PENSIONS POLICY INSTITUTE

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Investment market volatility: analysis commissioned by TUC

This analysis has been commissioned by the Trades Union Congress (TUC)

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Introduction

The Trades Union Congress (TUC) commissioned the Pensions Policy Institute (PPI) to undertake analysis of the impact of investment market performance upon the retirement outcomes for savers in Defined Contribution (DC) pension schemes. Unlike Defined Benefit (DB) pension schemes, DC schemes confer investment risk upon the member. When investments underperform this results in a poorer outcome for the member of the scheme.

Historical investment performance in recent years includes the impact of the financial crisis of 2008 which reduced both the value of equities and bonds. A member of a DC pension, even after freedom and choice came into force, may have little choice as to when they must crystallise any pension assets due to their personal circumstances. For any person who crystallised these losses into retirement income, this has a long lasting impact upon the quality of their life in retirement. For those who retired at the top of the market, potentially through no more than serendipity, they may enjoy a more secure retirement through sheer good fortune. This spread of outcomes caused by historical investment market performance is discussed in Chapter one.

Future investment return is uncertain and DC savers will be subject to these vagaries. This adds complexity to retirement planning as market performance is a factor that an individual saver has little control over. This uncertainty results in a range of potential outcomes at retirement which are discussed in Chapter two.

Potential retirement outcomes under both known historical variations and uncertain future investment returns have been projected using the PPI Individual Model.[1] This modelling gives a scale to the impact that the investment market may have upon an individual as a result of having to bear this investment risk. Increasingly investment strategies adopted by DC default funds are likely to include a wider variety of investments. This diversification across asset classes may reduce the spread of outcomes, but may come at a cost to an average outcome.

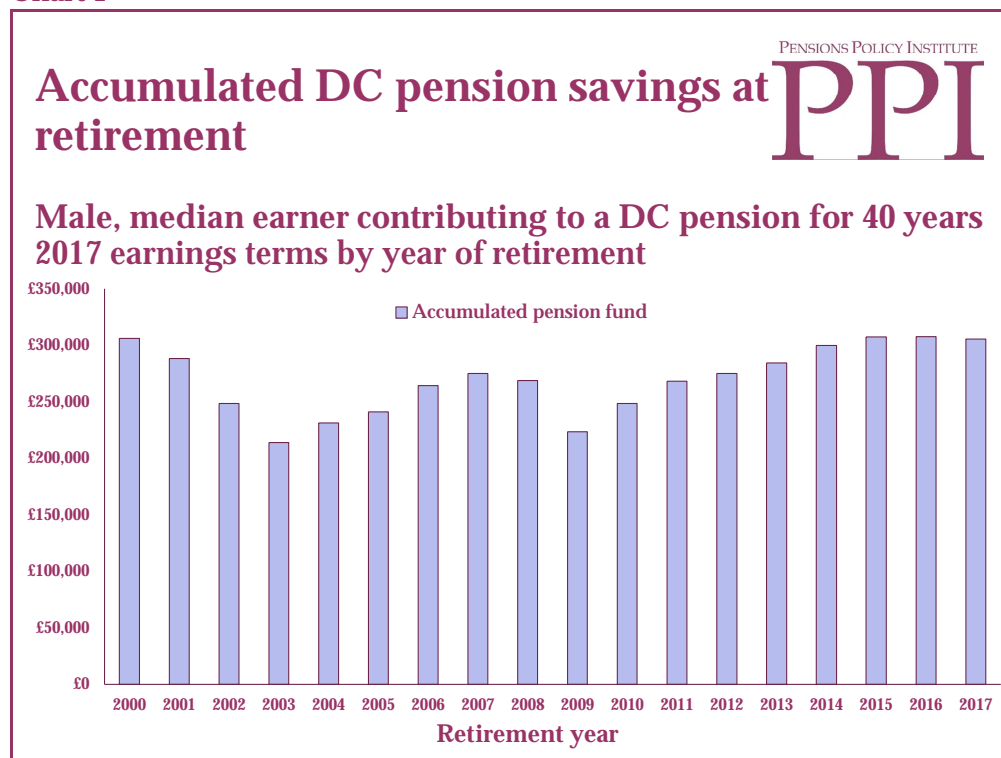[1] See Appendix One: Assumptions and modelling for further details

Chapter one: the impact of historical investment returns upon member outcomes

The majority of the value of a pension pot at retirement is comprised of investment returns generated over the accumulation period. This value on top of the contributions depends upon the rate of investment returns, which have varied year by year.

Using a standardised contribution pattern it is possible to assess the impact these variations have upon the accumulation of a pension pot. Contributions are assumed to have been made for 40 years, from age 25 until retirement, for individuals born from 1935 through to 1952 at 8% of age-specific male median earnings. Incomes are assumed to have changed in line with historical averages and investment performance has been assumed to reflect historical market performance of equities and bonds.

These pension pots have matured since the turn of the century at different values which reflect the differing historical investment returns [Chart 1]. The outcomes demonstrate the impact of financial crises, where investments have made losses, and bull markets[2] which have allowed investments to grow.

Chart 1[3]

Accumulated DC pension savings at retirement

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Male, median earner contributing to a DC pension for 40 years 2017 earnings terms by year of retirement

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[2] A bull market is one in which prices are rising
[3] PPI modelling; underlying data Table 1.1

Poor investment market performance shortly before retirement has the most detrimental impact upon the accumulated savings of a retiree. This century there have been two notable periods of stock market losses, the financial crisis of 2008, and the impact of the September 11th attacks and subsequent stock market losses in 2002. These two periods lead to the lowest values of accumulated pension savings at retirement. Recovery from these losses has taken years of a bull market to achieve, leading to peaks around 40% larger than the lowest outcomes.

Converting these pension pots to an income using current annuity rates gives a sense of scale to retirement outcomes, from £12,000 to £17,000 per year of private pension income on top of State entitlement and other savings [Table 1]. However the purchasing power of a pension pot has changed over the years as a result of changing market conditions affecting the annuity rates which were available. Historical annuity rates, which reflect the economic circumstances of the time (including anticipated long-term investment performance), have been used to convert these pension pots into illustrative income levels.

Table 1: DC outcomes at retirement for a male, median earner, contributing to a DC pension for 40 years, 2017 earnings terms
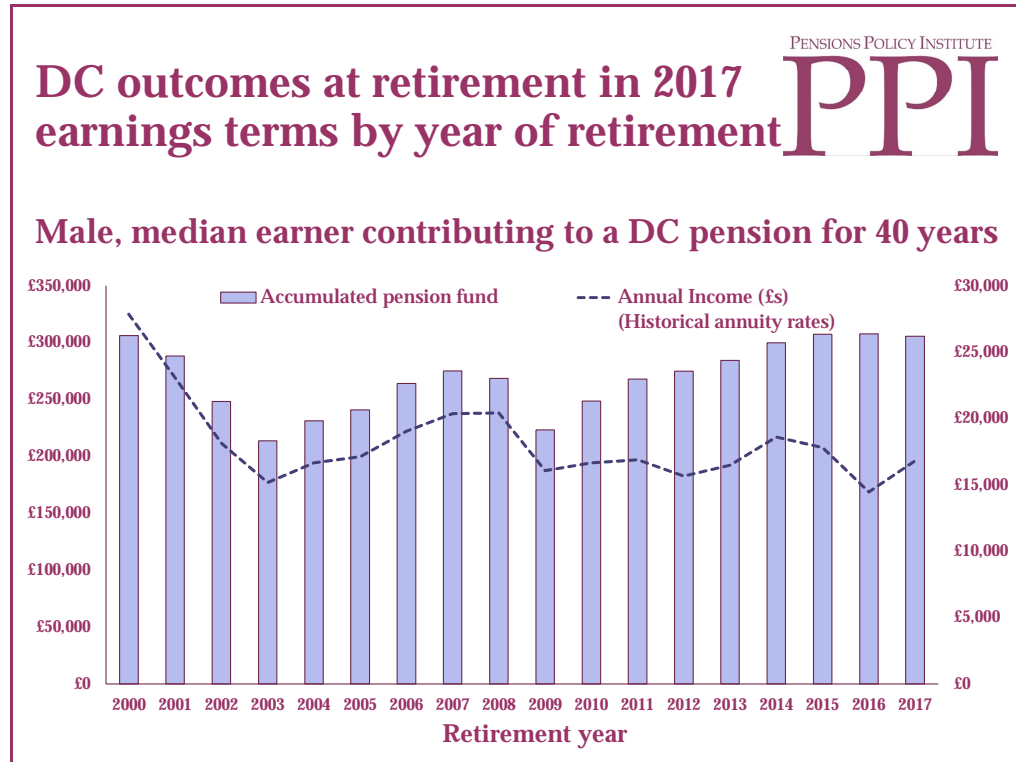
Retirement year	Accumulated pension fund	Historical Annuity Rate	Annual Income (£s) (2017 annuity rates)	Annual Income (£s) (Historical annuity rates)
2017	£305,500	5.5%	£16,800	£16,800
2016	£307,800	4.7%	£16,900	£14,500
2015	£307,300	5.8%	£16,900	£17,800
2014	£299,900	6.2%	£16,500	£18,600
2013	£284,400	5.8%	£15,600	£16,500
2012	£275,000	5.7%	£15,100	£15,700
2011	£268,100	6.3%	£14,700	£16,900
2010	£248,600	6.7%	£13,700	£16,700
2009	£223,400	7.2%	£12,300	£16,100
2008	£268,800	7.6%	£14,800	£20,400
2007	£275,200	7.4%	£15,100	£20,400
2006	£264,300	7.2%	£14,500	£19,000
2005	£241,000	7.1%	£13,300	£17,100
2004	£231,300	7.2%	£12,700	£16,700
2003	£213,800	7.1%	£11,800	£15,200
2002	£248,500	7.3%	£13,700	£18,100
2001	£288,400	8.0%	£15,900	£23,100
2000	£306,300	9.1%	£16,800	£27,900

The annuity rates illustrated are only indicative for the retirement year. Individuals who choose to purchase an annuity may have paid above or below these rates subject to market fluctuations, differing charges, whether they have shopped around to obtain a better rate, variations within the year, or any other individual circumstances such as eligibility for an enhanced annuity.

Since the 2008 financial crisis the Bank of England's quantitative easing[4] programme has contributed to depressed annuity rates. Quantitative easing has inflated the market price of gilts, thus reducing their yields, and these are an important asset used to back annuity purchases.

This reduction in the annuity rates has largely negated the benefits from the investment gains of the recent bull market. This has left the most recent retirees no better off than those who had retired at the trough of the market [Chart 2].

Chart 2[5]

DC outcomes at retirement in 2017 earnings terms by year of retirement

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Male, median earner contributing to a DC pension for 40 years

Legend: Accumulated pension fund — Annual Income (£s) (Historical annuity rates)

Retirement year

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[4] **The Bank of England has undertaken a project of buying back gilts to inject money into the UK economy. This has increased gilt prices, reducing their yield which has depressed annuity rates.**
[5] **PPI modelling; underlying data Table 1**

Chapter two: uncertainty caused by unknown future investment returns

Future investment returns are uncertain. Asset returns are subject to varying levels of volatility. This reflects the degree of risk or uncertainty attached to investment returns. Generally assets which generate higher returns are associated with greater risk and a balance often needs to be struck between risk and reward.

With a consistent contribution pattern throughout a working life the range of potential DC pot sizes at retirement varies greatly due to this uncertainty. A median earning male contributing throughout working life may be able to expect an accrued pension pot (median of projected outcomes) of £154,400 (in 2017 earnings terms). Yet in 10% of cases their pot may be 40% lower due to adverse investment markets (an impact which is comparable in scale to the recent financial crisis). However there is also the opportunity for a higher outcome, and in approximately 10% of outcomes they may accumulate a pension pot around 80% higher than the median [Chart 3].

Chart 3
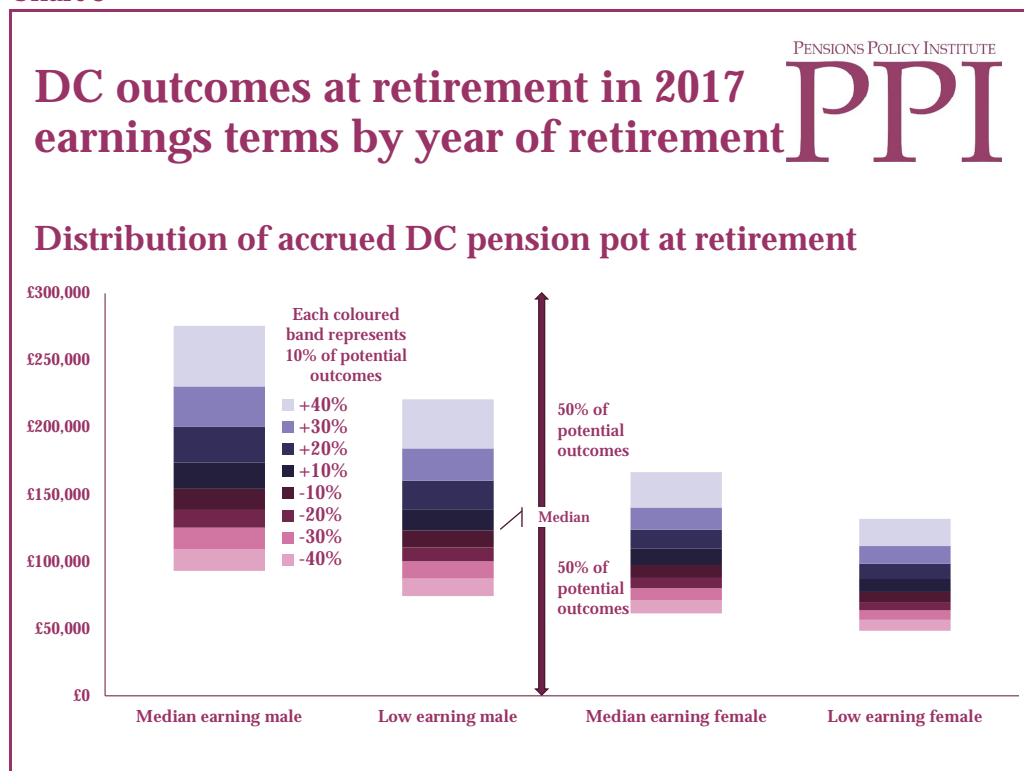
An unknown economic future also introduces uncertainty to the level of the State Pension that may be payable. State Pension indexation under the triple lock includes a floor which protects it from loss under circumstances when a private pension may suffer.

Private pension income may exceed that received from the State under certain economic circumstances which aid private pension accumulation. For a pension outcome which compares favourably to earnings over a lifetime, different components are aided by different aspect of future economic conditions:

Income levels:
· Low income growth results in a low final salary against which it can be easier to achieve a higher replacement rate.

Private pension:
· Low earnings growth reduces final salary and places greater weight upon pension contributions made at younger ages which have longer to accumulate investment returns.
· High fund growth from investment returns increases the pot relative to earnings.

State Pension, (assumed to be indexed in line with the triple lock):
· High triple lock indexation relative to earnings growth requires years of either:
   Ø High CPI;
   Ø Earnings inflation below 2.5%.

Other income: comprises benefit income and taxation
· Tax bands are assumed to grow in line with earnings, to reduce the tax burden in retirement high earnings increases will raise the thresholds.

Detailed results have been broken into deciles by the value of the private pension at retirement [Tables 2.1-2.4]. The chances of being in a higher private pension decile increase with the following combination of factors:
· High investment growth
   Ø This increases the amount of investment return accrued during the accumulation of the pension pot.
· Low earnings growth
   Ø This reduces the final value of earnings, making higher replacement rates more attainable and increasing the value of contributions made at younger ages relative to final salary.
   Ø This will also contribute to a higher State Pension in current earnings terms as a result of the underpins (CPI & 2.5%) within the triple lock.

For a median earning man the lowest 10 per cent of outcomes deliver an average pot of £78,800 (in 2017 earnings terms), enough to purchase a weekly income of £62. But in the highest 10 per cent of outcomes, the pot averages £353,000 affording a weekly income of £277, nearly four and a half times larger [Table 2]. With lower private pension, retirement income is more dependent upon the State Pension (73% of income is State Pension in decile 1). This is due to low investment returns resulting in smaller private pension pots.

In the highest decile 65% of income comes from private pension saving as a result of favourable economic circumstances in accumulation. A smaller effect at higher replacement rates is from State Pension, representing a higher proportion of final earnings (though a smaller proportion of retirement income) through the triple lock keeping pension indexation above earnings increases. The tax burden becomes greater when associated with higher income levels.

Table 2: The distribution of retirement income outcomes for a median earning man

Decile	Accrued pension pot at retirement	Private pension income (per week)	State Pension income (per week)	Other sources of income and tax paid (per week)	Total income (per week)
1	£78,800	£62	£170	£0	£232
2	£101,700	£80	£171	-£1	£250
3	£117,200	£92	£174	-£4	£262
4	£131,200	£103	£174	-£5	£272
5	£146,900	£115	£173	-£7	£281
6	£163,500	£128	£175	-£9	£294
7	£187,300	£147	£177	-£12	£311
8	£214,600	£168	£173	-£15	£327
9	£250,400	£197	£177	-£20	£354
10	£353,100	£277	£179	-£32	£424

Additional results are given for a low earning man [Table 3], and median and low earning women [Tables 4 – 5].

Table 3: The distribution of retirement income outcomes for a low earning man

Decile	Accrued pension pot at retirement	Private pension income (per week)	State Pension income (per week)	Other sources of income and tax paid (per week)	Total income (per week)
1	£65,500	£51	£166	£1	£218
2	£82,100	£64	£169	£1	£234
3	£96,300	£76	£170	-£1	£245
4	£107,100	£84	£171	-£2	£253
5	£116,100	£91	£175	-£4	£262
6	£130,000	£102	£177	-£6	£273
7	£151,800	£119	£175	-£8	£286
8	£168,600	£132	£178	-£10	£300
9	£197,500	£155	£180	-£14	£321
10	£280,500	£220	£183	-£25	£379

Table 4: The distribution of retirement income outcomes for a median earning woman

Decile	Accrued pension pot at retirement	Private pension income (per week)	State Pension income (per week)	Other sources of income and tax paid (per week)	Total income (per week)
1	£56,100	£44	£165	£1	£210
2	£67,600	£53	£169	£1	£222
3	£78,500	£62	£169	£1	£232
4	£86,600	£68	£171	£-	£239
5	£92,800	£73	£174	-£1	£246
6	£103,600	£81	£176	-£2	£255
7	£116,600	£92	£176	-£4	£263
8	£130,000	£102	£177	-£6	£273
9	£149,100	£117	£181	-£9	£289
10	£204,000	£160	£185	-£16	£329

Table 5: The distribution of retirement income outcomes for a low earning woman

Decile	Accrued pension pot at retirement	Private pension income (per week)	State Pension income (per week)	Other sources of income and tax paid (per week)	Total income (per week)
1	£44,800	£35	£165	£1	£201
2	£54,300	£43	£168	£1	£211
3	£62,900	£49	£169	£1	£219
4	£69,200	£54	£170	£1	£225
5	£74,100	£58	£174	£1	£233
6	£83,400	£65	£175	£-	£240
7	£92,500	£73	£176	-£1	£247
8	£102,400	£80	£178	-£3	£255
9	£116,900	£92	£182	-£5	£269
10	£160,800	£126	£186	-£11	£301

Appendix one: assumptions and modelling

The modelling for this report considers the projection of an individual using the PPI's Suite of pension models, using a stochastic approach of economic assumptions. The economic scenarios are generated using the PPIs economic scenario generator. The models used are detailed below. Results are presented in 2017 earnings terms.

The pensions system
The pension system modelled is as currently legislated. The triple lock is assumed to be maintained. Individuals are assumed to be members of a Defined Contribution (DC) occupational pension scheme and the entire fund is used to purchase an annuity.

Investment assumptions
Investment returns are modelled stochastically with curves generated by the PPIs Economic Scenario Generator (ESG). 1,000 scenarios were produced providing values for equity returns, bond returns, cash returns, CPI and earnings increases each year for each scenario. The assumed median values for each of these values are listed below:
CPI: 2.0%
Earnings: 4.3%
Fund return: 6%
Fund volatility: equivalent to a portfolio mix of 60% equity, 40% bond

Historical assumptions
Historical fund returns have been derived from equity and bond performance since 1960 published in the Barclay's equity gilt study.

Historical annuity rates are representative of the market in the indicated year. These have been derived from work of the Financial Services Consumer Panel (FSCP) and Sharing Pensions.

Other economic assumptions
Other economic assumptions are taken from the Office for Budget Responsibility's Economic and Fiscal Outlook (for short-term assumptions) and Fiscal Sustainability Report (for long-term assumptions).

Fund charges are assumed to be 0.5% for DC/master trust schemes set up for automatic enrolment.[6]

Long-term earnings growth is assumed to be 4.3%, and other economic assumptions are taken in line with Office of Budget Responsibility (OBR) assumptions,[7] derived from their 2017 Fiscal Sustainability Report. The earnings band for automatic enrolment contributions and minimum salary assumption are assumed to grow with average earnings.

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[6] Equivalent Annual Management Charge for multi-employer/Master trust schemes such as Legal and General's Worksave, NEST and The People's Pension.
[7] OBR (2017)

The individuals modelled

The individuals modelled are designed to illustrate the typical impact that may be experienced by members of a DC pension scheme.

Earnings levels

Earnings levels are age and gender specific rates taken from Office for National Statistics (ONS) Annual Survey of Hours and Earnings (ASHE) data.

Working age lifecourse

The lifecourses modelled are informed by analysis of the English Longitudinal Study of Aging (ELSA) dataset undertaken within the WHERL project. Men are assumed to work full-time throughout working ages. Women are assumed to take a ten year career (and pension contributions) break before returning to work full time. This lifecourse data is representative of the lifecourse data of 45% of men aged 65 to 74, and 18% of women aged 60 to 69, at the time of the survey.[8]

Contribution rates

All individuals are assumed to make pension contributions of 8% of gross earnings.

The Economic Scenario Generator

The PPI's Economic Scenario Generator (ESG) is used to produce randomly generated future economic scenarios based upon historical returns and an assumption of the median long-term rates of return. It was developed by the financial mathematics department at King's College London. It is used to test how the distribution of outcomes is influenced by the uncertainty of future economic assumptions.

Key results

The model generates projected future inflation rates, and earnings growth

- Inflation rates
    - Ø Future CPI increases and earnings inflation rates
- Investment returns
    - Ø Returns are produced for the major asset classes of equity, cash and gilts

This produces nominal returns which can be combined to produce investment returns for a more complex portfolio.

Application of output

The output of the ESG is a number of economic scenarios which are employed by the PPI's other models to analyse the distribution of impacts on a stochastic economic basis.

Key data sources

The specification of the model is based upon historical information to determine a base volatility and future assumptions to determine a median future return:

- **Historical returns:** Historical yields and returns as well as inflation measures are used to determine the key attributes for the projected rates

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[8] The Wellbeing, Health, Retirement and the Lifecourse project (WHERL, www.wherl.ac.uk)

- **Future returns:** Future returns are generally taken from the Office for Budget Responsibility (OBR) Economic and Fiscal Outlook (EFO) to ensure consistency with other assumptions used in the model for which the economic scenarios are being generated. Volatility can also be scaled against historical levels.

Summary of modelling approach

The six identified risk factors modelled are:

G	Nominal GDP
P	CPI
W	Average weekly earnings
Y^l	Long-term yields
Y^s	Money market yields
S	Stock returns

Using these variables, a six dimensional process, x_t is defined.

$$x_t = \begin{bmatrix} \ln G_t - \ln G_{t-12} \\ \ln(P_t - \ln P_{t-12} + 0.02) \\ \ln W_t - \ln W_{t-12} \\ \ln\left(e^{Y_t^l} - 1\right) \\ \ln\left(e^{Y_t^s} - 1\right) \\ \ln S_t \end{bmatrix}$$

Where t denotes time in months.

The development of the vector x_t is modelled by the first order stochastic difference equation:

$$\Delta x_t = A x_{t-1} + a + \varepsilon_t$$

Where A is a 6 by 6 matrix, a is a six dimensional vector and ε_t are independent multivariate Gaussian random variables with zero mean. The matrix A and the covariance matrix of the ε_t were determined by calibrating against the historical data. The coefficients of a were then selected to match the long term economic assumptions.

It follows that the values of x_t will have a multivariate normal distribution. Simulated investment returns will, however, be non-Gaussian partly because of the nonlinear transformations above. Moreover, the yields are nonlinearly related to bond investments.

The first component and third components of x_t give the annual growth rates of GDP and wages, respectively. The fourth and fifth components are transformed yields. The transformation applied ensures that the yields are always positive in simulations. Similarly the second component gives a transformed growth rate of CPI. In this case, the transformation applied ensures that inflation never drops below -2% in the simulations. This figure was selected to be twice the maximum rate of deflation ever found in the historical data.

The Individual Model

The Individual Model is the PPI's tool for modelling illustrative individual's income during retirement. It can model income for different individuals under current policy, or look at how an individual's income would be affected by policy changes. This income includes benefits from the State Pension system and private pension arrangements, and can also include income from earnings and equity release. It is useful to see how changes in policy can affect individuals' incomes in the future.

This model can be used in conjunction with economic stochastic scenarios derived from the PPI's economic scenario generator to produce stochastic output.

Key results

The key output from the model is the built-up pension wealth and entitlement over the course of the individual's work history and the post-retirement income that results from this.

The post-retirement income is presented as projected cashflows from retirement over the future lifespan of the individual. These are annual cashflows which include the following key items:

- State Pension
  - Ø Reflects entitlement and the projected benefit level of State Pension components.
- Private pension
  - Ø Derived from the decumulation of the pension pot, allowing for tax-free cash lump sum and the chosen decumulation style (e.g. annuity or drawdown).
- Other state benefits
  - Ø Other benefits contributing to post-retirement income such as pension credit.
- Tax
  - Ø Tax payable on the post-retirement income, to understand the net income available to the individual.

These cashflows are calculated as nominal amounts and restated in current earnings terms.

Outcomes are expressed in current earnings terms for two reasons; it improves the comprehension of the results and reduces the liability of either overly optimistic or cautious economic assumptions.

Application of output

The model is best used to compare outcomes between different individuals, policy options, or other scenarios. The results are best used in conjunction with an appropriate counterfactual to illustrate the variables under test.

Key data sources

The specification of a model run is based upon three areas:

The individual

The individual to be modelled is specified based upon an earnings and career profile. Saving behaviour for private pension accumulation is considered, as well as the behaviour at retirement.

These are generally parameterised according to the project in question, designed to create vignettes to highlight representative individuals of the groups under investigation.

The policy options

The policy option maps the pension framework in which the individual exists. It can accommodate the current system and alternatives derived through parameterisation. This allows flexing of the current system to consider potential policy options to assess their impact upon individuals under investigation.

This area has the scope to consider the build-up of pensions in their framework such as the auto-enrolment regulations for private pensions and the qualification for entitlement to state benefits.

The framework in retirement allows for the tax treatment and decumulation options taken by the individual as well as other sources of state benefits which influence the post-retirement outcomes for individuals.

Economic assumptions and scenarios

The model is capable of running with either deterministic or stochastic economic assumptions.

The deterministic assumptions used are generally taken from the Office of Budget Responsibility (OBR) Economic and Fiscal Outlook (EFO) to ensure consistency. They cover both historical data and future projected values. Alternatively the model can be used in conjunction with the PPI's Economic Scenario Generator (ESG) to produce a distribution of outputs based upon potential future economic conditions.

Summary of individual modelling approach

The model projects the pension features of the individual, both in accumulation (pre-retirement) and decumulation (post retirement) phases.

It projects the pre-retirement features of the individual through the accumulation of pension entitlement, both state benefits and occupational Defined Benefit schemes.

This is done through the modelling of the career history of the individual, deriving pension contributions and entitlement from the projected earnings profile.

The entitlement to and the level of state benefits are projected such that from retirement their contribution to the income of the individual can be calculated. Private pension income is modelled and assumes a decision about the behaviour of the individual at retirement. This allows for the chosen decumulation path of any accrued private pension wealth.

Limitations of analysis

Care should be taken when interpreting the modelling results used in this report. In particular, individuals are not considered to change their behaviour in response to investment performance. For example, if investments are performing poorly, an individual may choose to decrease their withdrawal rate and vice versa.

Monte Carlo simulation can be a powerful tool when trying to gain an understanding of the distribution of possible future outcomes. However, in common with other projection techniques, it is highly dependent on the assumptions made about the future. In this case, the choice of distribution and parameters of the underlying variables, the investment returns of equities, gilts and cash are important to the results.

Acknowledgements and Contact Details