

report

Validation of the Actuarial Valuation for the Australian Priority Investment Approach to Welfare

PREPARED FOR

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ISSR

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LIST OF ABBREVIATIONS

ABS	Australian Bureau of Statistics
AGA	Australian Government Actuary
ATO	Australian Tax Office
CPI	Consumer Price Inflation
CURF	Confidentialised Unit Record File
DAA	Data Analysis Australia
DSP	Disability Support Pension
DSS	Department of Social Services
ERP	Estimated Resident Population
GLM	Generalised linear model
HILDA	Household, Income and Labour Dynamics in Australia
ISSR	Institute for Social Science Research
MTAWE	Male Total Annual Weekly Earnings
PBLCI	Pensioner and Beneficiary Living Cost Index
PIA	Priority Investment Approach
PwC	PricewaterhouseCoopers
SA1	ABS Statistical Area level 1
SA2	ABS Statistical Area level 2
SA3	ABS Statistical Area level 3
SA4	ABS Statistical Area level 4
UQ	The University of Queensland

EXECUTIVE SUMMARY

Introduction

Consistent with the recommendations of the McClure Review of Australia's welfare system, the Australian Government Department of Social Services is implementing the Australian Priority Investment Approach to Welfare which aims to reduce welfare dependency and to improve the lifetime wellbeing of people and families in Australia. This approach uses actuarial analysis to estimate the future lifetime cost of Australia's social security system. The results of the analysis will inform development of policy interventions for cohorts at risk of long-term welfare dependency to improve lifetime wellbeing.

This report summarises findings from the validation of the first actuarial valuation undertaken by PricewaterhouseCoopers (PwC) in conjunction with Data Analysis Australia (DAA), which forecasts the total lifetime costs of the 2015 Australian population. The validation was undertaken with reference to the scope of the valuation for the Provider and has focused on the specific processes and methodologies that were used to produce the baseline valuation. This included the simulation of the baseline model population, the projection of the welfare utilisation of the population into the future and the actuarial payment and indexation assumptions applied to the model.

The approach to the baseline valuation was validated against five main criteria: reasonableness, technical accuracy, transparency, coherence and adaptability or flexibility.

Summary of findings

The review has concluded that the approach to the baseline actuarial valuation undertaken by PwC is thorough and that the specification for design and analysis of the data to obtain the valuation is of high quality. The five validation criteria were applied to each of the ten methodological stages in achieving the valuation and, conditional on the data available, 80 percent of the criteria were rated as excellent.

Other key findings are summarised below.

- The creation of the model population and the associated projection of lifetime cost is a process that is highly dependent on the quality and completeness of data and this report notes some key areas where the quality of data provided to PwC could be improved for future valuations.
- Overall, the documentation relating to the valuation is good. The information provided in the Valuation Report, the Method Report and the set of working

documents, supplemented by discussion with PwC, was sufficient for the purposes of this review which was undertaken by a team of actuarial and statistical experts. The documentation could be further refined in future valuations to facilitate improved knowledge transfer to the Department.

- The valuation provides a central estimate of the expected future lifetime costs. The PwC Valuation report discusses the inherent uncertainty within the valuation and provides a sensitivity analysis to illustrate the impact of changes in assumptions on lifetime cost. However, inclusion of a quantified measurement for the range of possible outcomes would provide additional confidence in the valuation. We believe that there is a need to investigate and quantify uncertainties, particularly those related to process error.
- One of the key drivers of the lifetime cost is the real discount rate, which is the difference between the discount and indexation assumptions. Consideration should be given to setting the real discount rate on a long-term basis, and not varied by term to give internal consistency between the discount and indexation assumptions.
- The aged pension is by far the largest component of the lifetime costs and while the valuation does show a split of the overall lifetime cost including and excluding the aged pension we believe that the input of actionable activities arising from this work may be made more transparent by reporting overall results and sensitivities both with and without including the aged pension.
- Overall the approach developed by PwC is technically accurate and fit for purpose. Accuracy of the flow assumptions and welfare class movement assumptions could be improved through a refinement of the model specifications and the impact of these refinements on the lifetime cost requires further investigation.
- The modular approach adopted is flexible and adaptable, allowing for future development. We have noted some limitations with flexible specification of time periods.

An actuarial valuation involves the development, selection and application of a complex and independent projection methodology and assumptions determined via a synthesis of historical experience and judgement. A key principle of actuarial valuations is achieving objectivity of method and assumptions: there is intended to be no deliberate under or over estimation of potential costs.

Valuation methodologies and results are potentially open to serious misuse by individuals or organisations that are not subject to actuarial professional standards and do not have a detailed understanding of the model development and intended uses. This risk is exacerbated with the valuation of lifetime costs completed by PwC because it is the first time such work has been undertaken and due to the size and complexity of the actuarial

analysis. This baseline valuation work would be undermined by any misuse and appropriate technical documentation and support material should be provided to the Department to minimise the risk of misuse.

It can be envisaged that at some time in the future the Department may employ its own internal actuaries to take responsibility for similar actuarial analysis. If that is the case, to maintain objectivity of outcomes consistent with standard actuarial principles, we recommend that the Department continues to engage external review of any actuarial work of substance until such time as the Actuaries Institute develops professional standards applicable to such work.

Recommendations

A number of recommendations have emerged from this review and are summarised below. Full details of these recommendations are included in Section 6.

- We recommend that PwC is provided access to a sample of unit record Census data that is larger than the one percent sample. This would allow more accurate representation of important small sub-groups in the model population and valuation.
- Improvements in the specification of models for flow assumptions are recommended to more accurately predict transitions in circumstances of individuals and their subsequent utilisation of welfare. This may benefit from input by experts in the area of life course pathways of socially disadvantaged subgroups.
- We recommend that simulations of the model population and projections into the future are replicated multiple times to quantify uncertainty in valuation estimates for whole population and cohorts of interest. Quantifying and reporting of statistical process uncertainty in the predicted lifetime costs associated with different numbers of replications of the simulated lifetime pathways of individuals would improve confidence in the number of simulations used to produce the valuation.
- The actuarial valuation model relies heavily on access to high quality longitudinal data. We recommend that the Department continues to invest in developing the quality and completeness of the data provided for the purpose of future valuations.
- In order that changes due to changes in economic assumptions are not interpreted as due to policy changes or from other causes, we strongly recommend that assumptions are set on a long-term basis and not routinely changed to reflect current economic conditions. Further, any changes to assumptions should reflect changes in perceptions of long-term economic conditions. To facilitate this we recommend that the assumption setting process be formalised and clarified in a model governance framework. In particular, the roles of the IDC members and the

actuarial consultant should be clearly set out and the process for changes in assumptions be clarified, and any such changes be clearly documented and signed off. This is particularly important given the high sensitivity of the lifetime costs to these assumptions.

- We recommend that the MTAW assumption (and any other indexation assumptions considered in future, such as national minimum wage), be set on a constant long-term basis in order to be internally consistent with the discount rate assumption.
- We recommend that details of the model, together with comprehensive support materials on potential uses and appropriate use of the model is transferred from PwC to the Department to enable future valuations and to avoid misuse. The knowledge transfer process should ensure that the Department has the sufficient knowledge and capability to use the model and model results appropriately.

In addition to these recommendations, considerations for model enhancement have been included in Section 6.

1 INTRODUCTION

The Department of Social Services (the Department) is implementing an investment approach to welfare. The primary aim of the Australian Priority Investment Approach to Welfare is to reduce welfare dependency and to improve the lifetime wellbeing of people and families in Australia. This approach uses actuarial analysis to estimate the future lifetime cost of Australia's social security system and the results of the analysis will be used to develop policy interventions for cohorts at risk of long-term welfare dependency and, in turn, improve lifetime wellbeing and reduce the Commonwealth's future costs. The use of actuarial valuations is consistent with the recommendations of the McClure Review of Australia's welfare system and is a Ministerial priority.

The University of Queensland's (UQ) Institute for Social Science Research (ISSR), in partnership with Deloitte, has been engaged to validate the first two actuarial valuations of the Commonwealth's social security and income support system using the Australian Priority Investment Approach to Welfare. This report summarises findings from the validation of the first actuarial valuation known as the 'baseline valuation' which estimates the total lifetime costs for the Australian population as at 30 June 2015 and was undertaken by PricewaterhouseCoopers (PwC) in conjunction with Data Analysis Australia (DAA).

2 CLARIFICATION OF SCOPE

The validation of the baseline valuation has been undertaken using a stepwise approach to ensure that the methodology of the actuarial valuation, used for each step of the valuation process, is appropriate and that the model developed to provide the valuation results is reasonable for the intended purpose.

The objectives of the validation processes were to:

- Assess the reasonableness of assumptions and parameters used throughout the model;
- Assess how well the actuarial analysis is able to predict the lifetime costs of groups and sub-groups that have high lifetime costs;
- Assess the adequacy and technical accuracy of technical documentation developed by the Provider, including the Methods Report and any additional technical documents.

The validation process did not include reviewing the underlying dataset extracted from the Department of Human Services Enterprise Data Warehouse, reconstructing the analyses already undertaken as part of the actuarial valuation, or testing of alternative statistical or actuarial models to improve the valuation.

The validation of the baseline valuation has focused on evaluating the specific processes that were used to produce the final model valuation including the simulation of the baseline model population, the projection of the population and welfare utilisation into the future using a dynamic micro-simulation model and the actuarial payment and indexation assumptions applied in the models.

Context of the Validation

The Department contracted the Provider to conduct a baseline actuarial valuation and three subsequent annual valuations of the Commonwealth's social security and income support system. The initial scope for the Provider of the actuarial valuation was to

- undertake actuarial valuation design, data analysis and reporting;
- provide actuarial models with the capacity to develop and evolve over time;
- provide estimated future lifetime cost of social security and income support benefits and associated forecasts at aggregate level;
- provide cohort group lifetime cost estimates and associated forecasts;
- provide insight into client cohort behaviour including transfers between benefit types and the extent to which client cohorts move on and off benefits;

- estimate key drivers of future lifetime cost and their respective relative influence, at aggregate level and by segment, including but not limited to:
 - macroeconomic factors, for example, unemployment rate and inflation rate;
 - cohort characteristics including, but not limited to, age, country of birth, Indigenous status, educational attainment level, labour force status, age of initial entry to the social security and income support system, duration on benefit, history of other benefits, and where available, demographic characteristics related to families such as the number and age of children; and
 - past and future policy changes related to payments, programs and services.
- compare the characteristics of benefit claimants and clients in the social security and income support system, at a cohort level;
- further analyse the lifetime cost for specific client groups to inform policy development and operational responses;
- analyse other patterns, trends, characteristics or features identified through the actuarial analysis that are considered relevant to the Commonwealth's social security costs, including the intergenerational transmission of disadvantage;
- evaluate the effectiveness of policy initiatives (related to payments, programs and services) targeting specific cohorts and consequent financial impact;
- manage the project from design to completion, and deliver project components on time;
- transfer knowledge, models and support materials to the Department to enable future valuations of the Commonwealth's current and future liabilities under Australian social security system; and
- maintain a constructive relationship with the Department, adhere to the highest standards of probity and professionalism, and deliver work of excellent quality.

3 METHOD FOR VALIDATION

The approach to the validation of the baseline valuation focused on applying actuarial expertise within a project framework informed by academic and statistical rigour as outlined below. These steps will be repeated for the validation of the 2016 actuarial valuation, with a focus on refinement and amendment as applicable.

3.1 APPROACH TO ACTUARIAL VALUATION

An initial peer review of the approach to the creation of the model population and decisions made for producing the valuation was undertaken from an actuarial and statistical standpoint.

The review assessed:

- the principles, methods and parameters used to develop the underlying baseline data;
- the approach to annual projections of the population;
- the interaction of assumptions, and assumptions that may be missing or incorrect;
- specification of dynamic statistical models for estimating transition probabilities;
- the approach to dynamic micro-simulation of population data and benchmarking;
- consideration of uncertainties in underlying data, projected data, simulated data, and estimated lifetime costs; and
- the realisation of the potential of an Investment Approach in the current actuarial valuation.

The initial review was an opportunity to critically engage with the paradigm used by PwC, prior to reviewing the detailed steps within the methodological framework. The method refers to the process for simulating the model population data, specifying the model parameters, developing the assumptions, projecting forward and summarising the expected welfare payments. The review process was facilitated by regular correspondence with the Department, ISSR and Deloitte via teleconference and face-to-face meetings. Clarification of the data, methodology and assumptions adopted in the original valuation was sought through consultation with PwC in an effective and cooperative manner.

The application of the validation criteria focused on the assessment of three primary components outlined below:

- a) the reasonableness of the assumptions and parameters used throughout the model ;
- b) how well the actuarial analysis is able to predict lifetime costs;
- c) the adequacy and technical accuracy of technical documentation.

Consideration was given to:

- the process for creating individual records representing the entire Australian population as at 30 June 2015;
- the use of existing evidence about the social, demographic and economic trends of individuals (e.g. demographic trends in population growth and historical trends in welfare dependency);
- specifications of statistical models used to estimate the transition probabilities for dynamic characteristics associated with welfare utilisation;
- the formulation of the dynamic micro-simulation model used to project the future circumstances and characteristics of the closed Australian population; and
- the assumptions related to future annual payments and indexation.

This included an assessment of the formulation of the final statistical models used and the inclusion of relevant predictor variables reflecting individual, demographic and family characteristics as well as justification for the exclusion of missing predictor variables. Consideration was also given to eligibility for payment types under different circumstances.

3.2 SPECIFICATION OF VALIDATION CRITERIA

In the validation of the baseline valuation, the term 'validation' was applied in context of the quality of the approach and specifically to the 'fitness for purpose or usefulness of information produced' (Baffour, King, & Valente, 2013; Brackstone, 1999; Herzog, Scheuren, & Winkler, 2007; Montgomery, 1991). This is the standard definition used for the validation of a dynamic micro-simulation model (Caldwell & Morrison, 2000; Harding, Keegan, & Kelly, 2010) which is a large component of the approach taken for modelling the actuarial valuation.

By defining quality in regards to the 'fitness for purpose', it becomes possible to produce tangible measures of quality that are directly related to the 'usefulness' of the final model results. More importantly, however, we can characterise quality through specific attributes or criteria, and these criteria can be used to validate or assess the quality of the final model results.

The criteria for consideration in the validation process used here are:

- a. Reasonableness,
- b. Accuracy,
- c. Transparency,
- d. Coherence, and
- e. Adaptability/Flexibility.

These criteria were selected following a review of the literature. In consultation with the Department, they were further refined to suit the unique purposes of the actuarial valuation. The validation criteria were used to systematically assess the methodology and assumptions of the valuation processes against the aims, objectives and original project scope.

This report accords with the Code of Professional Conduct issued by the Actuaries Institute and to the extent relevant Professional Standard 315 which relates to external peer review of general insurance liabilities.

3.3 APPLICATION OF VALIDATION CRITERIA

The method used for the baseline valuation can be broadly described in ten steps:

Step 1: Development of a data set which represents the Australian population at 30 June 2015. This was achieved in two steps: creation of the synthetic population followed by creation of the model (baseline) population.

Step 2: Segmentation of welfare recipients into classes.

Step 3: Simulation of the future lifetime pathways of each person in the model population using a dynamic micro-simulation model conditional on attributes in previous year.

Step 4: Development of assumptions to project future circumstances and characteristics of each person in the population.

Step 5: Development of assumptions to estimate the probability of each person receiving welfare in each future year.

Step 6: Development of assumptions to estimate the future annual payments for each person who receives welfare.

Step 7: Development and application of adjustments to the assumptions.

Step 8: Development of indexation assumptions to index the payments made in future years.

Step 9: Summary of valuation results from the projection module.

Step 10: Uncertainty and sensitivity of the valuation.

Step 3 above represents the specification of the over-arching projection model encompassing the steps 4-8. The projection model contains components that rely on complex assumptions and the method for developing each of these assumptions has been considered separately as a step in the valuation process. Each of the ten methods steps were validated for quality and fitness for purpose using the five criteria. The objective of each step was identified and the approach taken by PwC to address the objective was summarised. The strengths and limitations of the approach were identified against the relevant validation criteria. The assessment of each step taken concludes with a set of suggestions and recommendations where applicable. Appendix I maps the valuation steps to the process modules and knowledge store files.

3.4 VALIDATION FINDINGS

Following the application of the validation criteria to assess the ten methods steps set out in the actuarial analysis undertaken by PwC, the validation findings are summarised to provide an overview of the strengths and limitations of the assumptions and parameters used through the model. This includes the implications of the identified shortcomings in the actuarial analysis and recommendations for remediation if applicable and advice on the usability, accuracy and transparency of technical documentation relating to the actuarial analysis and valuation of the social security system.

4 APPROACH TO THE ACTUARIAL VALUATION

The approach to the actuarial valuation uses statistical methods and dynamic micro-simulation models to create the model population and to project the lifetime welfare pathways of all individuals in the population. Financial projections are then made to estimate the future lifetime cost of Australia's social security system for the model population.

The validation process was facilitated by an initial meeting with the Department on 21 June 2016 followed by regular correspondence via weekly teleconferences including the Department and ISSR-Deloitte. The ISSR-Deloitte team undertook an initial review of the Valuation Report and the corresponding Methods Report prepared by PwC. Several meetings were arranged with PwC to obtain further documentation and detailed information on the statistical and actuarial components of the model, and to discuss and clarify outstanding queries. To assist with the validation, PwC provided the ISSR-Deloitte team with a set of working papers and exhibits that have been used to share information about the model development between the Provider and Department. It was agreed with the Department that validation of the SAS code used to implement the model for the actuarial valuation was not required.

ISSR reviewed Steps 1 to 5 of the valuation process including the creation of the model population and the dynamic micro-simulation model. Deloitte actuaries reviewed the actuarial assumptions related to the simulation of annual payments, payment indexation and adjustments in Steps 6 to 8. The ISSR-Deloitte team together provided the validation findings arising from these reviews.

The models developed and applied in the valuation process included hundreds of individual assumptions and therefore it was not possible to review or validate each and every one. However, the relevant sets of assumptions were reviewed and a broad philosophy was taken to their validation, including consideration of the appropriateness of the data used and model specification.

5 SPECIFICATION OF VALIDATION CRITERIA

The validation criteria used were:

- a. Reasonableness
- b. Accuracy
- c. Transparency
- d. Coherence
- e. Adaptability/Flexibility.

In the context of the actuarial valuations, the **reasonableness** of the model and resulting predictions refers to the degree to which the information produced as part of the model approach meet the needs of the Department, and other users and stakeholders. This is particularly important given the ever-changing policy context and national situation. This reasonableness is assessed in conjunction with the intended purposes of the approach, and as such involves a number of broad activities, for example, checking the reasonableness of the processes used to create the in-scope model population, the projection of the population into the future and the feasibility of the assumptions. This includes the particular strengths and perceived weaknesses of the approach, and also any processes to mitigate against these weaknesses.

The **accuracy** of the model approach refers to the degree to which the model outputs describe the phenomenon of interest (here the total lifetime costs associated with an individual's interactions with the welfare system). Accuracy concerns reliability, precision and robustness, and is usually characterised in terms of uncertainties. These uncertainties can be systematic (e.g. variation in model assumptions, policy environment or international factors), or non-systematic (e.g. sampling, simulation and modelling errors). In reality, the precise measurement of any phenomenon is unattainable due, primarily, to the fact that no measuring instrument is perfect, and secondly, that it is impossible to correct for all sources of error. Therefore, the accuracy of the final model results will depend on the explicit methods and procedures put in place to identify and control for any uncertainties that occur throughout the actuarial valuation process, from inception to fruition and across the different modules.

The **transparency** of the model approach reflects the manner in which information regarding the actuarial valuation has been conveyed. Transparency, in this context, also refers to the ease with which information on the processes can be ascertained. Related to this is the availability of different mediums (both technical and non-technical) in which the information can be provided, to suit a wide variety of users.

The **coherence** of the model approach reflects the degree to which the final model outputs can be collated with other existing summary information. Theoretically, this concerns conceptual integrity, and can be assessed through considering how the results align with information from a broader analytical framework. In this context, coherence refers to the degree of agreement with external information, such as demographic data from the Australian Bureau of Statistics (ABS), actuarial data from the Australian Government Actuary (AGA), and economic and financial data from the relevant Commonwealth departments.

The **adaptability** or **flexibility** of the approach refers to the degree to which the valuation framework is easily applied in future, without the need for technical expertise and to accommodate changes in assumptions.

These five criteria are inter-related, and actions to improve one criteria could have an adverse impact on the others. As a consequence, any assessment or validation of the quality of the actuarial valuation needs to examine the five criteria together.

6 APPLICATION OF VALIDATION CRITERIA

In this section of the report the validation criteria are applied to each of the methodological steps undertaken by PwC in the actuarial valuation of the social security system. The validation for each step is structured in a similar manner, beginning with the objectives, followed by an outline of the processes undertaken to address the objectives. The strengths of the processes and considerations for future enhancement of the valuation model are discussed with regards to the validation criteria elaborated in the previous Chapter 5. The strengths of the valuation methodology against the validation criteria are summarised in Table 7.1.

6.1 DEVELOPMENT OF A DATA SET WHICH REPRESENTS THE 2015 AUSTRALIAN POPULATION

The actuarial valuation includes an estimation of all future welfare payments to a closed population of Australian residents. The population is closed in the sense that new individuals cannot enter the population following the baseline valuation date. This enables the projection of the future lifetime costs of all individuals in the population as of 30 June 2015. The concept of a full population model is a pivotal aspect of the valuation method and hence the valuation method begins with the development of a baseline dataset.

6.1.1 Objective

The aim of this first step was to create a complete dataset that represents the full population of Australia at 30 June 2015. This dataset should have three main features. First, it should reflect the full (in-scope) population of Australia. Second, it should include comprehensive information on individuals who have recently received welfare payments as well as those who have not previously received welfare. Third, the dataset records information at the individual level with one unit record per person. This baseline information provides a starting point for the method to project the welfare path of each individual through their lifetime.

The definition of the in-scope population is the estimated Australian resident population as at 30 June 2015 which is comprised of current Australian citizens, permanent residents, recent migrants and temporary residents. There was agreement between the Department and PwC that the model population should include all current residents and any current welfare recipients residing overseas.

6.1.2 Approach taken by PwC

There were two stages to the creation of the baseline dataset. The first stage was concerned with creating a synthetic population dataset which is the simulated unit record data for the in-scope population of Australian residents, defined as all individuals living in Australia, or residing overseas, at 30 June 2015. The second stage produced the model population dataset, which replaced the synthetic population with administrative data for people in receipt of Commonwealth welfare payments. The combined datasets therefore included actual data for current and recent welfare recipients and representative data for the rest of the population.

In providing the data used for the valuation, the Department of Social Services scrambled the personal identifier attached to each record as well as excluding certain information such as names, detailed address information, and Australian Business Numbers.

a) Synthetic population creation

At the time of the development of the baseline dataset for the actuarial valuation, there was no fully comprehensive unit record dataset available that represented the in-scope population (of Australian residents on 30 June 2015). Therefore, the creation of the synthetic population was achieved as follows:

- Sample census – A 1% confidentialised unit record file (CURF) sample from the 2011 census was used as a base to develop the synthetic population dataset.
- Expansion – This 1% sample was expanded to include a simulated record for every individual.
- Undercount Adjustment - The expanded population was adjusted to the 2011 estimated resident population, through correcting for those missed in the census, and those usually resident in Australia who were absent on census night. This was achieved using the ABS Estimated Resident Population.
- Timing Adjustment – The 2011 estimated synthetic resident population was then aged forwards to 2015, accounting for net migration and deaths. This shifted the profile of the 2011 population by age, gender and location to the 2015 population profile.
- Data Enhancement – A number of key characteristics were either not available (e.g. Indigenous status) or had limited detail (e.g. age in 5 year bands instead of in single age years, lack of low level geographical information) in the expanded 2015 synthetic resident population. An imputation algorithm was therefore used to replace missing information on these variables in the population dataset, with more detail obtained from summarised Census data. For these enhancements TableBuilder (the ABS software product used to create customised tables from ABS census and other survey data) was used to summarise data representing

relevant variables in the 2011 ABS Census to identify the distributions of missing or incomplete population characteristics, namely Indigenous status, age and geographical location in the synthetic population.

- Indigenous Status - Indigenous status was not initially available in the 1% CURF. Instead ancestry information was available (categorised as: "Australian Aboriginal ancestry", "Other Oceanian ancestry", "Other Australian ancestry", and "All Other ancestry"). Using TableBuilder summary information, imputation probability rules for Indigenous status based on ancestry information were determined. Indigenous status imputation probabilities for each level of ancestry were scaled according to geographical location, age band, gender and income range with the aim of obtaining a distribution similar to that provided by the TableBuilder summary data. The outcomes were derived distributions of Indigeneity by geographical location, age band, gender, income range and ancestry level. Where Indigenous status was not available, the possible outcomes were uniformly spread within appropriate groupings of these variables.

This approach produced a unit record file of the synthetically created, representative population, including age (in single years), gender, and geographical location (SA2 location), as well as Indigenous status, labour force status, student status, income, need for assistance, disability status, carer status, educational attainment (school and non-school/vocational), citizenship, and number of children.

b) Model population creation (baseline population)

Following the creation of the synthetic population, the next procedure was to produce the model population. This was achieved in several stages as described below:

- The model population was developed from the synthetic records of the 2015 estimated resident population combined with the latest DSS administrative data for people in receipt of Commonwealth payments (PIA longitudinal social security administrative dataset).
- An algorithm was created which replaced records for artificial people in the synthetic population with records of actual people in receipt of Commonwealth welfare payments. Data recorded for each individual in receipt of welfare payments were used to substitute a synthetic record in the 2015 estimated resident population dataset.
- This replacement algorithm determined which individuals to replace and did so through matching records from the DSS administrative dataset with the synthetic dataset on an initial set of variables. If a match was found on this initial set of variables, it was set aside as 'first pass'; for each subsequent 'pass' a different subset of the initial set of variables was considered as the next most appropriate

subset of variables for matching, and the matched individuals were set aside yet again, until all individuals in receipt of Commonwealth payments were matched with a unique individual in the 2015 estimated resident population dataset. The individuals in the 2015 estimated resident population dataset were then replaced by their PIA longitudinal social security administrative dataset matched counterparts. The objective of this replacement process was to ensure that both the component for people in receipt of Commonwealth welfare payments and the residual non-welfare recipients' component of the final population retained a realistic profile in terms of the important demographic characteristics.

- This produced a unit record dataset which contained individual characteristics, as well as details of payments and social security benefits for those who have been in receipt of Commonwealth welfare payments.
- A number of variables (e.g. educational attainment) within the PIA longitudinal social security administrative dataset had a considerable amount of missing information. For these records the missing values were replaced by the value in the corresponding synthetic population dataset record which was matched with the administrative record in the PIA longitudinal social security administrative dataset (as described above).
- It was important to identify recent exits from the welfare system (people who exited within the last three years) as this is an indicator of likely future welfare utilisation.

Finally, to ensure that the profile of the final model population resembled the profile of the estimated resident population, adjustments were made to calibrate the model population to have the same composition in terms of key demographic characteristics. This was achieved through comparing the merged population summarised by several characteristics (for example age, gender, Indigenous status, geographical location and income) with ABS information from the ERP 2015. This baseline dataset forms the model population referring to the full resident population of Australia, which represents the population at the valuation date (30 June 2015) and contains individual person records for all current and previous welfare recipients, as well as all potential future welfare recipients.

The model population consists of 23.9 million people (including overseas residents who are currently receiving welfare payments (0.1 million)), of which 8.00 million are current welfare recipients (33.5%), 3.91 million (16.4%) are previous welfare recipients, and 11.95 million (50.1%) are other Australian residents, see Table 1 (page vi in the Valuation Report).

It is this dataset which was projected forwards to produce the actuarial valuation of the social security and income support system, and therefore this model population, and its associated assumptions, is central to the validation approach.

In the model population, welfare recipients (past and current) were represented by data from the PIA longitudinal social security administrative dataset (both actual and imputed) while for future welfare recipients, representative data from the rest of the population was obtained from the synthetic population (based on the estimated resident population).

6.1.3 Strengths

- The whole of population approach combined with individual unit level information allows the projection of every individual's lifetime costs associated with family, and personal circumstance. This enables the capture of future welfare costs for individuals in the population who are not currently in the welfare system.
- The use of a random sample of confidentialised unit records from the census is a standard and acceptable practice in microsimulation studies for building a simulated population.
- The synthetic population is an expansion of the 1% CURF sample of the 2011 ABS census and the accuracy of the simulated population relies on the ability of the expansion method to recreate an accurate representation of sub-populations of interest. Potential inaccuracies in the expansion and subsequent projection to 2015, were partially compensated by adjusting to external benchmarks and summary data from the ABS by aligning the synthetic population to the ERP on 30 June 2015. Additionally, formal validation checks were applied by PwC to compare the synthetic population to the ABS census summary data.
- The combination of the PIA longitudinal social security administrative dataset and the synthetic census population dataset provides valuable insights into historical movements into and out of the welfare system.

6.1.4 Considerations for Enhancement

- The 1% CURF for the ABS census data is limited in the number of variables recorded and the absence of detailed information on some variables. For example, Indigenous status is absent, and age is categorised in five year bands. While it is acknowledged that the 1% sample is the only census CURF data made available for analysis, that is representative of the entire Australian population in 2011, access to the larger 5% sample would improve the presence and representativeness of small sub-groups of welfare-dependent people in the population, if it were available.
- Other variables such as country of birth and geographical location are present in the 1% census CURF in limited detail only. Imputation procedures were used to simulate the level of detail required for the synthetic population, based on summary information from the complete ABS census. The imputation algorithm used to enhance the model population ensures that all individuals, including both

welfare recipients and non-welfare recipients, retained a realistic profile in terms of key demographic characteristics (for example, age, gender, Indigenous status). The imputation process and algorithm used was complex, and there were a number of ad hoc decisions involved when choosing between multiple donors. More information about the definition of 'similarity' and any decisions around how missing information was dealt with is necessary for future model maintenance.

- The lack of key characteristics such as Indigenous status in the 1% census CURF could be problematic in terms of internal consistency. Indigenous status has been found to be remarkably variable between censuses (O'Donnell and Raymer, 2015). Since Indigenous status is an important characteristic that is related to welfare dependence, and was imputed for the model population, an investigation of the consistency of Indigenous status should be considered in subsequent valuations. Unless there is a specific adjustment made, the evidence shows that there could be as much of a discrepancy of 10%. Any processes in the valuation models using Indigenous status will be influenced by this inconsistency in Indigenous identification. One way to improve on this source of internal consistency is through access to a larger sample of ABS census CURF.

6.1.5 Assessment of Validation Criteria

6.1.5.1 Reasonableness

The steps and processes followed by PwC to produce a dataset which represented the whole of the Australian population at 30 June 2015 were reasonable.

6.1.5.2 Technical Accuracy

We have not undertaken a complete technical review of all algorithms used in the simulation of the model population. The approach taken to expand the 1% CURF of the census data to simulate the 2011 population and then to project this to the 2015 model population, appears to be technically valid based on the documentation provided.

6.1.5.3 Transparency

The set of working papers and exhibits shared by PwC gave detailed descriptions of the data sources, assumptions and methodology for creation of the model population. However, the process for imputation of missing data has not been clearly described in the report or working papers.

6.1.5.4 Coherence

The use of ABS population and demographic data in the development of the model population dataset implies that there is generally internal and external coherence with the estimated resident population to the extent possible with the sample data provided. Internal consistency of small sub-groups of the population that are not well-represented in the 1%

census CURF data may be compromised, for example, ethnic minorities. This could be improved by facilitating the provider with access to a larger sample of ABS census CURF, for example a 5% sample.

6.1.5.5 Adaptability/Flexibility

The approach and methodology used to produce the final model population dataset, the assumptions, development and decision processes through collaborative model design between the Department and PwC are sufficiently adaptable and flexible for future implementation of the actuarial valuation.

6.1.6 Suggestions and Recommendations

It is suggested that collaboration with ABS be further developed by the Department to explore the possibility of using the 5% sample census CURF to simulate the synthetic population. This would enable more accurate simulation of population data and improve representation of small population sub-groups, for example, people who identify as Indigenous Australians.

6.2 SEGMENTATION OF WELFARE RECIPIENTS INTO CLASSES

Previous experience and research provides evidence that past and current receipt of welfare is a strong predictor of future receipt of welfare. People with certain personal circumstances, household characteristics and family information will exhibit similar welfare utilisation patterns. Therefore, welfare class groupings were defined to reflect each individual person's life situation and their utilisation of welfare.

6.2.1 Objective

The segmentation of the population into welfare classes was designed to enable the examination of key drivers and influences for broad categories of welfare utilisation.

This second step, referred to as the model population segmentation (6.2 Segmentation of welfare recipients into classes), in combination with the first step (6.1 Development of the Model Population) forms the 'population module' (see Appendix I). The population module is designed to produce data that is representative of the full Australian in-scope population and capture the welfare utilisation of individuals in the population. It is used to generate an individual dataset with records for all existing welfare recipients as well as all potential future welfare recipients.

6.2.2 Approach taken by PwC

Each individual was assigned to a unique welfare class each year. This is to accurately reflect the fact that an individual's welfare utilisation is related to their different life

circumstances and stages, and this can vary from year to year. There are twelve welfare classes to which a person can belong.

A two key grouping structure was used for the model design:

- a. Class variable: groups the population into unique segments.
- b. Payment category: groups welfare payments into categories.

a) Class variable – segmentation of the model population

The class variable provided a description of how the model segmentation categorises the population into the twelve welfare classes. These twelve welfare classes were arranged into three groups (active-income support; active-non-income support; inactive) and are summarised below:

- Active – Income Support: 1. Studying; 2. Working Age; 3. Parenting; 4. Carers; 5. Disability Support; 6. Age Pension
- Active – Non-income Support: 7. Family; 8. Carer; 9. Other
- Inactive; 10. Previous welfare recipient; 11. Dead; 12. Rest of Australian Population.

These classes were defined by reference to the welfare types being currently received. However, the welfare types were grouped so that the classes are more a reflection of the individuals' life situation than the actual payment structure they were accessing through the welfare system.

There are some specific rules and considerations when assigning each person to a class:

- The classes are mutually exclusive and a person is assigned a unique class each year.
- These classes are defined in reference to the welfare received in the last year.
- Classes are a reflection of individual's life situation, past experiences and characteristics.
- A move from one income support class to another income support class during the year will be immediately reflected in an individual's class status.
- A move from a non-income support class to an income support class will also be reflected immediately in the individual's class status.
- Exits from an income support class to a non-income support class during the year will not be reflected as a change until the following year.
- Exits from the welfare system i.e. from income or non-income support to the welfare classes 10 (previous welfare recipient) or 11 (dead) are not reflected as class moves until the next year.

- More information on the specific rules and considerations surrounding the mapping of payment types and categories with welfare classes is provided in Appendix A of the Method Report.

b) Payment categorisation: grouping of in-scope payments for the model population

To provide a mapping of how the different payments align with the twelve welfare classes, PwC and the Department worked together to define which payment types were in-scope. There were around 100 payment types in the data and 80 were determined to be in-scope. These were determined to represent the majority of payments.

The list of payments considered to be in-scope, and therefore included in the model valuation are provided in Table 6 and Table 7 of the Valuation Report. Some out-of-scope payments are veterans' payments, aged care benefits, and payments under the National Disability Insurance Scheme (NDIS)

These in-scope payment types were grouped into 17 broader payment categories and the existence of a payment received by an individual was considered for modelling the movement between welfare classes.

The categorisation was intended to achieve a balance between the model valuation being able to capture different features of each payment type and the costs associated, and the costs of having the additional complexity of more payment categories in the model.

A number of criteria were followed:

- In-scope payments cover 'those for which the Department has policy responsibility at the valuation date'.
- Out-of-scope payments were defined as those that were not the policy responsibility of the Department, including those administered by the Department.
- The Department makes a broad range of payments, and each type of payment serves a different purpose, and provides support for different segments of the population.
- The factors associated with each payment and likelihood of utilising each payment are different.
 - It is theoretically feasible to model each payment separately, but this was considered to be too complex for the proposed purposes and can be inefficient in terms of cost and time.
- There are 17 payment categorisations (7 income support; 10 non-income support).
- These payment categories are used to model the current social security system, but the categories are flexible to reflect future changes in the design of social security system.

- The categorisation was used in modelling both the utilisation of each payment category and actual payments.
- These welfare payment types were mapped onto the welfare class segmentation variable through specific criteria.
- This information is fed into the welfare utilisation module. The module was used to develop the assumed probability of each individual in the population receiving welfare in each future year. This probability is estimated for both the existing welfare recipients, and the wider population.
 - This welfare utilisation is modelled separately for each payment category
 - In 2014/15 the 17 payment categories represented a cost of \$108.8 billion (with two-thirds spent on income support payments (\$73 billion)).
 - Again, it is worthwhile to note that whilst people are in a single class for each year, they may receive payments from a number of different payment categories during the course of the year.

6.2.3 Strengths

- The classes make sense, are stable, and are driven by individual circumstances rather than the payment categorisation itself.
- The segmentation approach, in combination with the full Australian population dataset, can be used for targeted analysis of groups and identification of people with similar circumstances, characteristics and demographic attributes who are not receiving welfare payments, in comparison with those who are in receipt of welfare payments.
- The inclusion of the 'rest of Australia' as a separate class allows the valuation to include future experience: someone aged 25 years old not on the system could eventually go on to age pension in approximately 40 years' time.
- The segmentation into classes and payment types provides useful information on understanding the dynamics of how people move into, move through, and move out of the welfare system.

6.2.4 Considerations for Enhancement

- Welfare segmentation - Class assignment is made based on the most recent payment categorisation, however, this could be extended to include length of time in receipt of the payment, to better capture the extent of welfare utilisation in the same class.
- It was highlighted that the segmentation and payment mapping involved the assignment of entitlement codes (from 178 individual datasets produced by the Department) into unique combinations of payment categories. The validation and quality assurance checks by PwC identified some errors, and involved a number

of ad hoc processes to correct for these errors. A more simplified process by the Department to creating a smaller number of (larger) datasets and increased automation will reduce the process errors introduced through merging and manipulation of multiple datasets.

6.2.5 Assessment of Validation Criteria

6.2.5.1 Reasonableness

Overall the approach adopted in the segmentation of the model population into mutually exclusive welfare classes is reasonable given the large number of potential payments and the need to reduce the number of categories to better understand movements among welfare classes. The chosen method of categorisation has achieved a balance between the valuation being able to effectively capture movement between welfare classes defined by different eligibility and payment features, and the additional complexity of a larger number of payment categories for the class assumptions.

6.2.5.2 Technical Accuracy

We have not undertaken a full technical review of the algorithms used, but the review of the materials provided, and consultation with PwC suggest that the approach undertaken for the segmentation is technically sound. Furthermore, appropriate validation processes to verify the model outputs and results through internal peer review by the Department, DAA and PwC have been detailed.

6.2.5.3 Transparency

The shared working papers provide a very good overview of segmentation processes and design decisions.

6.2.5.4 Coherence

A number of validation processes were used to ensure internal and external coherence in the model population after segmentation of welfare recipients into classes, and over time. This was facilitated through reconciling the entitlements data against known summary expenditure information on the administered social security payments and benefits. Further reconciliation was undertaken against historical expenditure data.

6.2.5.5 Adaptability/Flexibility

The rationale for the design of segmentation classes and mapping of payment types and categories have been made with full consideration of the scope, purpose and context of the valuation approach. The classification into past and current welfare recipients is adaptable and flexible for future validations since it provides a better reflection of the influences of past experience on current and future welfare circumstances.

6.2.6 Suggestions and Recommendations

- It is suggested that more detailed welfare payment information will allow the better categorisation of welfare utilisation. For example, there is currently not enough information to distinguish individuals receiving ABSTUDY payments from those receiving other study related payments. It is anticipated that there are different circumstances and behavioural characteristics that influence the trajectories of people on these two payment types.
- The 'rest of Australia' (class 12) comprises over 50% of the population and is categorised by one single class. Despite having the lowest future lifetime costs per person, this class accounts for approximately 40% of the total lifetime costs for the full population. Over half of the model population is not in receipt of welfare payments at the valuation date. It is possible that sub-groups of this 'rest of Australia' class move into and out of other welfare classes at different rates and therefore further partitioning of this portion of the population may improve the accuracy of the class movement assumptions. . For example, spatial regions and co-located industry sectors are associated with the types and availability of employment to individuals residing in the region, and also with access to higher education. Vulnerability of regions to sectors of the economy, such as the agricultural and mining sectors, will influence employment opportunities and the duration of unemployment. Different locations of residence may therefore impact on the rates of movements in and out of other welfare classes for individuals with similar risk factors. Stratifying the 'rest of the population' class by geographical location, and investigating rates of class movement for each stratum, for example by broad labour market regions, may lead to a more refined partitioning of the 'rest of Australia' for the purposes of valuation and targeting of interventions.

6.3 SIMULATION OF FUTURE LIFETIME PATHWAYS

6.3.1 Objective

To estimate the lifetime cost associated with the entire population or segments of the population, it was necessary to project the welfare payment pathway for all individuals in the model population from the valuation date and then subsequently aggregate the welfare payments received throughout their lifetime.

In this stage of the valuation, the projection module, the future pathway of each individual in the model population was projected forwards, using a dynamic micro-simulation model that reflects the circumstance and life situation of all individuals, conditional on circumstances and characteristics in the previous year.

6.3.2 Approach taken by PwC

The cornerstone of the valuation method is the projection module which facilitates the annual projections of the model population. This module utilises a dynamic micro-simulation model to simulate the future lifetime pathway of each person in the model population (baseline dataset) through the annual evolution of the population. This takes each individual in the model population and ages them forwards over the remainder of their natural lifetimes (which is capped at 110 years of age). The circumstances and characteristics of each individual, including the likelihood of welfare payment receipt and the associated annual payment, were projected for each future year from the valuation date, conditional on the value of all measured attributes from the previous year. The simulation model predicts the transitions in selected characteristics for each individual, in each year, and uses the individual's personal circumstances to influence future transitions. For example, the projection of the 2016 population was conditional on the attributes of each individual recorded in the baseline dataset representing the model population at 30 June 2015.

The subset of time-variant attributes simulated from year to year includes:

- Age;
- Mortality status;
- Partnership status, basically partnered or single;
- Children, number and ages;
- Education status;
- Payment category;
- Utilisation of each payment category; and
- Derived variables such as duration in class.

These variables were chosen, in consultation with the Department, to reflect the risk-based characteristics that are likely to be associated with a person's welfare class movements. In addition, these attributes were used to calibrate the micro-simulation model so that for each year of the simulation, the dynamics of welfare utilisation were reproduced and the population aged appropriately while maintaining the correct gender distribution. As part of the overall model development, a calibration adjustment was made to the model predictions, by checking both cross-sectional and longitudinal alignment, to ensure the reasonableness of the annual simulated population.

Mortality is an important factor that influences the future welfare dependence and population projection and therefore it was important to predict the event of death of an individual for each year in the simulation model. The age of an individual will increase incrementally from one year to the next and so the age transition was deterministic. However, the value (or state) of all other variables listed above will either remain the same

or change to one or more permissible states depending on the circumstances of the individual. To capture the dynamic nature of the population, the event of a transition from one state to another was predicted using dynamic generalised linear models (GLMs), specifically binary logistic or multinomial logistic models. The statistical models predicted transition probabilities which were then used in the simulation process to generate one possible transition outcome.

To be able to predict transitions in the state of a variable, longitudinal data is required. Two sources of data used to inform the simulation model were the HILDA longitudinal survey and the DSS longitudinal dataset, the PIA longitudinal social security administrative dataset.

For a variable representing an individual characteristic, the event of transitioning from one state to another is likely to be dependent on transitions in other variables. For example, the birth of a child is associated with partnership status. To capture the dependency between transitions on different variables, the dynamic simulation model reproduces the statistical dependency in transitions by using a progression of steps in which the prediction of a transition in a variable is based on predictions for other variables in the same year.

A single iteration of the simulation model cycles through the following process for each individual:

- reads population information at the start of a year,
- predicts whether a change in individual attributes will occur,
- predicts change in welfare class,
- predicts payment category utilisation,
- predicts the amounts of payments allocated to individuals in each class,
- updates population information for the start of the following year.

Micro-simulation is concerned with simulating future populations, which by definition is uncertain. Running multiple replications of the micro-simulation model is required to provide an understanding of the uncertainty in future predictions. To quantify the uncertainty in the prediction of lifetime costs it was recommended by Data Analysis Australia (DAA) that at least ten simulations of lifetime pathways would be appropriate. Lifetime costs should be reported only for groups of a minimum size of 1,000 and an assessment of the distribution of lifetime costs associated with a group requires about 100 simulations for each individual pathway or 100,000 simulations overall (for all individuals in the group). Measures of uncertainty in the predictions of lifetime costs associated with statistical process error were not included in the Valuation Report.

There were a number of steps in the dynamic micro-simulation model that were modularised to enable flexibility and efficiency of approach, as well as providing an intuitive

step-by-step approach to model development. These modules fed into the overarching projection module and contributed to the projection of the population through consideration of:

- flow assumptions,
- welfare utilisation assumptions,
- payment assumptions,
- adjustments to the assumptions, and
- indexation assumptions.

Where possible, assumptions selected by PwC were evidence-based, and where a range of supportable assumptions exists a “central” assumption has been adopted by PwC which is intended to neither over- or under-estimate the result. The validation process involved an examination of the considerations made to select this “central” assumption.

The modules and more detailed information about the approach to modelling are described below in steps 4-8 (Sections 6.4-6.8). The output from this projection module was information on each person’s lifetime welfare pathway and payments received which was then used to develop the valuation results for welfare classes and the overall population.

6.3.3 Strengths

- The projection module uses a traditional approach to building a dynamic micro-simulation model (see for example Harding et al., 2010) to predict the lifetime welfare pathway of each individual in the model population.
- The module makes use of the most comprehensive and appropriate sources of relevant longitudinal data available in Australia (HILDA and the PIA longitudinal social security administrative dataset).
- The dynamic micro-simulation model reproduces the statistical dependency in transitions for time-variant attributes by using a progression of steps in which the prediction of a transition in a variable is based on predictions for all other variables in the same year.
- Calibration adjustments were made to the model predictions to ensure the reasonableness of the simulated population characteristics in both cross-sectional and longitudinal alignment.

6.3.4 Considerations for Enhancement

- An investigation of the statistical process uncertainty in the simulated lifetime costs for cohort groups and the overall population, and its impact on the estimated variance, should be summarised in the report to provide more confidence in the valuations.

- The decision to consider annual projections only, ignores multiple changes in circumstances and welfare class movements within a twelve month period. Consideration of quarterly projections, in addition to annual projections, may enable more accurate predictions of transitions in individual circumstances and movement between welfare classes. However, implementation of quarterly projections would involve substantial additional analyses of seasonality during the year, and the improvement in accuracy may not be significant compared to the resources and effort required. The additional focus on quarterly periods may also detract from the model's key purpose, which is to consider the lifetime cost in the long-term. An investigation of whether the valuation would be improved by better capturing the frequency of movements among welfare classes could be reported.
- Simulation of lifetime pathways for each individual in the model population at least ten times to obtain a reliable measure of lifetime welfare cost, and the estimated process uncertainty, for specific cohorts and the entire population. While PwC have provided valuation results to the Department from a dynamic microsimulation model with 100 simulations, a report on the findings from this simulation study should be produced to confirm the extent of process uncertainty in the valuation results associated with the simulation process.

6.3.5 Assessment of Validation Criteria

6.3.5.1 Reasonableness

Overall the approach adopted for the projection module, and the dynamic micro-simulation model is reasonable.

6.3.5.2 Technical Accuracy

We have not undertaken a full technical review of the algorithms used in the dynamic micro-simulation model, but the review of the materials provided, and consultation with PwC suggest that the approach undertaken for formulating the simulation component of the model is technically sound. However, quantifying and reporting of statistical process uncertainty in the predicted lifetime costs associated with different numbers of replications of the simulated lifetime pathways of individuals would improve confidence in the number of simulations used to produce the valuation.

6.3.5.3 Transparency

The shared working papers and the Valuation and Methods Reports provide a very good overview of the dynamic micro-simulation model and design decisions.

6.3.5.4 Coherence

Calibration adjustments were made to ensure internal and external coherence in the model population both cross-sectionally and longitudinally.

6.3.5.5 Adaptability/Flexibility

The components of the dynamic micro-simulation model have been compartmentalised into five modules so that the assumptions associated with each model can be updated independently of the others. Flexibility in the model related to the specification of the time period for projection is limited and could be improved in future model enhancements.

6.3.6 Suggestions and Recommendations

- Preparation of a paper on the results from performing multiple simulations (at least ten) to quantify uncertainty in prediction of transition probabilities from one year to the next, and over a whole lifetime for the entire model population.
- It is suggested that transition models be considered for additional risk characteristics, for example, labour force participation. However, these decisions need to be balanced against data quality, data availability and model complexity.
- While we have observed a rigorous approach applied to the assumption setting process we recommend that future valuations include a clear separation of any movement in the overall valuation between the following elements:
 - Changes in modelling methodology
 - Changes in modelling assumptions
 - Changes due to emerging experience.

6.4 DEVELOPMENT OF ASSUMPTIONS TO PROJECT FUTURE CIRCUMSTANCES AND CHARACTERISTICS OF EACH PERSON

6.4.1 Objective

Projection of the model population from the valuation date into future years is dependent on many assumptions. These assumptions can be classified into five broad types: flow, welfare utilisation, payment adjustments, and indexation, which are managed through the five modules contained within the overarching projection module (Section 6.3). The purpose of the flow assumptions module is to control and manage the assumptions associated with predicting the future values of selected demographic and risk characteristics for each individual in the population from one year to the next. These risk characteristics refer to the personal and/or household factors and attributes that put an individual at risk of being in receipt of welfare.

In this step of the valuation, the aim was to accurately predict the change in selected demographic and risk characteristics from one year to the next over a lifetime for each individual in the model population. This required using the most relevant Australian longitudinal data available to develop dynamic statistical regression models to accurately predict annual transitions in the time-variant variables of interest.

6.4.2 Approach taken by PwC

Demographic models that project the population over time typically focus on the evolution of the population by age and sex, including the events of birth and death. For the purposes of this projection the model population is closed and it is the pathways of these individuals through major life events and household circumstances related to welfare utilisation that are important. This necessarily includes the event of death for each individual.

The circumstances that are assumed to be related to welfare utilisation are partnership formation and dissolution, the number and ages of children. Education attainment is also considered as a dynamic characteristic which is related to employment, occupational status, income and hence working age welfare payments.

The identified risk characteristics (variables) to be projected from the model population are, in order:

- Ageing,
- Mortality,
- Partnering,
- Gaining/losing children
- Ages of all children (reflects known children and modelled births), and
- Education attainment.

Both the HILDA and the PIA longitudinal social security administrative dataset were used to develop the projection models for the flow assumptions. The HILDA dataset is based on a household survey and was expected to be reasonably representative of the whole Australian population and so was used to model transitions in demographic variables (flow assumptions) for individuals in payment classes 10 (previous welfare recipients) and 12 (the rest of Australia), that is, for individuals who were not current income support recipients. The PIA longitudinal social security administrative dataset was used to model the flow assumptions separately for individuals who were classified to payment classes 1-9.

These two datasets are the most accessible and relevant in Australia for developing these projections. However, there are some limitations which are described below. The projection method for each of these variables differs depending on the permissible values and whether the dynamic nature of the variable is deterministic or stochastic. The approach used to predict annual transitions for each variable is described below.

(i) Ageing

The projection of age is deterministic and was increased incrementally with each annual projection.

(ii) Mortality

The projection of mortality is conditional on the age of an individual. Mortality status was predicted by comparing to the ABS demographic tables, supplemented with the Australian Government Actuary's (AGA) life tables. But these ABS and AGA tables only contain mortality rates by age and sex. Both Indigenous and non-Indigenous mortality tables were used to produce mortality estimates for the following specific subgroups in categories of Indigeneity and receipt of disability support:

- Indigenous and non-Disability Support Pension,
- Indigenous and Disability Support Pension,
- Non-Indigenous and non-Disability Support Pension,
- Non-Indigenous and Disability Support Pension.

(iii) *Partnering*

Being in a partnership is an important determinant of welfare utilisation. It is therefore necessary to consider whether an individual is in a partnership or not and when their partnership status changes. Partnership status is conditional on the pre-specified projections of age and mortality transitions.

The HILDA longitudinal survey data was used to identify a model for partnership status dependent on the status in the previous year and other selected variables that were available in the model population dataset. Partnership status is defined as a dichotomous variable with two possible outcomes being either partnered or single. To project partnership status in the following year, two transition models were developed for the:

- Probability of remaining single or changing to partnered,
- Probability of remaining partnered or becoming single following partnership dissolution.

Explanatory variables included in the models were:

- Sex,
- Age of individual,
- Indigenous status,
- Number of dependent children.

While this specification of partnership status to include only two possible outcomes is simplistic, PwC acknowledged that the inclusion of additional status categories such as cohabitation and divorce, may improve model predictions of transitions in the demographic variables, and hence the flow assumptions. Even though payment eligibility does not distinguish between married and de facto partners, the likelihood of forming or dissolving a partnership does differ between the two categories as does the likelihood of birth and number of children. Previous research using HILDA data (e.g. Haynes, Baxter, Hewitt, and Western (2015)) has shown that the variables representing earnings in previous year, education (degree or not), birth of a child in previous year and duration in previous marital status (single never married, cohabiting, married, separated/divorced) are also associated with partnership transitions and could be included in the model if they are also recorded in the model population dataset.

The HILDA data was used to develop partner transition models for payment classes 10 and 12. The DSS longitudinal data set was used to develop partner transition models separately for all other payment classes 1 to 9. Transition probabilities for partnership were found to differ across the different payment classes and thus it was important to separate out the flow assumptions across payment classes. Projections from these transition models were then adjusted to calibrate to the proportions of individuals in different payment classes and age bands. Adjustment was also required to compare the experiences of cohorts of individuals over time.

(iv) Number of Dependent Children

For each person in the model population HILDA data was used to model transitions in the number of dependent children conditional on partnership status. Children were maintained in the model up to age 24 years.

The approach was to investigate:

- the simulation of dependent children tracking the age of each child,
- demographic changes regarding dependent children using the event approach.

For the forward projection, a series of dynamic generalised linear regression models were developed for predicting:

- Births, both single and multiple,
- Gaining one or more other dependent children.

The explanatory variables included in the regression models were:

- partnership status transition,
- parent age,
- parent sex,
- number of children,
- welfare class
- Indigenous status.

The birth and number of children may also depend on other parent and household characteristics such as ethnicity, income, education level.

The statistical models have been developed by reference to the HILDA survey data and validated and refined using the PIA longitudinal social security administrative dataset for the welfare classes where such data was sufficiently complete, such as for those receiving study payments.

(v) *Education attainment*

Education attainment is associated with outcomes such as employment, occupational status, earnings, partnership status and number of children. So while there is no direct link between education attainment and welfare utilisation it can be considered as a proxy for other important factors related to welfare utilisation. Therefore it is reasonable to model transitions in education attainment and include this characteristic in the projection of the model population. The transition model for education attainment is divided into two parts:

- the first part is to determine the likelihood of an individual remaining at the same “highest level of education”,
- the second part is used to determine the level of education attainment an individual receives if their education level increased over the year.

Explanatory variables in the logistic regression model include age, sex and Indigenous status. However, individual background characteristics and the location they live in were not included, for reasons of model simplicity.

The approach taken by PwC to determining appropriate assumptions primarily uses dynamic generalised linear models, a statistical modelling approach that includes consideration of all foundation and risk factors. The review of the modelling results has highlighted that all individual factors are highly significant but overall the model fit is low. This is expected when modelling transitions at the individual level as there are many reasons why an individual might experience a transition that is not measurable or captured by factors recorded in the data. The predicted transitions will more accurately reflect trends for large groups of individuals when combined.

6.4.3 Strengths

- The statistical forms of the dynamic transition models are appropriate but simplistic.
- Two sources of longitudinal data have been used to separately model the transitions in life circumstances for those who are in receipt of income support payments (PIA longitudinal social security administrative dataset) and those who

are not (HILDA data) to reflect the different characteristics of these two groups that were not able to be measured.

- Where there is a strong dependency between the flow assumptions for two or more variables, the projections for each variable are modelled in order, within the same iteration of the simulation model. This ensures that the projection for one variable is conditional on the other(s) to capture the dependencies.

6.4.4 Considerations for Enhancement

- As with most national household surveys, the HILDA survey is not representative of households in remote areas of Australia or of disadvantaged sub-groups of the population. The households remaining in the survey become less representative of the population due to attrition from the survey over time. The effects of attrition from the survey on future projections could be investigated.
- Geographical location could be an important determinant of life pathways and welfare utilisation. However, it was not included as a factor in the dynamic transition models as it is not possible to forecast location of residence for an individual throughout their lifetime.
- The processes of transitions in life circumstances are often different for men and women and so interactions between sex and all other explanatory variables should be considered in the models.
- The effects of interactions among explanatory variables on the flow assumptions should be further investigated and documented for future model development.

Additional variables related to employment status and earnings for individuals and their partners, as well as geographical location, should be made available to the Provider where possible to improve the accuracy of model predictions.

The transition models for partnership status, birth of a child and education attainment could be enhanced to improve model predictions and hence the flow assumptions. Using HILDA data, previous research has found that partnership transitions were associated with age (quadratic relationship across the entire adult age range), earnings in previous year, education (degree or not), birth of a child in previous year and duration in previous marital status (single never married, cohabiting, married, separated/divorced). These transitions were dependent on whether partnership formed was de facto or married. Birth of a child and the timing of birth in the life course are also associated with partnership status, ethnicity, Indigenous status, education level and earnings.

The processes for transitioning through partnerships, birth of children, education and employment are generally different for men and women and so the transition models should be enhanced by including interactions between sex and other variables in the models.

6.4.5 Assessment of Validation Criteria

6.4.5.1 Reasonableness

Overall the approach adopted for the flow assumptions module is reasonable, given the limitations to the range of possible variables available in the PIA longitudinal social security administrative dataset, including a measure of earnings and duration in previous partnership status.

6.4.5.2 Technical Accuracy

The review of the materials provided, and consultation with PwC suggest that the approach undertaken for formulating the dynamic generalised linear models for generating the flow assumptions are basically sound but could be improved by considering additional variables and more complex interactions to improve model fit at the individual level.

6.4.5.3 Transparency

The shared working papers and the Valuation and Methods Reports provide a good overview of the dynamic models used to generate the flow assumptions.

6.4.5.4 Coherence

Calibration adjustments were made to ensure external coherence in the model population for both cross-sectional and longitudinal alignment. Internal consistency of flow assumptions would be improved by refining adjustments for additional demographic variables and important interactions among variables.

6.4.5.5 Adaptability/Flexibility

The dynamic models specified for the flow assumptions are adaptable and flexible.

6.4.6 Suggestions and Recommendations

It is recommended that improvements are made to the development of the projection assumptions through a refinement of the dynamic transition models. This should include adding variables that are known to be of importance in predicting transitions in partnership status, birth of a child and educational attainment, such as earnings and ethnicity. The effects of interactions among the variables included in the models should be further investigated as this may improve the accuracy of the projections.

Furthermore, it is recommended that a more detailed explanation of the modelling is incorporated into subsequent reviews and that additional analysis is undertaken to support the assumption that statistical process error is minimal.

6.5 ASSUMPTIONS FOR FUTURE WELFARE RECIPIENTS

6.5.1 Objective

The aim of this step in the projection module was to predict the likelihood that an individual transitions into or out of a welfare class.

6.5.2 Approach taken by PwC

As described in Section 6.2, previous experience and research provides evidence that past and current receipt of welfare is a strong predictor of future receipt of welfare. Historical data from the PIA longitudinal social security administrative dataset, back to 2001, were used to identify patterns of entry into each of the welfare classes and the movement between classes. People with certain personal circumstances, household characteristics and family circumstances exhibit similar welfare utilisation patterns.

Welfare utilisation has been modelled in two steps: first by categorising individuals by their main welfare class and assessing how this evolves over time, and second by assessing the utilisation of each category of payment conditional on the individual's class and other characteristics. Initially, foundation assumptions were explored by observing the overall level of transitions among welfare classes by age and sex at the cohort level. This included observing the most likely destinations and the extent of variation in the transitions from year to year. This was followed by developing dynamic statistical generalised linear models, more specifically dynamic multinomial logistic regression models, to predict individual level probabilities for transition from one welfare class to a set of other permissible classes conditional on individual experience and circumstance. The simulated transitions in class movement were then calibrated to the foundation assumptions for welfare utilisation.

The event of death was predicted by simulating whether a person died in the previous year using mortality rates. Given that death was not predicted, the likelihood of transitioning to each of the permissible destination welfare classes was modelled using multinomial logistic regression models, separately for each class of origin, conditional on previous welfare experience and other risk characteristics including:

- Age,
- Sex,
- Country of birth,
- Indigenous status,
- Partner status,
- Number and ages of children,
- Highest level of education attainment, and

- Past welfare system information (duration in system, age at entry, duration in current class, previous class, details of payment utilisation).

6.5.3 Strengths

- Combination of foundation assumptions and predicted transitions from models.
- Form of the dynamic statistical models is appropriate.
- Models included previous welfare system information at macro and micro levels.
- Model diagnostics were thoroughly investigated to explore relevant subsets of predictive variables and to assess model fit.

6.5.4 Considerations for Enhancement

- Technical documentation could be enhanced with more detail on the approach to modelling and calibration adjustments.

6.5.5 Assessment of Validation Criteria

6.5.5.1 Reasonableness

Overall the approach adopted for the welfare class assumptions module is reasonable, given the limitations to the range of possible variables available in the data.

6.5.5.2 Technical Accuracy

The review of the materials provided, and consultation with PwC suggest that the approach undertaken for formulating the dynamic generalised linear models for generating the welfare class assumptions are basically sound but could be improved by considering additional variables and more complex interactions to improve model fit at the individual level.

6.5.5.3 Transparency

The working papers could provide more detail on the statistical approach to the modelling steps involved in combining the foundation and risk based assumptions for transferring knowledge to the Department.

6.5.5.4 Coherence

Calibration adjustments were made to ensure internal and external coherence in the model population cross-sectionally and longitudinally.

6.5.5.5 Adaptability/Flexibility

The dynamic models specified for the welfare class assumptions are adaptable and flexible.

6.5.6 Suggestions and Recommendations

It is recommended that improved step-by-step technical detail be provided to the Department to facilitate future modelling of an individual's movement in payment utilisation and welfare class and calibrating the predicted transitions to the foundation assumptions.

6.6 FUTURE ANNUAL PAYMENTS FOR EACH WELFARE RECIPIENT

6.6.1 Objective

To develop assumptions to estimate the future annual payments for each person who receives welfare, based on their projected circumstances and characteristics at that time.

6.6.2 Approach taken by PwC

A simple approach has been taken to estimating expected future annual payments amounts under each payment category for each individual in a particular welfare class based on their life situation (foundation assumptions) and risk factors (risk assumptions).

For the foundation assumptions, PwC have taken the empirical average payment amount information and using judgement from trends identified different averages of empirical data selected. Based on recognition of the relative concentration and sparseness of data these averages are further smoothed across different ages and years of experience. Consideration of external information such as policy changes may introduce further adjustments.

Risk assumptions were modelled using either a GLM, a decision tree or using loading factor methodology. The model structure was selected based on how well the structure represented the underlying process. Generally where payment distributions were less variable with payment amounts fixed depending on a few simple rules, decision trees were used. Where payment distributions were more varied GLMs were used. For payment group P, because supplement eligibility requirements are heavily related to whether the base case payment is received, a loadings model was used. The loadings model was applied for the carer, disability support and aged pensions classes where materiality was greatest.

6.6.3 Strengths

- The approach is simple and transparent.
- Actual experience can be relatively easily compared to expectations in future valuations.

6.6.4 Considerations for Enhancement

No significant weaknesses have been identified. No significant future considerations have been identified.

6.6.5 Assessment of validation factors

6.6.5.1 Reasonableness

The approach taken is reasonable and based on the available data and timeframes.

6.6.5.2 Technical Accuracy

We have not performed a full technical review of the models developed by PwC. However, our review of the materials provided by PwC suggest that the modelling undertaken is technically sound and that appropriate validation processes have been undertaken and internal technical and peer review processes have been completed.

6.6.5.3 Transparency

The documentation provided from the Knowledge Store provides a good overview of the modelling and validation processes undertaken.

6.6.5.4 Coherence

To test the assumptions selected actual payments for years 2009/2010 to 2014/2015 have been compared with estimated payments derived by applying the selected assumptions.

6.6.5.5 Future Adaptability & flexibility

The simplicity of the assumption setting for this piece of the modelling will make the monitoring of actual versus expected experience easy to assess and any future changes to benefit structures and payments can be easily incorporated into the modelling and assumption setting processes.

6.6.6 Suggestions and Recommendations

Our review has not highlighted any recommendations or suggestions.

6.7 DEVELOPMENT AND APPLICATION OF ADJUSTMENTS TO THE ASSUMPTIONS

6.7.1 Objective

To develop and apply adjustments to the assumptions and resulting simulations where appropriate to ensure aggregate projections reconcile to external benchmarks and, in time, to allow for economic impacts.

6.7.2 Approach taken by PwC

The adjustment to assumptions considers two areas:

- Forward looking policy adjustments,
- Economic adjustments.

6.7.2.1 Forward looking policy adjustments

Forward looking policy adjustments are intended to ensure that assumptions reflect currently legislated policy changes. Announced policy changes that have not yet been legislated are excluded. Adjustments were only made for policy changes that had a material impact across the population or for major population groups.

Assumptions were set on three bases relative to the most recent five years of experience.

Where the policy changes:

- were fully reflected in the experience, assumptions were set by giving consideration to all five years of experience;
- were partially reflected in the experience, assumptions were set using time periods that reflected the change, and excluding time periods that did not reflect the change;
- were not yet reflected in the experience, assumptions were set using explicit adjustments to the model assumptions.

The form of the adjustments reflected the legislated policy changes. Government modelling of the impact of policy changes was researched and given consideration in setting relevant assumptions.

For the baseline valuation the following policy changes were implemented through a reduction in the average size of payments in the relevant payment category by an adjustment to indexation factors:

- Repeal of the income support bonus, and
- Repeal of the schoolkids bonus and closure of CDEP supplement.

Changes to the age pension qualifying age were explicitly allowed for by the model since it includes assumptions relative to retirement age rather than at specific ages.

Changes to the assets test, age pension taper rate, and treatment of defined benefit income streams were implemented through:

- Adjustments to numbers in pension age classes based on Department estimates;
- Reductions to entry rates into pension age classes based on adjusted historical data;
- Changes to the payment sizes for pension age, IS carer and disability classes based on Department estimates;
- Increases in entry rates for Classes 4, 5, and 6 based on Department estimates.

6.7.2.2 Economic adjustments

The economic adjustments module will be calibrated to Treasury projections and will consider the extent to which the economic conditions at the valuation date have deviated from the expected long run position. Adjustments will be made to the modelling to allow economic factors to revert to the long run position over the valuation timeframe.

However, PwC have noted that this module has not been incorporated into the baseline valuation due to the timelines for the valuation. Given that the unemployment rate at the time of the valuation was close to Treasury's expected long run rate the impact of not including this model is not material. We have therefore not commented in detail on PwC's proposed approach but will consider the model in more detail should it be included in the next valuation.

6.7.3 Strengths

Following discussion between PwC and DSS it was agreed that forward looking policy adjustments would be restricted to currently legislated policy changes. This approach avoids complications that might be caused under circumstances where announced changes are not ultimately legislated by parliament. This provides a clear demarcation between what is included and not included in the model. It is important to note however, that this approach does lead to inconsistencies with other Treasury forecasts, such as the Forward estimates which are based on the assumption that planned policy changes are implemented.

6.7.4 Considerations for Enhancement

We have not identified any significant areas for enhancement with the approach at this time. We will evaluate the approach taken to economic adjustments in our next report. However, it is worth noting that the validation of eligibility for the Aged Pension is an important part of assessing the overall costs split between Aged Pension and other costs.

Including assumptions regarding the status and duration of individual's Australian residency may make this process more robust and further investigation could be undertaken to assess the merits of adding this assumption.

6.7.5 Assessment of validation factors

6.7.5.1 Reasonableness

The approach to allowing for future policy changes is reasonable and consistent with standard actuarial practice. In some cases significant expert, but subjective, adjustments to assumptions were required and Department estimates were considered.

6.7.5.2 Technical accuracy

For policy changes that are not reflected in the experience, or are only partially reflected, it is naturally difficult to make technically accurate adjustments. In particular, the structure of the model may not be amenable to direct adjustments of assumptions, and a balance must be struck between overly complex models that are more flexible, and simpler and more robust models that are less flexible to future changes.

None-the-less, within these limitations, PwC's overall approach is likely to produce technically accurate results.

6.7.5.3 Transparency

Adjustments for policy changes are transparently documented within the report and supporting material.

6.7.5.4 Coherence

Since Department estimates were often consulted in order to make adjustments, the results are likely to be coherent with other Treasury estimates.

6.7.5.5 Adaptability/Flexibility

The baseline valuation has had sufficient flexibility and adaptability for adjustments to assumptions for future policy changes. However, this is by no means guaranteed in future. PwC have taken a practical approach to consider each change on a case by case basis.

6.7.6 Suggestions and Recommendations

At this time we have no suggestions or recommendations in respect of adjustments to assumptions.

6.8 DEVELOPMENT OF INDEXATION ASSUMPTIONS TO INDEX THE PAYMENTS MADE IN FUTURE YEARS

6.8.1 Objective

To develop indexation assumptions to index the payments made in future years and discounting assumptions to calculate the lifetime cost.

The indexation assumptions applied by PwC are intended to reflect how payments are expected to increase in each future year within the projection period. The indexed payment cash flows are then discounted to allow for the time value of money in order to derive the lifetime cost.

The economic assumptions are important in that they change the balance between the lifetime costs of different generations. Higher discount rates, or lower indexation rates, result in an increased weight to the lifetime cost of the current population, and a lower weight to the lifetime cost of future generations. This can therefore skew policy decision making.

6.8.2 Approach taken by PwC

External economic data sources and reference points including the following have been used to select indexation and discounting assumptions:

- Treasury forecasts;
- Consultation with the Australian Government Actuary (AGA);
- Consultation with other IDC members.

Initially, the role of PwC in determining indexation and discounting assumptions was to research and discuss options with the IDC (including the Department and the AGA) and to provide comment on the assumptions prescribed by the IDC.

However, during the course of the baseline valuation, we understand that the assumption setting process shifted and the assumptions were ultimately set based on recommendations from a paper produced by the AGA. PwC then implemented these assumptions, and we understand that PwC's view was that these assumptions were reasonable.

For the baseline valuation, the following key assumptions have been made:

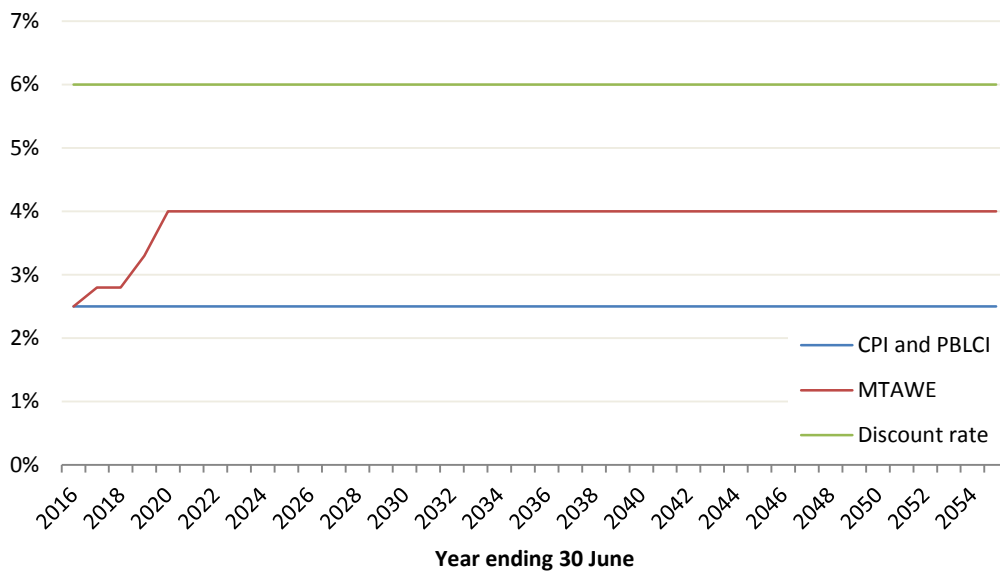
- A constant rate for Consumer Price Inflation (CPI) and Pensioner and Beneficiary Living Cost Index (PBLCI) of 2.5% p.a. across all future years;

- A Male Total Annual Weekly Earnings (MTAWE) assumption which rises from 2.5% p.a. in 2015/16 to 4.0% p.a. for 2019/20 onwards;
- A constant discount rate of 6% p.a. is applied across all years.

The approach taken to setting CPI, MTAWE and PBLCI assumptions is consistent and uses Treasury forecasts in the short term, progressing to a long term assumption. At the time of setting the assumptions for the baseline valuation the short and long term forecasts for CPI and PBLCI were the same giving rise to what appears to be a constant assumption over time for these factors. Although the current factors produce a constant rate for the baseline valuation, if the long and short term views diverge in the future the assumptions for CPI and PBLCI may vary over time.

This approach was selected by PwC to balance the objective of year to year changes in forecast payments being reasonable over the short term with a preference for a constant gap over a longer duration.

The graph below shows the assumptions selected for the baseline valuation:



6.8.3 Strengths

Discount, rates have been set consistent with long term assumptions.

6.8.4 Considerations for Enhancement

There appears to be a lack of clarity on who owns the assumption setting process for indexation and discounting assumptions.

As discussed below, the process for setting the CPI, PBLCI and MTAW assumption is not internally consistent with the remaining assumptions.

In setting these assumptions there are two key considerations:

- Long term stability is preferable to setting assumptions on a short term basis with potential for changes between valuations;
- The process and decision making responsibilities should be clearly defined.

Changes to the indexing assumptions will result in significant changes to the lifetime cost. Care must be taken that any such changes are not interpreted as directly due to policy changes.

6.8.5 Assessment of validation factors

6.8.5.1 Reasonableness

There are a number of approaches taken to setting economic assumptions in actuarial valuations, and there is no method prescribed under the circumstances of the investment approach. Therefore the specific purpose of the actuarial valuation, as defined in PwC's scope of work, must be taken into account in determining the reasonableness of assumptions.

Given this purpose, we regard the following as important factors:

- Long-term basis;
- Internal consistency of assumptions;
- External consistency of assumptions.

In order that changes due to changes in economic assumptions are not interpreted as due to policy changes or from other causes, we strongly recommend that assumptions are set on a long-term basis and not routinely changed to reflect current economic conditions. Further, any changes to assumptions should reflect changes in perceptions of long-term economic conditions.

This appears to be the case in the setting of the discount rate as a long term rate. However, the methodology applied to derive the CPI, PBLCI and MTAW assumptions is set on a market basis in the short term, and so will result in changes from valuation to valuation. Thus any changes due to changes in the MTAW assumption at consequent valuations need to be separately identified and not attributed to policy changes or other factors.

The key driver of the lifetime cost is the real discount rate, which is the difference between the discount and indexation assumptions. Again, we would recommend that the real

discount rate is set on a long-term basis, and does not vary by term. This would give internal consistency between the discount and indexation assumptions. However, the MTAW assumption is not set on a long term basis, and is therefore inconsistent with the remaining assumptions.

Lastly, there is a strong case that the economic assumptions for indexation and discount rate be externally consistent with other costs of long-term payments, such as the Government's superannuation liabilities. The AGA has provided advice on this basis regarding the discount rate. However, no external comparisons appear to have been made for the indexation assumptions. Again, these comparisons are required in order to ensure internal consistency of the final adopted assumptions.

6.8.5.2 Technical Accuracy

The adopted economic assumptions are technically accurate.

6.8.5.3 Transparency

The adopted assumptions are explicit and clearly reported. However, the process for developing and agreeing the assumptions has not been clearly described in the report.

6.8.5.4 Coherence

Our comments above regarding internal and external consistency of assumptions are relevant in considering coherence of assumptions.

6.8.5.5 Future Adaptability & flexibility

We cannot see any limitations in the future adaptability and flexibility of the assumptions.

6.8.6 Suggestions and Recommendations

We recommend that the assumption setting process be formalised and clarified in a model governance framework. In particular, the roles of the IDC members and the actuarial consultant should be clearly set out and the process for changes in assumptions be clarified, and any such changes be clearly documented and signed off. This is particularly important given the high sensitivity of the lifetime costs to these assumptions.

Secondly, we recommend that the MTAW assumption (and any other indexation assumptions considered in future, such as national minimum wage), be set on a constant long-term basis in order to be internally consistent with the discount rate assumption.

6.9 SUMMARISE VALUATION RESULTS FROM THE PROJECTION MODULE FIT FOR PURPOSE

The total lifetime cost for the model population of 23.9 million people has been estimated at \$4,764 billion as at 30 June 2015. In making this estimation PwC has recognised that this is an uncertain figure but it can be used to guide long term thinking around the dynamics and cost of the welfare system. The figure should be considered as a baseline figure to allow the assessment of the potential impact potential financial impact of policy changes on total lifetime cost.

Furthermore comprehensive commentary on the valuation results and the methodology developed by PwC to analyse subsequent valuations against the baseline will be provided in our second review in late 2016.

6.9.1 Objective

The objective of the actuarial estimate of future lifetime cost as at 30 June 2015 is to provide a baseline against which future changes in the estimate of lifetime cost can be measured. The actuarial valuation model has been designed to provide the Department with a platform that can be further developed over time.

The results of the baseline valuation are documented in PwC's final report to the Department, titled "Valuation Report 30 June 2015 Baseline Valuation" ("The Valuation Report").

6.9.2 Approach taken by PwC

Detailed commentary on the methodology and assumptions applied in the various components of the modelling approach is provided in Section 6.1 to 6.7.

PwC have included a comprehensive breakdown of the lifetime cost in the Valuation Report. In the Executive Summary the results of the valuation are shown in total and split by welfare class and payment category.

The body of the Valuation Report covers the following key areas relating to the valuation results:

- Overall results;
- Results for current welfare recipient classes;
- Analysis of exits and entrants;
- Results for non-welfare recipient classes;
- Forecasts;
- Dynamics of the system;

- Groups of interest.

It should be noted that the valuation methodology and reporting has been designed to meet the specific scope of work requested. The model is focused on the financial outcomes and that in using the model results to develop interventions it should be considered in the wider context of costs and benefits that are beyond the scope of the current model. In particular PwC has noted that it is important to consider the following in addition to the valuation results:

- Short term impacts over budget forecast periods as determined by detailed overnight costing models;
- Broader costs and benefits to other parts of the system, using more traditional economic approaches such as cost/benefit analysis;
- Qualitative impacts on people's lives and their lifetime wellbeing.

6.9.3 Strengths

- The Valuation Report is well written and clearly articulates the results of the baseline valuation.
- Results are shown split by welfare class and payment category.
- Results are shown including and excluding the aged pension.
- A detailed section is included within the Valuation Report providing further commentary on the future lifetime cost for "groups of interest" who have relatively high lifetime costs but where more effective policy setting or interventions could reduce the overall costs.
- Model use and limitations are discussed.
- The use of the Knowledge Store for technical documentation results in a Valuation Report that is suitable for a non-technical audience.

6.9.4 Considerations for Enhancement

We have not identified any significant areas for enhancement with the approach at this time.

By definition the baseline valuation does not incorporate the comparison to prior valuations that will be required in future reports. A key area for future consideration is the development of a framework for the Analysis of Change that will be required to explain the reasons for movement in the valuation results. The Analysis of Change should address the following items:

- Breakdown of movement due to changes in:
 - Economic assumptions;
 - Other assumptions
 - Methodology;

- Data;
- Legislated policy.

The Valuation Report is designed to be read by a varied audience. To avoid misinterpretation and misuse consideration should be given to whether certain audiences should be provided with a short form report or just the Executive Summary rather than the full report for future valuations.

6.9.5 Assessment of Validation Criteria

6.9.5.1 Reasonableness

Overall the documentation of the valuation results is well-articulated and comprehensive.

6.9.5.2 Technical Accuracy

A rigorous technical review process is in place to ensure the overall valuation results accurately reflect the modelling completed by PwC.

6.9.5.3 Transparency

The Knowledge Store files and Reports, and related documentation provided detailed description of the data sources, assumptions and methodology on how the model population was created. The processes have been transparently laid out and the justifications for these decisions have been clearly articulated.

6.9.5.4 Coherence

The methodology, assumptions and results documented in the Valuation Report are consistent with the information provided in the Knowledge Store.

6.9.5.5 Adaptability/Flexibility

The overall platform created by PwC includes the flexibility to generate and report results for the whole population, for sub-groups of the population, for different scenarios and for different sets of assumptions.

6.9.6 Suggestions and Recommendations

At this time we have no specific suggestions or recommendations in respect of the reporting of the valuation results.

6.10 UNCERTAINTY AND SENSITIVITY OF VALUATION

6.10.1 Objective

The actuarial valuation of lifetime cost is uncertain as it designed to be a central estimate that is an estimate that is neither optimistic nor pessimistic, but at the centre of a range of possible outcomes.

The sensitivity analysis is used to demonstrate how much the overall valuation result would move if key valuation assumptions were changed.

6.10.2 Approach taken by PwC

PwC have recognised that there are areas of uncertainty within the valuation results and that the lifetime cost results are sensitive to the underlying assumptions. A range of alternative assumptions have been tested and are presented in the Valuation Report.

- Mortality assumptions:
 - AGA tables with adjustments for age pensioners;
 - ABS life table replacing AGA life table;
 - No mortality improvements;
 - Removal of mortality adjustments for specific population groups.
- Economic assumptions:
 - Discount rate increases by 1% to 7%;
 - Discount rate reduces by 1% to 5%;
 - Long term CPI increases by 1% to 3.5%;
 - Long term CPI decreases by 1% to 1.5%;
 - Long term MTAWA increases by 1% to 5%;
 - Long term MTAWA decreases by 1% to 3%.
- Aged pension:
 - Adjustment to reflect increase in future numbers of part-pensioners is removed;
 - Age pension payments increase by 10%.
- Entry and exit rates:
 - Rates of movement from the rest of the population to the active classes increases by 5% for ages up to retirement age.
 - Rates of movement from the rest of the population to the active classes increases by 5% for retirement age and above.
 - Rates of movement from the active classes to the rest of the population increase by 5%.

6.10.3 Strengths

- The sources of uncertainty are identified and clearly articulated;

- Sensitivity of the valuation results to key assumptions have been tested.

6.10.4 Considerations for Enhancement

- The model provides a central estimate of the expected future lifetime costs, but does not give any guidance regarding uncertainty or the range of possible outcomes.
- Additional analysis to show the range of possible outcomes in addition to the central estimate.
- The aged pension is by far the largest component of the lifetime costs and it may be of value to show the sensitivity to the following assumptions split between aged pension and other welfare payments for:
 - Mortality assumptions;
 - Economic assumptions;
 - Entry and exit rates.
- The assumptions tested in the sensitivity analysis should be aligned with the Analysis of Change which will be included in future valuations.
- The inclusion of additional sensitivities to reflect key assumptions relating to specific future potential policy changes should be considered.

6.10.5 Assessment of Validation Criteria

6.10.5.1 Reasonableness

The range of sensitivities considered by PwC is reasonable. However, the report could be enhanced by providing guidance on the range of possible outcomes around the central estimate of costs which has been derived.

6.10.5.2 Technical Accuracy

We have not seen any evidence to suggest that the sensitivity analysis is not accurate. The process is subject to the same rigour of technical review as all other modelling components.

6.10.5.3 Transparency

The working papers, reports, and related documentation provided detailed description of the data sources, assumptions and methodology on how the sensitivities were applied. The considerations relating to the uncertainty and sensitivities are clearly articulated.

6.10.5.4 Coherence

Since Department estimates were often consulted in order to make adjustments, the results are likely to be coherent with other Treasury estimates, but this is not confirmed or explicitly stated with the report.

6.10.5.5 Adaptability/Flexibility

The baseline valuation has had sufficient flexibility and adaptability for adjustments to assumptions for assumption, methodology and future policy changes. Additional sensitivities can be incorporated as the model develops.

6.10.6 Suggestions and Recommendations

At this time we have no specific suggestions or recommendations in respect of the reporting of the valuation results.

7 VALIDATION FINDINGS

Table 7.1: Rating of each validation criteria applied to each of the methodology steps undertaken by PwC in the actuarial valuation of the Australian Priority Investment Approach to Welfare.

Steps in Valuation Model by Validation Criteria	Reasonable-ness	Technical Accuracy	Transparency	Coherence	Future adaptability
Step 1: Creation of model population at 30 June 2015	✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓
Step 2: Segmentation of welfare recipients into classes	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Step 3: Specification of dynamic micro-simulation model	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓
Step 4: Assumptions to project individual circumstances	✓✓✓	✓✓	✓✓✓	✓✓	✓✓✓
Step 5: Assumptions for welfare class transitions	✓✓✓	✓✓	✓✓	✓✓✓	✓✓✓
Step 6: Assumptions for future annual payments	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓

Steps in Valuation Model by Validation Criteria	Reasonable-ness	Technical Accuracy	Transparency	Coherence	Future adaptability
Step 7: Adjustments to assumptions	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Step 8: Payment indexation assumptions	✓✓✓	✓✓✓	✓✓✓	✓	✓✓✓
Step 9: Summarising valuation results fit for purpose	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Step 10: Uncertainty and sensitivity of valuation	✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓

Table Legend:

- ✓✓✓ **Excellent** The approach undertaken was thorough given availability of resources.
- ✓✓ **Very good** The approach taken was sound but could be improved with further investigation.
- ✓ **Good** The approach undertaken could be improved in several ways or requires more consideration and explanation.

X Development Required

8 REFERENCES

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APPENDIX I: VALUATION STEPS MAPPED TO REPORT MODULES AND SHARED WORKING PAPERS

Steps to validate	Module	Working Papers	Data Used and Notes
<p>1. Development of a data set which represents the Australian population at 30 June 2015.</p> <p>1.1 Synthetic population creation (August 2011).</p> <p>1.2 Model (baseline) population creation (30 June 2015).</p>	<p>Population module</p>	<p>Chapter 6 Population data sources</p> <p>Chapter 7 Other data sources</p> <p>Chapter 11 Population module</p>	<p>ABS Census 2011, 1% CURF</p> <p>Summaries of ABS Census data from TableBuilder to create population summaries by age, sex and S2 areas</p> <p>ABS Estimated Resident Population</p> <p>ABS Labour Force Survey</p> <p>DSS welfare data</p> <p>Aged to ERP 2015</p> <p>Mortality Tables</p>

Steps to validate	Module	Working Papers	Data Used and Notes
2. Segmentation of welfare recipients into classes.	Population module	Chapter 3 Segmentation Chapter 4 Payment categorisation	DHS Payments Guide Documents describing consideration and process for agreeing classes and assigning people to classes.
3. Simulation of the future lifetime pathways of each person in the model population using a dynamic simulation model conditional on values in previous year: includes projected circumstances and characteristics, likelihood of income support receipt and subsequent annual payment.	Projection module	Chapter 10 Method design documents See other chapters below Chapter 14 Model validation	Considers the evolution of the model population over each time period as described in steps 4-8 and modules listed below. ERP profile comparison to ABS releases (by age, sex). Education analysis to check the profile of educational attainment by age and sex.

Steps to validate	Module	Working Papers	Data Used and Notes
<p>4. Development of assumptions to project future circumstances and characteristics of each person.</p> <p>4.1 Mortality</p> <p>4.2 Partnering</p> <p>4.3 Children</p> <p>4.4 Education attainment</p>	Assumptions modules - Flow assumptions	<p>Chapter 16</p> <p>Chapter 17</p> <p>Chapter 18</p> <p>Chapter 19</p> <p>Chapter 20</p>	<p>HILDA (Rest of Australia).</p> <p>DSS longitudinal income support recipient data for payment classes.</p> <p>AGA tables for life expectancy (mortality).</p> <p>DSP information from ABS to account for different profiles of people with disability.</p>
<p>5. Development of assumptions to estimate the probability of each person receiving welfare in each future year.</p>	Assumptions modules - Welfare utilisation	Chapters 21-24	<p>DSS longitudinal income support recipient data (PIA longitudinal social security administrative dataset).</p> <p>Based on foundation and risk assumptions for movements within and between payment classes.</p>
<p>6. Development of assumptions to estimate the future annual payments for each person who receives welfare.</p>	Assumptions modules - Payment assumptions	Chapter 4 Payment categorisation	<p>Use of historic data on payments and applied to foundation assumptions.</p> <p>Summary of utilisation numbers by payment category, previous class, age and sex.</p>

Steps to validate	Module	Working Papers	Data Used and Notes
		Chapter 15 Policy settings Chapters 25-28 Payment utilisation & amount Chapter 31 Age pension	For pension age, use of historic data for age pensioners receiving part and full pensions. Department of Treasury adequacy of retirement incomes in future projections. Benchmarking and calibration adjustments to ensure population characteristics reconcile with external sources from Treasury.
7. Development and application of adjustments to the assumptions.	Adjustments module	Chapter 30 Adjustments	Long term forecasts from DSS and AGA and discounting information from IDC.
8. Development of indexation assumptions to index the payments made in future years.	Indexation assumptions module	Chapter 29 Inflation & discounting	None

Steps to validate	Module	Working Papers	Data Used and Notes
9. Summarise valuation results from the projection module fit for purpose.	Results module	None	None

Note:

- DSS data extraction was not audited by PwC or validated by UQ-Deloitte.
- The creation of the DSS master dataset was not validated by UQ-Deloitte.
- Information on DSS data contained in Chapters 1, 2 and 5 of the PwC working papers.
- Chapters 8-9, 12-13 not provided by PwC.