

## *LTCM and Lessons for Risk Management Systems and Supervision*

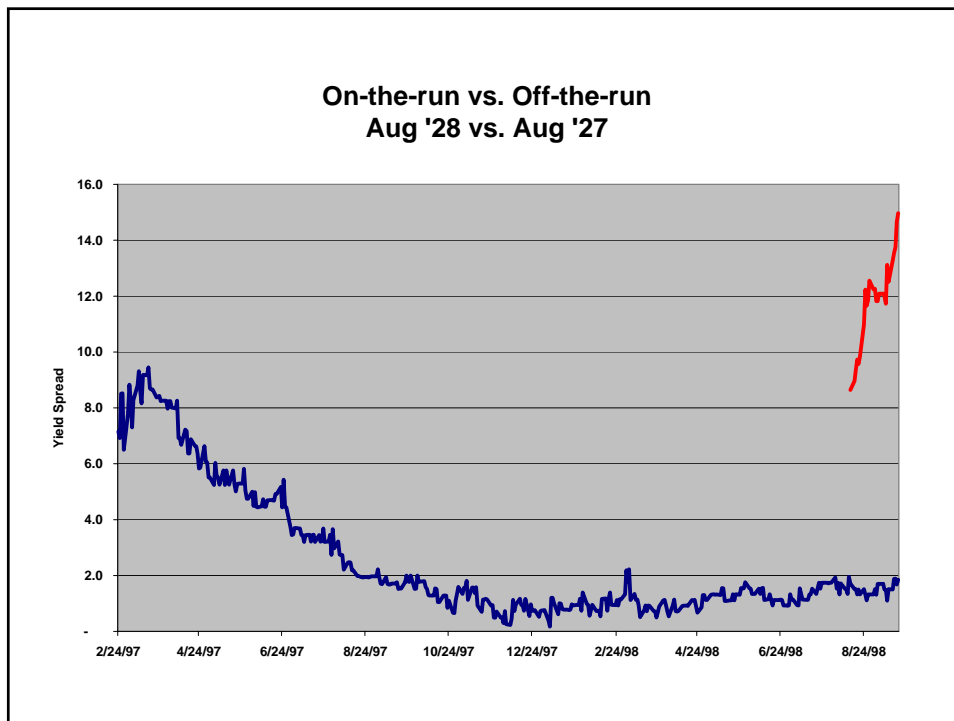
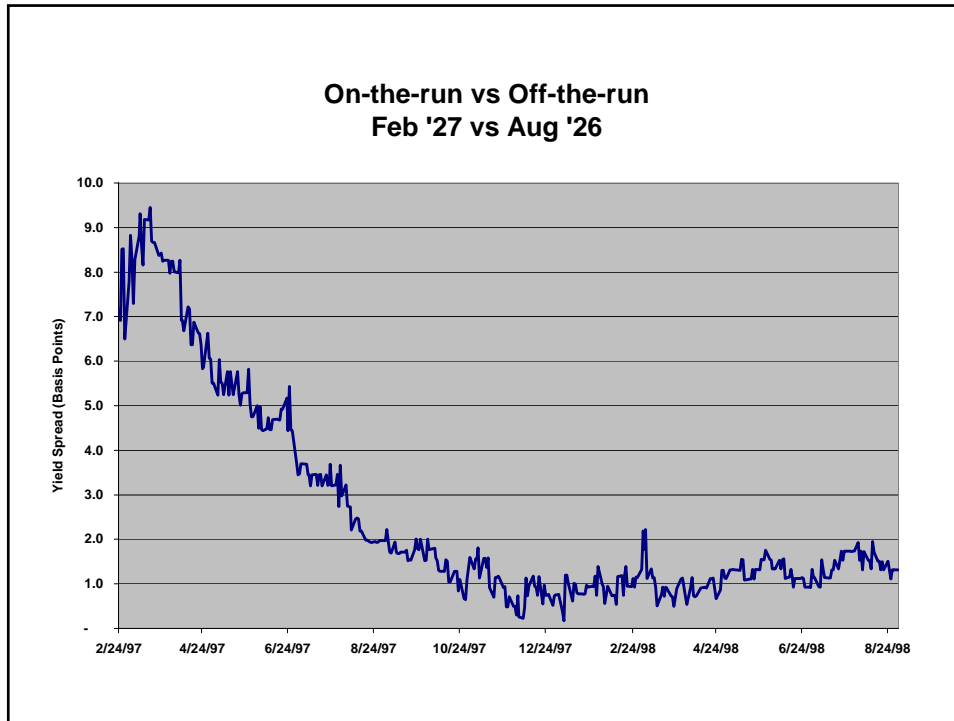
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**Prepared for**  
**The World Bank's Risk Management Seminar**  
**Washington, D.C., May 18 2004**

## *Outline*

- **Arbitrage**
- **LTCM\***
- **What did they do wrong?**
- **Lessons**

\*Based on André F. Perold (1999), "Long-Term Capital Management, L.P." Harvard Business School Cases 200-007, 200-008, 200-009, 200-010.



## *How to structure the trade?*

- Buy the 29 yr, short the 30 yr
- Fund the 29 yr in the repo market
- Sell short the 30 yr through a reverse repo transaction

## *Balance Sheet*

29 yr Tbond	\$100	Collateralized debt (repo)	\$100
Collateralized loan (reverse repo)	\$100	30 yr Tbond	\$100

## *P & L*

Yield spread (29 yr vs 30 yr)

+ Reverse Repo - Repo

+  $P_{29} - P_{30}$

## *Collateral Maintenance*

- Daily mark-to-market
- One-way versus two-way marks

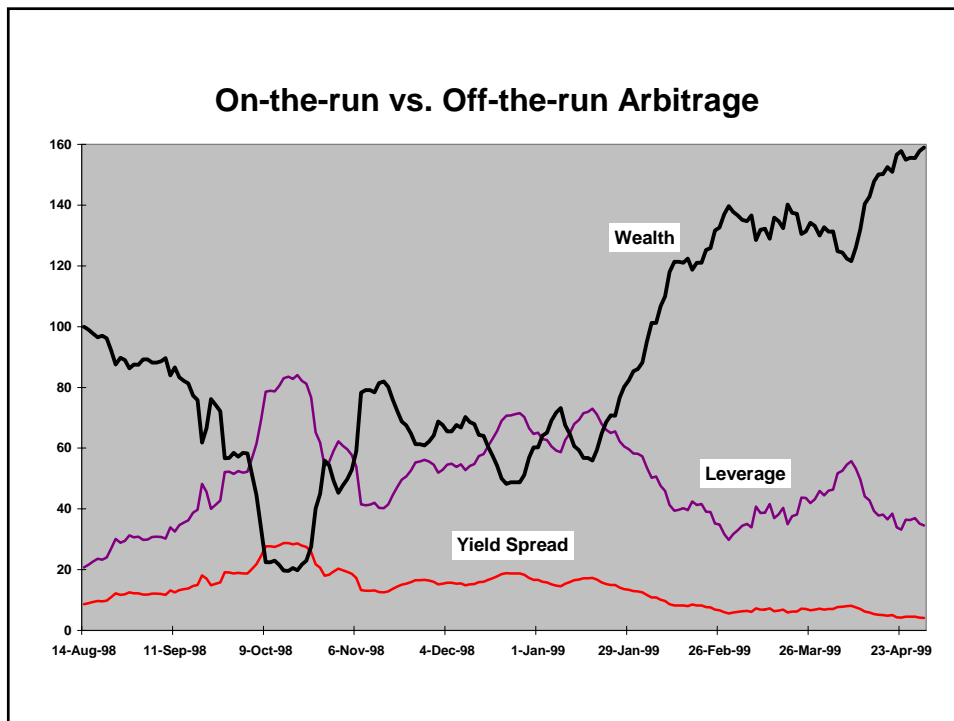
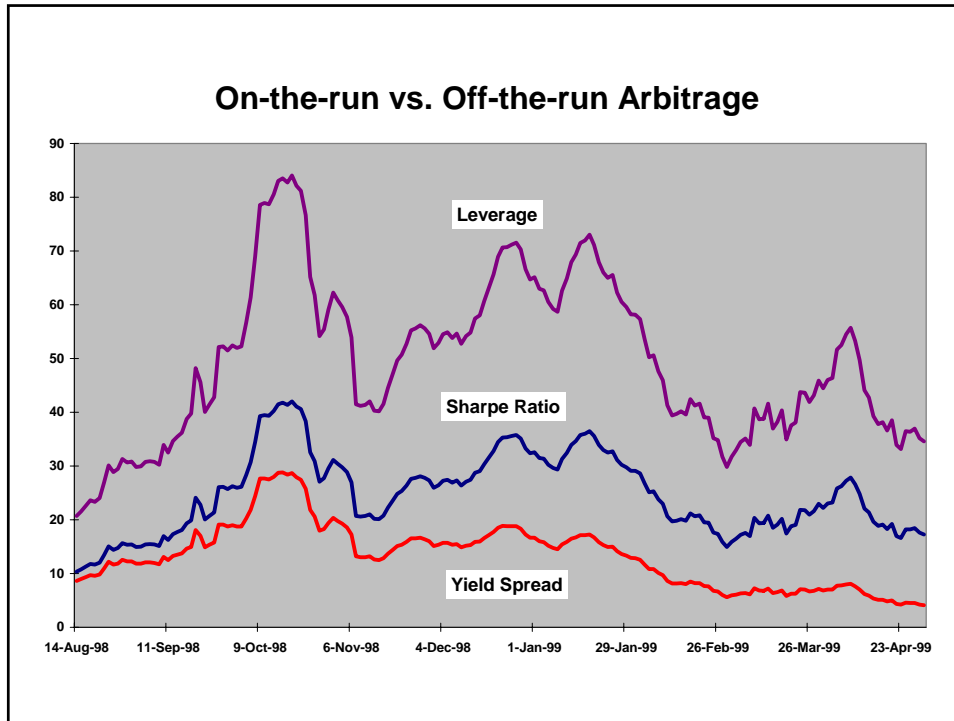
## *Issues*

- How much risk?
- Position size?
- How much capital?
- When to put it on?
- When to take it off?

## *Ex Post P&L*

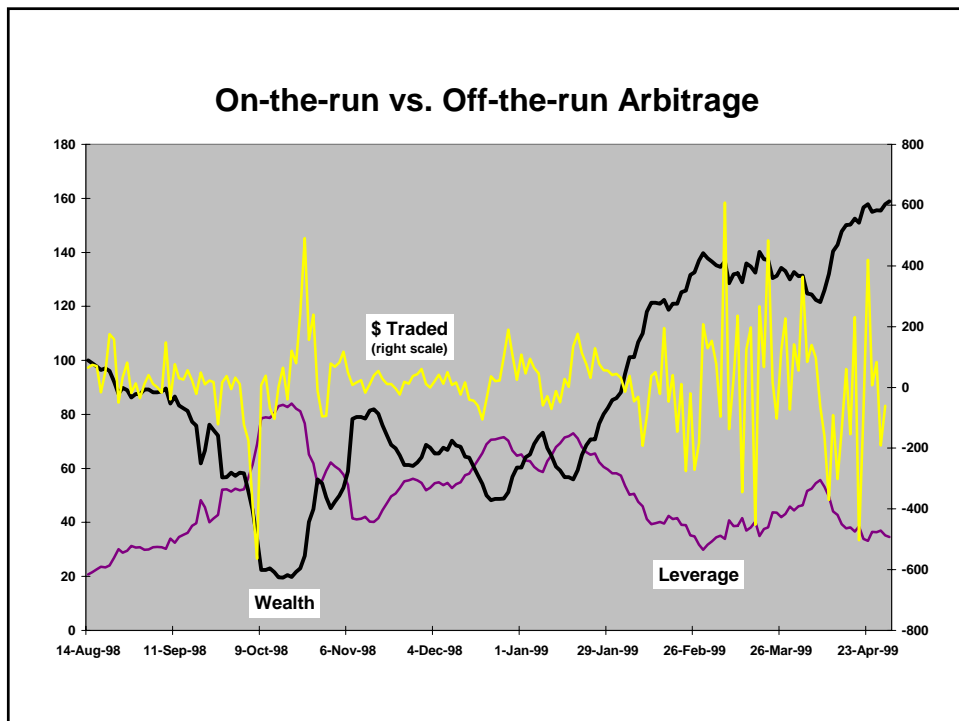
## *Example*

- **Constant risk tolerance = .25**
- **Exposure**  
= Risk tolerance x Sharpe Ratio/ $\sigma$
- **Expected spread decay is linear, converging in August, 1999**
- **Daily P&L =  $\Delta$  Spread x Duration**



*\$ Traded*

- Leverage = L
- Excess return = R
- $\frac{\$Traded}{Wealth}$   
=  $L(L-1)R + \Delta L + L\Delta LR$



## *LTCM*

- **Founded February, 1994:**
  - Capital \$1 billion
  - Principal's share \$146 million

## *Pre-tax Income of Salomon Brothers*

	<u>1993</u>	<u>1992</u>	<u>1991</u>	<u>1990</u>
<b>Prop trading</b>	416	1,416	1,103	485
<b>Other</b>	1,159	(26)	(67)	(69)

## *LTCM*

	<u>Net Return</u>	<u>Gross Return</u>	<u>Dollar Profits</u>	<u>Ending Capital</u>
1994	20%	28%	\$0.4	\$1.6
1995	43%	59%	\$1.3	\$3.6
1996	41%	57%	\$2.1	\$5.2
1997	17%	25%	\$1.4	\$7.5

## *LTCM*

- **As of 12/97:**
  - Capital \$7.5 billion
  - Principal's share \$1.9 billion
  - Assets \$129 billion
  - Notional off-balance sheet > \$1 trillion

## *Morgan Stanley (1996)*

	<u>\$billions</u>
<b>Net income</b>	<b>1.0</b>
<b>Assets</b>	<b>129.4</b>
<b>Equity</b>	<b>7.4</b>
<b>Contractuals</b>	<b>1,317.0</b>

## *Long-Term Financing*

- **Equity lock-up (3 yr., staggered)**
- **\$230 million unsecured 3 yr. term loans**
- **\$700 million unsecured revolving line of credit, annual renewal**
- **Term repos (6-12 months)**

## *Trades included....*

- **Government bond spreads**
- **Swap spreads**
- **Yield-curve spreads**
- **Mortgage spreads**
- **Volatility spreads**
- **Risk arbitrage**
- **Equity relative-value trades**

## *Back Office*

- **7,600 positions**
- **6,700 contractals**
- **55 counterparties**
- **Inability to net across legally-distinct entities within large firms**

## *Liquidity Management*

- **Capital uses: mark-to-market losses and working capital**
- **Uses of working capital**  
= Financing haircuts + equity and futures margin requirements
- **Sources working capital**  
= Equity capital + term debt + revolver

## *Risk Management*

- **Downside risk diminishes as value discrepancies become extreme**
  - Leveraged investors commit capital first
  - Then unleveraged investors
- **Stress testing (e.g., breakup of EMU)**
- **Diversification**

## *Diversification*

- **Example:**
  - Uncorrelated trades
  - Each trade: SD = \$100 million
  - 9 trades: S.D. = \$300 million
  - 10 trades: S.D. = \$316 million
  - 10th trade adds \$16 million to portfolio SD
- **100% correlation: Total SD = \$1 bn**

## *Correlations*

- **Long-horizon correlations driven by fundamental risks**
- **Short-horizon correlations driven by fundamental risks + liquidity effects**

## *1997: Issue of Fund Size*

- **Desired Volatility of 20%**
- **Returns uncorrelated with the S&P**
- **Expected excess return = \$750 million**
- **Daily P&L sigma** = \$45 million  
= \$720 million p.a.  
= 10.7% of capital
- **Models estimate daily sigma at \$60 million**  
= \$960 million p.a.

## *Fund size (cont.)*

- **LTCM estimates excess capital of at least \$2 billion**
- **Implication: Marginal \$2 billion is earning**
  - Libor before fees
  - Libor - 2% after fees
- **Return capital? Whose capital?**

## *The Decision*

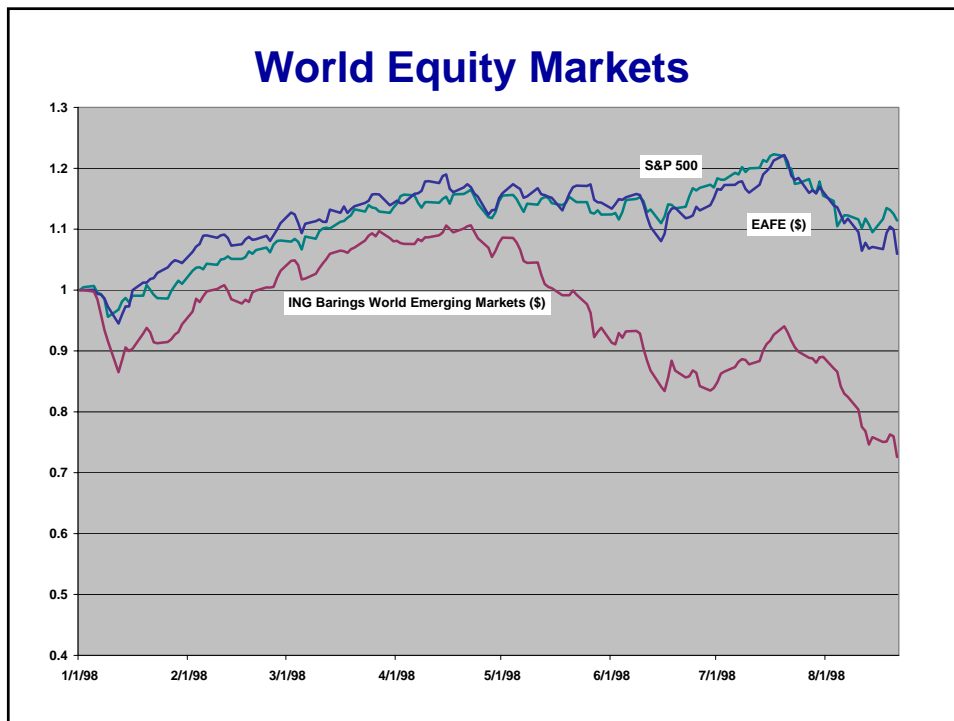
- **Distribute \$2.7 billion on 12/31/97**
- **Favor strategic and early investors**
- **Management company and related investors exempt**

## *LTCM: Jan-June 1998*

- **Jan-April: flat performance**
- **May & June: -16%, \$4.1 billion**
- **Firm reduces daily sigma by 10%**
- **Liquidates least attractive positions  
= more liquid positions**

*July, 1998*

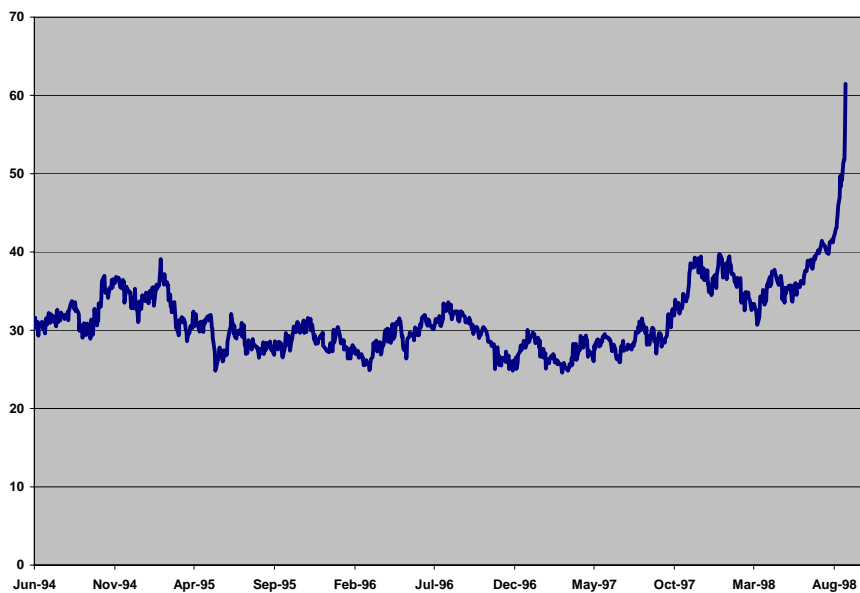
- Salomon Smith Barney closes down its U.S. bond arbitrage group
- Up 7% through July 21
- Then, pattern of daily losses resume, across many positions

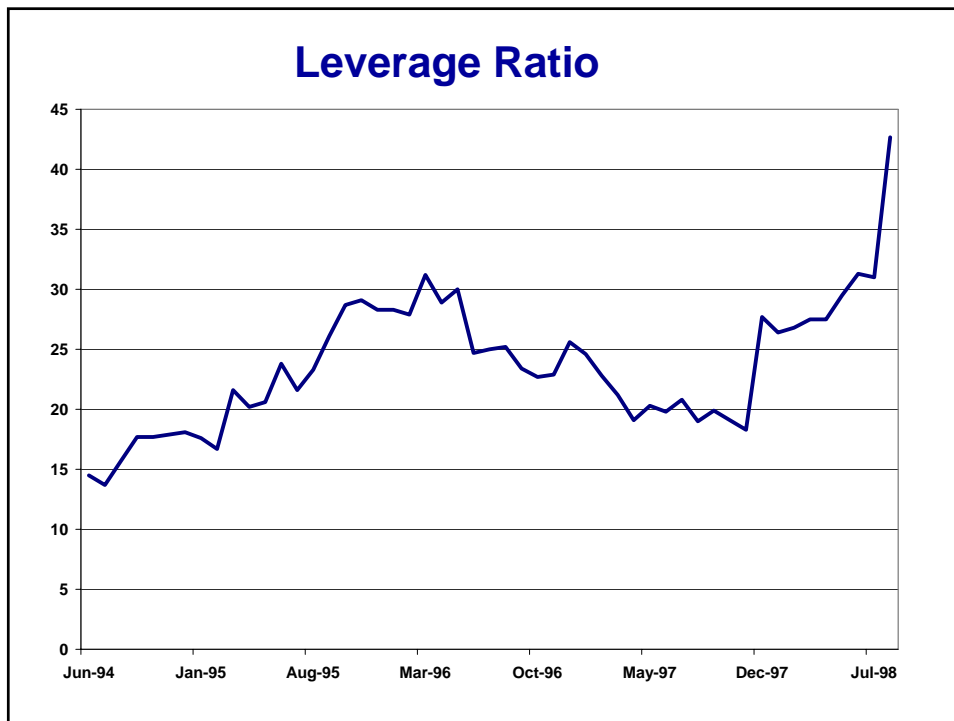
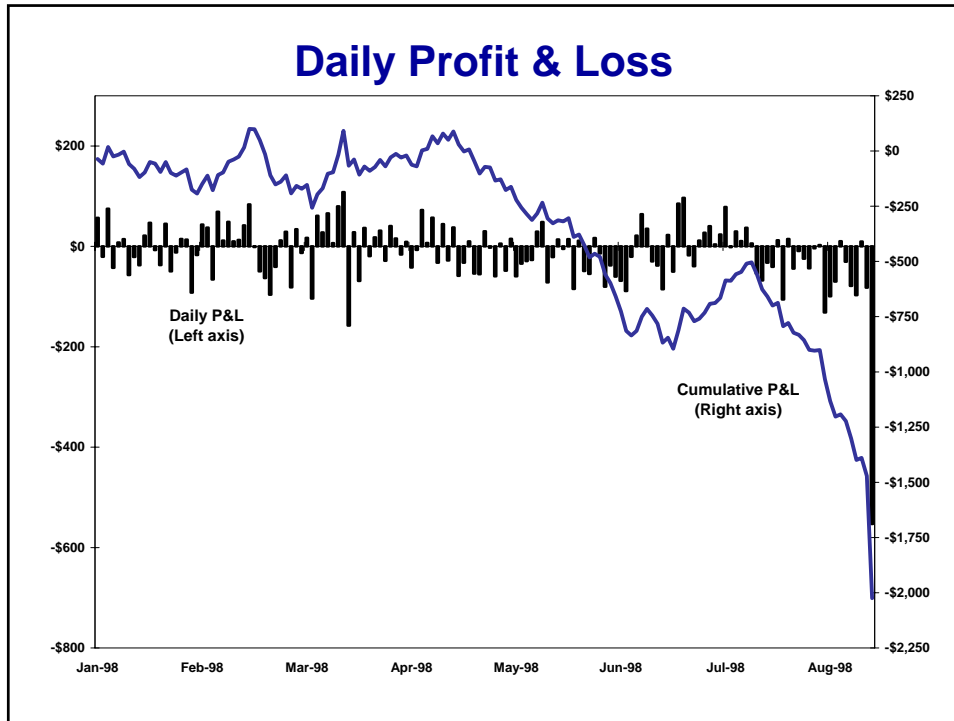


## August 1998

- **Aug 17:** Russian default  
Flight to quality
- **Aug 21:** Fund loses \$550 m  
(Risk arb, Swap spread)
- **YTD down 40%, -\$1.8 b, to \$3.0 b**

### 10 yr. U.S. Treasury Swap Spreads





## *Working capital*

- **Sources:**

Equity	2.95
Term debt	0.23
Credit facility	<u>0.90</u>
Total	4.08
- **Uses of working capital:** 2.10

## *What should LTCM do?*

## *Sept 2: Letter to investors*

- **Fund down 52% ytd to \$2.3 billion**
- **Ytd losses \$2.5 billion**
- **82% of losses in relative value trades, 18% in directional trades**
- **Positions take significant time to accumulate efficiently**
- **Best opportunities ever seen**

## *September, 1998*

- **Fund raising fails**
- **Negative rumors**
- **Some market participants bet against LTCM**
- **Some liquidate similar positions**
- **Bear Stearns demands more collateral**
- **Some counterparties “mark to worst”**

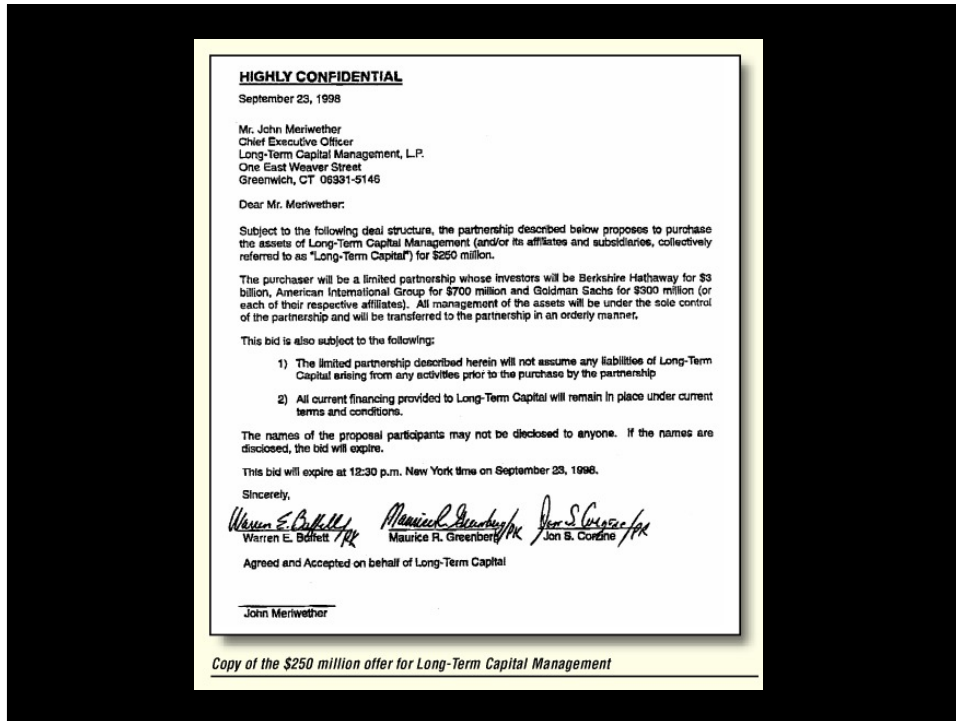
## *Mark to Worst*

When it became apparent they were having difficulties, we thought that if they are going to default, we're going to be short a hell of a lot of volatility. So we'd rather be short at 40 than 30 right? So it was clearly in our interest to mark to as high a volatility as possible. That's why everybody pushed the volatility against them, which contributed to their demise in the end."

*RISK*, October 1999

## *September 1998*

- **On September 21:**
  - One day loss of \$553 million
  - Capital below \$1 billion
- **Sept 23: Buffet/AIG/Goldman "offer"**



## September 1998

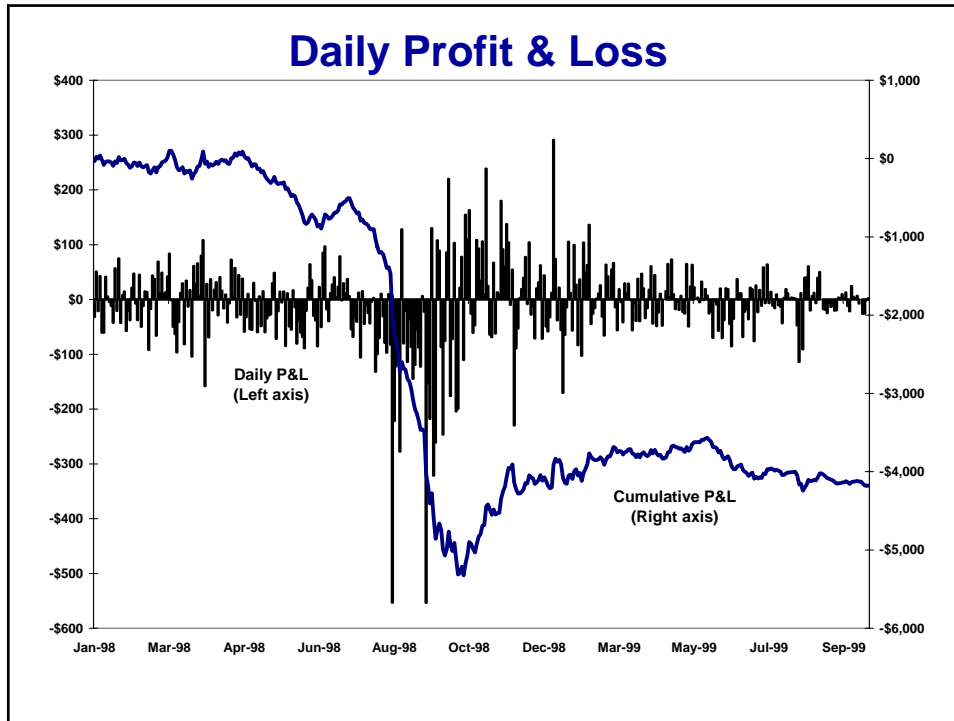
- On September 21:
  - One day loss of \$553 million
  - Capital below \$1 billion
- Sept 23: Buffet/AIG/Goldman "offer"
- Sept 23: Consortium of 14 firms puts up \$3.6b for 90%

### *LTCM Fund Losses Jan-Sept 25, 1998 (\$ millions)*

<b>Fixed-Income Rel. Value</b>	<b>\$1,628</b>
<b>Equity Volatility</b>	<b>1,314</b>
<b>Emerging Markets</b>	<b>430</b>
<b>Directional</b>	<b>371</b>
<b>Equity Pairs</b>	<b><u>306</u></b>
<b>Total</b>	<b>\$4,600</b>

### 10 yr. U.S. Treasury Swap Spreads





*Where did LTCM go wrong?*

## *Some Issues and Questions*

- **Scale**
- **Who else is doing the same thing?**
- **What is their business model?**
- **Liquidity shocks**
- **Funding sources**
- **Diversification**
- **Transparency**
- **Franchise value**