Pension Plan Management: Assumptions for a New Century

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Ontario Teachers' Pension Plan Board

Overview

➢ **Demographic Trends**

➢ **Economic Assumptions**

➢ **Surplus and Asset Mix**

➢ **Financial Markets**

➢ **Surplus Risk Management**

➢ **Real Retirement Income and Fiscal Policy**

Teachers' Assumptions

➢ **Demographic Trends**
 – **Slow Rise In Active Membership**

➢ **Economic Assumptions**
 – **3% Real North-American Growth, 2% Inflation**
 – **3.5% Real Risk Free Return, 2% Equity-Bond Spread**

➢ **Surplus and Asset Mix**
 – **Real Assets, Stocks Best Fit With Liabilities**

➢ **Financial Markets**
 – **Risk of Surplus Loss Very High Near Term**

➢ **Surplus Risk Management**
 – **Benefit and Surplus Policy Key To Risk Control**

➢ **Real Retirement Income and Fiscal Policy**
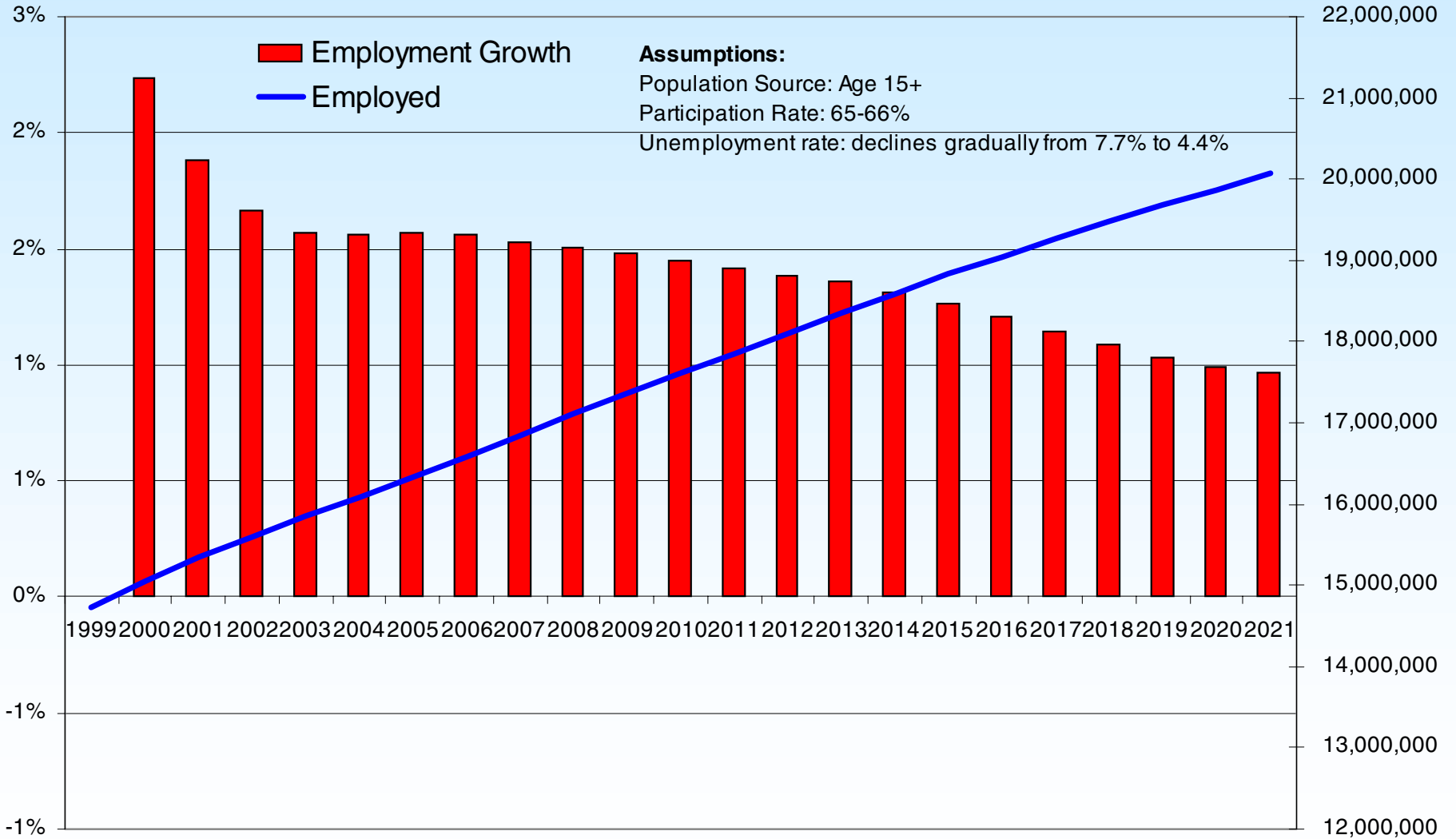 – **Real Value of Pensions May Not Be as High As Assumed**

Demographics

- ➢ **Population Growth 1% or Less**
  - – **Affects GDP More Than GDP/Capita**

- ➢ **Employment/Population: Conflicting Trends**
  - – **Aging Population - Healthier Population**
    - » **Falling Unemployment**
    - » **Falling Participation Rates**
    - » **Higher Participation in Part-Time Employment**
  - – **Is Retirement Economically Feasible for All**
    - » **Real Value of Retirement Income**
      - ◆ **Relative Price Shift?**
      - ◆ **Real Private Cost of Medical Care**

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Employment Projection by Strategic Projection
Growth rate from 2000 to 2021: 1.4%

Legend:
- Employment Growth
- Employed

Assumptions:
Population Source: Age 15+
Participation Rate: 65-66%
Unemployment rate: declines gradually from 7.7% to 4.4%

Teachers' Fund is Aging

In 1990:

Actives: 138,000

Pensioners: 37,700

Pensioners In Their 50s: 18%
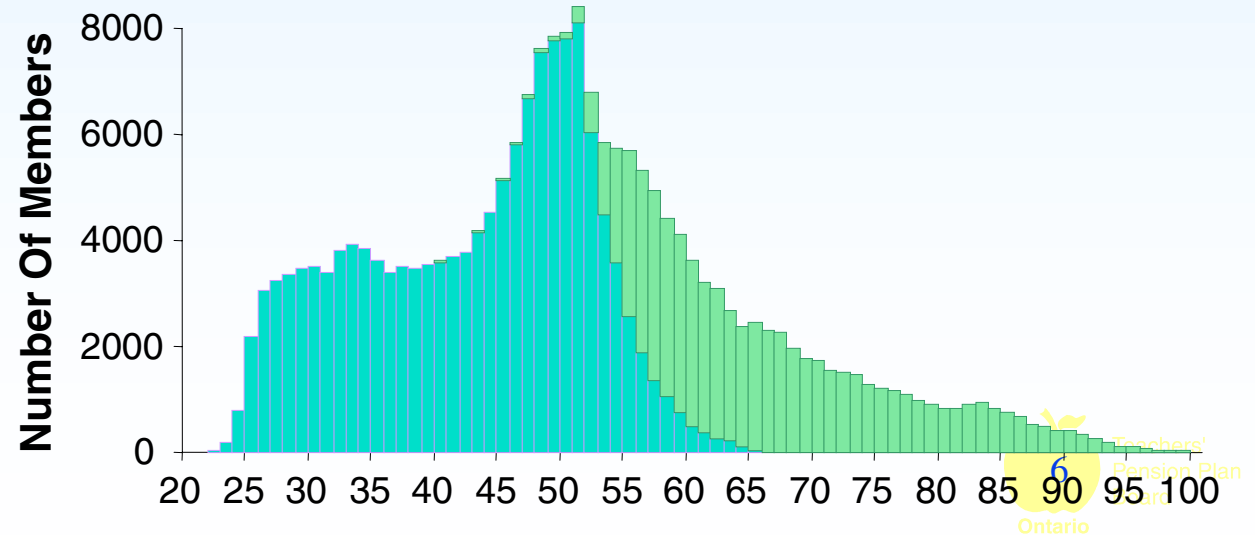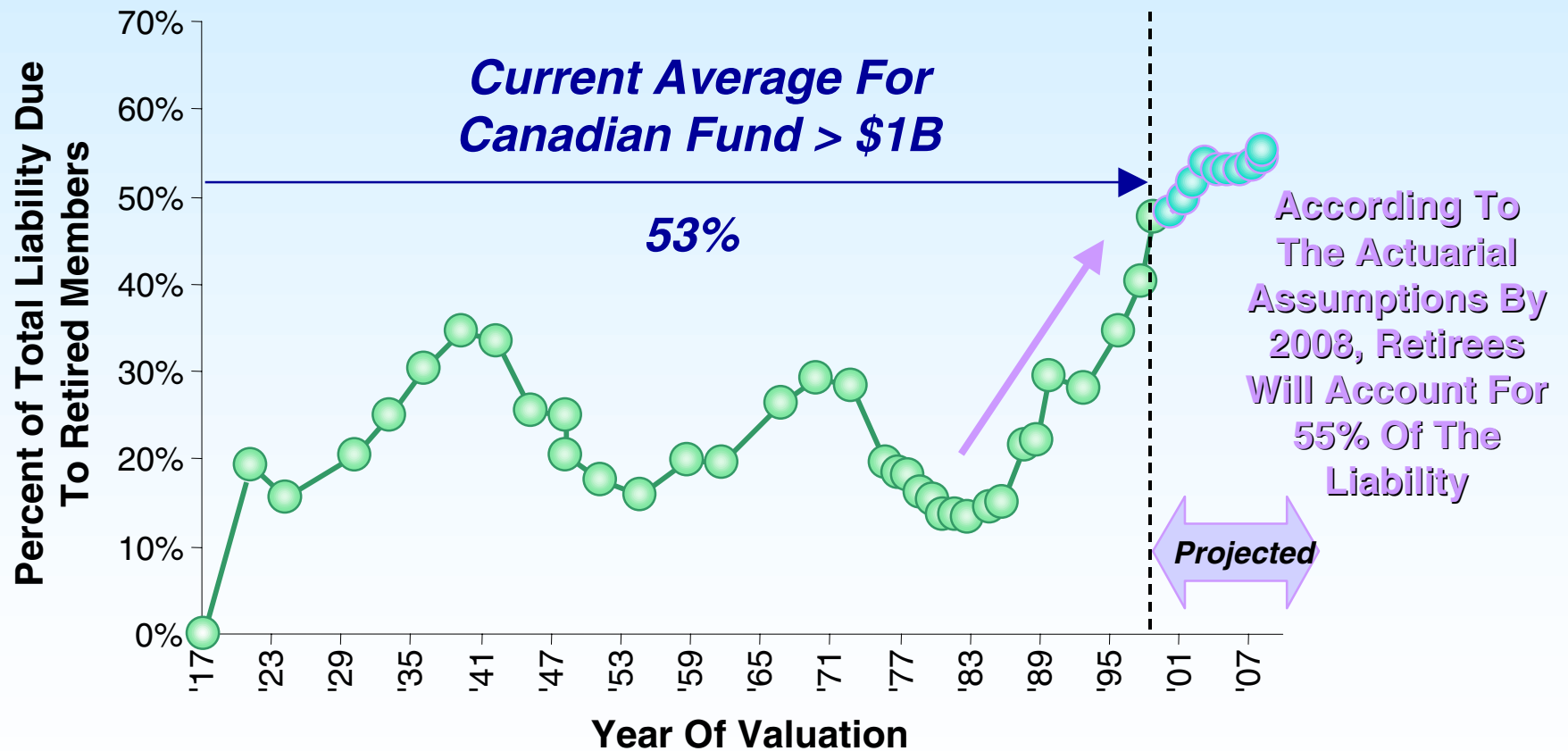
+ 6,200

+ 30,300

In 1999:

Actives: 144,200

Pensioners: 68,000

Pensioners In Their 50s: 32%

Active Members

Pensioners & Survivors

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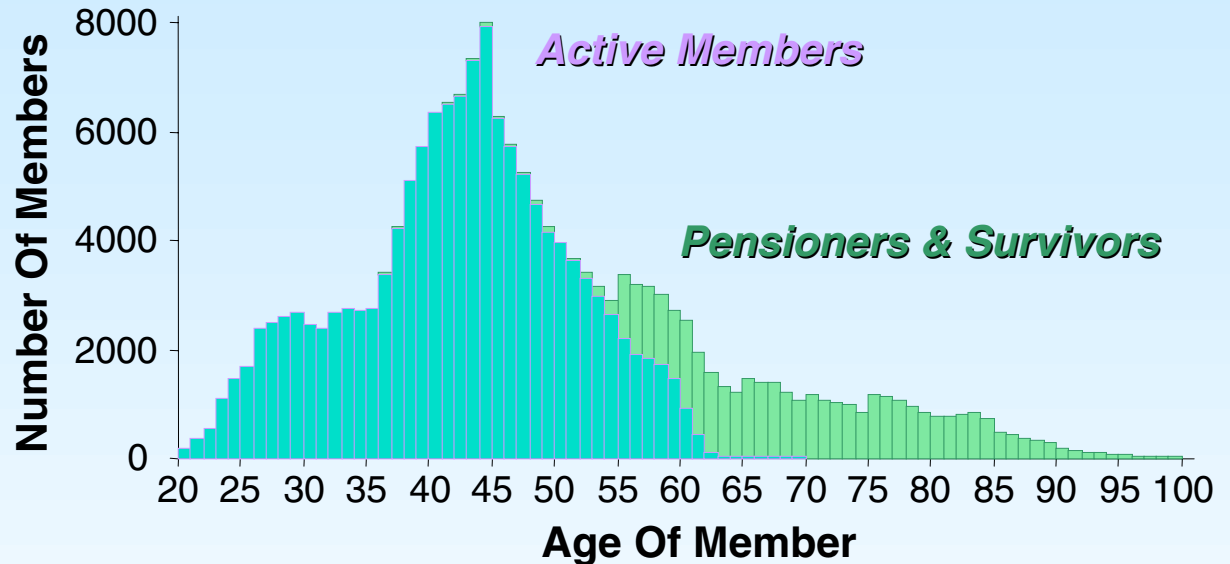
% of Liability Due to Retirees Is Rising
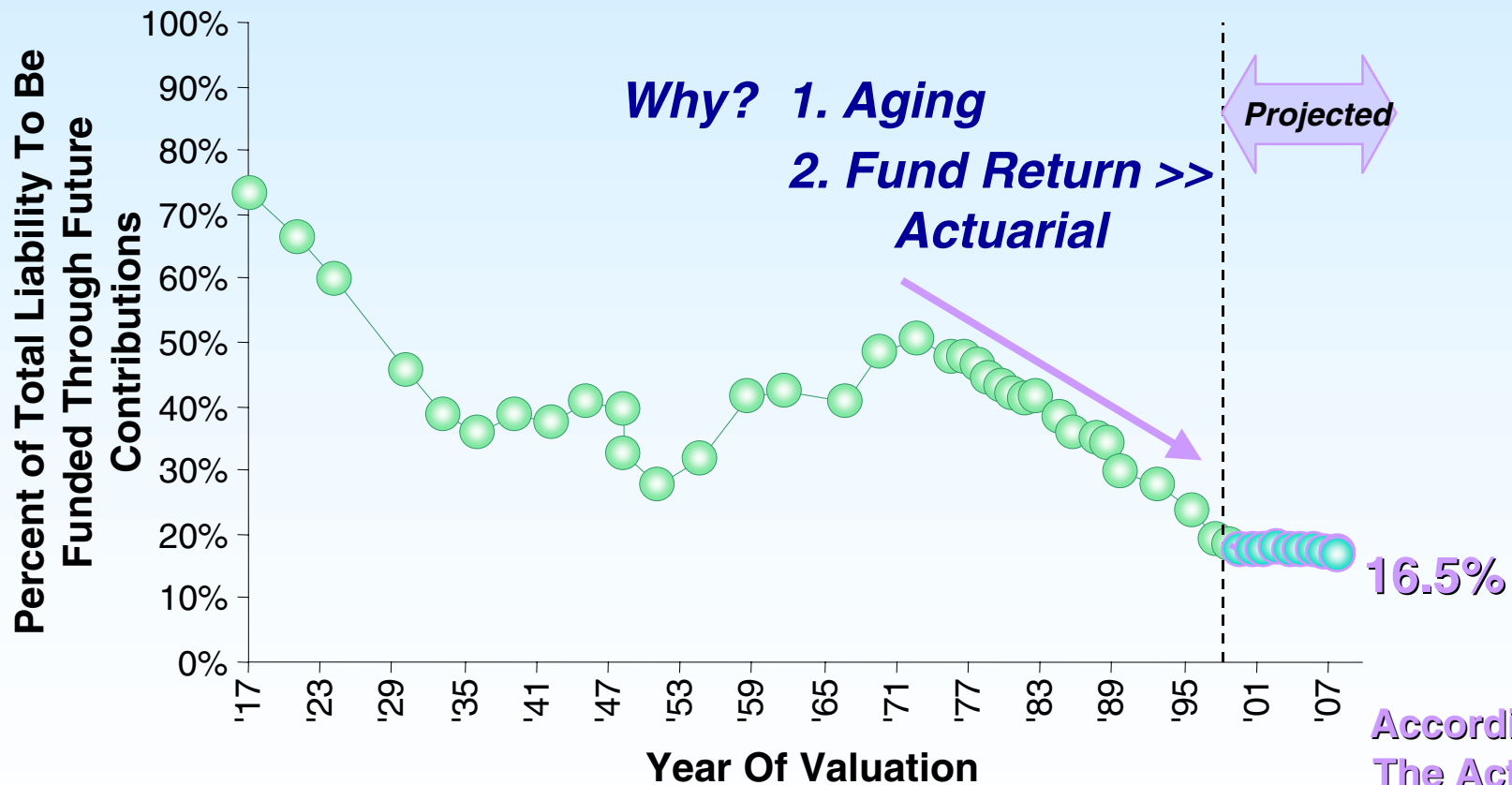
Contributions/Liabilities Falling

Percentage Of Total Liability To Be Funded Through Future Contributions

Why? 1. *Aging*

2. *Fund Return >> Actuarial*

Projected

16.5%

Percent of Total Liability To Be Funded Through Future Contributions (y-axis: 0% to 100%)

Year Of Valuation ('17 to '07)

According To The Actuarial Assumptions

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Contribution Risk Rising

Increase In Teachers' Contribution Rate For A 1% Investment Shortfall

Y-axis: **Increase In Teachers' Contribution Rate For A 1% Investment Shortfall** (0.0% to 1.0%)

X-axis: **Year Of Valuation** ('17 to '07)

1% Investment Shortfall, Teachers' Contribution Rate Will Increase by 0.9%

According To The Actuarial Assumptions

Projected

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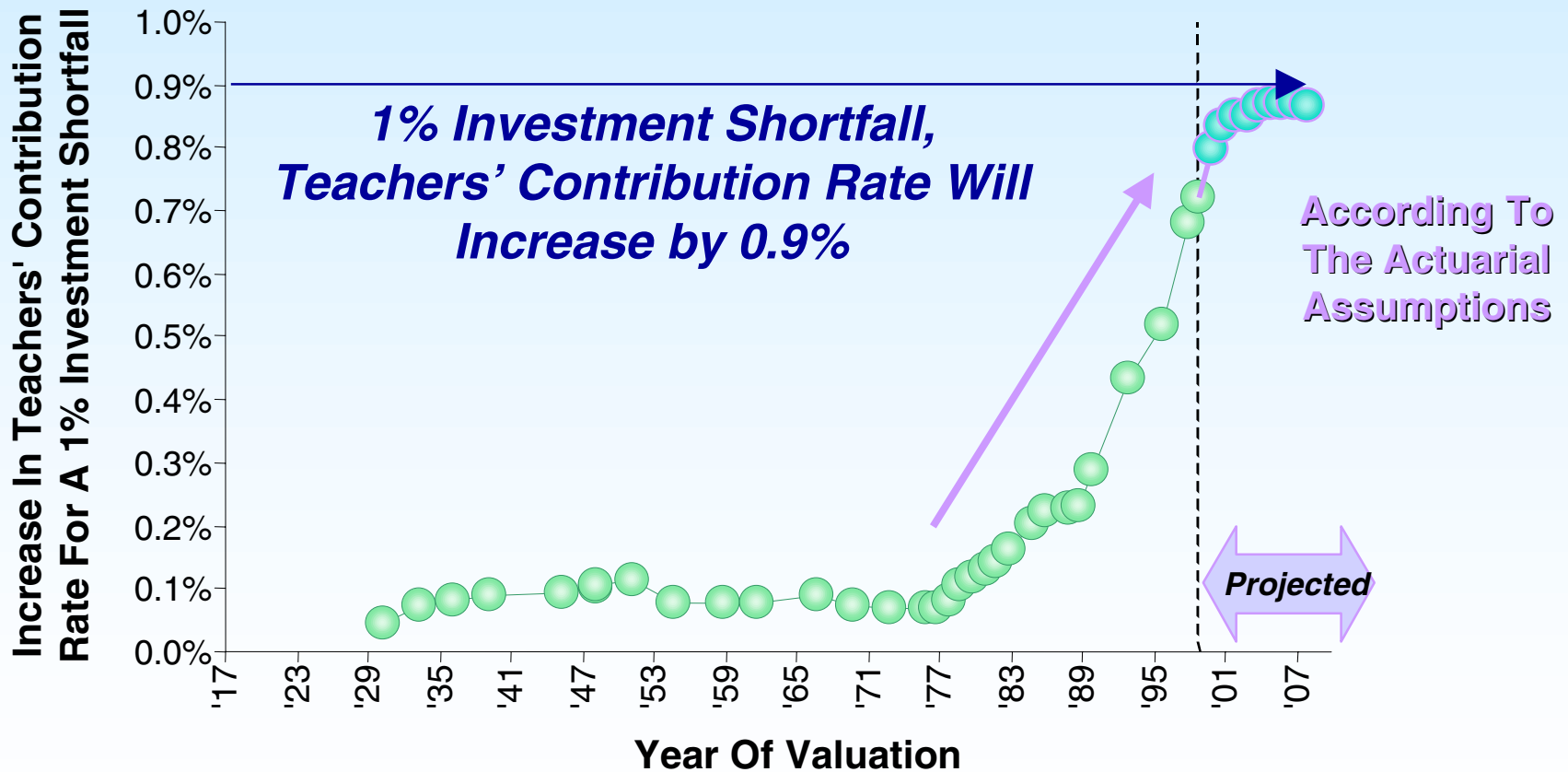
Implications of Aging

- **Active, Retired Member Interests Can Diverge**
  - **If Expected Return on Assets Is High**
    - » **High Volatility, Lower Average Cost of Pensions**
  - **If Expected Return on Assets Is Mediocre**
    - » **High Volatility, High Average Cost of Pensions**

- **Very High Demand for Teachers**
  - **May Induce Structural Change In Education**

Economic Assumptions

> **Near Term:**
>   - **2000: ~ 4% Real Growth + 2.5% Inflation**
>   - **2001: ~ 3% Real Growth + 2.5% Inflation**

> **Medium Term**
>   - **2002-2005: ~ 2% + 2% Inflation**

> **Next Cycle**
>   - **2006-2015: ~ 4% + 2% Inflation**

> **Very Long Term**
>   - **Beyond 2015: ~3% + 2% Inflation**

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Economic Assumptions (2)

➢ **Labour Productivity and Real Wages: 2-2.5%**

 – **1% -1.5% Capital Deepening**

  » **Drop in Cost Of Capital Equipment**

 – **Up to 1% From Technological Change**

  » **Innovation**

  » **More Efficient Sourcing of Inputs**

  » **Lower Materials Intensity**

➢ **Employment Growth: Trending Down to 1%**

 – **Population Growth (Slowly falling)**

 – **Lower Unemployment (Limited)**

 – **Labour Participation Rate (Stable?)**

Economic Assumptions (3)

- ➤ **Real Interest Rates**
  - **Should Be Slightly Above Economic Potential**
  - **3.5% May be Too Low.**
    (N.B.: Bond Yield – Current Inflation Not Reliable)

- ➤ **Savings Rate**
  - **Correlated with Inflation and Unemployment**
  - **Positively Correlated With Equity Performance**
    - » **1% of US Consumption Linked to Wealth**
  - **Link to Demographics Ambiguous**
    - » **Current Rate Far too Low**
    - » **Aversion to Fiscal Tax Expenditure Just Poor Accounting**

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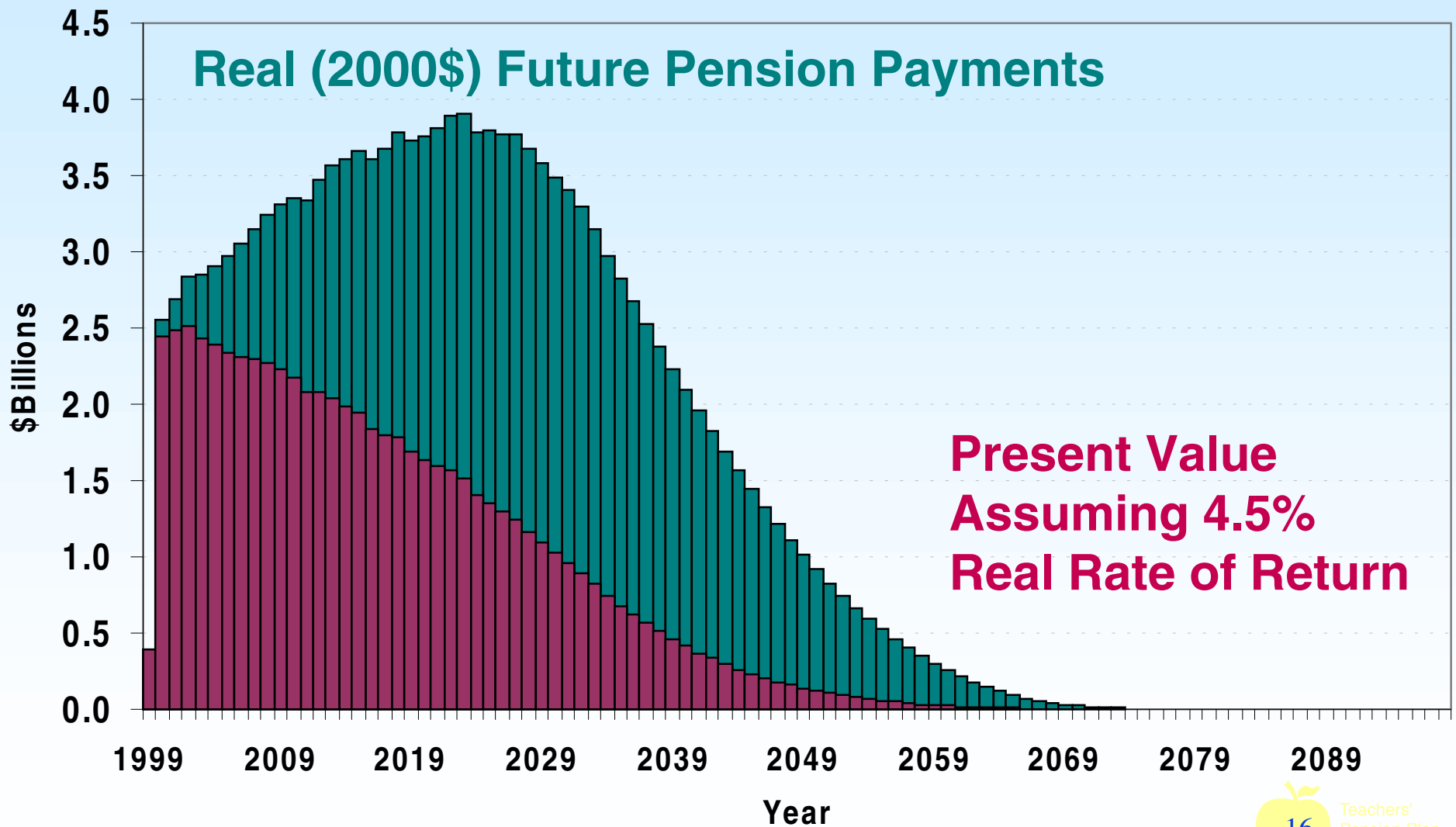Teachers'
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Typical Teacher

- **Started in 2000, Will Work For 30 Years**
  - **Average Salary $50,000**

- **Will Be Retired For 30 Years**
  - **Abstracting from Demographic Uncertainty**

- **Gets $25,000/yr From Plan in 2000 Dollars**
  - **CPP Pays The Balance**

- **What Contribution Rate Will Fund Pension?**

Real Returns & Contribution Rates

Real Return	Contribution Required to Earn 50% Pension % of Salary (Real Wage Constant)		
0%	50%	=	$50\% / (1+0.00)^{30}$
1%	37%	=	$50\% / (1+0.01)^{30}$
2%	28%	=	$50\% / (1+0.02)^{30}$
3%	21%	=	$50\% / (1+0.03)^{30}$
4%	16%	=	$50\% / (1+0.04)^{30}$
5%	12%	=	$50\% / (1+0.05)^{30}$
6%	9%	=	$50\% / (1+0.06)^{30}$

Need 0.5% More Than 4% to Cover Real Wage Gains

Real Pension Promise 2000-2099

Real (2000$) Future Pension Payments

Present Value Assuming 4.5% Real Rate of Return

$Billions

Year

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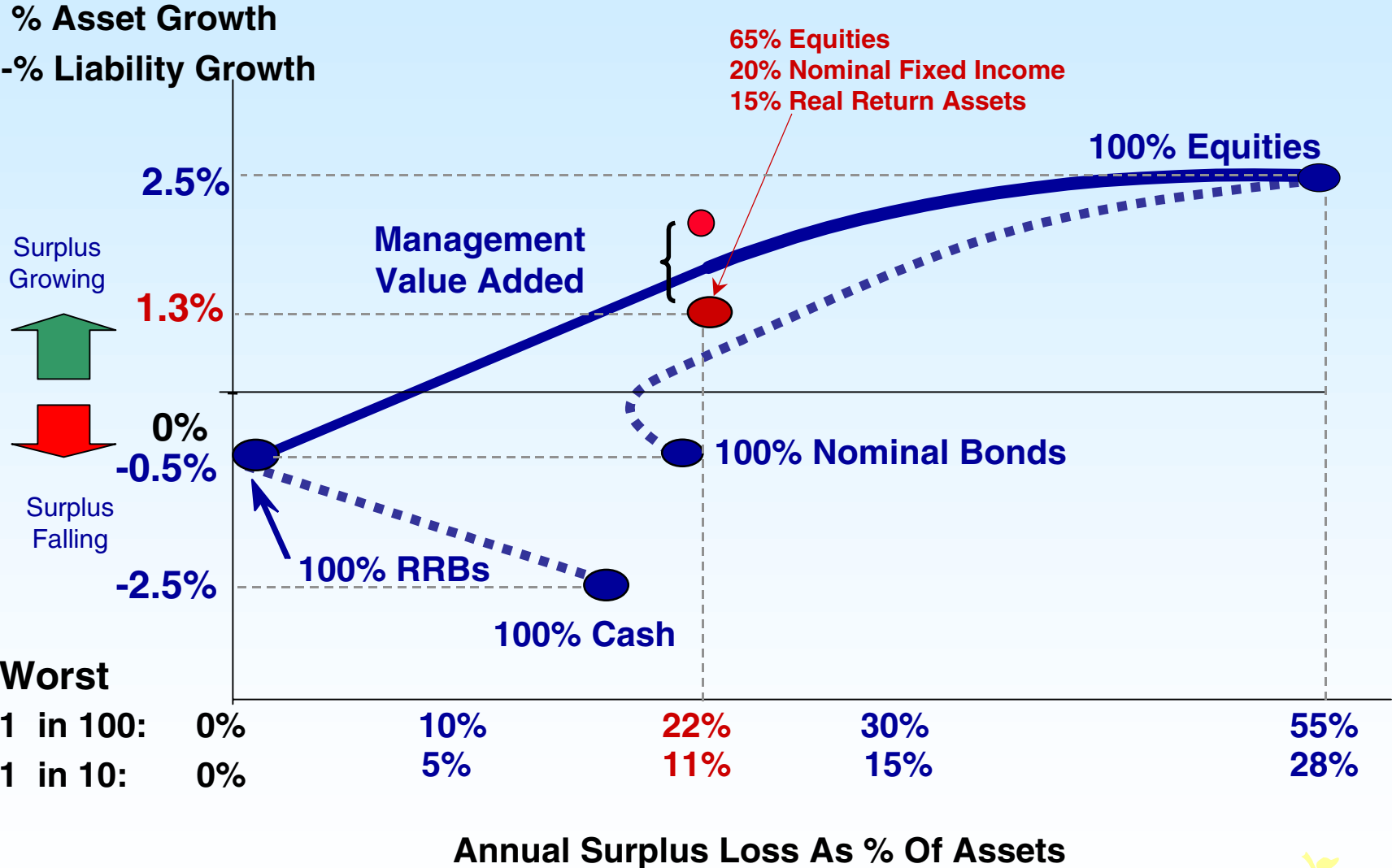Teachers' Pension Plan Board

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Matching Up is Hard To Do
No Perfect Fit Between Assets and Liabilities

➢ **Stable Real Return**
- ➢ **Assets Hard To Find**
- ➢ **Returns Usually Less Than 4.5%**

➢ **High Real Duration: Sensitivity to Change in Real Rates**
- ➢ **1% Change in Liabilities Changes Value by 15%-20%**
- ➢ **Only Real Return Bonds Come Close**

➢ **Low Risk: Probability of Loss**
- ➢ **Stocks: High Average Returns, High Risk Of ST Loss**
- ➢ **Real Rate Bonds: Modest Avg Returns, Low Risk of ST Loss**

➢ **Correlation: Tendency to Move Up and Down Together**
- ➢ **Assets Should Have High Correlation with Liabilities**
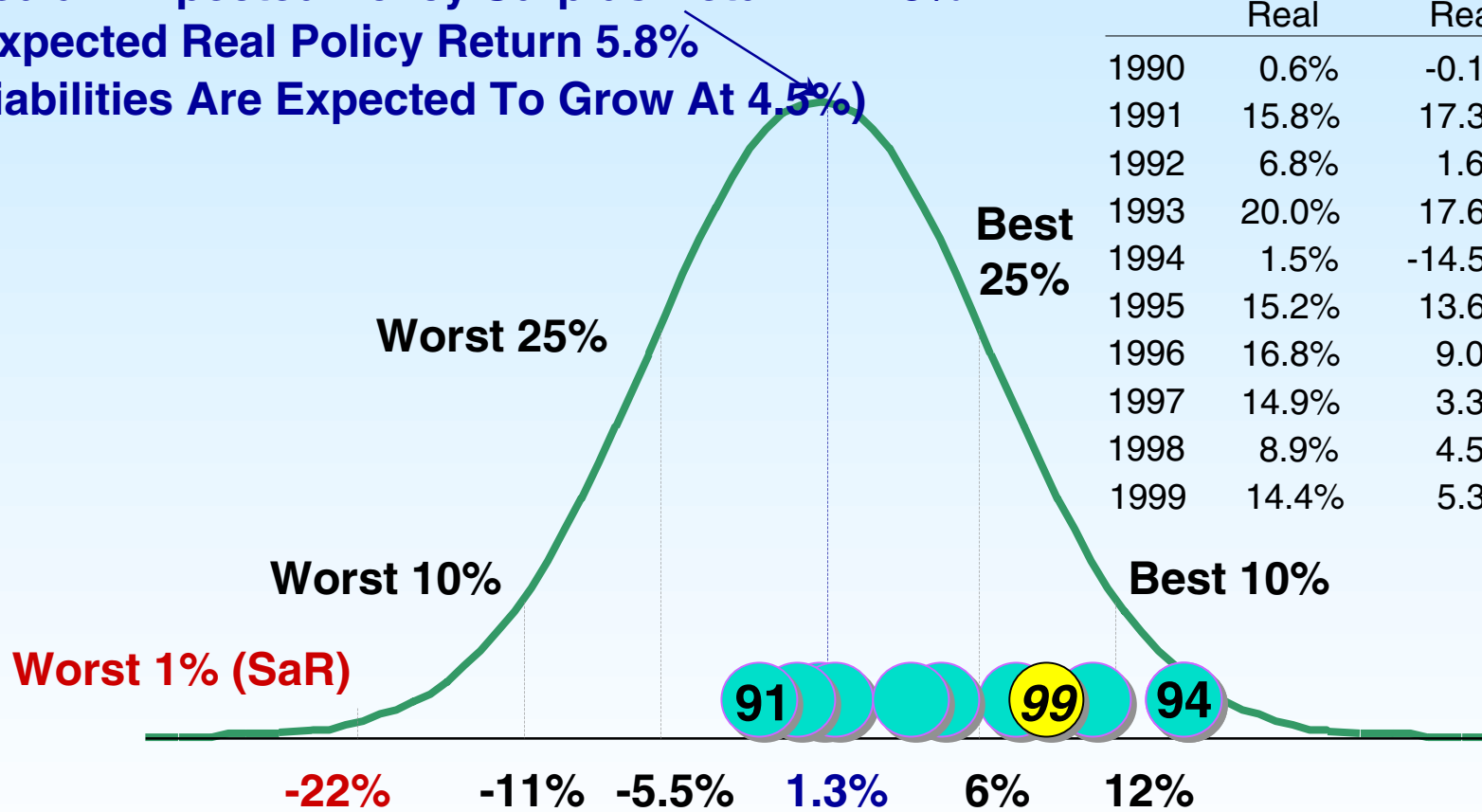- ➢ **Two Assets Ideally Have Low or Negative Correlation**

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Policy Surplus Risk And Return

% Asset Growth

-% Liability Growth

65% Equities
20% Nominal Fixed Income
15% Real Return Assets

100% Equities

2.5%

Surplus
Growing

Management
Value Added

1.3%

0%
-0.5%

Surplus
Falling

100% Nominal Bonds

100% RRBs

-2.5%

100% Cash

Worst

1 in 100:	0%	10%	22%	30%	55%
1 in 10:	0%	5%	11%	15%	28%

Annual Surplus Loss As % Of Assets

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Annual Surplus Risk And Return

Median Expected Policy Surplus Return = 1.3%
(Expected Real Policy Return 5.8%
 Liabilities Are Expected To Grow At 4.5%)

	Asset Real	Liability Real	Surplus
1990	0.6%	-0.1%	0.7%
1991	15.8%	17.3%	-1.5%
1992	6.8%	1.6%	5.2%
1993	20.0%	17.6%	2.4%
1994	1.5%	-14.5%	16.0%
1995	15.2%	13.6%	1.6%
1996	16.8%	9.0%	7.8%
1997	14.9%	3.3%	11.6%
1998	8.9%	4.5%	4.5%
1999	14.4%	5.3%	9.1%

Best 25%

Worst 25%

Worst 10%

Best 10%

Worst 1% (SaR)

91   *99*   94

-22%   -11%   -5.5%   1.3%   6%   12%

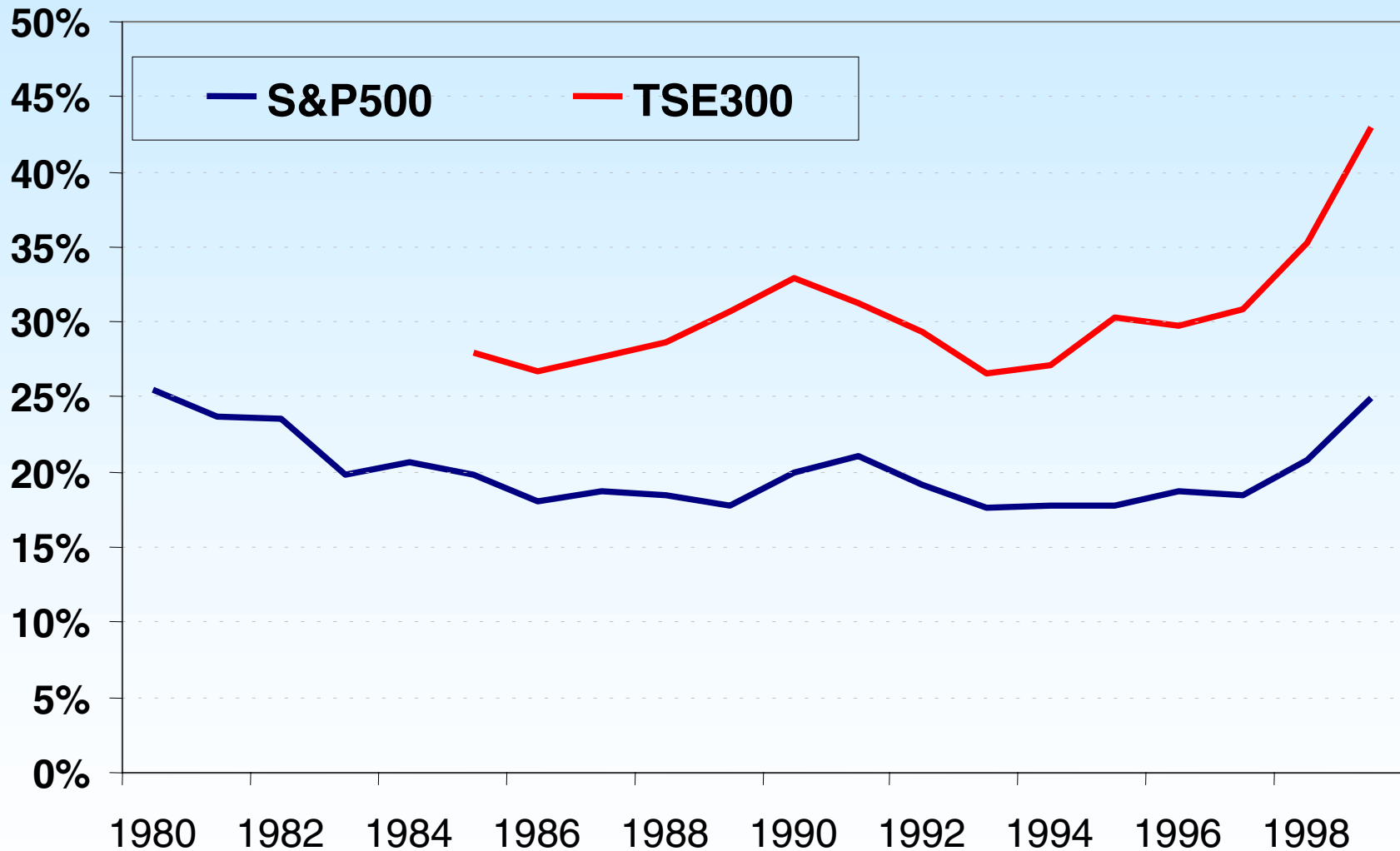**Surplus Growth = Asset Growth - Liability Growth**

Another Better Than Top Quartile Year
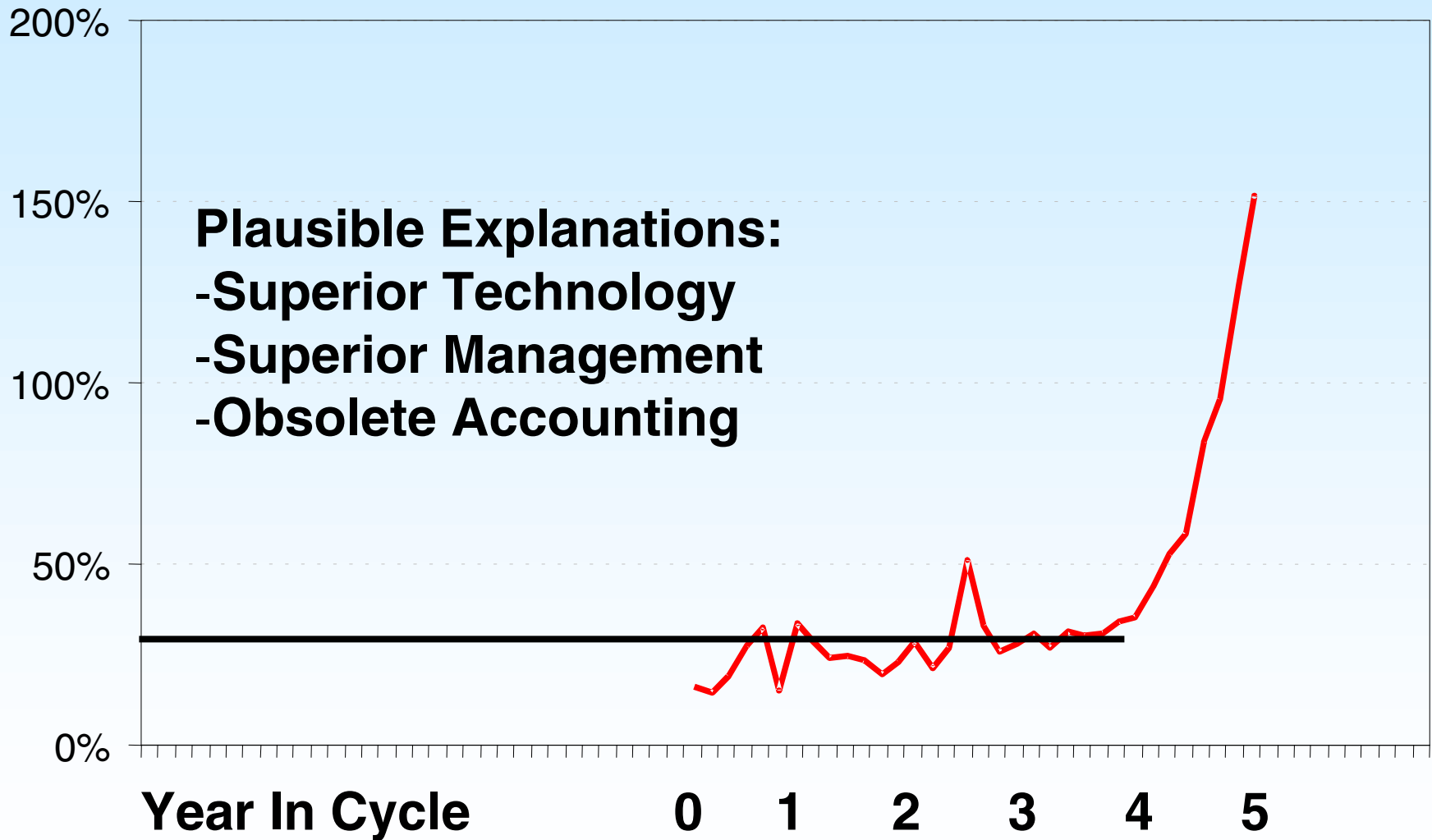
Why Are We Worried?

➢ **Disconnect Between Economy and Markets**

    – **Corporate Earnings Are Only Growing at the Rate of Economic Growth of around 5%**

    – **Earnings Forecasts Assume Growth of 15%**

    – **Long, Low Inflation Cycle Has Reduced Perceived Need for Equity Risk Premium**

➢ **Liquidity for U.S. Stock Purchases**

    – **Sources Drying Up**

➢ **Implication Of Drop In U.S. Market**

    – **All Markets Will Drop in Short Run**
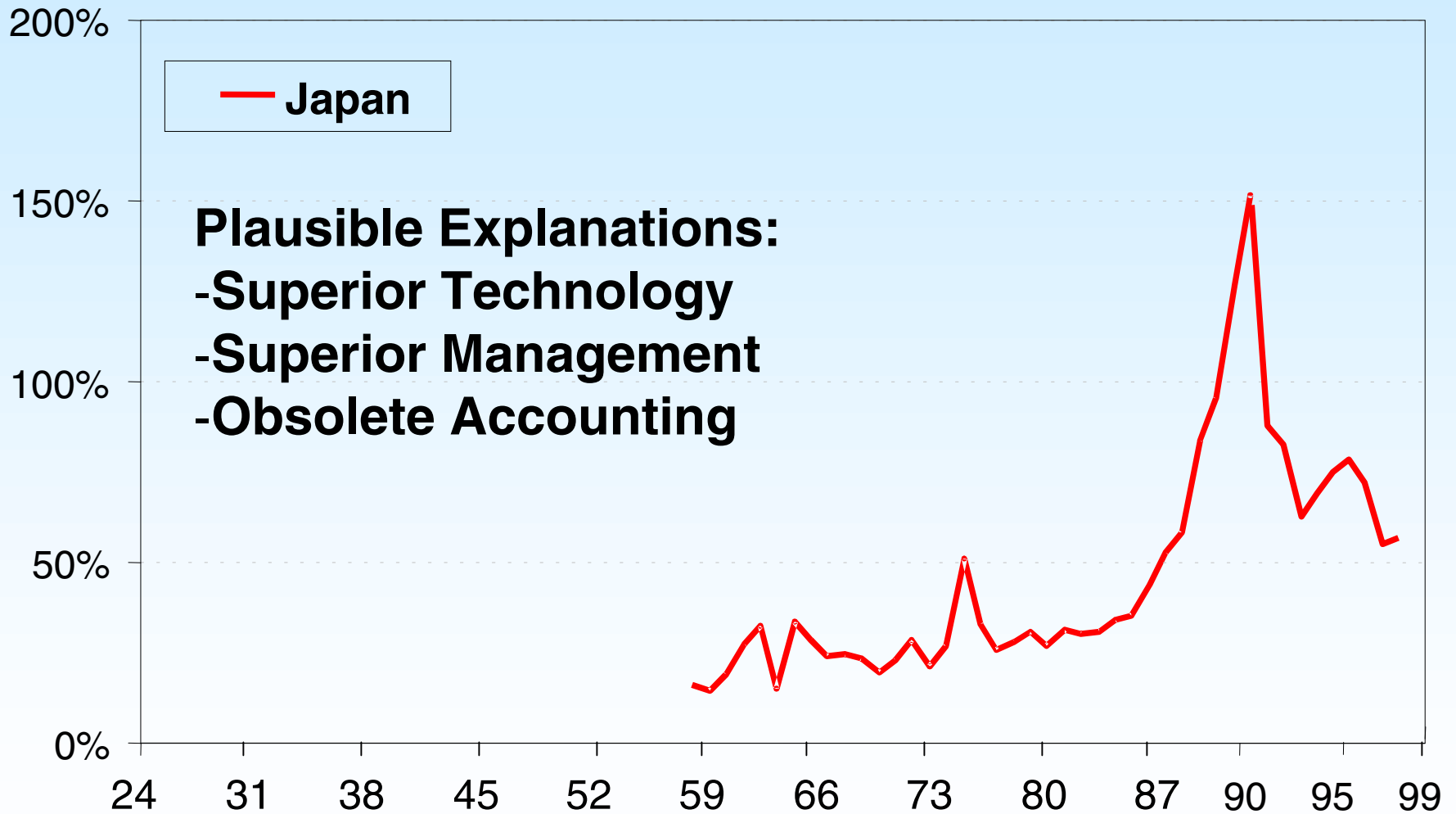
    – **Non-U.S. Should Recover Faster**
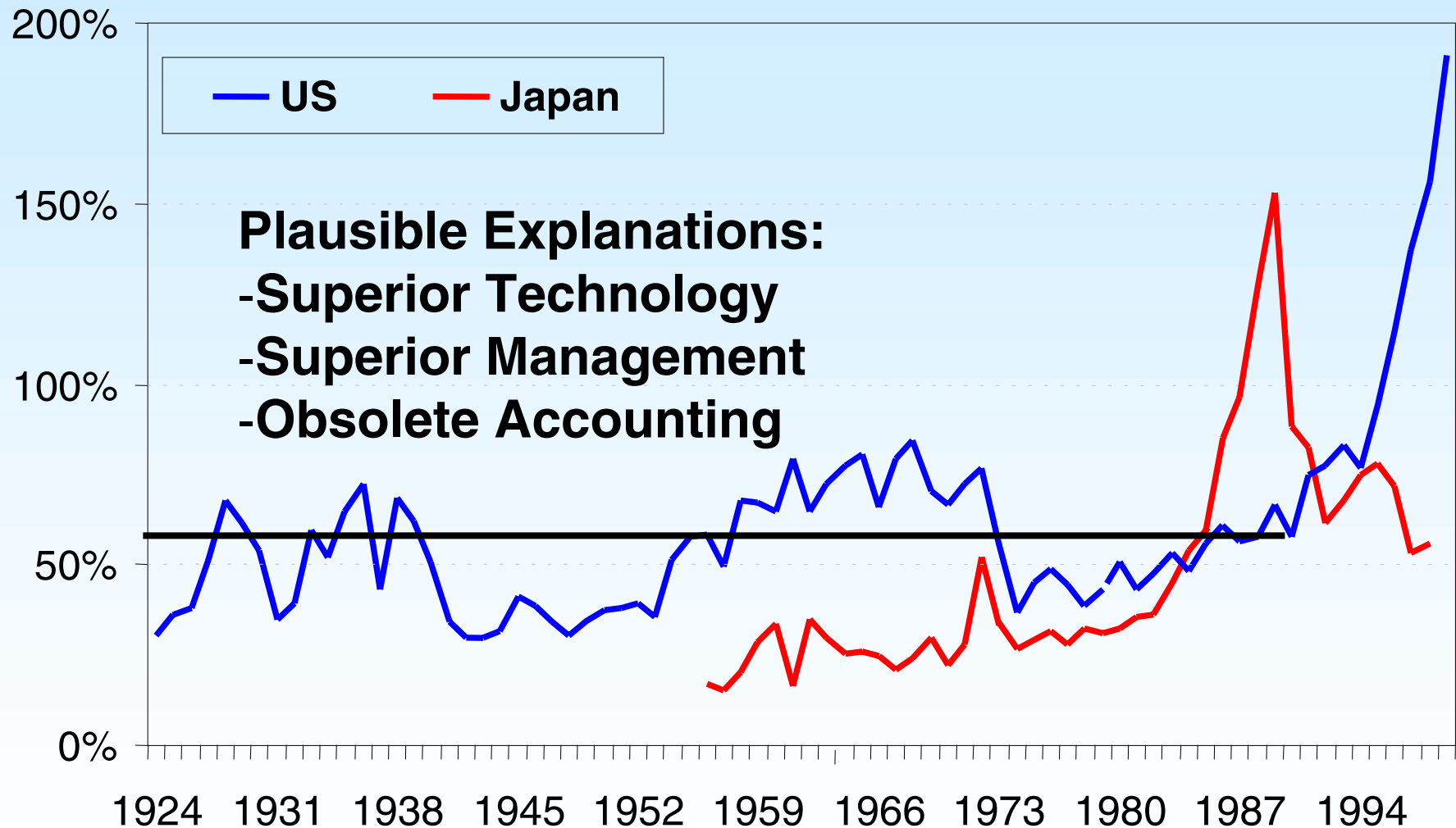
Weight of Largest 10 Largest Stocks

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Stock Market Value as % of GDP

Plausible Explanations:
-**Superior Technology**
-**Superior Management**
-**Obsolete Accounting**

200%

150%

100%

50%

0%

Year In Cycle　　　0　　1　　2　　3　　4　　5

Stock Market Value As % of GDP

Legend: — Japan

Plausible Explanations:
-Superior Technology
-Superior Management
-Obsolete Accounting

y-axis: 0%, 50%, 100%, 150%, 200%

x-axis: 24, 31, 38, 45, 52, 59, 66, 73, 80, 87, 90, 95, 99

Stock Market Value as % of GDP

Legend: US (blue), Japan (red)

Plausible Explanations:
-Superior Technology
-Superior Management
-Obsolete Accounting

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US Profits as a Share of GDP
Forecasts Assume 5% Nominal GDP Growth

X% — With Profit Growth Of x%

IBES Analysts' Long-term Earnings Growth

15%
10%
5%
0%

25

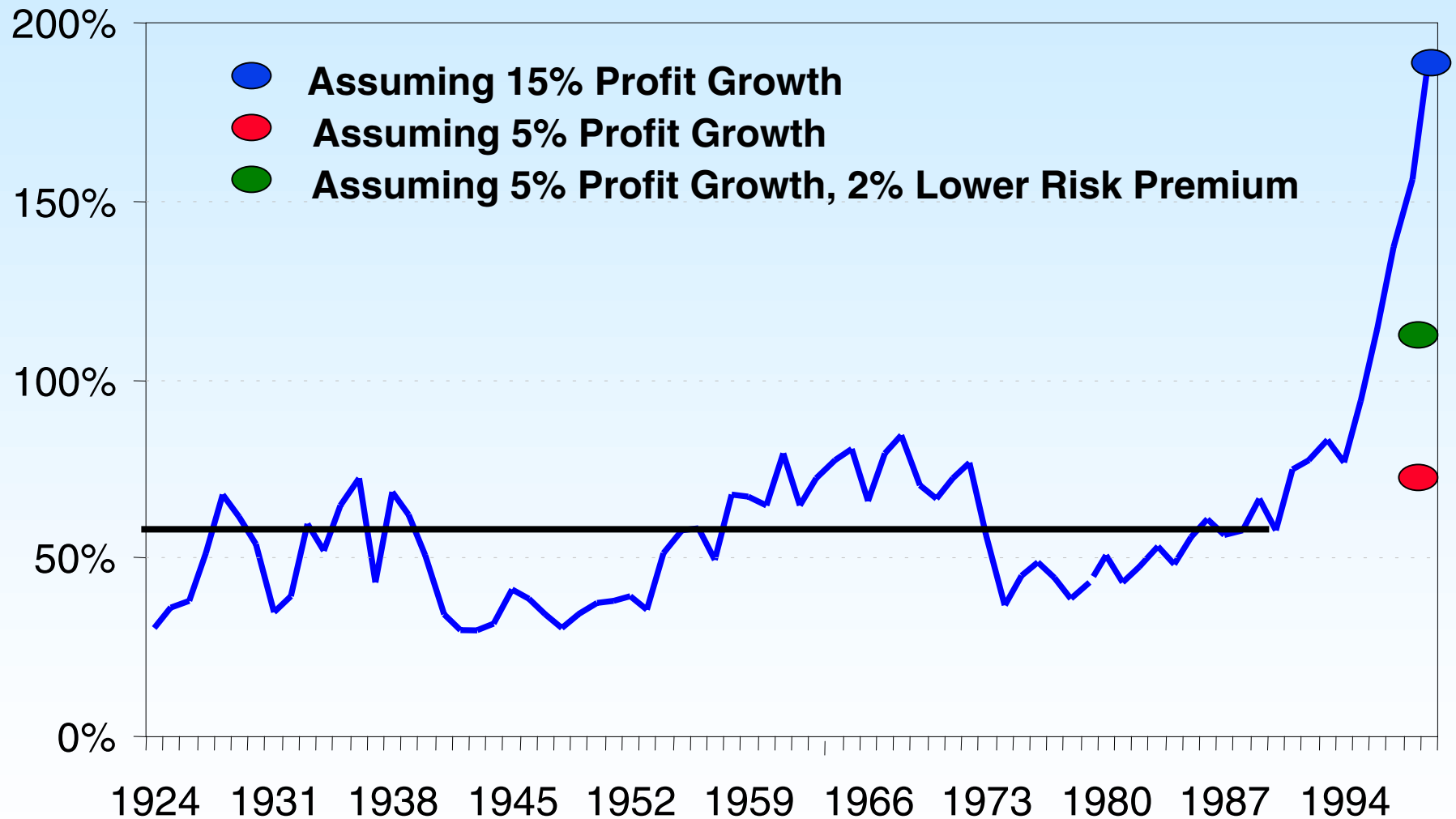Teachers' Pension Plan Board

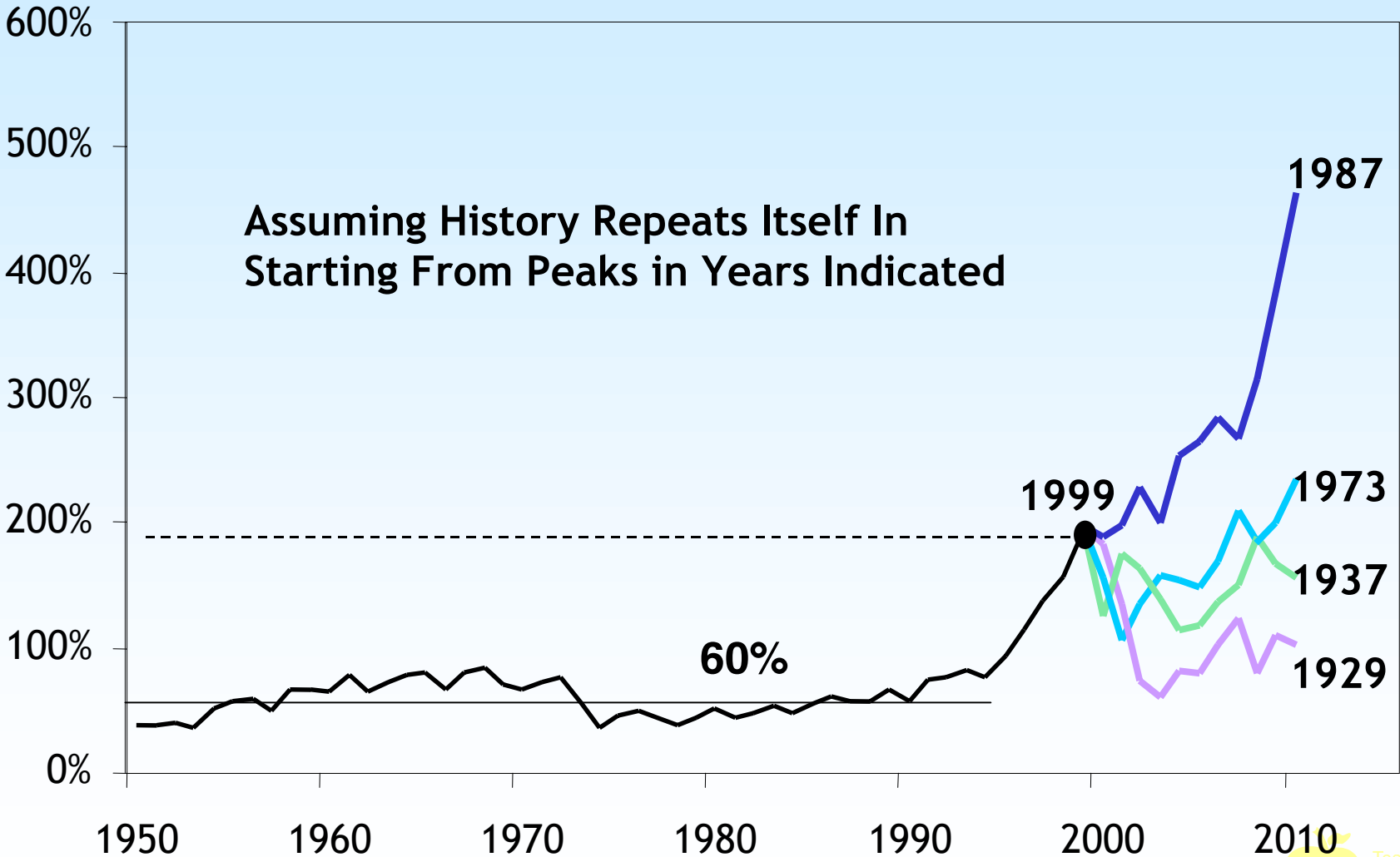Ontario
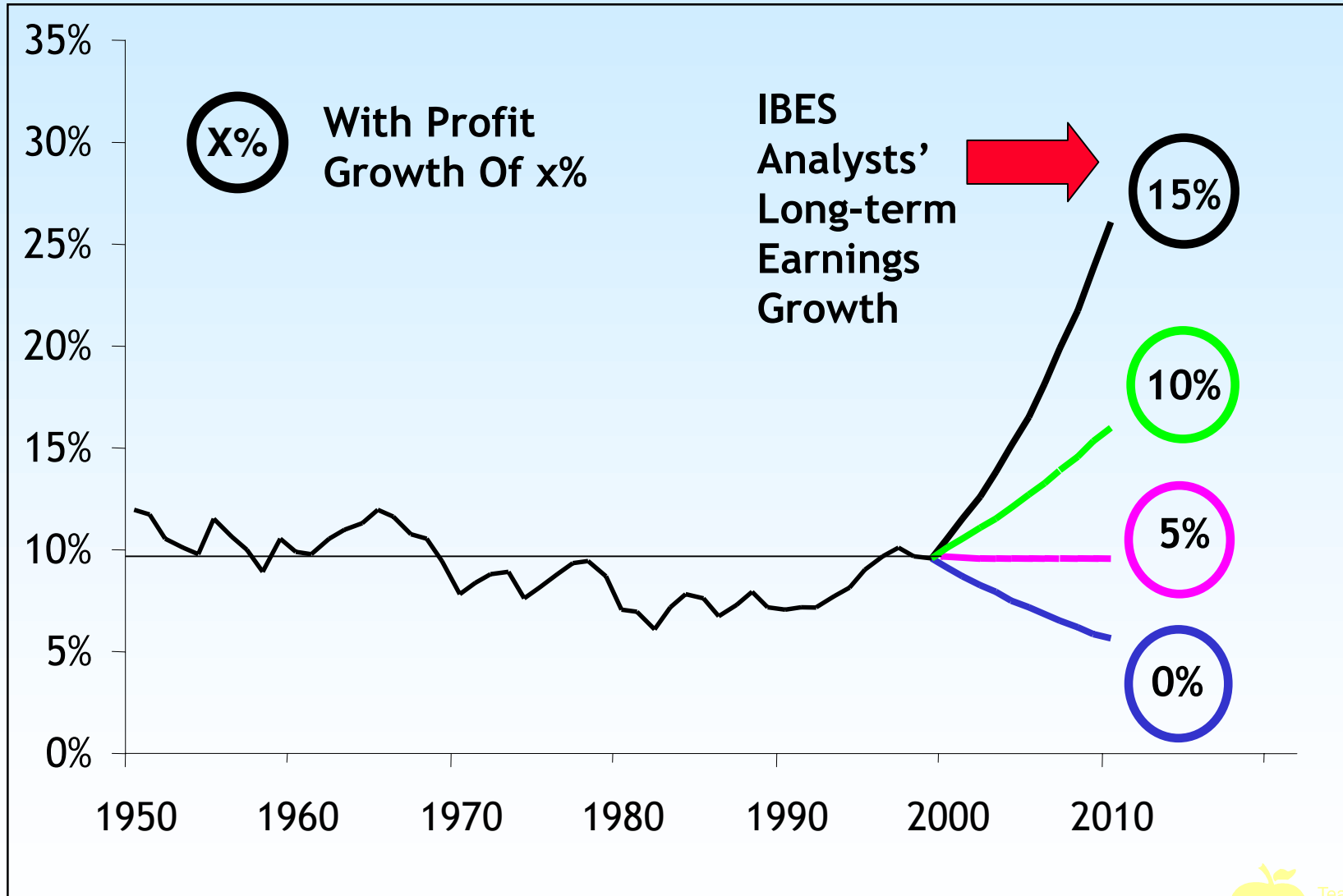
Lower Discount Rate For Earnings

➤ **Higher Productivity Raises Earnings Growth**

– **Real Rates Will Be Higher as Well**

➤ **GDP Stability Reduces Equity Risk Premium**

– **Evidence: 1-2 Reduction in Equity Premium**
  ***If* Stable Inflation Is Permanent**

➤ **Dow 36000: Equity Risk Premium Is Zero**

– **Implies Stock Return Equals Bond Return**

– **P/Es Of 100 "Reasonable"**

– **Very High Stock Sensitivity to Interest Rates**

– **But….If Returns Are same, Why Hold Stocks?**

U.S. Market Valuation as % of GDP

Legend:
- Assuming 15% Profit Growth
- Assuming 5% Profit Growth
- Assuming 5% Profit Growth, 2% Lower Risk Premium

Y-axis: 0%, 50%, 100%, 150%, 200%

X-axis: 1924, 1931, 1938, 1945, 1952, 1959, 1966, 1973, 1980, 1987, 1994

US Market Cap / GDP Scenarios
Forecasts Assume 5% Nominal GDP Growth

Assuming History Repeats Itself In Starting From Peaks in Years Indicated

1987

1973

1999

1937

60%

1929

600%

500%

400%

300%

200%

100%

0%

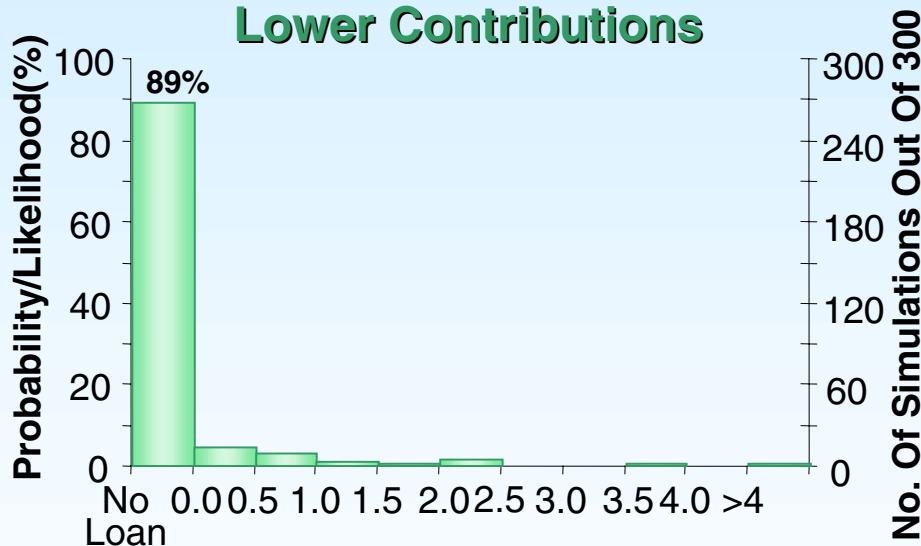1950   1960   1970   1980   1990   2000   2010

Controlling Contribution Risk

➢ **Investment Policy (Board)**

    ➢ **Choosing Assets That Resemble The Liabilities**
    ➢ **Earning Return > Actuarial Assumption**

➢ **Benefit Policy (Partners)**

    ➢ **Lower Contribution Or Improve Benefits Gradually**

➢ **Surplus Policy (Partners)**

    ➢ **Maintain A Surplus Cushion**
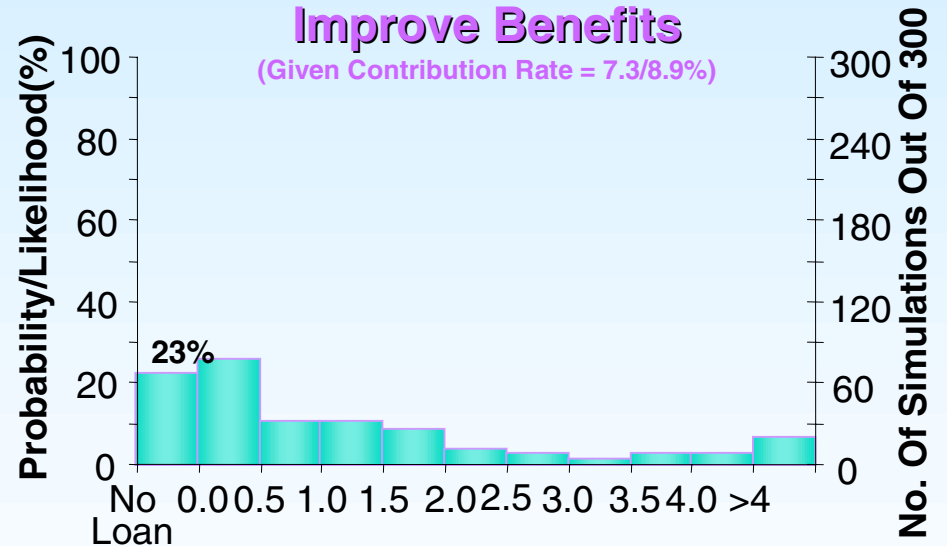
Zero Surplus Policy

Surplus Is Used To Lower Contributions

89%

Probability/Likelihood(%) — 100, 80, 60, 40, 20, 0

No Loan 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 >4

No. Of Simulations Out Of 300 — 300, 240, 180, 120, 60, 0

Risk=Size Of Largest Outstanding Loan Over Ten-Year Horizon In Billions

Probability Of No Loan = 89%

Average Size Of Loan   = $0.1B

Surplus Is Used To Improve Benefits
(Given Contribution Rate = 7.3/8.9%)

23%

Probability/Likelihood(%) — 100, 80, 60, 40, 20, 0

No Loan 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 >4

No. Of Simulations Out Of 300 — 300, 240, 180, 120, 60, 0

Risk=Size Of Largest Outstanding Loan Over Ten-Year Horizon In Billions

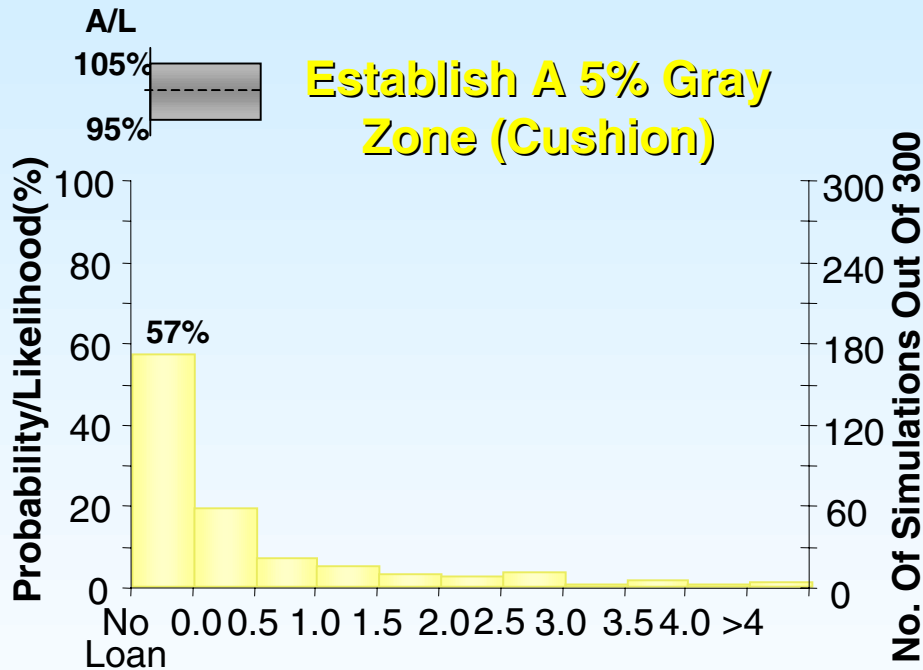**Probability Of No Loan = 23%**

Average Size Of Loan   = $1.3B

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Positive Surplus Policy

A/L
105%
95%

Establish A 5% Gray Zone (Cushion)

Rate Stabilization Fund
(With Next $6.2B Of Surplus)

Left chart:
- Y-axis (left): Probability/Likelihood(%) — 0, 20, 40, 60, 80, 100
- Y-axis (right): No. Of Simulations Out Of 300 — 0, 60, 120, 180, 240, 300
- X-axis: No Loan, 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, >4
- Bar labeled **57%**

Risk = Size Of Largest Outstanding Loan Over Ten-Year Horizon

Probability Of No Loan = 57%
Average Size Of Loan = $0.5B

Right chart:
- Y-axis (left): Probability/Likelihood(%) — 0, 20, 40, 60, 80, 100
- Y-axis (right): No. Of Simulations Out Of 300 — 0, 60, 120, 180, 240, 300
- X-axis: No Loan, 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, >4
- Bar labeled **98%**
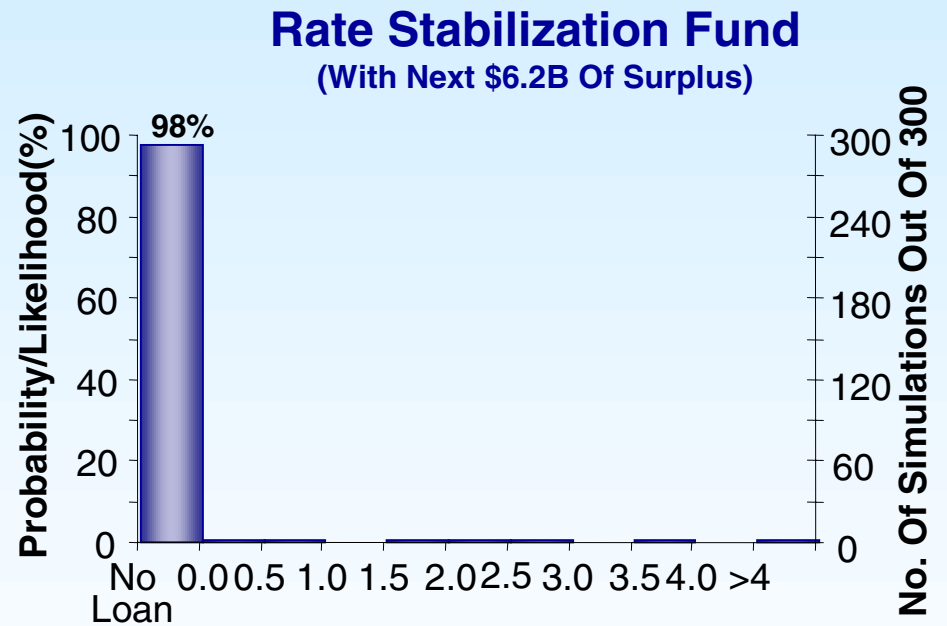
Risk = Size Of Largest Outstanding Loan Over Ten-Year Horizon

Probability Of No Loan = 98%
Average Size Of Loan = $0.1B

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Surplus Cuts Contribution Risk
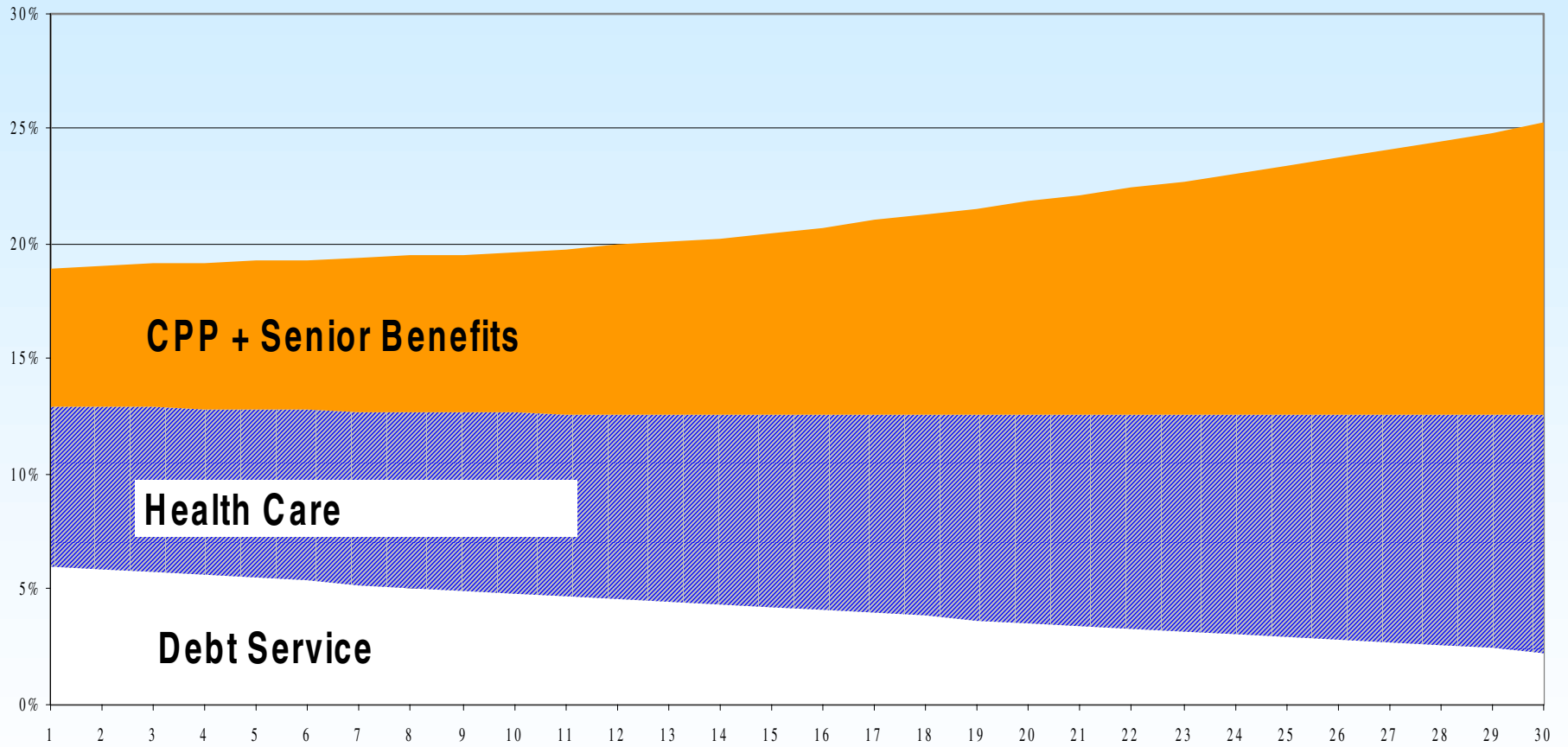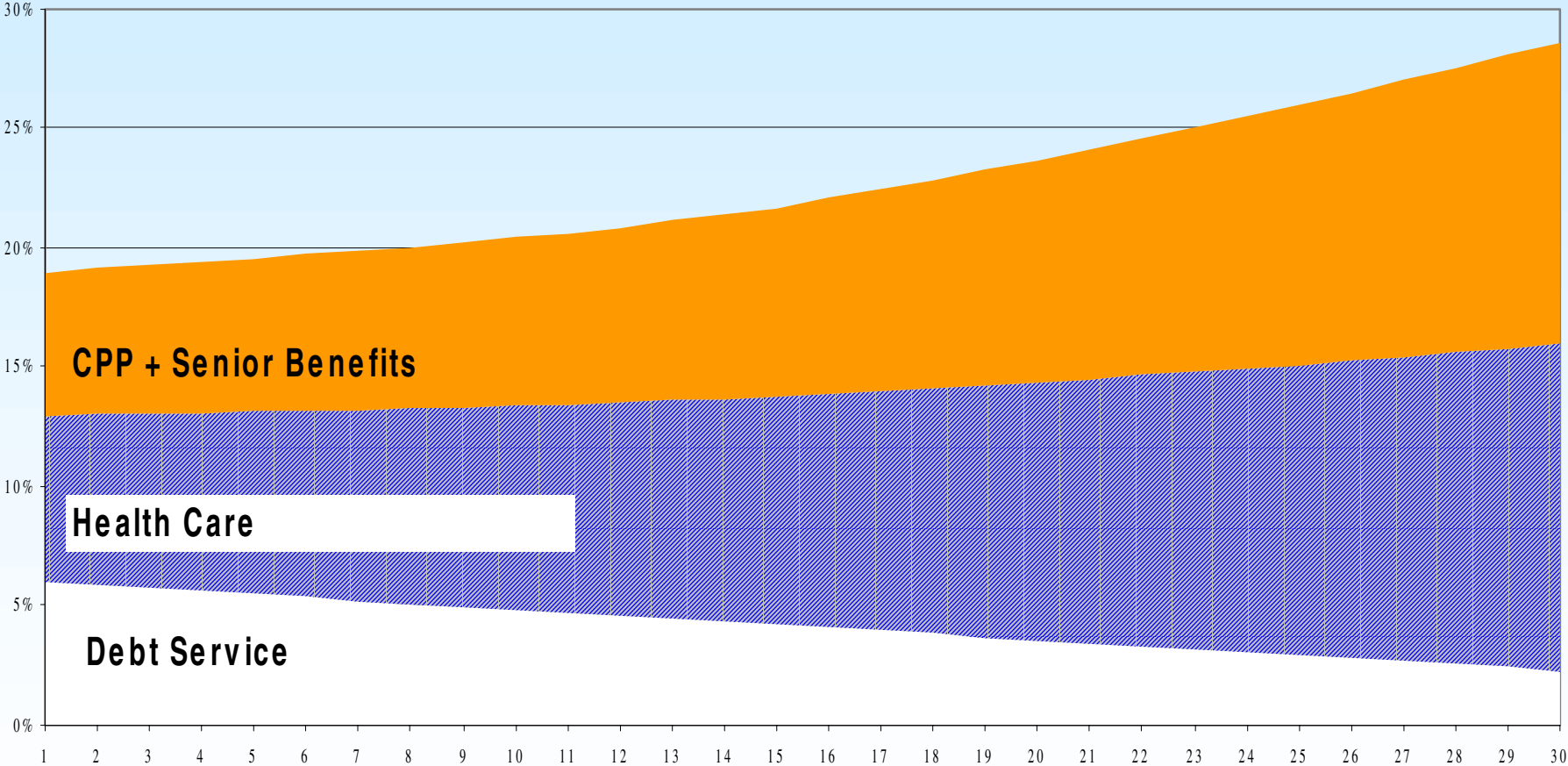

Chart: Assets ($Billions) vs. Time

- **MV of Assets (10% Surplus)** — red curve
- **Decrease Contributions** — arrow pointing to red peak
- **100% Liability Funding** — arrow pointing to diagonal line
- **Increase Contributions** — arrow pointing to black trough
- **10% Of Liability** — double-headed arrow
- **MV of Assets (No Surplus Cushion)** — black curve

Y-axis: $80, $70, $60 — Assets ($Billions)
X-axis: Time

Base Scenario

CPP + Senior Benefits

Health Care

Debt Service

Relative Price Of Medical Care Rises 1%/Yr

CPP + Senior Benefits

Health Care

Debt Service

Relative Price of Medical Care Rises 2% /Year

CPP + Senior Benefits

Health Care

Debt Service

The Goal Is Surplus

- **Cover Pensions Indexed To Inflation**
  - **Assets > Liabilities**

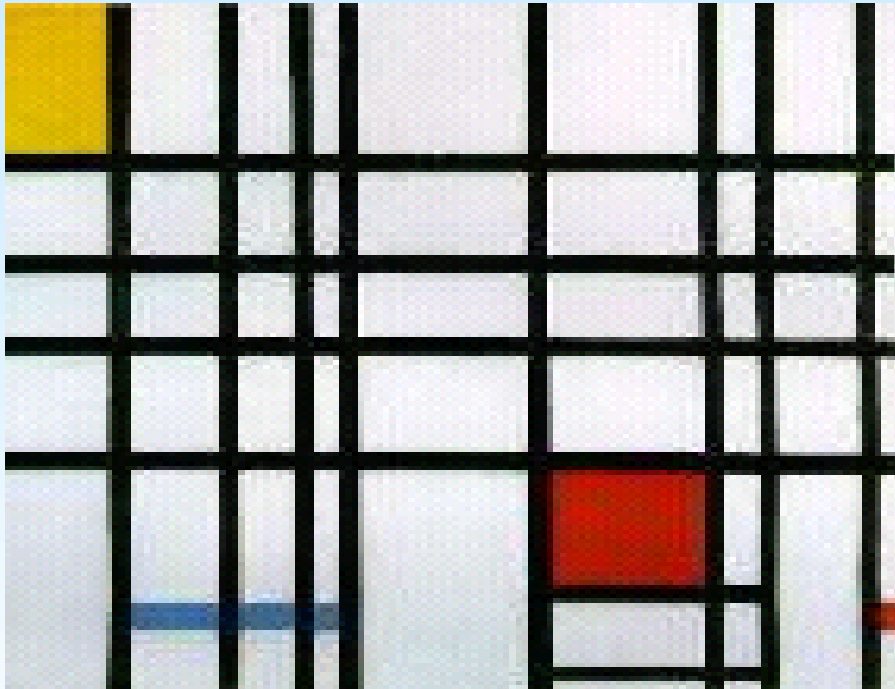 *Get To Surplus Position*

- **Reduce Contribution Rates**
  - **Return On Assets > Growth In Liabilities**

  Produce Surplus Growth

- **Limit Risk Of Contribution Rate Hikes**
  - **Match Volatility Of Assets, Liabilities**

  Limit Surplus Risk

Correlation Makes Risks Non-Separable

Risks Cannot Be Measured or Managed One at A Time

➢ Reducing One Risk May Increase Surplus Risk

➢ Risks Must Ideally Be Viewed From Fund Level

Adding Two Risks Of Losing $100

$$Risk_A = Risk_B = \$100$$

$$Risk_A + Risk_B = \sqrt{Risk_A^2 + Risk_B^2 + 2x\ Correlation_{AB}\ x\ Risk_A\ xRisk_B}$$

200
Correlation = 1:

-"Perfectly Correlated"
-Go Up, Down Together
-Risks Are Additive

140
Correlation = 0

-"Uncorrelated"
- Moves Not Related
- Risks Less Than
  Additive

0
Correlation = -1

- "Perfectly Negatively
   Correlated"
- Moves Are Opposites
- Risks Cancel

$\sqrt{}$ $(100^2 + 100^2 + 2x\mathbf{1}x\ 100x100) = 200$

$\sqrt{}$ $(100^2 + 100^2 + \mathbf{0}) = 140$

$\sqrt{}$ $(100^2 + 100^2 - 2x(\mathbf{-1})x\ 100x100) = 0$

Example:

$300 Microsoft Stock

$350 TSE Stock

$500 RRBs

$300 Microsoft Stock

$350 Commodities

$500 Fund Liabilities