Planning for Retirement: Asset Liability Management for Individuals

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1. Introduction

Pension systems are in crisis. Every day brings dire warnings of future poverty across the globe for large numbers of older people. Governments and corporations are pushing the responsibility for pensions and healthcare back to individuals. With current demographic trends the present workforce will be faced with the problem of significant 'pension gaps' which unless somehow covered will force drastic changes in their post retirement lifestyles. The relatively affluent are no exception. For the last few years, even before the crisis, *Fortune* magazine has devoted an annual special issue to the problem with subtitles like 'Take control of your future'. For example, the July 2006 issue begins: 'Traditional pensions are melting away…'. By and large however the asset management industry remains focussed on asset returns measured by relative performance and treats individuals' liabilities at best in aggregate in terms of asset return goals. Financial planning/wealth management advice for individuals sorely needs innovation.

Global pensions crisis

From 1975 to the present day the global *dependency ratio* – the ratio between retirees and workers – has been on the increase. The OECD forecasts that this ratio will continue to rise for the OECD countries in total from 22% in 2000 to 47% in 2050 (OECD, 2009a). In the developed world this is largely because, due to rising affluence and advances in health care, people are living longer. For example, life expectancy in the UK has risen from 76.7 years to 80.2 years in the past 20 years and is forecast by Towers Watson to rise to 84.7 years in the next 20. According to McKinsey and Company, the number of people aged 60 or more is projected to double in the first half of this century, from 12.2 million in 2000 to 20.4 million in 2040, and their share of personal financial assets in the UK to rise from 68% to 76% in the same period. This has forced governments to progressively reduce planned state retirement benefits across the developed world, nevertheless resulting in significant government expenditures forecast to range from 5% to 22% of GDP at their peaks around 2040 (McKinsey & Company, 2005). These forecasts may seem optimistic after the financial crisis of 2007-2009 which hit pension funds heavily with significant real losses, for example, amounting to 37.5% of capital in Ireland and 26.2% in the USA in 2008 (OECD, 2009b).

In Europe there are currently about 45 million people in the baby boomer generation, now aged between 40 and 60, and another 45 million aged 60 or over. But, as is well known, the habits and lifestyle of these two groups are very different. Baby boomers are healthy, better educated and more affluent, while subscribing to liberal, individualistic and even counter-culture values and remaining proactive and participatory in politics and society generally. The over 60s, although adapting to the Web culture, are much more conservative and less inquisitive, tending to be more traditional and considerate of their children, for example, with regard to bequests. They tend to have a significantly greater propensity than baby boomers to continue to save in retirement, keep assets aside for inheritance and to store assets against a rainy day. On the other hand, as a by product of globalisation, baby boomers are more likely to travel extensively and spend extensive periods, or even move, abroad.

The possible effects of the pensions crisis on personal lifestyles for both groups may be significant – savings and pensions eaten by inflation in a prolonged period of poor financial returns together with reduced state pensions – but few households have the ability to mitigate these risks. A similar situation applies to household health and mortality risks, such as need for long term care and the risk of outliving current wealth, but these contingencies are even more difficult to manage without professional help.

Financial planning

The best of current financial planning advice is based on investment portfolio optimization, introduced by the Nobel Laureate Harry Markowitz nearly sixty years ago, which is applicable only to short time horizons. Investment risk is measured by variability of returns and clients are advised to make risky investments, i.e. with much higher equity components, while they are young and become more risk averse, i.e. hold more bonds and cash, as they approach retirement. Much effort is expended to derive an investor's attitude to risk. Lifestyle goals such as retirement, children's education, weddings, second houses, boats, cars, etc. (when not simply aggregated) are treated in terms of separate investment pots with relative priorities reflected by contribution rates. All such funds are balanced only in terms of current market conditions and clients' 'risk appetites' and no account is taken of random events in life, like sickness or death, uncertain future incomes and costs, or varying priorities over time. As a result, the investment strategies proposed tend generally to be overoptimistic.

A number of software tools utilizing this approach are now available for individual household use with PC's or over the internet, but no joined up view of a household's financial requirements in terms of income, asset and liability cash flows is given. Hoevengars *et al.* (2009) and Amenc *et al.* (2009, 2010) try to take account of forward household liabilities by applying the best practice approach described above to a funding ratio variable, but even in the institutional pension fund setting from which it comes this is best handled by explicit cash flow matching (Dempster *et al.,* 2009). See also Wilcox & Fabozzi (2009) who account for the uncertain present value of future liabilities using a Bayesian discretionary wealth approach which derives risk aversion from surplus and uses the joint posterior distribution of both investor and investment attributes as a basis for scenario based optimal asset allocation in a Markowitz framework.

Does the current best-of-breed advice accord with practical client reality? A Bank of Italy (2005) survey of investors suggests the answer is no. For example, the young were found to hold less equity, not more, and in fact the highest equity proportion (25%) was held by the 65-74 age group. In general the survey showed attitudes to risk to depend on many factors other than age. These findings accord with common sense and the survey identified human capital (lifetime future earning capacity), family structure, wealth base and housing needs as most critical to household investment choices.

Naturally factors affecting portfolio choices change with age at a pace unique to the individual. Uncertainty about the future is highest when householders are young and reduces with age. Traditional advice and products link risk with the age. Depending on household circumstances such advice may incorrectly limit exposure to risky assets approaching retirement, just when more certainty about future lifestyle could allow more investment risk taking. In general a household is *not* a *static* entity, it may represent different types of households over time as desired lifestyles and circumstances change. The recent financial crisis hit individual households severely – lost of real estate equity, reduction in pension benefits, loss of savings value, increased unemployment rates and many other factors – all showing that the current state of financial planning and wealth management advice for individuals needs new innovative approaches (Kahneman, 2009).

Chapter overview

In this chapter we describe the recently developed *individual* Asset Liability Management (*i*ALM) system for support of lifestyle planning through lifelong savings and asset allocation which has been designed to meet this challenge. Our exposition is directed to a broad audience and avoids the highly technical details of the mathematical model underlying *i*ALM. Here we focus on a few new ideas underlying our system which we illustrate by creating financial plans for a middle class UK household in Section 3. Section 2 first gives a high level description of the system, its use and its extensive testing while Section 4 concludes.

2. Lifestyle Planning With *i*ALM

The *i*ALM system is a decision support tool for individual household financial planning based on stochastic programming theory and a state of art software implementation.

Approach and methodology

A mathematical model description and some details of implementation are given in Medova *et al*. (2008) and Dempster & Medova (2010). The main features of the dynamic stochastic programming implementation are, in brief, modelling and simulation of stochastic returns for financial assets, economic factors and liabilities, the household input dependent formulation of the stochastic optimization problem with major decision points corresponding to the times of expected significant changes in the household's balance sheet and the solution of a large scale equivalent piece-wise linear deterministic problem. Such an *individua*l asset liability management (*i*ALM) problem is a large scale risk managed optimal resource allocation problem over linked networks of various household cash flows in order to satisfy consumption and other goal based demands.

All cash flows, such as projected incomes, forecast returns on investments, existing and future liabilities, are specified by household spending on desired goals and are simultaneously simulated forward to the time of the expected death of the household head(s). The objective is to achieve the desirable amount of spending on specified lifestyle goals according to household chosen priorities and subject to the availability of resources. The balance between assets and liabilities sets the requirements for the portfolio return from investments and therefore forms the household's dynamic attitude to risk. The first year portfolio allocation is to be implemented and all other decisions are generated in the form of 'what if scenarios' which are summarised in various graphs over household lifetime. There are many submodels and software modules involved in the creation of the overall *i*ALM model (for a detailed description of this *meta* model, see Dempster & Medova (2010).).

We would like to point out that management of the personal finances of a household of any wealth is very different from the asset liability management of institutional funds. This is because the events connected with individual liabilities cannot be smoothed out by diversification over a large number of investors, pensioners or events. We do not share view of some other authors that individual liabilities can be replaced by proxies like TIPS or a real estate index (see for example Amenc *et al*. (2010), this volume). Personal liabilities are sharp and often occur at fixed points in time (children's education, weddings) or are discretionary (house purchase, retirement) or highly uncertain (future income, redundancy, illness, death, need for long term care). This imposes technical requirements on lifetime planning which are further complicated by the practical requirement of accommodating very different lifestyles and wealth over a uncertain planning horizon depending upon the ages of the individuals involved.

On the asset side of the *i*ALM model there is much more similarity with institutional fund management models. The asset returns are represented by indices and portfolio allocation is at the level of preselected asset classes. Some of the asset return models used in *i*ALM are described in our previous publications Dempster *et al*. (2007), (2009). For UK investors the investment universe is given by nine assets:

- Bank cash
- Treasury bills (3 month)
- Gilts (10 years)
- AA corporate bonds (10 years)
- Domestic equities
- International equities
- Alternatives
- Real estate
- Commodities.

The US version of *i*ALM includes all the above plus TIPS (US indexed gilts) and municipal bonds.

In summary, the *i*ALM mathematical formulation involves the modelling of economic factors and market asset returns, individual's liabilities in terms of both random discrete events and continuous processes, random lifetimes of individuals from different age groups and highly individual preferences for goal oriented consumption, savings and investment. The optimization objectives are framed in terms of the risk-adjusted expected present value of lifetime household spend.

Implementation

The current version of the *i*ALM model includes 20 random processes that vary over a client's lifetime (up to 90 years forward) and around 200 mathematically formulated conditions (constraints). A typical household problem might involve a half a million variables and a similar number of constraints. Such a complex problem can only be formulated and solved efficiently with the *STOCHASTICS*™ suite software developed specifically for stochastic programming applications and used previously for institutional fund management applications (Dempster *et al*., 2006, 2007, 2008, 2009).

The behavioural characteristics of an individual client household can be revealed to an advisor through an interactive dialogue by generating alternative versions of the financial plan each of which requires just a few minutes on an average desktop or laptop computer. The client may analyze retirement and savings alternatives by changing their preferences on goals and goal priorities. This is what behaviour finance views as an essential feature of any advisory tool. Other findings in behavioural finance show that investors often under diversify their portfolios due to irrationally heavy discounting of the future. Depending on temperament, people also tend to overestimate their financial prospects to varying degrees which results in unrealistic discretionary allocations for spending on goals. This behaviour is controlled by iALM's risk management which imposes discretionary limits on asset class allocations and portfolio *draw down* on each scenario.

The *i*ALM system's feature is its unique ability to determine optimum values for many decision variables – spending, borrowing, saving, investment, etc. – across time and simultaneously for multiple future scenarios of random processes and events representing uncertain markets and life circumstances. This optimal plan contains spending and portfolio recommendations both for now and for the current view of future decisions. All aspects of the client's forward financial plan can be examined on all scenarios in 'what if' mode. There are many visual tools available in the system which aids analysis of the generated optimal financial plan in terms of cash flow and wealth evolution, balance sheets, goal achievement likelihoods, etc. The task of assembling many pieces of information about individuals' incomes, liabilities and discretionary spending, to say nothing of forecasting returns on available investments, has been a challenge from the point of view of software development and all effort has been made to simplify the process – from initial household data entry to presenting lifetime summaries as comprehensively as possible.

Each *i*ALM plan is expected to be updated periodically, or at the occurrence of major lifestyle events, to correct for imperfect forecasts and to take account of unforeseen events which can not be statistically modelled. The implemented *i*ALM portfolio allocation decisions are at the strategic level by virtue of taking a long term view of individual circumstances. The system is designed to be used in conjunction with a short term (annual) tactical allocation which can exploit the financial advisor's knowledge at the level of individual investments in funds or financial instruments. Both levels must of course consider the appropriate legal and institutional framework regarding taxation and pension regulations specific to each jurisdiction and these aspects are modularized within the *i*ALM system.

System evaluation

The *i*ALM system has undergone extensive testing on profiles of US investors including careful reviews of client needs. The behavioural aspects of the systems design recommendations have been tested using its ability to analyze the relationships between current wealth, future earnings, savings and desirable consumption in constructing dynamic portfolios with life-style enabling returns. In addition *i*ALM's performance has been successfully back tested over a ten year period of market conditions including the internet bubble and crash and favourably compared to top financial advisor's client recommendations and short term Markowitz mean variance portfolio composition.

The UK version of the model has been analysed using information about various households from the weekly Money sections of the Financial Times (2005-2007). This collection of household profiles has been augmented with household profiles supplied by a few independent financial advisers and with private client data from a UK bank.

In all evaluations it has been observed that the interactive use of the *i*ALM helps to build the relationship between financial adviser and client. A client's reaction to the possible outcomes (e.g. projected wealth at the time of retirement given by the generated financial plan) may require 'readjustment' of inputs (e.g. reducing the desirable standard of living after retirement to a lower level). Through interactive learning the system provides a final version of the financial plan which emphasizes regret avoidance and is suitable to the client's individual choices regarding risks.

3. Case Study

In this section we will illustrate the use of iALM on an example UK family. Our aim is to demonstrate to the reader that financial advice embraces much more than the generation of financial plan based on a single data input. It is rather a process of discussion between client and a professional who helps to analyse a variety of outcomes of personal circumstances and preferences, the result of which is the choice of the most appropriate investment decisions for immediate implementation consistent with a long view of household resources and personal abilities. To accommodate this aim we will use in the sequel as many views as possible from the graphical user interface (GUI) of the system selecting appropriate input screens and output graphs.

Household information and assumptions

We start with the basic household information of Jim and Carolyn Jones which is summarised in Figure 1.

Profile Summary for Jones, Jim

Personal Data

- H1 was born in 1966 and is now 43 years old and would like to retire at 65.
- H2 was born in 1964 and is now 45 years old and would like to retire at 65.
- 2 dependents.

Starting Assets Data

Non Qualified Asset Account TOTAL: £62,000

Carolyn's Cash Account	Cash, Taxable	£10,000
Joint Account	Cash, Taxable	£5,000
HSBC	Cash, Taxable	£10,000
Bonds	Fixed Income - Long Duration Bonds	£5,000
Childrens Accounts	Cash, Taxable	£2,000
National Savings	Cash, Taxable	£5,000
Equities	Equities - Domestic	£25,000

SIPP Account TOTAL: £15,000

SIPP Account	Cash, Taxable	£15,000

ISA Account TOTAL: £35,000

ISA Family Account	Cash, Taxable	£35,000

Tangible Assets TOTAL: £300,000

Family Home	£300,000

Figure 1. **Household profile summary**

All information needed for financial plan generation is classified in categories: personal data, cash inflows and outflows, starting assets. The position limits and modelling assumptions are data which can be edited by the financial adviser.

In this example the goal is spending on general consumption over household lifetime, i.e. pre- and post-retirement annual spending within limits specified by the household. Acceptable and desirable levels are specified by each. In a situation where there are many goals, each goal may have a different priority. These goals are merely objectives whose probability of achievement are unknown to household. Their personal attitudes and sociological make up may greatly overestimate/underestimate these values. The purpose of useful financial advice is therefore to 'readjust' household expectations to the objective reality of their current and prospective resources. Figure 2 details the input data for liabilities and goals. Figure 3 shows projected salaries and other inflows.

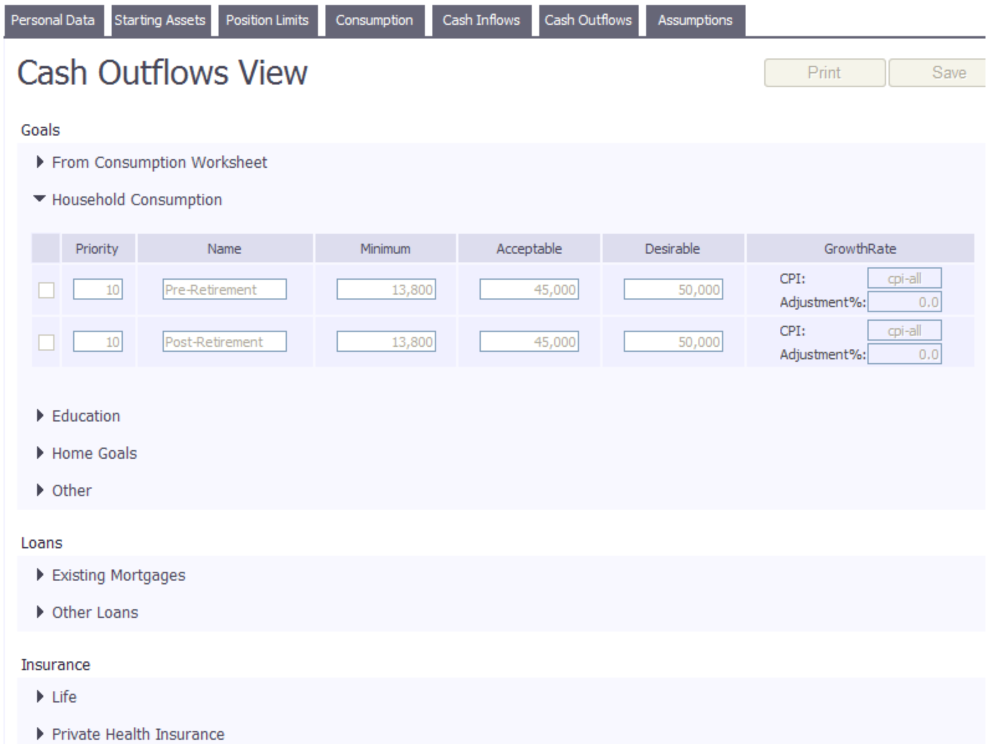

Figure 2. Range of household consumption pre- and post-retirement

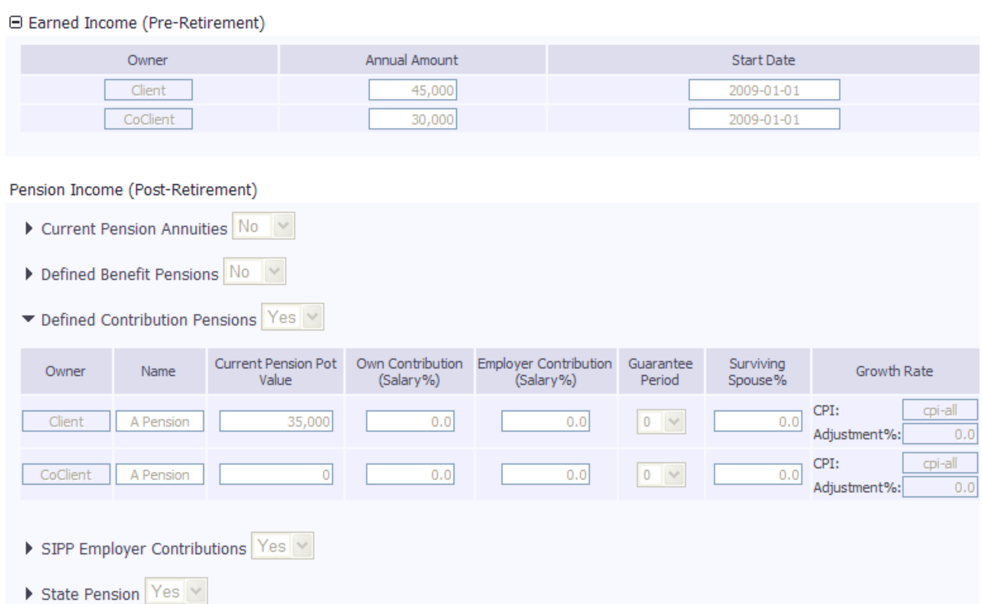

Figure 3. Household income and pensions

To model and simulate various economic factors we made the simplifying assumptions regarding the growth of salaries shown below. The scenarios for various cash flows including salaries are abruptly stopped by the occurrence of the death of the last head of household. Because the *i*ALM problem is formulated for the household (not at the level of individual heads of the family unless only one is specified at input), we assume that the level of total consumption is reduced for a surviving head by a certain percentage, e.g. in this example by 25%.

To allow more financial flexibility, any household (particularly a young one) may opt to borrow against their equity in their house[1]. We impose limits on the maximum amount of borrowing with the cost given by a specified spread over the short term rate (the three month interest rate termed the Treasury bill rate above). These assumptions are shown in Figure 4.

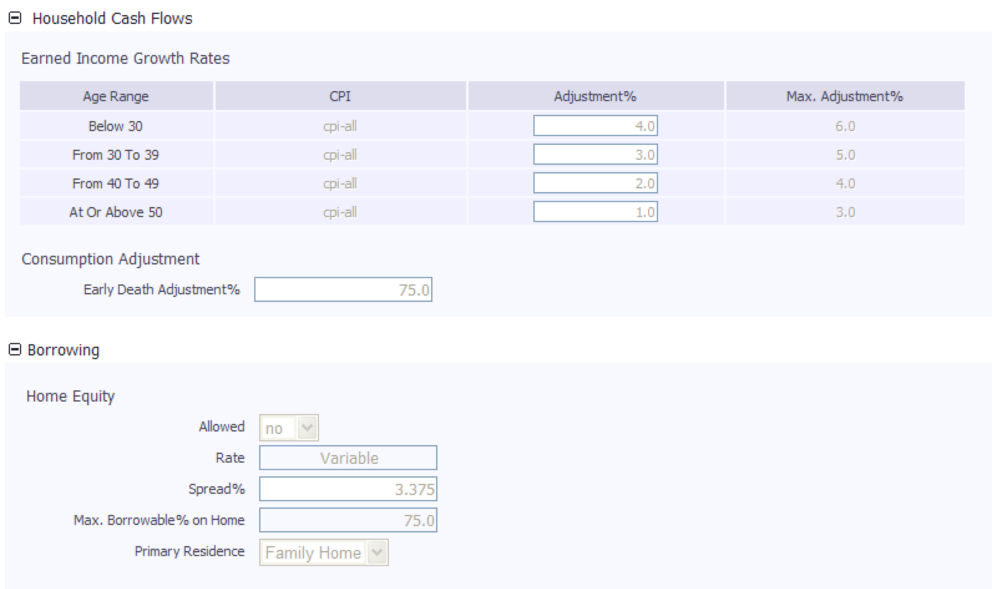

Figure 4. Salary growth and borrowing restrictions

Our principal economic stochastic factor is the consumer price index (CPI)[2] . A variety of spreads to price the specific liabilities are shown in Figure 5, together with the assumptions regarding the growth of pensions and the current limits on pension contributions[3].

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[1] Households are also allowed to borrow against total salary income within specified limits.

[2] CPI is modelled as a mean reverting (geometric Ornstein Uhlenbeck) process with parameters estimated over the past ten years up to 2009 [Dempster & Medova (2010)].

[3] The pension assumptions are UK tax and pension 2009 regulations [HMRC (2009)]

⊟ Pension Assumptions

Growth Assets

DC Pension Asset: Fixed Income - Corporate AA Bonds

Annuity Asset: Fixed Income - Long Duration Bonds

Contribution Limits

Annual Limit: £235,000

Lifetime Limit: £1,650,000

⊟ Inflation

CPI	Mean
cpi-all	3.0%
cpi-shelter	0.7%
cpi-nursing	2.1%
cpi-drugs	1.4%
cpi-medical	0.8%
cpi-school	3.9%
cpi-university	3.4%

Figure 5. Pension and specific item inflation spreads over CPI

Other 'rule-based' assumptions regarding investments and taxes are shown in Figures 6 and 7 which are self explanatory. Note that 'Risk tolerance' in Figure 6 is expressed by the discretionary limits on annual portfolio drawdown applied to each generated scenario.[4]

⊟ Investment Assumptions

Risk Tolerance

Portfolio Loss Tolerance%: 15.0

Transaction Costs

Asset Class	Buy%	Sell%
Equities - Domestic	1.5	1.5
Equities - International	1.5	1.5
Fixed Income - Long Duration Bonds	1.0	1.0
Fixed Income - Corporate AA Bonds	1.0	1.0
Commodities	1.0	1.0
Property	1.0	1.0
Alternatives - Hedge Funds of Funds	1.0	1.0
Cash, Taxable	0.0	0.0

Managed Account Fees

AssetClass	Fraction%
Equities - Domestic	0.75
Equities - International	1.0
Fixed Income - Long Duration Bonds	0.35
Fixed Income - Corporate AA Bonds	0.35

Figure 6. Investment assumptions

[4] Portfolio risk can also be controlled by discretionary limits on each asset class allocation expressed in maximum fractions of portfolio wealth.

⊟ Taxes and Contributions

Income Tax Rates (Per Person)

Income From	Income To	Income Tax Rates
£0	£6,035	0.0%
£6,036	£40,635	20.0%
£40,636	Unlimited	40.0%

National Insurance Rates (Earned Income Only)

Income From	Income To	National Insurance Rates
£0	£4,680	0.0%
£4,681	£40,040	11.0%
£40,041	Unlimited	1.0%

Allowances

Capital Gains Allowance	£9,600
ISA Annual Allowance	£7,200

Figure 7. Tax and National Insurance contribution assumptions

Equipped with this information, which is minimal to specify a financial plan for the household, we proceed to the analysis of the first such plan generated by optimizing the *i*ALM meta model.

Analysis of household lifetime optimal plans

As we said above, the resulting solution gives the optimum value for many decision variables across all generated scenarios and for each time interval, i.e. annually. Therefore there is an enormous amount of information available for analysis. In the iALM graphical user interface (GUI) this information is classified by category and presented by a variety of visual tools – graphs over household life time, tables, balance sheets for selected dates, views of main scenarios, and so on. Figure 8 shows the classes of optimal decisions and Figure 9 gives a summary of goal achievement in this first version of the Jones' financial plan[5].

Figure 8. Optimal decision classes for analysis (with Goals highlighted)

[5] Here 'Terminal Wealth' is the remaining wealth at the time of death of last head of household. It is not a household 'goal' unless one is specified in 'cash outflow' as a bequest at a specified date. In this example there is no requirement for a bequest goal and hence terminal wealth is not optimized.

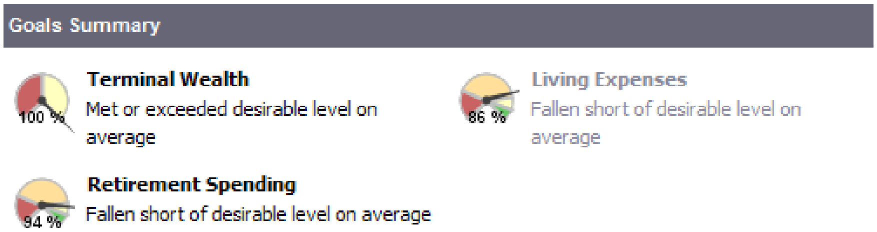
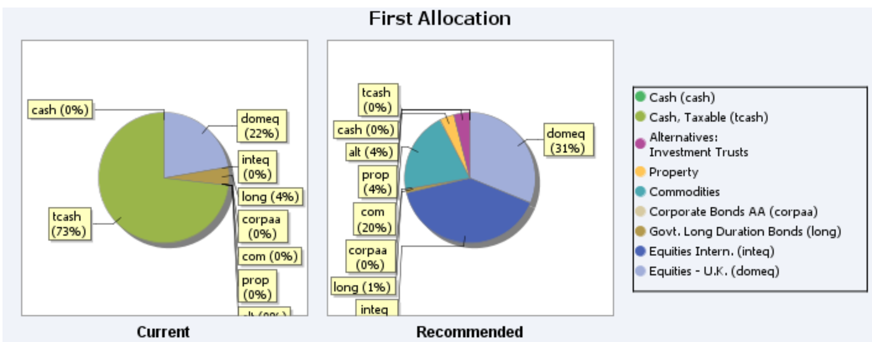


Figure 9. Probabilities of acceptable goal achievement in per cent

The portfolio allocation for the current year to be implemented in the first year of the plan is shown in Figure 10. As is seen from total portfolio return and its volatility shown, the investment risk is high and as a consequence, the probability of goal achievement shown above is low.



Description	Current (£)	Current (%)	Recommended (£)	Recommended (%)	Δ (Absolute)	Δ (Fractional)
Domeqs	£25,000	22.32%	£38,605	31.32%	+£13,605	+9.00%
Inteqs	£0	0.00%	£49,308	40.00%	+£49,308	+40.00%
Longs	£5,000	4.46%	£1,191	0.97%	-£3,809	-3.50%
Corps(AA)	£0	0.00%	£0	0.00%	+/-£0	+/-0.00%
Commod.	£0	0.00%	£24,775	20.10%	+£24,775	+20.10%
Property	£0	0.00%	£4,501	3.65%	+£4,501	+3.65%
Alts	£0	0.00%	£4,890	3.97%	+£4,890	+3.97%
TCash	£82,000	73.21%	£0	0.00%	-£82,000	-73.21%
Cash	£0	0.00%	£0	0.00%	+/-£0	+/-0.00%
Total	£112,000		£123,270		+£11,270	
Return		5.83%		9.77%		+3.93%
Vol		3.09%		9.20%		+6.10%

Figure 10. Initial financial portfolio allocation for immediate implementation

The histograms in Figure 11 show that the distribution of spending values across all scenarios is very disperse. The expected annual spending on ‘living’ is lower than the acceptable value. Similarly, while the acceptable post-retirement spending is just barely achieved in expectation, its histogram has a heavy left tail with a few scenarios having very low values.

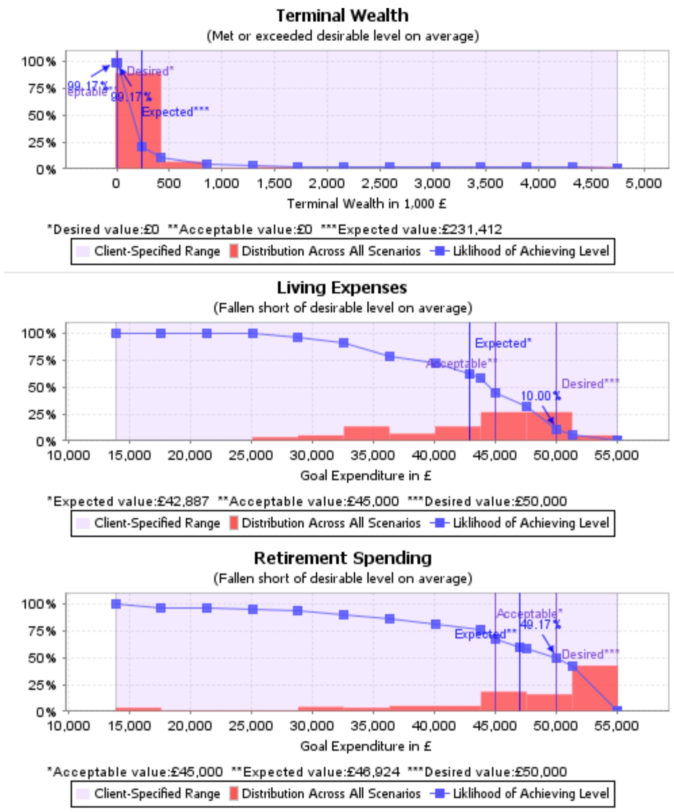


Figure 11. Goal achievement histograms across scenarios

Analysis of this plan shows that household' s expectations for a comfortable life style are overly optimistic and therefore we should consider either reducing consumption or prolonging retirement for few years, or both.

We opt to change the household heads' retirement age to 67 leaving all other information as in previous version of the Jones financial plan. This new instance of the plan requires about 2 minutes solution time (on an i5 laptop) with selected results analysed below.

First we look at the goal achievement histograms in Figure 12.

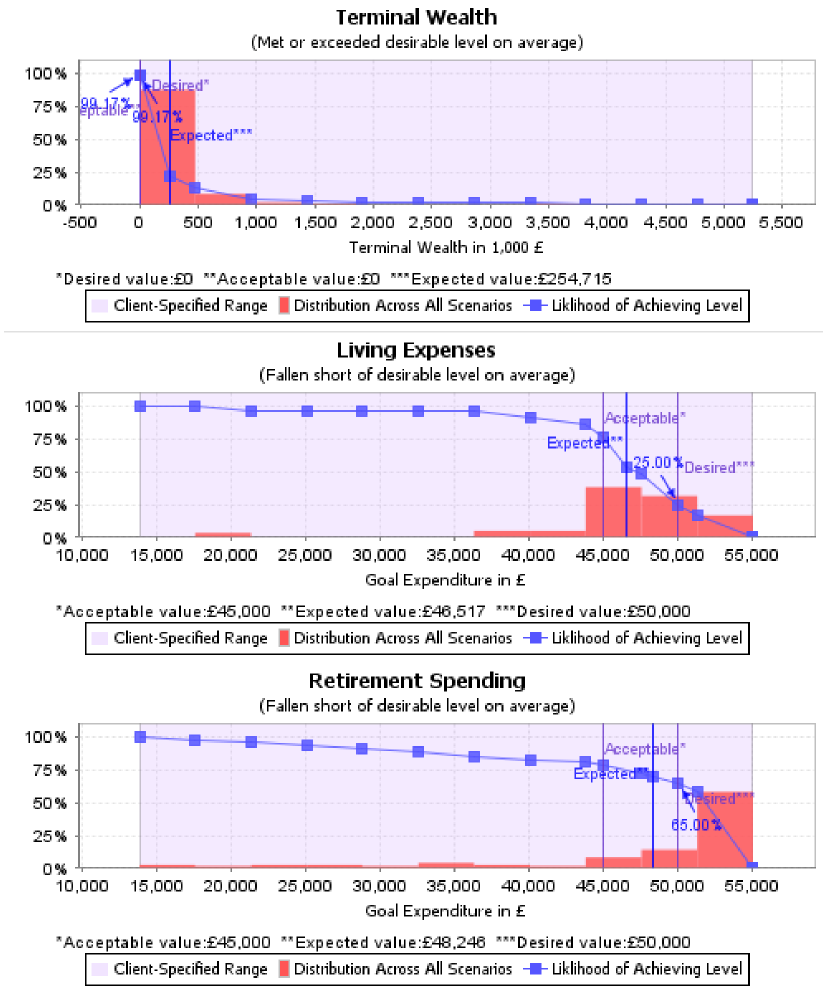
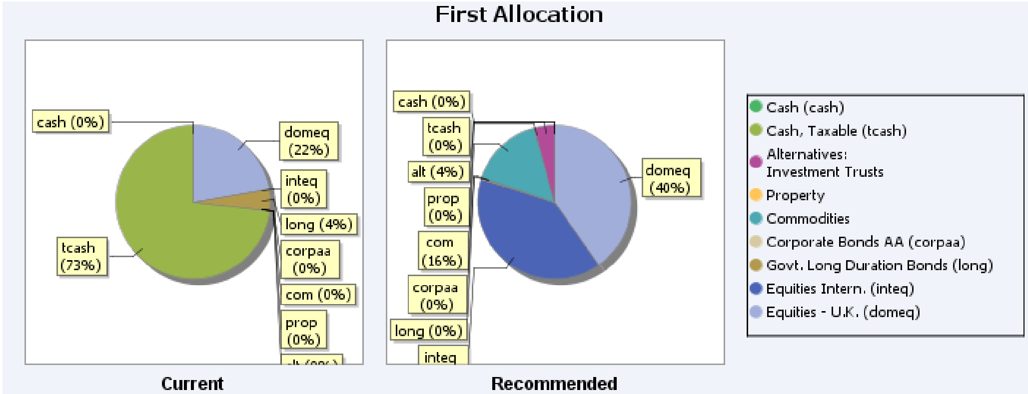


Figure 12. Goal achievement when the Jones' planned retirement is postponed

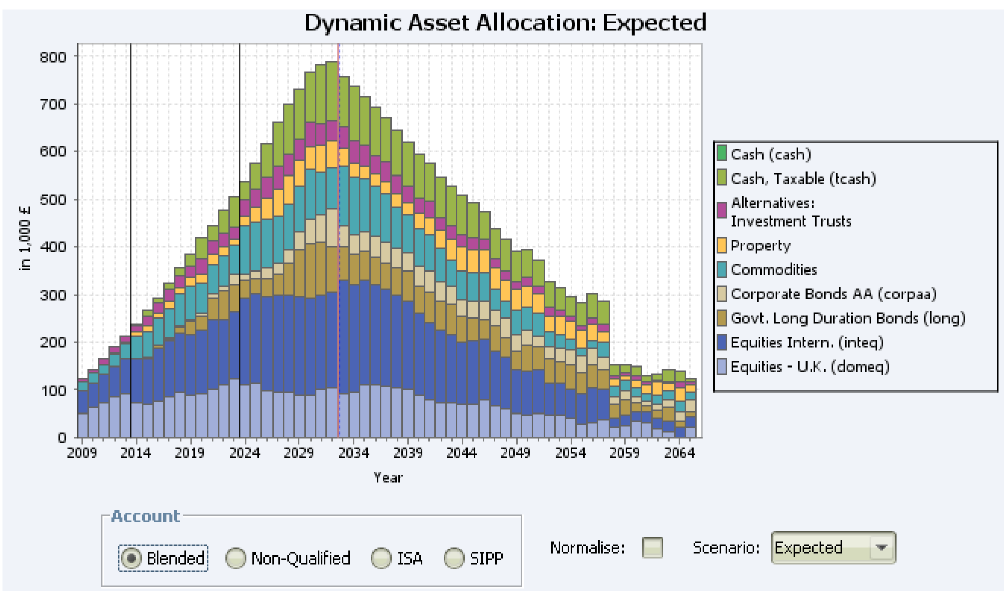
Now both pre- and post-retirement spending on alternative scenarios mainly concentrates between acceptable and desirable levels although there are still some post-retirement values on low scenarios that correspond to the dire prognostications of the pension crisis. The expected value of consumption per annum prior to retirement is £46, 517 (in current pounds) with 75% of scenarios having at least the acceptable value. The post-retirement consumption expectation is now higher, with expected spending of £48, 246 per annum, but more variation, with nevertheless 65% of the scenarios at or above the acceptable level of spending.

The Jones household can accept this plan as the one they will follow. Figures 13, 14, 15 and 16 show various recommended decisions over household life time for this plan. These graphs present averages over many generated scenarios.



Description	Current (£)	Current (%)	Recommended (£)	Recommended (%)	Δ (Absolute)	Δ (Fractional)
Domeqs	£25,000	22.32%	£49,763	40.30%	+£24,763	+17.98%
Inteqs	£0	0.00%	£48,761	39.49%	+£48,761	+39.49%
Longs	£5,000	4.46%	£388	0.31%	-£4,612	-4.15%
Corps(AA)	£0	0.00%	£0	0.00%	+/-£0	+/-0.00%
Commod.	£0	0.00%	£19,442	15.75%	+£19,442	+15.75%
Property	£0	0.00%	£0	0.00%	+/-£0	+/-0.00%
Alts	£0	0.00%	£5,122	4.15%	+£5,122	+4.15%
TCash	£82,000	73.21%	£0	0.00%	-£82,000	-73.21%
Cash	£0	0.00%	£0	0.00%	+/-£0	+/-0.00%
Total	£112,000		£123,477		+£11,477	
Return		5.83%		9.77%		+3.93%
Vol		3.09%		9.45%		+6.36%

Figure 13. Portfolio implementation for the Jones' deferred retirement plan



Year	domeq	inteq	long	corpaa	com	prop	alt	tcash	cash
2033	£92,967	£236,053	£71,901	£43,881	£124,727	£37,916	£43,315	£105,067	£0

Figure 14. Prospective expected total portfolio forward allocations by value

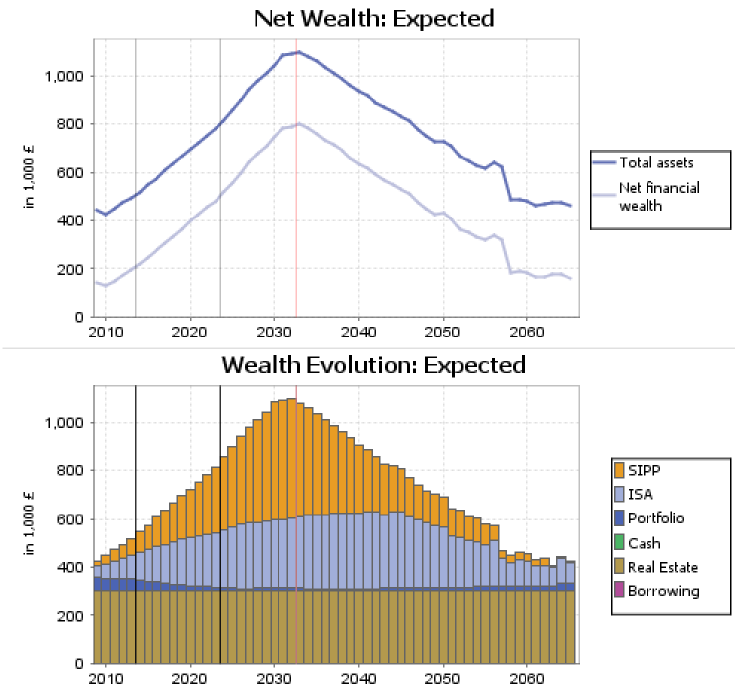


Figure 15. Prospective lifetime evolution of Jones family expected wealth

The evolution of expected wealth depicted in Figure 15 adheres to the (Modigliani) life cycle theory – wealth accumulation to retirement (date indicated by the vertical red line in the graph) and wealth decumulation thereafter to household expiry. [6]

A selected view of three main wealth scenarios is shown in Figure 16 which illustrates that projected wealth is affected greatly not only asset returns but also by household length of life and related liabilities. The four scenarios are sorted by household expected total lifetime spend on goals in current pounds.

[6] This is a typical middle class phenomenon not exhibited by the wealth evolution of higher net worth individuals.

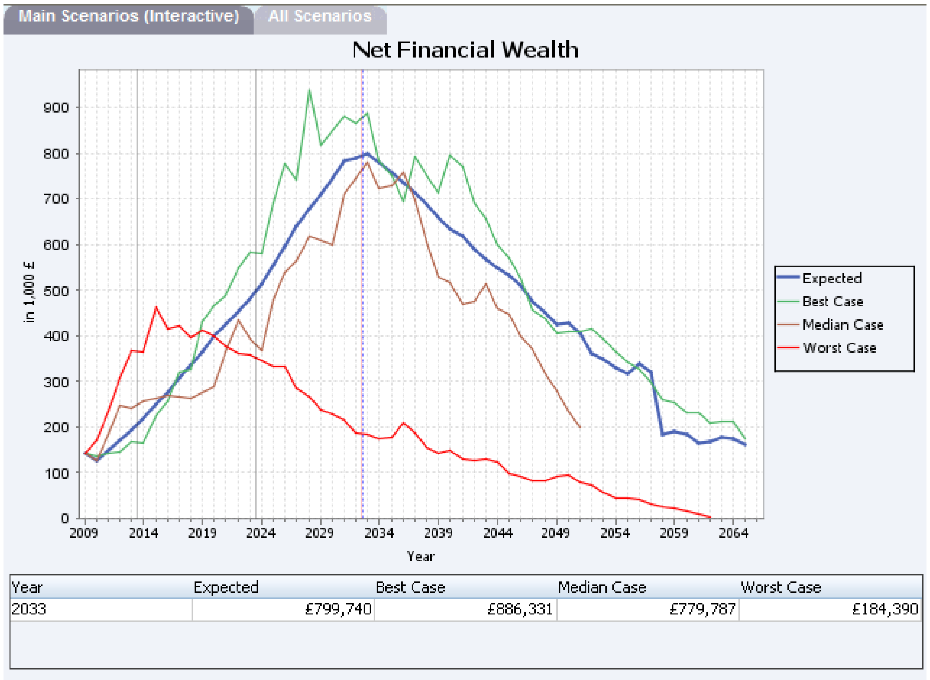


Figure 16. Alternative prospective household wealth scenarios

Further considerations

Evaluation of additional goals is important in developing an acceptable family financial plan. Our preferred approach is to solve iALM with respect to all goals under consideration according to priorities (preferences) expressed by the household – some would prefer to provide to their children education at the expense of a comfortable retirement.

The usual current practice approach of planners and wealth managers is to create separate funds for each goal. This is far from optimal as the initial allocation of wealth to goals must be arbitrary when no prospective decisions or circumstances are accounted for. Using *i*ALM annual savings are prospectively allocated to financial portfolios to enable optimal forward goal achievement at minimal risk.

Another related feature of *i*ALM is its prospective annual optimal use of tax-shielded accounts over a household's lifetime to provide an important active management component of savings.

Without further comment we introduce one more version of the Jones financial plan with the additional goals specified in Figure 17. We assume that all other inputs are as in the previous version of the plan with household heads retiring at age 67.

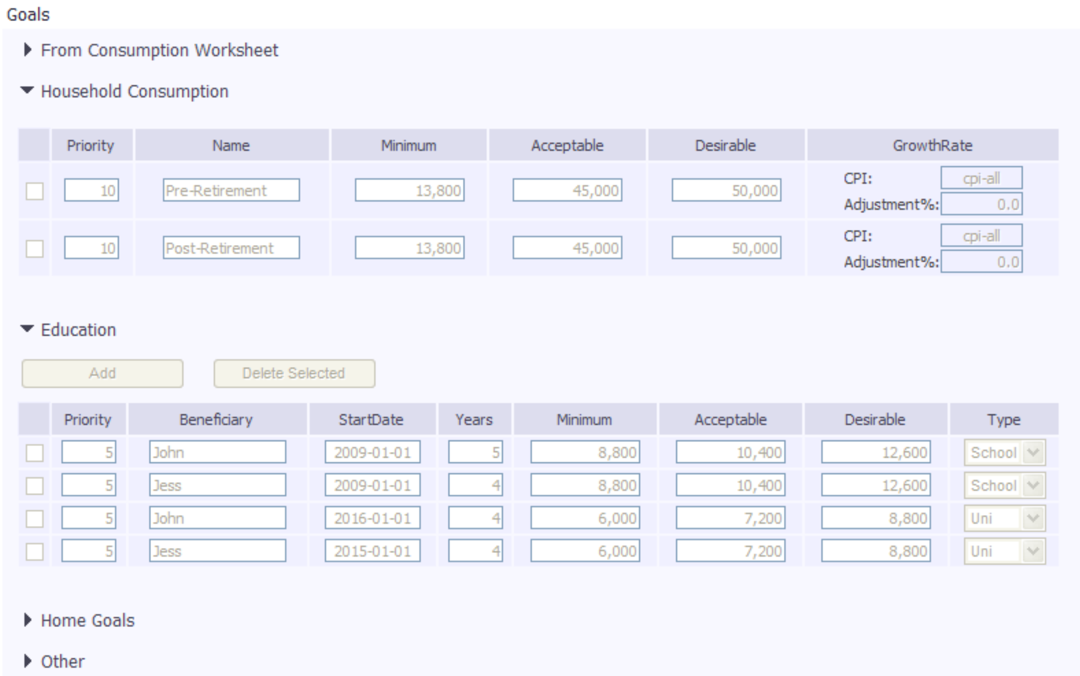
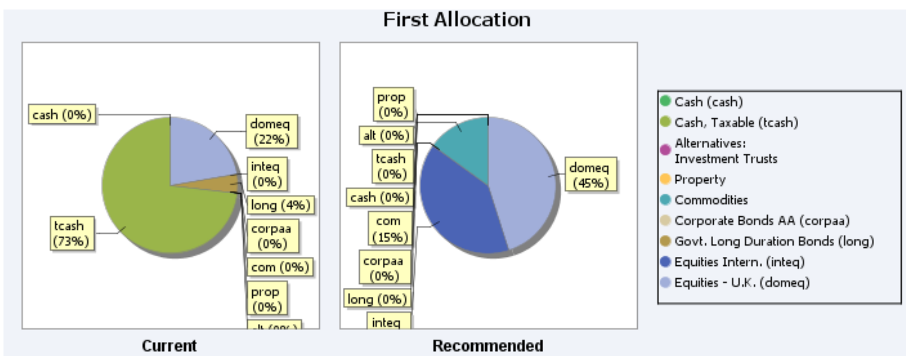
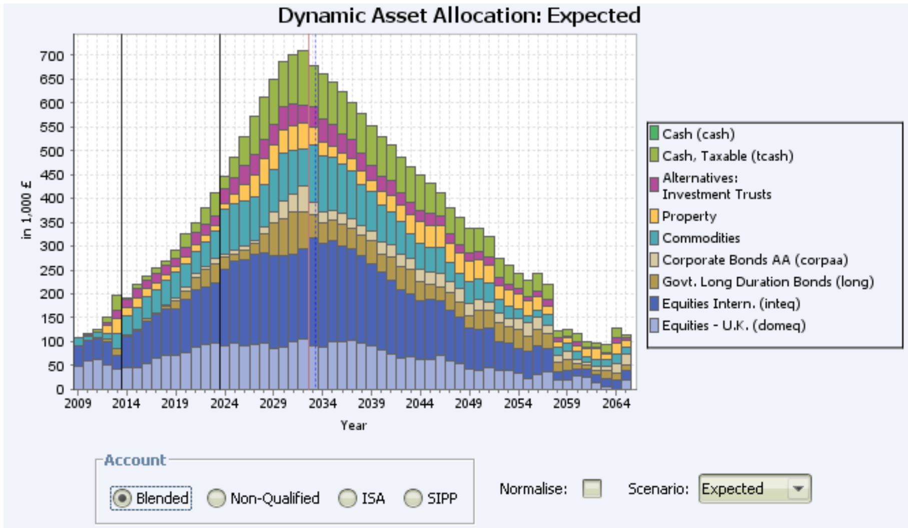


Figure 17. Additional children's educational goal specification

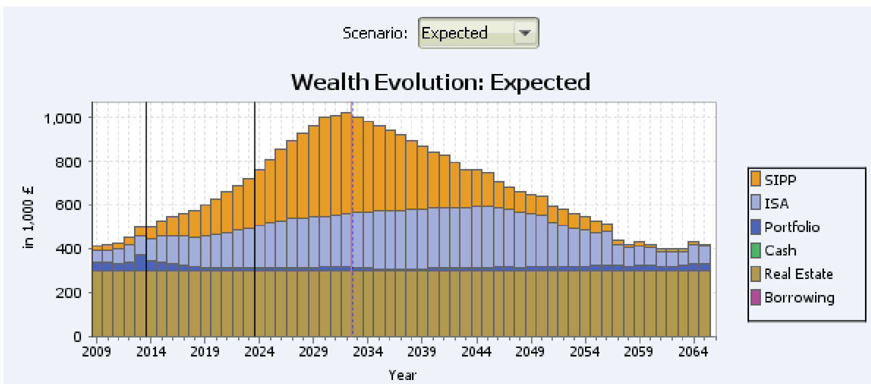


Description	Current (£)	Current (%)	Recommended (£)	Recommended (%)	Δ (Absolute)	Δ (Fractional)
Domeqs	£25,000	22.32%	£49,011	45.05%	+£24,011	+22.73%
Inteqs	£0	0.00%	£43,516	40.00%	+£43,516	+40.00%
Longs	£5,000	4.46%	£0	0.00%	-£5,000	-4.46%
Corps(AA)	£0	0.00%	£0	0.00%	+/-£0	+/-0.00%
Commod.	£0	0.00%	£16,262	14.95%	+£16,262	+14.95%
Property	£0	0.00%	£0	0.00%	+/-£0	+/-0.00%
Alts	£0	0.00%	£0	0.00%	+/-£0	+/-0.00%
TCash	£82,000	73.21%	£0	0.00%	-£82,000	-73.21%
Cash	£0	0.00%	£0	0.00%	+/-£0	+/-0.00%
Total	£112,000		£108,789		-£3,211	
Return		5.83%		9.74%		+3.91%
Vol		3.09%		9.86%		+6.76%

Figure 18. Implemented portfolio recommendation with children's education



Year	domeq	inteq	long	corpaa	com	prop	alt	tcash	cash
2033	£89,892	£227,515	£47,814	£27,709	£120,299	£34,923	£45,329	£85,797	£0



Year	Borrowing	Real Estate	Cash	Portfolio	ISA	SIPP
2033	£0	£300,000	£0	£15,457	£251,174	£437,306

Figure 19. Expected portfolio value and wealth evolution with education goals

Figures 20, 21 and 22 emphasize the potential sacrifices a family makes for the education of its children. In the worst case scenario in Figure 20 the Jones family wealth is exhausted when Jim is 76, only 9 years after retirement, although he and Caroline live into their nineties.[7] Although Figure 21 shows that the household's educational goals for both children are achieved at acceptable levels with over 70% probability, all have fallen short of acceptability in expectation, even though the expected household consumption levels have been reduced only slightly from the previous plan, compare Figures 22 and 11.

[7] We have not here considered either the possibility of borrowing against their home equity or the purchase of an annuity soon after retirement, although in practice both avenues would be open to the Jones family and the consequences could be explored with *i*ALM.

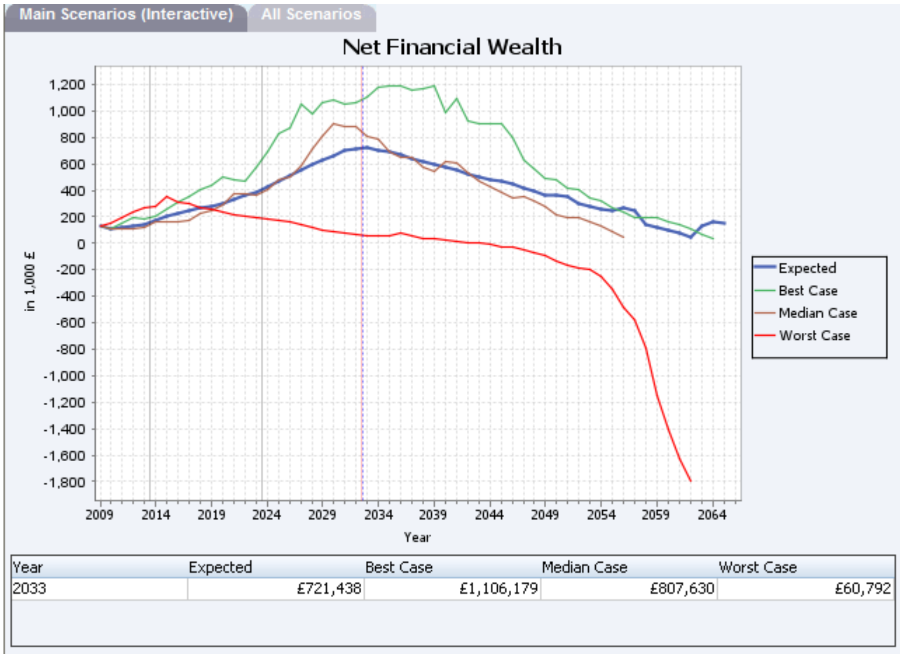


Figure 20. Prospective alternative scenarios with educational goals

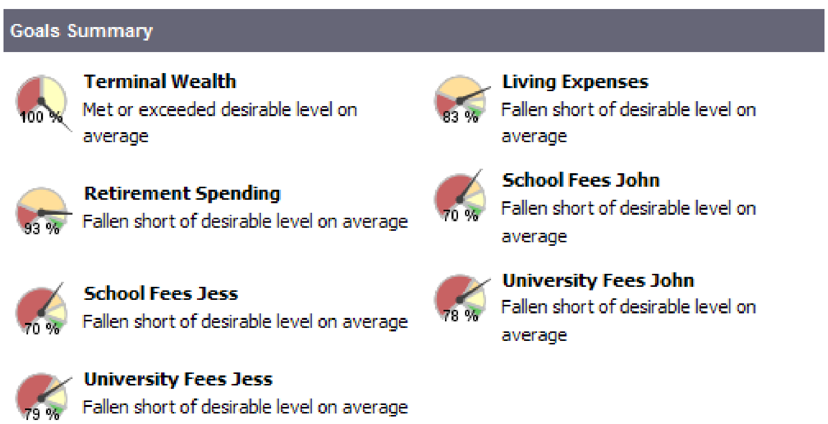
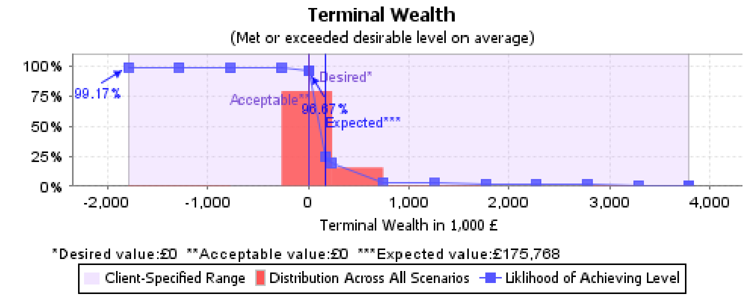
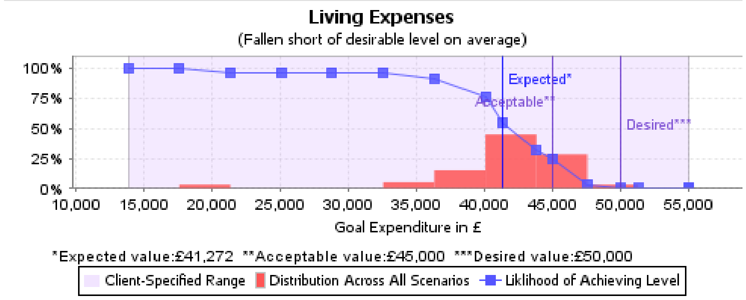
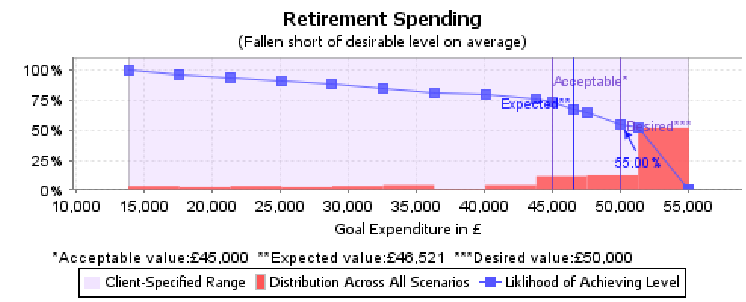
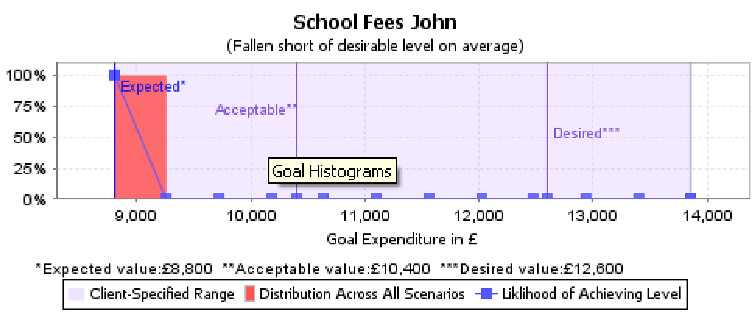


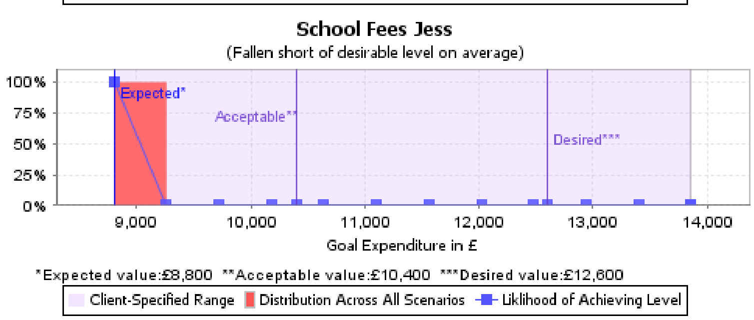
Figure 21. Probabilities of acceptable goal achievement with education goals


Terminal Wealth
(Met or exceeded desirable level on average)
100% 75% 50% 25% 0%
99.17%
Acceptable**
Desired*
96.67%
Expected***
-2,000 -1,000 0 1,000 2,000 3,000 4,000
Terminal Wealth in 1,000 £
*Desired value:£0 **Acceptable value:£0 ***Expected value:£175,768
Client-Specified Range
Distribution Across All Scenarios
Liklihood of Achieving Level


Living Expenses
(Fallen short of desirable level on average)
100% 75% 50% 25% 0%
Expected*
Acceptable**
Desired***
10,000 15,000 20,000 25,000 30,000 35,000 40,000 45,000 50,000 55,000
Goal Expenditure in £
*Expected value:£41,272 **Acceptable value:£45,000 ***Desired value:£50,000
Client-Specified Range
Distribution Across All Scenarios
Liklihood of Achieving Level


Retirement Spending
(Fallen short of desirable level on average)
100% 75% 50% 25% 0%
Acceptable*
Expected**
Desired***
55.00%
10,000 15,000 20,000 25,000 30,000 35,000 40,000 45,000 50,000 55,000
Goal Expenditure in £
*Acceptable value:£45,000 **Expected value:£46,521 ***Desired value:£50,000
Client-Specified Range
Distribution Across All Scenarios
Liklihood of Achieving Level


School Fees John
(Fallen short of desirable level on average)
100% 75% 50% 25% 0%
Expected*
Acceptable**
Desired***
Goal Histograms
9,000 10,000 11,000 12,000 13,000 14,000
Goal Expenditure in £
*Expected value:£8,800 **Acceptable value:£10,400 ***Desired value:£12,600
Client-Specified Range
Distribution Across All Scenarios
Liklihood of Achieving Level


School Fees Jess
(Fallen short of desirable level on average)
100% 75% 50% 25% 0%
Expected*
Acceptable**
Desired***
9,000 10,000 11,000 12,000 13,000 14,000
Goal Expenditure in £
*Expected value:£8,800 **Acceptable value:£10,400 ***Desired value:£12,600
Client-Specified Range
Distribution Across All Scenarios
Liklihood of Achieving Level

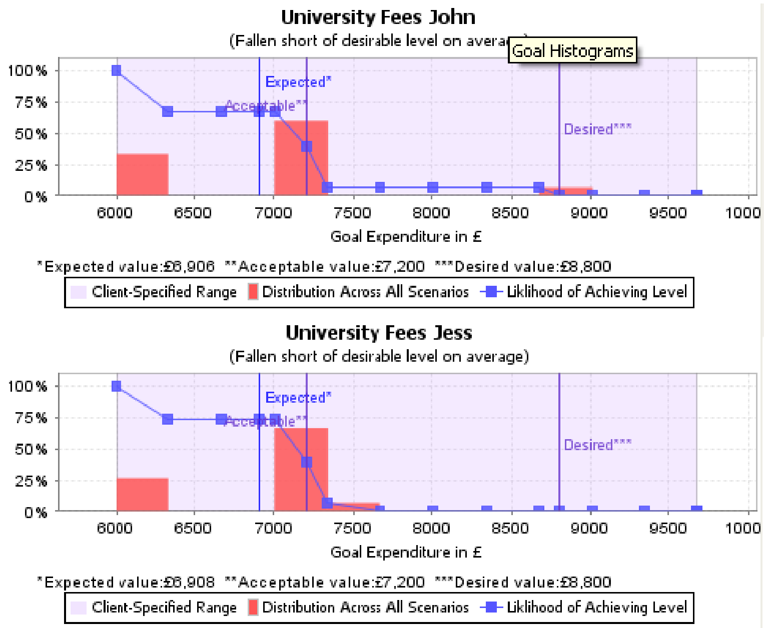


Figure 22. Histograms of goal achievement with educational goals

4. Conclusion

This paper discusses a user friendly tool for life style life cycle planning called *i*ALM (individual asset liability manager) which has been developed to help financial advisors, planners and wealth managers engage in creative dialogue with individual households. The sophisticated technology employed in iALM is a reality today, but a focus on consumer education and financial services organizational change will be required to bring such systems into widespread use in the future. There is evidence that preparations to meet these requirements, involving both opportunities and threats, are currently being made by leading players, both commercial and governmental. Otherwise the consequences of the coming pensions crisis will be more severe than they need be for middle class people everywhere.

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