Seminar 1
Financial Intermediary Balance Sheet Management

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Balance Sheet Arithmetic for Passive Investor

- Household balance sheet

Assets	Liabilities
House, 100	Equity, 10 Mortgage, 90

$$\text{Leverage} = \frac{\text{Assets}}{\text{Equity}} = 10$$

- Assume that the market value of debt is constant at 90.

$$L = \frac{A}{A - 90}$$

- Leverage is inversely related to total assets:

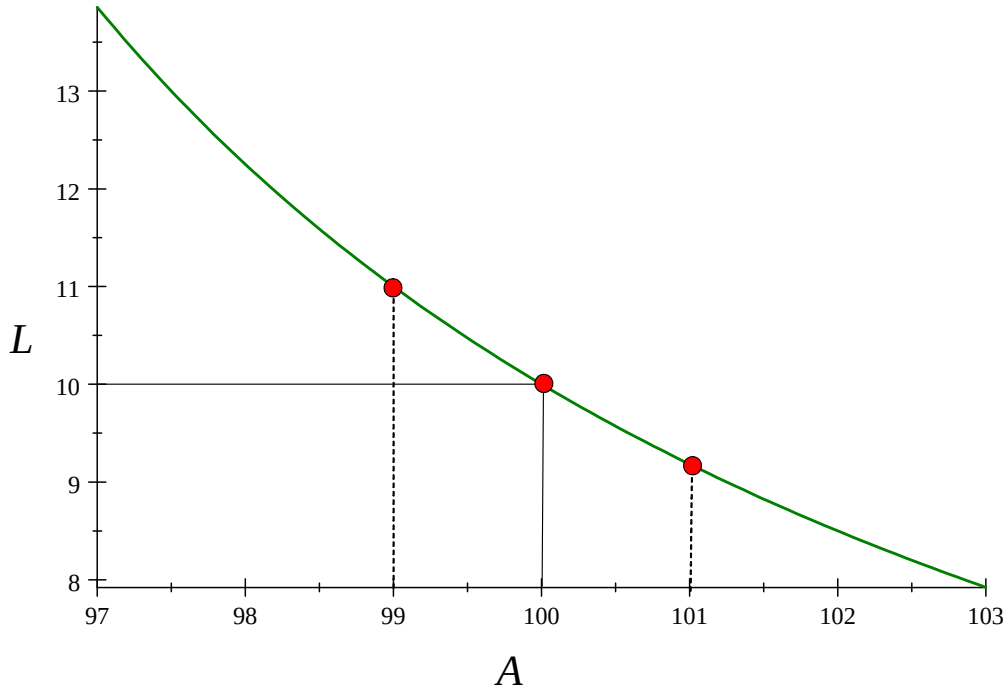
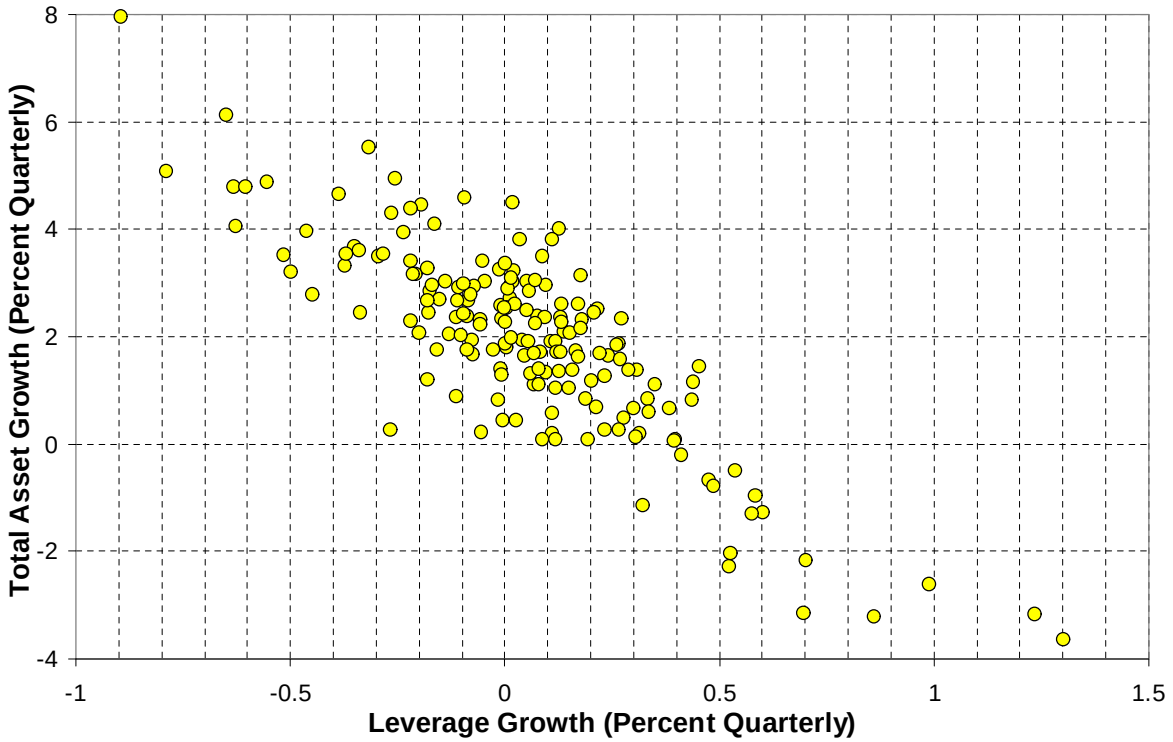


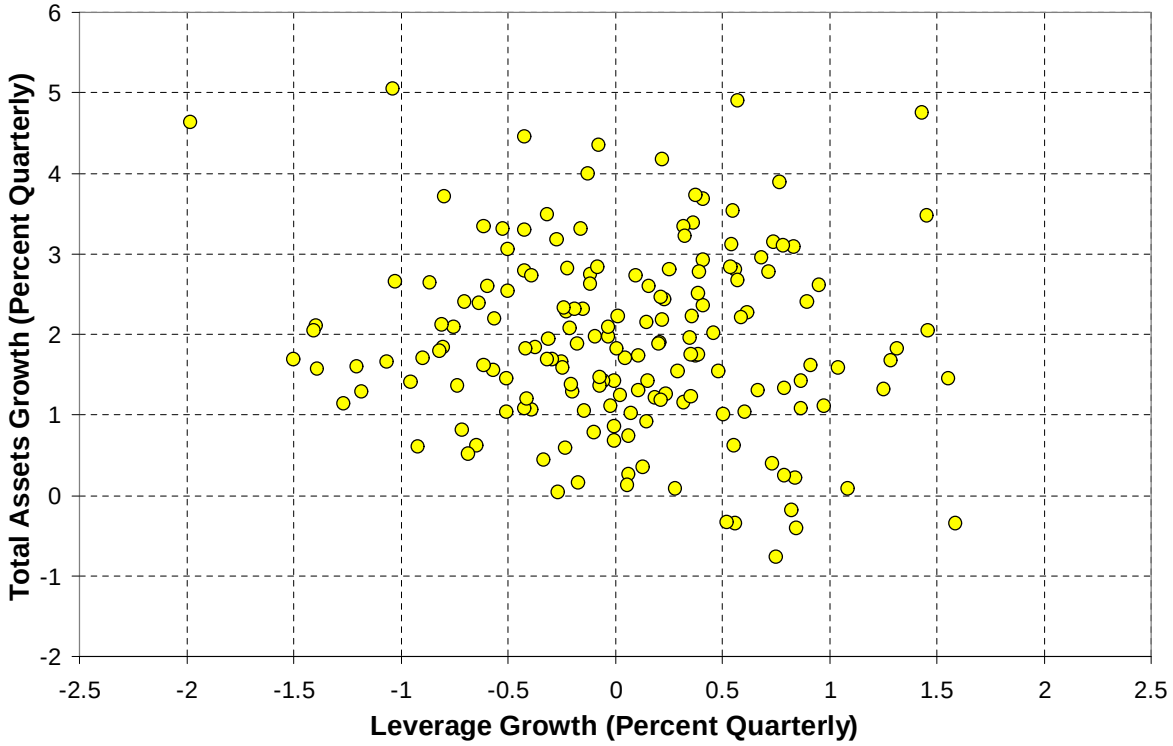
Figure 1: Leverage of Passive Investor

Balance Sheet Size and Leverage: Households



Non-Financial, Non-Farm Corporations

Figure 2:



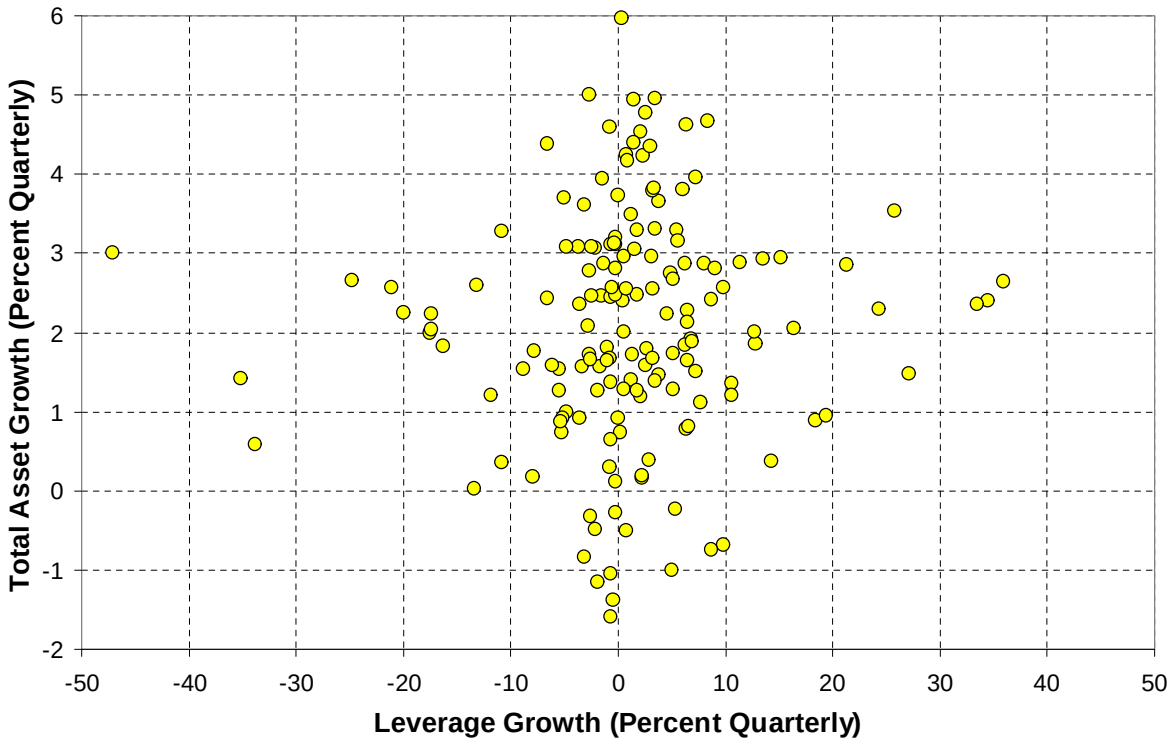
Financial Institutions

Financial institutions *actively manage balance sheets* so as

- to meet Value-at-Risk constraints
- to meet performance measures such as return on equity (ROE).
- to hit desired credit ratings
- meet regulatory requirements

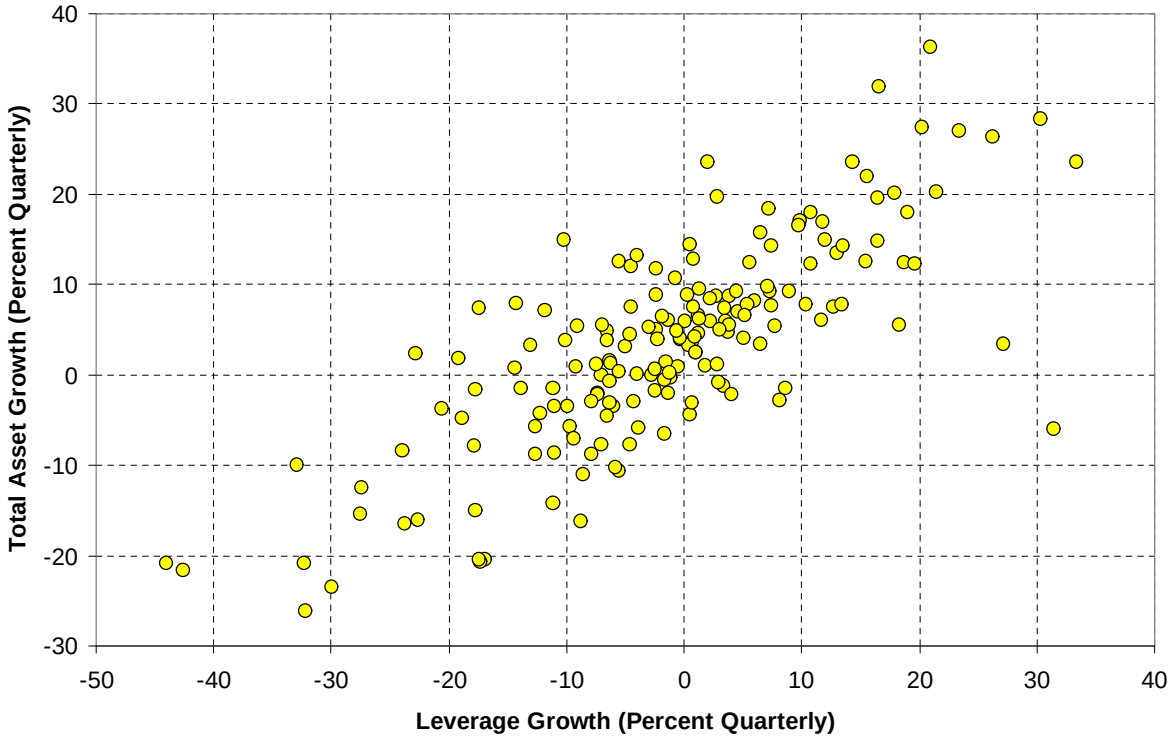
What are the consequences?

Commercial Banks



Security Dealers and Brokers

Figure 3:



Wall Street Investment Banks

Name	Sample
Bear Stearns	1997 Q1 – 2008 Q1
Goldman Sachs	1999 Q2 – 2008 Q1
Lehman Brothers	1993 Q2 – 2008 Q1
Merrill Lynch	1991 Q1 – 2008 Q1
Morgan Stanley	1997 Q2 – 2008 Q1

Wall Street Investment Banks

Why investment banks?

- Their balance sheet is very close to the ideal of being continuously marked to market.
  - Stylized balance sheet of an investment bank:

Assets	Liabilities
Trading assets	Short positions
Reverse repos	Repos
Other assets	Long term debt
	Shareholder equity

- They are a significant part of financial system, both in quantities and impact through prices

CONSOLIDATED STATEMENT OF FINANCIAL CONDITION

IN MILLIONS NOVEMBER 30	2005	2004
ASSETS		
Cash and cash equivalents	**$ 4,900**	$ 5,440
Cash and securities segregated and on deposit for regulatory and other purposes	**5,744**	4,085
Financial instruments and other inventory positions owned:		
(includes $36,369 in 2005 and $27,418 in 2004 pledged as collateral)	**177,438**	144,468
Securities received as collateral	**4,975**	4,749
Collateralized agreements:		
Securities purchased under agreements to resell	**106,209**	95,535
Securities borrowed	**78,455**	74,294
Receivables:		
Brokers, dealers and clearing organizations	**7,454**	3,400
Customers	**12,887**	13,241
Others	**1,302**	2,122
Property, equipment and leasehold improvements		
(net of accumulated depreciation and amortization of $1,448 in 2005		
and $1,187 in 2004)	**2,885**	2,988
Other assets	**4,558**	3,562
Identifiable intangible assets and goodwill		
(net of accumulated amortization of $257 in 2005 and $212 in 2004)	**3,256**	3,284
Total assets	**$410,063**	$357,168

See Notes to Consolidated Financial Statements.

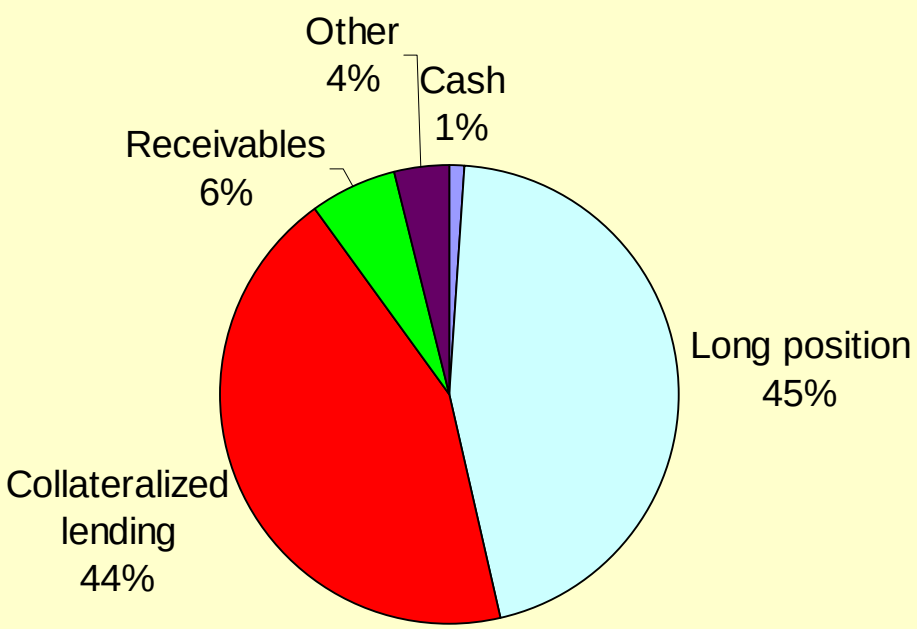
CONSOLIDATED STATEMENT OF FINANCIAL CONDITION

(continued)

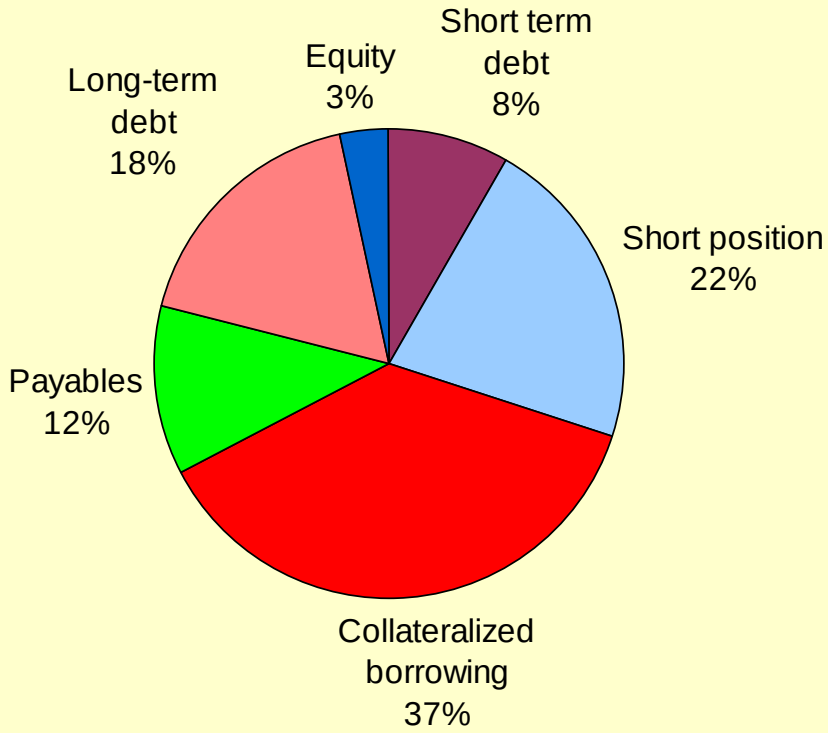
IN MILLIONS, EXCEPT PER SHARE DATA NOVEMBER 30	2005	2004
LIABILITIES AND STOCKHOLDERS' EQUITY		
Short-term borrowings	**$ 2,941**	$ 2,857
Financial instruments and other inventory positions sold but not yet purchased	**110,577**	96,281
Obligation to return securities received as collateral	**4,975**	4,749
Collateralized financings:		
Securities sold under agreements to repurchase	**116,155**	105,956
Securities loaned	**13,154**	14,158
Other secured borrowings	**23,116**	11,621
Payables:		
Brokers, dealers and clearing organizations	**1,870**	1,705
Customers	**47,210**	37,824
Accrued liabilities and other payables	**10,962**	10,611
Long-term borrowings	**62,309**	56,486
Total liabilities	**393,269**	342,248
Commitments and contingencies		
STOCKHOLDERS' EQUITY		
Preferred stock	**1,095**	1,345
Common stock, $0.10 par value;		
Shares authorized: 600,000,000 in 2005 and 2004;		
Shares issued: 302,668,973 in 2005 and 297,796,197 in 2004;		
Shares outstanding: 271,437,103 in 2005 and 274,159,411 in 2004	**30**	30
Additional paid-in capital	**6,314**	5,865
Accumulated other comprehensive income (net of tax)	**(16)**	(19)
Retained earnings	**12,198**	9,240
Other stockholders' equity, net	**765**	741
Common stock in treasury, at cost: 31,231,870 shares in 2005 and		
23,636,786 shares in 2004	**(3,592)**	(2,282)
Total common stockholders' equity	**15,699**	13,575
Total stockholders' equity	**16,794**	14,920
Total liabilities and stockholders' equity	**$410,063**	$357,168

See Notes to Consolidated Financial Statements.

Lehman Balance Sheet (2007)

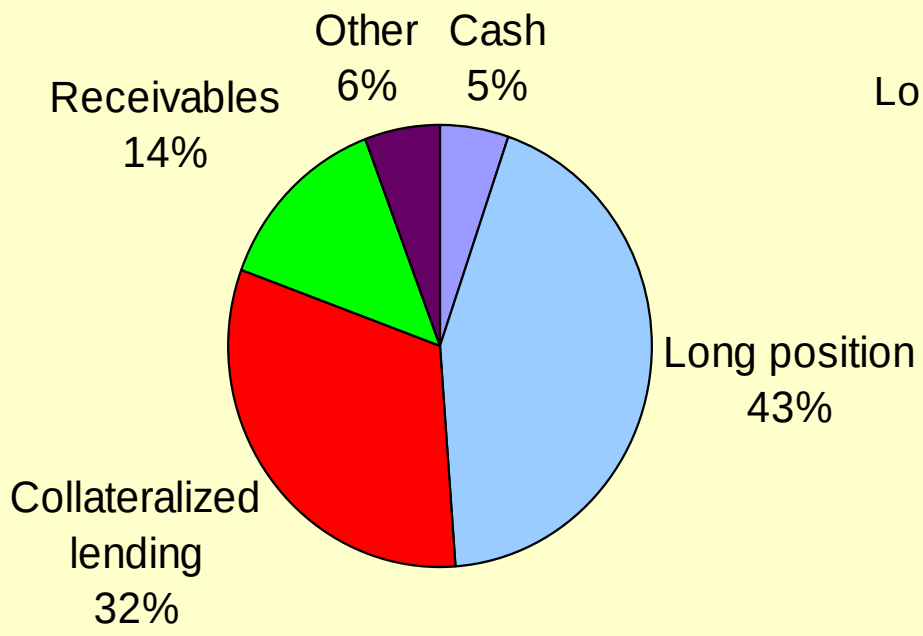


Assets

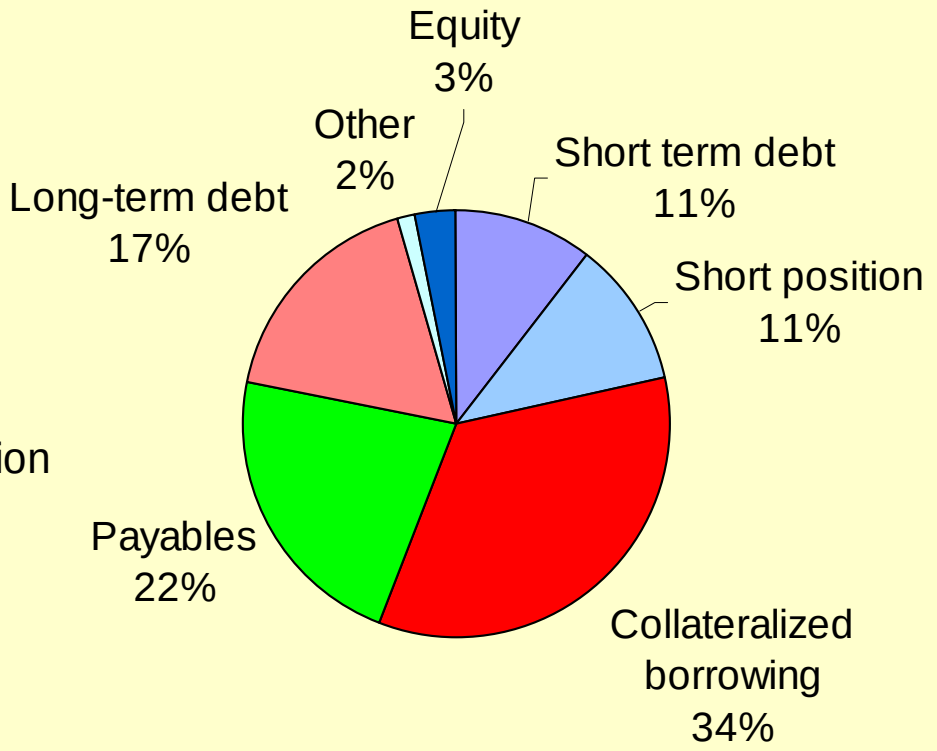


Liabilities

Bear Stearns Balance Sheet (2007)



Assets

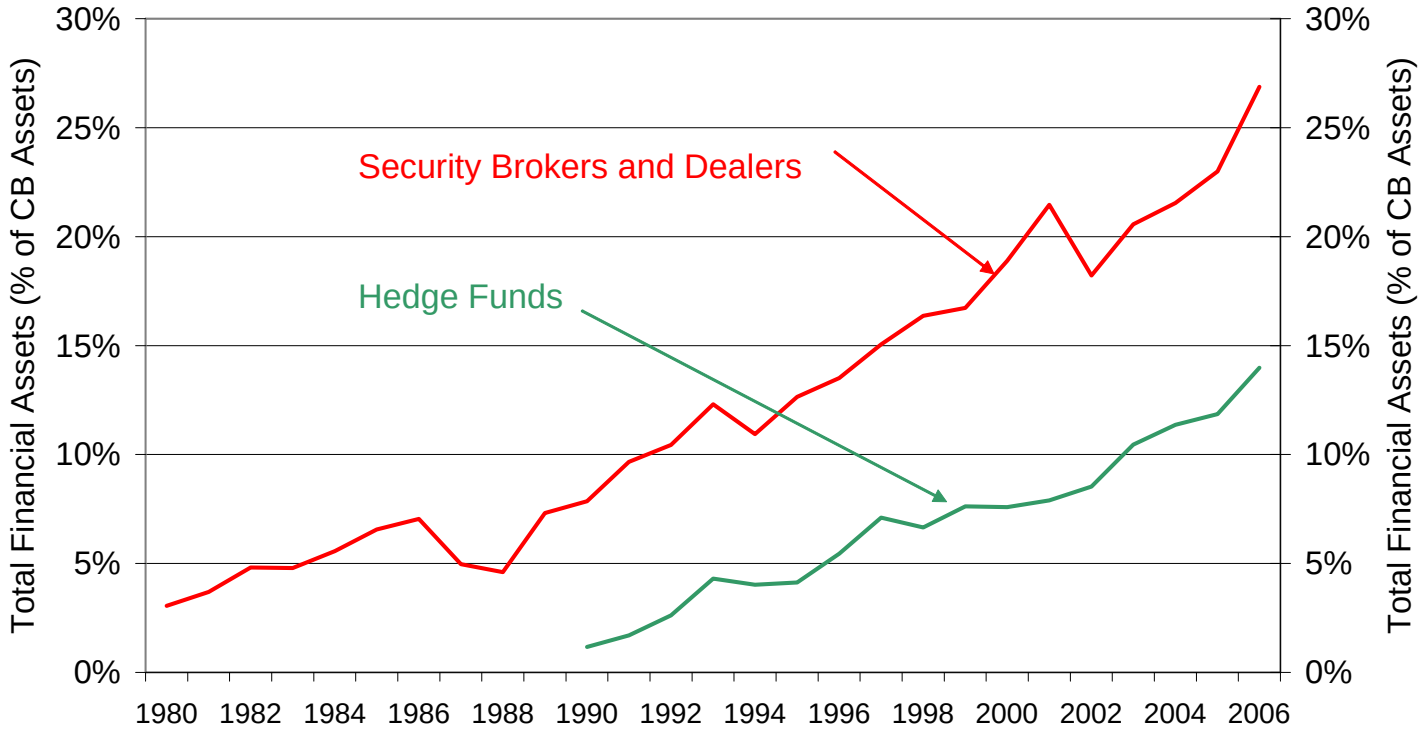


Liabilities

Figure 4:

Total Financial Assets of Financial Intermediaries

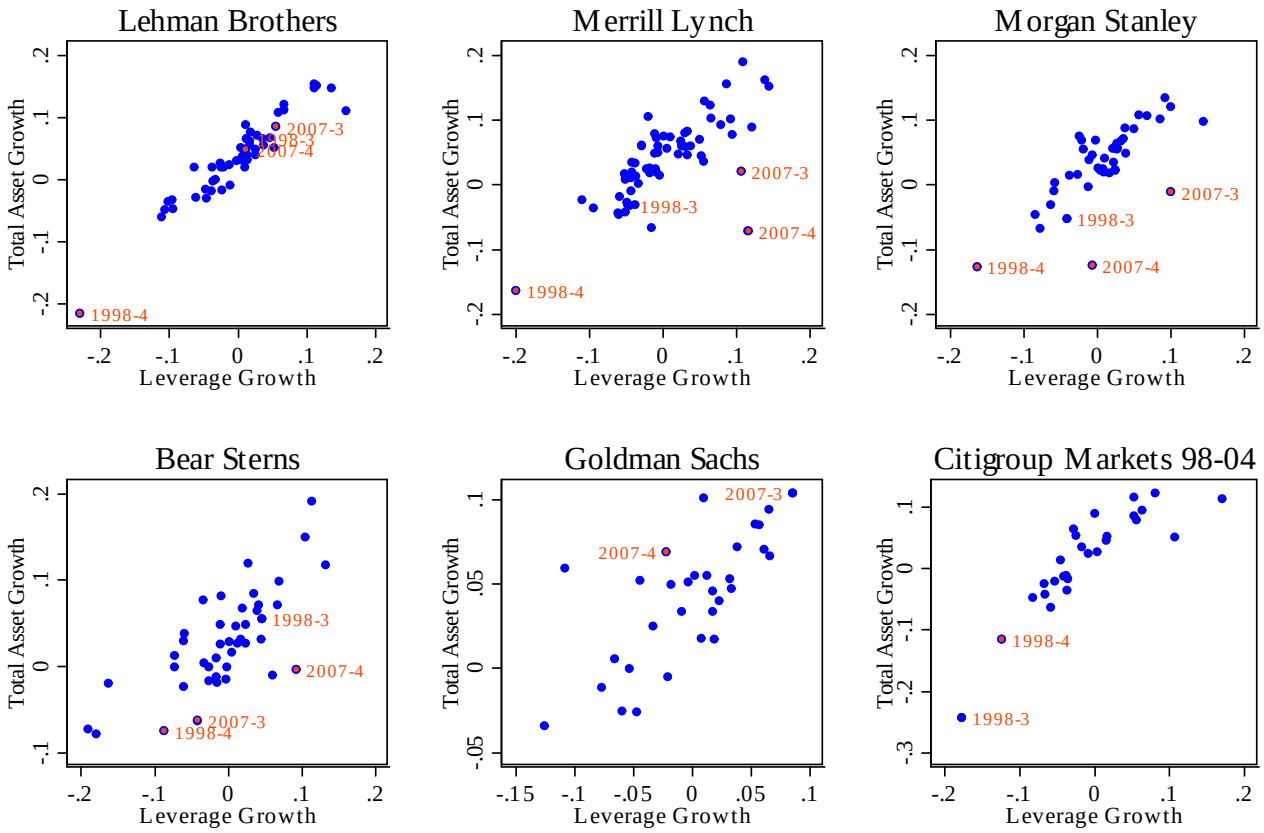
as % of Commercial Bank Total Assets

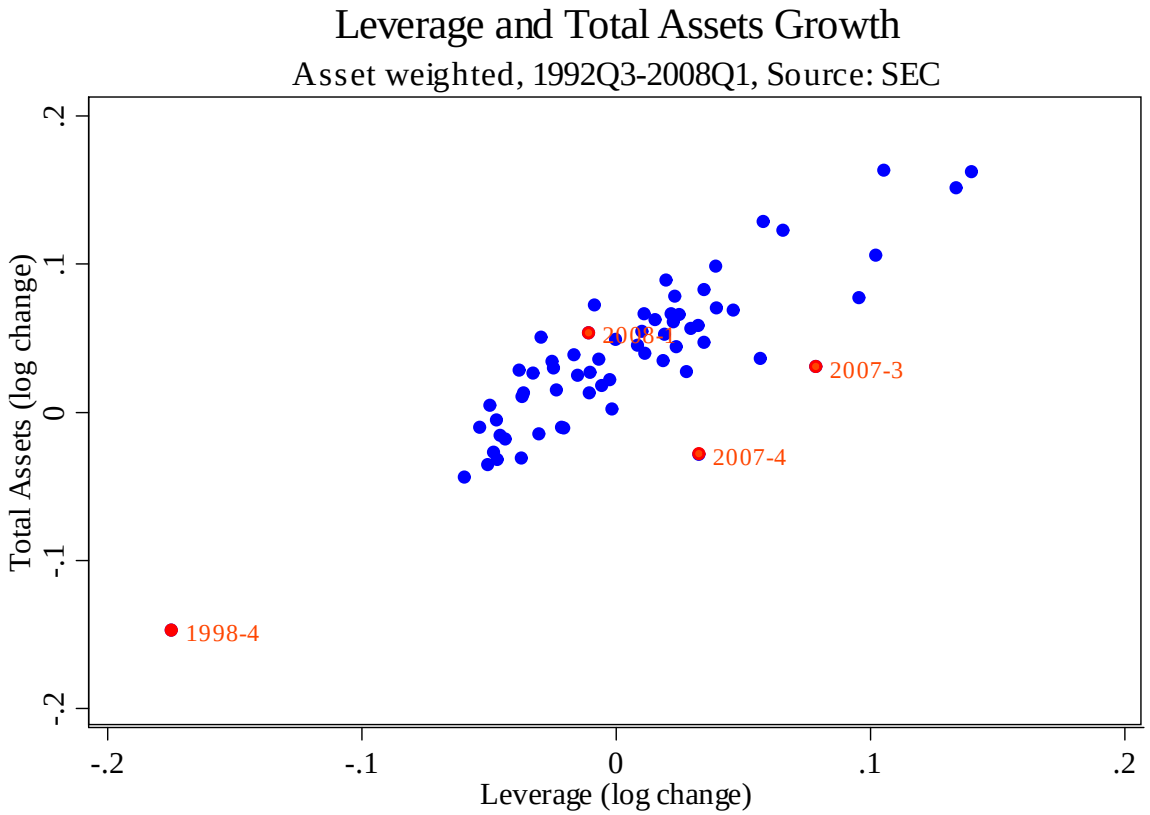


Source:
Total financial assets of Security Brokers and Dealers are from table L.129 of the Flow of Funds, Board of Governors of the Federal Reserve.
Total financial assets of Bank Holding Companies are from table L.112 of the Flow of Funds, Board of Governors of the Federal Reserve.
Total Assets Under Management of Hedge Funds are from HFR.

US Investment Banks

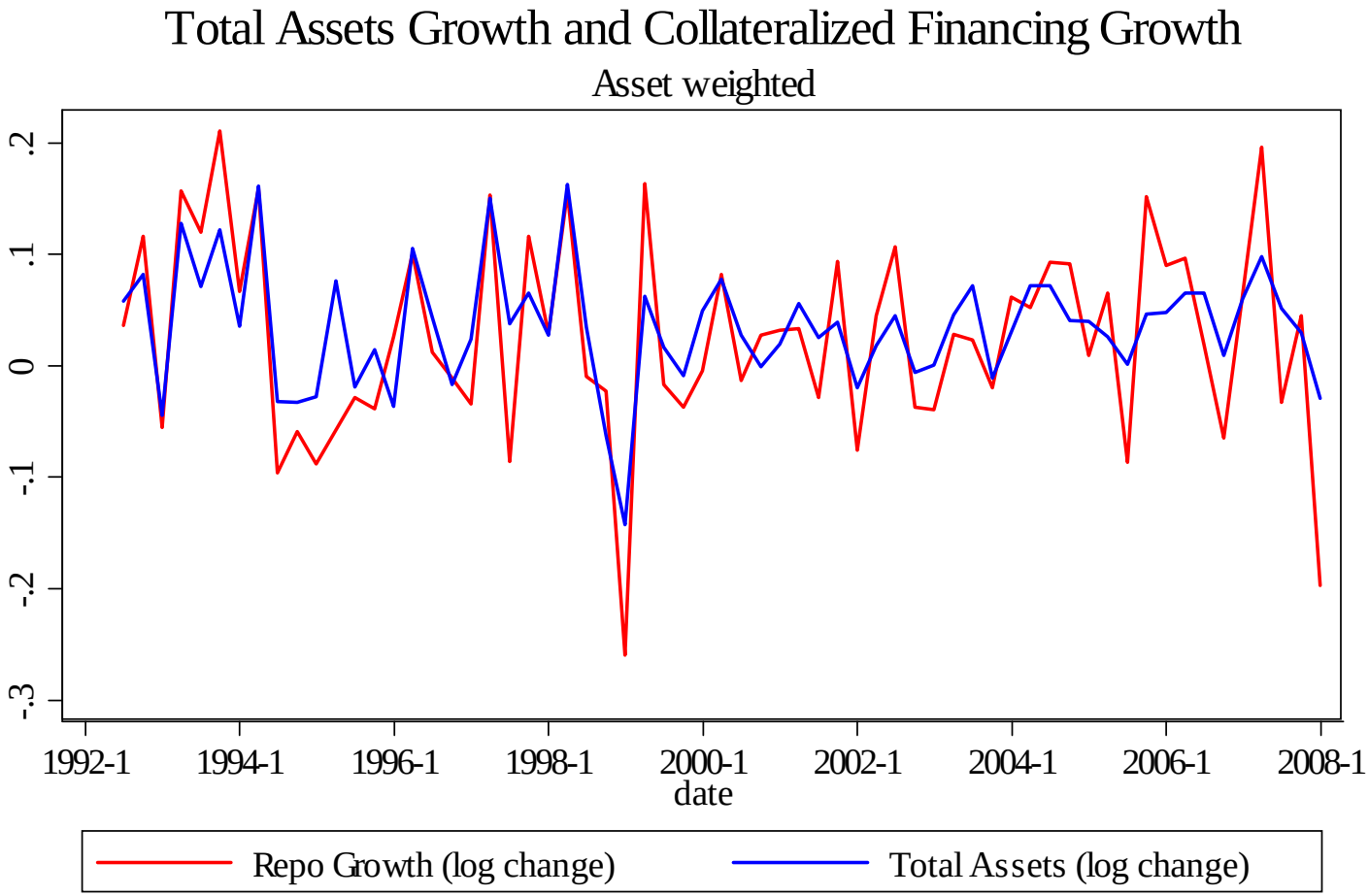
Total Assets and Leverage



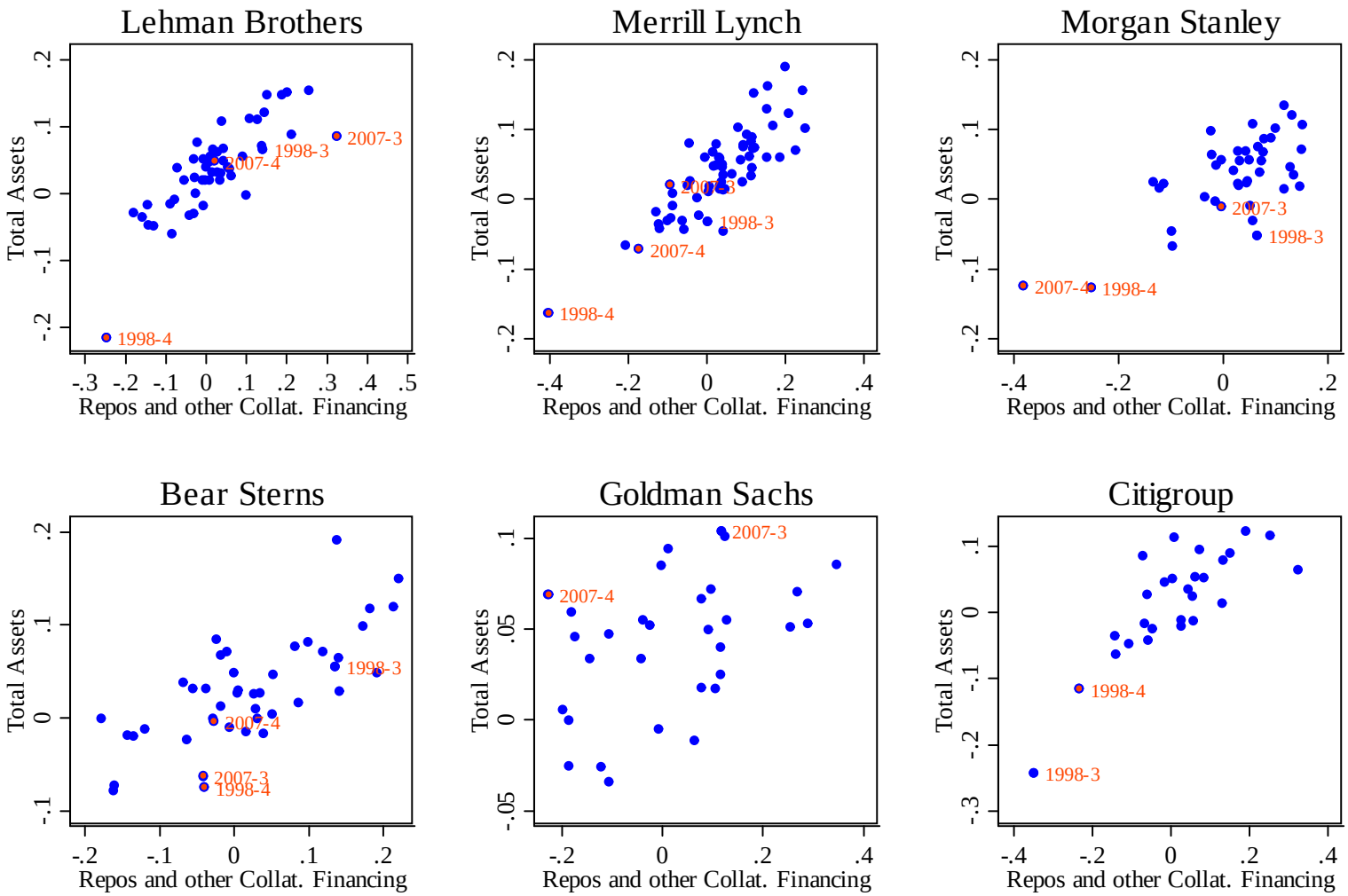

Leverage and Total Assets Growth
Asset weighted, 1992Q3-2008Q1, Source: SEC
Total Assets (log change)
.2
.1
0
-.1
-.2
-.2
-.1
0
.1
.2
Leverage (log change)
2007-3
2007-4
1998-4

Margin of Adjustment

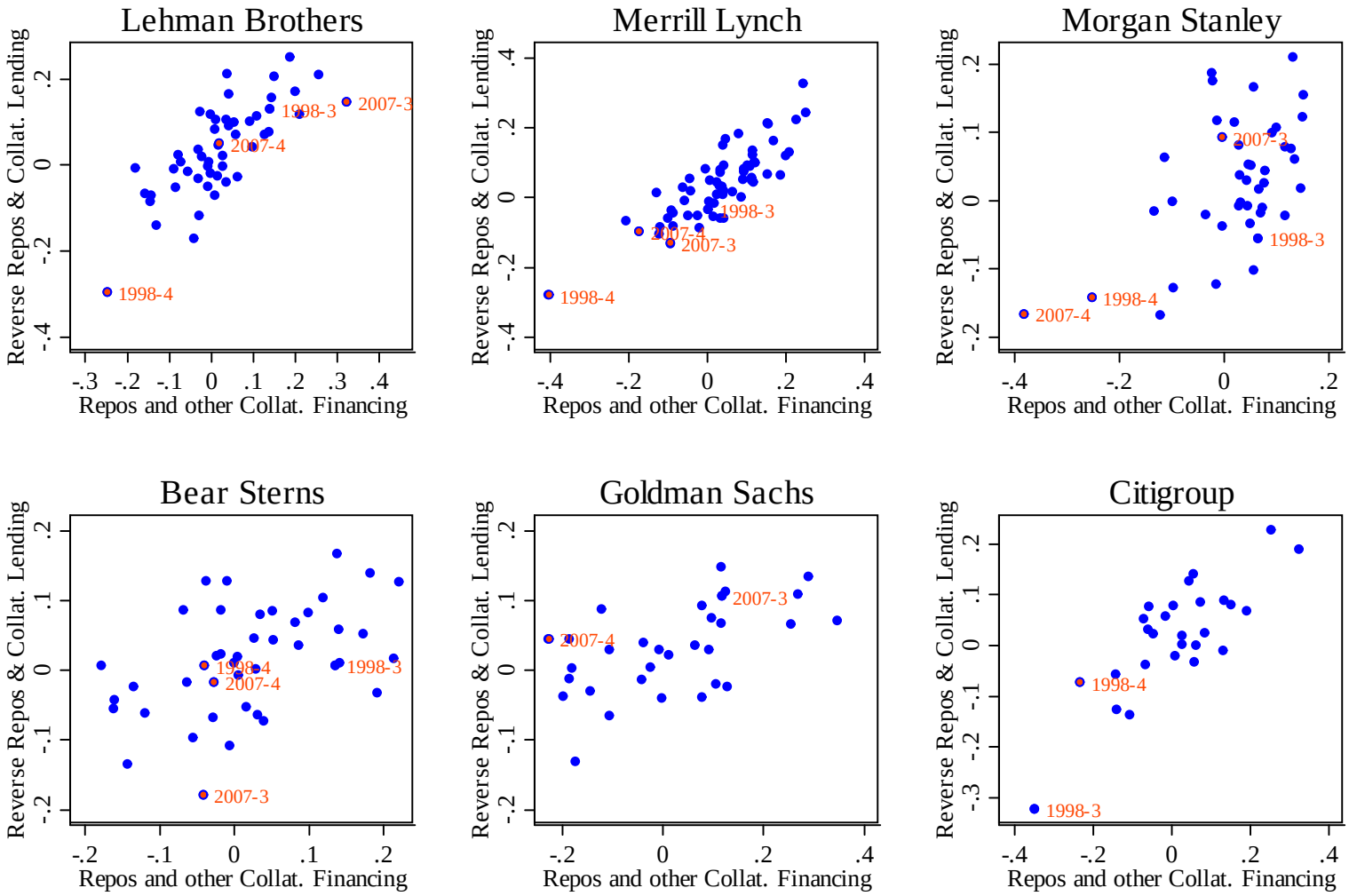
- Total assets and leverage move together.
- Repos are the margin of adjustment.
- Repos are the cheapest form of taking on debt (and hence leverage).


Total Assets Growth and Collateralized Financing Growth
Asset weighted
.2
.1
0
-.1
-.2
-.3
1992-1
1994-1
1996-1
1998-1
2000-1
2002-1
2004-1
2006-1
2008-1
date
Repo Growth (log change)
Total Assets (log change)

Total Assets and Repos



Repos and Reverse Repos



Value at Risk

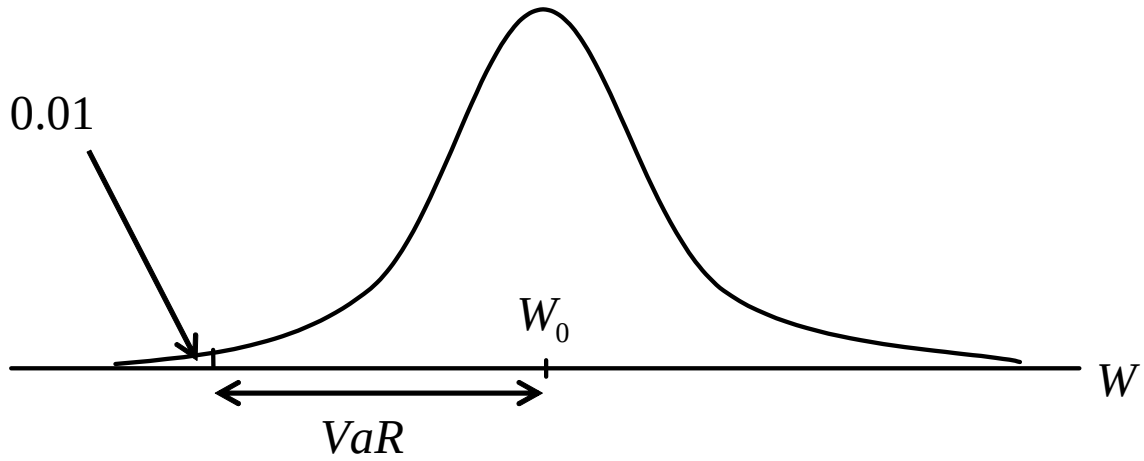
Informally speaking, *Value-at-Risk* is motivated by the question:

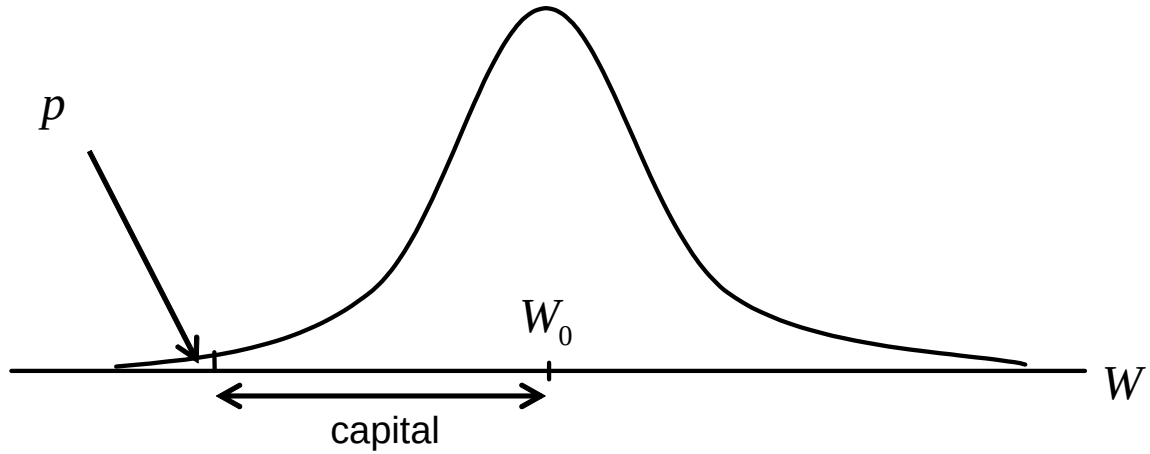
> "*What (realistically) is the worst that could happen over one day, one week, or one year?*"

Definition. Let W be a random variable. The **value at risk** at confidence level c relative to base level W_0 is the smallest non-negative number denoted by VaR such that

$$\text{Prob}\,(W < W_0 - \text{VaR}) \leq 1 - c$$

Example. W is the market value of assets of the firm at some fixed date in the future, and W_0 is today's assets. If the firm has capital (equity) equal to value at risk, it will remain solvent with probability c.


0.01
W_0
W
VaR


p
W_0
W
capital

Portfolio Choice under VaR

Investor forms a portfolio consisting of two assets - a risky security and cash.

Price of risky security at date t is p_t

Units of the risky security held by the investor is y_t,

Cash at date t is denoted by c_t.

$\tilde{r}_{t+1}$ is return from date t to date $t+1$

$$p_{t+1} = (1 + \tilde{r}_{t+1})\, p_t$$

For now, assume $\tilde{r}_{t+1}$ i.i.d. with mean $\mu > 0$ and variance σ^2.

Capital (equity, net worth) e_t.

Three Possible Balance Sheets

Leveraged long position

Assets	Liabilities
Securities $p_t y_t$	Equity e_t Debt $-c_t$

Leverage is

$$\frac{p_t y_t}{e_t}$$

Short position

Assets	Liabilities
Cash c_t	Equity e_t Securities $-p_t y_t$

Leverage is

$$\frac{e_t - p_t y_t}{e_t}$$

Long-only

Assets	Liabilities
Cash c_t Securities $p_t y_t$	Equity e_t

Balance sheet identity:

$$p_t y_t + c_t = e_t$$

New value of capital e_{t+1} is

$$\begin{aligned} e_{t+1} &= p_{t+1}y_t + c_t \\ &= p_{t+1}y_t + e_t - p_t y_t \\ &= (p_{t+1} - p_t)\, y_t + e_t \\ &= [(1 + \tilde{r}_{t+1})\, p_t - p_t]\, y_t + e_t \\ &= \tilde{r}_{t+1} p_t y_t + e_t \end{aligned}$$

Investor has a period-by-period decision problem

Objective at date t is to maximize the expected return on capital from date t to date $t+1$, subject only to Value-at-Risk constraint.

Confidence level associated with the VaR constraint be α.

At each date, investor keeps ehough capital so that probability of insolvency is at most $1 - \alpha$.

The investor becomes insolvent if $e_{t+1} \leq 0$. This happens when the return on the risky security is sufficiently bad so that $\tilde{r}_{t+1} p_t y_t + e_t \leq 0$, or

$$\tilde{r}_{t+1} \leq -\frac{e_t}{p_t y_t}$$

Smaller is the initial equity level e_t or the larger is the initial holding y_t, the greater is the chance of going bust.

ϕ defined as

$$\text{Prob } (\tilde{r}_{t+1} \leq \mu - \phi\sigma) = 1 - \alpha \tag{1}$$

$\phi\sigma$ is the Value-at-Risk for the risky return $\tilde{r}_{t+1}$ at the confidence level α relative to the mean return μ.

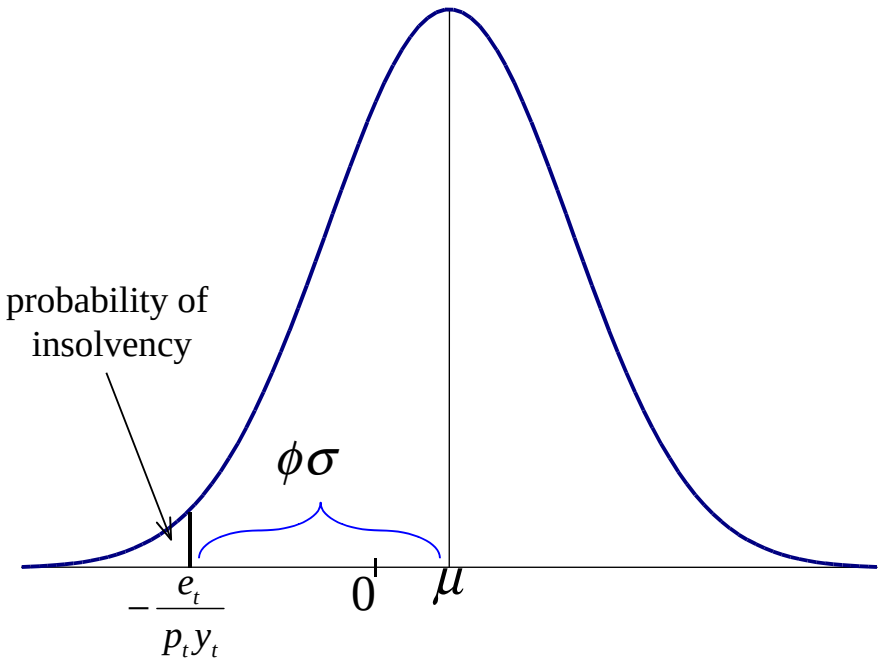


Figure 5: Probability density of $\tilde{r}_{t+1}$

By choosing the size of the holding of the risky asset y_t, the investor can ensure that the probability of his becoming insolvent next period is kept at most $1 - \alpha$.

From Figure 5 probability of insolvency is exactly $1-\alpha$ when

$$\mu + \frac{e_t}{p_t y_t} = \phi\sigma \tag{2}$$

Solving for the dollar value of the risky security position, we have

$$p_t y_t = \frac{e_t}{\phi\sigma - \mu} \tag{3}$$

The investor cannot hold any more than this amount of the risky security, since then the probability of insolvency rises above the threshold value $1-\alpha$, thereby violating his Value-at-Risk constraint.

Will the investor hold any less? No, since $\mu > 0$ so that

$$E\left(e_{t+1}\right) = \mu p_t y_t + e_t \tag{4}$$

Expected equity value next period is strictly increasing in y_t

Leverage is

$$L = \frac{p_t y_t}{e_t} = \frac{1}{\phi\sigma - \mu}$$

Given our assumption of constant μ and σ, leverage is also constant.

Characterize portfolio decision is one of maintaining constant leverage in the face of price changes.

Proportional change in equity is

$$\frac{e_{t+1} - e_t}{e_t} = \tilde{r}_{t+1} \frac{p_t y_t}{e_t} = \tilde{r}_{t+1} \cdot L \tag{5}$$

Proportional change in total assets as a consequence of the price change (but before the portfolio adjustment) is

$$\frac{p_{t+1} y_t - p_t y_t}{p_t y_t} = \tilde{r}_{t+1} \tag{6}$$

Comparing (5) and (6), equity rises L-times faster than total assets.

Constant leverage implies

$$\frac{p_t y_t}{e_t} = \frac{p_{t+1} y_{t+1}}{e_{t+1}} = L \tag{7}$$

Hence

$$\frac{y_{t+1}}{y_t} = \frac{e_{t+1}/e_t}{p_{t+1}/p_t} = \frac{1 + \tilde{r}_{t+1} \cdot L}{1 + \tilde{r}_{t+1}} \tag{8}$$

Proportional increase in the holding of the risky security can be expressed as a function of the return on the risky asset $\tilde{r}_{t+1}$ and the degree of leverage L.

$$\frac{y_{t+1} - y_t}{y_t} = \frac{\tilde{r}_{t+1}}{1 + \tilde{r}_{t+1}} \cdot (L - 1) \tag{9}$$

Price response is upward-sloping in the return $\tilde{r}_{t+1}$.

The higher is the target leverage L maintained by the investor, the steeper is the demand response to price changes.

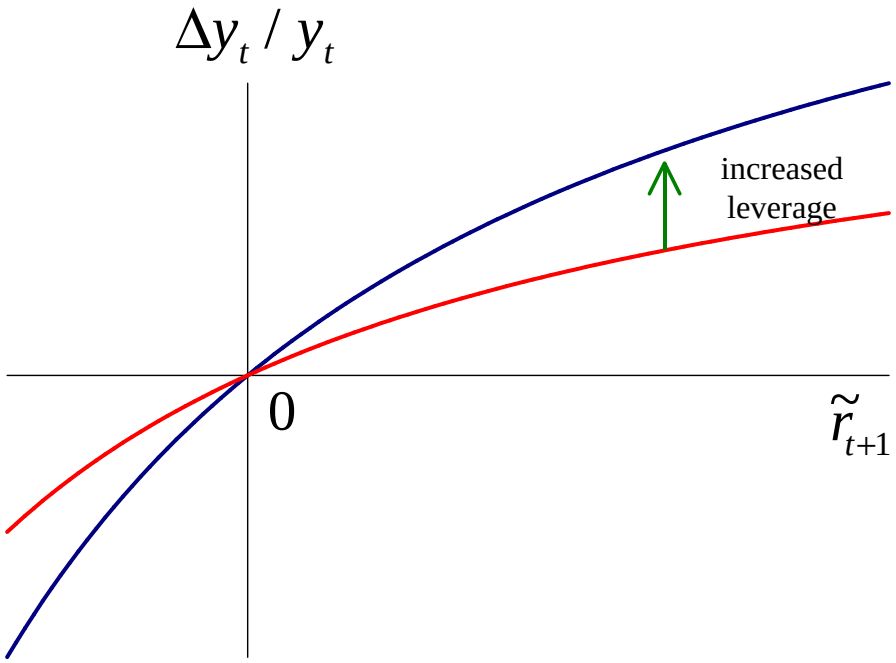


Figure 6: Upward-sloping demand response to $\tilde{r}_{t+1}$

Numerical Example

Initial balance sheet

Assets	Liabilities
Securities, 100	Equity, 10
	Debt, 90

Assume price of debt approximately constant. Suppose the security price increases by 1% to 101.

Assets	Liabilities
Securities, 101	Equity, 11
	Debt, 90

Leverage falls to

$$\frac{101}{11} = 9.18$$

If bank targets **constant leverage**, it must take on additional debt of D to purchase D worth of securities on the asset side so that

$$\frac{\text{assets}}{\text{equity}} = \frac{101 + D}{11} = 10$$

The solution is $D = 9$. In other words, the bank takes on additional debt worth 9, and with this money purchases securities worth 9.

The demand curve is upward-sloping.

The new balance sheet looks like this.

Assets	Liabilities
Securities, 110	Equity, 11
	Debt, 99

The leverage is now back up to 10.

The mechanism works in reverse, too. Suppose there is shock to the security price so that

Assets	Liabilities
Securities, 109	Equity, 10
	Debt, 99

Leverage is too high $(109/10 = 10.9)$.

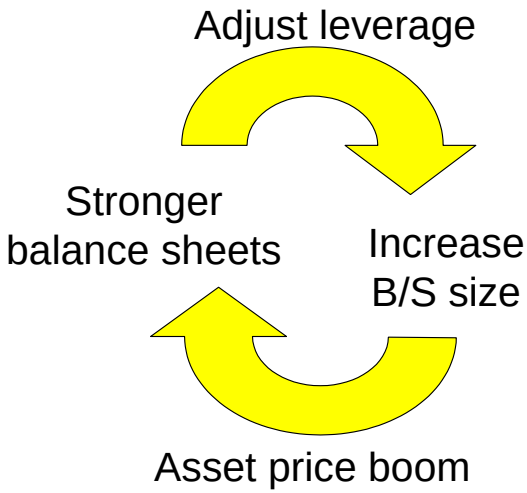
Sell securities worth 9, paydown debt of 9.

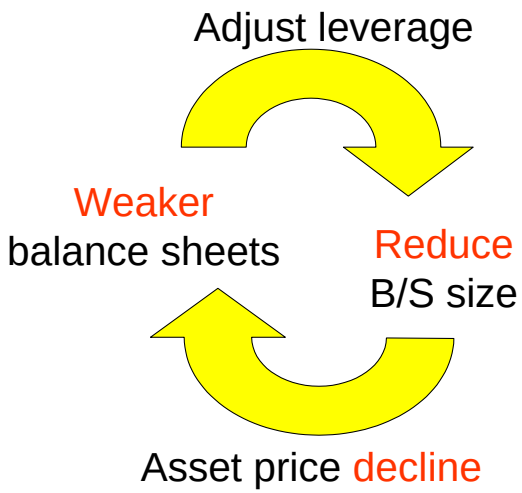
Assets	Liabilities
Securities, 100	Equity, 10
	Debt, 90

Back to leverage of 10.

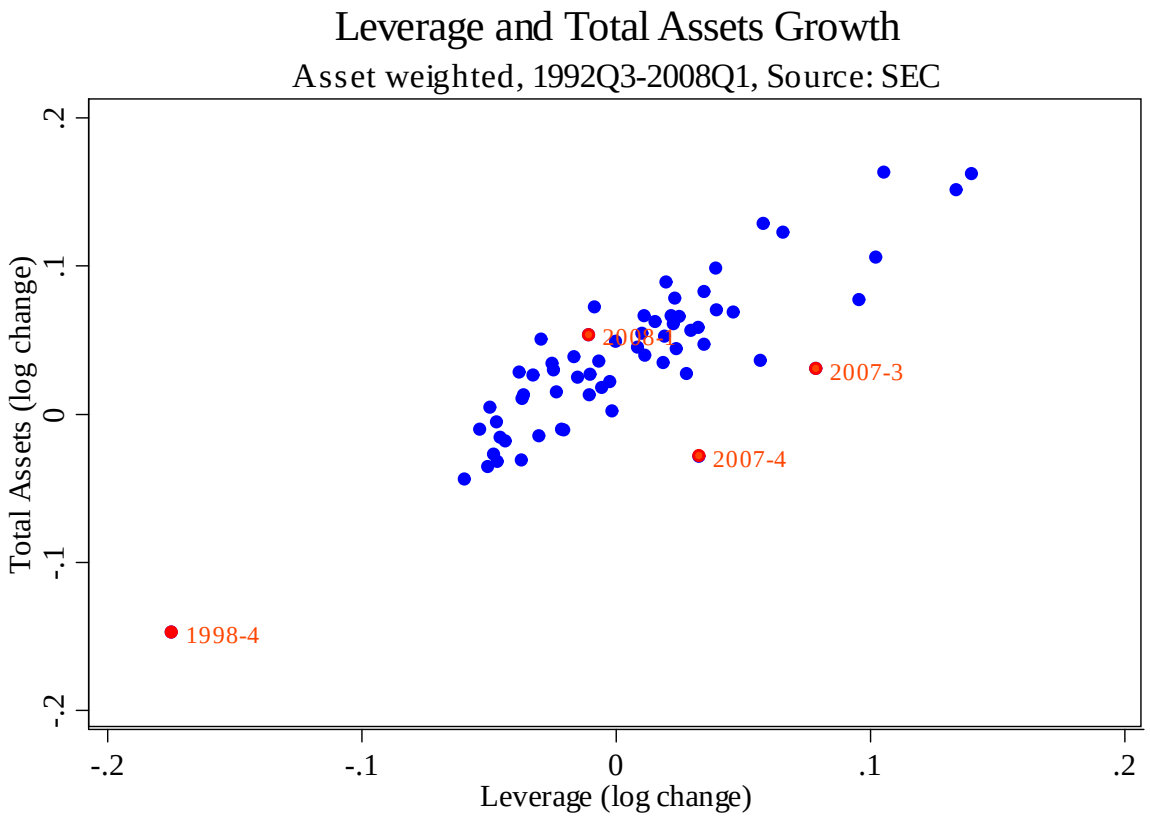
Supply curve is downward-sloping.

Amplification





US Investment Banks



Explaining Leverage and Assets

Slope is approximately 1

$$\ln A_t - \ln A_{t-1} \simeq \delta + \ln\left(\frac{A_t}{E_t}\right) - \ln\left(\frac{A_{t-1}}{E_{t-1}}\right)$$

Suggests...

$$\begin{aligned} \ln E_t &= \delta + \ln E_{t-1} \\ A_t &= \lambda_t^* E_t \end{aligned}$$

Equity is forcing variable and A_t is determined by realization of permitted leverage λ^*

What Do Corporate Finance Textbooks Say?

Under conditions of the Modigliani-Miller (MM) theorems

- Undertake a project if and only if it has positive net present value (NPV)
- Balance sheet size A is then determined
- Choice of funding (debt or equity) is irrelevant

What Do Corporate Finance Textbooks Say?

When MM conditions fail

- Debt financing has tax advantage
- Optimal debt ratio trades off tax advantage against costs of financial distress
- Balance sheet size A is given by set of positive NPV projects with optimal debt ratio

Explaining Leverage

Value at risk (VaR) at confidence level c relative to some base level A_0 is smallest non-negative number V such that

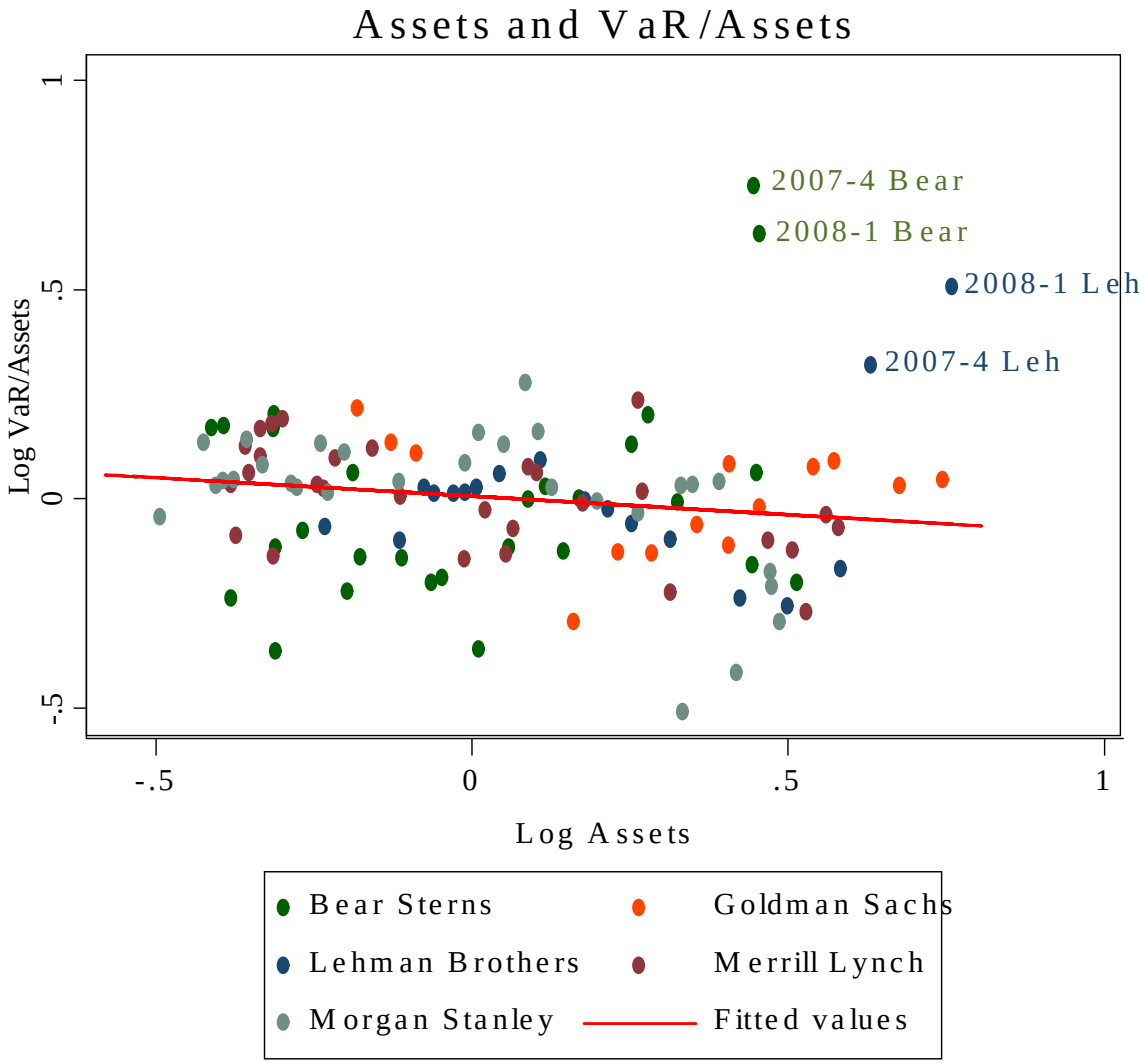
$$\text{Prob}\left(A < A_0 - V\right) \leq 1 - c$$

Equity capital E meets total value at risk

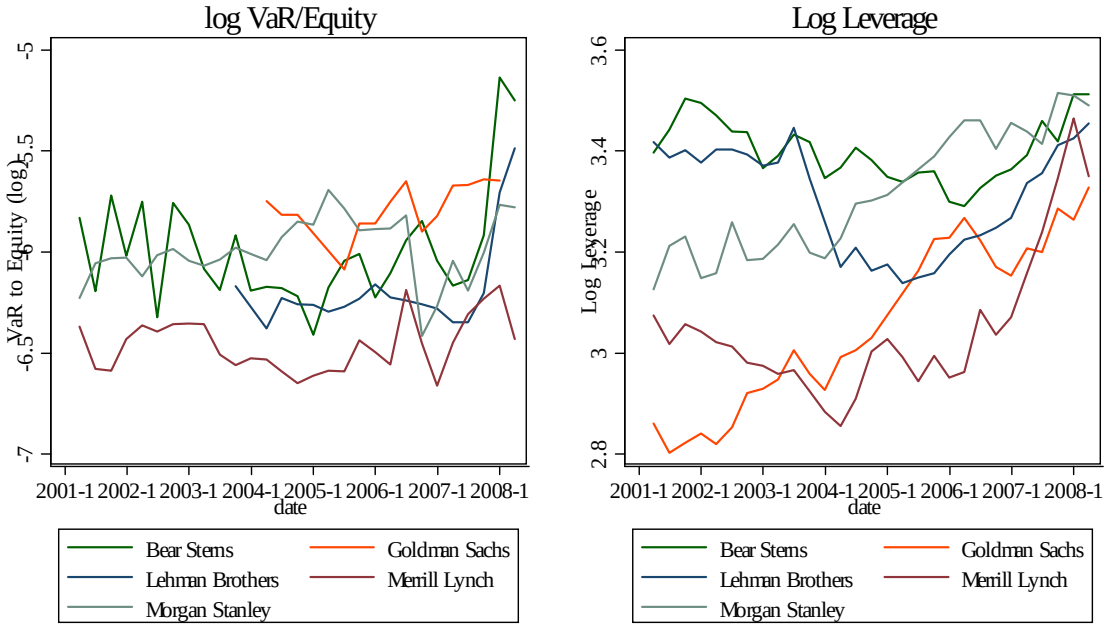
$$E = V = v \times A$$

v is value at risk per dollar of assets. Leverage λ^* satisfies

$$\lambda^* = \frac{A}{E} = \frac{1}{v}$$


Assets and VaR/Assets
Log VaR/Assets
1
.5
0
-.5
2007-4 Bear
2008-1 Bear
2008-1 Leh
2007-4 Leh
-.5
0
.5
1
Log Assets
Bear Sterns
Goldman Sachs
Lehman Brothers
Merrill Lynch
Morgan Stanley
Fitted values

VaR/Equity and Leverage



Pre-conditions for Amplification

"The value added of a good risk management system is that you can take more risks."

[Anonymous risk manager, May 2007]

"While many believe that irresponsible borrowing is creating a bubble in housing, this is not necessarily true. At the end of 2004, U.S. households owned $17.2 trillion in housing assets, an increase of 18.1% (or $2.6 trillion) from the third quarter of 2003. Over the same five quarters, mortgage debt (including home equity lines) rose $1.1 trillion to $7.5 trillion. The result: a $1.5 trillion increase in net housing equity over the past 15 months."

[Wall Street Journal commentator, May 31, 2005]

Shedding Light on "Liquidity"

- Asset price booms often linked to "liquidity" in financial system
- Suggestive metaphors, such as
  - *"Awash with liquidity", The Economist, February 3rd 2005.*
  - *"Liquidity sloshing around", Reuters, July 26th 2006.*

Aggregate Liquidity

Liquidity is the rate of growth of aggregate balance sheets.

Strong balance sheets $\Rightarrow$ surplus marked-to-market capital
$\Rightarrow$ "surplus capacity" in banking system

- For surplus capacity to be utilized, intermediaries expand their balance sheets.
  - On the liabilities side, take on more short-term debt.
  - On the asset side, search for potential borrowers

- How hard do financial intermediaries search for borrowers?
  - Sub-prime mortgage market
  - Debt financing of private equity / LBOs