Lecture 10

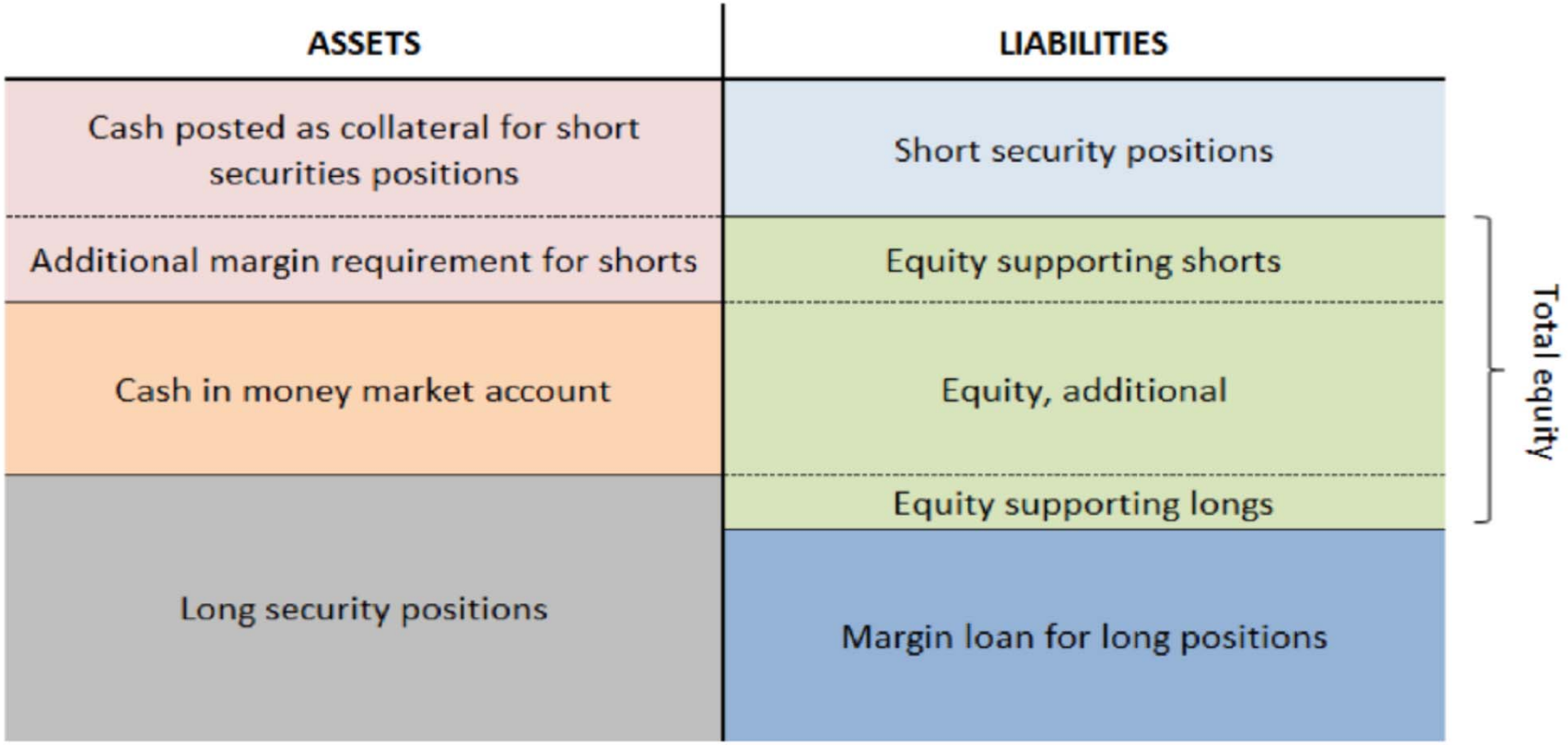
Financing Trading Positions and Managing Risk

Part 1: Financing a Trading Strategy (think hedge fund)

- Equity capital supplied by investors
- Not permanent, but withdrawal subject to lock-up and redemption notices
- Main source of leverage: collateralized loans subject to margin requirement

- Why use leverage?
- leverage = long positions/NAV [Note: NAV = fund equity]
- gross leverage = (long positions + short positions)/NAV
- net leverage = (long positions - short positions)/NAV
- Limits of leverage: margin requirements

A hedge fund's balance sheet



Mark to market, interest rates, and financing spreads

- P&L = change in equity

$$R_t^{\text{long}} \times \$\text{long} - R_t^{\text{short}} \times \$\text{short} + \text{financing}$$

where

$$\text{financing} = r_t^f \times \$\text{cash}^{mm} + r_t^{\text{rebate}} \times \$\text{cash}^{sec.lender} - r_t^{\text{PB}} \times \$\text{cash}^{PBloan}$$

- Financing spreads:
- Interest rate paid on margin loan greater than the money market rate (fed funds): $r_t^{\text{PB}} > r_t^f$.
- Interest rate earned on cash collateral supporting short positions less than money market rate: $r_t^f > r_t^{\text{rebate}}$.

Margin requirements and limits to leverage

Suppose fund can margin positions to level *m* where likelihood of negative equity in position over some brief period is 1%

- Funding a long position: margin requirement, m:

$$\text{Prob}\left(-\frac{p_{t+1}-p_t}{p_t} > m\right) = 1\%$$

- Funding a short position

$$\text{Prob}\left(\frac{p_{t+1}-p_t}{p_t} > m\right) = 1\%$$

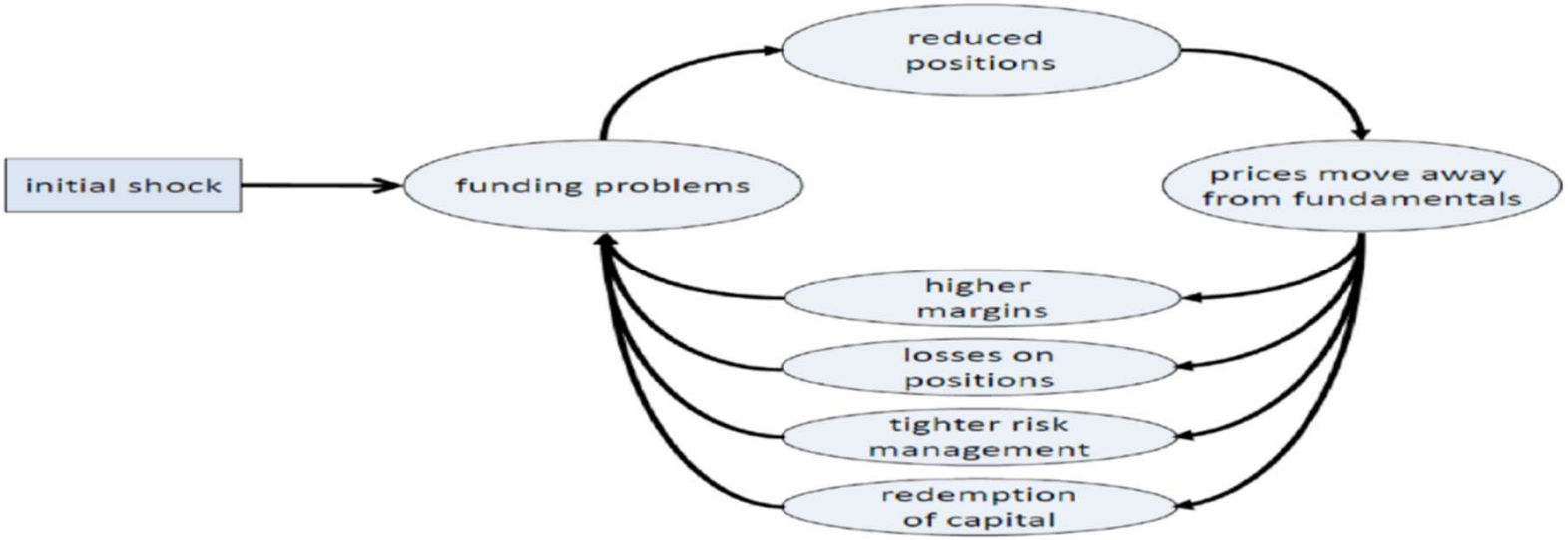
- Funding the overall portfolio

$$\sum_i m_i \times p_t^i \times \text{size}^i \leq \text{cash posted as margin} \leq \text{capital}$$

- Violating the first inequality (the portfolio's margin constraint): margin call

When Things Go Wrong

- Funding liquidity risk:
  - Risk that a hedge fund cannot fund the position throughout the life of the trade
  - Risk of being forced to unwind positions as the fund hits/nears a margin constraint or as investors pull out
- Forced liquidation very costly:
  - Tends to happen when investment opportunities are particularly good
  - Not at a random time: more likely during a liquidity spiral



When Things Go Wrong (continued)

- Forced liquidation can be very costly
- There exists a crash risk that is difficult to detect during normal trading days
- Return distributions are inherently non-normal:
  - While price changes are driven by fundamental news on most days
  - Price changes are driven by forced selling during liquidity spirals.
- Correlations across securities can suddenly change
  - During a liquidity event, the prices of securities held by traders with funding problems start to co-move, even if their fundamentals are unrelated
- Liquidity crisis is contagious
  - losses in one market can lead to fire sales in other markets, hurting more traders and spreading the crisis

The Leverage of Financial Firms

- Compared with other types of corporations, financial firms have relatively liquid balance sheets, made up largely of financial positions.
- This relative liquidity allows a typical financial firm to operate with a high degree of leverage.
- For example, major broker-dealers regulated by SEC frequently have a level of accounting capital that is close to the regulatory minimum of 8% of accounting assets, implying a leverage ratio on the order of 12-to-1.
- Ironically, in light of the relatively high degree of liquidity that fosters high leverage, a significant and sudden financial loss (or reduced access to credit) can cause dramatic illiquidity effects.

Example: Goldman Sachs in 2014

in millions	2014
Cash and cash equivalents	57,600
Cash and securities for regulatory and other purposes	51,716
Collateralized agreements:	
Repo Lending and federal funds sold	127,938
Securities borrowed	160,722
Receivables:	
Brokers, dealers and clearing organizations	30,671
Customers and counterparties	63,808
Loans receivable	28,938
Financial instruments owned	312,248
Other assets	22,599
Total assets	**856,240**

in millions	2014
Deposits	83,008
Collateralized financings	
Repo financing	88,215
Securities loaned	5,570
Other	22,809
Payables:	
Brokers, dealers and clearing organizations	6,636
Customers and counterparties	206,936
Financial instruments sold short	132,083
Unsecured short-term borrowings	44,540
Unsecured long-term borrowings	167,571
Other liabilities and accrued expenses	16,075
Total liabilities	**773,443**
Total shareholders' equity	**82,797**

Key Risks Faced by Financial Institutions

Market Risk

- Interest rate risk: changes in level, slope and curvature of yield curves, credit spreads
- Equity price risk: changes in prices and volatilities of individual equities, baskets of equities and equity indices.
- Currency rate risk: changes in spot prices, forward prices and volatilities of currency rates.
- Commodity price risk: changes in spot prices, forward prices and volatilities of commodities

Counterparty Credit Risk: failure of counterparties to fulfill contractual duties, losses in the market value due to counterparty downgrades

Liquidity Risk: the risk of increased costs, or inability to adjust financial positions

Operational Risk: fraud, systems failures, trading errors

Capital-at-Risk or Value-at-Risk

- For a typical broker-dealer or proprietary trading operation, the consequences of market risk can be experienced over relatively short time horizons; often a few weeks, if not days (or shorter)

- Discussions between regulators and their constituent financial institutions have resulted in a widely applied measure of market risk called “capital-at-risk” or “value-at-risk.”

- Fixing a confidence level p (such as 99% or 95%) and a time horizon (such as two weeks or one day), the VaR of a given portfolio measures the loss in market value that is exceeded with probability 1-p.

- A typical reporting of VaR would be the following statement: *“There is a 5% chance the bank will lose more than $5 million over the next trading week.”* p=95%, horizon = one week, and VaR=$5 million.

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Details of VAR Calculation

- Consider a portfolio consisting entirely of the S&P 500 index. The current market value of the portfolio is $100 million.
- Using the historical return data available up to day t, the EWMA model gives us a volatility forecast σ_{t+1} for the next day.
- Over this one-day horizon, the value of the portfolio will be

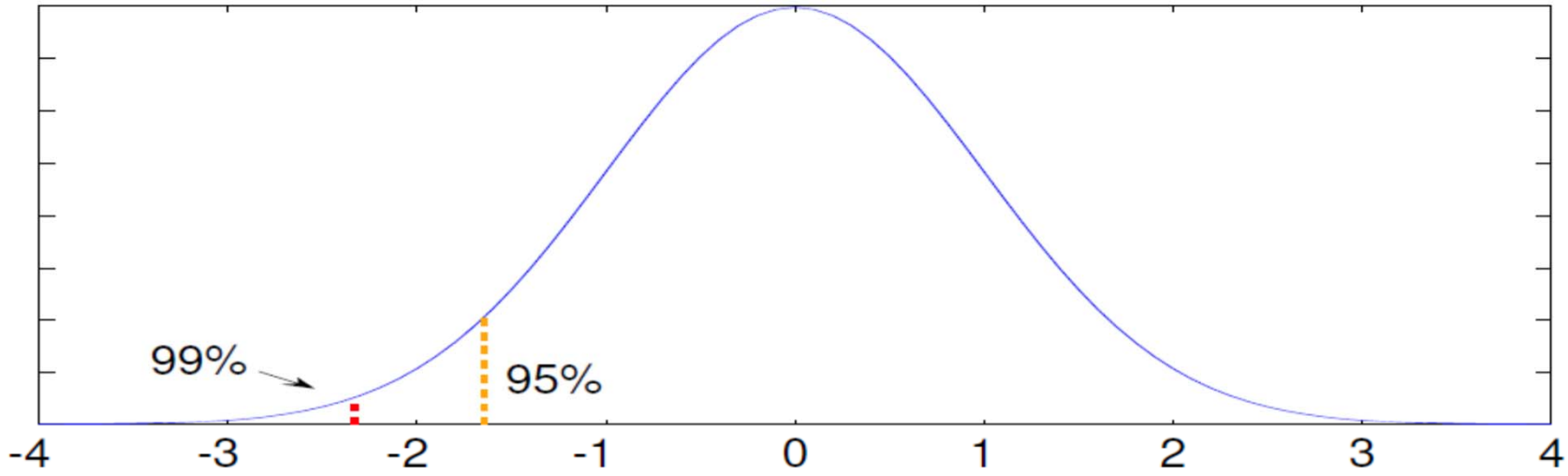
$$\$100\,\text{M} \times (1 + \tilde{R}_{t+1})$$

  where the volatility forecast for $\tilde{R}_{t+1}$ is σ_{t+1}. As discussed earlier, the mean of $\tilde{R}_{t+1}$ is negligible for the one-day horizon.
- We are interested in knowing the *distribution*, particularly the *tail distribution* of the portfolio value over the next day.

Calculating VaR (continued)

Assuming Normal Distribution

- The 99% confidence level and the 1% worse-case scenario: a -2.326 σ move away from the mean. The 95% confidence level: -1.645 σ.



- The loss in portfolio value associated with the 5% worst-case scenario:

$$\$100\text{M} \times 1.645 \times \sigma_{t+1}$$

- For daily returns on the S&P 500 index, $\sigma \approx 1\%$: VaR=\$1.645M.

Calculating VaR (continued)

- Can relax assumption of normality and consider the following
  - (a) alternative distribution that better describes future returns
  - (b) historical distribution of returns of current portfolio
  - (c) adjusted historical distribution of returns to reflect changes in risk

- Challenges
  - (a) rare tail-risk events are difficult to estimate or model, but these are the things you are most worried about!
  - (b) you may be able to uncover consensus estimates on tail risk from far out-of-the-money derivatives prices
  - (c) stress tests and scenario analyses may help (yield curve shift, etc.)
  - (d) at the portfolio level understanding the covariance matrix of component assets will be important

Gaming the VaR: Here is a portfolio that may appear to generate positive alpha at low risk if careful detective work is not done: Large position in a market index and a short position in out-of-the-money index call options

Views on VaR *Excerpts from "Risk Mismanagement"*

- *"VaR is a useful tool. The more liquid the asset, the better the tool. The more history, the better the tool. The less of both, the worse it is. It helps you understand what you should expect to happen on a daily basis in an environment that is roughly the same." — David Viniar, CFO, Goldman.*

- *"VaR is a peacetime statistic" — Aaron Brown, Risk Manager, AQR*

- *"Relatively useless as a risk-management tool and potentially catastrophic when its use creates a false sense of security among senior managers and watchdogs. This is like an air bag that works all the time, except when you have a car accident."* — David Einhorn, Greenlight Capital.

VaR for Internal and External Monitoring of Risk Exposures

- By now, VaR has become an industry standard to measure market risk.
- SEC requires firms to include a quantitative disclosure of market risks in their financial statements and VaR becomes the main tool for doing so.
- Risk managers use VaR to quantify their firm's risk positions to their board. Top executives usually know their firm's daily VaR within minutes of the market's close.
- This timely aggregation of individual traders' risk into firmwide risk could be an extremely valuable signal for the top management
- VaR also used in regulating financial institutions
- Alternative measures may also be useful:

$$\text{Expected Shortfall} = ES = E(\text{loss} \mid \text{loss} > VaR)$$