An introduction to the

Member's Default Utility Function

VERSION 1 | MDUF v1

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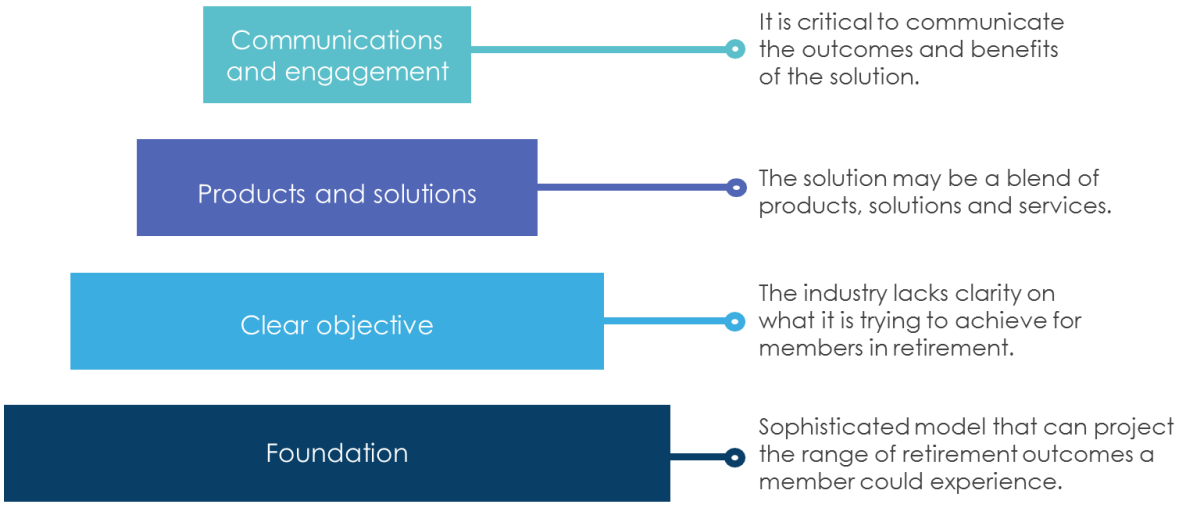
Introduction

Providing retirement outcome solutions is a hugely challenging and complex area. Technically the retirement outcomes problem can be defined as:

> *"A dynamic, integrated consumption and investment decision problem."*

At the heart of the problem is a decision on a joint consumption and investment strategy which should be reviewed regularly. The problem is made more complex by many factors such as the fact that every person has their own characteristics and situation (heterogeneous population), the large range of available products, solutions and services (yet shortage of product exists in some key areas), combined with the difficulties experienced by the industry in communicating complex financial solutions to fund members who on average have low levels of financial literacy.

The industry needs to further mature by developing products, solutions and strategies that meet the retirement outcome challenge. Meeting this challenge can be broadly mapped out in the following framework.



In this paper we focus on the solution, rather than the communication aspects of meeting this challenge. Specifically we focus on the need for a clear objective of what we are trying to achieve for members in retirement. Obviously there is a discovery process for fund members who become advice clients. However many members will default into retirement solutions. What should we assume for their retirement outcome objectives? More to the point, ultimately what should a trustee of a super fund assume to be sensible objectives of default fund members?

This last question is the focus of this paper. We created a panel of academics and industry professionals to determine an appropriate and sensible set of objectives for trustees to assume on behalf of their default fund members, members they know little about. We then converted these preferences into a mathematical function, known as a utility function. This function has been given the name *"Member's Default Utility Function Version 1"* or *"MDUF v1"* for short.

Existing retirement outcome metrics used in the industry are flawed. MDUF v1 incorporates preferences which are not considered by other metrics. In particular, MDUF v1 recognises the importance of the income experience (level and variability), places a value on any residual benefit, and acknowledges that most people are risk averse. In effect we believe MDUF v1 is a superior retirement outcome metric.

MDUF v1 is a credible and powerful metric which can be used by industry, regulators and policymakers for varying purposes. To list a few applications:

- Post-retirement solution design by super funds and other product providers
- Assessment of design by regulators and ratings groups
- Welfare analysis by policy groups

We are proud that MDUF v1 has been made available in an open-architecture format, whereby papers, presentations, models and Q&A are all available on a website. We encourage the industry to collaborate more on addressing the retirement outcome challenge.

The paper proceeds to detail the development of MDUF v1 and demonstrate applications.

We believe that if the industry embraces MDUF v1 then it can raise Australia's retirement outcome system to another level. We appreciate you taking the time to read this paper.

Background to the Project

Mine Wealth + Wellbeing (Mine) have a dedicated Retirement Outcomes team which forms part of the Investment team. The team has been focused on developing retirement outcome modelling capability and the education of the Board, Executive and broader firm.

The team, Estelle Liu and Dr Adam Shao, along with CIO David Bell, have strong academic backgrounds in retirement outcome modelling. Arguably, due to weight of money, retirement outcome modelling remains one of the few areas in finance where academia is ahead of industry. Specifically academics often use utility functions to solve retirement outcome problems (a utility function is simply a mathematical representation of preferences).

This technique (of using utility functions) is highly appealing and after internal training sessions the Board could see the merit in the approach as well. However, just as there are infinite unique sets of preferences, there is an infinite number of unique forms that a utility function could take.

Rather than adopt an internally developed utility function, the team at Mine thought it would be better to collaborate with a larger panel of leading academics and industry experts. In doing so a commitment was made by Mine to share this work with the broader industry.

The panel was structured as follows:

- Mine led the project sessions and produced the documentation and formal case studies for discussion.
- Panel members would provide insights, cite key reference papers, and engage in important debates around specific features. The essence and resolution of these debates is documented in the Working Paper to provide strong insight to external parties and to add credibility and legitimacy to the work.

At the conclusion panel members were provided a choice of whether to be recognised as "*Working Group*" members or "*Informal Contributors*". The panel is detailed below:

- David Bell, Mine Wealth + Wellbeing
- Estelle Liu, Mine Wealth + Wellbeing
- Dr Adam Shao, Mine Wealth + Wellbeing

- Assoc. Prof. Anthony Asher, UNSW
- Nick Callil, Willis Towers Watson
- Prof. Geoff Kingston, Macquarie University
- Dr David Knox, Mercer
- David Schneider, 10E24
- Tim Unger, Willis Towers Watson
- Dr Geoff Warren, ANU

"Working group members have been contributors who also endorse the MDUF v1 as a sensible starting point when determining a set of preferences for Trustees to assume on behalf of those members whom they have little insight into."

- Dr Jack Ding, Milliman
- Wade Matterson, Milliman
- Craig McCulloch, Milliman
- Nicolette Rubinsztein, UniSuper

"Informal contributors have participated in the MDUF v1 Project but make no endorsement."

Throughout this project the lens used by the panel was to consider:

"What is a sensible set of financial preferences for a trustee to assume on behalf of a default fund member?"

This means that we ignore behavioural biases which may exist. We take a view that it is potentially dangerous for a trustee to cater to behavioural biases, some of which may be irrational and threaten a sustainable retirement outcome.

The project took about 18 months to complete the first version of this work. It was originally estimated that the work would take around 6 months. The difference was because of the robustness of debate on many issues, which is broadly captured in the Working Document. We believe this adds strongly to the integrity and credibility of this work.

We make reference to *"version 1"* or *"v1"* notation. This is because we envisage that in a couple of years' time a working group will be formed to create a version 2. This would afford the opportunity to consider subsequent industry and academic research and see if the representation of member's preferences can be improved.

Legitimacy and credibility of MDUF v1

The "Straw Man" concept

There are many discussions around retirement outcome objectives, measurements and design. Many of these have identifiable flaws. It is probably impossible to have a perfect objective / metric. What the panel has sought to achieve is to create a highly credible starting point regarding a sensible objective for trustees to assume on behalf of their default fund members.

We believe that credibility in MDUF v1 has been achieved in a number of ways:

1. The breadth and depth of relevant experience across the panel. Collectively there is over 200 years of relevant experience amongst panel members. The panel was diversified by role (academic, consultant and asset owner).
2. The timeframe of the project, 18 months, allowed for a large amount of discussion and robust debate on key areas.
3. The design of MDUF v1 is supported by a large amount of academic literature. Academic literature itself goes through a strong review process. Overall there is a foundation of research which supports MDUF v1.
4. The testing of MDUF v1 through developed models (included in the Working Paper) produced results which broadly reconciled with existing research (examples include an estimation of the value of the Age Pension and determination of appropriate age-based percentage drawdown rates for account-based pensions). Broadly all results and implications were considered to be intuitively sensible to the panel.
5. Through further engagement with industry, regulators and policymakers, we have been able to gauge whether there are any gaps or conflicting beliefs in the design of MDUF v1.

6. We are seeking to produce an academic paper and have the MDUF v1 published in an academic journal.

We believe that MDUF v1 has a strong "straw man" role to perform. In this respect super funds could begin with MDUF v1 as the starting point for determining and reflecting default member objectives, from which they could then consider and justify if and how they would step away to their own tailored objective.

What Preferences are reflected in the design of MDUF v1?

As explained previously, the aim of this project was to develop a sensible set of preferences for trustees to assume on behalf of default members. These preferences were then reflected into a mathematical formula. This section focuses on the preferences.

The panel determined that from a retirement outcomes perspective that the following are a sensible set of preferences:

1. Members prefer higher (rather than lower) income in retirement;
2. Members would prefer a smooth rather than a volatile income stream;
3. It would be undesirable for a member to outlive their retirement savings (or the income stream it generates);
4. Members place some value on the residual benefit at death;
5. Members are economically risk averse: this means that the size of the joy experienced from a higher level of consumption is less than the size of the pain experienced by an equivalently sized reduction in consumption.

Our first observation is that a number of these preferences pull against each other. For instance:

- The preference for higher income (1) may encourage high risk taking which runs contrary to the preference for a less volatile income stream (2);
- The preference to not outlive retirement savings (3) may encourage annuitisation, but doing so could guarantee no residual benefit at death (4).

Determining the appropriate trade-off between the different preferences was an important part of the panel's work.

Of the five preferences detailed it is the residual benefit preference which generated greatest debate amongst panel members. In the end the panel agreed that placing some value on any residual benefit was appropriate for a number of reasons including the following:

- There is a distinct risk of dying early in retirement. Assuming one were to retire today at age 65 (according to current life tables): then for a male (female) there is a 1.1% (0.6%) chance of dying in the first year of retirement and a 15.6% (9.9%) chance of dying in the first decade of retirement. In these cases

we believe that it would be inappropriate for a trustee to design a post-retirement solution which places no value on any residual benefit;
- The superannuation system is designed around the individual, not the household, yet over 65% of people retire with a partner. For households with a significant income difference between the two partners the residual account value provides the retirement outcome for the surviving (low income) partner;
- Empirical research suggests that people do place value on the bequest aspect associated with a residual benefit;
- Residual benefit acts as a reserve pool for many life events related to aged care, healthcare, travelling and family.

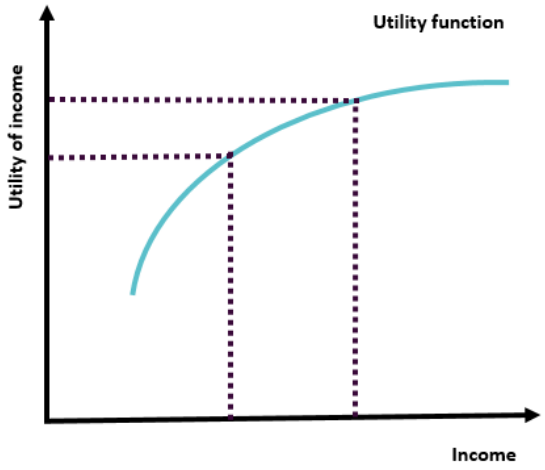
On the issue of residual benefits we note that the design of MDUF v1 is such that the utility of the residual benefit is less than the utility of the income it would generate. This means that MDUF v1 does not encourage a strategy of asset hoarding while living on the Age Pension. This is discussed in more detail in some of the other MDUF papers.

We note that MDUF v1 does not incorporate access to capital (i.e. liquidity) as a preference. There is currently no dominant stream of research on how to incorporate liquidity preferences into a preference function. This would be a valuable consideration in a version 2 project. In the meantime we would advise that super funds consider incorporating formal liquidity limits (modelled through the retirement lifecycle) into their retirement solution design.

How are these Preferences Incorporated into MDUF v1?

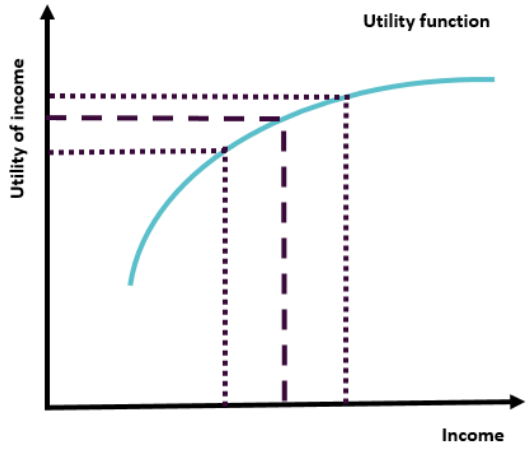
The five preferences detailed in the previous section have been incorporated into MDUF v1 via the utility function design. We use charts to illustrate how these preferences are incorporated into MDUF v1.

1. Higher income generates greater utility:



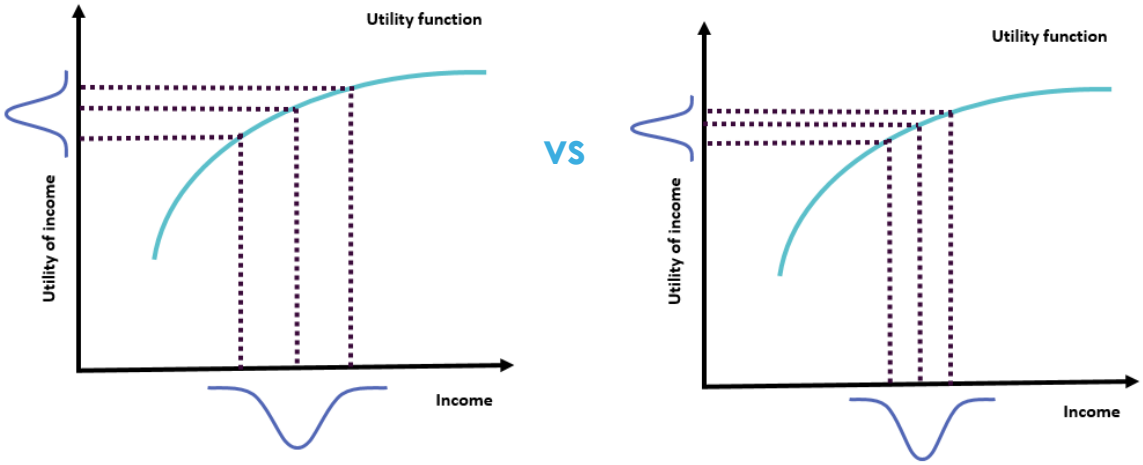
We can see in the chart above that higher income (shifting across to the right) generates greater utility.

2. Members are economically risk averse:



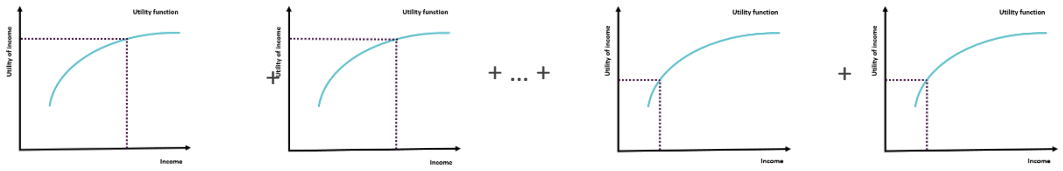
The increase in utility from a higher level of income is less than the loss of utility from an equally sized drop in income. This can be marginally identified along the vertical axis of the chart above. This is due to the curved nature of the MDUF v1. This design feature is supported by substantial empirical research.

3. A less volatile income stream generates greater utility:



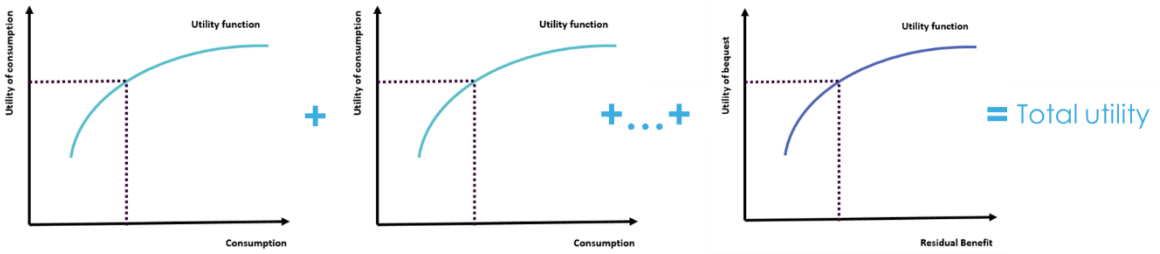
The chart on the right represents a less volatile income stream – the distribution of income is narrower in the right chart compared with the left (we assume the two distributions have the same mean level of income). We have already identified (in (2) above) that, through the MDUF v1, lower income experiences are 'penalised' more heavily relative to higher income scenarios. As the distribution of income scenarios widens the size of this relative penalty becomes larger. The overall expected (or average) utility, the probability weighted sum of utility across all possible outcomes, is therefore lower when, all else equal, volatility is greater.

4. Running out of savings is a poor outcome and results in a large reduction in total utility:



The charts above consider a lifetime of income for an individual who exhausts their retirement savings and lives off the Age Pension for the remaining years of their life. MDUF v1 penalises this possible outcome because, as explained in (2), the additional utility generated from a higher level of income is less than the loss of utility which comes from experiencing some years solely on the Age Pension.

5. Residual benefit at death generates utility:

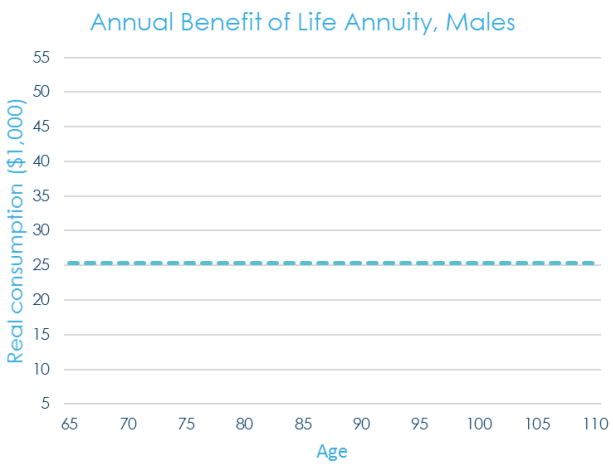


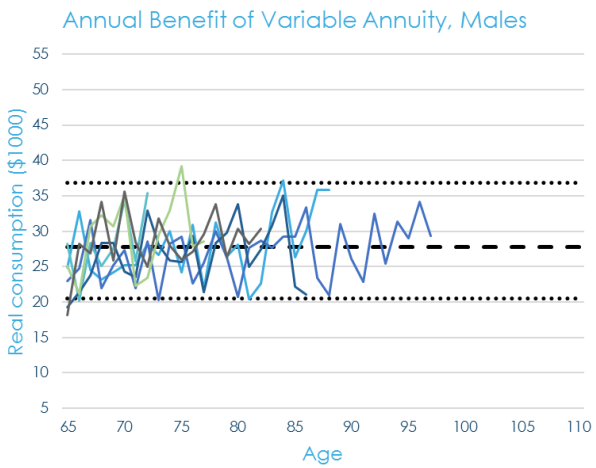
MDUF v1 is specifically designed to acknowledge that any residual account benefit adds to the overall utility measure.

Implications of MDUF v1

With these five preferences incorporated into the utility function, MDUF v1 has important implications in terms of retirement solutions and product design. Here we demonstrate two important conceptual implications.

One implication of MDUF v1 is that we can establish a trade-off between expected level and volatility of income. The two income streams represented below generate equivalent expected utility for a member. Effectively our homogenous, generic default member would be indifferent between these two income streams.

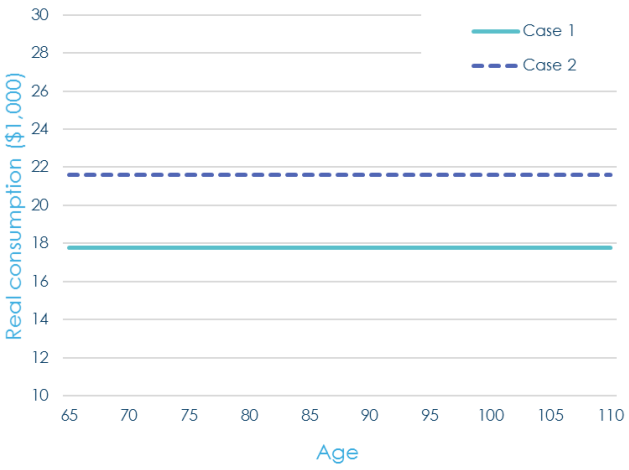


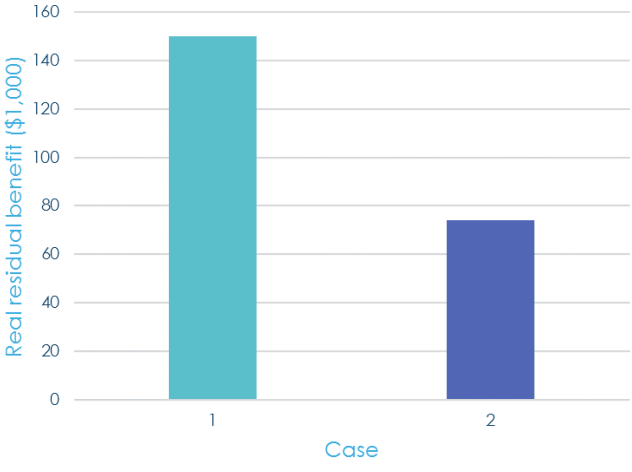


Of the charts above, the left shows a life annuity with a guaranteed for life, fixed inflation-indexed income stream. The right chart is of an income stream which is guaranteed for life but the income payments have some variability. The investor is being rewarded for this greater volatility through a higher expected outcome (dashed line). The two dotted lines represent a 95% confidence interval (so only 5% of yearly income experiences should lie outside of this range). The coloured lines represent some randomly simulated income streams.

It has always been difficult to trade off higher income against variability in income. A considered assessment of this trade-off is incorporated into the design of MDUF v1. Note that the example above is conceptual – it is set up as simply as possible to illustrate the concept. For this reason we assume we are in an environment where there is no Age Pension.

The second implication of MDUF v1 which we illustrate is the ability to identify the trade-off between different combinations of income stream and residual benefit. The chart below illustrates two combinations of (guaranteed-for-life) income streams and guaranteed residual benefit profiles.





The charts above illustrate two combinations of income and residual benefit which generate equivalent levels of expected utility using MDUF v1. Under MDUF v1 our homogenous, generic default member would be indifferent between these two 'products'.

These two examples illustrate the power of MDUF v1. It provides a heavily researched basis for establishing trade-offs between important preferences when designing retirement income solutions.

Of course trustees of some super funds may disagree with some of these implications. The open architecture nature of MDUF v1 allows a super fund to alter some of the parameter values and develop a utility function specific to their super fund.

MDUF v1 – a complex formula

MDUF v1 is a large and complex looking formula. The formula is detailed below:

$$E_0\left[\sum_{t=0}^{T}\left\{{}_tp_x\left(\frac{c_t^{1-\rho}}{1-\rho}\right)+{}_{t-1|}q_x\left(\frac{b_t^{1-\rho}}{1-\rho}\left(\frac{\phi}{1-\phi}\right)^{\rho}\right)\right\}\right]$$

- T: time horizon
- c_t: consumption in year t
- b_t: level of wealth at time t which equals the amount of residual account value if the person dies between $t-1$ and t
- ${}_tp_x$: probability of being alive at age $x+t$ conditional on being alive at age x
- ${}_{t-1|}q_x$: probability of dying between age $x+t-1$ and $x+t$ conditional on being alive at age x
- ρ: level of risk aversion
- ϕ: strength of residual account motive

We encourage the industry not to use complexity as an excuse for not contemplating adopting MDUF v1. Consider the following:

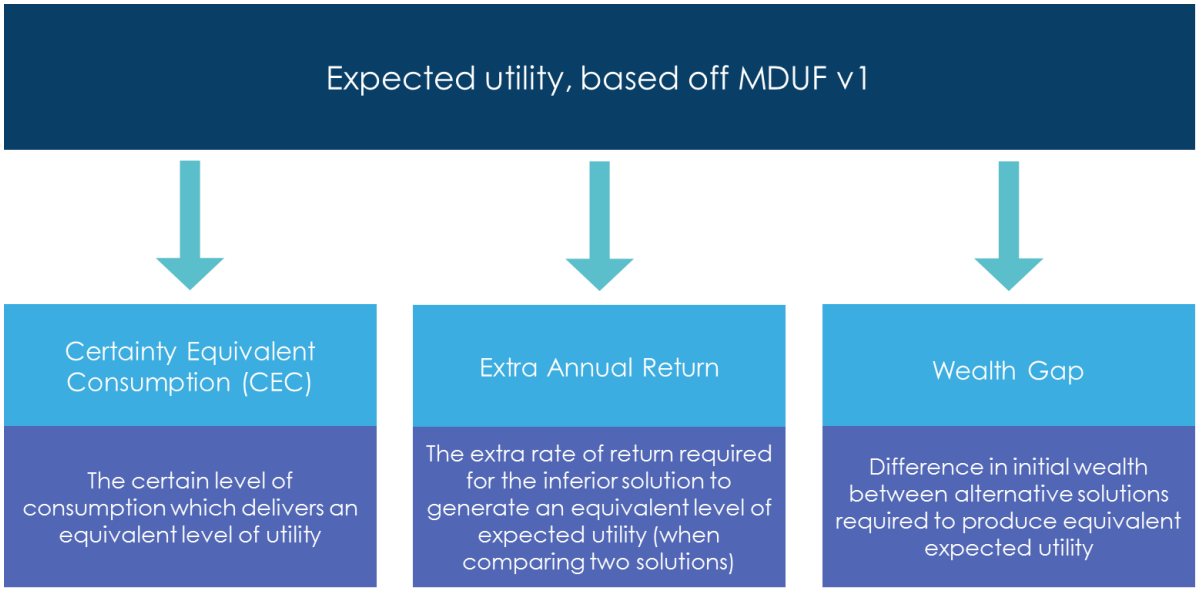
- Many aspects of funds management are highly complex and sometimes that complexity is not recognised because the topic area may have become common practice and is packaged up inside computer programs. An example is the broad approach used to construct investment portfolios. While there are different methods for constructing portfolios, many industry participants use mean-variance efficiency as an underlying foundation. If we were to write out the formulae behind this approach one might be surprised at its apparent complexity (see here for instance).
- Retirement outcomes is a complex problem – it involves a collection of risks which interact, most notably variability in investment and mortality outcomes. The preferences of super fund members are also complex rather than simple. In the case of MDUF v1 we have identified and incorporated five specific preferences which we believe are important. Ignoring any of these preferences to simplify the problem may be to the detriment of members. Added complexity comes from the fact that some of these preferences pull against each other.

— If the complexity of MDUF v1 increases industry recognition and acceptance around how complicated is the challenge of delivering very good retirement outcomes then this is hardly a bad outcome. Funds may strategically plan by creating appropriately skilled internal teams and forming stronger relationships with expert consultants.

Making the Measure of Utility More Understandable

An unfortunate drawback of utility is that the numerical value is not intuitive. First it is an ordinal not a cardinal measure, which simply means that alternative product solutions can be ranked based on utility but we cannot say that solution A is x% superior than solution B. Second, the utility measure is a negative number. This means that in comparing alternative solutions we are searching for the one with the least negative level of utility.

Fortunately there are techniques available to transform the utility measure into alternative measures which are more meaningful. These are detailed below.



The process for creating these measures is detailed in other papers. We note that these other measures enable the cardinal comparisons referred to above.

The wealth gap and extra annual return measures, in particular, are metrics which are readily understandable to all industry participants. A detailed example applying these metrics is included in the some of the other MDUF papers.

Alternatives to MDUF v1

Other retirement outcome metrics exist, but we believe these measures are inferior to MDUF v1. The below table summarises the issues addressed by a collection of different metrics:

Statistic	Income	Income volatility	Longevity risk (outliving)	Residual benefit	Risk aversion
Replacement rate	Considered	Ignored	Ignored	Ignored	Ignored
Shortfall risk	Not explicitly	Ignored	Considered	Ignored	Ignored
Funded ratio	Considered	Not explicitly	Ignored	Ignored	Ignored
Utility function	Considered	Considered	Considered	Considered	Considered

The above table is important for funds considering how to assess retirement outcome design. In choosing appropriate metrics it is just as important for a super fund to acknowledge what they are not incorporating and measuring as what they are incorporating. A definition and critique of each alternative metric is included in APPENDIX 1.

How can MDUF v1 help and be used?

There are many ways in which MDUF v1 can be applied. Here we consider different participants of the broader retirement outcome ecosystem and list some ways that MDUF v1 could be applied. This list is not exhaustive; indeed once you grasp the concept of maximising expected utility you will see that MDUF v1 has many applications.

1. Super funds

It may not be a surprise that we believe MDUF v1 has strong application to super fund and post-retirement solution design! There is nearly an unlimited list of projects in which MDUF v1 could perform an important role. Examples beyond product and solution design include:

- Valuing investment strategies such as portfolio protection and low volatility strategies.
- Estimating the benefits of projects such as personalised accounts (whereby a member's solution is designed based on their personal situation), and digital financial advice strategies.

However we believe MDUF v1 has the potential to perform a more important role within a super fund, that of acting as a guide for the allocation of capital and

resources. Consider that a super fund's objective is to deliver very good retirement outcomes, and that we believe the MDUF v1 is a superior metric for assessing outcomes. A super fund could conceivably make MDUF v1 a core part of their business decisions i.e. a metric used in the creation of business cases. Industry participants are aware of how difficult it is to compare and prioritise projects from different parts of the business. MDUF v1 may provide a framework which can assist and elevate the decision making process of super funds to be more consistent with their own objective.

2. Policymakers and regulators

MDUF v1 is highly valuable for policymakers and regulators. Currently, policymakers use deterministic (i.e. assume the mean expected outcome is achieved) techniques when estimating welfare benefits of policy changes. In doing so they are potentially ignoring the issue of risk: a risky dollar of retirement income and a sure dollar of retirement income be valued equivalently. Other highlighted features of MDUF v1, notably consideration of residual benefits and risk aversion, are features which may not be presently acknowledged by policymakers.

For regulators MDUF v1 raises the bar by providing open architecture access for all industry to a well-considered set of retirement outcome preferences formulated into a metric. Perhaps, as a result, MDUF v1 also has a "straw man" role to play for regulators: maybe regulators could compare how well-formed a super fund's preferences and objectives are against an accessible industry benchmark such as MDUF v1.

3. Investment managers

MDUF v1 provides a great opportunity for fund managers to demonstrate the value of products and services in a manner empathetic with the objectives of their potential clients. In particular, MDUF v1 has strong application in quantifying the benefits of reduced volatility, diversification, and solutions with reduced downside risk profile.

4. Life companies

Life companies can use MDUF v1 to assist in examining and explaining the benefits of their products and as an aid in product design.

5. Super fund ratings groups

MDUF v1 highlights that people have multiple important preferences when it comes to retirement outcomes. Currently the industry and ratings groups are heavily focused on the level of investment returns. Overall solution design as well as risk management also have a significant impact on retirement outcomes. Super fund ratings groups have open architecture access to all of the MDUF v1 materials. It would promote industry change and focus on retirement outcomes were ratings groups to incorporate MDUF v1 into their fund assessment.

6. Industry bodies

Industry bodies produce research which is presented to policymakers but face similar challenges to policymakers (described above) when it comes to assessing

retirement outcomes. Given the integrity of research and preferences incorporated into MDUF v1, it is relevant for industry bodies to consider, where relevant, how MDUF v1 can be used in their research.

7. Academics

There is a substantial amount of academic research that applies utility functions to address retirement outcome research questions. However there remains broad subjectivity over the choice of utility function. MDUF v1 may provide a more standardised utility function accessible to the academic community, particularly for Australian-focused research. The plan to have MDUF v1 published in an academic journal will create a strong foundation for it to be used by other researchers. Academic research which utilises MDUF v1 has a greater likelihood of being understood, hence accepted and applied, by industry. As an emerging trend in universities is to seek more industry relationships, MDUF v1 represents a standardised link between industry and academia regarding retirement outcome objectives.

8. Financial planners

Can MDUF v1 be applied to financial planning? The answer is yes, especially in the technology (pertaining to utility functions) which MDUF v1 brings to the industry. The super fund industry and financial planning industry both face similar problems, notably they commonly err in not considering the range of outcomes that their members / clients may experience. MDUF v1 forces one to focus on the range of outcomes, an important reflection for both industries. A key (current) difference between super funds and financial planners is that planners explore the preferences of each of their individual clients. An exciting future development may be one where financial planners develop individual utility functions for each of their clients.

Conclusion

MDUF v1 is here! We believe it is a superior metric for use in the design of retirement outcome solutions. It captures a number of important preferences that would be sensible and appropriate for a trustee to assume on behalf of their default members.

We highlight the credibility and integrity of this work. It has been a lengthy development process (18 months) involving a large group of high calibre people from industry and academia. Thank you to those people for their contributions. The research is built on the foundation of a large and high quality panel (and associated robust debates), a substantial trail of academic literature, and lots of quantitative modelling.

MDUF v1 has been made available through an open architecture framework. It is now an industry resource. Papers, presentations, models and Q&A are all accessible.

We are proud that both AIST (Australian Institute of Superannuation Trustees) and ASFA (Association of Superannuation Funds of Australia) have agreed to be custodians of this work. They will be working hard to make this research accessible to the industry.

We believe this raises the bar for the Superannuation industry by providing a quality 'straw man' against which to assess the way that funds are determining their objectives and designing retirement outcome solutions. Addressing the retirement outcome challenge is a major issue and collaboration potentially has an important role to play. It is in this spirit that we are excited to be sharing this work with you. We welcome feedback and encourage the sharing of research. We believe, if broadly adopted, that this work will contribute to a better retirement outcome for all Australians.

Appendix 1

Definition of Alternative Retirement Outcome Metrics

Retirement outcome metric	Definition	Critique
Replacement Rate	Measures expected income as a percentage of pre-retirement income. The metric is best applied if it is based on consumption (i.e. after tax and net of savings put aside for retirement).	— Replacement rate only focuses on the average outcome and does not consider the range of possible outcomes, be they driven by variability in investment or mortality outcomes. — Replacement rate ignores any residual benefit. — Replacement rate does not consider that members are risk averse. In fact replacement rate does not really consider risk at all!
Shortfall Risk	The percentage probability of experiencing an income below a threshold level. This metric improves if it is based on a stream of income over a lifetime of uncertain length, and incorporates Age Pension. However it is more commonly based on an assumed date of death and so just captures the impact of investment volatility.	— Shortfall risk is agnostic of the size of any shortfall. For example if a member experienced an annual income shortfall of $10k versus $1k is important yet the shortfall calculation ignores this… a shortfall is a shortfall. — Shortfall risk focuses on outcomes relative to a threshold level. Determining this threshold level is difficult and subjective. By comparison MDUF v1 simply focuses on the best outcome possible. — Shortfall risk ignores any residual benefit. — Shortfall risk does not consider that members are risk averse.
Funded Ratio	This is a popular statistic in other countries which have a stronger DB heritage. It first calculates a targeted level of income in retirement and then estimates the cost of a financial product (i.e. generally a life annuity) to purchase this outcome. The funded ratio is then a measure of, depending on specific definition, what percentage level a member's current account balance is of the estimated retirement cost, or how a member is tracking towards this outcome (including assumed future contributions and investment returns).	— The funded ratio generally ignores Age Pension interaction when calculating the percentage level. This is because other countries have a different social security system to Australia. — Determining the targeted level of income is difficult and subjective. By comparison MDUF v1 simply focuses on the best outcome possible. — Funded ratio doesn't apply well to solution design because its basis is the price of a life annuity. — Funded ratio ignores any residual benefit. — Funded ratio does not consider that members are risk averse.