



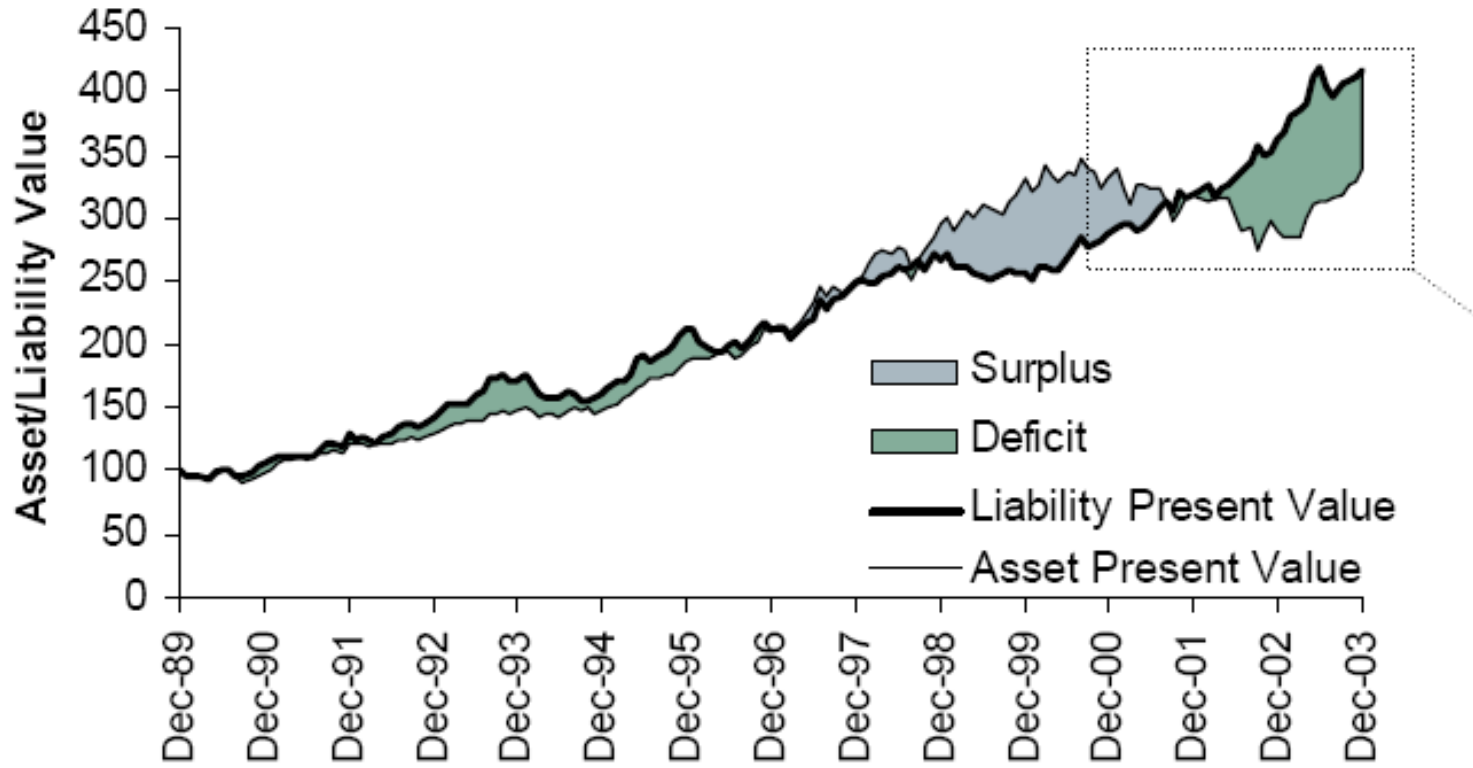
# Asset/Liability Management

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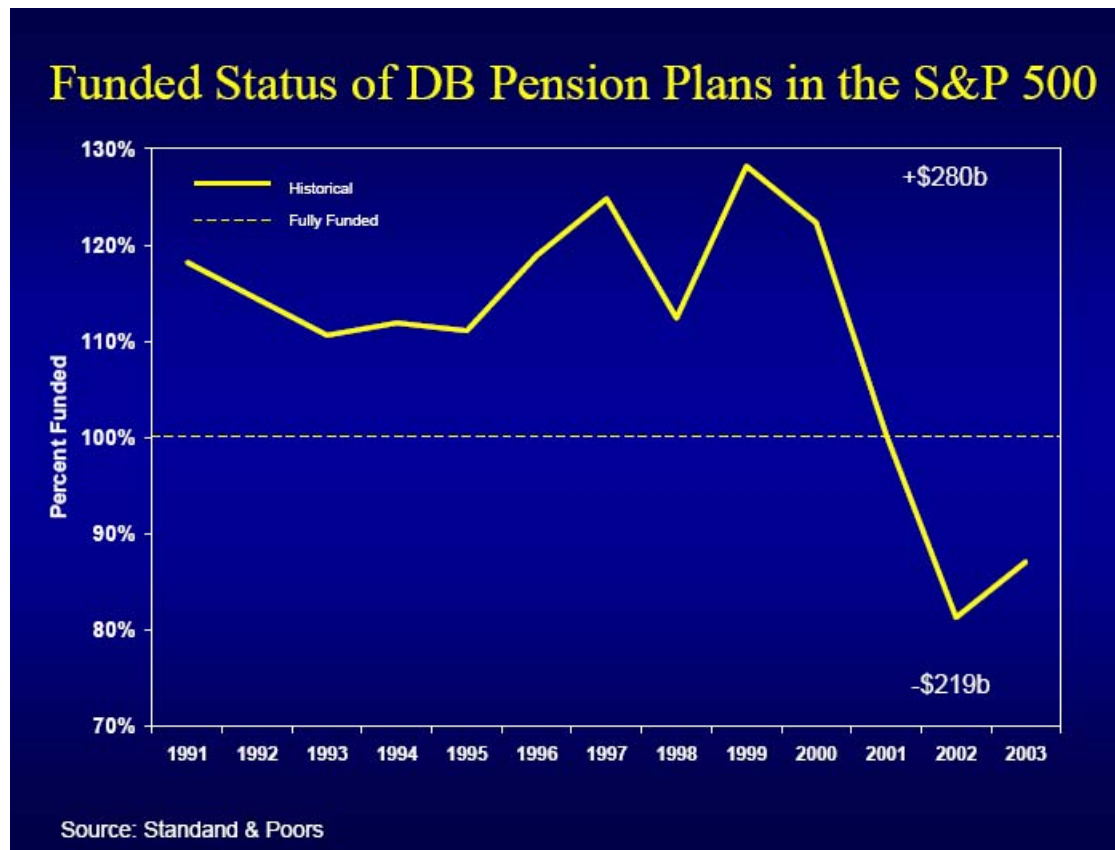
William F. Sharpe

STANCO 25 Professor of Finance, Emeritus  
Stanford University  
[www.wsharp.com](http://www.wsharp.com)

# A Hypothetical Plan's Funded Status



# S&P500 Plans' Funded Status





# Vote

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- The Defined Benefit system is a mess
  - True
  - Sort of true
  - Sort of false
  - False



# Stock-Bond Correlations

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## 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%



# Reasons for Changes

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## 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



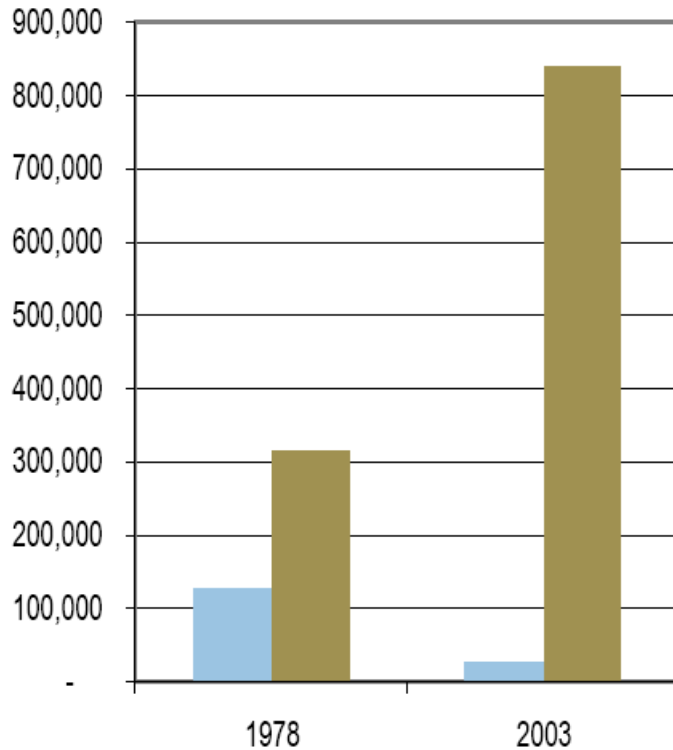
# Vote

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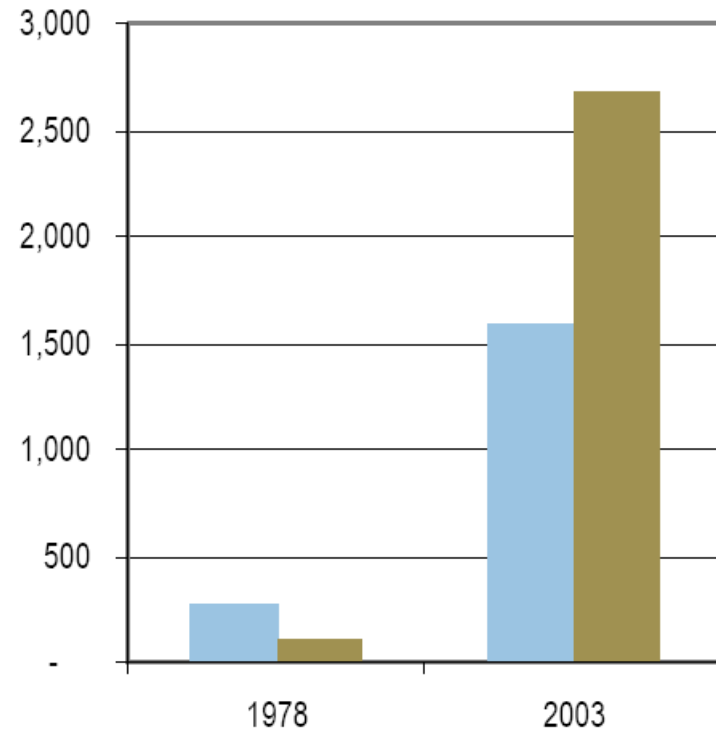
- Who is responsible?
  - Boards
  - Staffs
  - Actuaries
  - Accountants
  - Politicians
  - Greenspan
  - All of the above

# DB and DC Plans

Number of Plans



Asset Size (in billions)



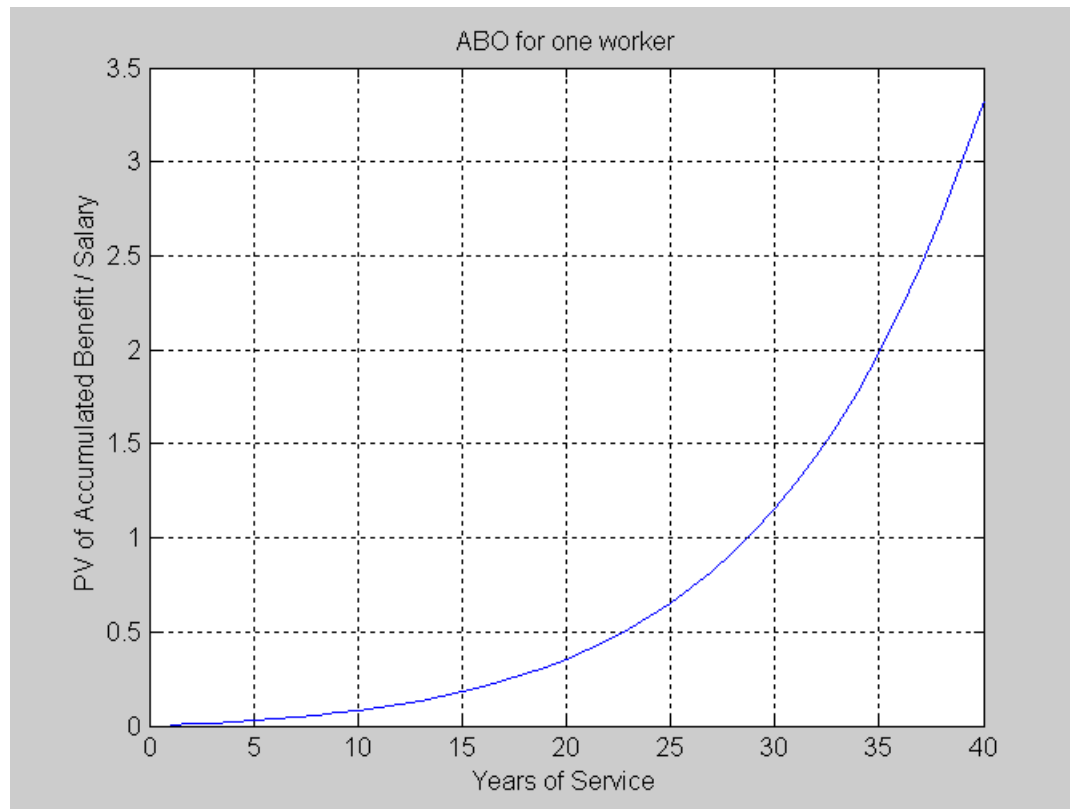
Source: EBRI

Defined Benefit Defined Contribution

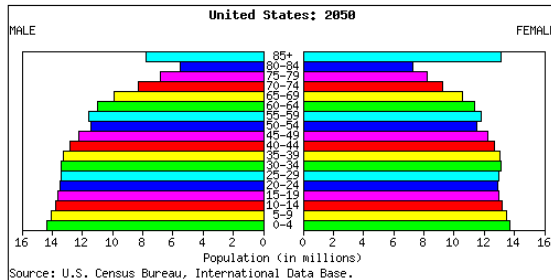
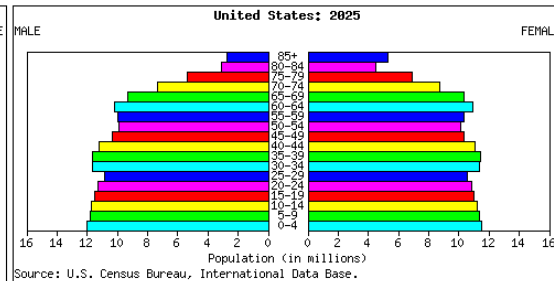
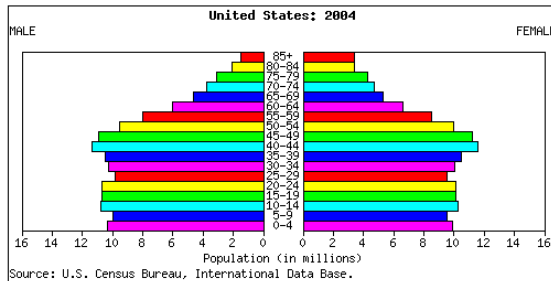
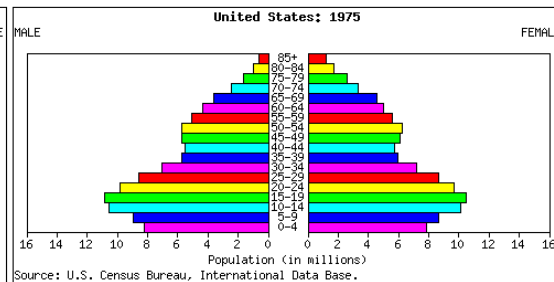
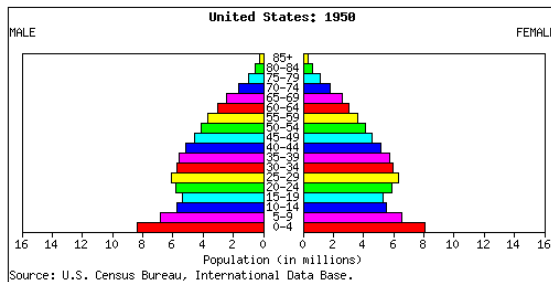
Defined Benefit Defined Contribution



# Backloading of Accumulated Benefits



# Population Pyramids: United States, 1950 - 2050





# Vote

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- What to do with DB plans?
  - Radical surgery
  - Life support
  - Euthenasia



# Asset Allocation Policy

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- **Setting** the Policy
  - Staff selects several candidate mixes
  - Board considers the implications
    - Monte Carlo forecasts
    - Multi-period measures
  - Board selects preferred mix
    - Target Mix
    - Ranges
- **Implementing** the Policy
  - Staff manages within ranges
  - Target is the goal



# Assumptions about Market Efficiency

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- Setting Policy
  - Passive benchmarks
  - Strategic allocation
- Implementing Policy
  - Passive core
  - Tactical allocation
  - Active managers



# Vote

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- Asset Allocation Policy should assume efficient markets
  - Agree
  - Disagree

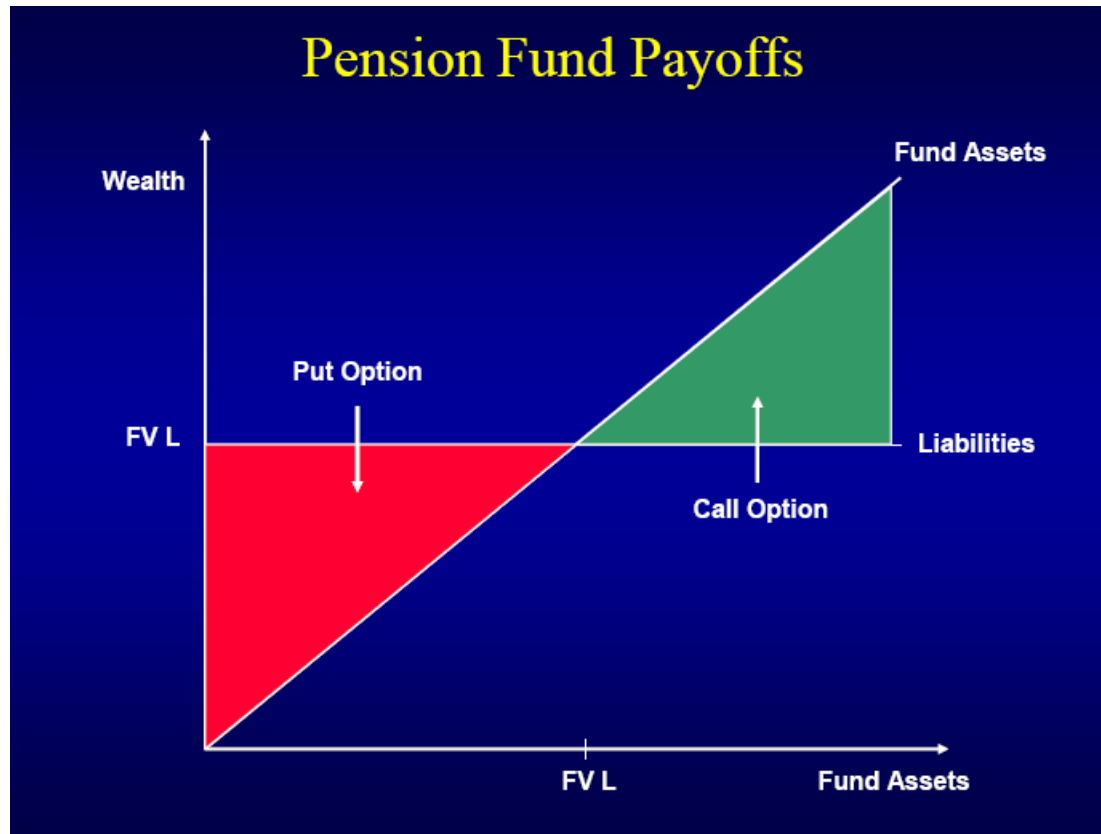
# Corporate and Pension Assets and Liabilities

## Model of Pension Claims

Company XYZ

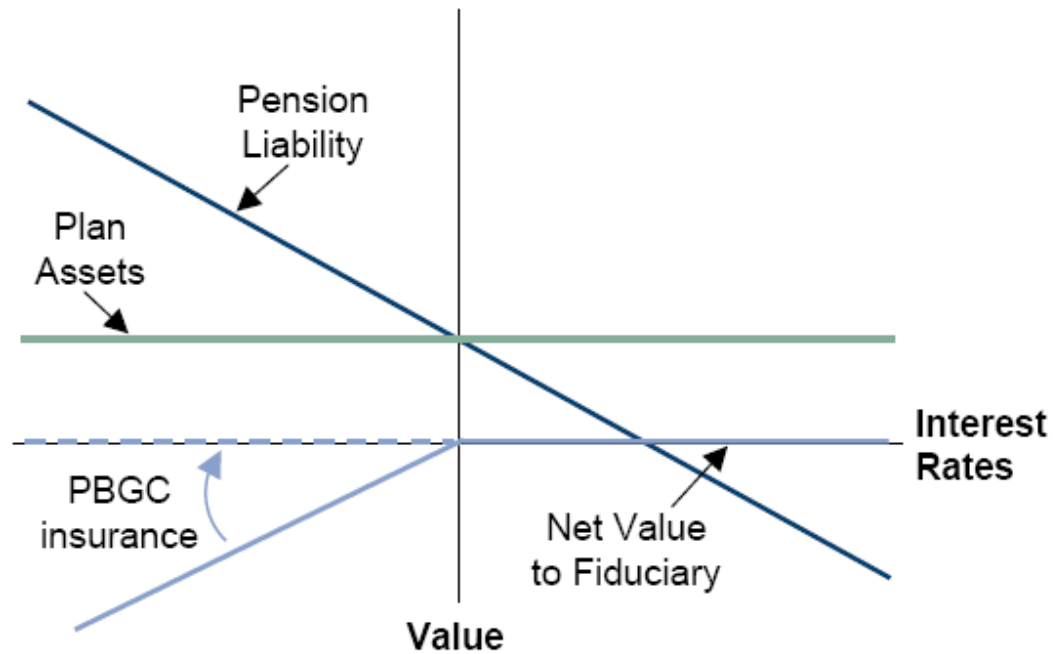
Operating Business	Debt	\$50
\$100	Equity	\$50
Pension Assets	P. Liabilities	\$100

# Put and Call





## Pension Liability – Revised Model



Analogy to a cap on surplus

# Risk and Return of What?

## 1. Assets

---

Fund Assets

Fund Net Worth

# Risk and Return of What?

## 2. Surplus

---

Fund Assets

Fund Liability

Fund Net Worth

# Risk and Return of What?

## 3. Surplus with Call

---

Fund Assets

Call on Sponsor

Fund Liability

Fund Net Worth

# Risk and Return of What?

## 4. Surplus with Put

---

Fund Assets

Put to PBGC

Fund Liability

**Fund Net Worth**

# Risk and Return of What?

## 5. Surplus with Call and Put

Fund Assets

Call on Sponsor

Put to PBGC

Fund Liability

**Fund Net Worth**

# Risk and Return of What?

## 6. Sponsor

---

Sponsor Assets

Fund Assets

Sponsor Liabilities

Fund Liabilities

Total Net Worth

# Risk and Return of What?

## 7. Shareholders (Taxpayers)

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Sponsors' Assets

Funds' Assets

Sponsors' Liabilities

Funds' Liabilities

Investors' Net Worths



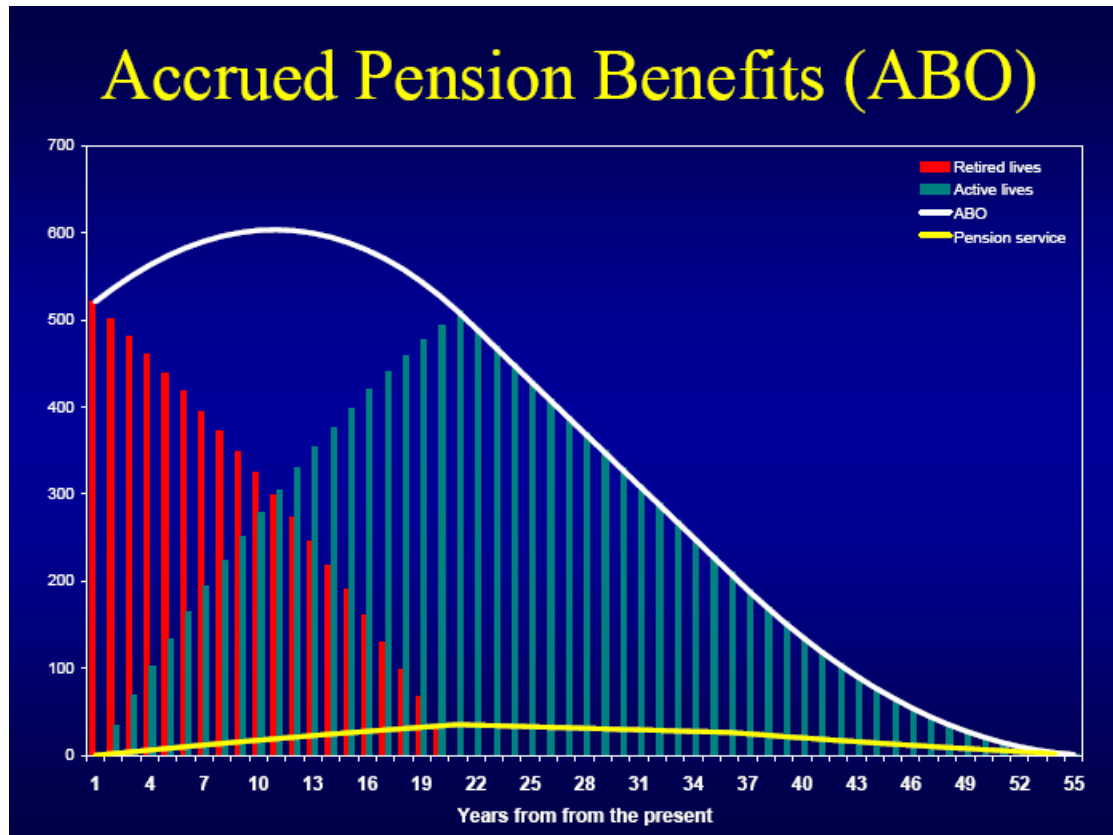


# Vote

---

- Asset Allocation Policy should take into account
  - Asset value
  - Liability value
  - Put to the PBGC
  - All of the above
  - Assets and Liabilities

# Benefit Payments





# Sets of Benefit Payments

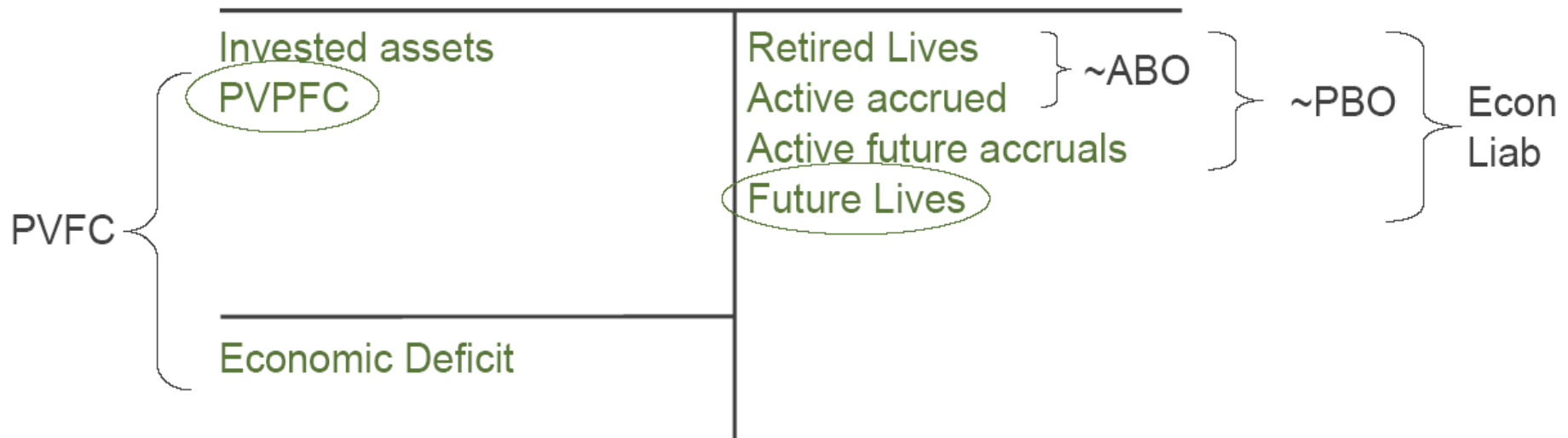
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	Present Salary	Future Salary
Past Service	ABO	PBO
Past and Future Service	???	EBO



# Assets and Liabilities

## Retirement Plan Balance Sheet





# Implicit Contracts

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- “An implicit contract is not worth the paper it is not written on.”

( Anon. )



# Vote

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- Asset Allocation Policy should take into account surplus based on
  - Present assets and ABO
  - Present assets and PBO
  - Present and future assets and EBO



# Discount Rates

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- Public plans: PBO
  - Expected return on assets
  - ROA (8 – 9%)
- Corporate plans
  - Income statement: PBO
    - ROA (8-9%)
  - Balance sheet: ABO
    - Average of past yields on high-grade corporates



# Pension Funding Equity Act of 2004: Liability Interest Rate

---

- 90% to 100% of weighted average yield on long-term investment-grade corporate bonds
  - Citigroup High Grade Corp (AAA/AA 10+ yrs)
  - ML US Corp. AA-AAA 10+ yrs
  - ML US Corp A 15+ yrs
- Weights
  - 4: Last 12 months
  - 3: Previous 12 months
  - 2: Previous 12 months
  - 1: Previous 12 months





# Discount Rates

---

- ROA
  - 8 – 9 %
- Corporate Average (April 2004)
  - 5.8 – 6.4 %
- 10-yr Treasury (today)
  - 4.06 %
- 30-yr Treasury (today)
  - 4.86 %



# Vote

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- Asset Allocation Policy should be based on liability based on
  - ABO at treasury rate
  - ABO at corporate rate
  - ABO at ROA
  - PBO at treasury rate
  - PBO at corporate rate
  - PBO at ROA



# Liability Proxies

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- Possible ingredients
  - Government Bonds
  - Corporate Bonds
  - Junk Bonds
  - TIPS
  - Common Stocks



# Liability Proxies

---

	<i>Retired Lives</i>	<i>Active Accrued</i>	<i>Active Future</i>	<i>Future Lives</i>
Long Bonds	100	50	30	10
Long TIPS	-	50	60	70
Domestic Equities	-	-	5	10
Foreign Equities	-	-	5	10



# Funding and Surplus Risk and Return

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- Surplus
  - $S_t = A_t - L_t$
- Relative Surplus
  - $S_1/A_0 = (A_1/A_0) - (L_0/A_0) (L_1/L_0)$
- Debt Ratio (reciprocal of funded ratio)
  - $d = L_0/A_0$
- Relative Surplus (excluding constants)
  - $R_A - d R_L$



# Assets, Liabilities and Factors

---

$$R = b_1 F_1 + b_2 F_2 + \dots + b_n F_n + \varepsilon$$

$$S = R_A - d R_L = (b_A - d b_L) F + \varepsilon_A - d \varepsilon_L$$

$$V_S = (b_A - d b_L) C (b_A - d b_L)' + v(\varepsilon_A) + d^2 v(\varepsilon_L)$$

$$E_S = (b_A - d b_L) E + E(\varepsilon_A) + d E(\varepsilon_L)$$



# Expected Returns and Betas

---

$$R = b_1 F_1 + b_2 F_2 + \dots + b_n F_n + \varepsilon$$

$$E = b_1 e_1 + b_2 e_2 + \dots + b_n e_n + \alpha$$

$$\text{CAPM: } E_i = r_f + \beta_i (R_m - R_f)$$

$$E = r_f + b \beta' (R_m - R_f) + \alpha$$

$$E_s = r_f + (b_A - db_L) \beta' (R_m - R_f) + E(\varepsilon_A) + dE(\varepsilon_L)$$



# Vote

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- Liabilities should be modeled as
  - Long-term nominal bonds
  - A proxy portfolio of asset classes
  - Specifically as a set of contingent claims



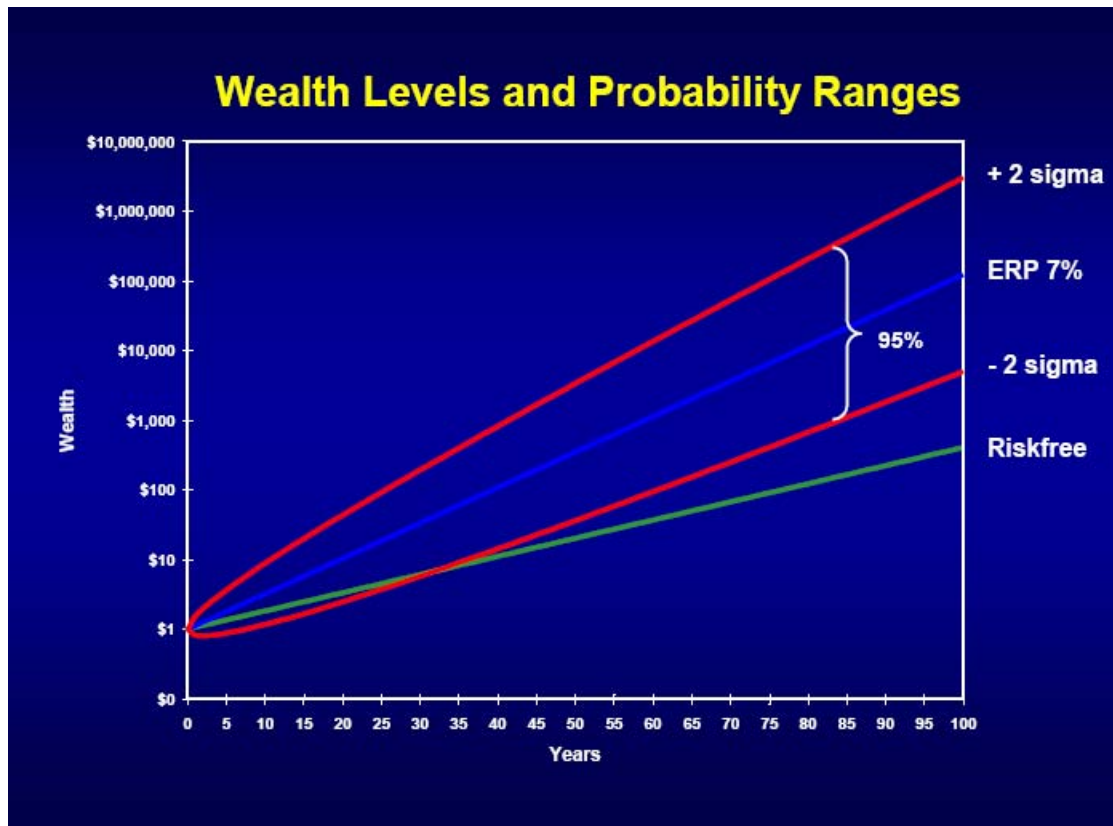


# Vote

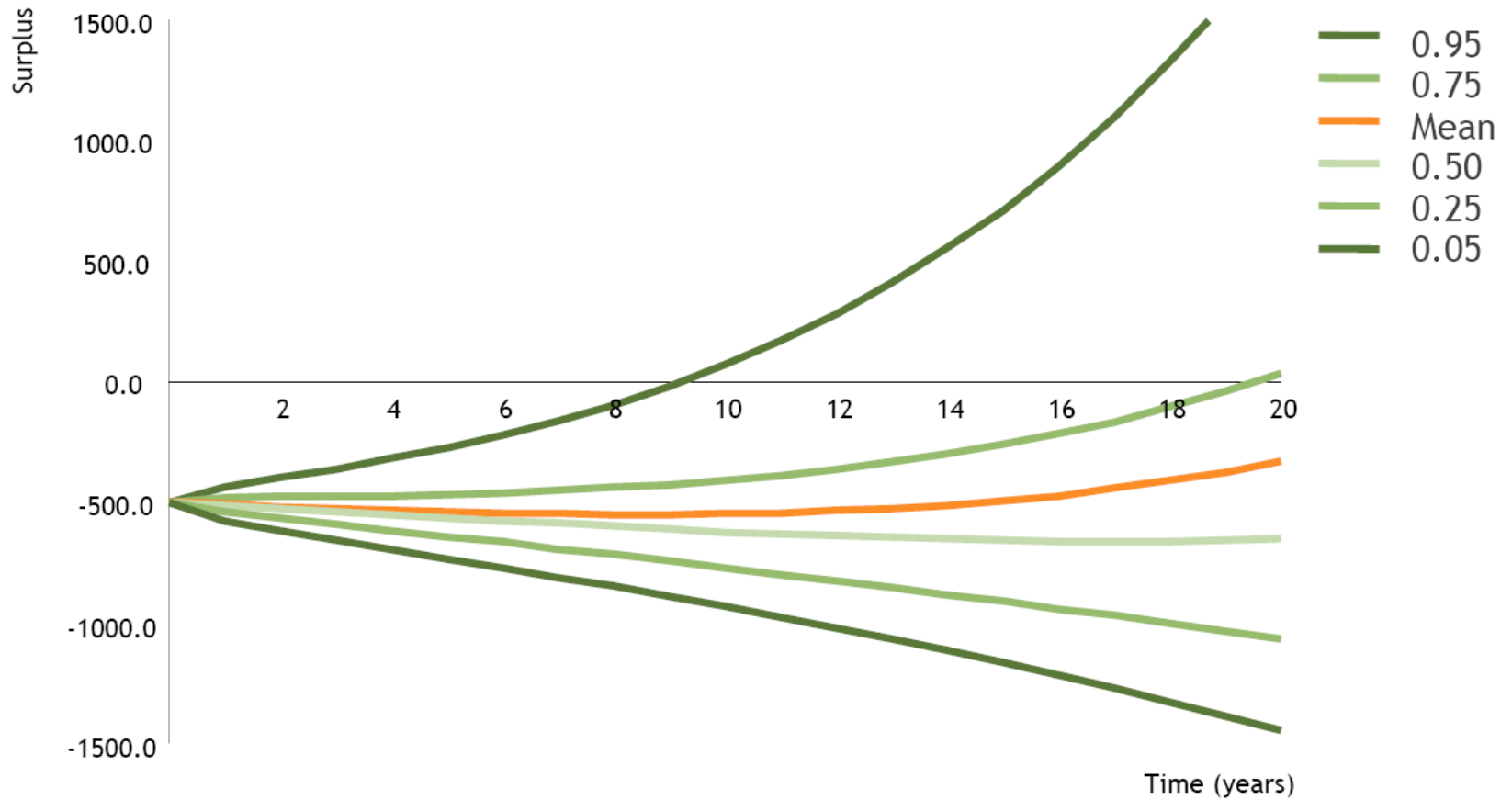
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- A Liability Proxy should be
  - Generic
  - Customized

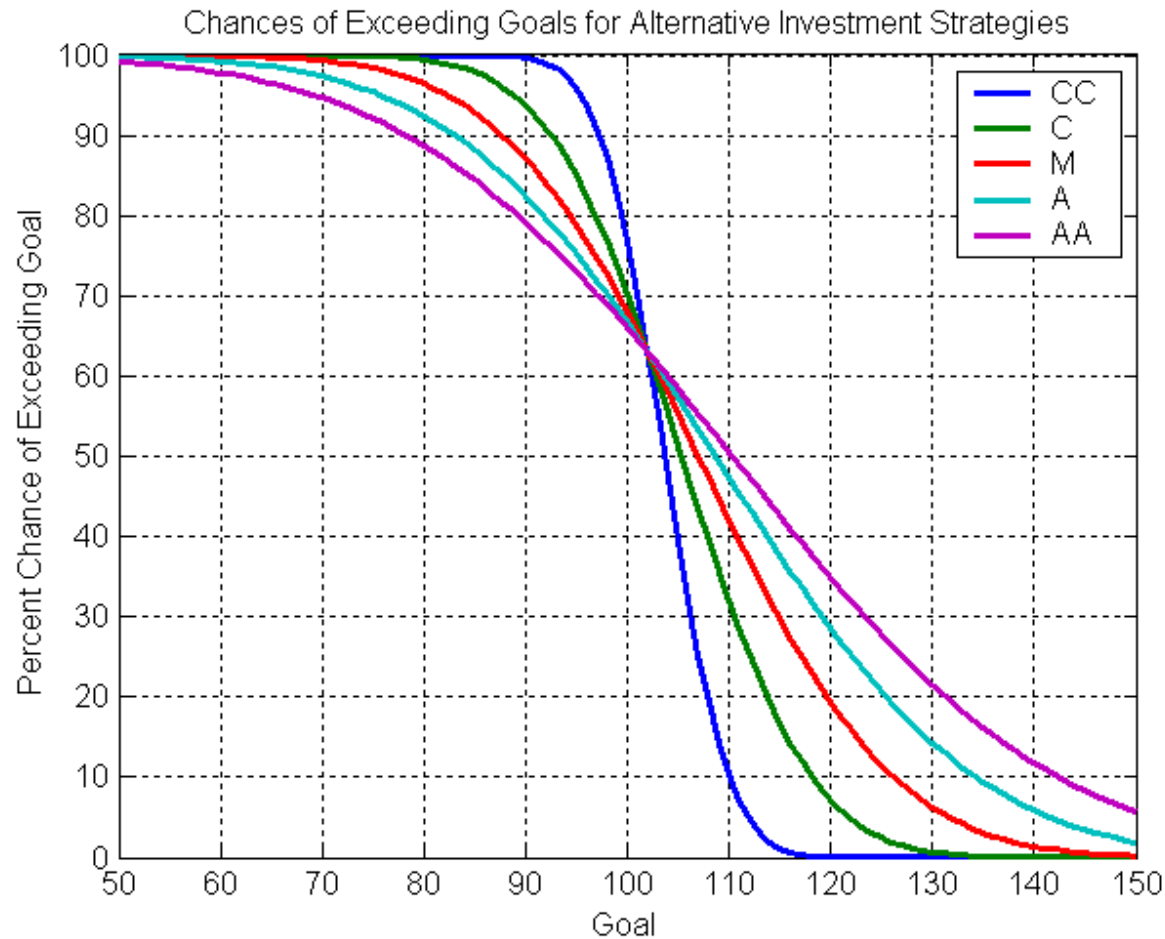
# Multi-year Projections



# A Surplus Tulip



# Implications of Alternative Policies





# Vote

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- Asset allocation policy should be set on the basis of surplus risk and return
  - Surplus next year
  - 10-year contributions and ending surplus
  - 20-year contributions and ending surplus
  - All of the above
  - None of the above



# Macro-consistent Investment Forecasts

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- If everyone used them, markets would clear
- For every asset class, the total amount demanded would equal the total amount available

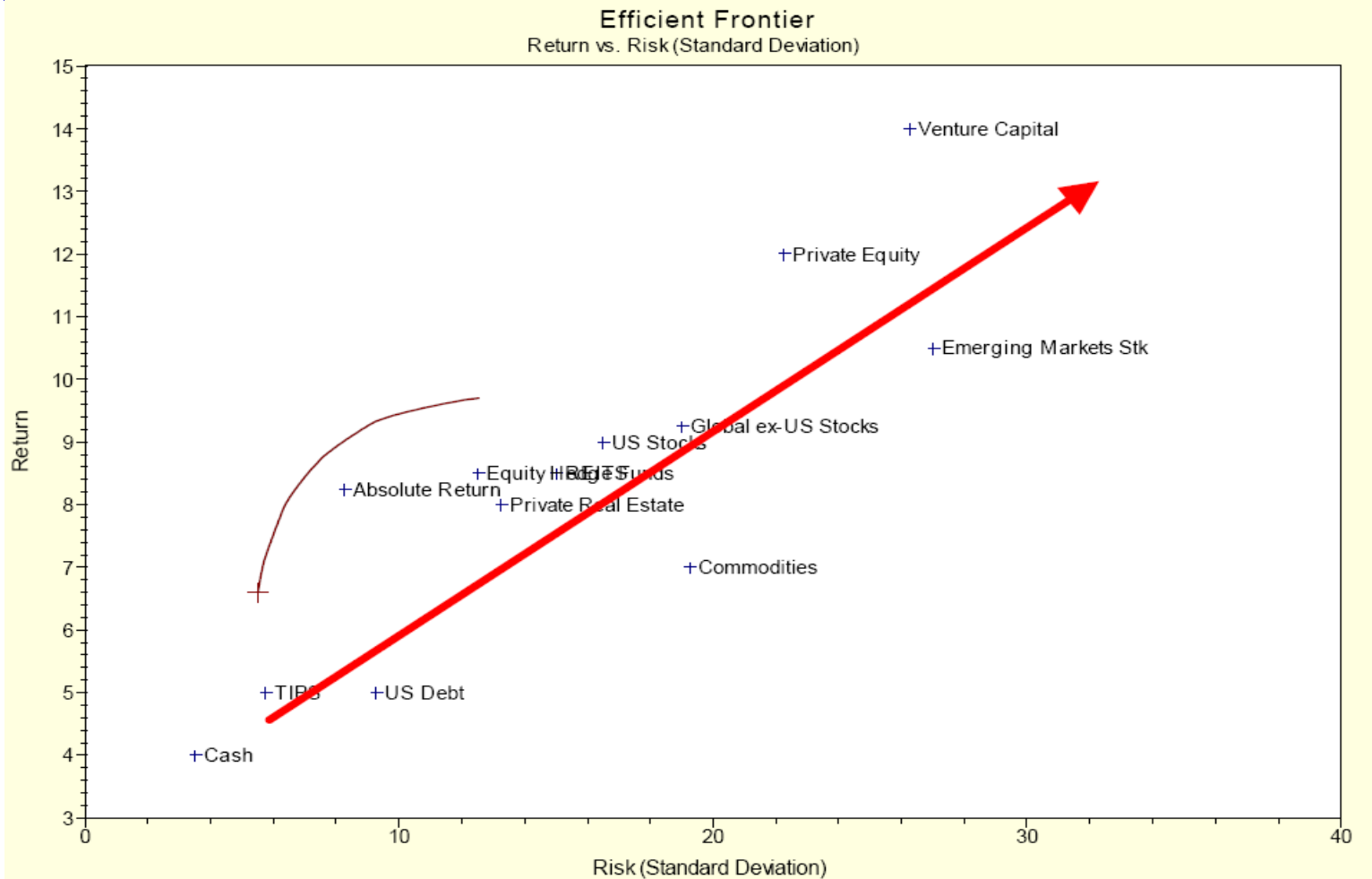


# Symptoms of Macro-Inconsistent Investment Forecasts

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- Optimization analyses without constraints produce implausible portfolios for a wide range of risk tolerances, etc..
- Analyses are performed with arbitrary upper and/or lower bounds on asset proportions
- Asset market values are not utilized in any way

# Asset Risks and Returns







# Asset Market Values

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- Relative market values of asset classes
  - Key information
- Macro-consistent forecasts
  - Must be consistent with current market values
- Macro-inconsistent forecasts
  - Lead to bets against the market
  - Even if bets are desired, current market values should be utilized



# Insuring Macro-consistent forecasts

---

- In general
  - Create an equilibrium consistent with current asset values
- More simply:
  - Create a representative investor who will choose the current **market portfolio**
    - relative market values of assets
  - Create an equilibrium consistent with that choice
  - Can be accomplished using **Reverse optimization**



# Typical Asset Allocation Policy Implementation

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- Ignores targets or
- Periodically rebalances to target percentages
  - Constant-mix strategy

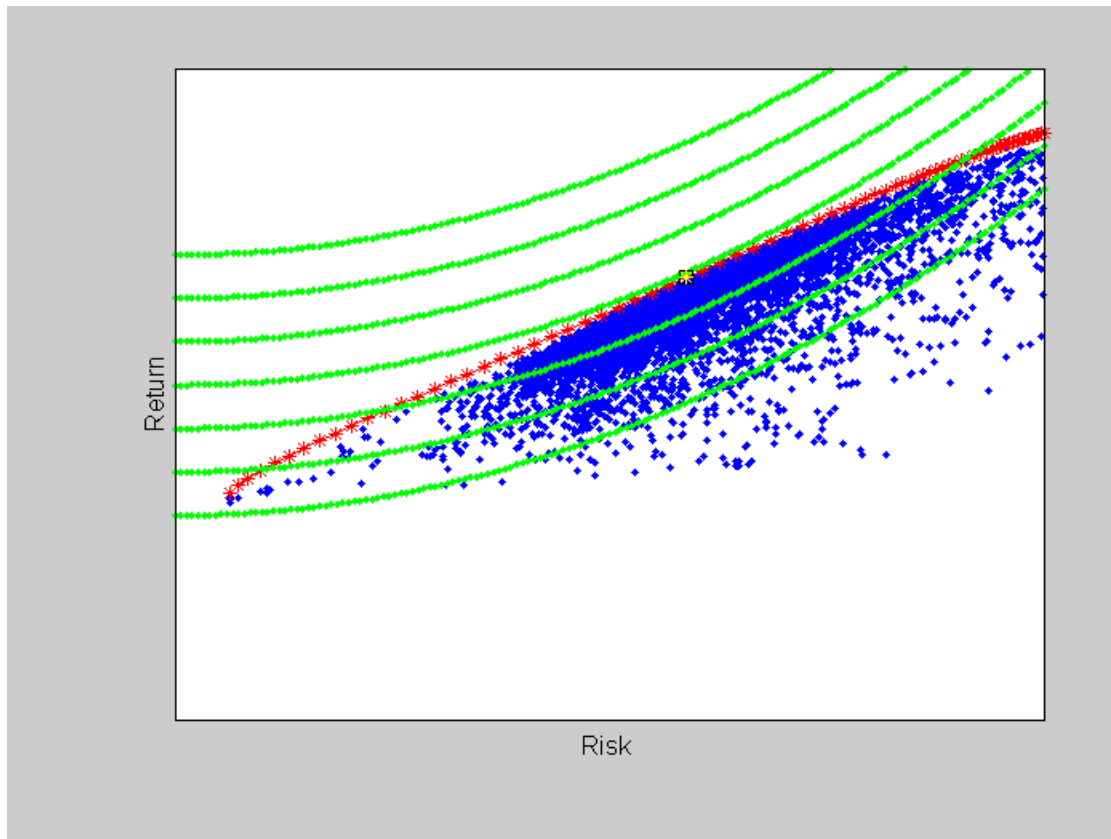


# Ideal Implementation

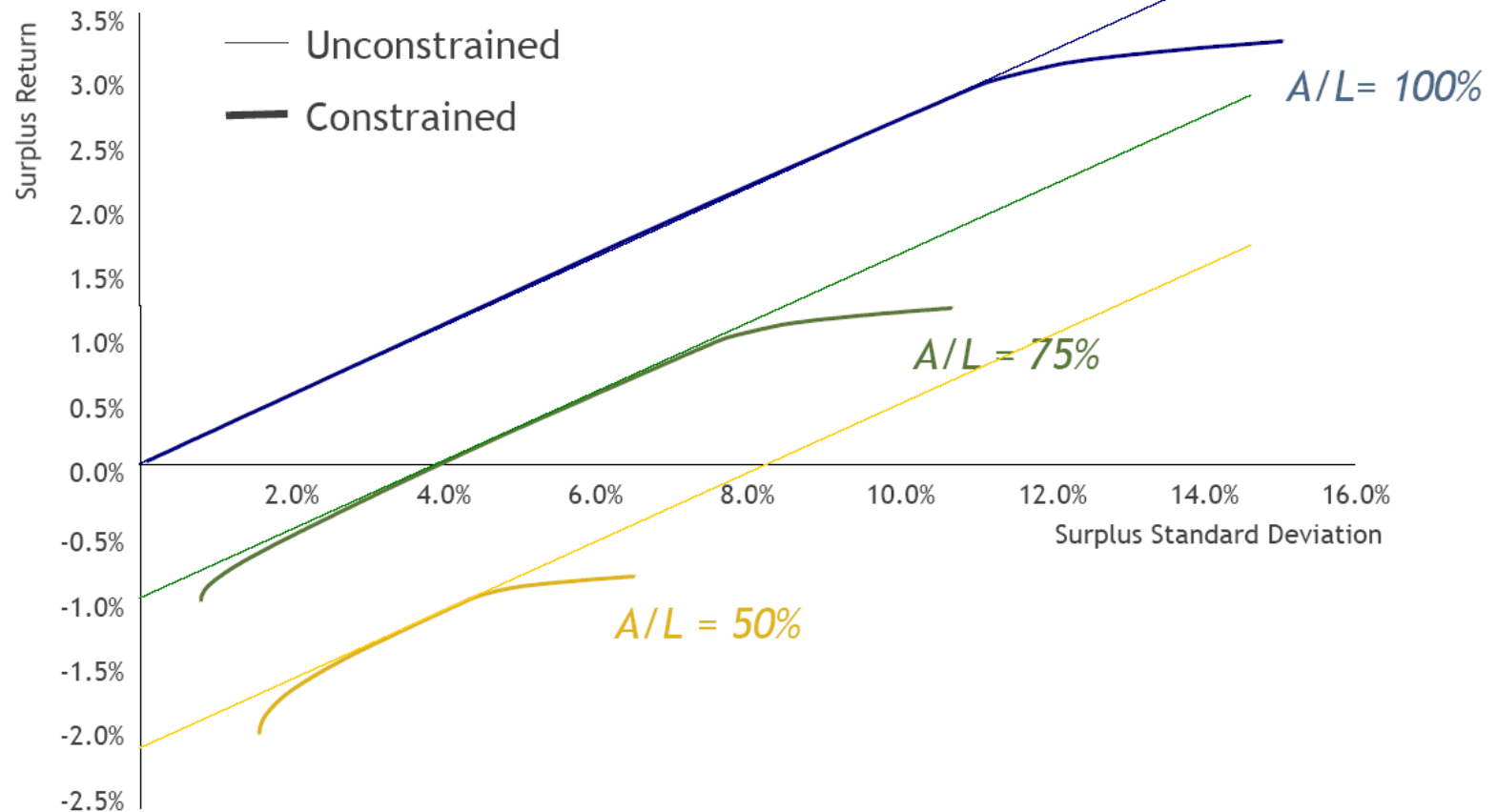
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- Redo Asset/Liability Study
- Use current
  - Asset risk and return projections
  - Funded status
- With board
  - Infeasible
- Without board
  - Requires estimate of board's utility function

# Inferring Board Risk Tolerance



# Effects of Changes in Funded Ratio





# Optimal Procedure for Revising Asset Allocation Policy

---

- Revise investment forecasts using
  - Current Asset Market Values
  - Reverse Optimization or a more general equilibrium model
- Find new asset allocation using
  - Current investor positions (e.g. liabilities)
  - Current investor preferences
  - Optimization



# Rebalancing to Prior Asset Allocation Policy

---

- A contrarian strategy
  - Sells relative winners
  - Buys relative losers
- Not macro-consistent in the short run
  - Only a minority of investors can follow such a strategy
- Assumes
  - Markets are inefficient (bets on reversals), and/or
  - Fund's risk aversion affected less by changes in wealth than that of average investor





# An Example with Two Asset Classes

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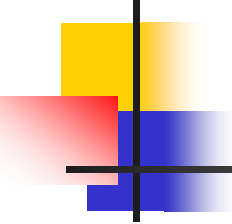
- Bonds:
  - Lehman Aggregate
- Stocks
  - Wilshire 5000
- Results generalize to more than two asset classes

# United States: Stocks / (Stocks+ Bonds)



Average, 197901-200406 = 60.2%

Stocks: Wilshire 5000  
Bonds: Lehman Aggregate



# Returns and Market Value Changes: 197901-200406

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	Stocks	Bonds	Stx-Bds
MV % Change	11.96	10.96	1.00
Return	14.01	9.10	4.91

12\*average monthly returns and percentage changes

Stocks: Wilshire 5000

Bonds: Lehman Aggregate



# June 2003: Initial Policy

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	Port %	Mkt \$	Mkt %	P% / M%	P%-M%	RelRatio
Bonds	40.0%	\$8,150	41.8%	0.956	-1.8%	0.927
Stocks	60.0%	\$11,337	58.2%	1.031	1.8%	1.000
Total	100.0%	\$19,486	100.0%			

Relative Ratio:

$$\frac{\text{P\%/M\% for asset}}{\text{P\%/M\% for stocks}}$$



# June 2004: Rebalancing to Initial Policy

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	Port %	Mkt \$	Mkt %	P% / M%	P%-M%	RelRatio
Bonds	40.0%	\$7,944	36.6%	1.092	3.4%	1.153
Stocks	60.0%	\$13,739	63.4%	0.947	-3.4%	1.000
Total	100.0%	\$21,683	100.0%			



# June 2004: Market-Adjusted Policy

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	(a)	(b)	(a*b)	(a*b)/sum
	Init Policy	MV Ratio	product	New Policy
Bonds	\$40.0	0.975	\$39.0	34.9%
Stocks	\$60.0	1.212	\$72.7	65.1%
Sum	\$100.0		<b>\$111.7</b>	100.0%



# June 2004:

## Market-Adjusted Policy Characteristics

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	Port %	Mkt \$	Mkt %	P% / M%	P%-M%	RelRatio
Bonds	34.9%	\$7,944	36.6%	0.953	-1.7%	0.927
Stocks	65.1%	\$13,739	63.4%	1.027	1.7%	1.000
Total	100.0%	\$21,683	100.0%			



# Waring

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- “Manage the plan’s economics.
- The accounting will follow, sooner or later.”





# Final Vote

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Asset Allocation Policy should be set  
and implemented using



Market Values



Smoothed Values