Columbia Business School

The Market Value of Social Security

John Geanakoplos (Yale University)
Stephen P. Zeldes (Columbia Business School)

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Wage risk:
has implications for important pensions questions

- How healthy are private and public pension plans?
- What discount rate should be used to compute pension liabilities?
- What share of pension assets should be invested in stocks?
- What is the present value shortfall in the Social Security system?
- Would it save money to index pensions to prices instead of wages?

Thought exercise

- Which would be more expensive for the government?
  - Index Social Security payments to average wages?
  - Index Social Security payments to prices?

- Observation #1
  - expected growth in wages - expected growth in prices = 1.1%
- Observation #2
  - real wage growth is risky

Many policymakers believe switching to price indexing would save money

OPINION | NOVEMBER 7, 2011 By Stephen Moore

THE WALL STREET JOURNAL.

A Look Inside the Super Committee

A change in the index formula (substituting the rise in prices rather than the rise in wages) to calculate benefits for Social Security and other federal programs would save about $200 billion over the next decade. And it would reap two to three times more in future decades. As Mr. Hensarling puts it, these reforms "are huge, because they start to bend the cost curve downward on the big entitlements."

Pozen Argues for $5T Plan to Cut U.S. Debt: Retirement Income Symposium

BY JAMES J. GREEN, ADVISORONE
October 18, 2011

Saying Social Security benefits schedule too generous, MFS chairman emeritus proposes using price index rather than wage index to cut debt

Santorum: Tie Social Security to prices

UPI.com
OVER 100 YEARS OF JOURNALISTIC EXCELLENCE

Published: June 12, 2011 at 3:01 PM

WASHINGTON, June 12 (UPI) -- Republican U.S. presidential hopeful Rick Santorum said Sunday he would like to see Social Security increases tied to price inflation rather than wages.

But would it?

- The answers to these, and other, pensions questions depend on an understanding of wage risk
- How much uncertainty is there about the path of future wages, and how does that uncertainty vary with horizon?
- How correlated are wages with factors that determine asset prices (e.g. aggregate stock market, consumption, …) and how does that correlation vary with horizon

Roadmap

- Future pension inflows and outflows depend on wages
- Wages are stochastic and correlated over long horizons with stocks and other asset-pricing fundamentals
- Assets with payoffs tied directly to wages ("wage bonds") are not currently traded in financial markets, but…
- We can estimate what the prices and implied term structure of discount rates would be if wage bonds were traded
- Future cash flows imply implicit positions (+/-) in wage bonds
- Can use positions and risk-adjusted discount rates to create "market value" shortfall measures and address other key questions

Preview of results

- We provide a simple model-based recipe for performing risk adjustment
- We get large risk adjustments with very small short-run correlation between wage growth and stock returns
- We find that most Social Security imbalance measures are significantly smaller than standard estimates
- The cost gap between wage indexing and price indexing shrinks when using risk adjustment; under some parameterizations, wage indexing becomes *less* expensive than price indexing

Related work …

- Geanakoplos, John, and Stephen P. Zeldes (2010), "**Market Valuation of Accrued Social Security Benefits**," in *Measuring and Managing Federal Financial Risk*, Chicago: University of Chicago Press.

- Lucas, Deborah, and Stephen P. Zeldes (2006), "**Valuing and Hedging Defined Benefit Pension Obligations – The Role of Stocks Revisited.**" Working paper.

- Benzoni, Luca, Pierre Collin-Dufresne and Robert S. Goldstein (2007), "**Portfolio Choice over the Life-Cycle when the Stock and Labor Markets are Cointegrated**." *Journal of Finance.*

- Geanakoplos, John, and Stephen P. Zeldes (2009), "**Reforming Social Security with Progressive Personal Accounts**," in *Social Security Policy in a Changing Environment*. Chicago: University of Chicago Press.

- Blocker, Andrew, Laurence J. Kotlikoff, and Stephen A. Ross (2009) "**The True Cost of Social Security**," Boston University working paper.

Ongoing work

- Currently working with Debbie Lucas and a team at Congressional Budget Office (CBO) to
  - Implement this approach using projections from CBO micro-simulation model
  - Explain this market-based approach to policymakers

Outline of talk

- Introduction
- The mechanics of Social Security
- Pricing wage-related claims
- Market-value measures of Social Security's financial status
- Wage vs. Price indexing
- Conclusions

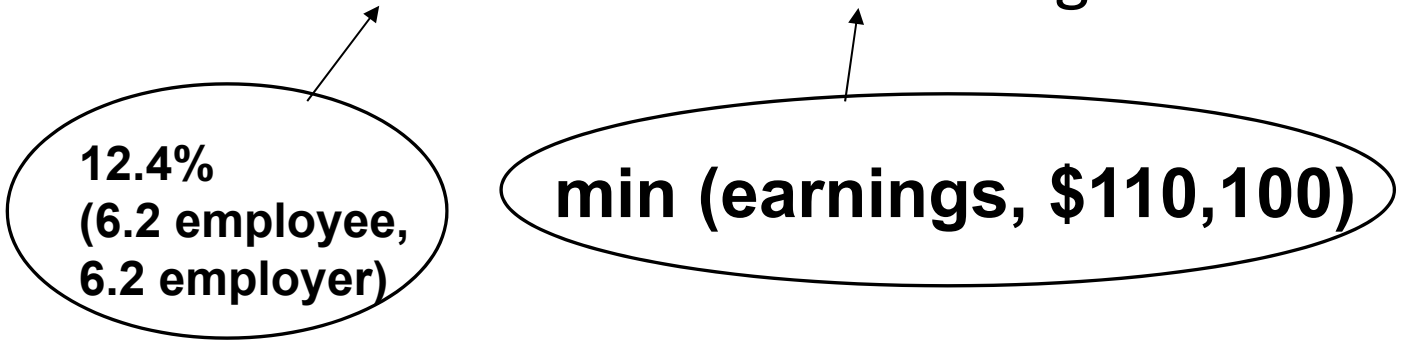
Taxes and benefits are linked to the average wage index

- **Taxes**: directly proportional to average wage index in year collected

- **Benefits**: directly proportional to average wage index in year individual turns age 60

Taxes are linked to the average wage index

Taxes = tax rate • covered earnings



Note: currently 4.2% for employees

Aggregate taxes = tax rate • AWI • number of workers

(AWI = Average Wage Index)

- So taxes are proportional to average wage index in year collected

Benefits are linked to the average wage index

- Benefits: proportional to average wage index in year individual turns age 60
  - Relative earnings = individual covered earnings/AWI
  - Compute average relative earnings across highest 35 years
  - Compute PIA (in average wage units) as concave function of average relative earnings
  - Benefit in first year = PIA (in average wage units) x **AWI at age 60**
  - Benefit in future years (each remaining year of life) indexed to CPI
- So uncertainty of retiree cash flows resolved earlier in time than receipt of cash flow

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What is the traditional approach and how do we differ?

- Traditional actuarial approach
  - Project future cash flows
  - Discount to present using risk-free government bond rates

  → "Actuarial present value" of imbalance

- Our approach
  - Project future cash flows
  - Discount to the present using the risk-adjusted discount rates

  → "Market value" of the imbalance

Why market value?

- Traditional measures do not adjust for risk
- Market value solvency measures answer the question: "How much would government need to pay financial markets today to balance the system, i.e., absorb the difference between cash inflows and outflows?"
- Treats non-traded future cash flows (taxes and benefits) similarly to traded assets (stocks and bonds)

Computing risk-adjusted discount rates: key ideas

- Investments with market risk have low payoffs in bad times when resources are most valuable (and vice versa in good times)
- Investors assign higher discount rates (and therefore lower values today) to future cash flows that are subject to more market risk
- Over long periods of time, aggregate wages tend to be high in good states and low in bad states; hence future wages have (long-run) market risk.
- Social Security cash flows are tied to aggregate future wages; hence they also have market risk which affects their present value

Computing risk-adjusted discount rates: key issues

- Computing the right discount rate for wage-linked cash flows requires estimating:
  - How much uncertainty there is about the path of future wages, and how that uncertainty varies with horizon.
  - How correlated wages are with factors that determine asset prices (e.g. aggregate stock market, consumption, etc.) and how that correlation varies with horizon.

Wage bonds: definition

- **j-period wage bond**: a security that pays a single amount in year t+j, equal to average economy-wide labor earnings (AWI) in year t+j

- One wage bond for each j, each with its own risk, price, and expected return

Solving for the discount rate: two models

1) General equilibrium macroeconomic model

2) Reduced-form model linking wages and stock prices

- In both models, wages and stock prices
  - Uncorrelated in the short run
  - Strongly correlated in the long run
- Solve for term structure of risk-premia built into discount rates
- Assume assets priced by rational agents who understand the model
- Can parameterize the two models such that risk-premia are identical in the two models

Simple general equilibrium macro model

Production function: $Y_t = \tilde{A}_t K^{\alpha} H_t^{1-\alpha}$ (We assume K fixed)

Utility function: $\frac{\left(C(1-H)^{\theta}\right)^{1-\gamma}}{1-\gamma}$

- Can solve for hours, wage, value of firm, risk free rate, required return on wage bonds, required return on stocks
- Results
  - Hours fixed in equilibrium
  - $r^{W}_{t,j} - r^{f}_{t,j} = \gamma \frac{\sigma^{2}_{a,t,t+j}}{j}$

Incorporating "news" about future productivity

- Under standard specification for A shocks, model implies a strong contemporaneous correlation between wage growth and stock returns

- Counter to empirical evidence (zero correlation)
  - See Goetzmann (2008), Blocker, Kotlikoff, Ross (2009)

- To break this link, we add a "news shock"
  - Agents receive information about future productivity above that in observed history of productivity

  - See Beaudry and Portier (2004), Schmitt-Grohé and Uribe(2009), and Jaimovich and Rebelo (2009)

$\epsilon_t = \{\epsilon_t^t, \epsilon_t^{t+1}, \epsilon_t^{t+2}, \epsilon_t^{t+3}, \ldots\}$

News shock / look-ahead model: Our specification

- In each period, agents get "news" about future productivity growth in all subsequent periods

- $\boldsymbol{\epsilon_t} = \{\epsilon_t^t, \epsilon_t^{t+1}, \epsilon_t^{t+2}, \epsilon_t^{t+3}, \ldots\}$ (sequence of shocks with exponentially decaying variances)
  - Subscript: pd in which shock learned by agents
  - Superscript: pd in which shock affects productivity growth

- Productivity growth: $\Delta a_t = g + \sum_{j=0}^{\infty} \epsilon_{t-j}^t$, determined by cumulative history of news

- $\sigma_{a,t+i}^2 = \sigma_\epsilon^2 \frac{1-\rho^{i-1}}{1-\rho}$ (conditional variance between i-1 and i)

Annual risk-premium on wage bonds

$$r_j^W - r_j^f = \gamma \cdot \frac{\sigma_\epsilon^2}{(1-\rho)} \cdot \frac{\sum_{i=1}^{j}(1-\rho^{i-1})}{j}$$

- Per-period risk premium is increasing in j
- The smaller is ρ, the smaller is the rate of increase

Comments on look-ahead / "news" model

- Asset prices (including wage bond prices) react today to news about future A, but wages only change when A is realized
  - Low contemporaneous correlation between stock returns and wage growth
  - Positive correlation between stock return and *future* growth in wages
- Return on wage bond ≠ wage growth
- Correlation between wage bond return and consumption growth increases with horizon

A reduced form model for wages and dividends

(Benzoni, Collin-Dufresne, and Goldstein, JF, 2007)

d = ln(dividends)
w = ln (labor earnings)
δ = dividend price ratio

$$d_{t+h} - d_t = (g_d - \frac{\sigma_d^2}{2}) + \sigma_d \, z_{d,t+1}$$

$$w_{t+1} - w_t = (g_w - \frac{\sigma_w^{\,2}}{2}) - \kappa(w_t - d_t - \overline{wd}) + \sigma_w z_{w,t+1}$$

assume constant price of risk → constant dividend price ratio

Use model to price wage claims as derivative on stock market

Discount rates in the reduced form model (using risk-neutral pricing)

$$r_j^W - r_j^f = (r^s - r^f) \bullet \frac{\sum_{i=1}^{j} 1-(1-\kappa)^{i-1}}{j}$$

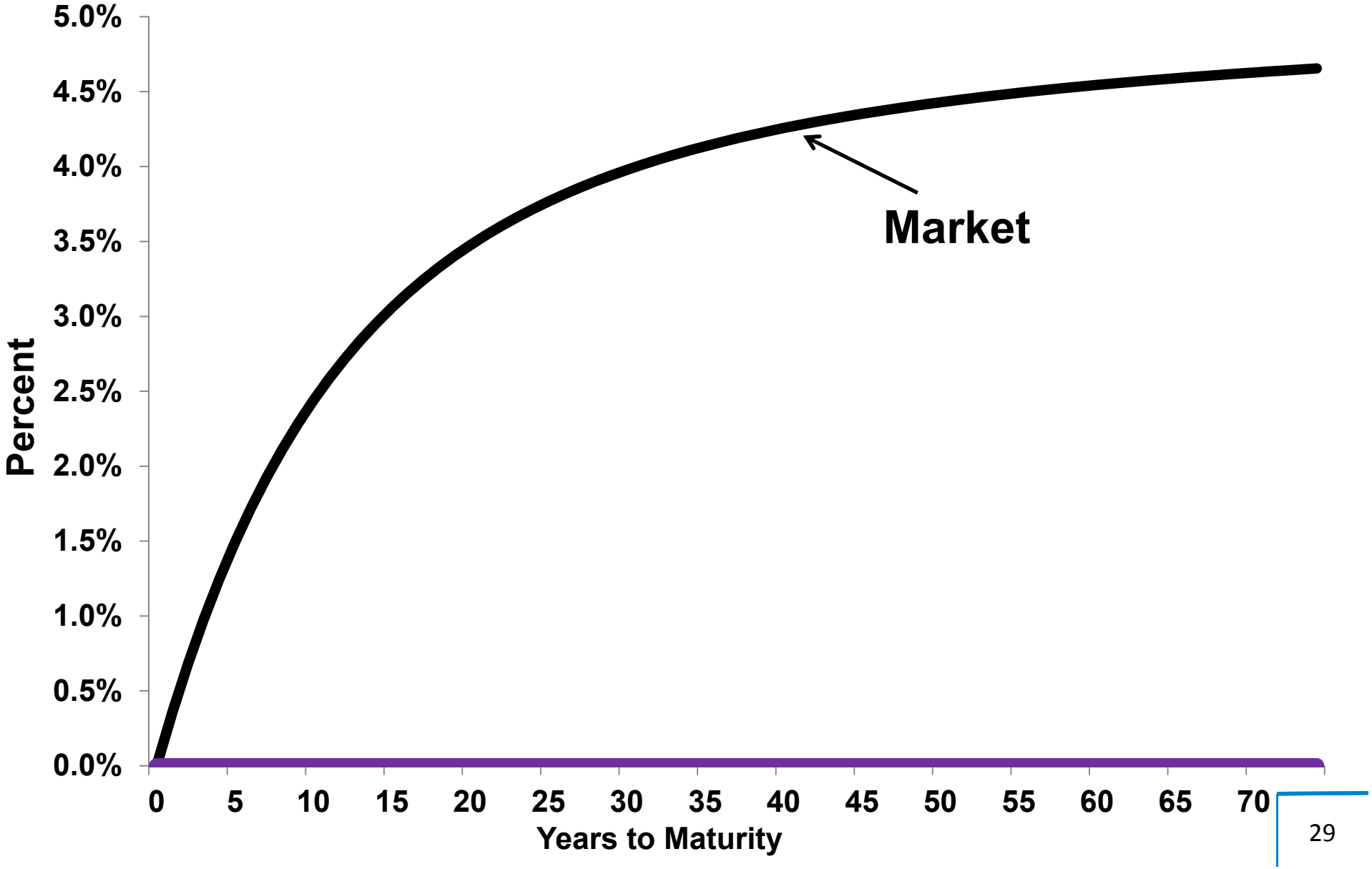
- Depends only on j, κ, and equity premium
- *Do not* depend on risk-free rate or expected wage growth
- Our two models can be parameterized to yield *identical* risk premia

Calibration parameters

- $\kappa = (1-\rho)$ =.15 (Benzoni et al)
- equity premium = 5 % (S&P 500 returns, 1959-2008)
- Implies γ = 64

- We will look at sensitivity to kappa (.10, .20) and equity premium
- To evaluate wage indexing vs. price indexing:
  - σ_Y = 2.8 % (from output data 1947-2008)
  - g_w = 1.1 % (Trustees report)

Figure 1: Discount rate for future wages – risk-free rate



Properties of the risk-adjusted discount rates

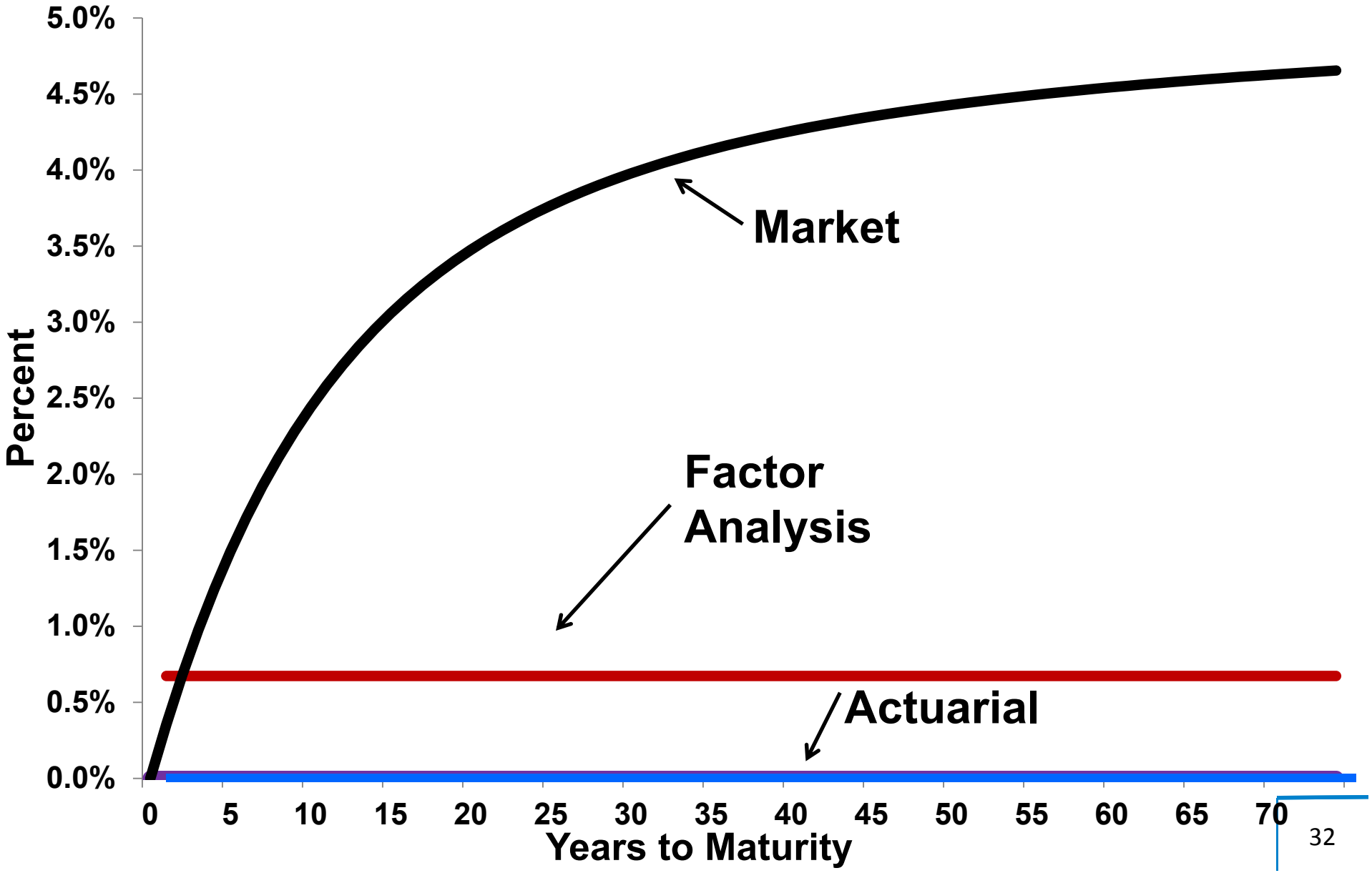
- Discount rate greater than risk-free rate
  - Risk premium is always positive

- Term structure of discount rates is upward sloping
  - Risk premium built into discount rate increases with horizon
  - Risk-adjusted rates are more like bond rates over short horizons but more like stock returns over long horizons

Factor analysis with few or no lags will not capture the long-run correlation

- Suppose wages and stock prices follow our model
- Apply Blocker, Kotlikoff, Ross (2009) factor approach to estimate risk adjustment using one lag of stock returns
- Would yield incorrect risk-adjustment
  - Underestimate risk correction for wage bonds, hence overestimating market price of wage bonds
  - Errors increase with horizon

Figure 3: Discount rate - risk-free rate (three approaches)



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Three solvency measures
(OASDI, 2009 actuarial values)

PV future outflows – PV future inflows – value of trust fund

- Immediate transition cost ($18.9 trillion)
  - Includes only outflows based on benefits already accrued
  - Ignores future inflows
- Closed group transition cost ($16.3 trillion)
  - Adds in future contributions and future benefits due to those contributions, for current participants only
- Open group unfunded obligation (75 yrs: $5.3 trillion; infinite horizon: $15.1 trillion)
  - Adds in future contributions and future benefits for future participants

Figure 4: Projected real cash flows
(Intermediate cost assumptions, 2009 Trustees Report)

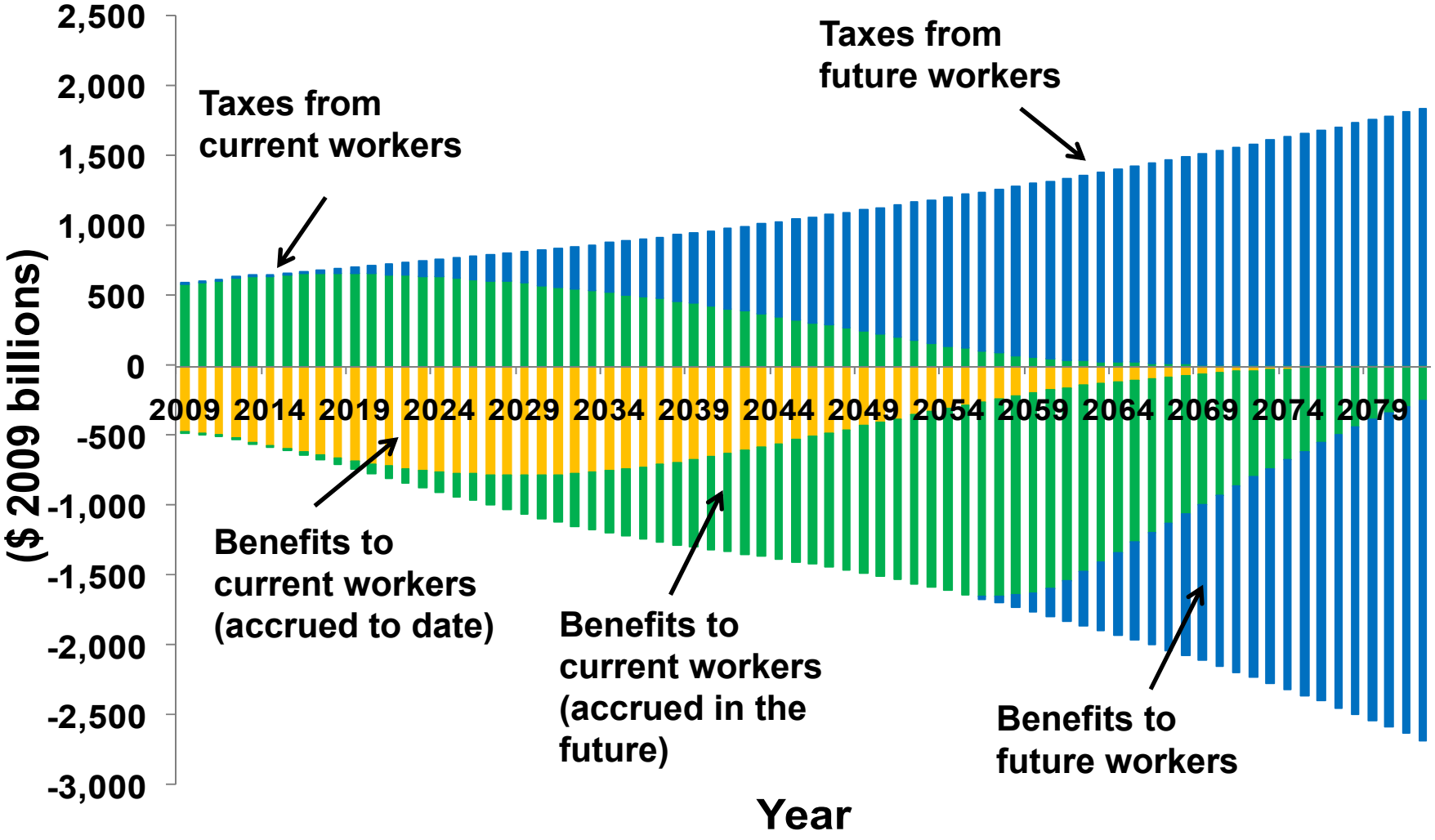
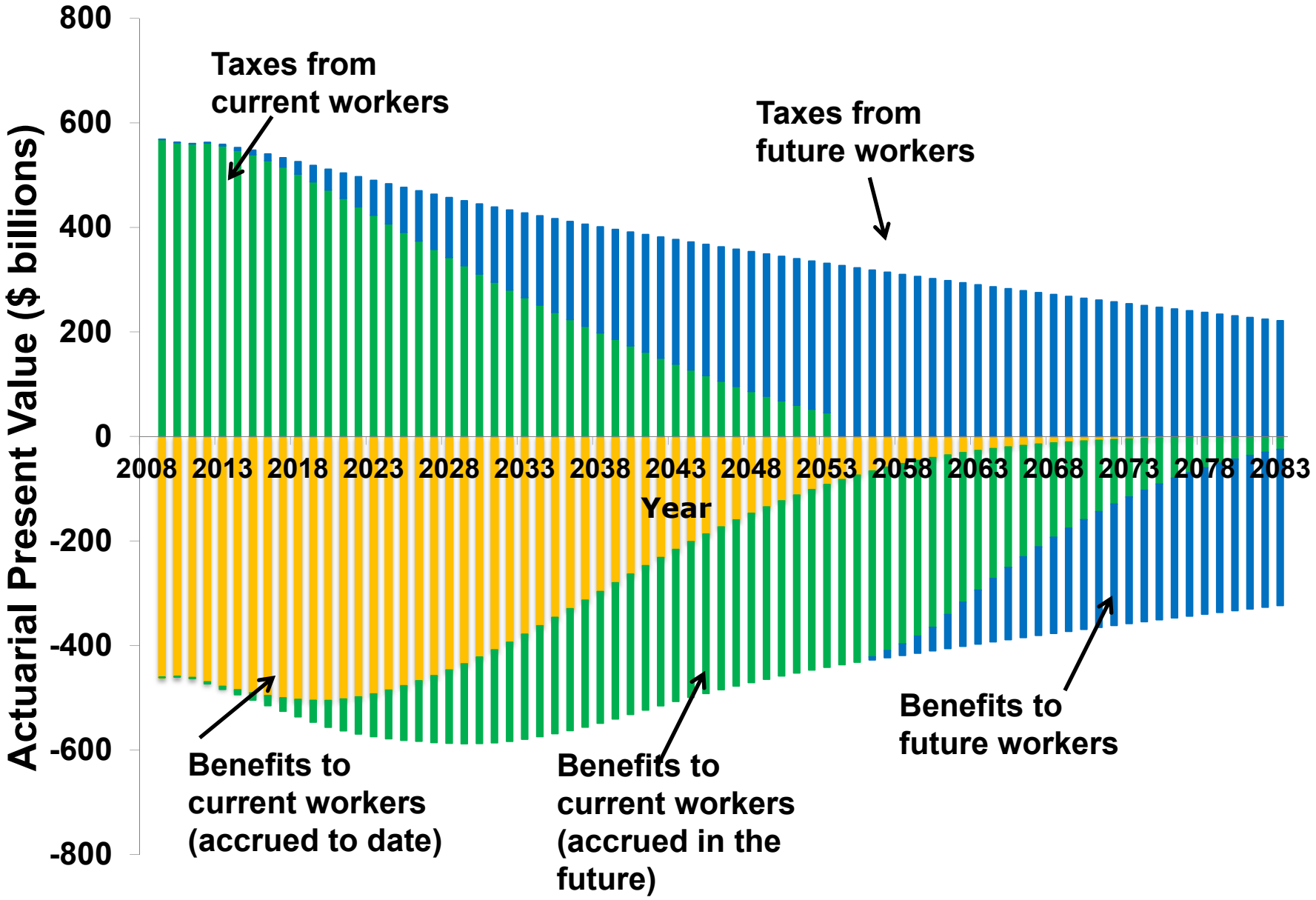


Figure 5: Annual Cash Flows, Actuarial PV



When is wage risk resolved?

- Taxes depend on AWI in year collected

  $(Taxes_{t+j} = AWI_{t+j} * N_{t+j} * \text{tax rate})$

  - Taxes paid j periods from now have wage risk over j periods

- Benefits depend on AWI when individual turns 60
  - Consider benefits paid in a given future calendar year
  - Wage risk resolved in different years for different cohorts
  - To compute market value, need to first rearrange cash flows into year wage risk is resolved

Figure 7: Actuarial Present Values by Year of Elimination of Market Risk

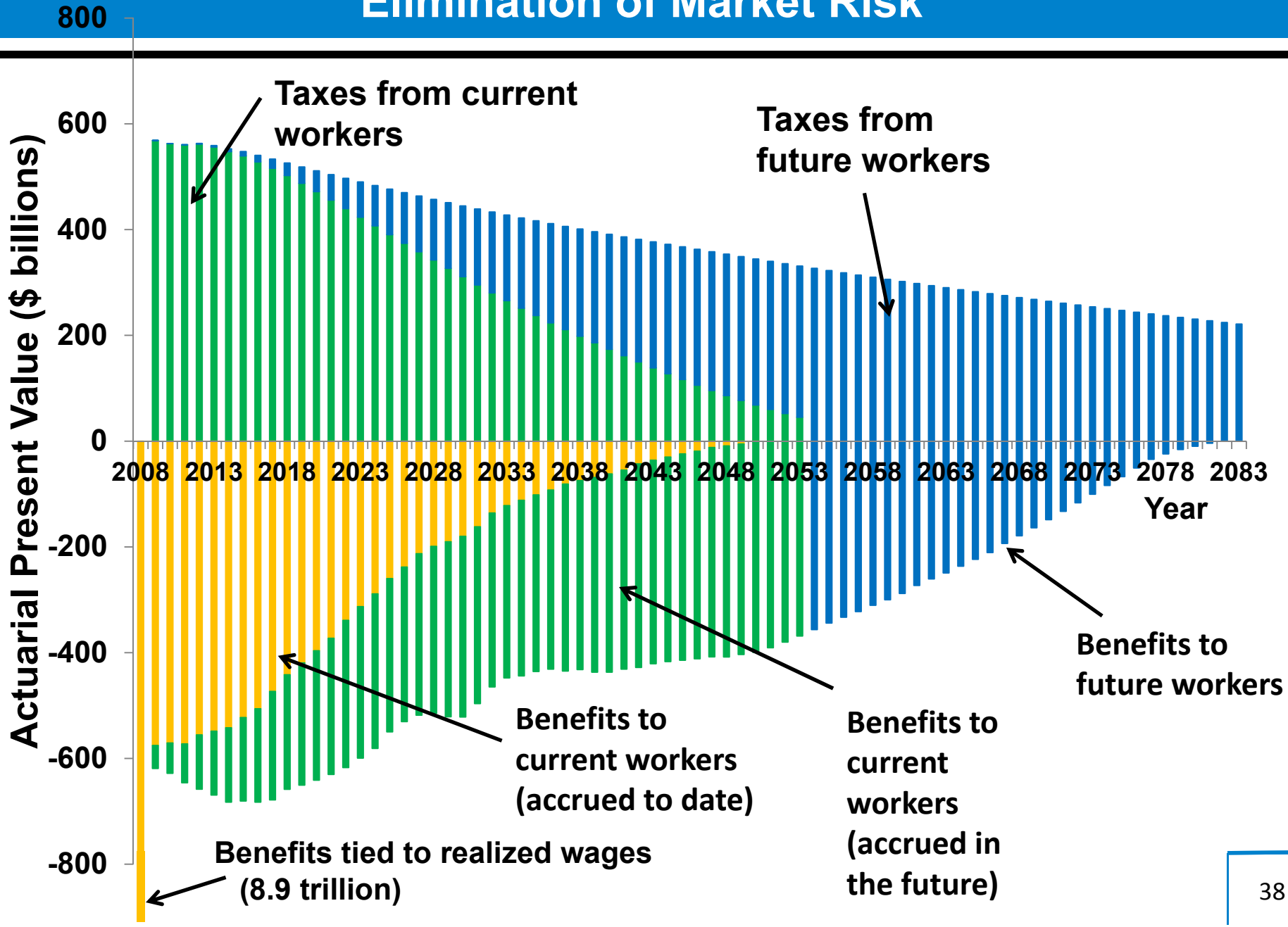
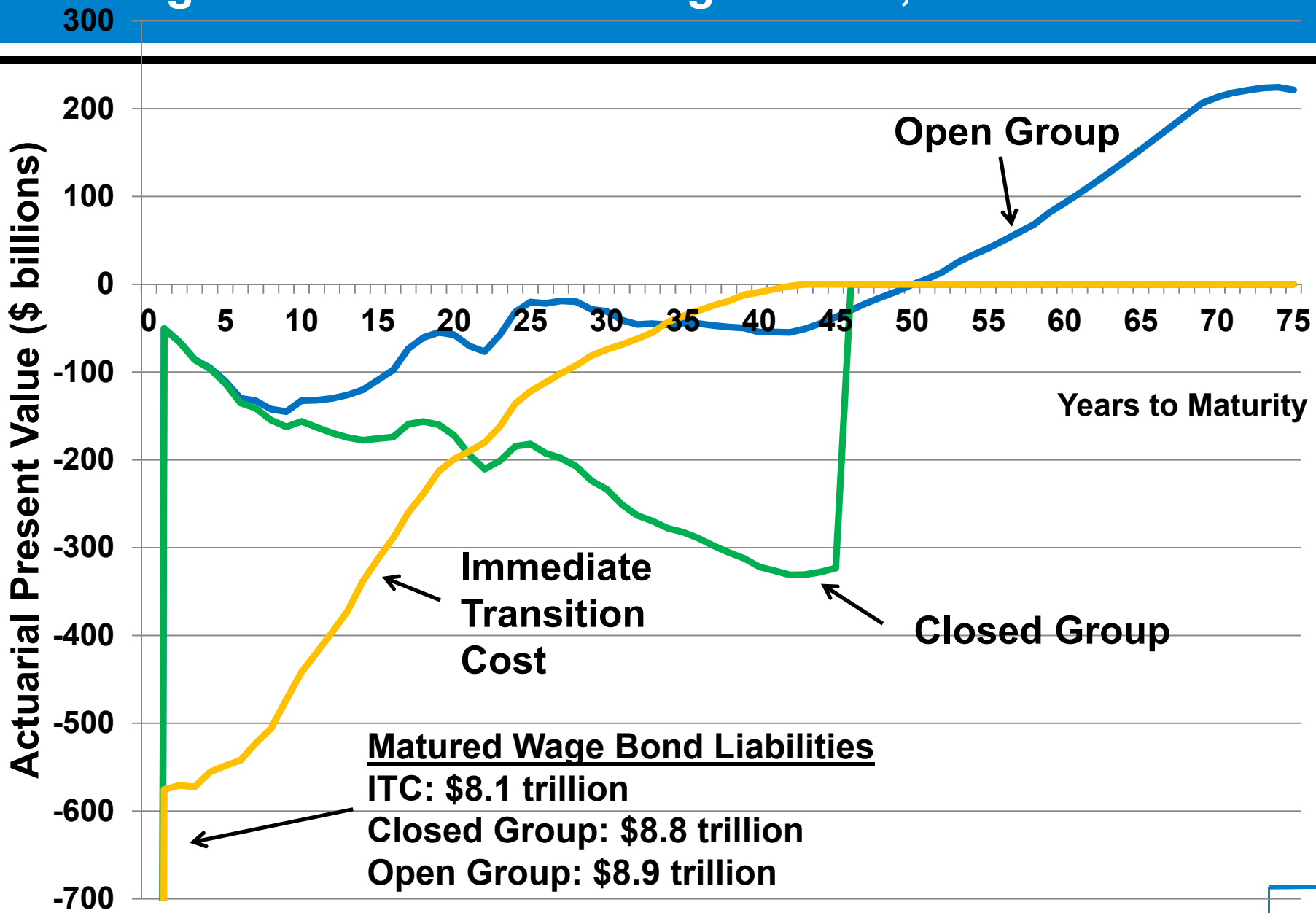


Figure 8: Net Value of Wage Bonds, Actuarial PV



Computing market value from actuarial value

- Convert streams of future taxes and benefits into present values by discounting at risk-adjusted rates
- Market value(j) =
  actuarial value (j) * mark-down ratio(j)
- Sum across j to get market value
- Easy to implement for those doing actuarial calculations

Figure 9a: Net Value of Wage Bonds, Market vs. Actuarial PV, Immediate Transition Cost

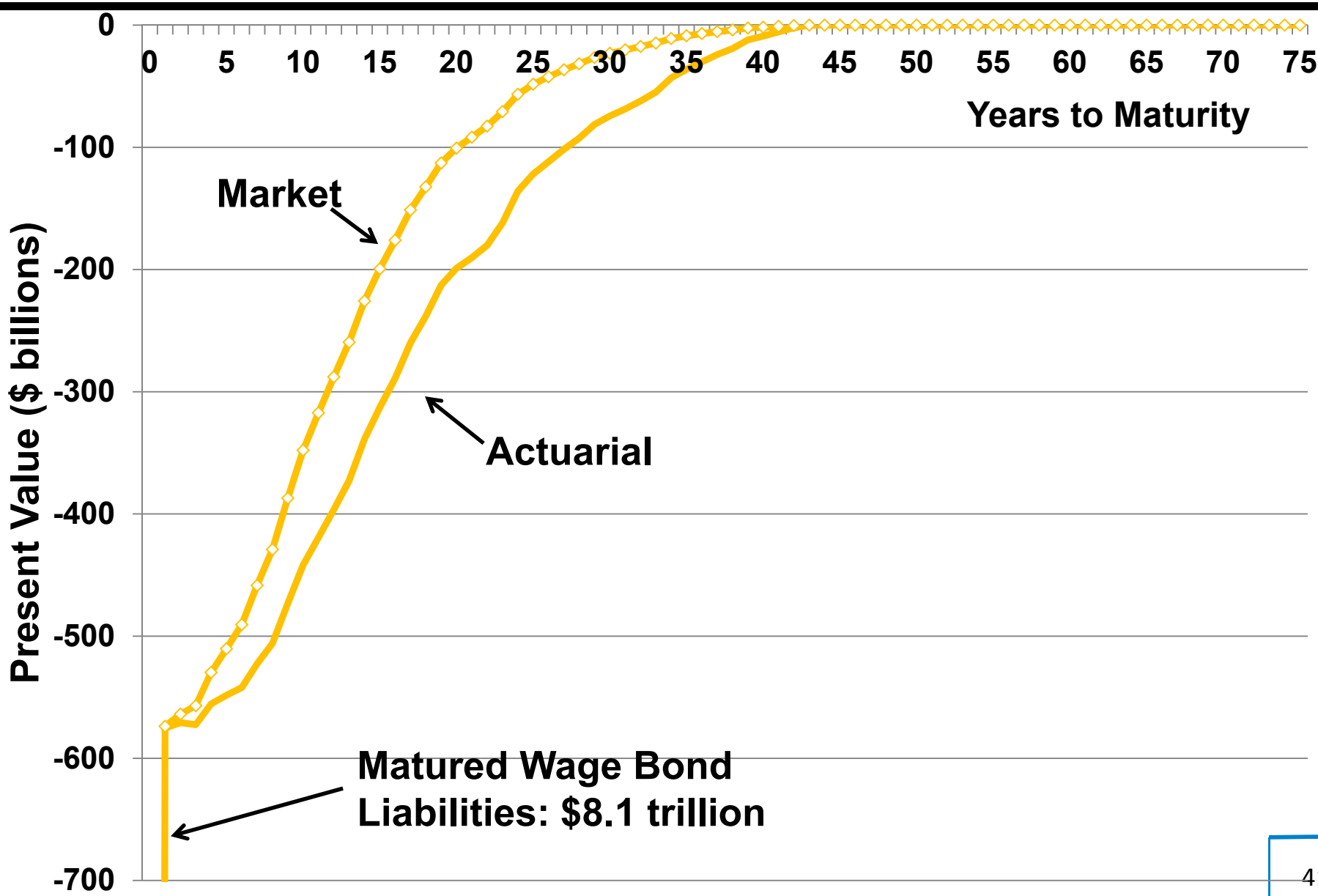


Figure 9b: Net Value of Wage Bonds, Market vs. Actuarial PV, Closed Group

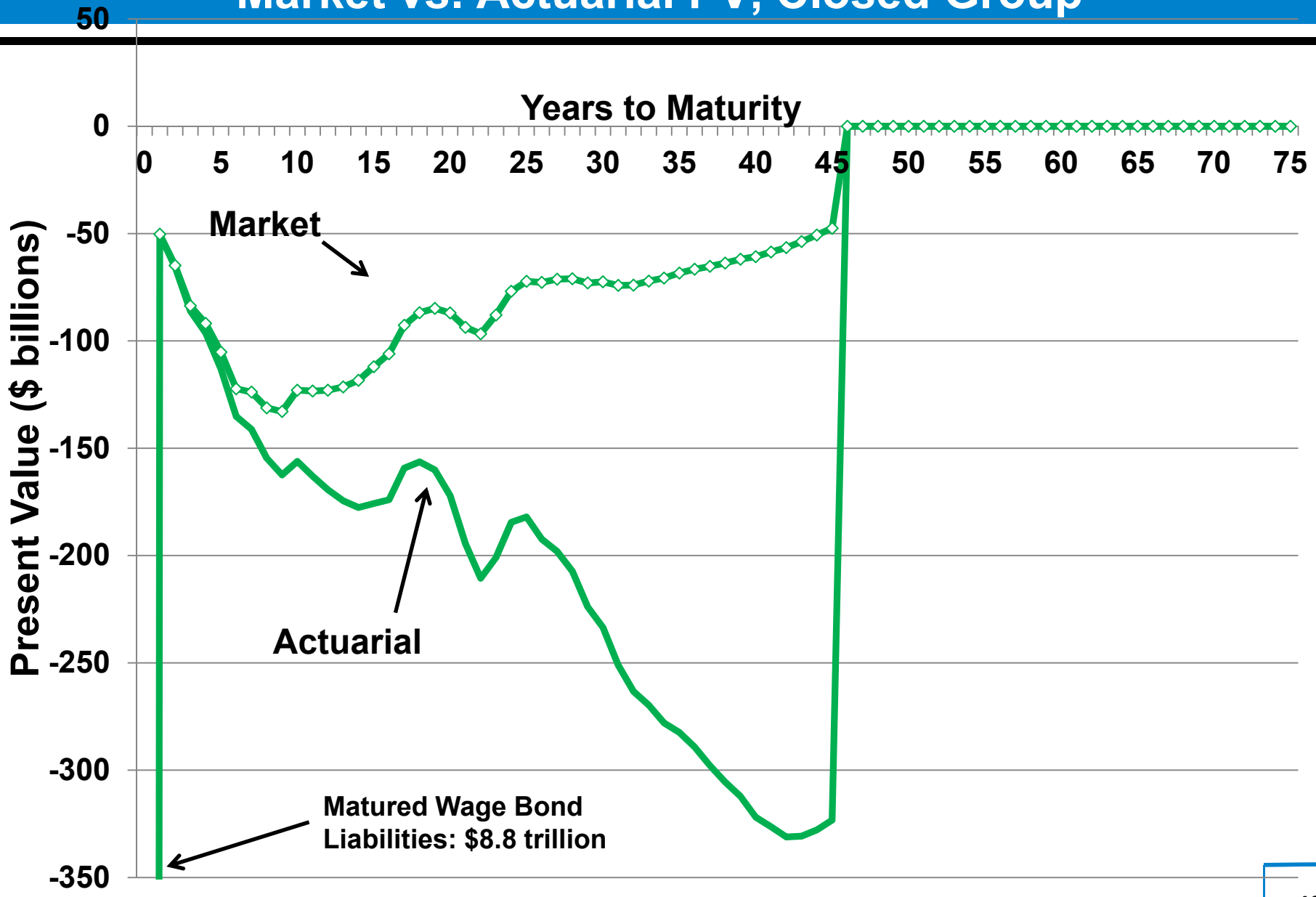
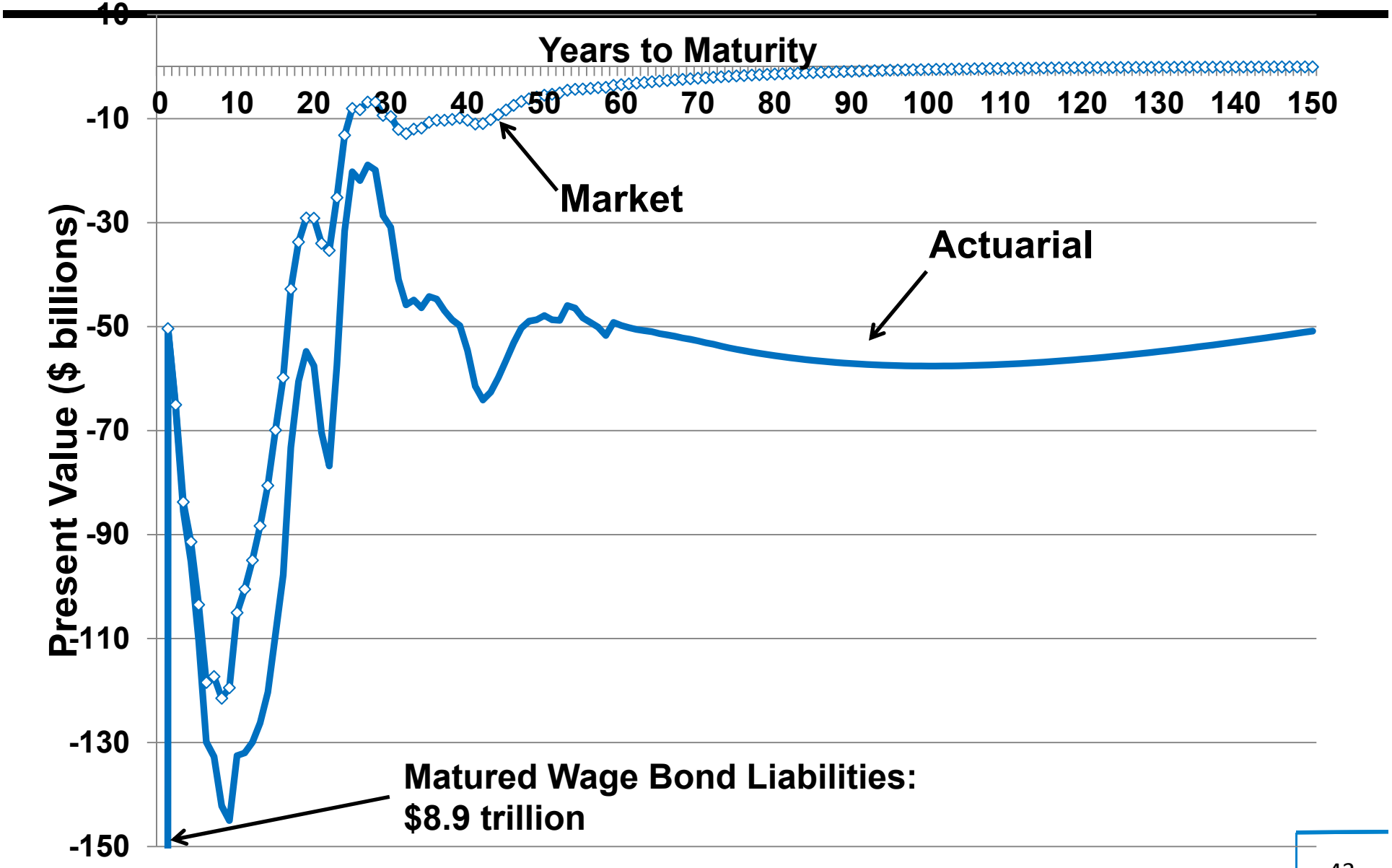


Figure 9d: Net Value of Wage Bonds, Market vs. Actuarial PV, Infinite Horizon Open Group



Results: Imbalances generally smaller under market value approach

- Risk adjustment generally leads to *smaller* deficit

- ITC: 18% smaller
- Closed group: 41 % smaller
- ∞ horizon open group: 68 % smaller

Results: 75-year open group

- 75-year open group: Risk adjustment leads to 40 % *larger* deficit
- Different from above
- **But** this measure is conceptually problematic: ignores accrued benefits when shutdown in 75 years
- Our proposed new measure: Open group + future shutdown cost
  - Run system for 75 years
  - Then shut down and pay all accrued benefits
- Resulting deficit: risk adjustment leads to 51% *smaller* deficit, consistent with other results

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Wage-indexing vs price-indexing

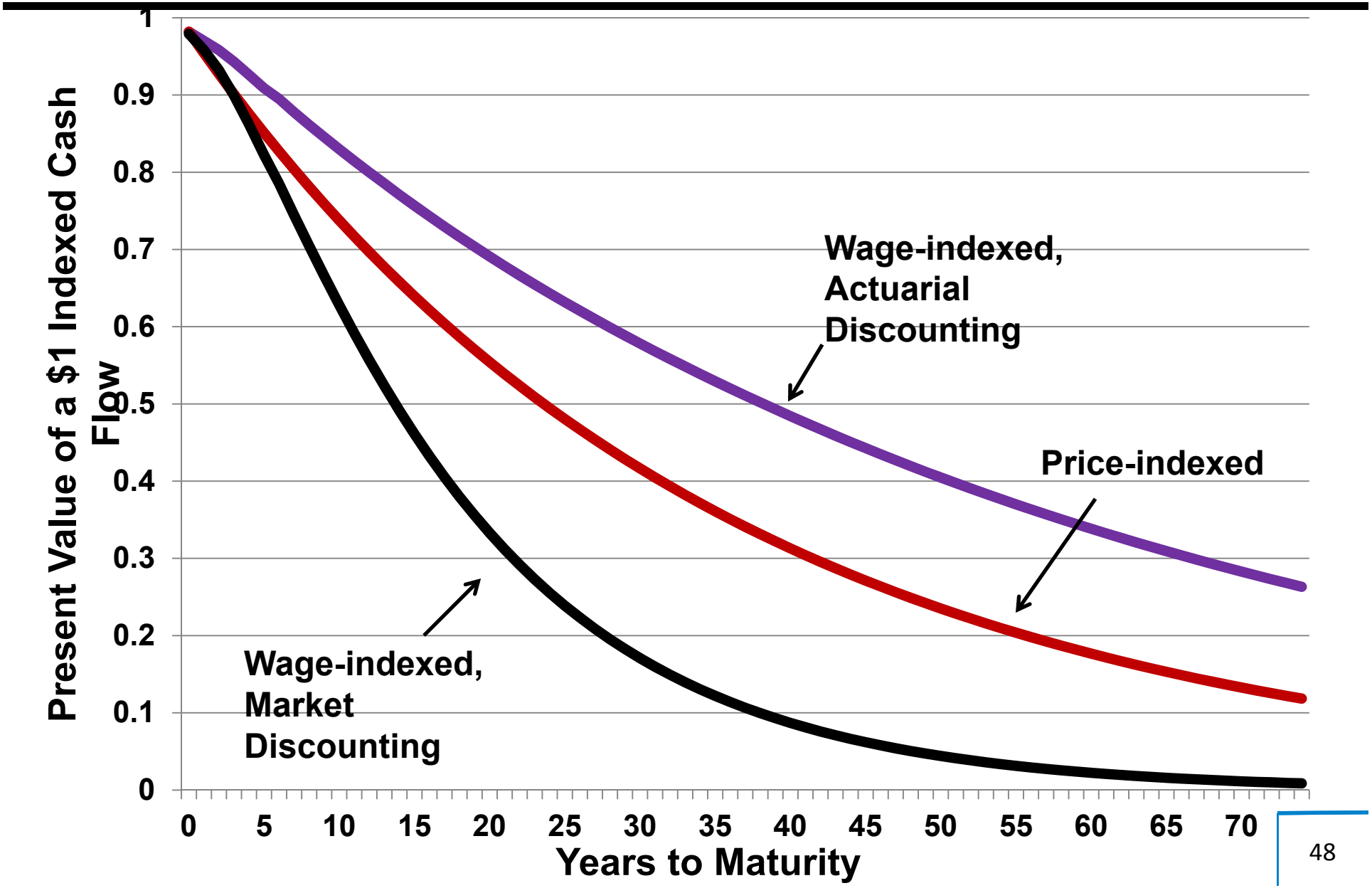
- Wages are expected to grow 1.1% per year faster than prices

- Consider two promises, each paying an amount j periods in the future

$1 indexed to inflation	$1 indexed to wage growth

- Which is more expensive from today's perspective?

Figure 10: Present values of wage-indexed vs price-indexed cash flows



Wage-indexing vs price-indexing: conclusions

- Under actuarial approach: wage indexing *more* expensive than price indexing
- Risk adjustment lowers cost of wage indexing; under preferred parameterization, risk adjustment makes wage indexing *less* expensive than price indexing
- Intuition: There are states of the world in which real wages will be lower in the future than they are today, and the value of a $ is very high in those states

Current work in progress

- Empirical estimates of short-run and long-run wage risk and cointegration with stock prices
- U.S. : 80 years of annual data
- OECD: 29 countries, generally ~40 years of data
- Examining
  - uncertainty in real wages at different horizons
  - correlation of real wage growth with financial returns at different horizons

Table 4: Countries With Negative Real Wage Growth

Horizon Years	# of Countries With Negatives	# of Times Negative	% of Times Negative
1	29	256	25%
5	26	174	20%
10	14	100	13%
20	6	46	10%
30	4	20	8%

Note: 29 countries in total

Conclusions re Social Security

- Market valuation is important and improves measurement of Social Security's financial situation
- Relative to actuarial value, market value leads to *lower* deficits
  - For ITC, closed group, and infinite horizon open group
- Under our parameterization, wage indexing is *less* expensive on a risk-adjusted basis than price indexing

Next steps…

- Additional research to enhance and calibrate macroeconomic models of wage risk
- Allow for inflation risk premium
- Empirical estimates of short-run and long-run wage risk and correlation with stock prices
  - U.S. : 80 years of annual data
  - OECD: 29 countries, ~40 years of data
- Estimate magnitudes of policy changes necessary to restore balance to the system (tax increases, benefit cuts)
- Encourage governments to adopt market-value approaches to measurement and policy evaluation

Other applications of this approach

- Overall government taxes and revenues (fiscal risk)
- Defined-benefit pensions (Lucas/Zeldes, 2006)
  - Valuing liabilities (higher discount rate for PBO than ABO)
  - Choosing asset allocation (hedging role for equities)
- Corporate discount rate
  - For cash flows tied to wages and other macro variables