

# Asset Allocation Decisions and Sponsor Valuation

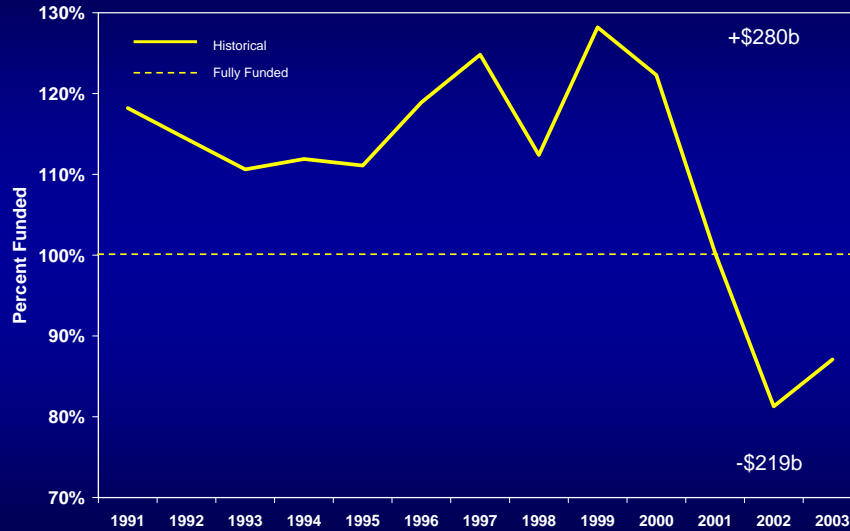
André F. Perold and Luis Viceira  
Harvard Business School

Prepared for the Q Group Fall Seminar  
La Quinta, Ca  
October 18, 2004

## A Typical Large Defined-Benefit Pension Fund

- Ratio of pension assets to market capitalization = 2:1
- 60% equity allocation means equities = 1.2 times market cap of firm

## Funded Status of DB Pension Plans in the S&P 500



Source: Standard & Poors

## U.S. Pension Initiatives

- Accounting
  - Elimination of smoothing of assets and liabilities (FASB)
  - Increased disclosure (FASB)
  - Redefinition of core earnings (Ratings Agencies)
- Funding
  - Use of Aa corporate bond yield (Congress)
  - Use of unsmoothed corporate yield curve (Treasury)
- Credit Ratings
  - PBO as corporate debt for credit rating of sponsor
- Pension Benefit Guaranty Corporation
  - Insurance premiums based on equity allocation

## PBGC Insurance Premia

- Since 2001:
  - \$19 per participant
  - 0.9% of funding shortfall
- Under consideration:
  - Premium = f(equity exposure)

## General Motors Pension Fund

	\$ Billions			
	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>
Pension Assets	87.5	85.3	73.7	66.8
Pension Liabilities	83.0	86.0	86.3	92.2
Net Pension Funding	4.5	(0.8)	(12.7)	(25.4)
Shareholders Equity	20.9	30.2	19.7	6.7
Market Value of Equity	39.7	25.4	25.6	20.4

## What if Pension Funds Sell Their Stocks and Buy Bonds?

- Who will buy the shares?
- Who will sell the bonds?
  
- Households?
- Corporations?

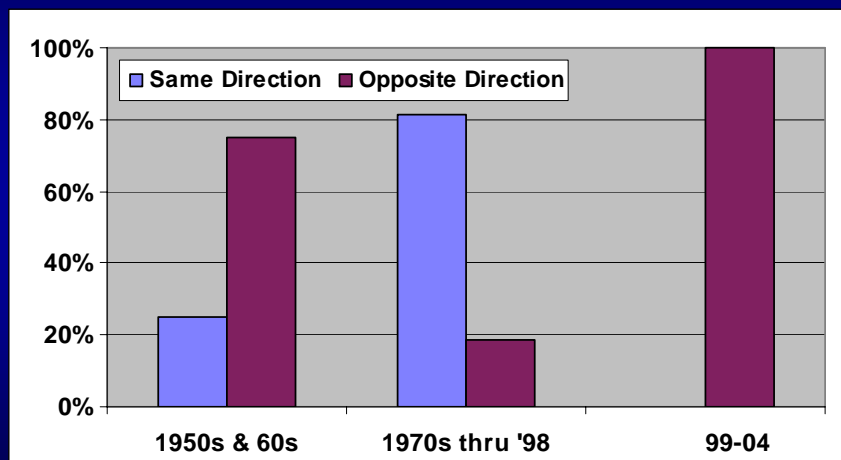
## Approximate Ownership of U.S. Equities By Defined Benefit Pension Funds (2003)

	<u>\$ Trillions</u>
Equity Market Value	14.0
U.S. Corporate DB Plans	0.9
U.S. Public DB Plans	1.2
Foreign DB Plans	0.5
Total Ownership by DB Plans	2.6

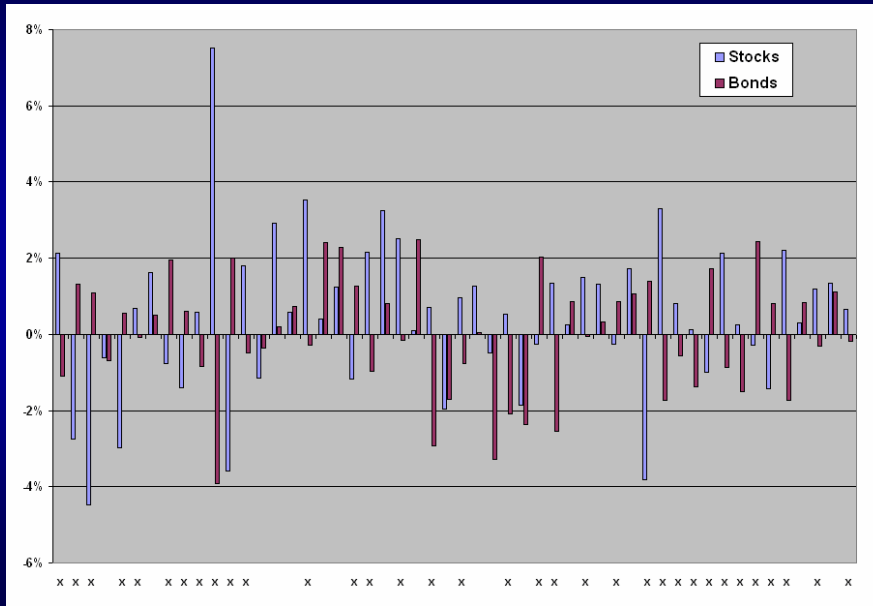
## Asset Allocation Considerations for Corporate Defined Benefit Plans

- Expected utility
- Modigliani & Miller
- Comparative advantage
  - Tax shields
  - Long time horizon
- Accounting
- Moral Hazard

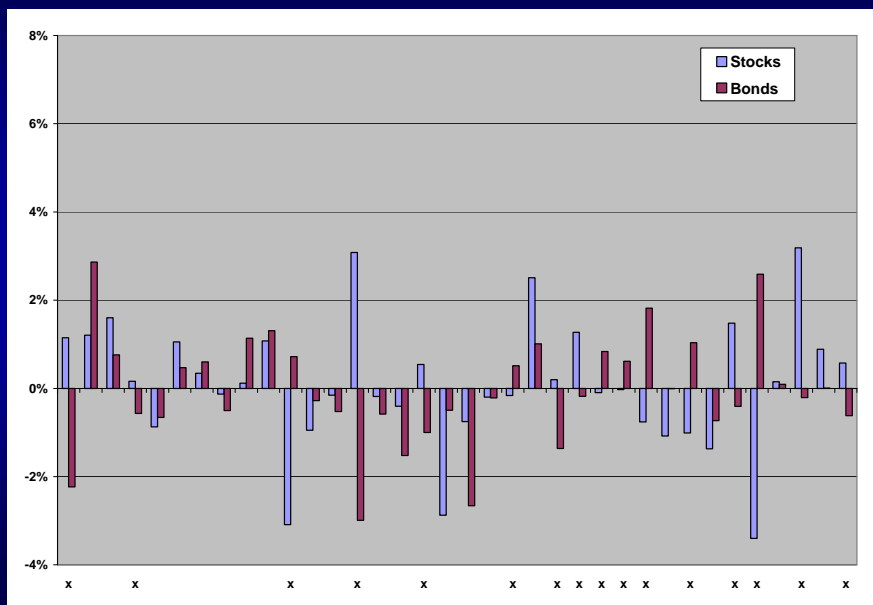
## Annual Co-Movement of U.S. Stocks and Bonds



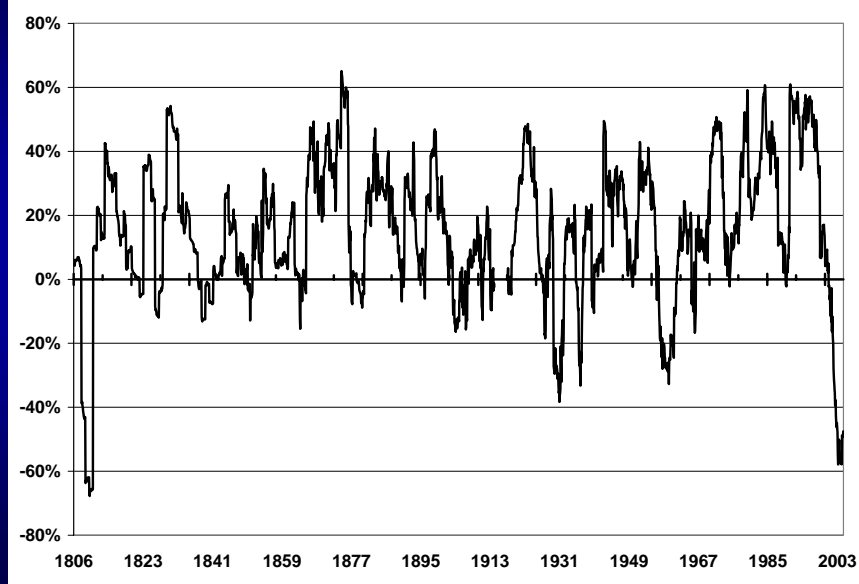
## Weekly Stock and Bond Returns in 2003



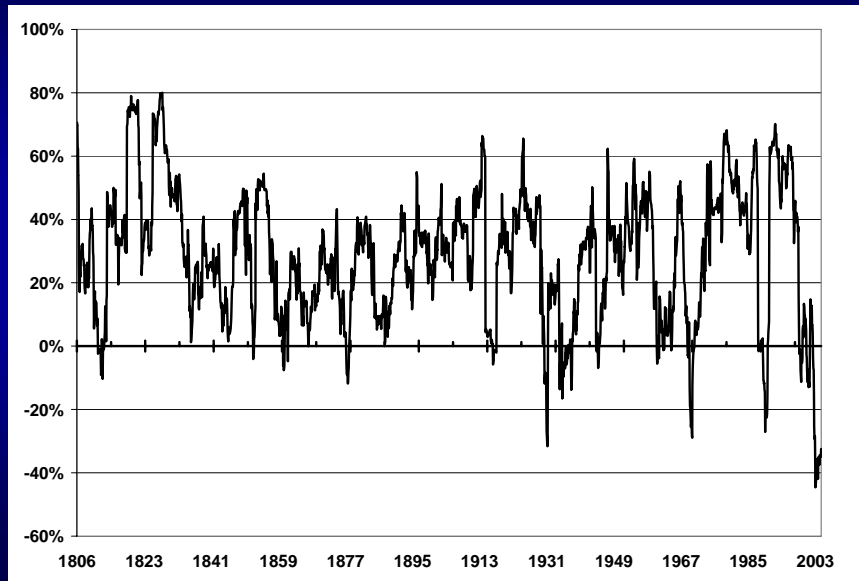
## Weekly Stock and Bond Returns in 2004



### U.S. Stock-Bond Correlation (rolling 3 yr, 1806-2004)



### U.K. Stock-Bond Correlation (rolling 3 yr, 1806-2004)



## The Changing Stock-Bond Correlation

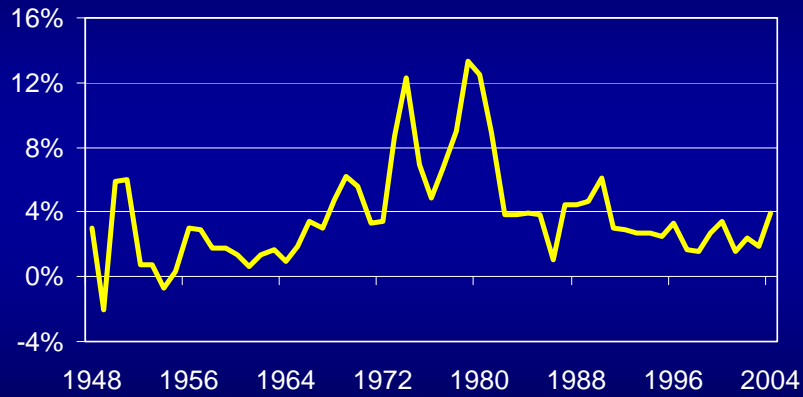
	<u>1976-1998</u>	<u>1999-2004</u>
US	30%	-31%
UK	38%	-18%
Australia	35%	-15%
France	35%	-35%
Germany	8%	-38%
Japan	12%	-23%
Sweden	28%	-30%

## What explains the changing correlation?

- Interest rates and inflation are proxies for business conditions
- When inflation is moderate and stable
  - Bonds go up and stocks go down when the business outlook gets worse, and vice versa when it gets better
- When inflation is high and volatile
  - Unexpected inflation is bad/good for stocks as well as bonds



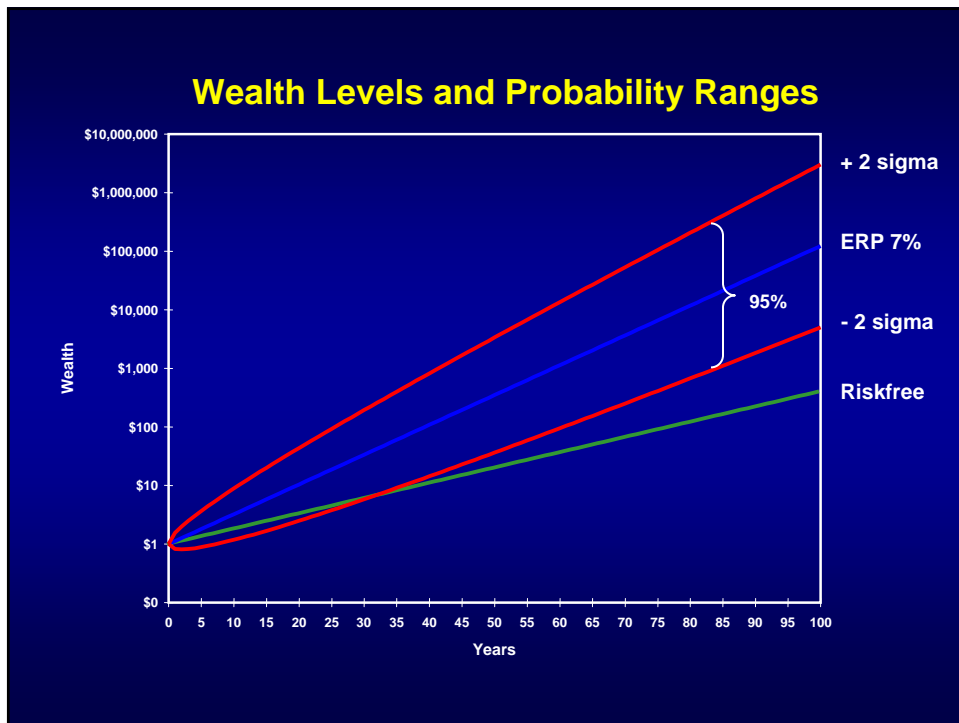
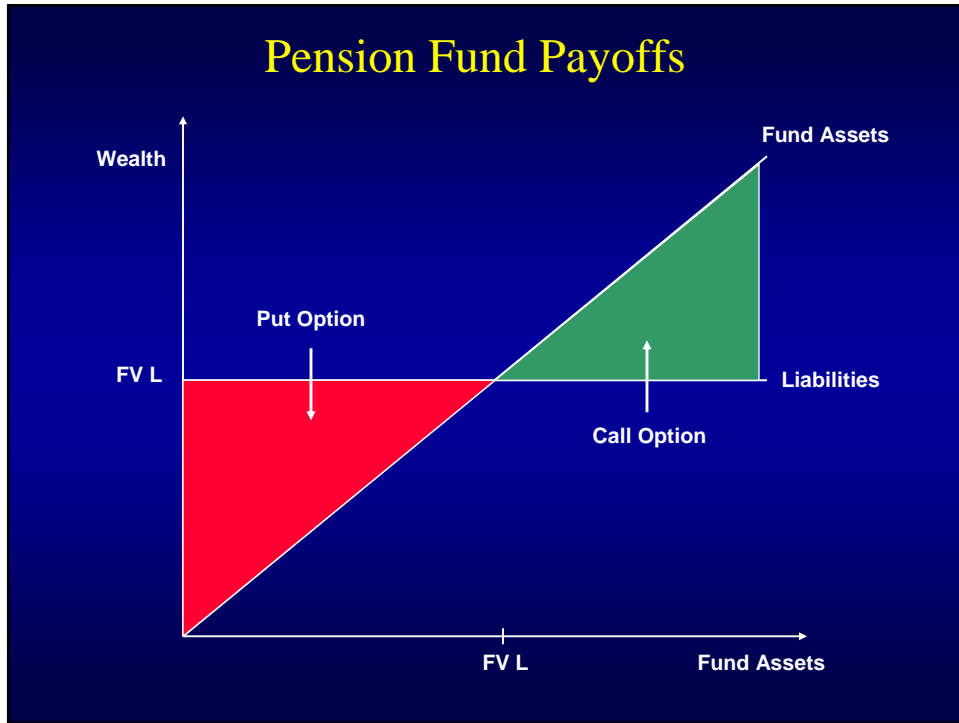
## U.S. CPI

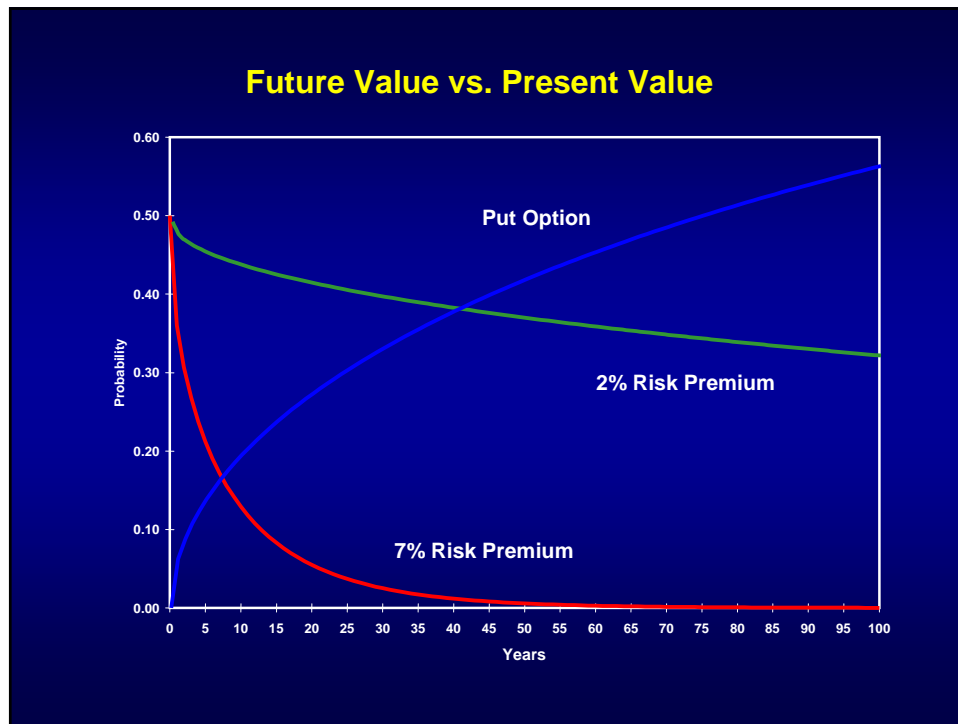


## How Risky Are Stock-Bond Portfolios Today?

	<u>Risk (S.D.)</u>	<u>Allocation</u>
Stocks	16%	60%
Bonds	14%	40%

<u>Portfolio Risk (S.D.)</u>			
<u>Correlation</u>	<u>Individuals</u>	<u>DB PFs</u>	<u>DB Hedged</u>
50%	13%	9%	10%
0%	11%	13%	10%
-20%	10%	14%	10%





## Pension Claims

- Sponsor's claim  
= Call option
  
- Pension beneficiaries' claim  
= Promised benefits – Put option  
(+ Government insurance)

## Value of the Pension Put

- Asset allocation
- Interest rate process
- Company and asset class returns
- Nature of promised pension payments
- Valuation of pension liabilities
- Minimum funding requirements
- Solvency of the sponsor
- Costs of financial distress
- Resolution of bankruptcy

## Model of Pension Claims

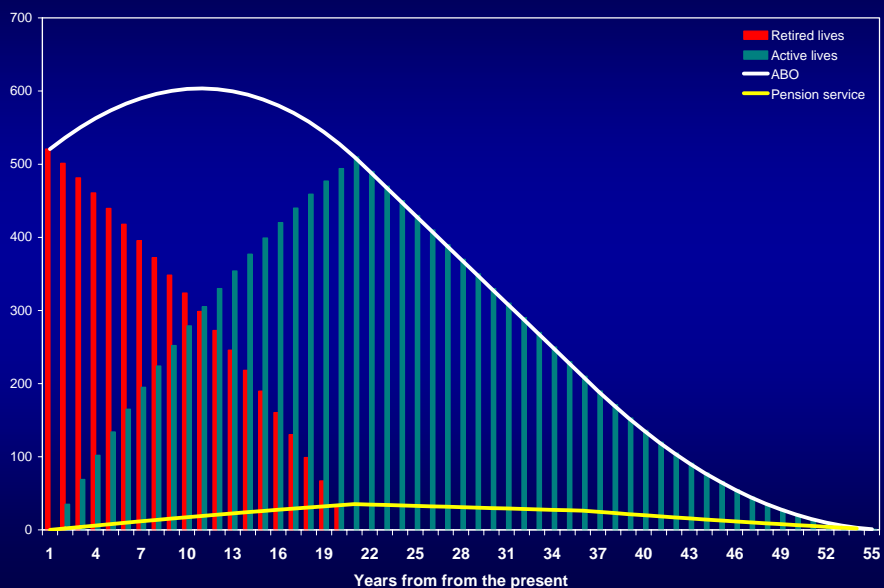
Company XYZ

Operating Business	Debt     \$50
\$100	Equity    \$50
Pension Assets   \$100	P. Liabilities \$100

## Pension Benefits

- Steady state workforce
- Deterministic demographics
  - Vesting begins at age 31
  - Retirement at age 65
  - Death at age 85
- One employee in each age cohort
- Wages grow with inflation
- Pension benefits are proportional to final wage times years of service

## Accrued Pension Benefits (ABO)



## Asset Returns and Asset Pricing\*

Stochastic discount factor:  $-m_{t+1} = x_t + z_t + v_{m,t+1}$

Value of a cash flow  $C_t$ :  $E_0\{C_t \exp m_t\}$

State variables:  
 $x_{t+1} = (1-\phi_x)\mu_x + \phi_x x_t + v_{x,t+1}$   
 $z_{t+1} = (1-\phi_z)\mu_z + \phi_z z_t + v_{z,t+1}$

Inflation:  $\pi_{t+1} = z_t + v_{\pi,t+1}$

Nominal short rate:  $r_{t+1} = x_t + z_t + \mu_r$

Stock market return:  $s_{t+1} = r_{t+1} + \mu_s + v_{s,t+1}$

Return on company assets:  $a_{t+1} = \beta_a s_{t+1} + (1-\beta_a)r_{t+1} + \mu_a + v_{a,t+1}$

Price of discount bond:  $-\ln(P_{n,t}) = A_n + B_{1,n} x_t + B_{2,n} z_t$

\*Campbell and Viceira (2001)

## Capital Market Assumptions

- Stock market volatility 16% p.a.
- Bond market volatility 13% p.a.
- Stock-bond correlation = 0.5 or -0.5
- Equity risk premium = 5% or 3%
- Asset mix = 60/40 or 0/100 stocks/bonds
- Pension liability (ABO) is discounted at long-term default-free rates
- Company assets: Beta = 0.5; Resid sigma = 20%

## Pension Model (cont)

- YOY change in pension liability  
= Liability return  
- Benefit payments  
+ Pension service
- YOY change in pension assets  
= Investment return  
- Benefit payments  
+ Pension service  
- Contribution holiday  
+ Minimum funding requirement

## Pension Model (cont.)

- Benefit payments = \$8.9
- Pension service = \$1.6
- MFR =  $k$  (Assets - 0.9 Liabilities),  $k = 1/12$  or  $1/5$
- Contribution holiday provided that  
Assets > 1.1 Liabilities
- Sponsor is insolvent when  
Op. Assets + A - L < Debt
- Termination upon insolvency or  $T = 30$
- Bankruptcy costs = 0% or 20% of operating assets
- No taxes

## Broad Observations and Conclusions

- Proposed pension reforms will create incentives to reduce equity exposure
- Low stock/bond correlations increase the risk of equity exposure in a defined benefit pension fund
- However, the “pension put” is valuable and may be reflected in sponsor valuations
- Eliminating equity exposure may reduce sponsor market value

## The Put Option Aside:

- Shares owned by corporate pension funds are held indirectly by households
- Individuals should be comfortable exchanging bonds for these shares
- Corporate plan sponsors will have less risk off-balance sheet – they can take more risk on-balance sheet through share repurchases
- But who will buy shares owned by public pension funds?



# Simulation Results

	A	B	C	D	E	F	G	H	I	J
<b>Stock-bond correlation</b>	0.5	-0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
<b>Cost of financial distress</b>	0%	0%	0%	0%	0%	0%	0%	20%	20%	0%
<b>Initial pension funding</b>	100%	100%	80%	80%	100%	120%	100%	100%	100%	100%
<b>Initial operating assets</b>	\$100	\$100	\$100	\$100	\$100	\$100	\$300	\$100	\$100	\$100
<b>Initial company debt</b>	\$50	\$50	\$50	\$50	\$50	\$50	\$50	\$50	\$50	\$70
<b>Asset allocation</b>	60%	60%	60%	0%	0%	60%	60%	60%	0%	60%
<b>Deficit at termination ("put")</b>	\$7.0	\$12.2	\$12.9	\$9.3	\$0.0	\$4.3	\$2.8	\$7.3	\$0.0	\$7.1
<b>Surplus at termination ("call")</b>	\$2.5	\$8.1	\$1.1	\$0.0	\$0.0	\$4.8	\$3.0	\$2.3	\$0.0	\$2.3
<b>Contribution holiday</b>	\$10.7	\$11.2	\$3.4	\$0.0	\$0.0	\$24.5	\$12.4	\$9.6	\$0.0	\$8.5
<b>Required funding</b>	\$6.2	\$7.2	\$11.6	\$10.7	\$0.0	\$5.1	\$12.6	\$4.6	\$0.0	\$3.7
<b>Initial unfunded liability</b>	\$0.0	\$0.0	\$20.0	\$20.0	\$0.0	-\$20.0	\$0.0	\$0.0	\$0.0	\$0.0
<b>Bankruptcy probability</b>	28%	44%	43%	56%	47%	14%	5%	37%	59%	48%
<b>Initial consolidated net worth</b>	\$50.0	\$50.0	\$30.0	\$30.0	\$50.0	\$70.0	\$250.0	\$50.0	\$50.0	\$30.0
<b>Market value of equity</b>	\$57.0	\$62.2	\$42.9	\$39.3	\$50.0	\$74.3	\$252.8	\$48.7	\$40.3	\$37.1