LIABILITY-RELATIVE ASSET ALLOCATION

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WE ALREADY KNOW MANY OF THE RIGHT ANSWERS

Sharpe

Markowitz

Leibowitz

Traynor

Campbell

Grinold

And many, many more!

Let's use what we know, fill in some holes, and see what we've got!

THE PLAN FOR THE DAY

There are many "moving parts" to cover

Today we'll cover the basics of …

- Surplus optimization in a liability-relative context
  - A modern approach to determining the policy portfolio
- A description of the pension liability that appropriately handles:
  - Market and non-market risks (beta and alpha)
  - Inflation duration and real rate duration
- Incorporating strategic and active decisions in the optimization process
  - Laying a foundation for including active managers, portable beta, etc.
- Tools for articulating surplus risk: "surplus tulips" and "A/L tulips"
- The roles of equity and fixed income in a pension portfolio
- The "limits of the possible" for investment solutions to pension funding problems
  - The importance of contribution, benefit policies

BUT WAIT, THERE'S MORE!

We would have to cover these additional topics to have completed a decent survey of the topic:

- More detail on incorporating alpha
  - Manager structure optimization to incorporate active managers
  - Alpha-beta separation, or better, "portable beta" strategies
  - Market timing based on non-equilibrium asset class expected return estimates
- More detail about matching the dual durations of the assets to the liability
- Lessons about the implicit options in the liability, when viewed in an economic context
- The implications of an "integrated balance sheet" view, versus the "separate trust" view
  - Tepper-Black tax arbitrage
  - Shareholder/taxpayer considerations
- Accounting treatment of pension plans:
  - Perverse incentives
  - Misleading measures
  - Connecting the economic liability to the accounting liability
- Non-myopic approaches to optimization, requiring utility theory and/or simulation
- Rebalancing

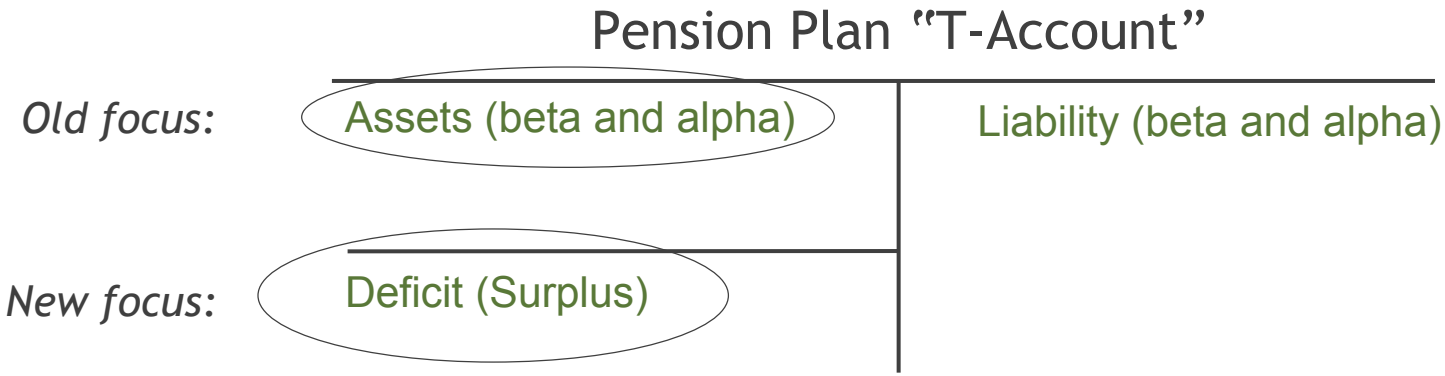
LIABILITY-RELATIVE INVESTMENT POLICIES: SURPLUS OPTIMIZATION

LIABILITY-RELATIVE POLICY TOOL OF CHOICE: *SURPLUS OPTIMIZATION*

Objective function: Maximize growth of surplus (shrinkage of deficit) for a given level of risk to the surplus (or deficit)

- We're managing a *portfolio* of assets *and* liabilities!

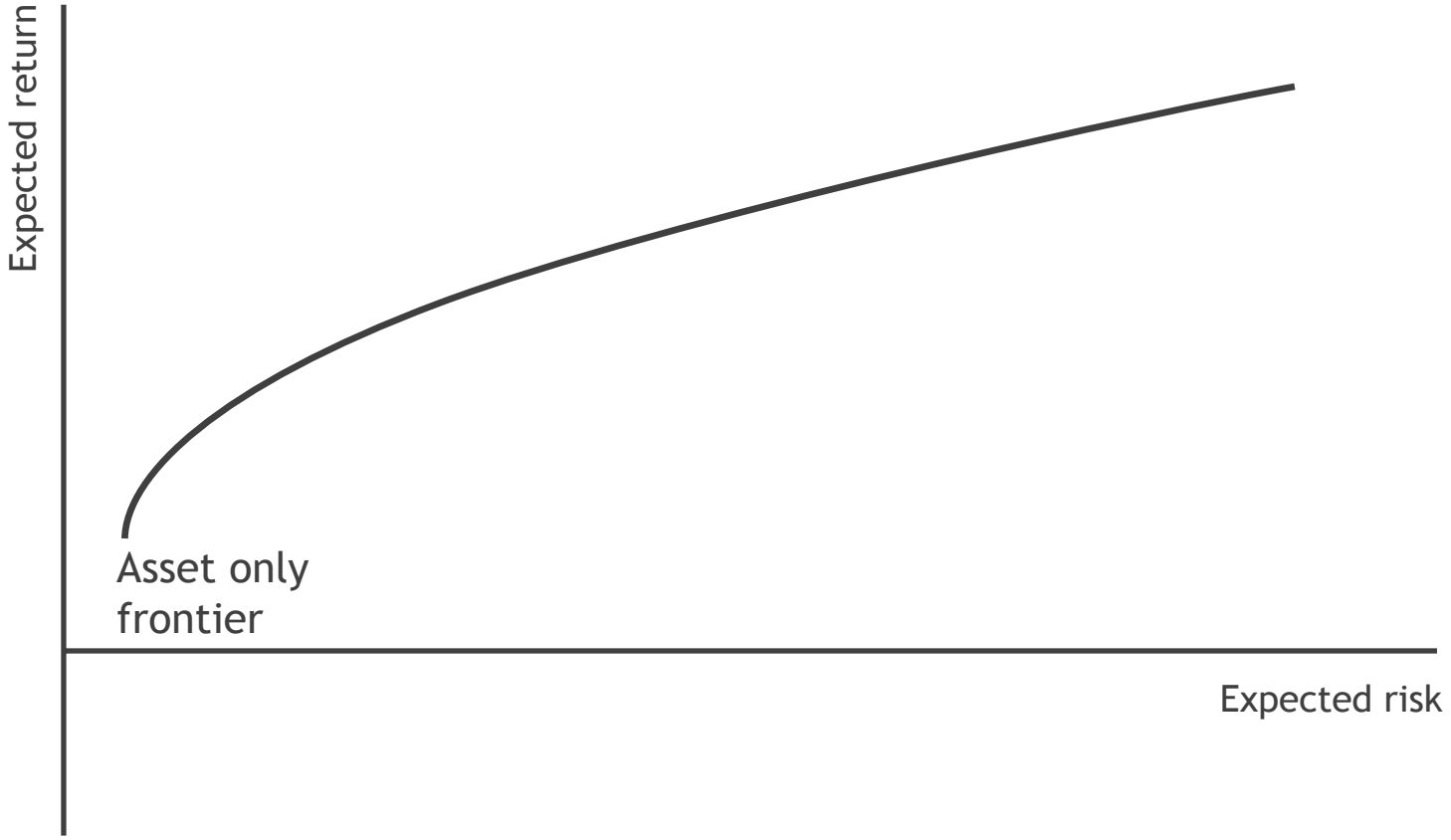
Method: Treat the liability as a constrained asset class, held short



INVESTING MORE WISELY

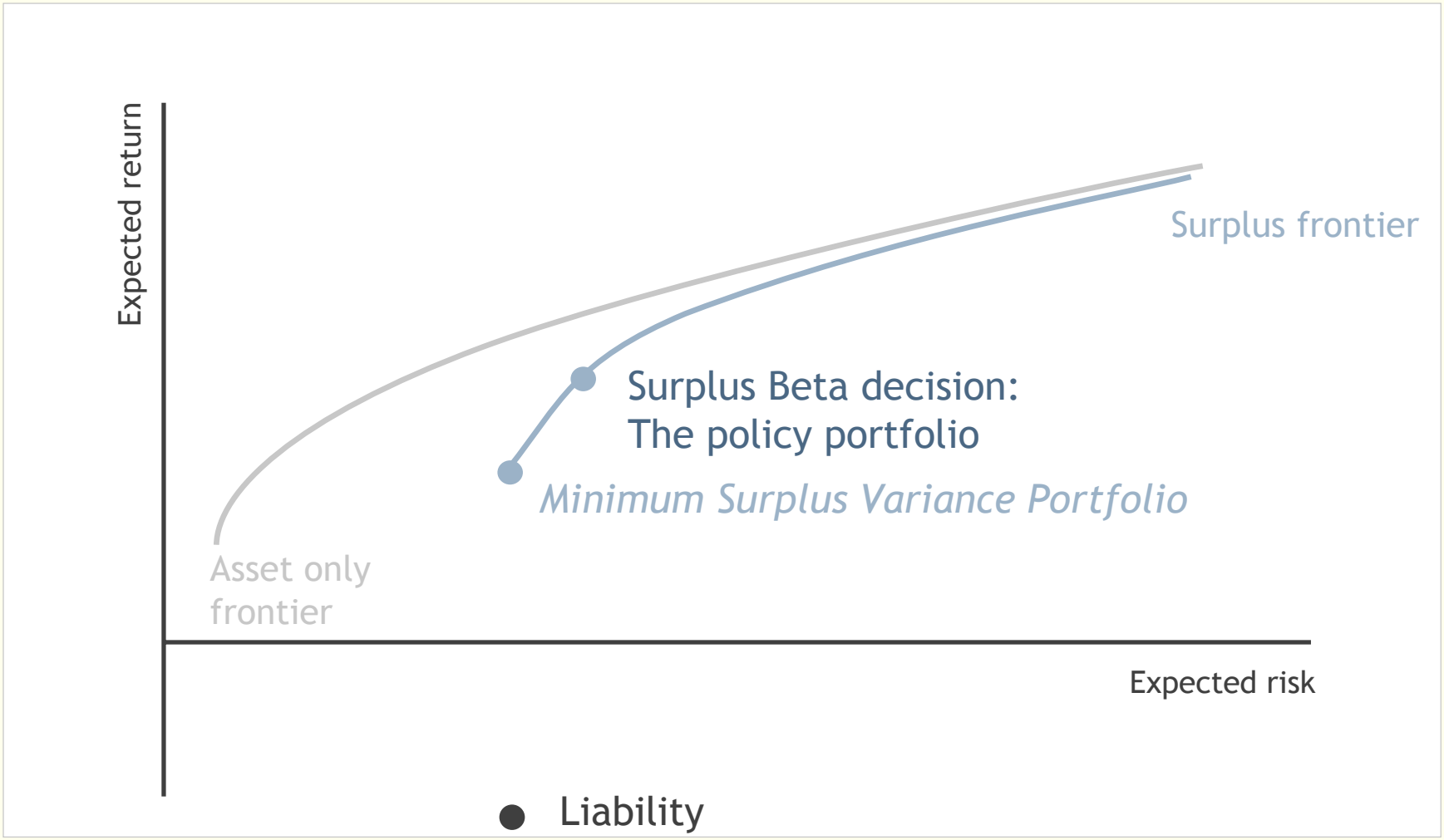
Asset Only Optimization

A stylized view:



INVESTING MORE WISELY

Surplus Optimization

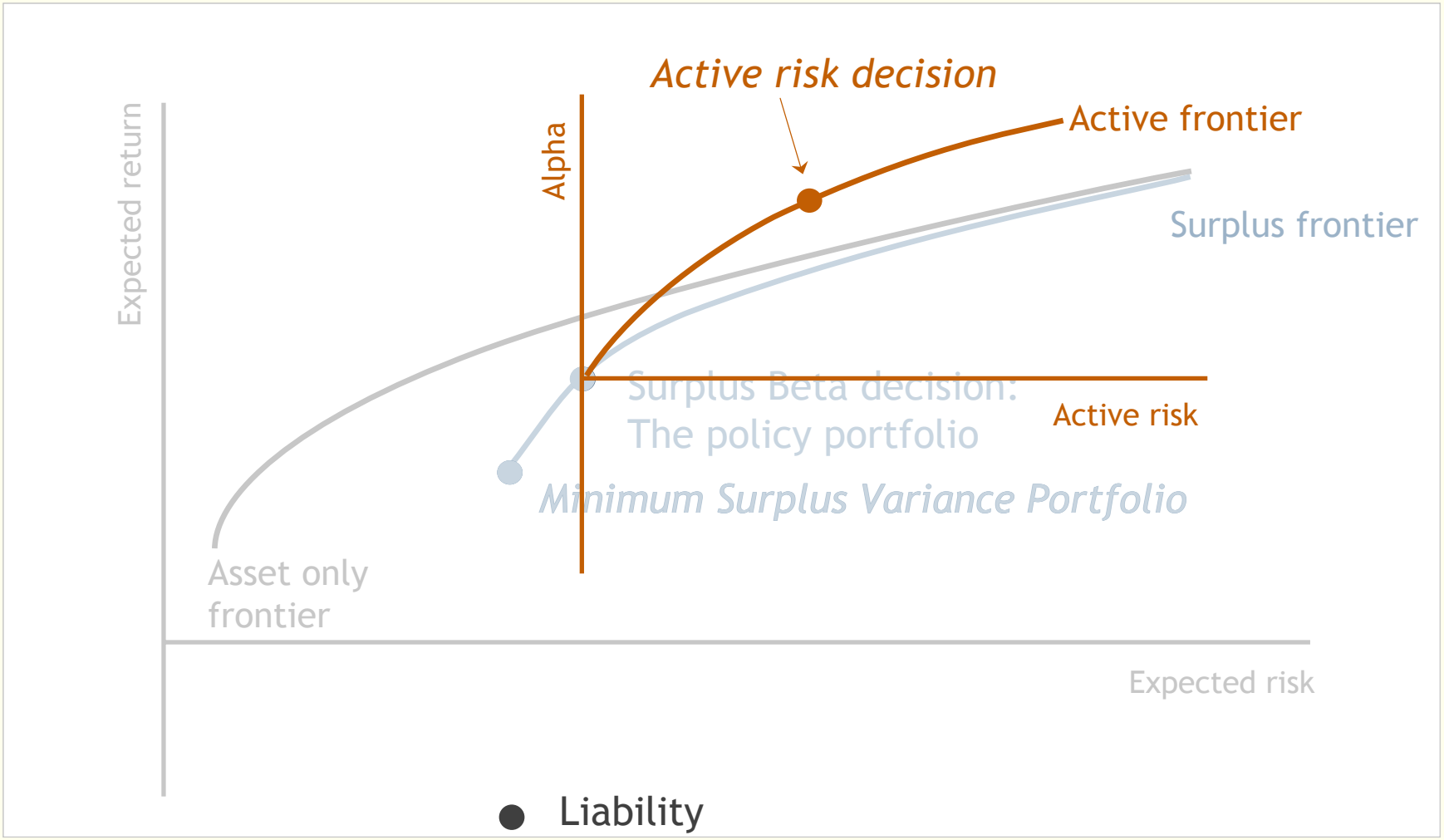


How much Surplus Beta Risk?

See: Waring, "Liability-Relative Investing II." Journal of Portfolio Management*, Fall 2004.*

INVESTING MORE WISELY

Controlling Active Risk



How much Surplus Beta Risk? … and how much Alpha Risk?

DESCRIBING SURPLUS, AND CHANGES IN SURPLUS

Developing a form of surplus return

If $S = A - L$, *then the change in surplus is…*

$$S_1 - S_0 = \left(A_1 - A_0\right) - \left(L_1 - L_0\right)$$

$$= A_0 \cdot R_A - L_0 \cdot R_L$$

Tracking changes in the wealth of the plan

A "NATURAL" FORM OF SURPLUS RETURN

$$S_1 - S_0 = S_0 \cdot R_S = A_0 \cdot R_A - L_0 \cdot R_L$$

$$\frac{S_1 - S_0}{S_0} = R_S = \left[\frac{A_0}{S_0} \cdot R_A - \frac{L_0}{S_0} \cdot R_L \right]$$

The natural thing to do is to divide through by beginning surplus to get surplus return.

But there is a zero-divide problem, and a sign change problem, for many values of beginning surplus.

ANOTHER FORM: SCALING SURPLUS RETURN TO THE LIABILITY

$$L \cdot R_{S(L)} = A \cdot R_A - L \cdot R_L$$

$$R_{S(L)} = \frac{A_0}{L_0} \cdot R_A - R_L$$

One alternative is to divide through by the liability that is being funded, to get a liability-relative form of surplus return

- A good form for pension plans, whose surplus is always small positive at best, and more often negative (deficit)

Sharpe, and Sharpe-Tint, was asset-relative measure, which is more general

- But less intuitive in pension context where low- and under-funding is common

INCORPORATING MARKET AND NON-MARKET RISKS IN SURPLUS RETURN

MODELING RETURNS: INCORPORATING BETA AND ALPHA

Every asset can be described in terms of its market-related and its unsystematic return components:

Assets $$R_A = R_F + \beta_A \mu_Q + \alpha_A$$

Liability $$R_L = R_F + \beta_L \mu_Q + \alpha_L$$

μ_Q is the excess return of the market portfolio

Asset beta returns:	Equilibrium, consensus returns for asset class
Asset alphas:	Alpha generated through managers' or investors' efforts at security selection, market timing
Liability beta returns:	Mostly bond-like; but arguably partially equity-like (future accruals)
Liability alphas:	Mortality risk; benefit decisions not related to market decisions; fixed "COLAs"; fixed crediting rate premiums on cash balance plans ("bonds plus 2%"); etc.

IS THIS JUST THE CAPM?

Not really: I allow for non-zero expectations for alpha

These are conditional forecasts, of necessity, assuming both:

- Some degree of inefficiency in the relevant market
- Above average skill and access to information not impounded in prices

See Waring & Siegel, "The Dimension of Active Management." Journal of Portfolio Management, *Spring 2003.*

MODELING SURPLUS RETURNS, WITH BETA AND ALPHA

Surplus: $$R_{S(L)} = \frac{A_0}{L_0}\left(R_F + \beta_A \mu_Q + \alpha_A\right) - \left(R_F + \beta_L \mu_Q + \alpha_L\right)$$

Reorganized: $$R_{S(L)} = \underbrace{\left(\frac{A_0}{L_0} - 1\right) R_F}_{\text{Risk-free return}} + \underbrace{\left(\frac{A_0}{L_0}\beta_A - \beta_L\right)\mu_Q}_{\text{Surplus beta return}} + \underbrace{\left(\frac{A_0}{L_0}\alpha_A - \alpha_L\right)}_{\text{Surplus residual return}}$$

Note that we can define "surplus beta" as: $$\beta_S = \left(\frac{A_0}{L_0}\beta_A - \beta_L\right)$$

"Surplus beta" describes the *net* market-related — and correlated — risk exposures of the plan: *only beta risks can be hedged!*

"Surplus alpha" is less interesting as a *net* value, as the asset and liability components are uncorrelated with few exceptions and thus do not hedge

WHY SEPARATE ALPHA AND BETA?

SAA practice is consistently "sloppy" in setting asset class expected returns

- Equilibrium expectations are typically intermingled with expectations based on current conditions
- With rigorous separation, we lay a basis for handling both types of expectations well

Investors do believe in using active managers

- And require fair support for their efforts
- Manager structure optimization can be integrated seamlessly with beta optimization

Conventional models of the liability do not separate hedgable risks (beta) from those that aren't (alpha)

- Only liability beta, not alpha, really matters to asset investment decisions
- The big Monte Carlo liability models attempt the impossible, to hedge against all risks!

Beta is unconditionally rewarded,
alpha is only rewarded conditionally

Beta is cheap, alpha is dear

MODELING RISKS

Asset and liability risks, stated separately:

$$\sigma_A^2 = \beta_A^2 \sigma_Q^2 + \omega_A^2 \qquad \sigma_L^2 = \beta_L^2 \sigma_Q^2 + \omega_L^2$$

Surplus risk:

$$\sigma_S^2 = \underbrace{\left(\frac{A_0}{L_0} \beta_A - \beta_L \right)^2 \sigma_Q^2}_{\text{Surplus beta risk}} + \underbrace{\left(\left(\frac{A_0}{L_0} \right)^2 \omega_A^2 - 2 \frac{A_0}{L_0} \omega_{A,L} + \omega_L^2 \right)}_{\text{Surplus residual risk}}$$

Note that beta-related surplus risk can also be expressed simply as $\beta_S^2 \sigma_Q^2$, using the surplus beta form suggested earlier

THE POLICY DECISION: HOW MUCH SURPLUS BETA?

THE SURPLUS UTILITY FUNCTION

Combining surplus return and surplus risk

$$Max\left(U_S\right) = R_S - \lambda\sigma_S^2$$

$$Max\left(U_S\right) = \left(\frac{A_0}{L_0} - 1\right)R_F + \underbrace{\beta_S\mu_Q - \lambda_\beta\beta_S^2\sigma_Q^2}_{beta-related\ surplus\ utility}$$

$$+\underbrace{\left(\frac{A_0}{L_0}\alpha_A - \alpha_L\right) - \lambda_\omega\left(\left(\frac{A_0}{L_0}\right)^2\omega_A^2 - 2\frac{A_0}{L_0}\omega_{A,L} + \omega_L^2\right)}_{\text{Surplus residual utility}}$$

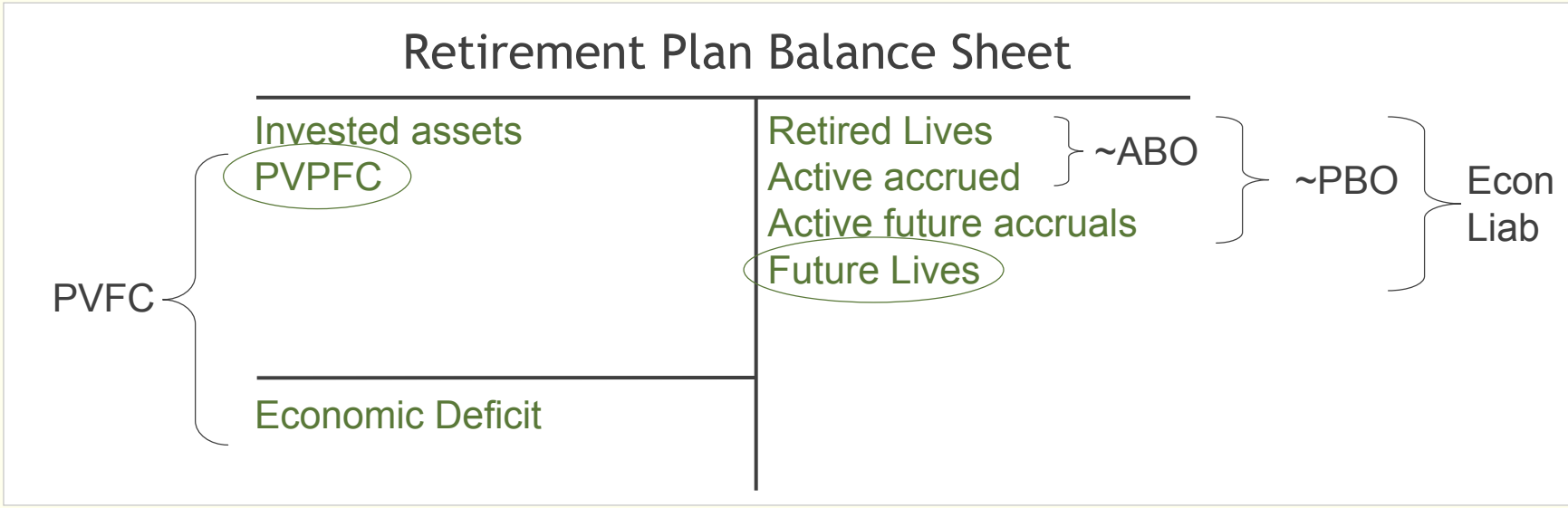
Where: $\beta_S = \frac{A_0}{L_0}\beta_A - \beta_L$

A "total return" — beta plus alpha — utility function, in *surplus*

We'll retain the constant terms, to represent the *portfolio's* utility

MODELING THE LIABILITY

THE "HIDDEN" ACCOUNTING: AN ECONOMIST'S VIEW



- PVPFC needs to be large enough so that the deficit is fairly within the reach of an investment policy having acceptable risk levels
- The liability can be understood with ordinary corporate finance principles
  - The cost of capital is equal to the expected return is equal to the discount rate! The liability can be understood with ordinary corporate finance principles
- *Notice: The Present Value of Future Contributions (PVFC) can't be changed by investment policy!*

MODELING THE ECONOMIC LIABILITY

1) Use best estimates of all variables in estimating future benefit payments

- No "artificial" assumptions for expected inflation, population growth rate, etc

2) Use market-related discount rate appropriate to the liability

- We only care about the liability's market-related return and risk characteristics, for asset allocation purposes

3) Select the measure of the liability you are interested in

- My view is to use the full, open group liability: draw a lesson from corporate finance
- Standard practice today is to solely look at some smaller measure oriented to benefit security, such as a termination measure

4) Match the dual durations of the assets to the liability, by adjusting the bond portfolio (requires coordination with surplus optimization)

5) The economic liability isn't a new idea, but it has been used so little that it often feels like one

- Read Traynor, Priest, and Regan (1976); Bookstaber and Gold (1988); Mulvey (1989); Michaud (1988 and 1998)
- Here we will develop it more fully

ESTIMATING THE DISCOUNT RATE FOR THE LIABILITY COMPONENTS:

Identifying market-related risk factors

Estimation table for market-related risk components in the liability (%):

	Retired Lives	*Active Accrued*	*Active Future*	*Future Lives*	*Expected Return* R_q
Long Bonds	100	50	30	10	5.00%
Long TIPS	-	50	60	70	5.25%
Domestic Equities	-	-	5	10	8.25%
Foreign Equities	-	-	5	10	8.25%
Discount Rate Σw^*R_q	5.00%	5.12%	5.48%	5.83%	

- First, discount the future cash flows in each segment to present value (cash flows provided by actuary)
- The present value-weighted average discount rate across all segments is the best estimate of the economic discount rate for the overall plan
- Good first cut "mental" liability beta estimate (excluding future lives): Bonds and TIPS

DURATION IN THE LIABILITY: THE ROLE OF BONDS

"The Other Market-related Risk"

The liability has two, separate durations, not a single, nominal duration[1]

- Real interest rate duration (typically long, 12 to 25 years)
- Inflation duration (typically less than 10 years; approaches zero if COLA)
- The MSV portfolio, or hedging portfolio, is mostly bonds

The *assets* should reflect a similar dual duration pair as the *liability*[2]

- Including a measure for the durations of equities
  - Durations of equities are "loose," but quantifiable
  - The good news is that equities can be included in a duration matching solution, unlike traditional duration matching
- The solution is a *total portfolio* duration solution
- But it is controlled by setting the TIPS and nominal bond allocations and durations[3]

So three identifiable roles for bonds (TIPS and nominals):

- To form the basis for the hedge of the assets against the liability
- To adjust the durations of the assets to work with those of the liability
- As a potential source of returns through skillful active management

1. *Goodman and Marshall, in Arnott and Fabozzi, op.* Asset Allocation, *Probus 1998.*
2. *Liebowitz, "Total Portfolio Duration."* Financial Analysts Journal, *Sept-Oct 1986.*
3. *Waring,* Journal of Portfolio Management, *Summer 2004.*

A COMMENT ABOUT ACCOUNTING FOR PENSIONS

Problems: Pension accounting distorts economic realities

- "Sticky" discount rates
- "Smoothed" assets
- Wrong discount rates
- Non-economic contribution, pension expense calculations, etc.
- Net result: perverse incentives cause bad management decisions

Prescription:

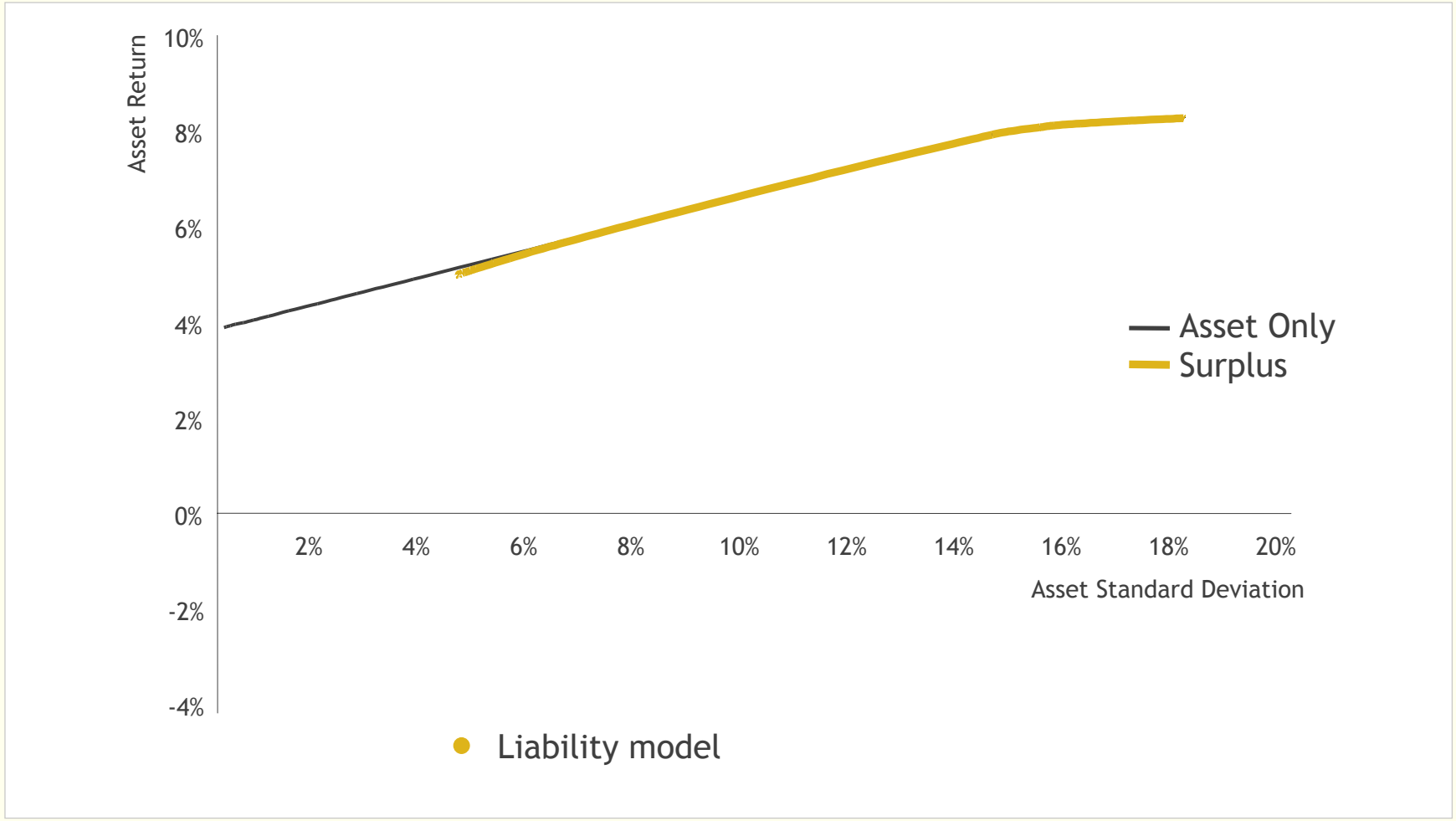
- Manage the plan's economics. The accounting will follow, sooner or later.
- Regulatory accounting should more closely reflect economic accounting, but possibly with some adjustments that are consistent with "good behavior"
- Requires a "fresh piece of paper" approach to actuarial practices
  - Incorporating today's knowledge of field of economic finance

The "real world" is market values,
which always drive book values

USING SURPLUS EFFICIENT FRONTIERS

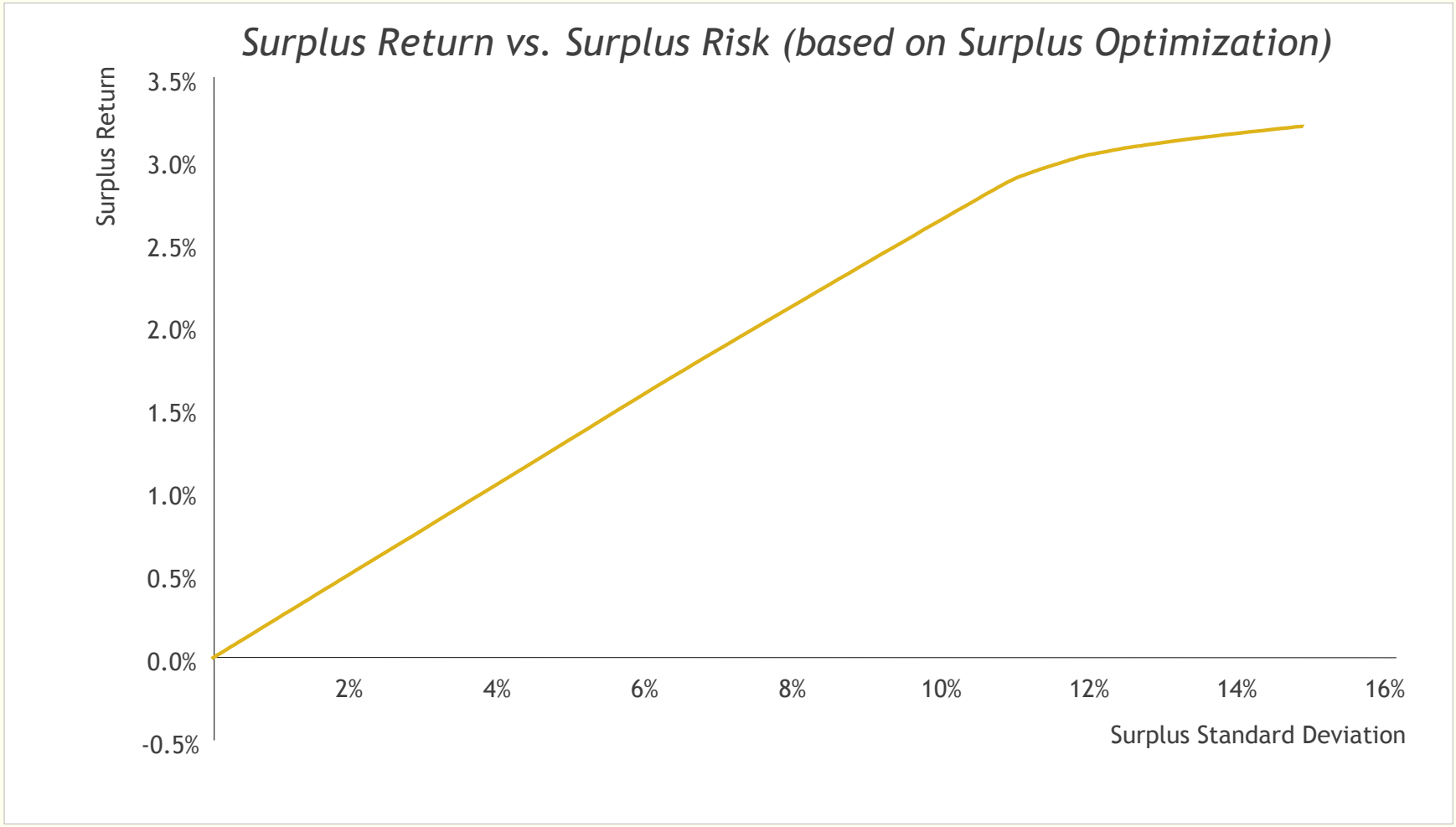
ASSET-ONLY COMPARED TO SURPLUS EFFICIENT FRONTIERS

In asset return vs. asset risk graphical space



SURPLUS EFFICIENT FRONTIER: ANOTHER VIEW

In surplus return vs. surplus risk graphical space (constrained)



THE IMPORTANCE OF FUNDING RATIOS

$$\beta_S = \frac{A_0}{L_0} \cdot \beta_A - \beta_L$$

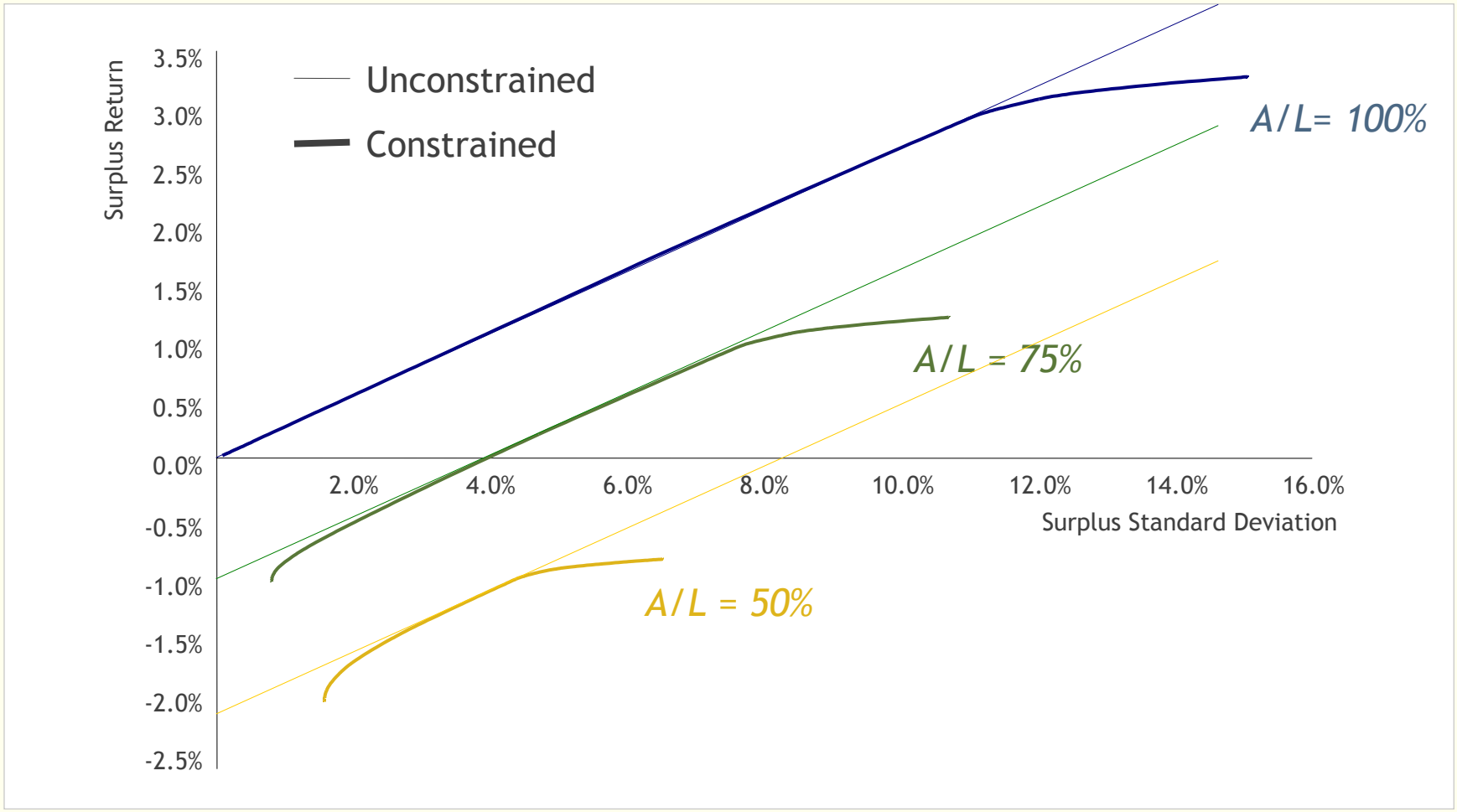
$$\beta_A^* = \frac{L_0}{A_0} \cdot \beta_L$$

When underfunded:

- The optimal asset beta for a minimum surplus variance portfolio is higher than that of the liability!

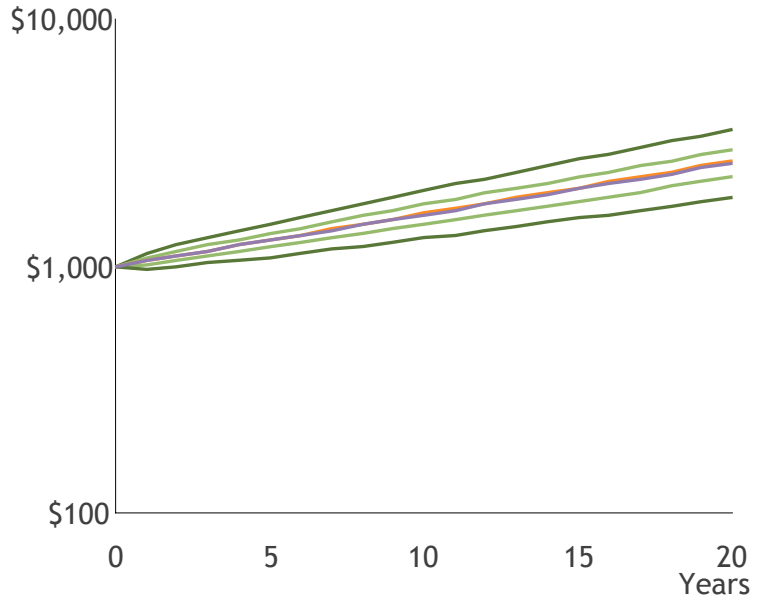
THE IMPACT OF FUNDING RATIO ON THE SURPLUS FRONTIER

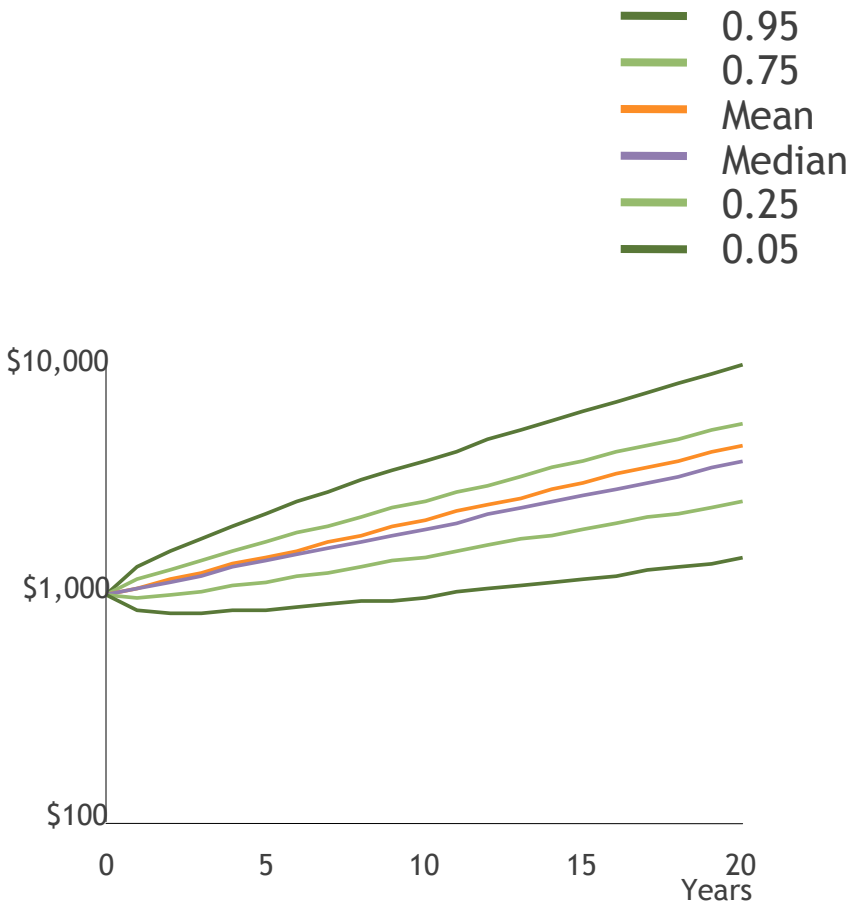
Constrained and unconstrained



ASSET RETURN DISTRIBUTIONS: A REMINDER

Left: Asset "tulip," minimum surplus variance portfolio (mostly fixed income, asset beta .405)
Right: Asset "tulip," 100% equity portfolio (asset beta 1.44)

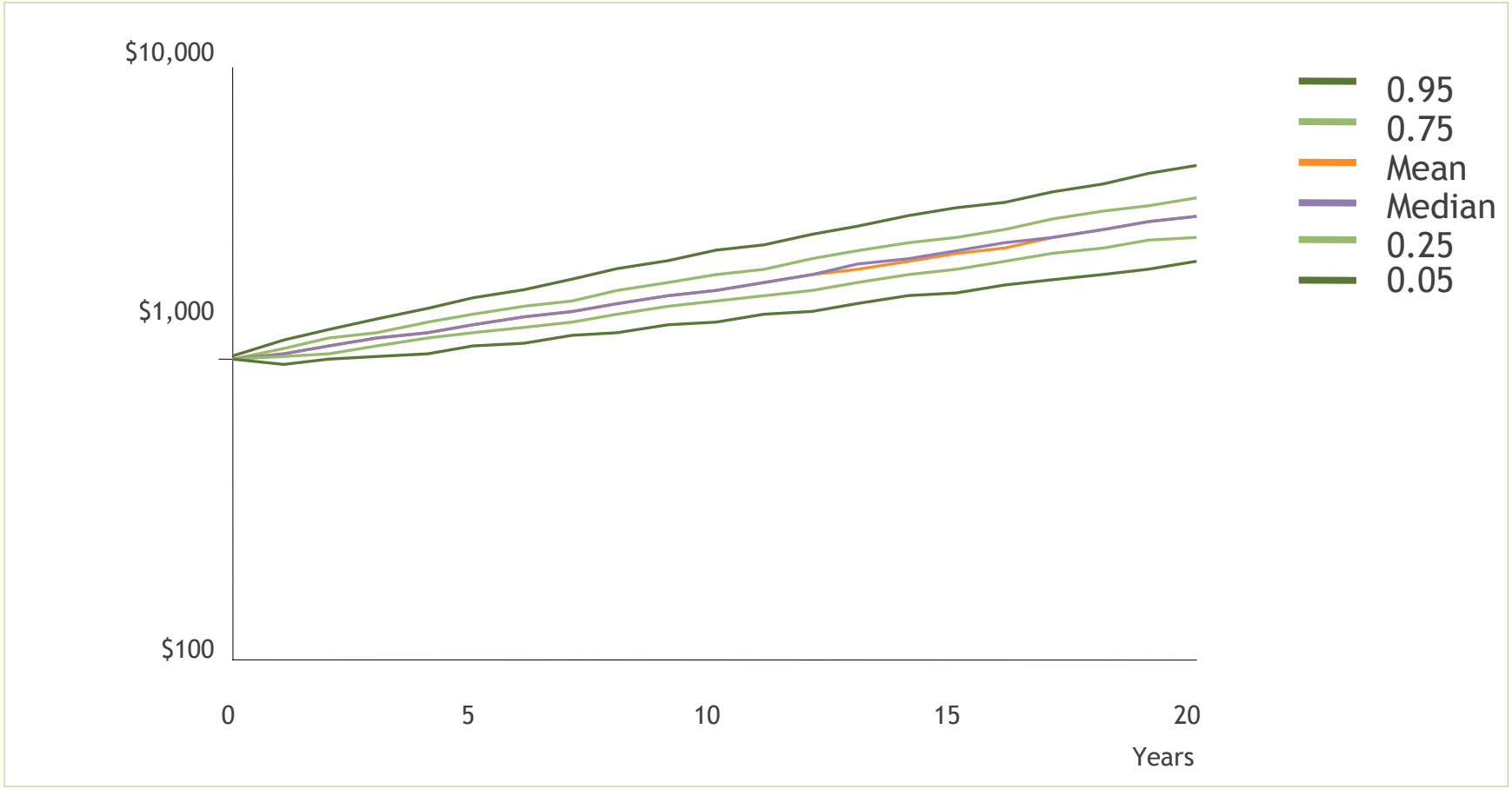




Seeking higher returns (steeper slope) means accepting a wider distribution of ending wealth

LIABILITY RETURN DISTRIBUTIONS ARE SIMILAR

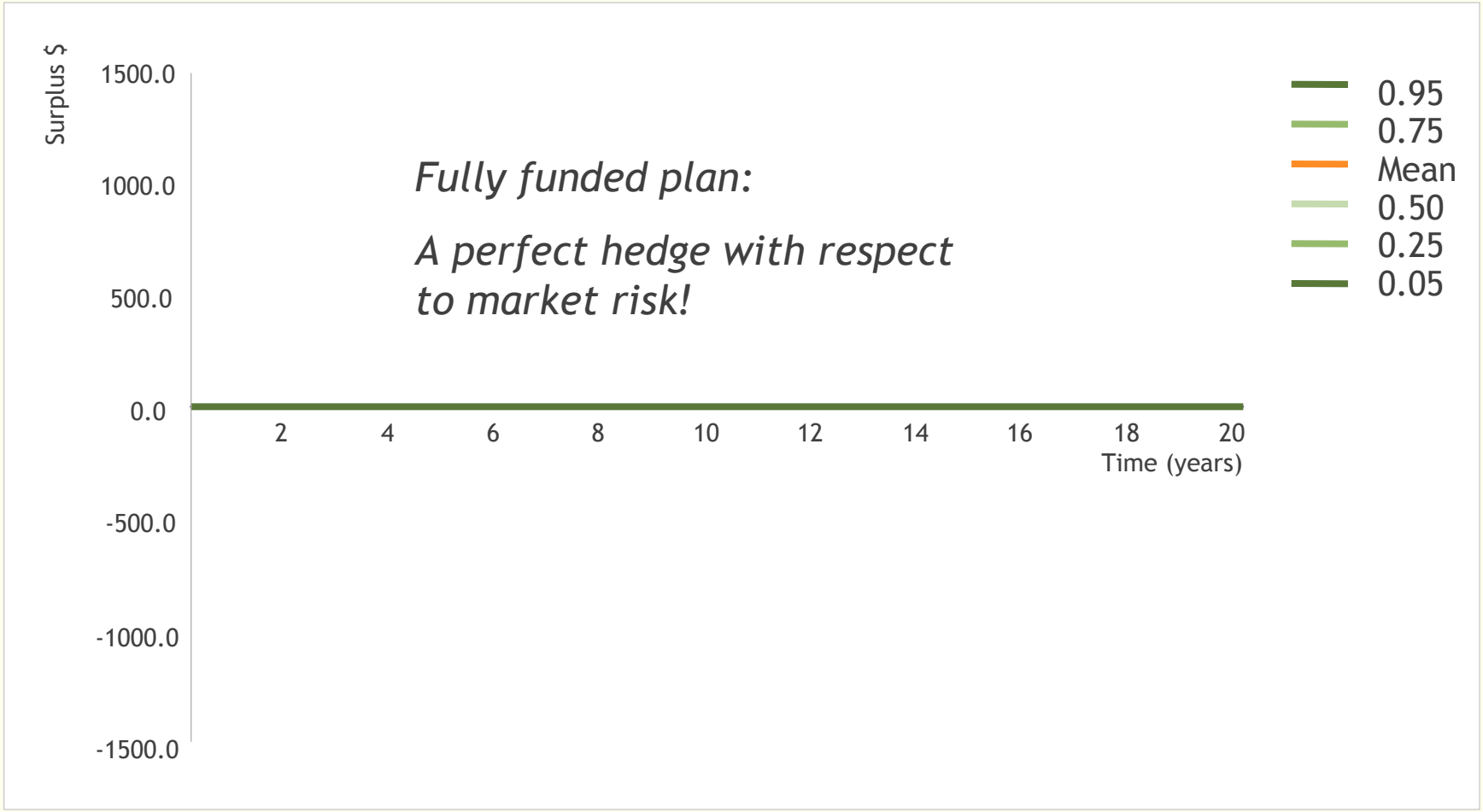
Liability "tulip", (mostly bond liability model, liability beta .405)



(Liability risk related to alpha is ignored here)

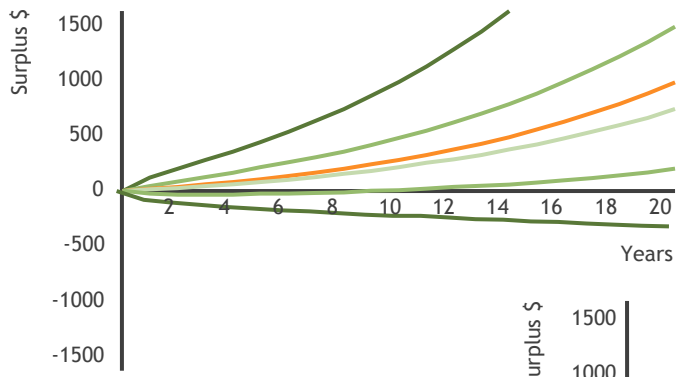
SURPLUS RETURN DISTRIBUTION: MINIMUM SURPLUS VARIANCE (MSV) PORTFOLIO

A/L = 100%, β_s = .00.



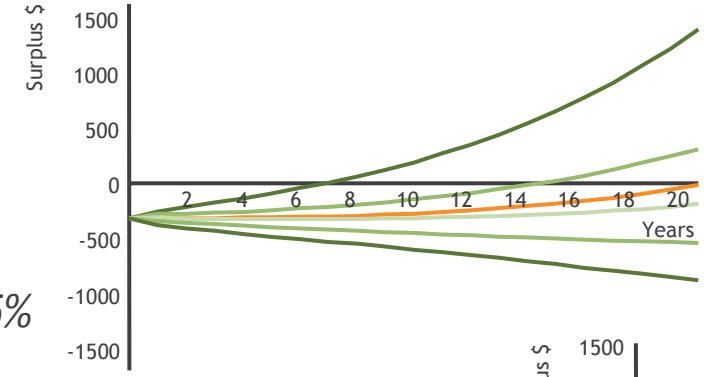
(Again, without liability alpha risk)

THE DISTRIBUTION OF EXPECTED FUTURE SURPLUS DETERIORATES WITH LOWER FUNDING RATIOS



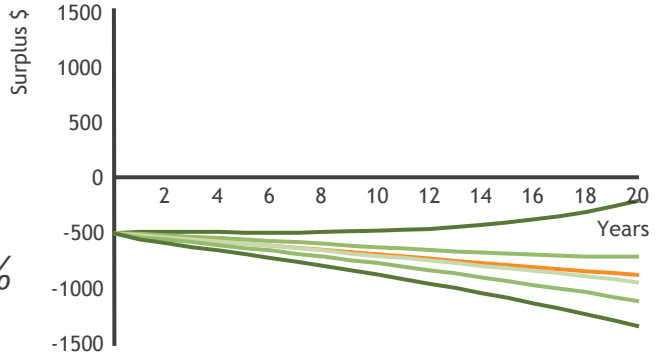
A/L = 100%

β_s = .55



A/L = 75%

β_s = .31



A/L = 50%

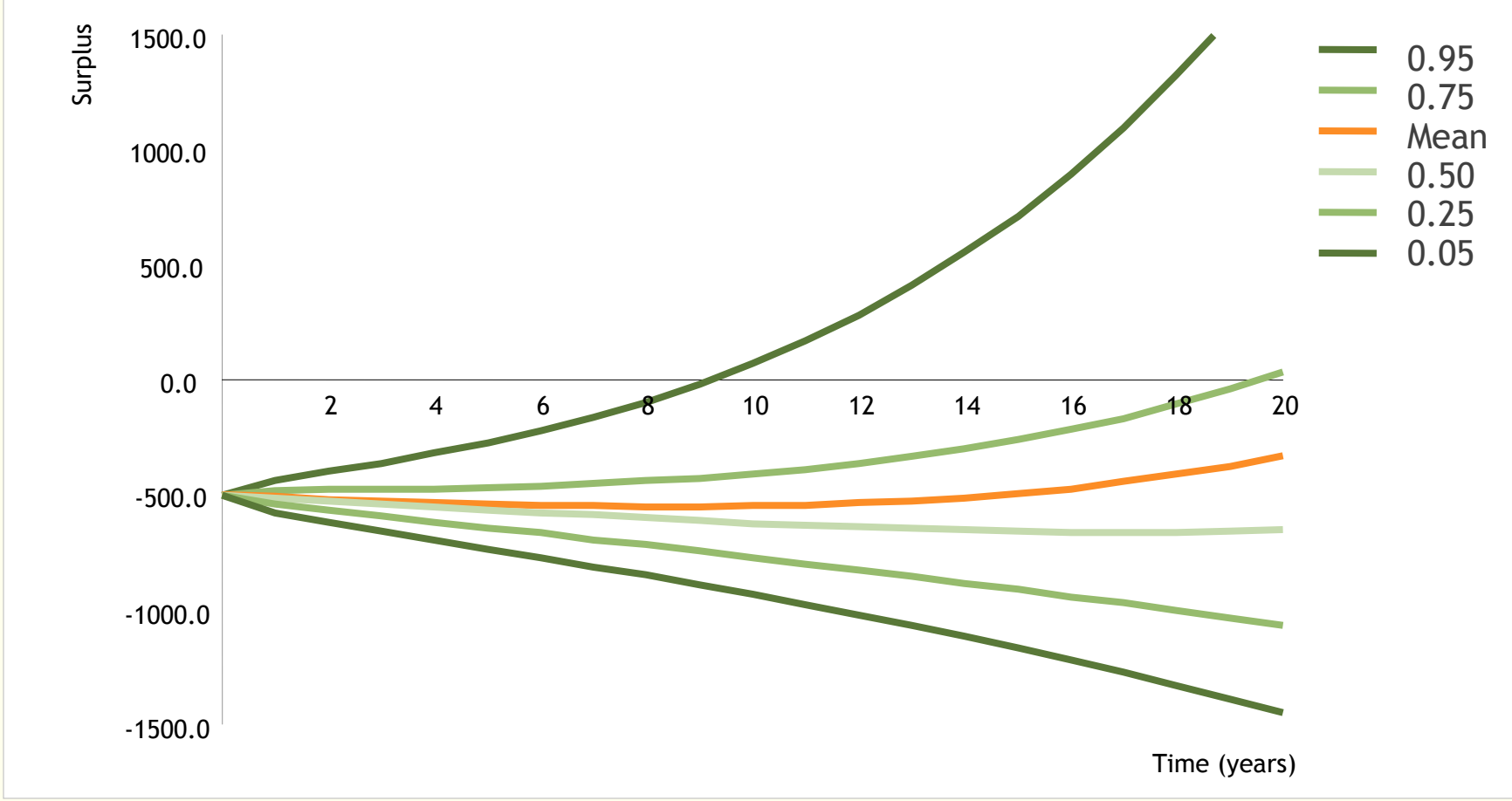
β_s = .07

All examples have 60% equity, but decreasing funding ratio means β_s is also decreasing.

0.95
0.75
Mean
0.50
0.25
0.05

MORE AGGRESSIVE INVESTING HELPS LESS AT LOWER FUNDING RATIOS: *THE LIMITS OF THE POSSIBLE*

A/L = 50%, 91% equity, βs = .32

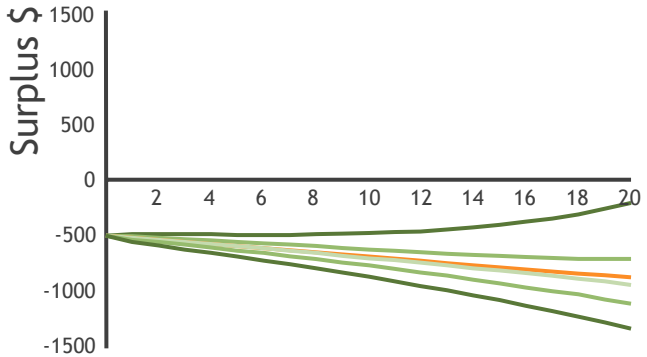


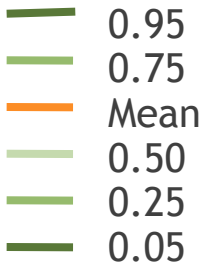
Only contribution policy, benefit policy, can save this plan

MAKING A POLICY DECISION: HOLDING FUNDING RATIO CONSTANT

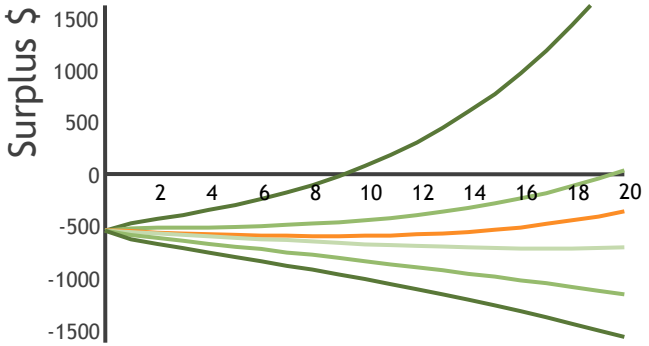
An extreme case: 50% funding

$\beta_s = .07$
60% Equity





$\beta_s = .32$
91% Equity

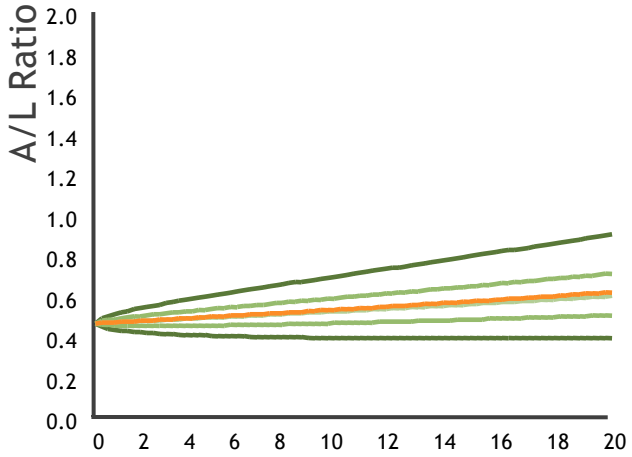


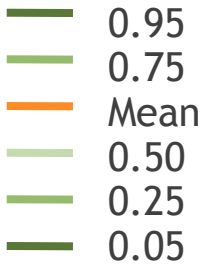
Thanks to Dr. Duane Whitney for calculating all of the tulip diagrams.

MAKING A POLICY DECISION: ANOTHER VIEW

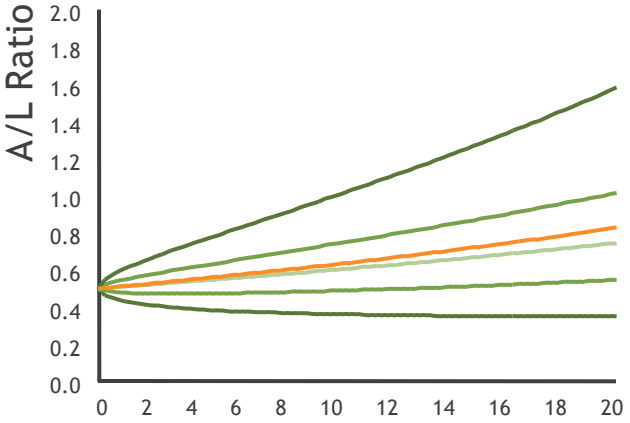
Distributions of future A/L ratios

β_s = .07
60% Equity





β_s = .32
91% Equity



THE TWO-FUND THEOREM WITH LIABILITIES

In surplus optimization

Consider this proposition:

The investor holds a combination of:

1) The liability-hedging portfolio (combined with an appropriate amount of the risk free asset), and

2) The market portfolio

- (In the "real world" there are some beta-related residuals in the liability, which partly obscure this result)
- The liability-hedging portfolio is the real risk-free asset
  - This explains the intuition of Campbell and Viceira that TIPS are an individual's real risk-free asset — they are the best hedge to most personal "liabilities"
- Liebowitz and Henriksson: surplus optimization is the general case, while asset-only optimization is the special case
  - The unconstrained surplus efficient frontier, in surplus space, is the generalized equivalent to the CML

THE ROLE OF EQUITIES

Why hold equities?

1) Hedging:	The liability beta model has small amounts of equity-like market risk, especially for future accruals; it must be hedged on the asset side
2) Compensatory: leverage	If under-funded, a higher asset beta (more equities) is required (even to achieve a minimum surplus variance policy)
3) Return:	Equity risk is *fairly compensated* – it is fair to take some considered amount of beta risk in the search for higher returns

RISK TOLERANCE IN THE PRESENCE OF A LIABILITY

How much surplus beta?

Roadmarks for a risk aversion discussion:

1) Zero surplus beta

- The marketer's position: all alpha, all of the time!
- Consistent with Tepper-Black; integrated view of the balance sheet
- But if you won't take unconditionally rewarded risk, why would you ever take risk that is only rewarded conditionally?

2) The market portfolio – Beta risk is fairly rewarded, after all!

- Suggested by Sharpe in 2004 "Equilibrium" chapter in internet text book
- But his is a PCM argument — may not counter Tepper-Black

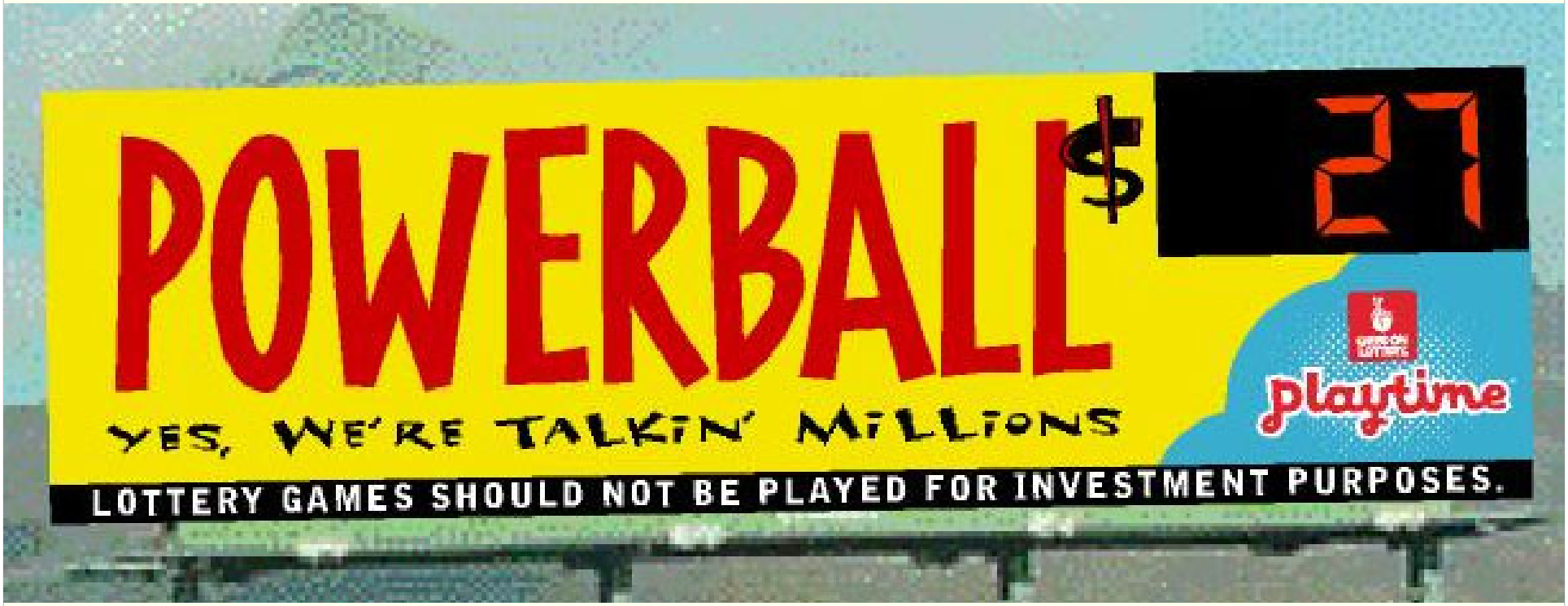
3) Historical levels of risk provide another reference point

- 50-50 equity-bonds, or less

My "trial close:"

Take some surplus beta risk,
but less than today's high levels

ONE INVESTMENT POLICY ALTERNATIVE:



CONCLUSION: CONTROLLING PENSION FUNDING RISKS

Two key questions decide your liability-relative investment policy:

How much surplus beta?

- Only market-related risks can hedge the liability
- Trade expected growth of surplus against risk to the surplus
- Tulip surplus, A/L distributions demonstrate the trade-off
- Coordinate with an appropriate contribution, benefit policies
- Back-up with a surplus duration targeting or matching effort
- Coordinate with enlightened accounting policies when possible

How much alpha?

- Conditional on skill, accept active risk in the search for alpha
- Consider reducing long-only constraint, alpha-beta constraint

Not all liability risk can be managed, but much of it can be