	700,000
Forex	9,995,548	- 4,848,216	34,258	1,113,258	34,258
Limit	15,000,000		150,000	2,000,000	150,000
Eq, FI, FX	35,102,649	19,827,668	354,694	2,830,423	547,153
Derivatives Book	3,508,476	946,738	18,020	270,614	18,020
Limit			50,000	500,000	
Total Position	39,499,600	21,662,881	372,454	3,432,675	579,919
Limit	55,000,000		700,000	5,800,000	4,000,000

5). Practical aspects of stress testing

Scenarios

Historical:

1987 – Black Monday

1997 – Asian crisis

1998 – Russia default

2000 – IT bubble

5). Practical aspects of stress testing

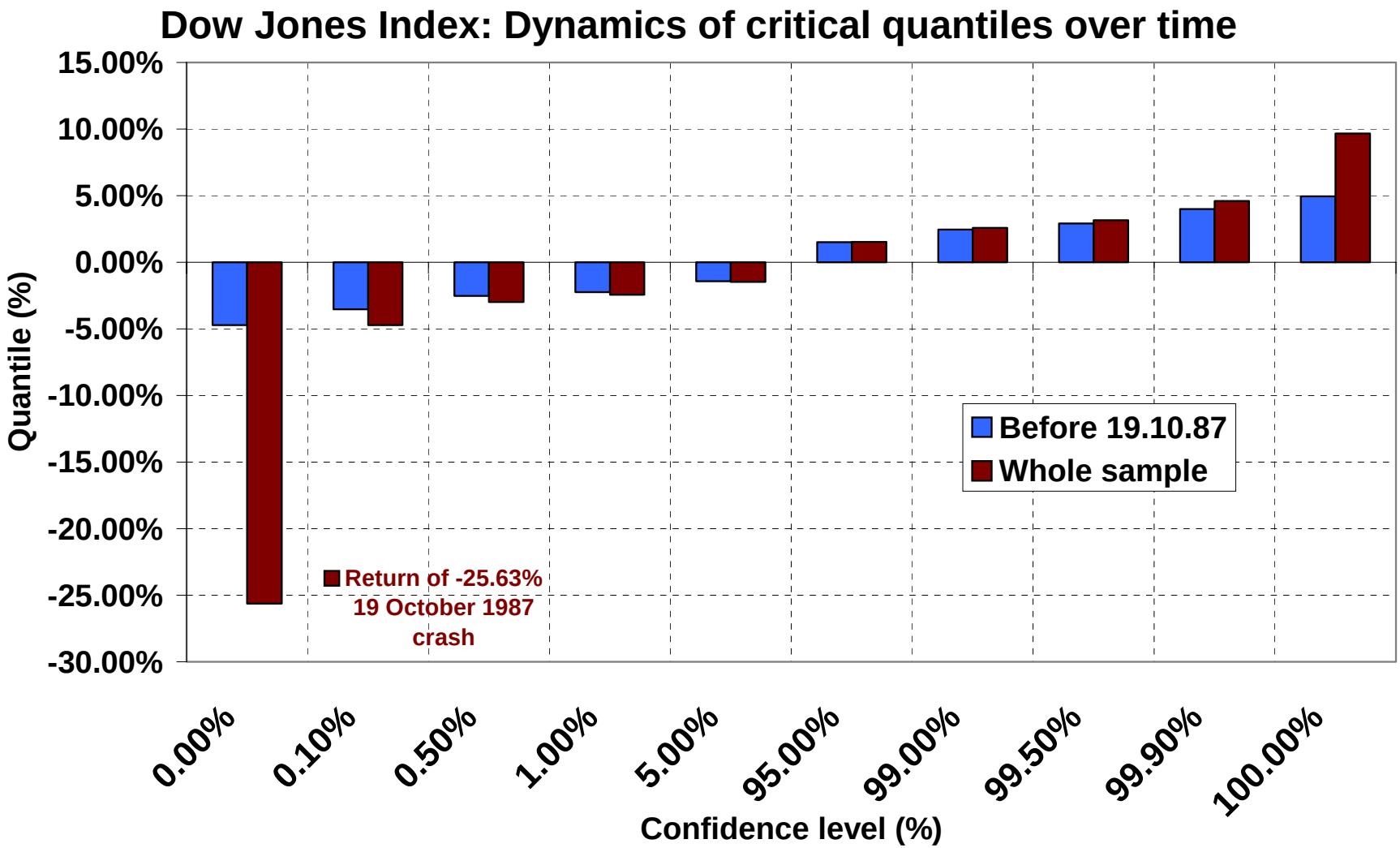
Scenarios

Hypothetical:

- Natural disaster
- Terrorist attack
- Oil price scenario
- Change in monetary policy

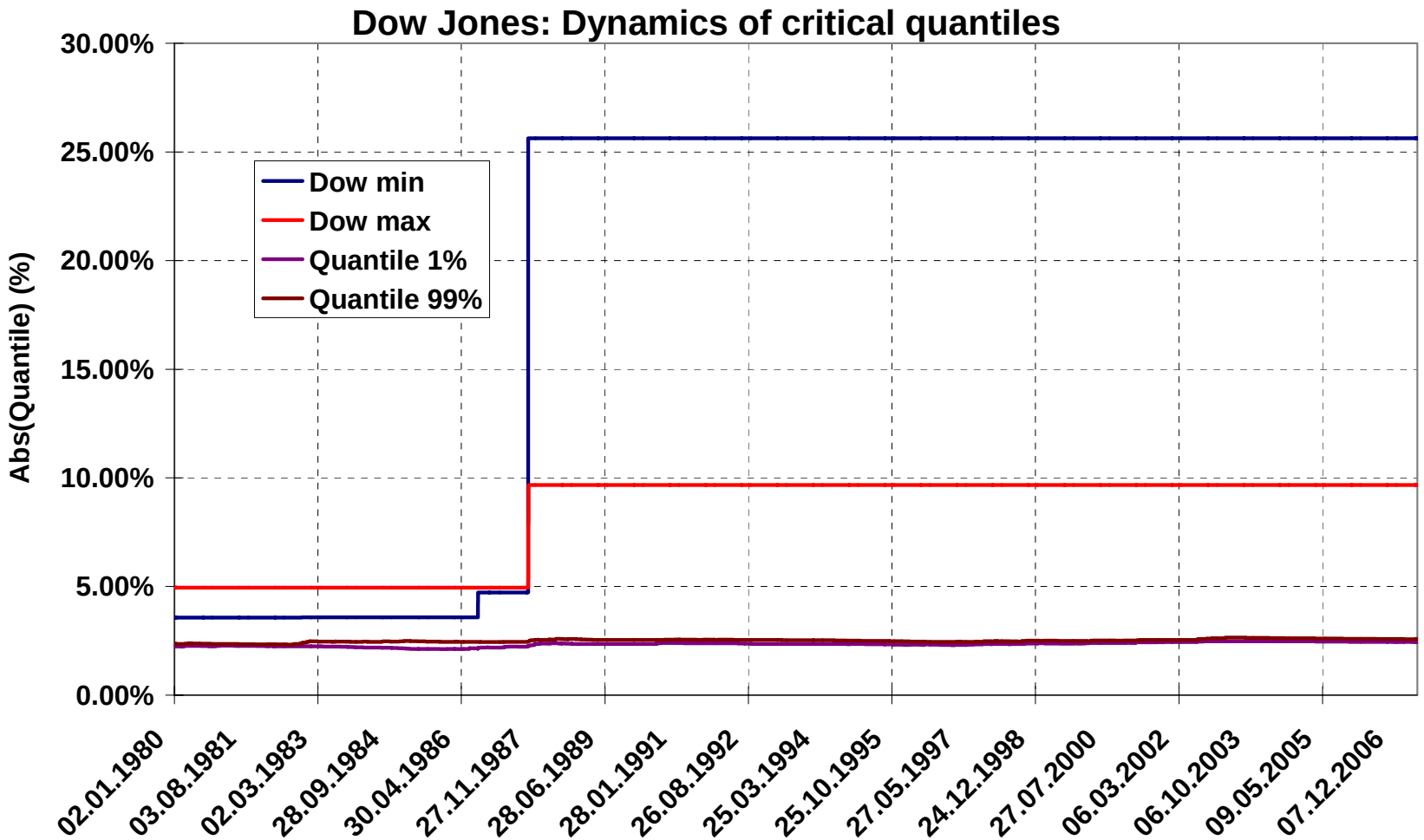
5). Practical aspects of stress testing

Scenarios



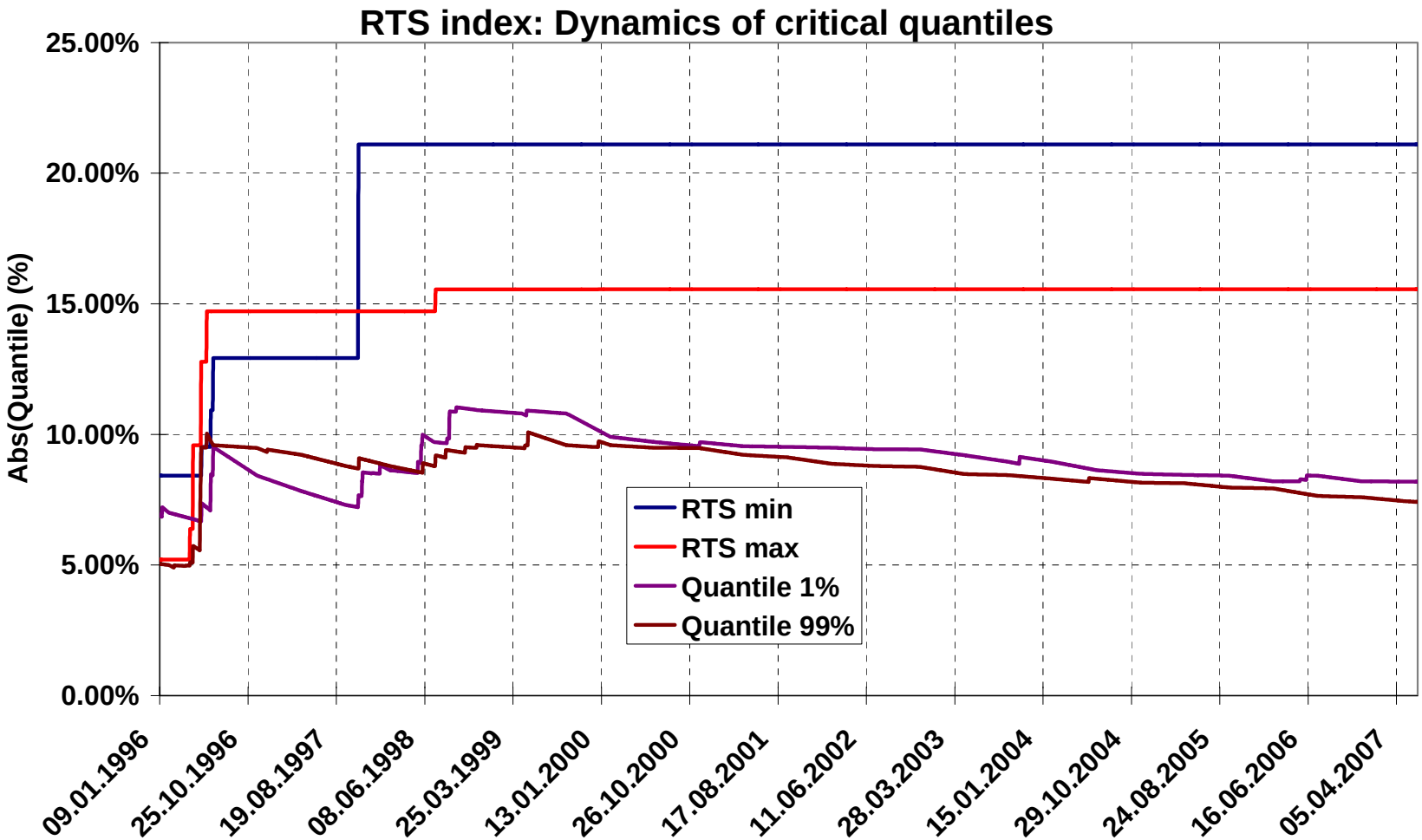
5). Practical aspects of stress testing

Scenarios



5). Practical aspects of stress testing

Scenarios



5). Practical aspects of stress testing

Macro stress testing

Example: Oil price scenarios

Time horizon – 1 year

1). Oil falls to 26$
=> RTS index falls 50%

2). Oil rises to 110$
=> RTS index rises 25%

5). Practical aspects of stress testing

Linear positions:

Empirical evidence suggests that correlations rise during falling markets

Hence, a natural stress test – set correlations to 100% and take larger number of std. dev.

5). Practical aspects of stress testing

Derivatives positions: Grid search approach

Grid-search approach uses **full revaluation** of derivatives position for different underlying variables **scenarios** – where each variable moves within predetermined range (e.g., +/- 10 std. deviations or within historical stress boundaries)

Problem:

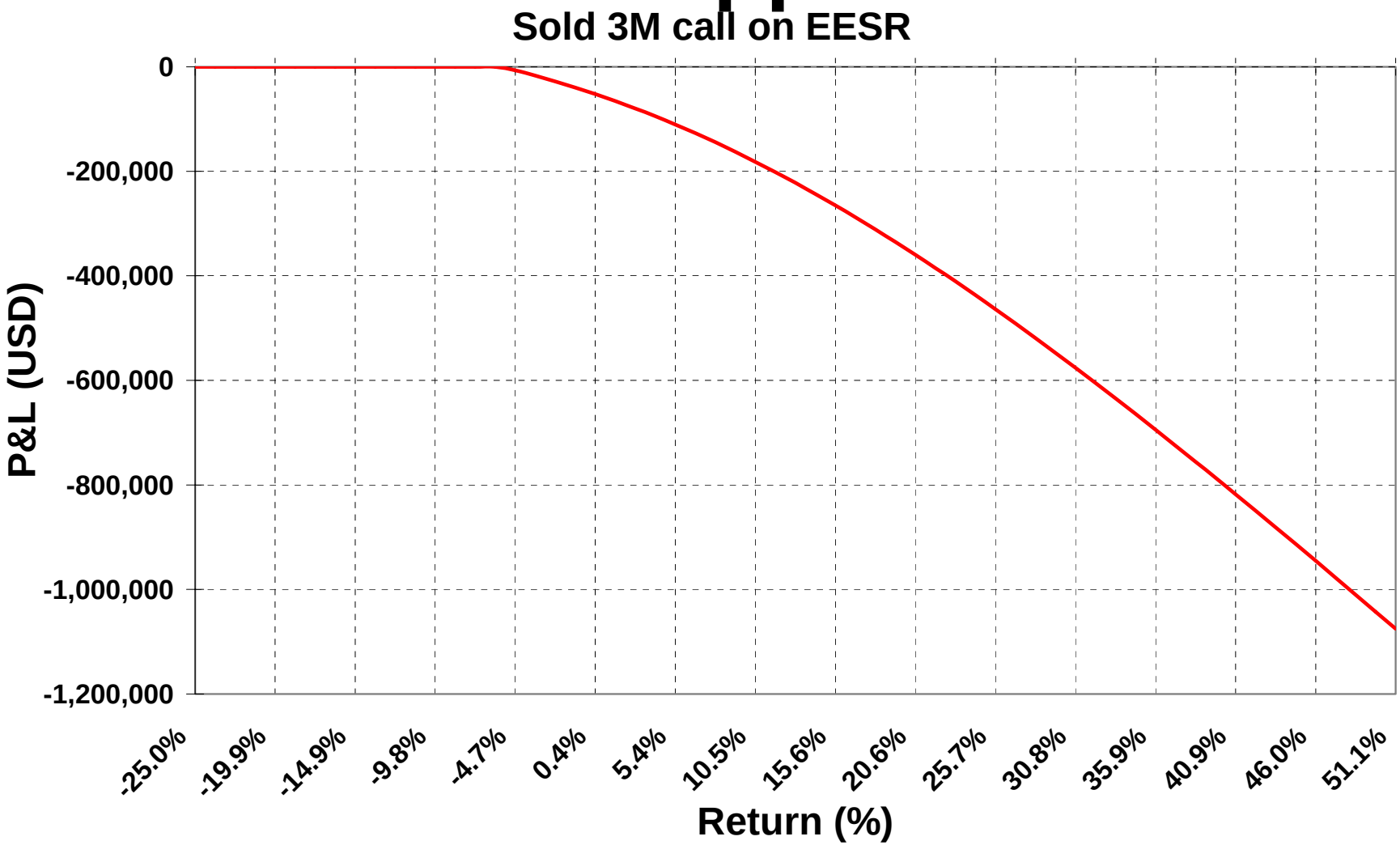
No accounting for crisis correlation effects

Solution:

Use copulas or “threshold correlations”

5). Practical aspects of stress testing

Derivatives positions: Grid search approach



5). Practical aspects of stress testing

Derivatives positions: Basket-type products

- You have **sold** a 3Month ATM call on **RTS** index

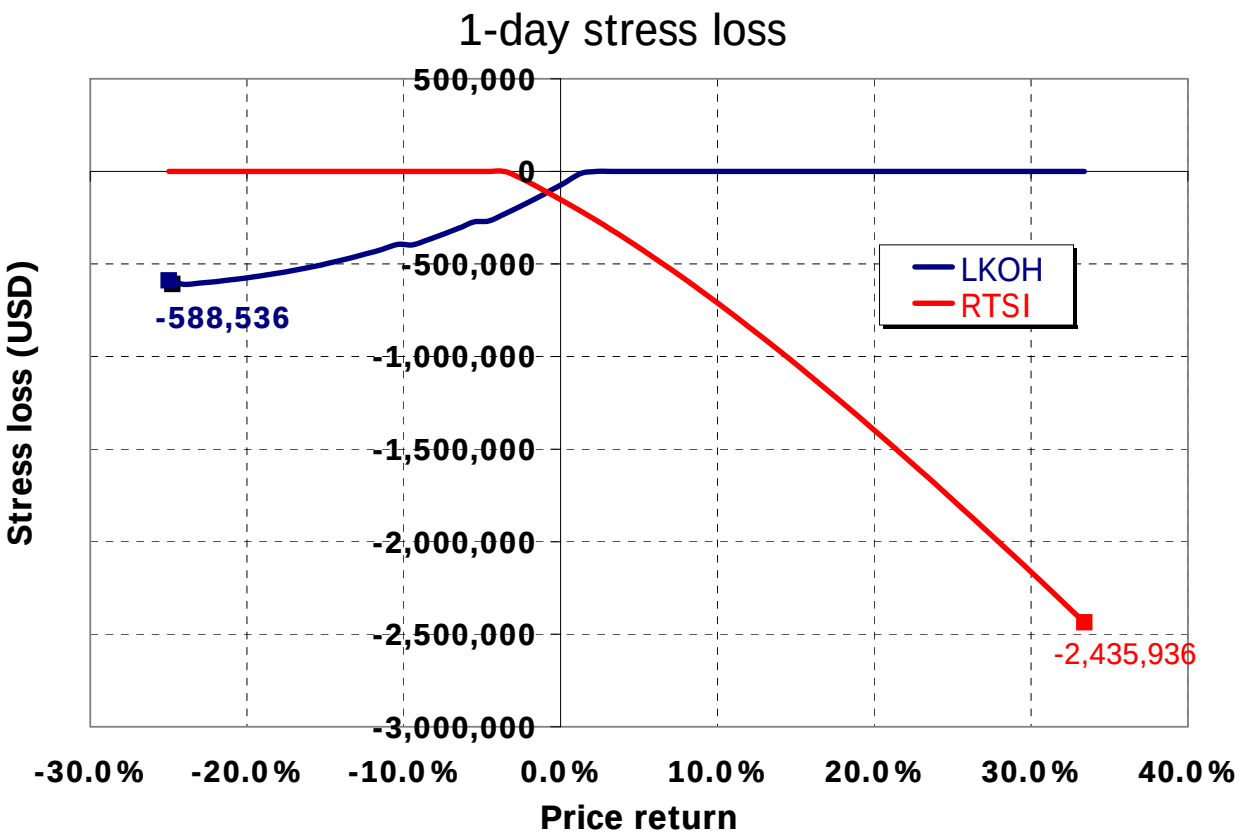
- You partially hedge sold call with a **long** 3Month ATM call on **Lukoil**

- Notional in both cases is the same ~**8.4** mio USD

5). Practical aspects of stress testing

Derivatives positions: Basket-type products

Stress-testing for each separate position uses a **full revaluation approach** on a grid comprised of historical stresses *(daily returns in range **from -30% to +30%**)*



5). Practical aspects of stress testing

Derivatives positions: Basket-type products

- Stress-testing for RTS index *(short 3M ATM call)* corresponds to a scenario when RTS index rises **+30%** coupled with rise in implied volatility

- Stress-testing for LKOH *(long 3M ATM call)* corresponds to a scenario when LKOH falls **-30%** coupled with implied volatility fall

5). Practical aspects of stress testing

Derivatives positions: Basket-type products

- We could have **summed up stress values** for different assets even if they are highly correlated but their values are not directly dependent on each other (e.g., Gazprom and Lukoil)

- But **we cannot sum stresses for LKOH an RTS** to give a stress for total position, because by construction LKOH cannot fall -30% while RTS rises +30%. **Thus, need to develop a new approach**

5). Practical aspects of stress testing

Derivatives positions: Basket-type products

Ticker	Name	% Weight in the Index
LKOH	LUKOIL	15.18%
GAZP	OAO Gazprom	14.18%
SBER	Sberbank	14.04%
ROSN	Rosneft Oil Co	7.34%
GMKN	MMC Norilsk Nickel	7.33%
SNGS	Surgutneftegaz	5.93%
MTS	Mobile Telesystems OJSC	4.79%
EESR	Unified Energy System	4.78%
NVTK	NovaTek OAO	2.39%
SNGSP	Surgutneftegaz	2.33%
PLZL	Polyus Gold Co	1.84%

For stress testing purposes we consider each asset in RTS index as an uncorrelated asset

E.g., *LKOH can fall -30% while MTS rises +30% and other stocks are unchanged which gives a change in RTS index of* ***-3.11%***

5). Practical aspects of stress testing

Derivatives positions: Basket-type products

- Each asset's return in index can take on any value in the grid from -30% to +30% with a step of 1%. Given the known weight in index, we can calculate the change in RTS index for each and every combination of returns in separate stocks, thus saving the structure of RTS index. This implies that RTS index cannot rise +30% while e.g. LKOH falls -30%, because the only way RTS rises +30% is when all the stocks in the index rise +30%

- With 11 assets' returns to be considered on a grid of 61 points *(-30% to +30% with 1% step)* it produces 61^{11} = ~$4*10^{19}$ variants which can not be effectively computationally implemented

- The solution is to use simulations with determined number of simulations sufficient for results convergence

- It appears that 50'000 simulations is enough for estimation of stress-testing of composite portfolio

5). Practical aspects of stress testing

Derivatives positions: Basket-type products

- Sum of individual stresses will give us a value of stress equal to **-588K** (LKOH) **-2’435K** (RTS)=**-3’023K** USD. But this value **cannot be achieved in reality**, because RTS index cannot rise +30% while LKOH falls -30%

- The results of simulations indicate that the worst case for the total portfolio will give us a loss of **-1’489K** USD which corresponds to a simulated LKOH return of **-21%** and a rise in RTS index of **+13%**. Rise in RTS index is explained by rise in other constituents of RTS index

6. Questions

Your questions?

Contact Information

Alfa-Bank

http:www.alfabank.com

http:www.alfabank.ru

Sergey Belousov, Market Risk Management Department,

Senior Risk Manager

ssbelousov@alfabank.ru