Problems of Aging and Financial Planning

Life-Cycles

Retirement

Earning years

Dependent years

Pensions:
- NI
- DB
- DC
- SIPP, 401K, etc

Consumption
investment & savings decisions
Impact of the Financial, Economic and Fiscal Crisis on Pensions

Average annual real net investment return of pension funds in selected OECD countries

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Zealand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luxembourg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

© 2013 Cambridge Systems Associates Limited

Pensions and Risks

<table>
<thead>
<tr>
<th>Scheme Type</th>
<th>Pension Type</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>State pensions</td>
<td>Governments</td>
<td>Reduced state social security guarantees due to high national debts</td>
</tr>
<tr>
<td>DB</td>
<td>Corporate</td>
<td>Loss in value of institutional pension funds due to current crash in asset prices and low interest rates</td>
</tr>
<tr>
<td>DC</td>
<td>Corporate and Individual</td>
<td>Low asset returns predicted for the next decade with the possibility of high inflation</td>
</tr>
<tr>
<td>SIPP, 401K, individual savings, etc</td>
<td>Individual</td>
<td>Loss in value of savings due to low saving rates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduced willingness of corporates/governments to accept funding risk of pensions and the move to 3rd pillar pension plans</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Should individuals rely on social security or take control of their future through individual financial planning?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Institutional ALM techniques for financial planning</td>
</tr>
</tbody>
</table>

© 2013 Cambridge Systems Associates Limited
Theoretical Models and Solutions

- Theoretical models assume that investors derive utility from consumption which is supported by financial wealth
  - Analytic solutions are available for portfolio of riskless and risky assets when the utility function takes some standard form
  - More complex models include stochastic labour income, variation in risk aversion across households, liquidity constraints, ...
  - Numerical solutions by dynamic programming are available for a small number of decision variables and assets due to the computational complexity of problem

Short and Long-term Investors

- Short term investors: the classic mean-variance analysis of Markowitz (1952)
  - Static analysis which assumes that investors care only about risk and return one period ahead
  - Financial wealth does not take into account income

- Long-term investors
  - Special case of myopic investors
  - Life cycle consumption investment models (Samuelson 1963, 1969; Merton 1969, 1973; ....)
Life Cycle Consumption Investment Models

- **Benchmark model** has many simplifying assumptions on financial and labour markets and on investor's preferences
  
  [Bovenberg et al, De Economist, 2007]
  
  - availability of risk free asset (bond), only one aggregated risk factor traded through equity, no housing; the interest rate, inflation, the volatility of inflation and the equity risk premium are constant over time, the prices are not affected by the decision of individuals, log returns are iid normal ...
  
  - the after-tax wage is constant and riskless with fixed retirement age
  
  - individuals aim to maximize lifetime utility which depends on consumption at each point in time, the weight of future expected utilities decline exponentially at the rate of time preference; preferences feature positive and constant relative risk aversion; risk aversion is measured by the curvature of the utility function for wealth

- **Stochastic control type models with complex solution techniques**
  
  - Campbell & Viceira’s (2002) book for exposition of the analytical models
  
  - The dynamic programming approach (proposed first in Samuelson 1969)

Empirical Results

- Empirical results from surveys and behavioural finance (Kahneman and Tversky, 1979; 1992) show that financial decisions of individuals can not be fully explained by Expected Utility Theory
  
  - People are not uniformly risk averse: they are risk averse on gains and risk-taking on losses
  
  - People overweight small probabilities and underweight large probabilities
  
  - There is a reference point (neutral outcome, benchmark, breakeven point) which defines gains and losses: value functions with an inflection point
  
  - Household investment choices depend on family structure, human capital, wealth base, housing needs, age (see, e.g. Bank of Italy Survey, 2006)
Financial Planning

• Professional financial planners traditionally resisted the academic solutions based on theoretical models – Asset allocation puzzle of Canner et al [J. Campbell, 2002]

• Common practice is based on the qualitative assessment of risk attitude by financial advisers
  – Risk attitude is usually related to the investor’s age and determined using questionnaires
  – Rule of thumb: equity fraction of one’s portfolio equals 100 – one’s age

• Best practice:
  – Special purpose funds: Retirement funds, educational funds, etc.
  – Portfolio is constructed using Markowitz single period portfolio mean variance optimization leading to myopic policies based only on current market data

‘Is Personal Finance a Science?’ P. Samuelson, Keynote Address, 2006

‘The myth of risk attitudes’
Daniel Kahneman JPM Fall 2009

“To understand an individual’s complex attitudes towards risk we must know both the size of the loss that may destabilize them, as well as the amount they are willing to put in play for a chance to achieve large gains. Temporary perspectives may be too narrow for the purpose of wealth management.

The theories - utility theory and its behavioural alternatives - assume that individuals correctly anticipate their reaction to possible outcomes and incorporate valid emotional prediction into their investment decisions. In fact, people are poor forecasters of their future emotions and future tastes – they need help in this task – and I believe that one of responsibilities of financial advisors should be to provide that help.”

New theory and innovative technology – HP Finance Project
New Meta-Model for Individual Financial Planning - *iALM*

- The *iALM* system is a **decision support tool** based on the **theory of stochastic optimization**

- Principal ideas are brought together from **behavioural and classical finance** and from **decision theory**

- It allows interactive re-solve of an instance of the problem to obtain long-term financial plans with different data inputs in order to compare the consequences of the changes in individual preferences [Medova *et al*, 2008]

Cambridge Systems Associates’s *iALM*

---

**Key Features of *iALM***

- **Optimal portfolio decisions** correspond to the best possible **desirable** consumption subject to existing and future liabilities

- **Portfolio risks** are managed by
  - constraining **portfolio drawdown** in each scenario
  - imposing **limits on portfolio asset holdings** in each scenario

- **Interactive use of the system** allows to look at the possible outcomes for a number of household’s preferences in order to **choose a most suitable financial plan over the long-term horizon**
Dynamic Stochastic Programming

- General idea of dynamic stochastic programming
  - Incorporate many alternative futures in the form of simulated scenarios for the discrete-time stochastic data process

\[ \Omega := \{ \omega_t : t = t_{1,0}, \ldots, t_{T+1,0} \} = \{ \omega_{t_1,0}, \ldots, \omega_{t_{1,0}}, \omega_{t_2,0}, \ldots, \omega_{t_{2,0}}, \ldots, \omega_{t_T,0}, \ldots, \omega_{t_{T,0}} \} \]

- Model future decisions and implement current ones to obtain a forward plan to the problem’s horizon
  - When current recommended solution is implemented, then all future solutions across future scenarios will follow with certain probability.

Scenario Tree Schema

A multi-period 3-3-2 scenario tree
Multi-stage Dynamic Stochastic Programme

\[
\min_{x^1,\ldots,x^N} f_1(x^1) + \mathbb{E}_{\omega^1}\left\{ \min_{x^2,\ldots,x^N} f_2(\omega^2, x^2) + \cdots + \mathbb{E}_{\omega^N}\left[ \min_{x^N} f_N(\omega^N, x^N) \right] \right\}
\]

s.t.
\[
A^1 x^1 = b_1
\]
\[
A^2(\omega^2)x^2 + A^2(\omega^2)x^1(\omega^2) = b_2(\omega^2) \quad \text{a.s.}
\]
\[
\cdots
\]
\[
A_N(\omega_N)x_N + \cdots + A_{N-1}(\omega_{N-1})x_N(\omega_{N-1}) + A_N(\omega_N)x_N(\omega_N) = b_N(\omega_N) \quad \text{a.s.}
\]

Deterministic Equivalent

\[
\min \left\{ f_1(x^1) + \sum_{t=1}^{N} p_t(x_t) f_t(x_t, x_{t-1}(\omega_t), \ldots, x_1(\omega_t)) + \cdots + \sum_{t=1}^{N} p_t(x_t) f_N(x_t, x_{N-1}(\omega_t), \ldots, x_1(\omega_t)) \right\}
\]

s.t.
\[
A^1 x^1 = b_1
\]
\[
A^2(\omega^2)x^2 + A^2(\omega^2)x^1(\omega^2) = b^2(x^1) \quad \text{a.s.}
\]
\[
\cdots
\]
\[
A_N(\omega_N)x_N + \cdots + A_{N-1}(\omega_{N-1})x_N(\omega_{N-1}) + A_N(\omega_N)x_N(\omega_N) = b_N(x_N) \quad \text{a.s.}
\]

Solution Methods

- Scenario history \(\omega^t \in \Omega\) is a possible realization of the random vector \(\omega^t\) and corresponds to a node of the scenario tree
- Deterministic equivalent of the stochastic program (SP) is very large sparse linear programming (LP) problem
  - coefficients and r.h.s. in the constraints are realization of stochastic random process.
- Solution method for linear objective
  - nested Benders or interior point
- The vector for the stochastic decision process is given by
  \[ x \in \{ X_t : t = t_1, \ldots, t_f \} = \{ x_{t_1,1}, x_{t_1,2}, \ldots, x_{t_1,t_2-1}, x_{t_2,1}, x_{t_2,2}, \ldots, x_{t_2,t_3-1}, \ldots, x_{t_f,1} \} \]
- Implementable decisions correspond to the root node of the scenario tree
Meta-Model Generation

Overview of individual ALM

Gather Individual and Market Data

Econometric and Actuarial Modelling

Scenario Tree Simulation

Optimization Model: Tailored Portfolios, Goal Spending, Cashflow Balances, etc

Personal data

Market data

Events model

Liabilities model

Model returns on investment classes

Events

Cash-out flows forecast

Cash-in flows forecasts

Dynamic optimization model for assets-liabilities
Objective: maximize risk managed goal spending

Various Constraints

Visualization of decisions
Framing of the Problem

- **Broad Framing:** overall objective is to provide ‘sustainable spending’ over a household’s lifetime in terms of desired consumption on multiple life goals specified by preferences and their priorities

- **Narrow Framing:** maximization of goal consumption at given times (annually)
  - Each single goal utility function is defined with respect to reference points chosen by the household in terms of spending on the goal

---

Value Function of the Prospect Theory

- Recall Value Function of the Prospect Theory

\[
v(x) = x^2 \text{ if } x > 0 \\
v(x) = -\lambda(x^3) \text{ if } x > 0 \\
\text{with a typical } \alpha = 0.88 \text{ and } \lambda = 2.25
\]
Individual Goal Utility – Narrow Framing

- Utility function for an individual goal is given by three reference points.
- For each single goal the level of spending \( y \) is in the range between acceptable (s) and desirable (g) and minimum (h) spending subject to existing and foreseen liabilities. Together with goal priorities these values specify the piecewise linear shape of the utility function for each goal.
- The objective is to maximize goal spending with a piecewise linear utility function for the year.

Overall Objective – Broad Framing

- To provide ‘sustainable spending’
- Optimization problem objective is to maximize the expected present value (over all scenarios) of life time consumption, i.e. spending on goals

\[
E \left[ \sum_{s=1}^{S} I_{[\text{any alive}]}(u_s(C)) \right]
\]

where

\[
u_s(C) = \sum_{g \in G_s} \phi_s \left( \pi^s z^s t^s + \pi^s t^s I^s \right)
\]

Here \( z^s t^s \) is excess borrowing, \( I^s t^s \) is total tax payment and \( \phi_s \) is the inflation index at \( t \).
- Consumption refers to all “elective” spending on chosen goals

\[
C_s = \sum_{g \in G_s} \phi_s \left( F^s g_t + F^s g_t \right) + \sum_{g \in G_s} \phi_s \left( F^s g_t + F^s g_t \right)
\]
Creating Individual Financial Plan

- **iALM** is a meta-model for **optimum resource allocation over networks of cashflows**
- The income from portfolio together with the streams of labour and other income provides the **best desirable consumption**
- Optimal management of **various portfolios**
  - Two types of portfolio: taxable and savings portfolios such as 401K (USA) or SIPP and ISA (UK)
- **Portfolio allocation sub-problem**
Wealth Generation

- Together with stream of income the solution to the portfolio allocations subproblem provide optimal projected spending on goals.
- Fundamental constraints of portfolio allocation subproblem:
  - Initial holding
  - Portfolio value
  - Portfolio cashflow
  - Asset inventory balance
  - Investment limits, position limits
  - Portfolio drawdown
  - etc
- Current (root node) portfolio allocation decisions must be implemented
  - Two types of portfolio: taxable and saving portfolios such as 401K (USA) or SIPP and ISA (UK)
- “What if” scenarios and projected optimal expected dynamic investment policy over a life-time.

© 2013 Cambridge Systems Associates Limited
Portfolio Variables and Parameters

Sets:
- all assets, coupon paying assets, dividend paying assets

Parameters:
- price of asset at time $t$
- return on asset at time $t$
- coupon return on asset at time $t$
- interest rate on cash deposits at time $t$
- spread of interest rate on margin loans over cash rate
- dividend return on asset at time $t$
- transaction cost (proportional) of purchase of asset $a$
- transaction cost (proportional) of sale of asset $a$
- lower position limit for asset $a$ (proportion of portfolio)
- upper position limit for asset $a$
- turnover limit (as proportion of portfolio value) for each asset
- turnover limit for initial rebalance parameter
- minimum acceptable portfolio value (proportional to previous time)

Variables:
- value of holding of asset $a$ at time $t$
- value of asset $a$ sold at time $t$
- value of asset $a$ bought at time $t$
- cash holding (banked cash) at time $t$
- quantity of asset $a$ held at time $t$
- quantity of asset $a$ sold at time $t$
- quantity of asset $a$ bought at time $t$
- decrease in portfolio value at time $t$
- increase in portfolio value at time $t$
- portfolio value at time $t$
- portfolio losses in excess of maximum acceptable loss
- income from coupon payments at time $t$
- income from dividend payments at time $t$
- margin borrowing at time $t$
- repayment of margin loans at time $t$
- additional margin borrowing at time $t$

Investment Securities and Models

Investment securities
- Domestic and International Equities
- Government Bonds
- Corporate Bonds
- Alternatives
- T-bills and all bond coupons
- Treasury Inflation Protected Securities (TIPS)
  - Cash
  - CPI
  - Other fixed assets

Fundamental financial models
- Multi-dimensional GBM
  \[ d \ln X_t = \mu_t dt + \sigma_t dW_t \]
- Geometric Ornstein-Uhlenbeck (OU) process
  \[ d \ln r_t = (\alpha - \beta \ln r_t) dt + \sigma dW_t \]
- OU process
  \[ dr_t = (\alpha - \beta r_t) dt + \sigma dW_t \]
- More complex econometric models

Simulation of stochastic processes for asset returns of selected securities according to the specified scenario tree:

Implemented in StochGen\textsuperscript{TM} Simulator [CSA’s STOCHASTICS\textsuperscript{TM} System]
Other Features

- Treatment of real estate purchase with alternative types of mortgage
- Treatment of borrowing
- Assumptions about income growth
- Assumptions about healthcare costs
- Insurance

iALM Solutions

- iALM provides optimum values for many decision variables – spending, borrowing, saving, etc – across time simultaneously for multiple scenarios of random processes representing uncertain markets and life circumstances
- Current iALM model includes 20 random processes that vary over the client’s lifetime and around 200 mathematically formulated conditions (constraints) per node
- Average desktop computer solving times are 3-5 minutes (Problem size over 3mln non-zero entries)

➤ An interactive process for analysing retirement and saving alternatives
Example, FT July 2 2006

Gnawing doubts on use of cash pile

A management consultant argues that companies could realize their potential costs and much labour for their

© 2013 Cambridge Systems Associates Limited

Profile Summary for the Pimott Household

Household Income

Annual Pre-Tax Income

Pension Contributions

Insurance Contributions

Household Expenses

Rent

Utilities

Entertainment

Travel

Transport

Food

Groceries

Restaurant

Gifts

Medical

Education

Insurance

Pets

Miscellaneous

Recreation

Healthcare

Travel

Car

Property Insurance

Life Insurance

Health Insurance

School Tuition

Tuition

Leasing

Finance

Credit Card

Debit Card

Other

Debt

Credit Card

Debit Card

Other

Financial Summary

Asset

Cash

Savings

Checking

Credit Card

Debit Card

Other

Liability

Mortgage

Credit Card

Debit Card

Other

Net Worth

© 2013 Cambridge Systems Associates Limited
Income

- Summary
  The client’s retirement year is 2021 (At age 85).
  The co-client’s retirement year is 2029 (At age 03).
  Earned Income (Pre-Retirement)
  
<table>
<thead>
<tr>
<th>Owner</th>
<th>Annual Amount</th>
<th>Start/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client</td>
<td>35,000</td>
<td>2009-01-01</td>
</tr>
<tr>
<td>Couple</td>
<td>30,000</td>
<td>2009-01-01</td>
</tr>
</tbody>
</table>

  - Pension Income (Post-Retirement)
    - Current Pension Annuities: Yes
    - Defined Benefit Pension: Yes
    - Defined Contribution Pension: Yes
    - ISIP Employer Contributions: Yes
    - State Pension: Yes

  - Additional Income

Cash Outflows

- Prior Consumption (Inflation)

<table>
<thead>
<tr>
<th>Accounted Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
</tr>
<tr>
<td>Date</td>
</tr>
<tr>
<td>Amount</td>
</tr>
<tr>
<td>Income</td>
</tr>
<tr>
<td>Outflow</td>
</tr>
</tbody>
</table>

- Calculation

<table>
<thead>
<tr>
<th>Points</th>
<th>Telephone</th>
<th>Start Date</th>
<th>Type</th>
<th>Income</th>
<th>Outflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Home</td>
<td>2010-01-01</td>
<td>X</td>
<td>5,000</td>
<td>4,500</td>
</tr>
</tbody>
</table>

- Home Goods

- Other

- Loans

- Other Loans

- Insurance
iALM cash flow assumptions

<table>
<thead>
<tr>
<th>Inflation</th>
<th>CPI</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>cp all</td>
<td>3.5%</td>
<td></td>
</tr>
<tr>
<td>cp shelter</td>
<td>0.7%</td>
<td></td>
</tr>
<tr>
<td>cp mortgage</td>
<td>2.1%</td>
<td></td>
</tr>
<tr>
<td>cp income</td>
<td>1.4%</td>
<td></td>
</tr>
<tr>
<td>cp medical</td>
<td>0.8%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Household Cash Flows</th>
<th>Earned Income Growth Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Range</td>
<td>CPI</td>
</tr>
<tr>
<td>Below 30</td>
<td>cp all</td>
</tr>
<tr>
<td>From 30 To 40</td>
<td>cp all</td>
</tr>
<tr>
<td>From 40 To 60</td>
<td>cp all</td>
</tr>
</tbody>
</table>

Consumption Adjustment
Early Cash Adjustment% 75.0%

iALM ‘rule-based’ assumptions

<table>
<thead>
<tr>
<th>Taxes and Contributions</th>
<th>Income Tax Rates (Per Person)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Income Tax</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td></td>
<td>40.0%</td>
</tr>
<tr>
<td></td>
<td>43.0%</td>
</tr>
</tbody>
</table>

National Insurance Rates (earnings income only)

<table>
<thead>
<tr>
<th>Income</th>
<th>Income Tax</th>
<th>National Insurance Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>£0 - £8,430</td>
<td>£0.0%</td>
<td>£0.0%</td>
</tr>
<tr>
<td>£8,440 - £10,600</td>
<td>£0.0%</td>
<td>£0.0%</td>
</tr>
<tr>
<td>£10,610 - £10,600</td>
<td>£0.0%</td>
<td>£0.0%</td>
</tr>
</tbody>
</table>

Allowances
Capital Gains Allowance £8,000
ISA annual allowance £7,000

Pension Assumptions
Growth Assets
DC Pension Asset
Annuity Asset
Contribution limits
Annual Limit £225,000
Unmarried limit £225,000
Married Limit £225,000

Two levels of risk management per scenario

- Asset class investment limits
- Portfolio draw down limits
Getting an Overview

Visual Summary of Profile
Portfolio
Wealth
Goals
Cash Flows
Performance of iALM

- Testing on real profiles of UK and US investors and comparison with recommendations of financial advisors
- Comparison with MVO based methodology
- Backtesting performance over 10 years: 1995-2005 for US model
- Behavioural aspects tested using ability to analyse relationship between current wealth, earnings, savings and desirable consumption
### Various Household Scenarios and iALM Solutions

<table>
<thead>
<tr>
<th>Profile: Entrepreneur Age 55</th>
<th>Sandy Check: Desirable-Acceptable</th>
<th>Return</th>
<th>Living 150,000</th>
<th>Retiremen t 110,000</th>
<th>Julie 22,000</th>
<th>Todd 17,000</th>
<th>U-Bequest 1 mln</th>
<th>Cottage 500,000</th>
<th>Bequest 500,000</th>
<th>Terminal wealth</th>
</tr>
</thead>
<tbody>
<tr>
<td>One income, 2 dependents, retirement at 62, 6 goals</td>
<td>17.3-13.3%</td>
<td>8.04</td>
<td>9.98</td>
<td>27,029</td>
<td>68,164</td>
<td>17,000</td>
<td>14,800</td>
<td>187,024</td>
<td>76,222</td>
<td>None</td>
</tr>
<tr>
<td>One income, 2 dependents, retirement at 62, 2 goals</td>
<td>14.7-11.9%</td>
<td>7.89</td>
<td>9.43</td>
<td>31,228</td>
<td>69,207</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Two incomes, 2 dependents, retirement at 62, 6 goals</td>
<td>14.8-11.9%</td>
<td>8.83</td>
<td>12.74</td>
<td>35,359</td>
<td>74,351</td>
<td>17,000</td>
<td>14,800</td>
<td>230,820</td>
<td>195,670</td>
<td>None</td>
</tr>
<tr>
<td>Two incomes, 2 dependents, retirement at 65, 5 goals</td>
<td>10.2-6.9%</td>
<td>8.7%</td>
<td>12.07</td>
<td>19,785</td>
<td>95,264</td>
<td>17,000</td>
<td>14,800</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Two incomes, 2 dependents, retirement at 65, 3 goals</td>
<td>10.5-6.2%</td>
<td>8.7%</td>
<td>12.36</td>
<td>41,551</td>
<td>87,252</td>
<td>17,000</td>
<td>14,800</td>
<td>None</td>
<td>None</td>
<td>493,366</td>
</tr>
<tr>
<td>Two incomes, 2 dependents, retirement at 65, 2 goals</td>
<td>9.2-5.0%</td>
<td>8.7%</td>
<td>11.84</td>
<td>70,412</td>
<td>106,205</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
Better lifestyle by working longer

Annual Saving and Retirement Age

© 2013 Cambridge Systems Associates Limited
Technical Summary

- Average desktop computer solving times are **2-15 minutes**
  - Pimlott profile: 152sec
- **iALM provides optimum values for multiple decision variables**
  - Recommended allocation for current year is robust with respect to the most unfavourable scenarios
- Probabilities of goals and shape of corresponding distributions are a good **indication of uncertainty** inherited in the plan
- Many other aspects of financial plans are available, e.g., cashflow statements, graphs of individual cash flows for liabilities, goal spending, taxes, borrowing through life and so on.

User Benefit Summary

- Comprehensive, long-term solution to wealth management tailored to individual needs:
  - Free format of specification of life goals and their values
  - Construction of the utility function based on distinct client needs
  - Hedging against longevity risks by solving random horizon optimization problem
  - Combination of life insurance with retirement saving plan
  - Consideration of different options for borrowing
  - Optimum use of tax-shield accounts
- **Interactive process** for analysing investment and savings alternatives for long-term financial planning
- **New paradigm in wealth management with support of HPC Finance**
iALM References