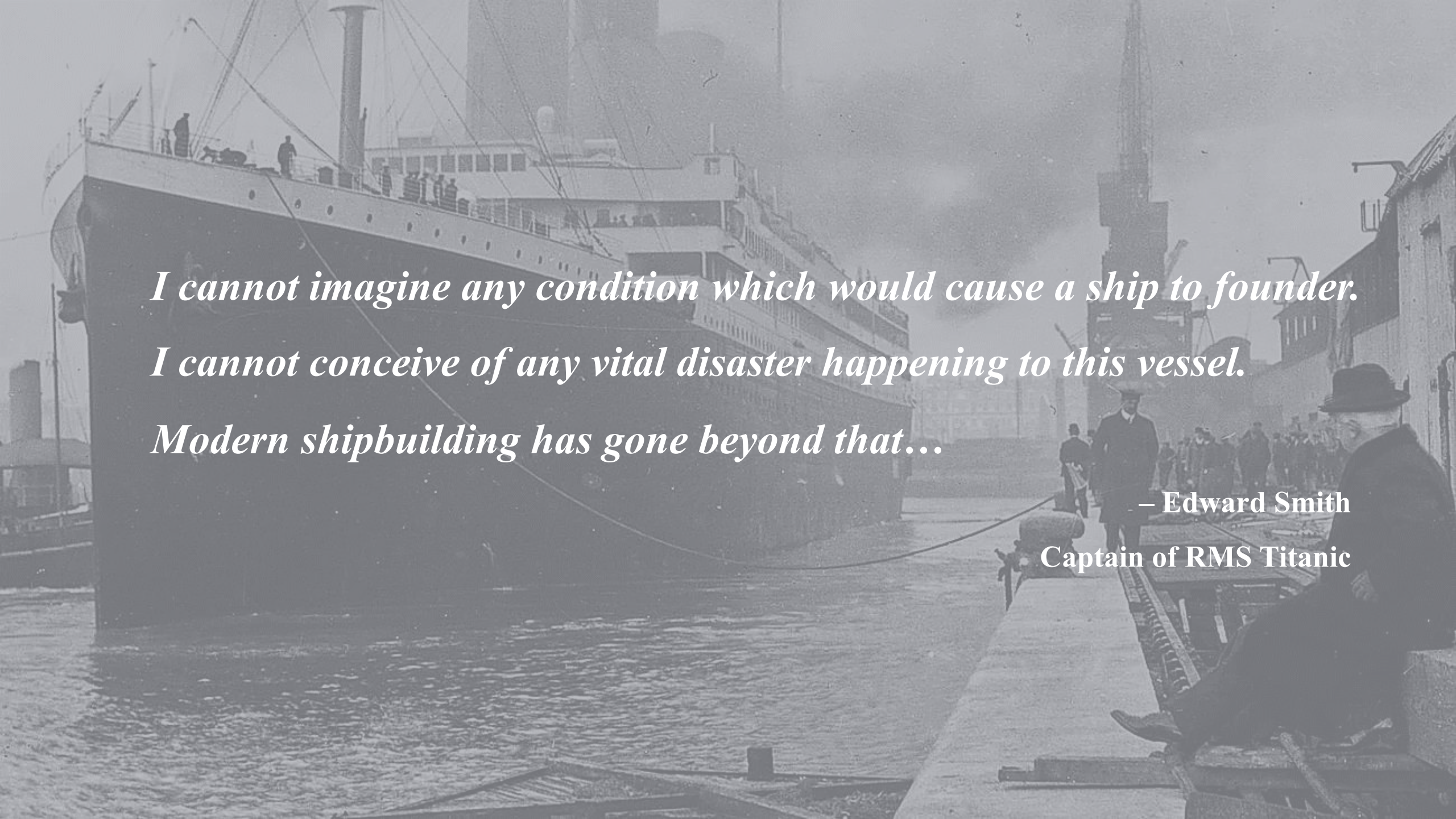
Long Term Capital Management: A Short-Lived Wonder

Li Jin Chen, Kanica Khatri, Claudio Llin, Alyssa Wei



I cannot imagine any condition which would cause a ship to founder.

I cannot conceive of any vital disaster happening to this vessel.

Modern shipbuilding has gone beyond that…

– Edward Smith

Captain of RMS Titanic

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Long Term Capital Management: A Short-Lived Wonder

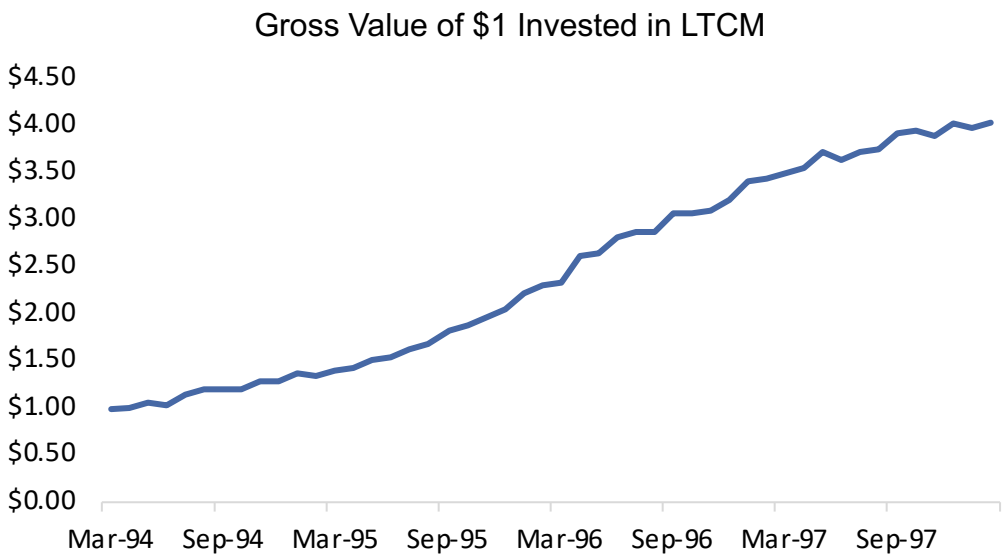
LTCM'S CAPTAINS

Robert Merton

John Meriwether

Myron Scholes

THE FUND THAT WAS PROMISED



Source: Perold – Long-Term Capital Management, L.P. (C) (1999)

- **Diversified Holdings**
- **Global Exposures**
- **Robust Models**
- **High Leverage, High Returns**

CORE STRATEGIES

Convergence
Relative Value

TRADES

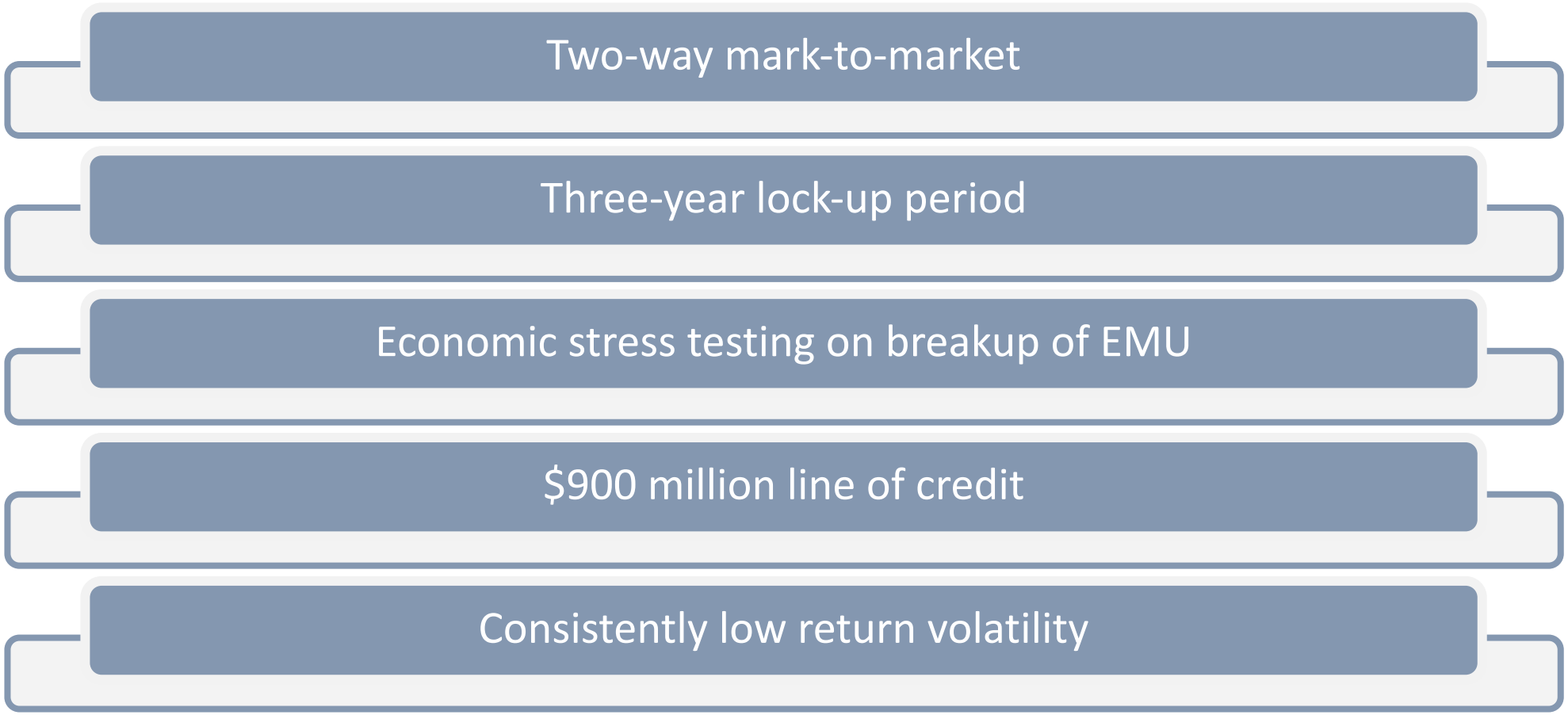
Swap Spreads	Mortgages
Merger Arbitrage	Equity Volatility
Equity Pairs	Yield Curve Arbitrage

LEVERAGE RATIO

22.5

(Jun.1994 – Aug.1997)

RISK MANAGEMENT MEASURES



01 Hidden Risks In Trading Strategies

FALSE DIVERSIFICATION

GLOBAL EXPOSURE

- United States
- Europe
- Emerging Markets

HEDGED POSITIONS

- Equity
- Fixed Income
- Derivatives

	Volatility	Default	Illiquidity
Long Interest Rate Swap	X	X	X
Short Equity Options	X		
Long Off-the-run Treasuries	X		X
Long Mortgage-backed Securities	X		X
Long Sovereign Debt	X	X	X

Source: Jorion - Risk Management Lessons from LTCM (2000)

COMPETITORS AND INVESTORS

III OFFSHORE ADVISORS

SOROS
Soros Fund Management

Salomon Brothers

Flight to Liquidity

LTCM COULD NO LONGER RELY ON MARKET EFFICIENCY OR MARKET LIQUIDITY

PROBLEMATIC MODEL ASSUMPTIONS

Equity Options Overpriced

⇩

Short Volatility

⇩

	Model Assumptions
Black-Scholes Model	Constant Stock Price Volatility
Value-at-Risk	Price-Taker Downward Bias in VaR Estimation

⇩

$ 1.3 BILLION LOSSES

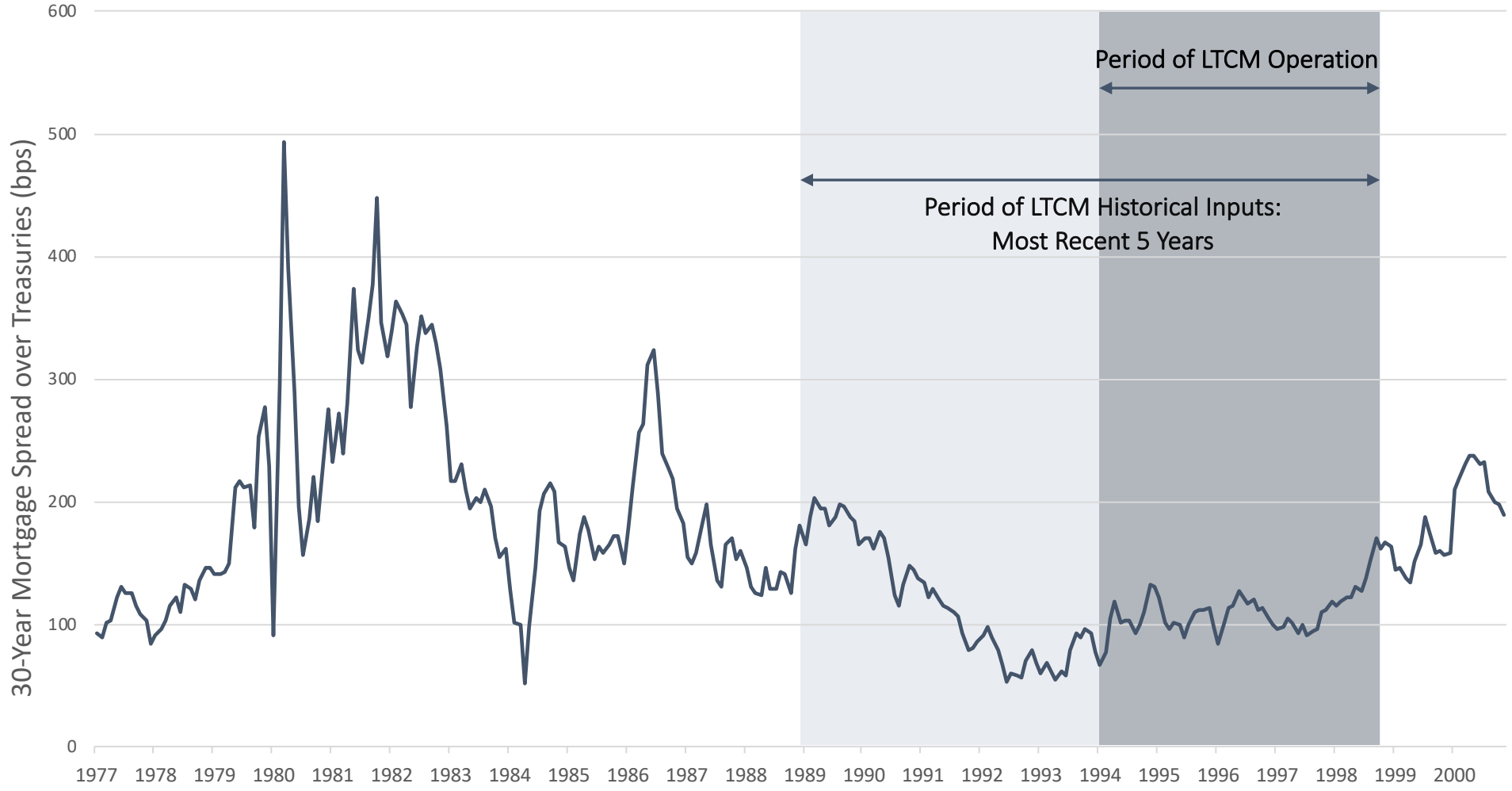
Correlations between LTCM Trades

BEFORE CRISIS	A	B	C	D	E	F	G	H
A	1	0.11	0.05	0.08	0.02	0.14	0.04	0.13
B	0.11	1	0.06	0	0.01	0.13	-0.07	0.05
C	0.05	0.06	1	-0.04	0.02	0.15	0.12	0.21
D	0.08	0	-0.04	1	0.07	0.04	0.05	-0.18
E	0.02	0.01	0.02	0.07	1	0.36	0.16	0.45
F	0.14	0.13	0.15	0.04	0.36	1	0.17	0.25
G	0.04	-0.07	0.12	0.05	0.16	0.17	1	0.25
H	0.13	0.05	0.21	-0.18	0.45	0.25	0.25	1

DURING CRISIS	A	B	C	D	E	F	G	H
A	1	0.04	0.79	-0.03	0.36	0.51	0.14	0.42
B	0.04	1	0.12	0.4	0.28	0.27	0.09	0.02
C	0.79	0.12	1	0.06	0.42	0.45	0.12	0.16
D	-0.03	0.4	0.06	1	0.11	0.16	-0.18	0.27
E	0.36	0.28	0.42	0.11	1	0.56	0.45	0.42
F	0.51	0.27	0.45	0.16	0.56	1	-0.05	0.42
G	0.14	0.09	0.12	-0.18	0.45	-0.05	1	0.29
H	0.42	0.02	0.16	0.27	0.42	0.42	0.29	1

Source: Chincarini – The Crisis of Crowding (2012)

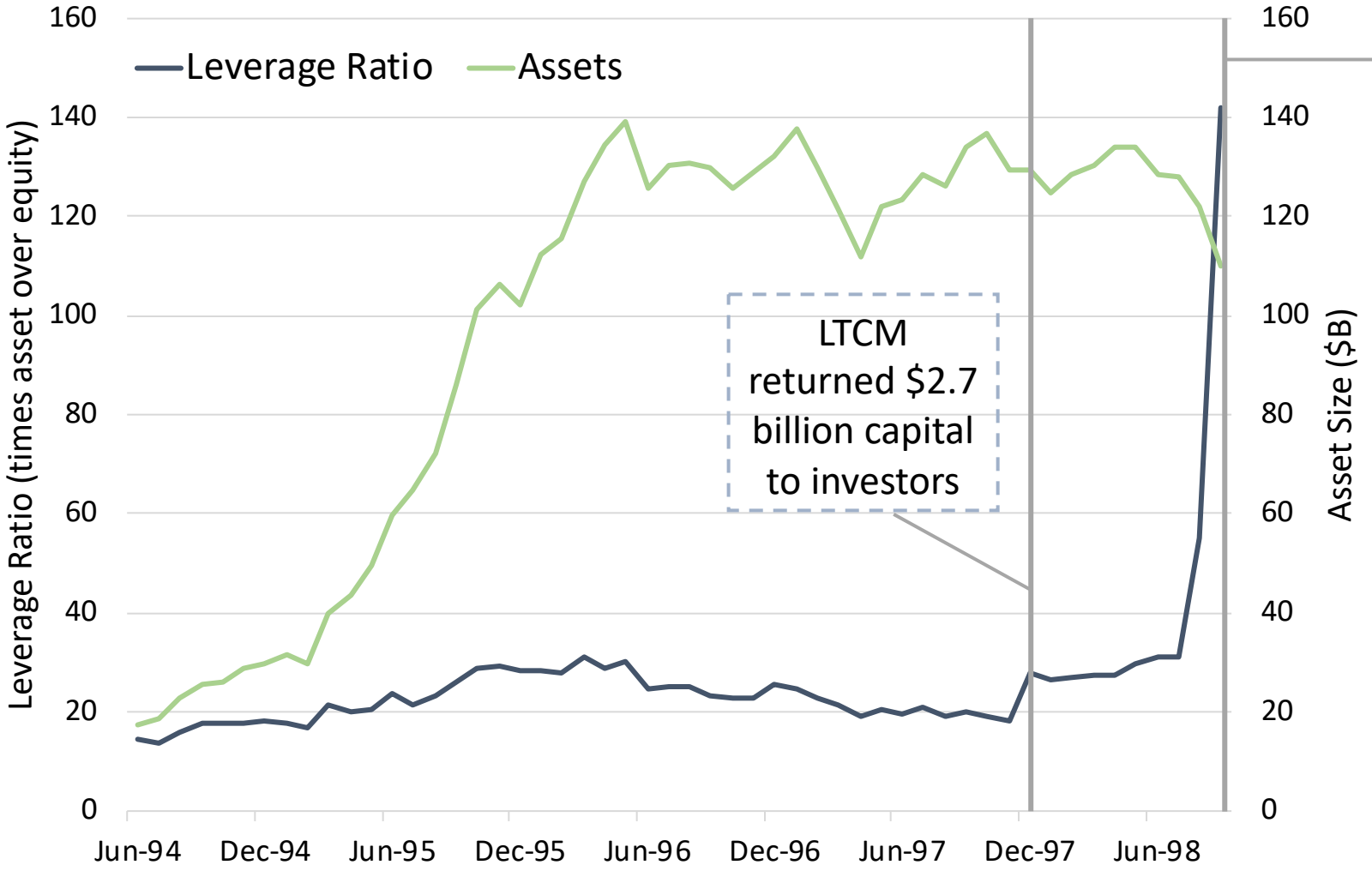
MYOPIC HISTORICAL INPUTS



Source: Federal Reserve, Bloomberg

02 Paralyzed by Illiquidity

VERGE OF INSOLVENCY

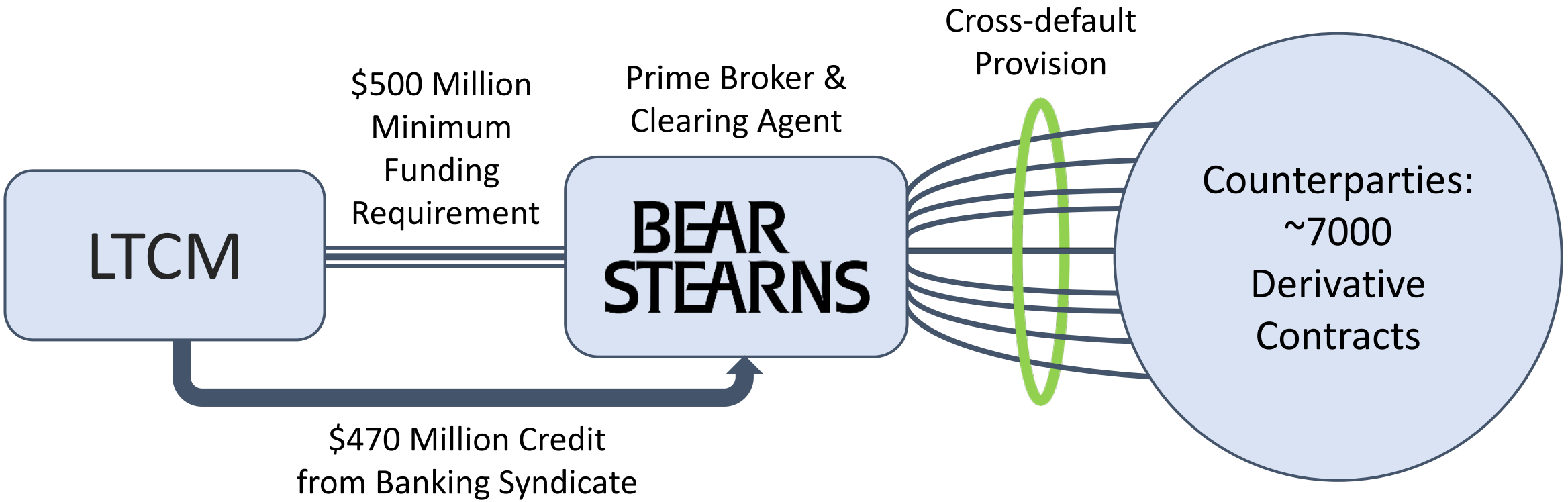


September 22nd, 1998

Assets:	$110 billion
Equity:	$773 million
Leverage:	142-to-1
VIX:	38.9

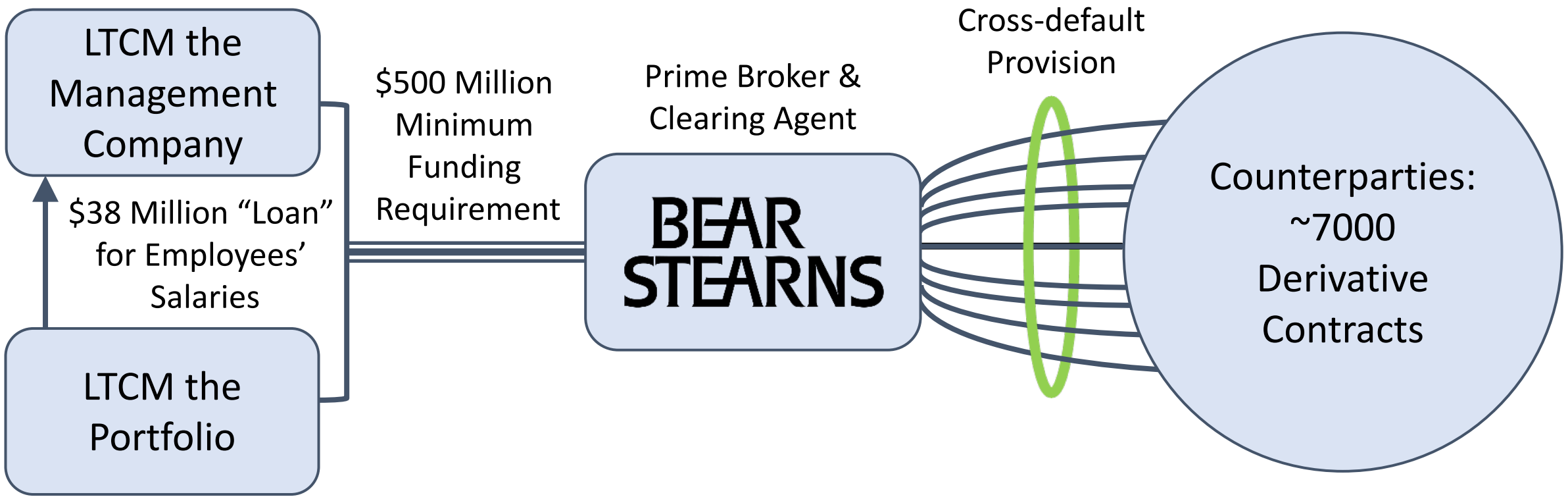
Source: Perold - LTCM Harvard Case (C) (1999)

BE LIQUID OR BE BANKRUPT



Sources: Lowenstein - When Genius Failed (2000), Shirreff - Lessons From the Collapse of Hedge Fund LTCM (2000)

BE LIQUID OR BE BANKRUPT



Sources: Lowenstein - When Genius Failed (2000), Shirreff - Lessons From the Collapse of Hedge Fund LTCM (2000)

SHORT-TERM CRISIS, LONG-TERM VALUE

Short-Term Crisis: Traders expected LTCM to quickly collapse from short squeeze

Long-Term Value: Warren Buffet and banking consortium willing to buy out the fund

After one year: 10% return; $3.65 billion capital injection recovered; fund dissolved

03 Would LTCM Survive Today ?

EXPOSURES OF LTCM'S PORTFOLIO

MODEL INPUTS (Mar.1994 – Apr.1999)

Dependent Variable		
LTCM Net Monthly Return	$NetMonthlyReturn$	
Independent Variables		**Proxies for Risks**
Baa Rated Corporate Bond Spread	$Baa10Y$	Credit Risk
CBOE Volatility Index	VIX	Volatility Risk
MSCI World Index	$MSCI\_W$	Foreign Stock Market Risk
S&P 500 Index	SPX	Domestic Stock Market Risk
10-year Treasury Yield	$Treasury10Y$	Bond Market Risk
U.S. Dollar Index	DXY	Exchange Rate Risk

Sources: Bloomberg, Yahoo Finance

EXPOSURES OF LTCM'S PORTFOLIO

MODEL INPUTS (Mar.1994 – Apr.1999) | **REGRESSION ANALYSIS**

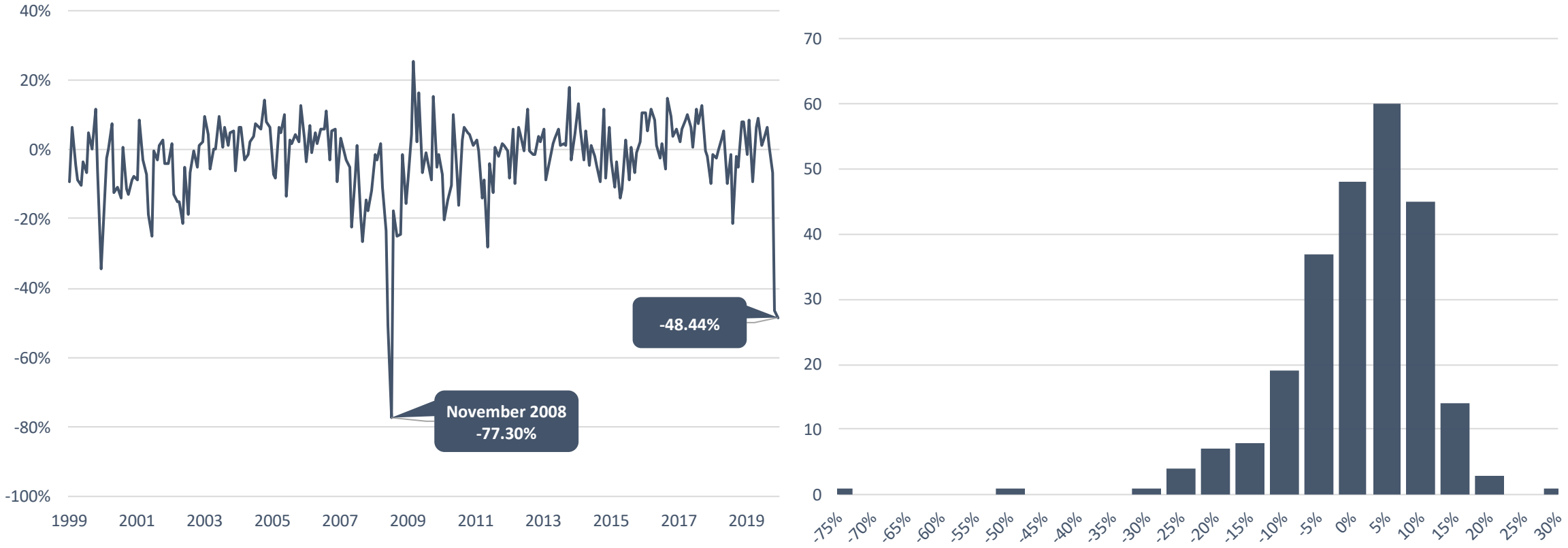
	Coefficient	Std. Error	p-value
(Intercept)	0.108	0.0296	< 0.001***
$\Delta Baa10Y_{t-1}$	-1.31	0.276	< 0.001***
VIX_{t-1}	-0.00647	0.00142	< 0.001***
$\Delta MSCI\_W_{t-1}$	1.26	0.263	< 0.001***
ΔSPX_{t-1}	0.549	0.241	0.027*
$\Delta Treasury10Y_{t-1}$	-0.338	0.276	0.226
ΔDXY_{t-1}	-0.304	0.511	0.554

Significance Codes: 0.1% *** 1% ** 5% * Multiple R-squared: 0.758 Adjusted R-squared: 0.731

HYPOTHETICAL MONTHLY RETURN OF LTCM

MODEL INPUTS (Mar.1994 – Apr.1999) | REGRESSION ANALYSIS | HYPOTHETICAL RETURN (May.1999 – Now)

$$NetMonthlyReturn_t = 0.108 - 1.31\Delta Baa10Y_{t-1} - 0.00647VIX_{t-1} + 1.26\Delta MSCI_{W\,t-1} + 0.549\Delta SPX_{t-1} - 0.338\Delta Treasury10Y_{t-1} - 0.304\Delta DXY_{t-1}$$



HYPOTHETICAL MONTHLY RETURN OF LTCM

Sources: Federal Reserve, Bloomberg

SENSITIVITY ANALYSIS

$\Delta Baa10Y_{t-1}$ \ VIX_{t-1}	75	85	94	103	112
38%	-88%	-94%	-100%	-106%	-112%
44%	-96%	-102%	-108%	-114%	-120%
51%	-104%	-110%	-116%	-122%	-128%
57%	-112%	-118%	-124%	-130%	-136%
63%	-121%	-127%	-133%	-139%	-145%

COVID-19

- Vaccine is still under testing
- Probability of its recurrence in fall

Fiscal Policy & Monetary Policy

- Interest rates hitting zero
  - Potential failure of valuation models
- Quantitative Easing (QE)

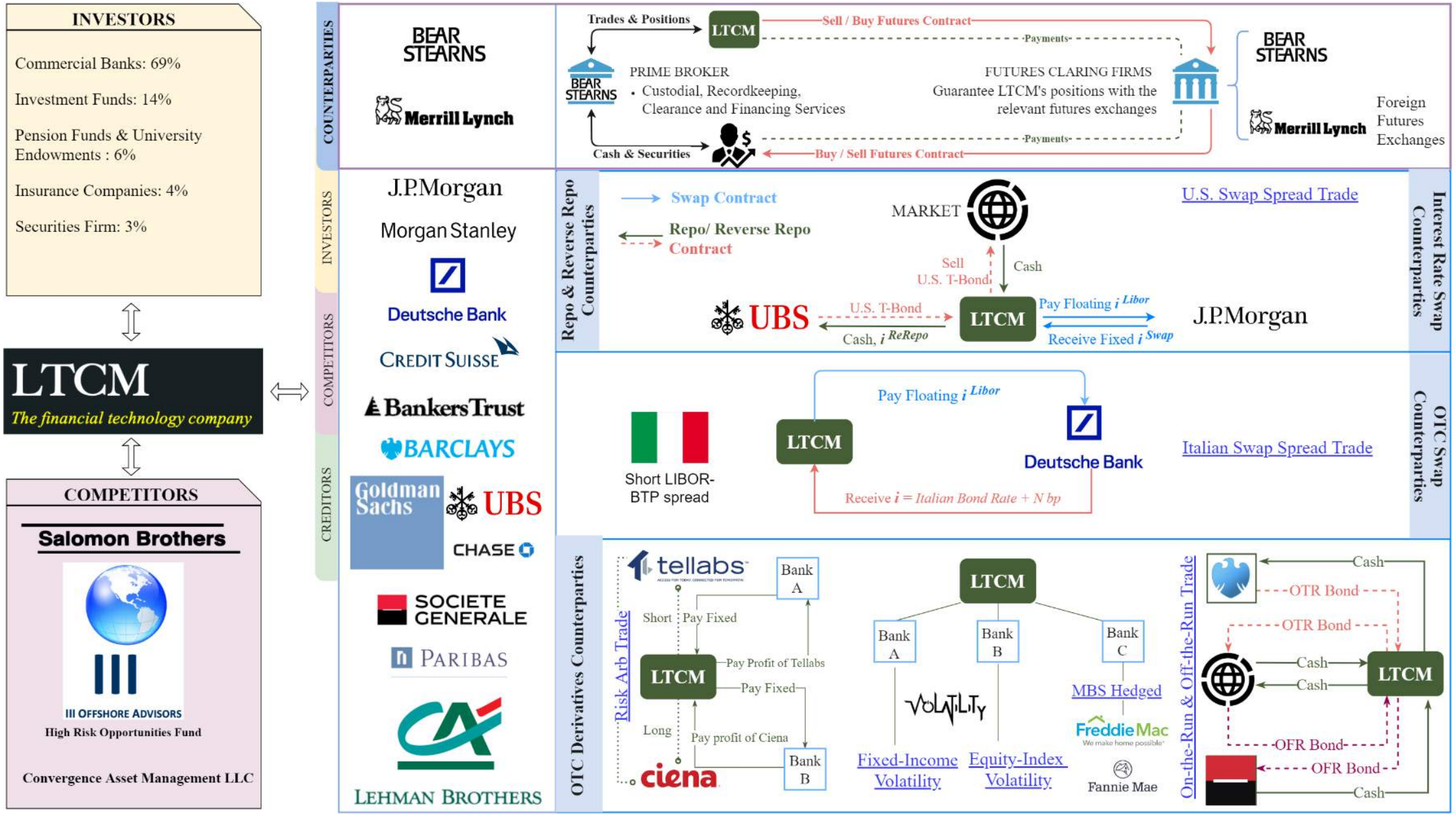
Post Election

- An intensification of US-China trade war
  - pressure on supply chain
  - companies move back onshore
  - pressure on wages and profit margins

Crowding Of Trading Strategies

Complicated Financial Instruments

04 Caught in Its Own Web



Sources: Chincarini - The Crisis of Crowding (2012), Lowenstein - When Genius Failed (2000), Perold - LTCM Harvard Case (C) (1999)

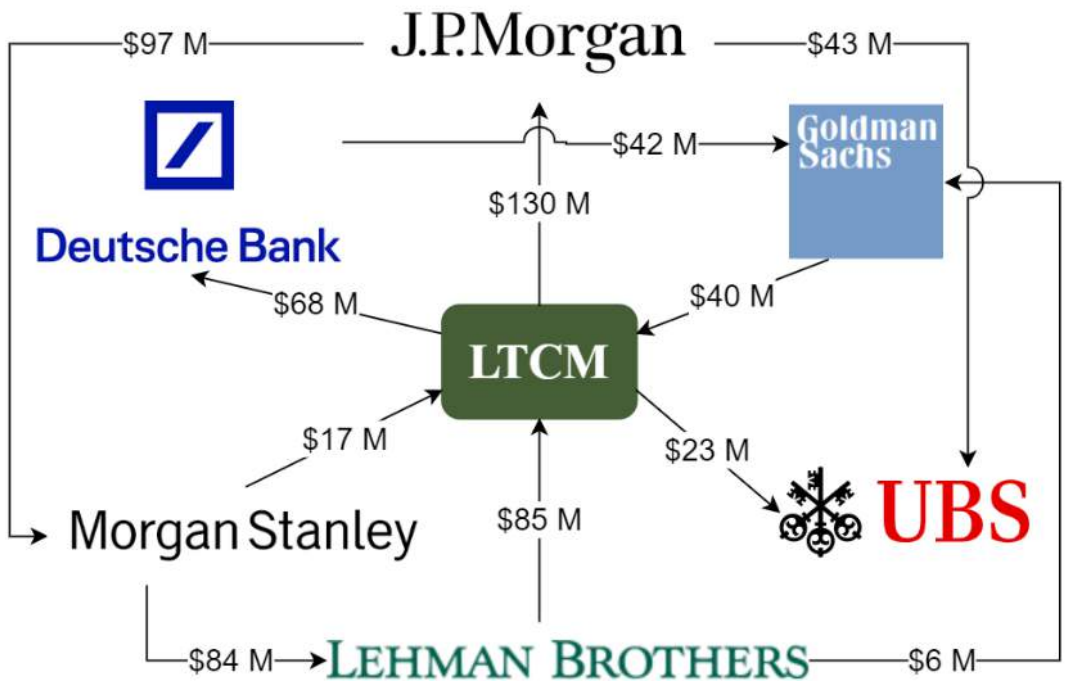
TRADES UNDER HYPOTHETICAL STRESSED SCENARIO

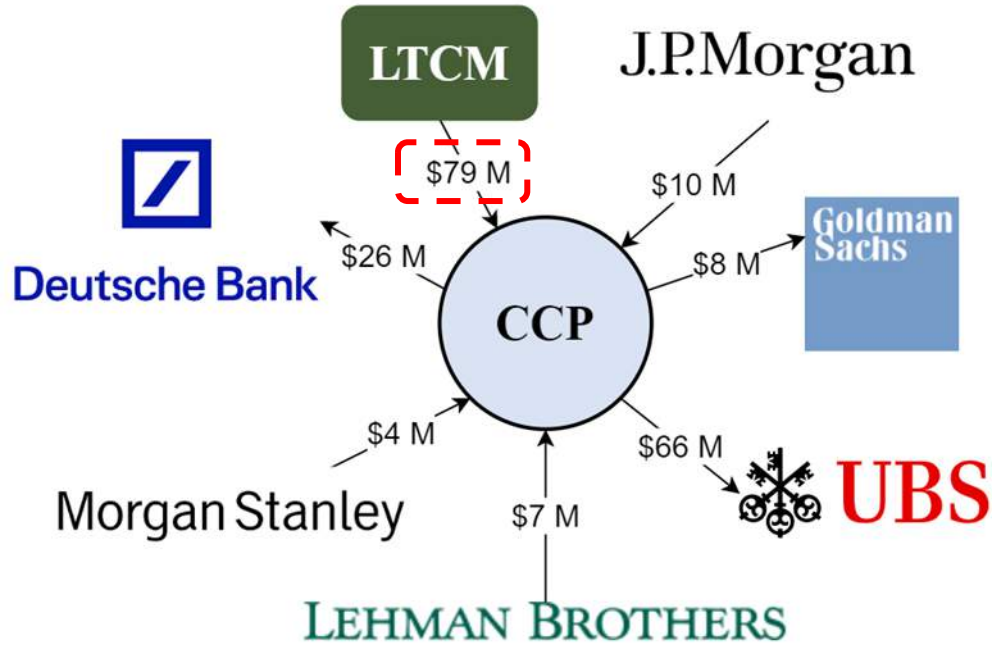
Trade	Trade Direction	Exposure in 1998 ($M per bp)	Inflation Adjusted Exposure ($M per bp)	2015 - 2020 Average Level (bp)	Hypothetical Entry Position (bp)	YTD Maximum Loss ($M)	Historical Worst Case (Million)	Historical Worst Case Condition	
								Spread / VIX	Time
Convergence Trades									
U.S. Swap Spread	Short	5	7.94	-2.4	-3.0	(115)	(659)	80	May 2008
Italian Swap Trade	Short	0.1	0.16	171	218	(12)	(12)	294	Apr 2018
Relative Value Trades									
Equity Volatility	Short	30	47.61	19	18	(1,324)	(1,689)	54	Nov 2008
U.S. Mortgage	Short	10	15.87	121	161	(784)	(1,641)	264	Dec 2008
Box Spread in Japan	Short	3	4.76	13	10	(60)	(218)	56	May 2010
Total						(2,295)	(4,218)		

Source: Chincarini - The Crisis of Crowding (2012)

- Using LTCM's exposures on a selected set of trades in 1998 and the current economic conditions, we examine how the fund would have performed year-to-date (Jan 1st to April 1st, 2020).
- That is then compared to the trades' worst possible losses over the last 20 years.

FUNCTIONS OF CENTRAL CLEARING COUNTERPARTY





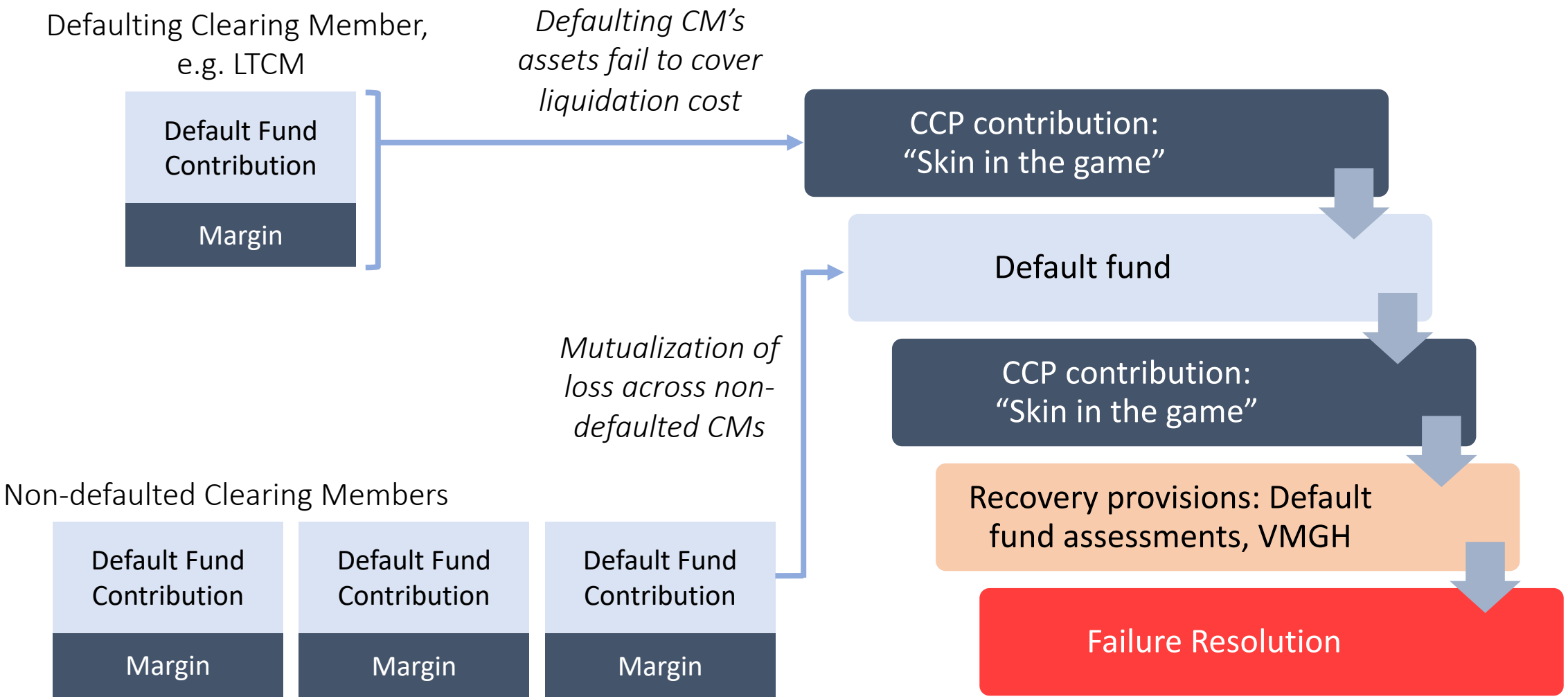
Fear of counterparty default

- Collateral mark-to-worst
- Collateral withholding

Counterparty default risk eliminated

- Greater market efficiency
- Reduction of systemic risk
- Losses from bad bets remain

CCP LOSS WATERFALL



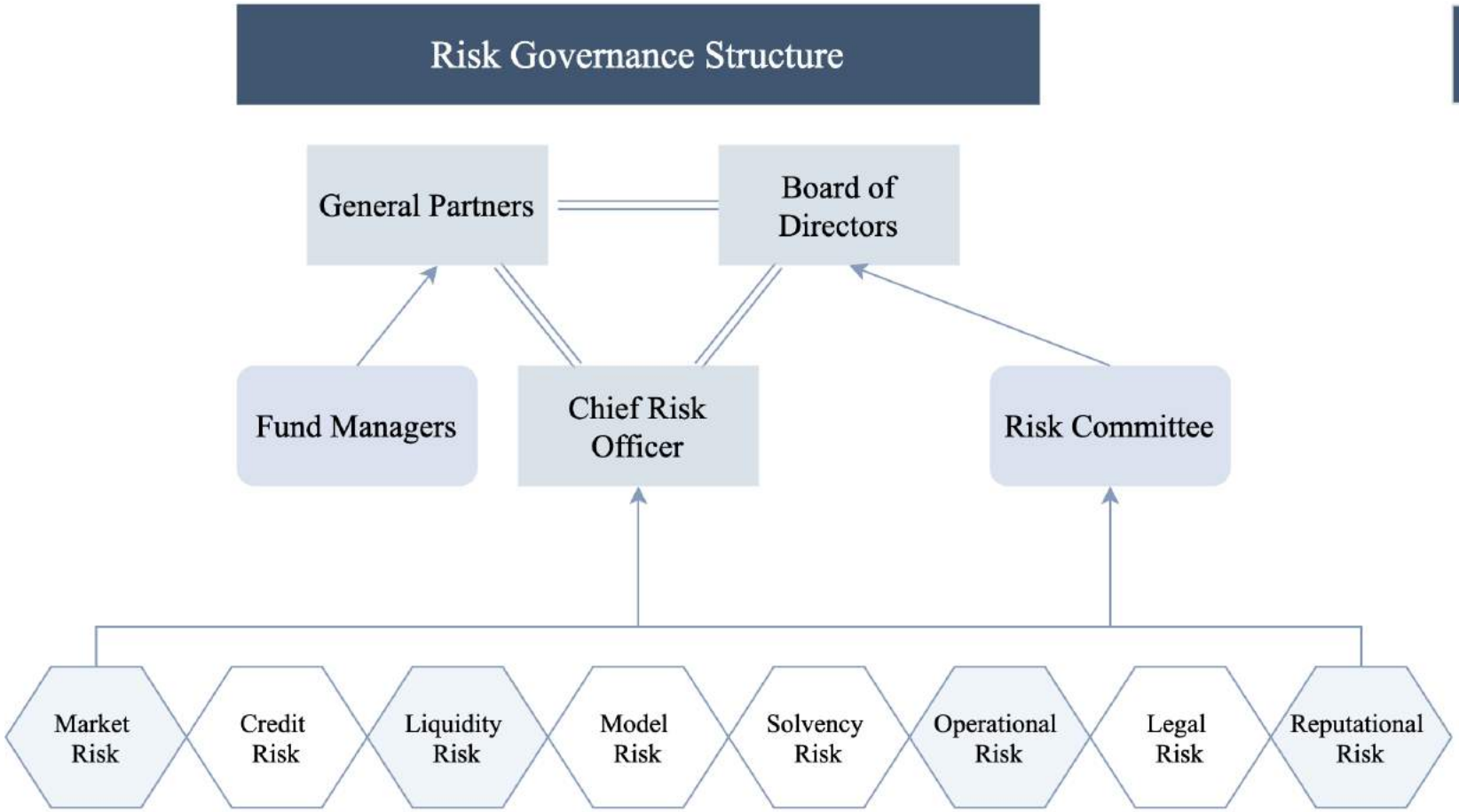
Source: Cont - Central clearing and risk transformation (2017)

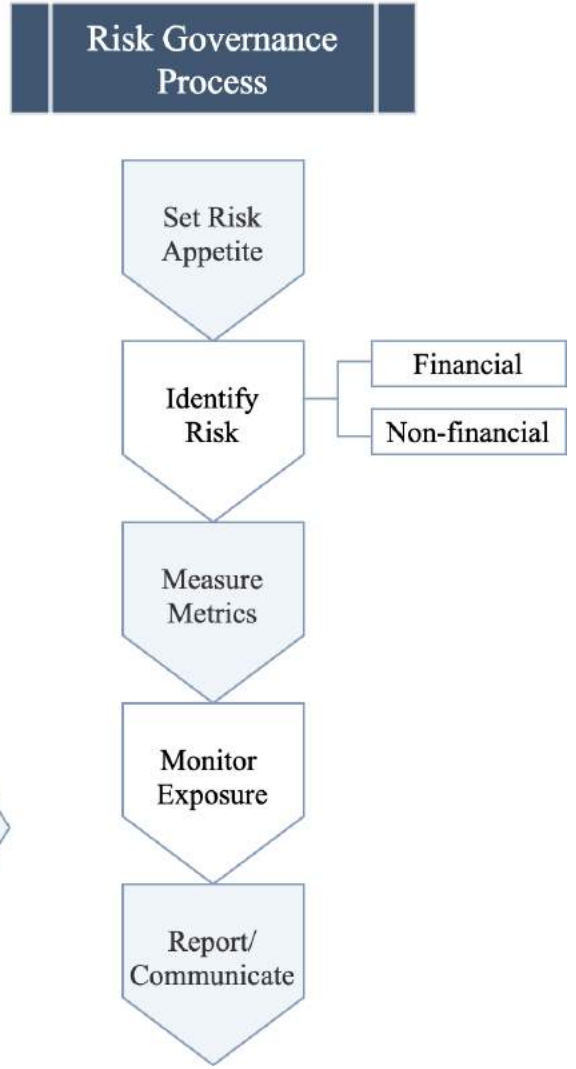
05 Improving Risk Governance

WHAT COULD BE IMPROVED

LIQUIDITY RISK	• Create a liquidity risk division that reports to the Chief Risk Officer • Monitor trades, review balance sheet positions, and ensure that short-term financial demands are met
MODEL RISK	• Implement a model risk division that reviews all financial models and prevents adverse outcomes • Conduct stress tests with the assistance of market and credit risk teams
STRESS TESTING	• Analyze worst-case scenarios instead of using recent historical events • Integrate other risk metrics aside from VaR

RECOMMENDED RISK GOVERNANCE STRUCTURE

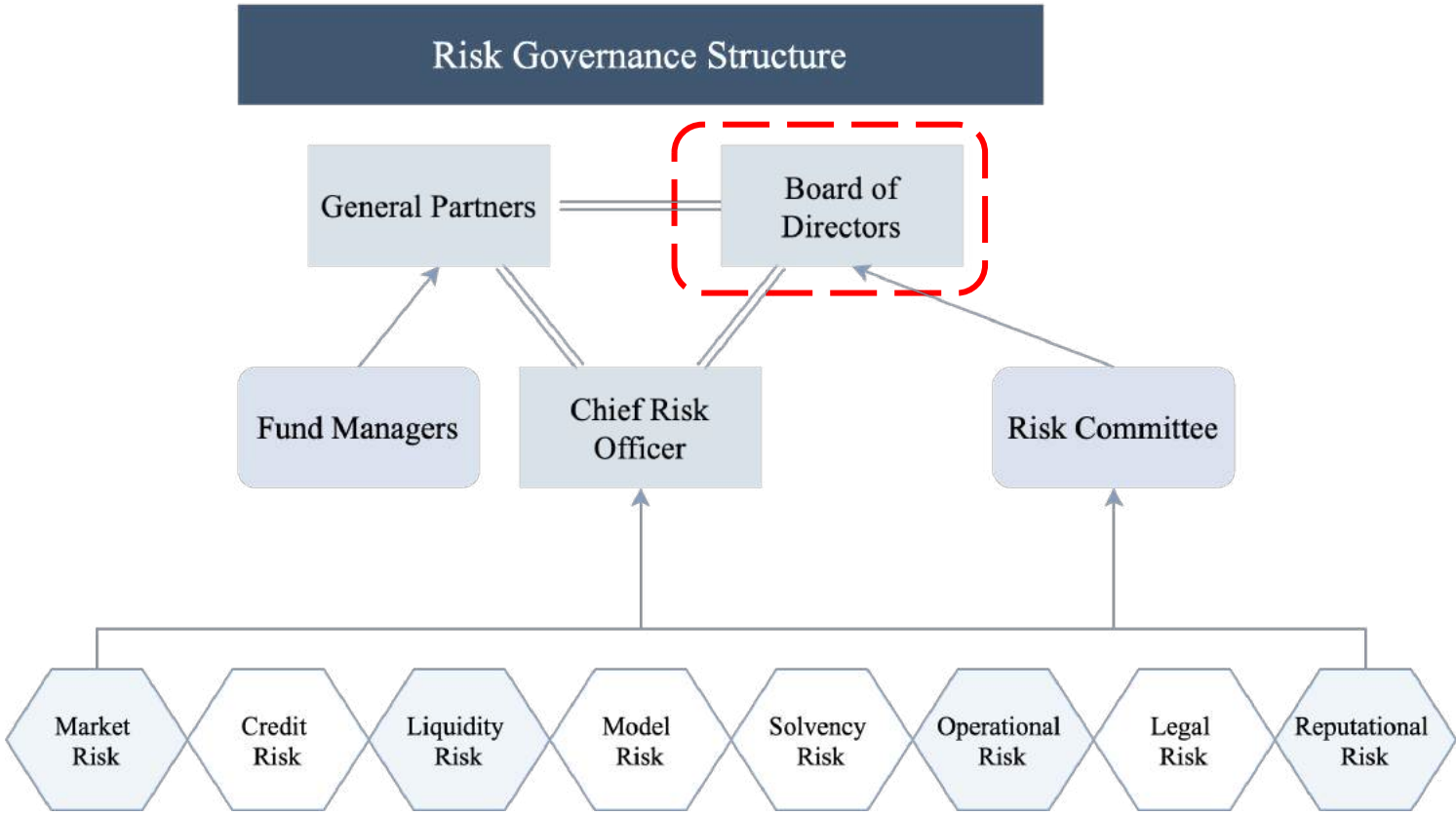




KEY RELATIONSHIPS

BOARD OF DIRECTORS

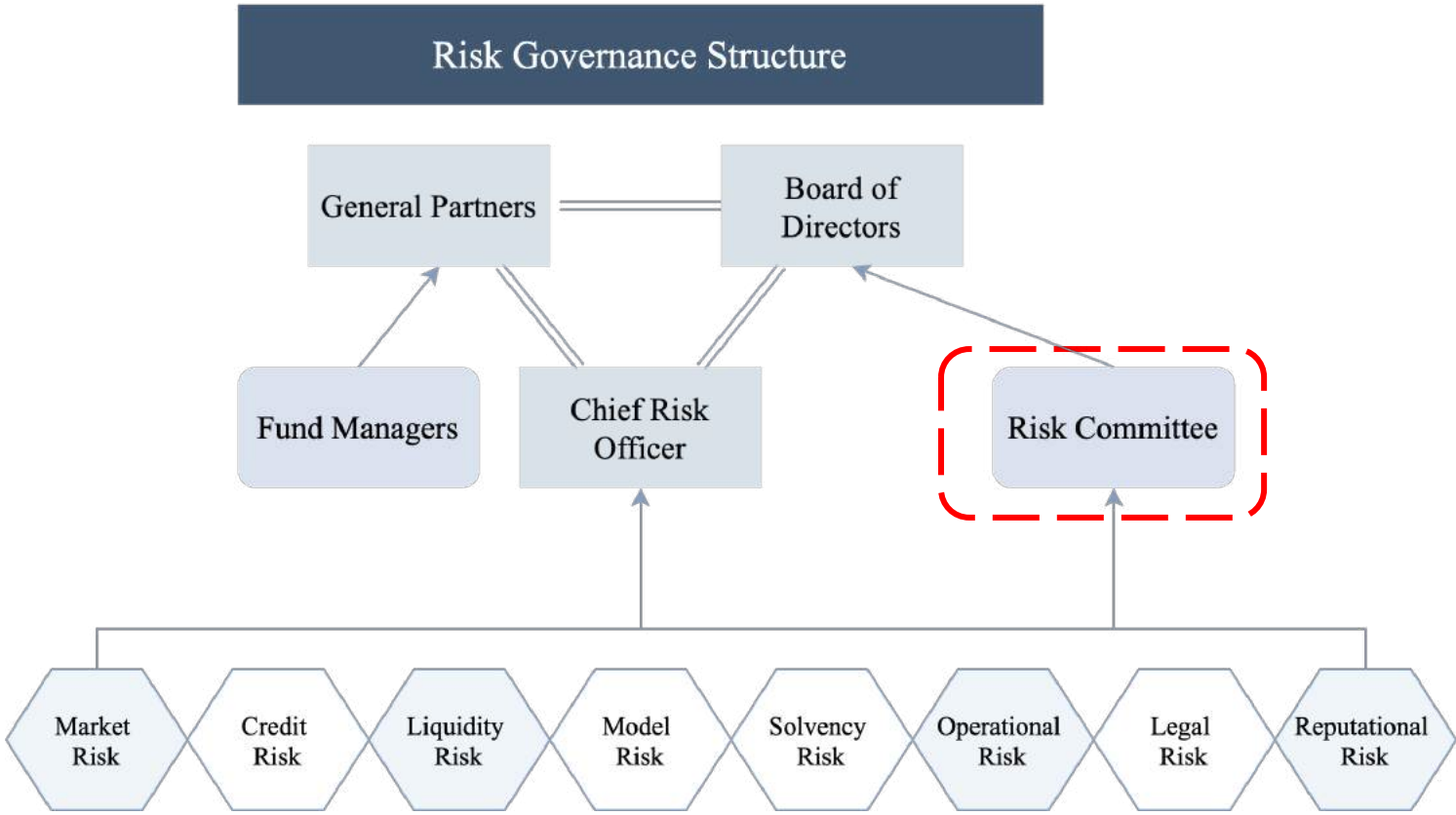
- Supervises all activities of the organization
- Coordinates with general partners to set out strategic objectives
- Involved in setting high-level policies affecting most risk management processes



KEY RELATIONSHIPS

RISK COMMITTEE

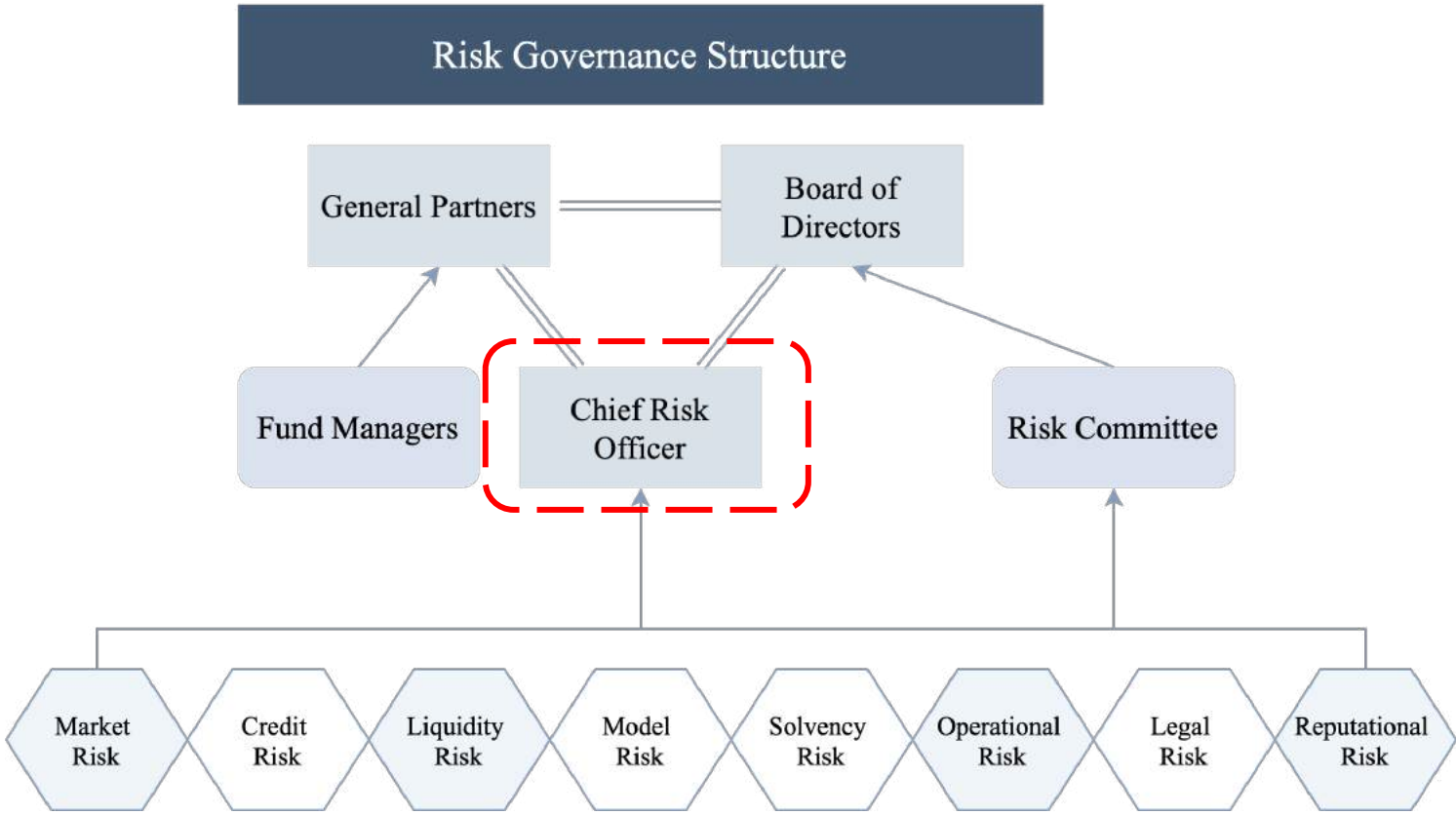
- Appointed by Board of Directors to supervise compliance of risk framework
- Establishes risk tolerance, communicates exposures, and monitors performance of Chief Risk Officer



KEY RELATIONSHIPS

CHIEF RISK OFFICER

- Approves exceptions to risk limits and monitors risk exposure on trades
- Works in conjunction with Risk Committee and Board of Directors to ensure compensation arrangements for trading teams do not encourage excessive or unnecessary risk taking
- Reports to General Partners and Board of Directors



POTENTIAL CONFLICTS

Conflicts introduced by modification to the risk governance structure:

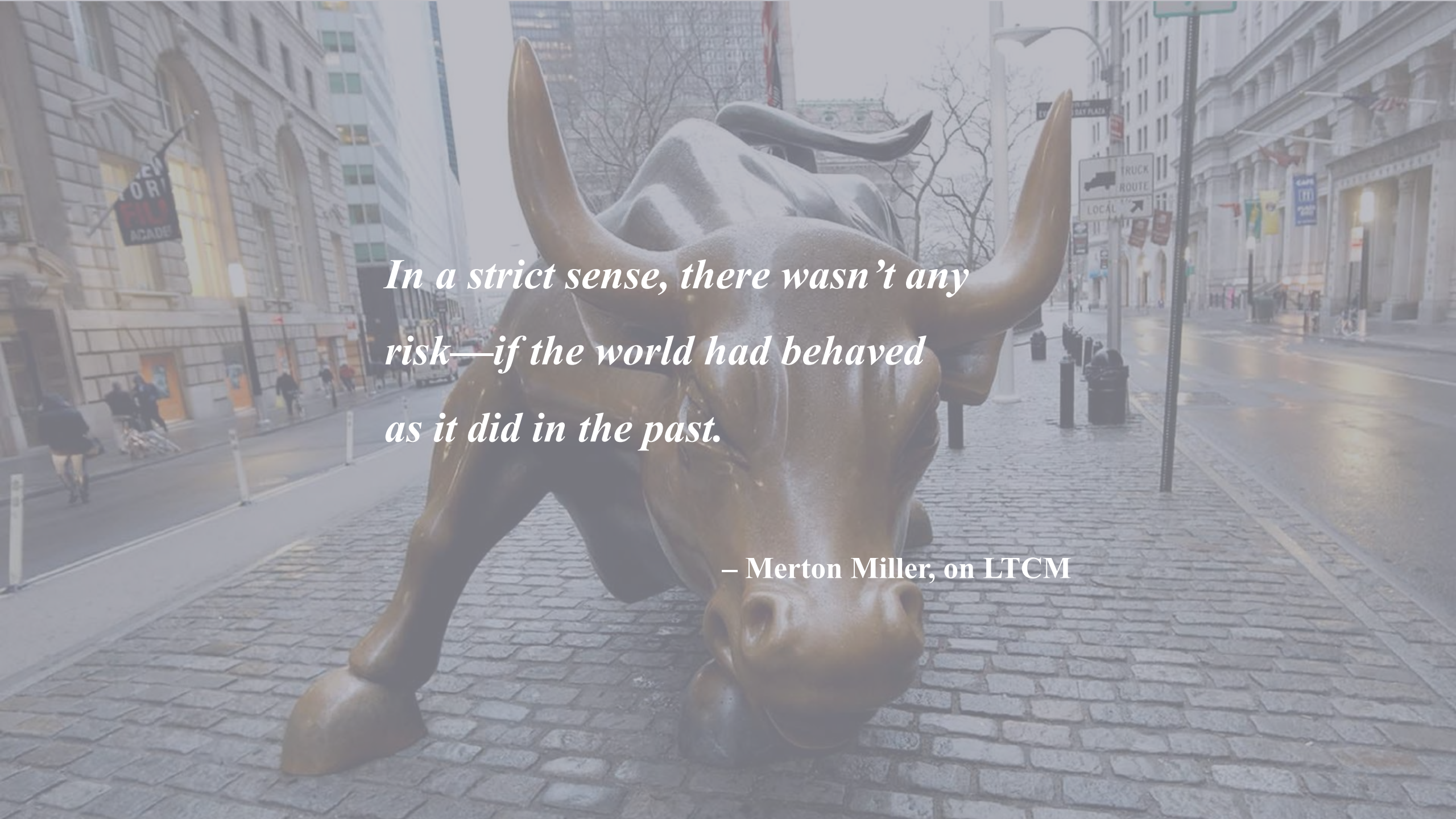
- Disagreement on trades between fund managers and risk personnel
- Risk Committee and CRO not delegated enough authority to perform duties
- Close working relationships make supervision more difficult

Conflict management and resolution:

- Good faith by GPs when establishing risk functions
- Proper “tone at the top”
- Clear guidance on risk functions’ authority and responsibilities
- Pre-established conflict resolution protocols
- External: increased acceptance of risk functions in hedge funds due to pressure from investors or better research on the topic

IN SUMMARY

- "Diversified" portfolio collectively exposed to credit, liquidity, and volatility risks
- Desperate need for liquid capital is indicative of a liquidity crisis
- Regression analysis shows the fund is vulnerable to stressed market conditions
- Liquidity strain exacerbated by the absence of CCP
- Need for a more rigorous and empowered risk governance structure



In a strict sense, there wasn't any risk—if the world had behaved as it did in the past.

– Merton Miller, on LTCM

Appendix 1: LTCM's Trading Strategies and Positions

Trades	Positions (as of August 21, 1998)
U.S. Swap spreads	Short: Long-maturity Treasury Bonds
IOs	Long: Fixed-rate residential mortgages
Commercial mortgages	Long: AAA-rated tranches of structured products backed by commercial mortgages
Differential swap-spread	Long: German, French government bonds 7-year Japanese government bonds Short: Long-maturity U.K. government bonds 10-year Japanese government bonds
Yield-curve relative-value	Pay: fixed in 3-year and 20-year swaps Receive: fixed in 7-year swaps
Fixed-income volatility	Long: 5-year options on Deutschmark-denominated interest-rate swaps
Floating-for-floating swap	Pay: lira Libor Receive: auction rate on Italian treasury bills plus 40 bp
Selling Stock-index volatility	Short: four-year put and call options on stock market indexes (mainly: S&P 500, CAC, DAX, FTSE)
Risk arbitrage	Equity risk arbitrage in merger acquisition
Other trades	e.g. Capital-structure trades, equity pairs trades

Source: Perold – Long-Term Capital Management, L.P. (C) (1999)

Appendix 2: Correlations between LTCM Trades Before and During the Crisis

BEFORE CRISIS	A	B	C	D	E	F	G	H
A	1	0.11	0.05	0.08	0.02	0.14	0.04	0.13
B	0.11	1	0.06	0	0.01	0.13	-0.07	0.05
C	0.05	0.06	1	-0.04	0.02	0.15	0.12	0.21
D	0.08	0	-0.04	1	0.07	0.04	0.05	-0.18
E	0.02	0.01	0.02	0.07	1	0.36	0.16	0.45
F	0.14	0.13	0.15	0.04	0.36	1	0.17	0.25
G	0.04	-0.07	0.12	0.05	0.16	0.17	1	0.25
H	0.13	0.05	0.21	-0.18	0.45	0.25	0.25	1

DURING CRISIS	A	B	C	D	E	F	G	H
A	1	0.04	0.79	-0.03	0.36	0.51	0.14	0.42
B	0.04	1	0.12	0.4	0.28	0.27	0.09	0.02
C	0.79	0.12	1	0.06	0.42	0.45	0.12	0.16
D	-0.03	0.4	0.06	1	0.11	0.16	-0.18	0.27
E	0.36	0.28	0.42	0.11	1	0.56	0.45	0.42
F	0.51	0.27	0.45	0.16	0.56	1	-0.05	0.42
G	0.14	0.09	0.12	-0.18	0.45	-0.05	1	0.29
H	0.42	0.02	0.16	0.27	0.42	0.42	0.29	1

A: Short U.S. Swap Spread
B: European Cross Swap Trade
C: Long Mortgage Trade
D: Japanese Box Trade
E: Short Equity Volatility Trade
F: Risk Arb Trade
G: Equity Relative-value Trade
H: Long Emerging Markets

Source: Chincarini – The Crisis of Crowding (2012)

Appendix 3: LTCM's Losses in Trades

Trades	Losses
Swaps	$1,600 million
Equity volatility	$1,300 million
Emerging markets (including Russia)	$430 million
Directional trades	$371 million
Equity pairs (e.g., Volkswagen and Shell)	$286 million
Yield curve arbitrage	$215 million
S&P 500 stocks	$203 million
Junk bond arbitrage	$100 million
Merger arbitrage	Roughly even
Total	**$4,505 million**

Source: Lowenstein - When Genius Failed (2000)

Appendix 4: Summary of Extrapolation on Returns

May 1999 - Jan 2020	∆Baa10Y	VIX	Return*
Min	-20.8%	9.5	-77.3%
Max	40.1%	59.9	25.4%
Average	0.135%	19.6	-2.0%
Std. Deviation	6.25%	7.8	10.9%

** Hypothetical Net Return of LTCM (Monthly)*

Appendix 5: Trades Under Hypothetical Stressed Scenario

Trade[a]	Trade Direction[b]	Exposure[c] (million per bp)	Inflation Adjusted Exposure[1] (million per bp)	2015 - 2020 Average Level (bp)	Intial Position[2] (bp)	YTD Maximum Loss[3] (Million)	Possible Worst Case[4] (Million)	Worst Case[5]	
								Spread / VIX	Time
Convergence Trades									
U.S. Swap Spread	Short	$ 5.00	$ 7.94	-2.37	-3.00	$ (115.06)	$ (658.61)	80.00	May 2008
Italian Swap Trade	Short	$ 0.10	$ 0.16	170.99	217.65	$ (12.13)	$ (12.13)	294.08	Apr 2018
Relative Value Trades									
Equity Volatility	Short	$ 30.00	$ 47.61	19.43	18.06	$ (1,323.56)	$ (1,688.73)	53.53	Nov 2008
U.S. Mortgage	Short	$ 10.00	$ 15.87	121.24	160.50	$ (783.98)	$ (1,640.96)	263.90	Dec 2008
Box Spread in Japan	Short	$ 3.00	$ 4.76	12.88	10.30	$ (59.99)	$ (218.05)	56.10	May 2010

a. Sample trades include: U.S. 10-year Swap Spread; Libor and Italian BOT Spread; U.S. Equity Market Volatility; U.S. 30-year Mortgage Spread; 7-year and 10-year Japanese Government Bond Spread

b. We assume LTCM would be short U.S. mortgage spread because the current level is higher than the average level of the past 5 years. Direction of other trades matches LTCM's actual positions in August 1998.

c. Exposure of Italian swap trade is estimated based on $1B notational position.

Other exposures are based on information from Perold – Long-Term Capital Management, L.P. (C) (1999).

1. Inflation conversion factor is 1.587, i.e. $100 in 1998 = $158.70 in 2020.
2. Initial position assumed for the U.S. swap spread trade is -3 bp. As LTCM usually asked for specific bond as collateral for reverse repo contract, the interest rate would be lower than the general level. The short position usually had a negative carry. Other assumed initial positions are based on those on January 1st, 2020
3. January 1st, 2020 – April 1st, 2020
4. Calculated based on historical data from 2000 to 2020
5. Spread or VIX level under the worst scenario during period 2000 – 2020

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