The Actuarial Profession
making financial sense of the future

ORTEC FINANCE

Momentum 2010
Andrew Slater

Discount rates
Who needs them?

10 December 2010

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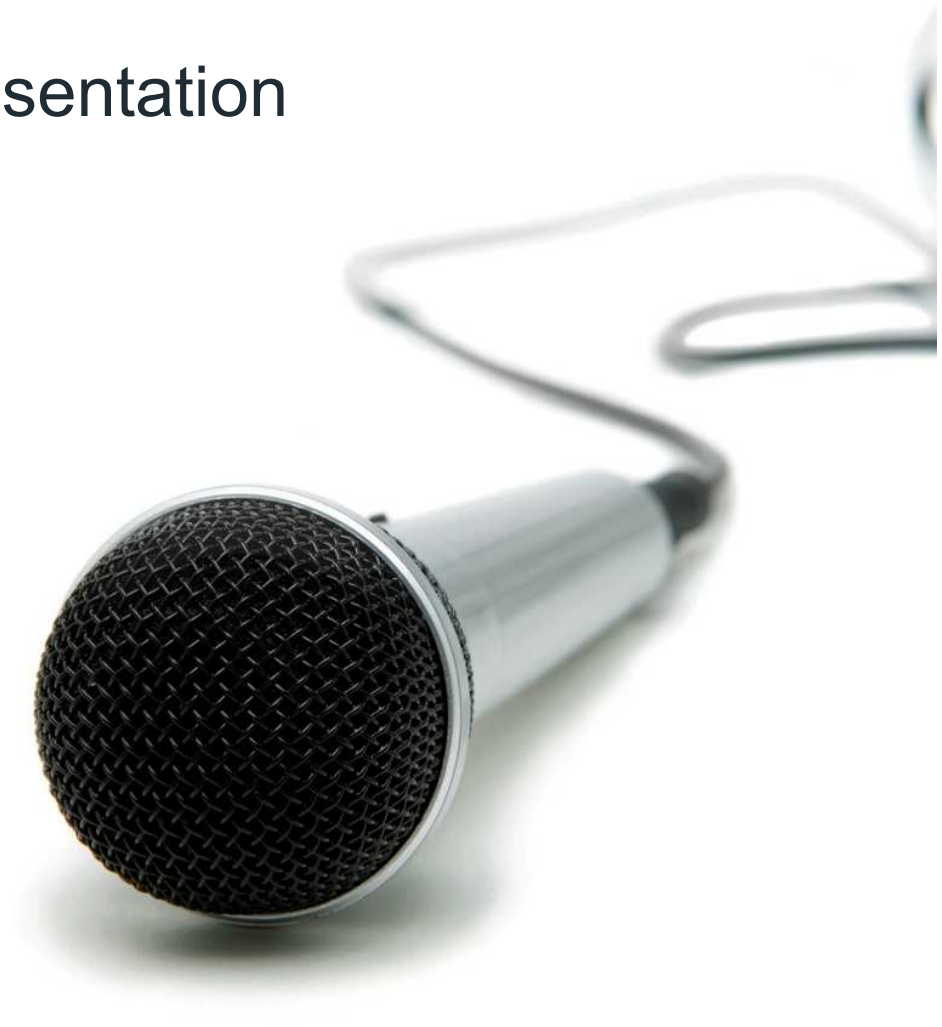

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Quotes 1

- It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change.
  - Charles Darwin

- You can know the name of a bird in all the languages of the world, but when you're finished, you'll know absolutely nothing whatever about the bird... So let's look at the bird and see what it's doing — that's what counts. I learned very early the difference between knowing the name of something and knowing something.
  - Richard Feynman

- If you didn't grow it, you didn't explain it.
  - Joshua Epstein

Quotes 2

- The conventional view serves to protect us from the painful job of thinking.
  - John Kenneth Galbraith

- Too large a proportion of recent "mathematical" economics are mere concoctions, as imprecise as the initial assumptions they rest on, which allow the author to lose sight of the complexities and interdependencies of the real world in a maze of pretentious and unhelpful symbols.
  - John Maynard Keynes

The origin of this talk: my notes from the Discount Rates Forum, Staple Inn, 23/3/10

- Reduce diversity of practice – why? Groupthink!
- Why is book value artificial? It is real! What is an artificial construct is a discount rate.
- Why should a market value exist?
- Liabilities (pension, insurance) are created by institutions. Therefore a match in a market does not exist.
- “Markets don’t tell you everything you want”
- ?embedded risk in discount rate
- Collapsing a random variable (distribution) to a number. Two purposes
  - Give information to someone else (external)
  - Make a decision (internal)

A possible rationalisation

Matching calculations

- What are the characteristics of the liability cash flow?
- Are there any traded instruments which *match liability cash flows*?
- Is the market deep, liquid and transparent?
- What is the next best thing?
  - Synthetic price?
    - Judgements about models and assumptions
    - Generally calibrate to market

Budgeting calculations

- How is the liability being financed?
- What is the current yield on the investments?
- Is the current yield the same as the total overall return?
- What is the next best thing?
  - Assumptions
    - Judgements about financial and economic indicators
    - Possibly informed by market analyses

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23 March 2010

Building blocks for discount rates

Matching calculations

- Build up to the matching asset
  - Reference market rates
  - Term structure
  - Default risk
  - Illiquidity premium
  - Diversification premium
- Result is a yield structure to apply to cash flows

Budgeting calculations

- Establish reference asset portfolio
  - Risk appetite and affordability
  - Nature of liability ; discretions; guarantees
  - Available market instruments
  - Prudence margins
- Adjust current yield on asset portfolio (eg for credit defaults) and make judgements about future expectations (eg equity growth)
- Result is (usually) a single 'expected return' (arithmetic or geometric) to apply to cash flows

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Transfer values 1

21 March 2006 - DWP to consult on Pensions Transfer Values

- The Minister for Pensions Reform Stephen Timms today announced that the Government will shortly consult on the way pensions transfer values are calculated.
- “The Government has delegated to the Actuarial Profession the responsibility for specifying the framework within which actuaries must work when advising pension scheme trustees on the calculation of transfer values.
- “Recently the Actuarial Profession consulted on changes to their guidance on the calculation of transfer values. The consultation gave rise to a significant difference of view on the way forward.
- “The Government has been in discussion with the profession about the results of their consultation. We have now agreed with the profession that the time is right for the Government to set out the principles in legislation that should underpin the calculation of transfer values.

Transfer values 2

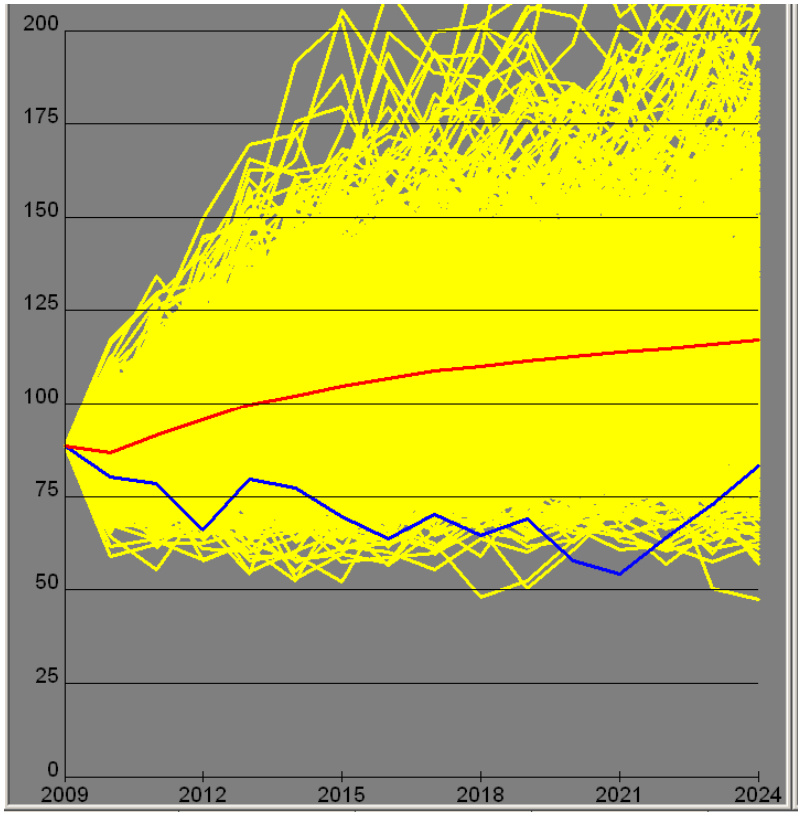
- Legislation gave members an option to a transfer value
- Codification of general practice at the time

- DB pension is an asset of the member
- So is the option

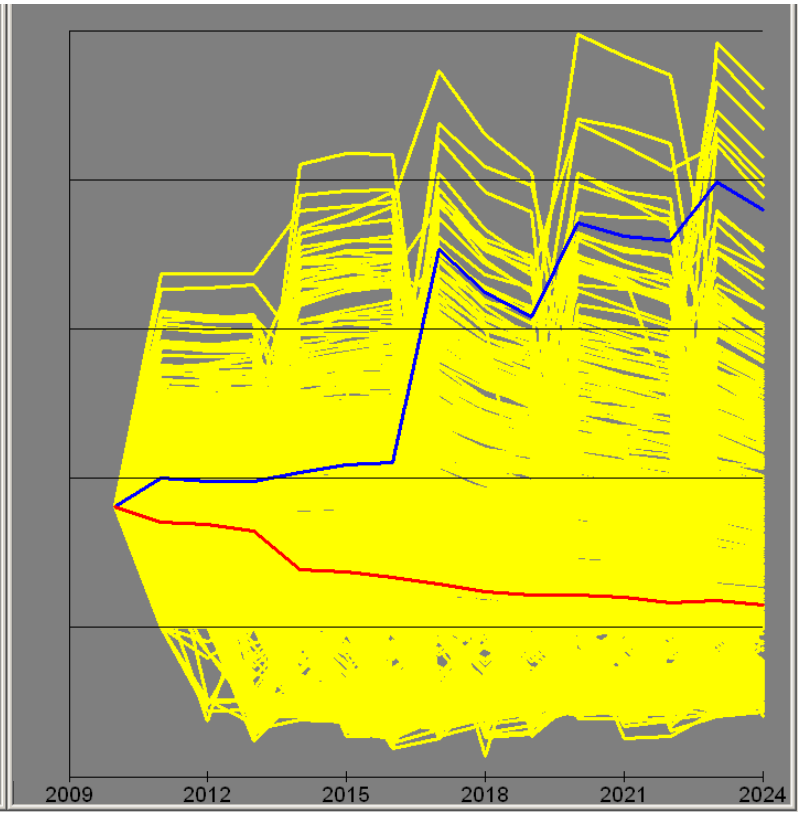
- Member's asset = 100%.(1-q) + PPF.q
  - q = probability of sponsor insolvency

Discount rate = gilt plus risk premium
ALM projection

Ongoing funding ratio (%)



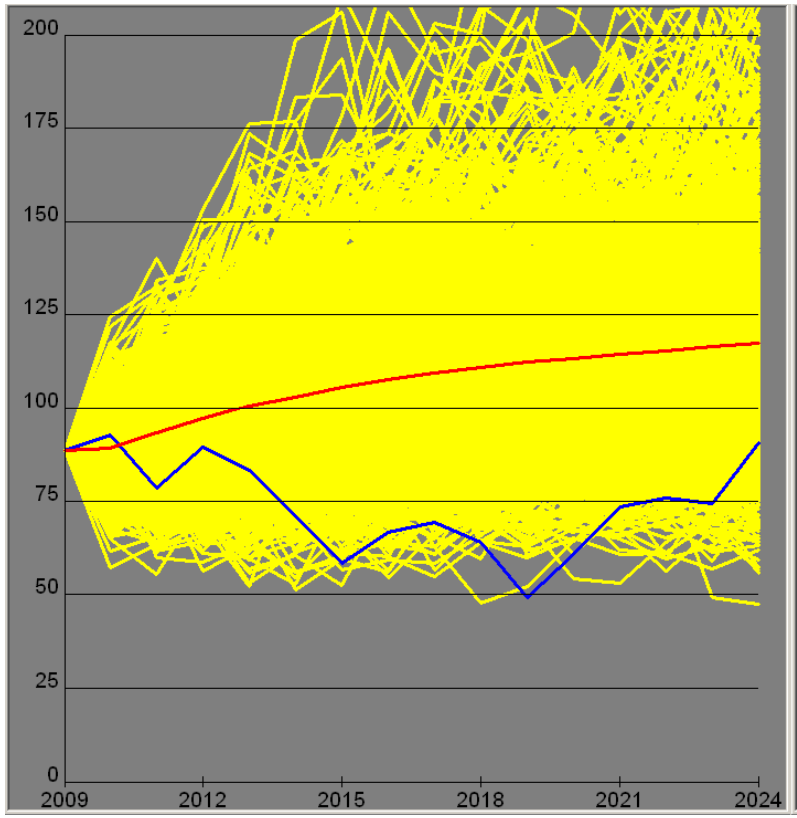
Deficit repair contributions



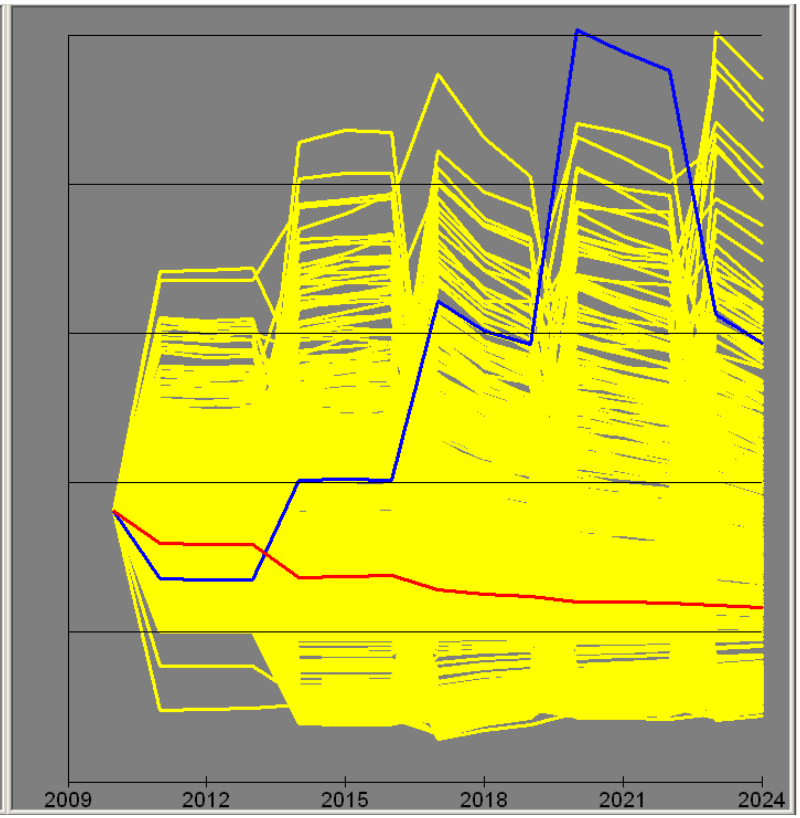
- Each yellow line is one of 1,000 stochastic simulations
- The red line is the mean (not a simulation)
- The blue line is a selected simulation

Discount rate = expected asset return
ALM projection

Ongoing funding ratio (%)



Deficit repair contributions



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Discount rate = gilt plus risk premium
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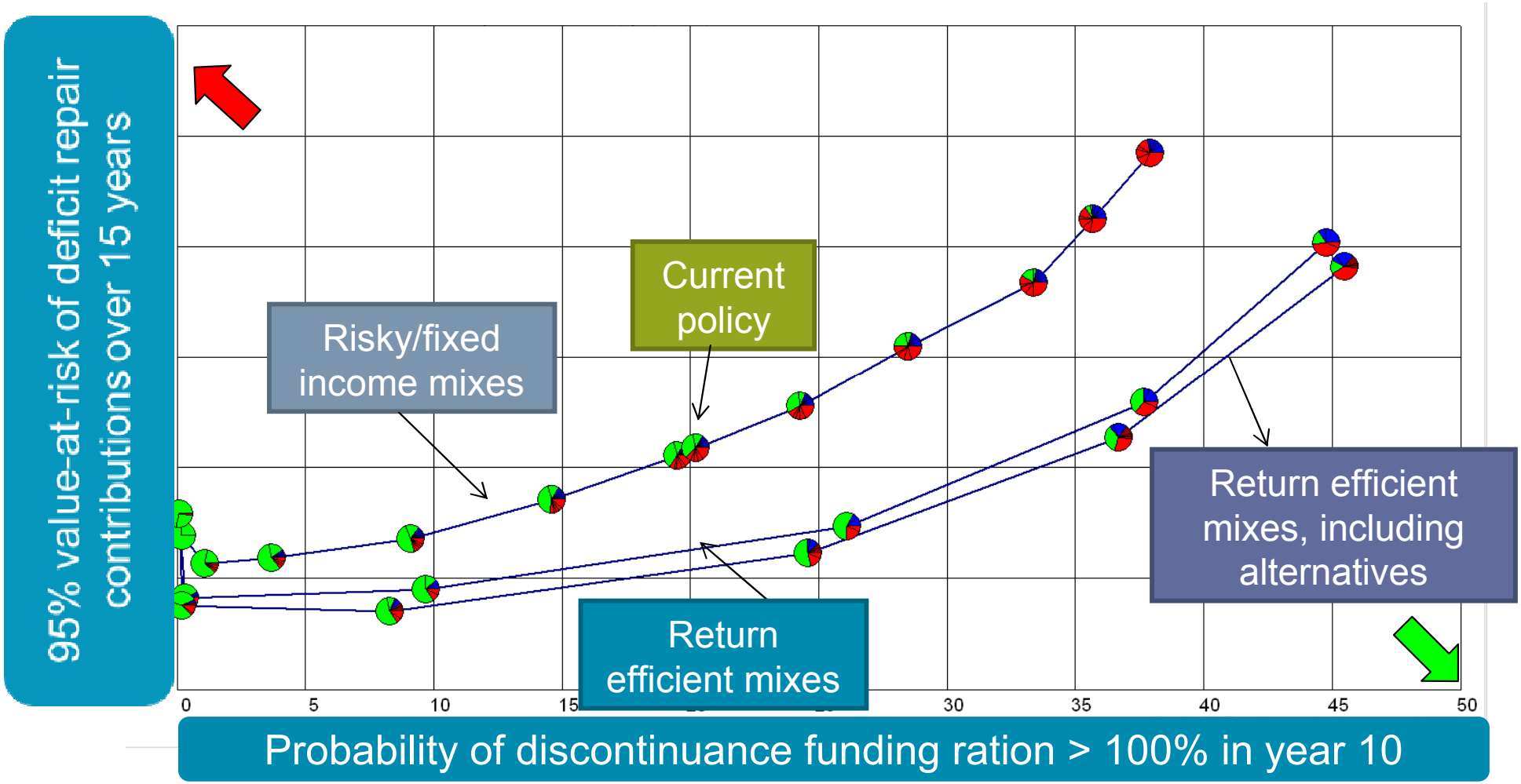
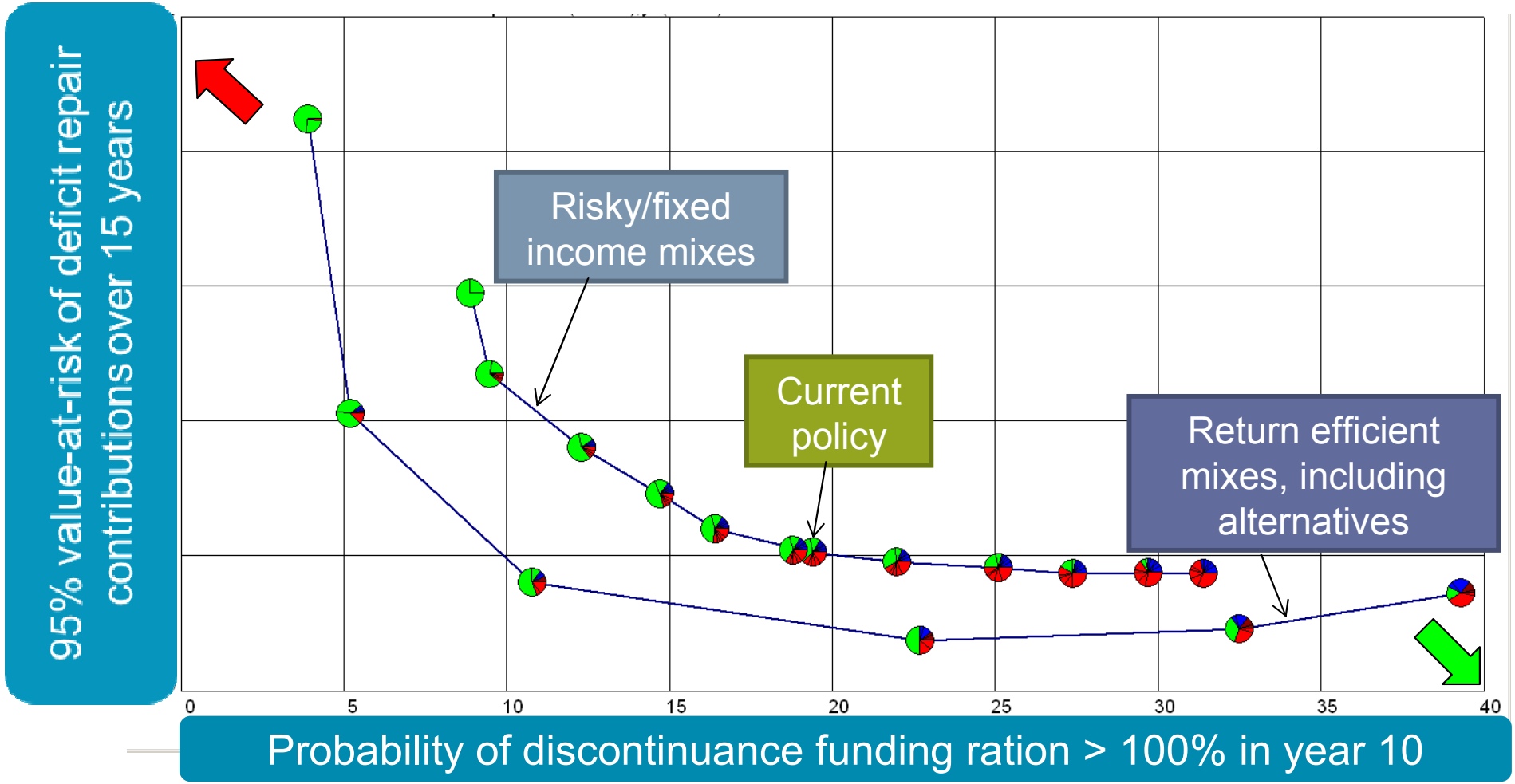


Discount rate = expected asset return
ALM projection



Discount rate construction
ALM conclusions

- The yellow clouds (15 year projection of ongoing funding ratio and deficit repair contributions) show a very similar range of results
  - The real obligation is the same regardless of how the discount rate is constructed
- Multi period (long term) statistics show
  - More intuitively shaped efficient frontiers when discount rate = expected asset return
  - The artificial link with short term yields leads to higher contributions when discount rate = gilt plus premium

Actuaries and Discount Rates

Paragraph 1.1

- Using discount rates may not always be the most helpful way of answering many of the questions which actuaries and others have to deal with in respect of the analysis of future cash-flows. In an ideal world discount rates might not be necessary at all.

Actuaries and Discount Rates

Paragraph 1.1

- Using discount rates may not always be the most helpful way of answering many of the questions which actuaries and others have to deal with in respect of the analysis of future cash-flows. In an ideal world discount rates might not be necessary at all. However, in practice, despite all the sophisticated tools available in the financial markets, asset and liability cash-flows rarely balance exactly over all periods of time and actuaries and other financial sector professionals regularly use discount rates as a tool to condense complicated cash-flow information into more manageable present value numbers.

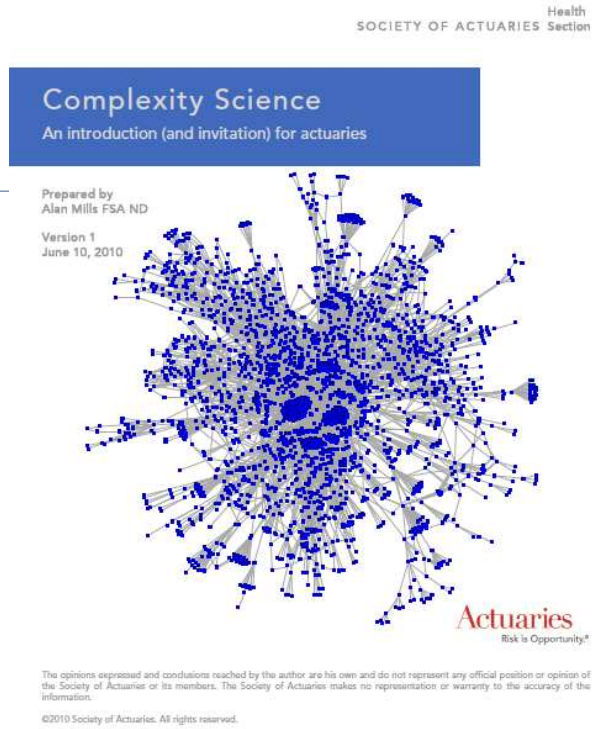
Alternative: a systems approach

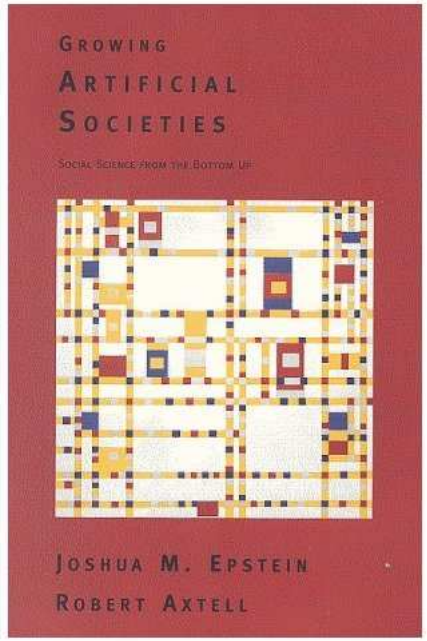
Table 1: A comparison of analytical and systems approaches – Source: De Rosnay

Analytical	Systems
Isolate: Concentrate on Components	Combine: Concentrate on component interactions
Consider the nature of interactions	Consider the effect of interactions
Base oneself on accuracy of detail	Base oneself on global perception
Modify one parameter at a time	Modify groups of parameters simultaneously
Independent of time: the phenomena are reversible	Integrate time and irreversibility
Validation of facts by experimental proof within the framework of a theory	Validation of facts by comparing the functioning of the model and that of reality
Models are precise and detailed but difficult to use for action	Models are not rigorous enough to serve as a basis for knowledge but valid for decision and action
Effective approach for weak linear interactions	Effective approach for strong, nonlinear interactions
Leads to a single-discipline (Juxtadisciplinary) outcome	Leads to a multidisciplinary outcome
Leads to programmed action on details	Leads to aim oriented action
Knowledge of details – poorly defined objectives	Knowledge of objectives – details unclear

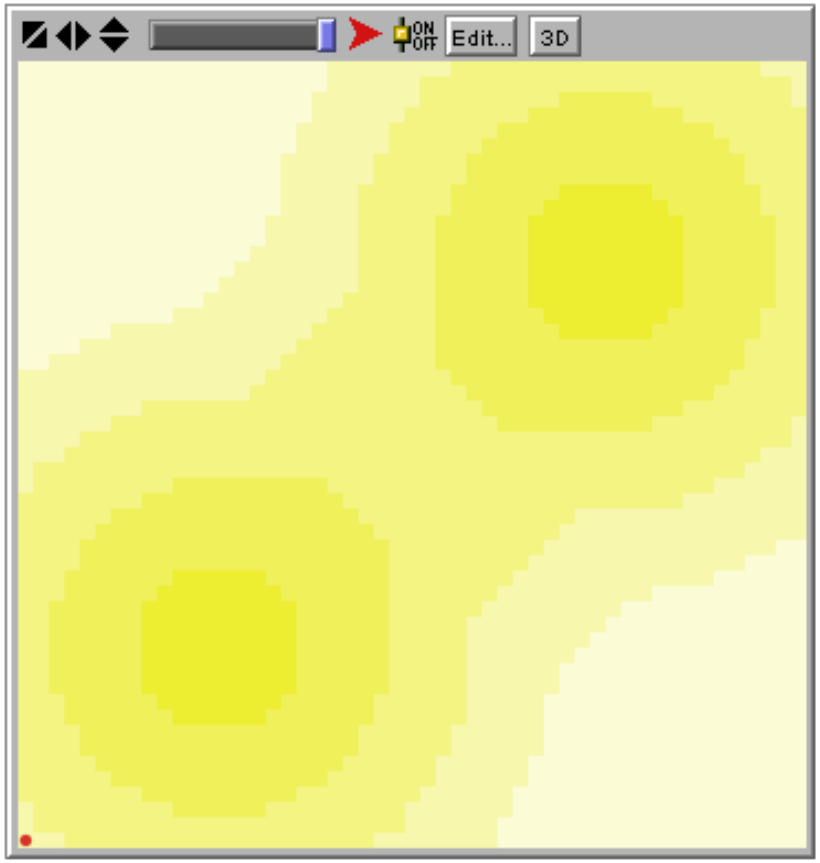
Sugarscape

- Two entities
  - **Environment** (51x51 lattice, torus)
  - **Agents** (could be variation within species and/or multiple species)
- Three types of rule
  - Environment – Environment
  - Agent – Environment
  - Agent – Agent





A sugarscape: max capacity at each point



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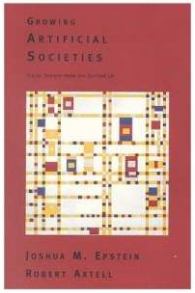
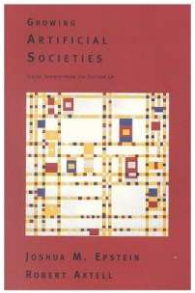


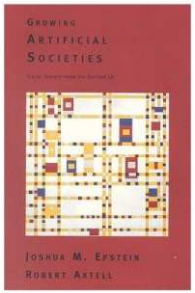
Sugarscape grow back rule G_α

- At each lattice position, sugar grows back at a rate of α units per time interval up to the capacity at that position



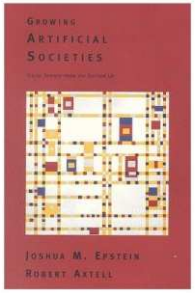
Agents

- Genetic characteristics
  - Sugar metabolism (1 to 4 units of sugar per time)
  - Level of vision (1 to 6 sites ahead)
  - Maximum age (could be infinite)
- Variable states
  - Position (x,y)
  - Amount of sugar
- Each time period agents
  - Metabolise sugar
  - Die if their sugar runs out or reach their maximum age



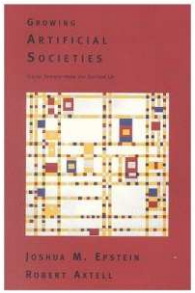
Agent movement rule M

- Look out as far as vision permits in the four principal lattice directions and identify the unoccupied site(s) having the most sugar
- If the greatest sugar value appears on multiple sites then select the nearest one (*)
- Move to this site
- Collect all the sugar at this new position
  - (*) if it appears at multiple sites the same distance away, the first site encountered is selected (the site search order being random)

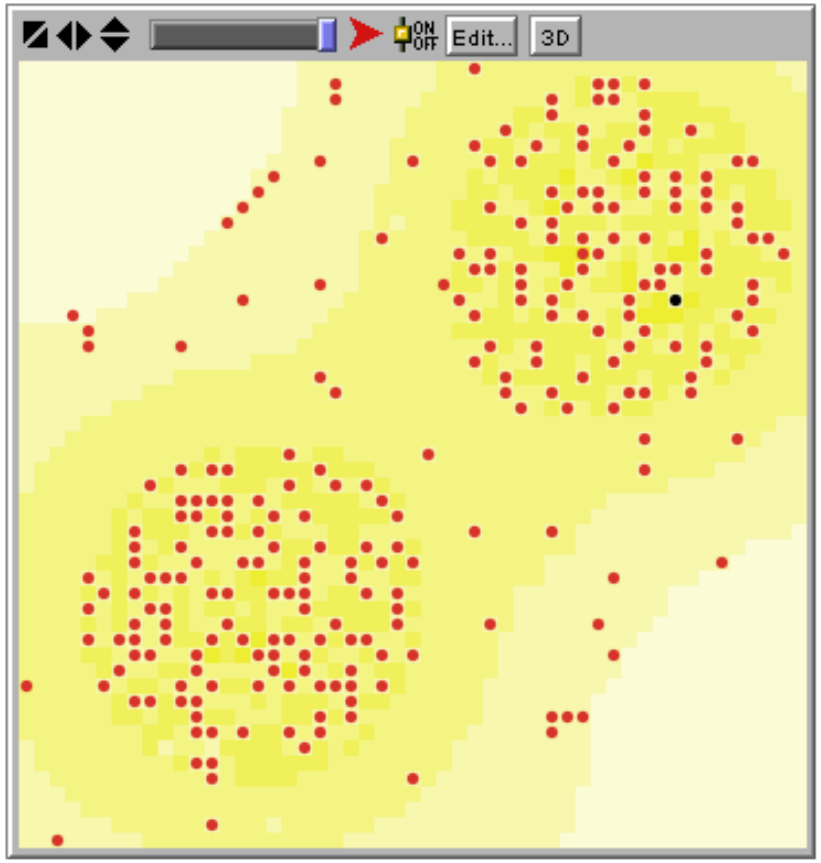


Agent replacement rule $R_{[a,b]}$

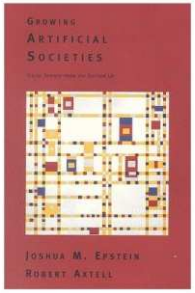
- When an agent dies it is replaced by an agent of age zero having random genetic attributes, random position in the sugarscape, random initial endowment, and a maximum age randomly selected in the range [a,b]



Simulation ({G_1}, {M, $R_{[60,100]}$})

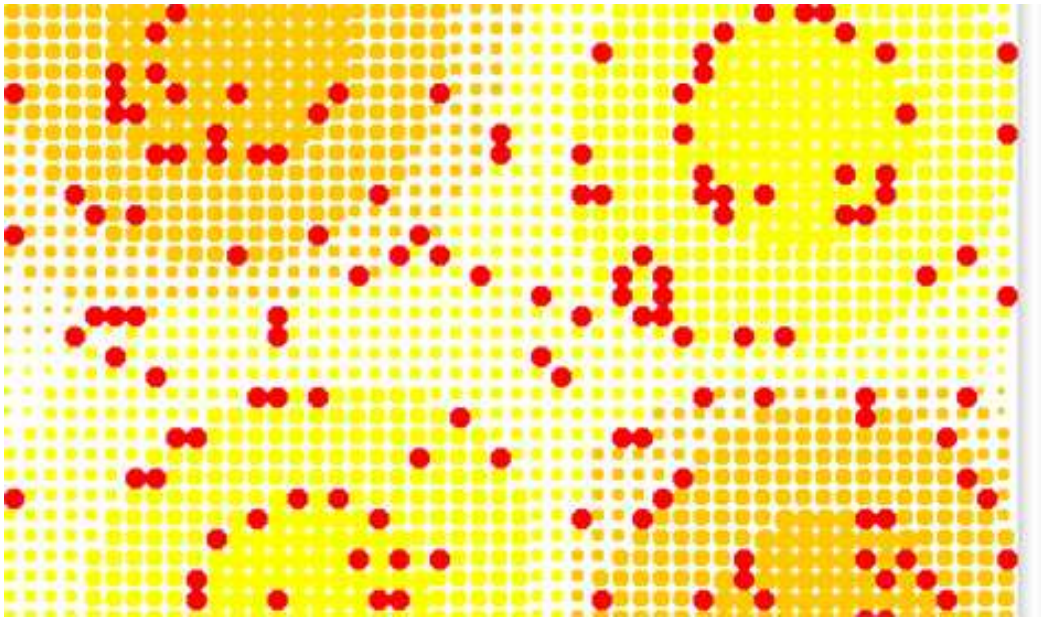


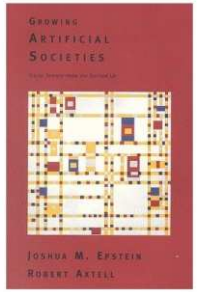
http://complexityworkshop.com/models/sugarscape.html experiment 3



Sugar & spice

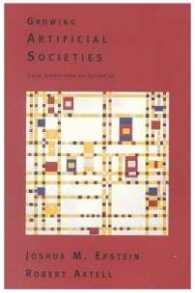
- Second commodity
- Agents need both to survive
- Spice metabolism
- Welfare function
- Trade





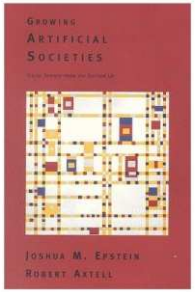
Multi-commodity agent movement rule M

- Look out as far as vision permits in each of the four lattice directions
- Considering only unoccupied lattice positions, find the nearest position producing maximum welfare
- Move to the new position
- Collect all the resources at that location



Agent trade rule T

- Agent and neighbour compute their marginal rate of substitution (MRS); if these are equal then end, else continue
- The geometric mean of the two MRS is calculated – this will serve as the price *p* [more elaborate bargaining could be constructed]
- The quantities to be exchanged are if $p>1$ then *p* units of spice for 1 unit of sugar; if $p<1$ then $1/p$ units of sugar for 1 unit of spice
- If this trade will (a) make both agents better off (increase their welfares) and (b) not cause the agents' MRS to cross over then the trade is made and return to start, else end



Welfare function

- A “rational” agent having, say, equal sugar and spice metabolisms but with a large accumulation of sugar and small holdings of spice should pursue sites having relatively more spice than sugar. One way to capture this is to have the agents compute how “close” they are to starving to death due to a lack of either sugar or spice. Imagine an agent with metabolisms *(m1, m2)* and accumulations *(w1, w2)*. The amount of time until “death” given no further resource gathering is simply

$$\tau_1 = w_1 / m_1; \tau_2 = w_2 / m_2$$

- The relative size of these two quantities is a measure of the relative importance of finding sugar or spice. The welfare function

$$W(w_1, w_2) = w_1^{m_1/m_\tau} w_2^{m_2/m_\tau}$$

- where $m\tau = m1 + m2$. This function reflects this importance relation and can be used in the agent movement rule to decide on which field to move.

Trade rules 1

- Let us just briefly mention the trade rule. The two key quantities in the trade rule are the MRS, the marginal rate of substitution, and the price. An agent's MRS of spice for sugar is the amounts of spice the agent considers to be as valuable as one unit of sugar, that is, the value of sugar in units of spice. It can be shown that this MRS for the welfare function is:

$$MRS = \frac{dw_1}{dw_2} = \frac{\dfrac{\partial W(w_1, w_2)}{\partial w_1}}{\dfrac{\partial W(w_1, w_2)}{\partial w_2}} = \frac{m_1 w_2}{m_2 w_1} = \frac{\tau_2}{\tau_1}$$

Trade rules 2

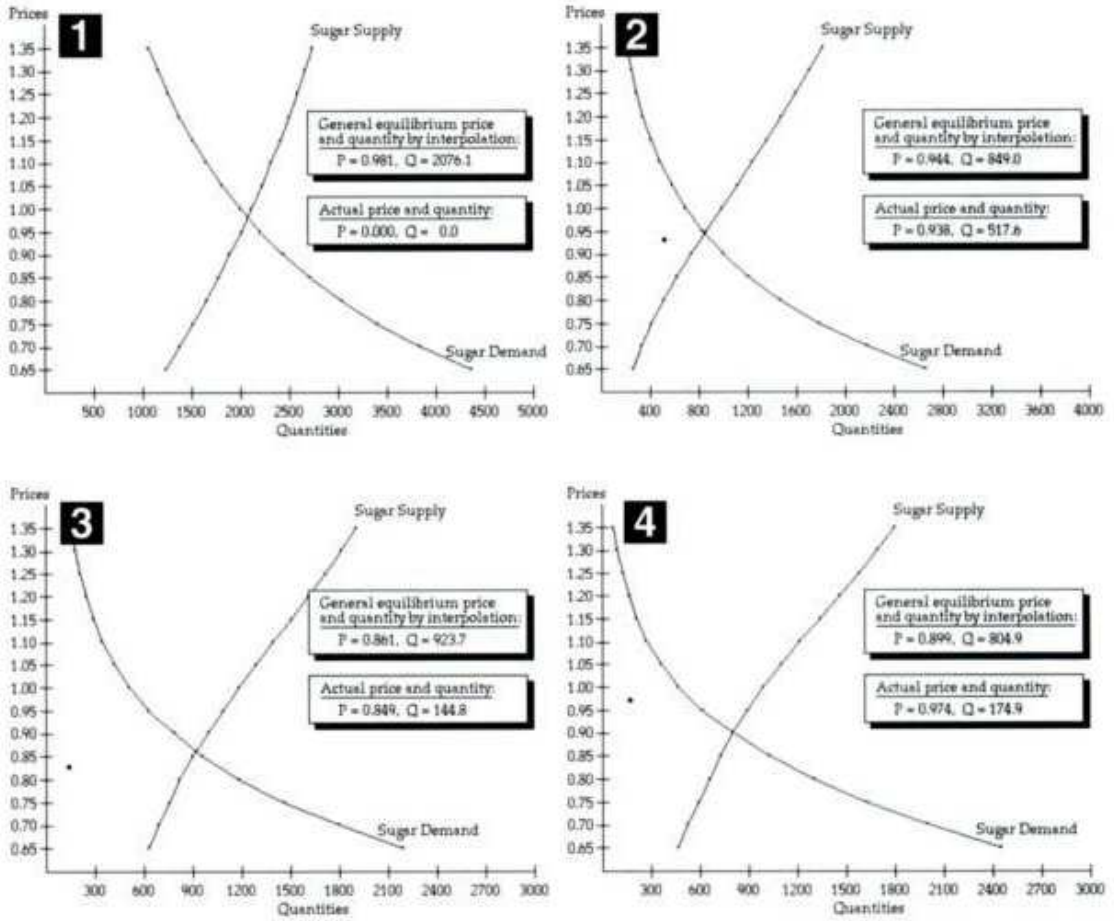
- If MRS<1, for example, then the agent thinks of itself as being relatively poor in spice. If MRSA>MRSB then agent A considers sugar to be relatively more valuable than does agent B, and so A is a sugar buyer and a spice seller while agent B is the opposite. As long as the MRSs are not the same there is potential for trade. The directions of trade are summarized:

	$MRS_A > MRS_B$		$MRS_A < MRS_B$	
Action	*A*	*B*	*A*	*B*
Buys	*Sugar*	*spice*	*spice*	*Sugar*
Sells	*Spice*	*sugar*	*sugar*	*Spice*

- The bargaining rule to determine the local price is: $p(MRS_A, MRS_B) = \sqrt{MRS_A MRS_B}$

Simulation ({G_1}, {M, T})

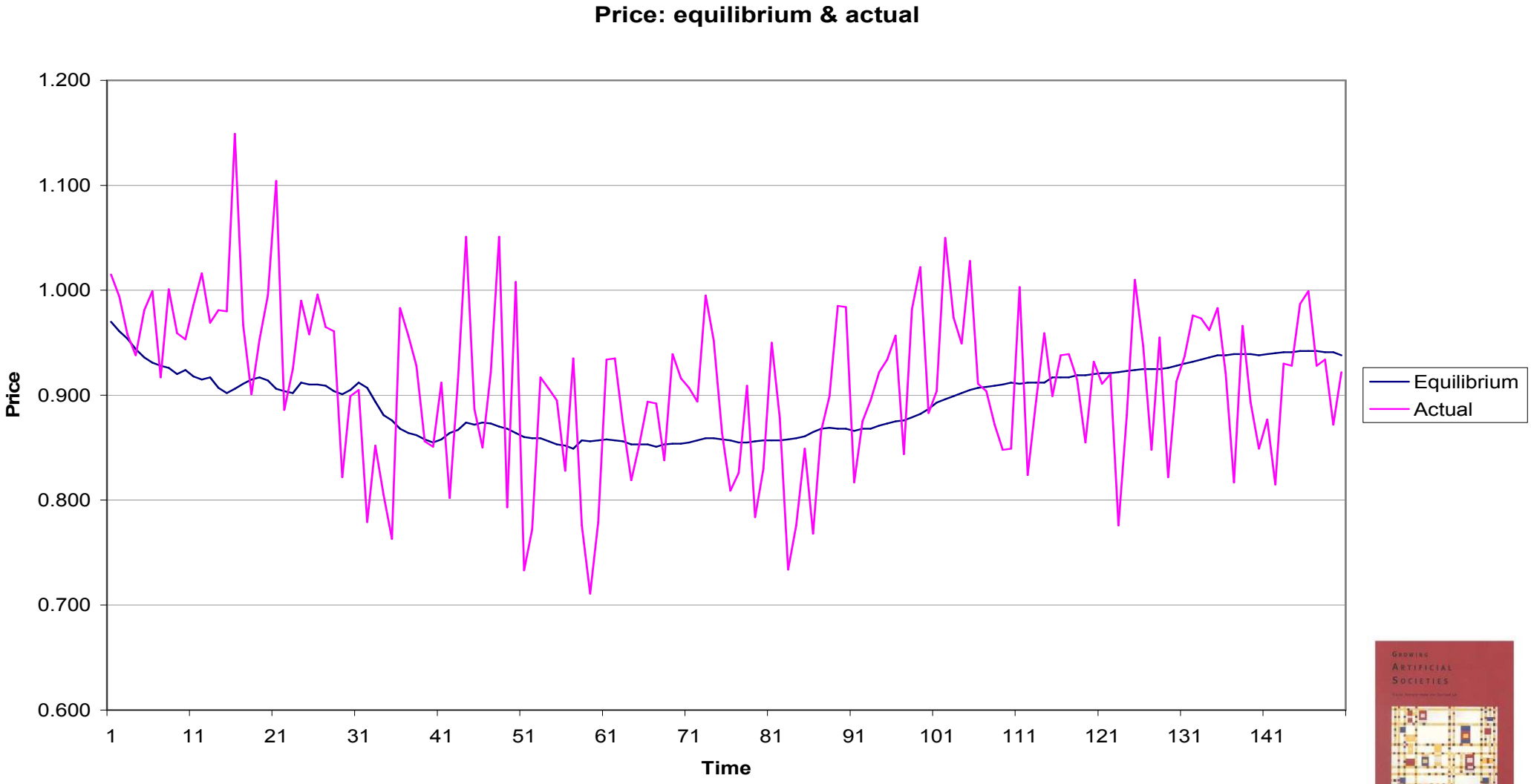
Animation IV-2. Evolution of Supply and Demand under Rule System ({G_1}, {**M**, **T**})



http://www.brook.edu/es/dynamics/sugarscape/animations/AnimationIV.mov

Sugarscape, page 115

Non equilibrium
Endogenous and exogenous volatility



Pension accounting 1 - discount rate

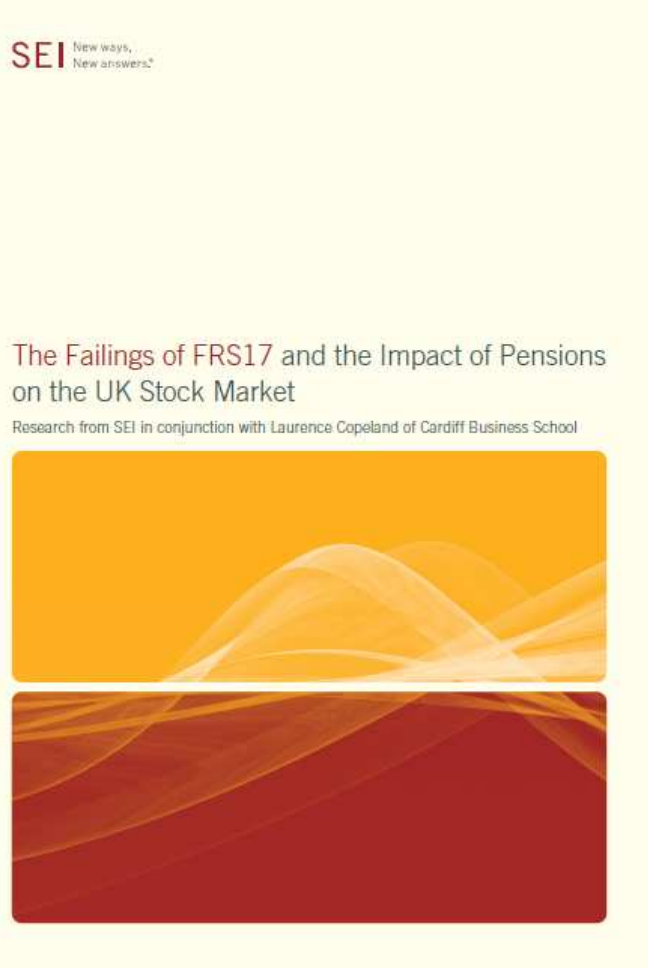
- Exchange of labour for deferred pay
- A – L = s/h funds (retained earnings and equity capital)
- Deferred pay obligation displaces shareholders' funds
- Discount rate = prospective ROE (as earnings on corporate assets unchanged)
- "Pension liability" should be fully on sponsor balance sheet (no scheme netting off)
- "Scheme assets", where they exist, are part of retained profit

Pension accounting 2 – pro and counter cyclicality

- Boom times: high ROE and high ability to service obligations
  - Central bank raises interest rates to cool economy
  - Under FRS17 the liability value decreases
  - Under ROE the liability value increases (lower ROE as boom times over)
- Depths of slowdown: company cash is scarce, survival is key
  - Central bank lowers interest rates to stimulate economy
  - Under FRS17 the liability value increases markedly
  - Under ROE the liability value decreases (ROE increases from cheap borrowing)

Pension accounting 3 – mark-to-market

- Pro-cyclical
- Inefficient allocation of corporate resource
- [Markets are a good mechanism for allocation of investor resource]
- Benefit reduction
  - Via PPF in UK
  - Directly in the Netherlands
    - FTK uses swap curve



These aren’t the yields you are looking for

Discounting

- Is artificial
- Can lead to loss of thought

Decision making

- Stress test on discount rate construction

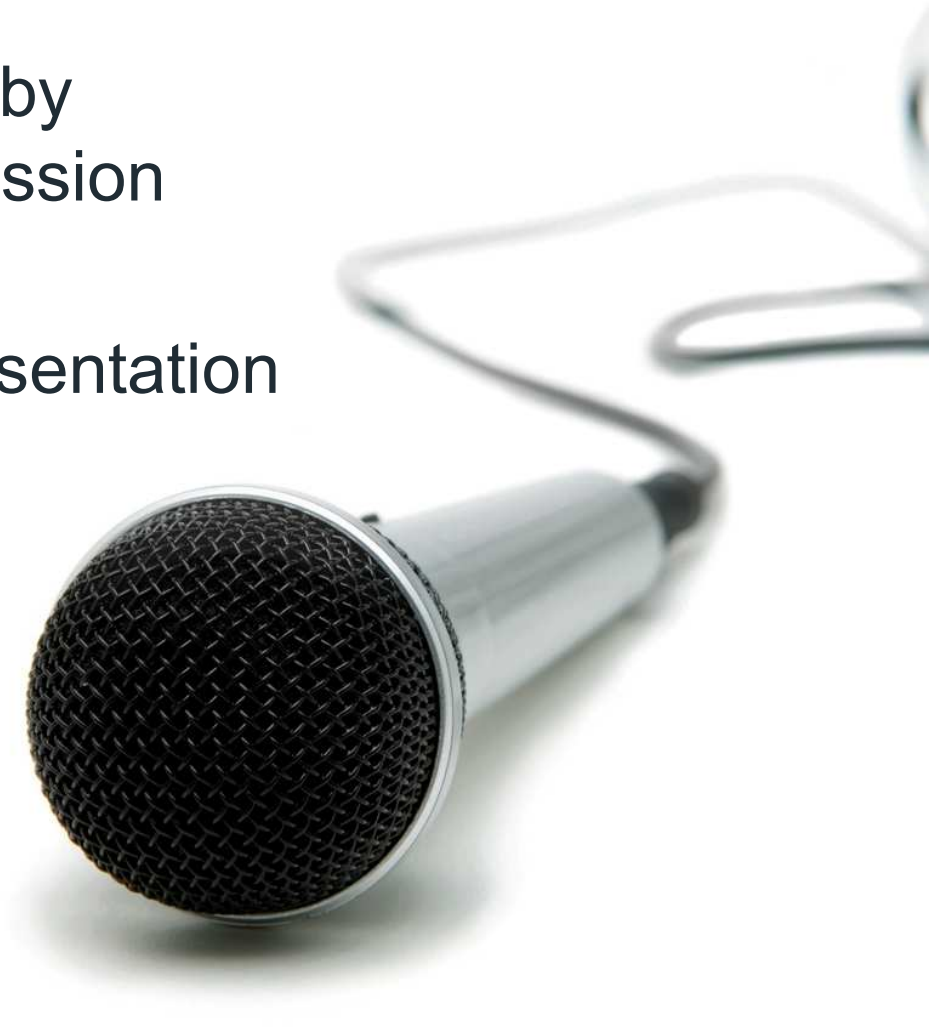
Information supply

- Give cash flows

Questions or comments?

Expressions of individual views by members of The Actuarial Profession and its staff are encouraged.

The views expressed in this presentation are those of the presenter.



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