OPTIMISATION OF RETIREMENT BENEFITS FOR AUSTRALIANS

By

EILEEN O'LEARY

Submitted for the degree of Doctor of Philosophy
February 2015

Victoria University
College of Business

Abstract

Australians have three principal sources for retirement funding - the Age Pension, individual superannuation and individual savings outside of the superannuation umbrella. The Age Pension, a non-contributory payment that, alone, provides only for a modest lifestyle, is means tested for both assets and income, with the provision available to receive either a full or part pension. Most Australians also hold a personal superannuation account into which is contributed a mandatory percentage of labour income, known as the Superannuation Guarantee. These accounts, for which the individual is responsible for the investment strategy and for which the individual bears the risk, can also receive discretionary, tax-advantaged contributions.

To find a way through the myriad of choices to achieve an optimal outcome whilst maintaining an appropriate level of consumption across a lifetime is a daunting task. This problem has led to the formulation of the research question for this thesis i.e.

- From a financial perspective how can an Australian optimise financial decisions in order to provide for a comfortable retirement?

The approach taken is that of optimisation. Linear programming is used to establish the set of decisions across a lifetime that will lead to optimal outcomes for an Australian household, with the study focussed on Australians earning median household labour income.

Four conclusions can be drawn from the study. The first is the pivotal role of owner-occupied housing in providing superior retirement outcomes with the second being that an increase in the Superannuation Guarantee rate will not improve these outcomes for the demographic considered. The third conclusion is the substantive role of the Age Pension in securing wellbeing across a lifetime for this particular population segment. The fourth conclusion is that there needs to be careful consideration of retirement funding products. Products such as life contingent annuities and reverse mortgages, presently not popular in Australia, are shown to be wealth enhancing for the conditions modelled, whilst saving through superannuation beyond the Superannuation Guarantee does not generally feature as an optimal approach.

Declaration

I, Eileen O'Leary, declare that the PhD thesis entitled "Optimisation of Retirement Benefits for Australians" is no more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.

[redacted]

26/2/2015

Eileen O'Leary **Date**

This thesis is dedicated to the memory of three people:

My parents, Nell and Gerry O'Leary, whose own schooling was cut short, who held a passion for learning and sacrificed much to provide education for their children.

My husband, Terry Monagle, who, in spite of his profound sadness at his impending death, insisted on planning with me for my life without him. He recognised that moving back from corporate life to a life of teaching and studying would be sustaining for my spirit, and I am so grateful for his generosity, wisdom and insight.

Acknowledgements

This thesis has been undertaken over many years and its completion provides me with the opportunity to express my gratitude to the people who have assisted me in so many ways.

Firstly, I must thank my supervisor, Dr. Segu Zuhair, who not only provided me with the idea for this thesis but also has patiently and wisely supported me through all the issues faced in undertaking such a major project over a prolonged period. Even when I felt overwhelmed, Dr. Zuhair never voiced doubts as to my ability to eventually find solutions to the problems at hand. In particular, he offered a listening ear, not only for academic problems, but also for the vicissitudes of life itself.

I also must thank Dr. Michael Ntalianis, my co-supervisor, for his support and encouragement. Also within Victoria University, the library staff at City Flinders campus – Peter O'Connell, Peter Ring, John Tripotseris and Meg Weller – have provided, invariably, cheerful and apposite advice.

Two members of the Graduate Research Centre of Victoria University deserve a special thank-you. Ms Tina Jeggo has been a constant presence, always offering wise and practical support. Dr. Lesley Birch intervened at a crucial time with practical arrangements. Without her recognition of my circumstances, I doubt if I would have completed this study.

Dr. Jim Lewis, a colleague from the Graduate School of Business and Law at RMIT University, has given me sustained and generous encouragement.

Mr. Greg Campbell, Portfolio Manager, and Mr. Curtis Heaser, Product Actuary, both of Challenger Life, provided pricing data for life-contingent annuities, and as well, invaluable discussion. Mr. Vern Fettke gave generously of his time and vast experience in financial planning, and also provided price data for life insurance products. Mr. Sam Zapulla gave insights into financial planning matters.

I am indeed fortunate in that, over all of my life, I have been sustained by a loving family. My siblings, Marita van Gemert, John O'Leary and Brendan O'Leary, have shown their encouragement and support in so many ways. My daughters, Clare, Catherine and Brigid Monagle, have been very supportive of my study, but have also exhorted me to ensure a balance between study and life in general, providing many opportunities to practise this balance. My three grandchildren, Honora, Terry and Thea, may not have offered explicit support for this thesis, but their presence in my life has brought enormous joy.

Table of Contents

List of Tables

Abbreviations

ABS	Australian Bureau of Statistics
AFSL	Australian Financial Services Licence
AHURI	Australian Housing and Urban Research Institute
AIST	Australian Institute of Superannuation Trustees
AOFM	Australian Office of Financial Management
APRA	Australian Prudential Regulation Authority
ASFA	Association of Superannuation Funds of Australia
ASIC	Australian Securities and Investments Commission
ASX	Australian Stock Exchange
AWOTE	Average weekly ordinary time earnings
BEM	Behavioural economic model
CAS	Comfortably affluent but sustainable
CFPB	Consumer Financial Protection Bureau
Co2Ch	Couple with two children
CIPR	Comprehensive income products for retirement
cv	Current value
DHS	Department of Human Services
DUM	Discounted utility model
EUT	Expected utility theory
F1Ch	Female with one child
FSI	Financial System Inquiry
FOFA	Future of Financial Advice
FSRA	Financial Services Reform Act
fv	Future value
GDP	Gross Domestic Product
HILDA	Household, Income and Labour Dynamics in Australia
HRS	Health and Retirement Study
HUD	(Department of) Housing and Urban Development (USA)
ISFA	Investment and Financial Services Association

IGR	Intergenerational Report
LCH	Life Cycle Hypothesis
LCPIH	Life Cycle Permanent Income Hypothesis
MBA	Modest but adequate
MILP	Mixed Integer Linear Programming
N.A.	Not applicable
NATSEM	National Centre for Social and Economic Modelling
NHC	Non-housing consumption
OECD	Organisation for Economic Co-operation and Development
p.a.	Per annum
PIH	Permanent Income Hypothesis
pv	Present value
RIM	Retirement and Income Modelling Unit
SCF	Survey of Consumer Finances
SEM	Standard economic model
SEQUAL	Senior Australians Equity Release Association of Lenders
SG	Superannuation Guarantee
SGL	Superannuation Guarantee Levy
SM	Single male
SPRC	Social Policy Research Centre

Chapter 1 Background and the problem

1.1 Living until retirement

As Benjamin Franklin famously said, in this world nothing is certain but death and taxes. But, after paying taxes and before death, maybe, there is retirement!

Retirement for the purposes of this thesis, unless explicitly noted otherwise, is that stage in life when a person has ceased to engage in paid labour. This stage of life has been a changing landscape over the last one hundred years or so, as is illustrated immediately below.

Australians who were young adults in the early years of the twentieth century could not necessarily expect to experience retirement. About 49% of males aged 25 and about 57% of similarly aged females would live to be 65, the traditional age of retirement in Australia. For this cohort, for those who did reach this age of 65, a male could expect to live another 12 years, whilst a female had a life expectancy of 14 years (Australian Bureau of Statistics (ABS), 2008a).

However, for young Australian adults born one hundred years later, the situation is very different. For young Australian males aged 25 at the recent turn of the century, about 75% can expect to live until age 65, whilst the comparative figure for females is 85%. Thus, a young adult can now confidently expect to reach the traditional age for retirement. Moreover, on reaching this age, future generations can expect many more years in retirement than their counterparts of one hundred years ago. A male who is 65 years old today has a life expectancy of 19 years and a female 22 years, and it can only be expected that, in 40 years time when the young adults of today are 65, these life expectancies will be even greater[1] (ABS, 2008a, 2012a)

People contemplating retirement may see these years as full of opportunity. In a national survey involving interviewees aged 30-69, more than 85% of non-retired people were looking forward to retirement with the anticipated benefits being more free time, less work stress and the ability to travel (ANOP Research Services, 2001). This

[1] Life expectancies for Australians have been steadily growing over the past 120 years. In 1880 a 65 year old male had a life expectancy of 11 years. By 1960, it was 12.5 years, by 1995, 16 years and in 2010 19 years. The comparable figures for females are 12 years, 15.5 years, 19.5 years and 22 years. (ABS, 2008a, 2012a)

view of retirement is echoed by Hunter, Wang and Worsley (2007) who reported that retirement is seen as a time of freedom to do what is liked rather than what is required. This rosy view of retirement is, unfortunately, not universal. Hamilton and Hamilton (2006), using research data about attitudes to impending retirement of Australian baby boomers, found that there is a divide between high income and low income baby boomers, with those having low incomes seeing retirement as a “distinct and welcome transition from work to leisure” (p. x), but being anxious due to perceived financial issues of funding of their retirement. Wealthier baby boomers, however, see retirement, not as a full withdrawal from the labour force but as the opportunity to change or modify activities, maybe even a change of career. This change offers lower intensity, greater flexibility and a stronger alignment to personal interests than that of the career undertaken over the previous 40 years. For these people, financial well being is just assumed.

Salt and Mikkelsen (2009) undertook a detailed survey of retirees and pre retirees for a large Melbourne local government area, finding that concerns regarding retirement centred around wellbeing, community engagement, family and social connection, and housing. Overarching all these concerns, however, is the concern of having adequate finances for retirement, in particular the ability to pay for services required for wellbeing, especially health services and recreational activities.

From the brief discussion above, it is clear that, at least for some retirees, the funding of their retirement consumption is a pressing issue. Obviously, given the increased number of people who are living to retirement age, this funding is also a public policy issue. Thus, it is appropriate to undertake a study of retirement funding with the intention being to both provide useful information to individual Australians and to inform policy analysis.

The organisation of this introductory chapter is as follows. As the Australian approach to retirement funding is unique, and very much a product of its history, both a description of the provision of retirement funding and its history is set out. Following this discussion is an assessment of the Australian system using an academic framework, together with an outline of the intergenerational financial issues that apply, given Australia’s changing demography. Continuing on from this assessment, a brief analysis is made as to how Australians view their retirement funding approach. The research problem of the thesis, together with specific objectives, is then stated and an introduction to the methodology is provided.

1.2 Retirement funding in Australia

The individual Australian retiree may have access to funds for retirement from three main areas: (i) the means tested Age Pension, (ii) funds provided from superannuation accounts, and (iii) funds provided privately, outside of the superannuation umbrella. A brief history of both the Age Pension and superannuation in Australia is given immediately below.

1.2.1 Evolution of the Age Pension

The Age Pension was introduced in Australia in 1908. Previous to the introduction of the pension, it was assumed that the aged would use their savings to provide for themselves in their older years, or would be able to rely on family for support, or, failing these two sources of funds, resort to seeking the assistance of benevolent organisations. The purpose of the pension was to be assistance to the deserving poor, aged 65[2] or more with a yearly amount of £26[3] being provided, this amount being such that would provide for modest living. The payment was subject to a means test on both assets and income, with the amount paid being reduced on a sliding scale depending on the level of these assets and income and as well, there were residency and racial qualifications to be met. It was not a contributory scheme but rather was paid out of consolidated revenue (Dixon, 1977).

Whilst over the hundred plus years of its existence there have been some changes, the Age Pension that exists today is of similar character to that of 1908. In particular, it is available to all Australians subject to a means test on both assets and income and is not a contributory scheme but it is paid out of consolidated revenue. The amount paid is essentially a safety net (Bateman, 2009).

[2] In 1908, the age of eligibility for the Age Pension was 65 for both men and women. It has remained at 65 for men, but in 1910 it was made available for women aged 60. In 1994 it was announced that the age for women would be raised in a phased process to 65, with full implementation by January 2014 (Nielson, 2010a).

[3] Australia's currency changed in 1966 from an imperial system to a decimal system. Nominally, £26 is equivalent to $52.

1.2.2 Superannuation in Australia

Apart from the Age Pension, the other major source of income in retirement for Australians is superannuation, this latter term being the name used in Australia for the structured process of putting money aside, either by the employer or the employee, during working life so as to have funds available for retirement. Whilst there have always been superannuation schemes in place in Australia, it is useful to consider these schemes in two phases, firstly the situation before the introduction of the Superannuation Guarantee (SG) and then the years since its introduction (Nielson, 2010a).

1.2.2.1 Superannuation before the Superannuation Guarantee

Before the 1980s, only 40% of the workforce had access to superannuation, these people being either senior management in private enterprise or public sector employees (Borowski, Schulz & Whiteford, 1987;Ward, 2000). There was no opportunity to preserve superannuation benefits when changing employers. Moreover, there were significant tax concessions associated with superannuation, in particular an incentive to take funds as lump sums rather than as pensions (Gallagher & Preston, 1993). The private enterprise superannuation funds, covering about 30% of employees in this sector, tended to be well funded, but the public service funds, covering 65% of the public service sector, were unfunded (Mitchell & Piggott, 2000).

1.2.2.2 The introduction of the Superannuation Guarantee

The 1980s saw the beginning of major structural economic change in Australia. In the early 80s there was high unemployment and low economic growth. Amongst economists and politicians there was a mood for substantial change to allow for freer trade, financial deregulation, deregulation of markets and a more flexible labour system, but the Australian people, and in particular the union movement, while wanting change, needed encouragement to embrace these fundamental shifts. As a result the government of the day entered into a formal social contract – The Accord – with the trade union movement, such that by the mid 1980s, workers were receiving 3% per annum superannuation as a trade-off for wage increases (Kelly, 2000).

In the early 90s the Australian government mandated superannuation for most Australian employees via the introduction of the *Superannuation Guarantee Charge Act 1992* (Ward, 2000). Under the SG, the agreement was that the contribution rate would rise in gradual steps to 9% by 2003 with there being no requirement for a co-payment by the employee. The superannuation contributions were to be paid into a complying fund, usually designated by the industrial award under which the payments were mandated. As well as accepting the SG payments, these funds also accepted complying voluntary payments from employee members (Australian Prudential Regulation Authority (APRA), 2007b).

In 2001, the Treasury of the Australian Government[4] published a history of the Australian retirement system for the 100 years since Federation with this document setting out how the introduction of the SG expanded the coverage of superannuation in Australia. In 1986, 40% of Australian employees had some form of superannuation but by 1999, this figure had risen to more than 90%. However, it is important to recognise that the type of superannuation provided had, for the most part, changed. The schemes provided to public servants and senior executives in the private sector were usually defined benefit, with the employer bearing the risk. With the advent of the SG, the great majority of new accounts were defined contribution with the employee taking on the investment risk (Treasury, 2001).

The introduction of the SG met several objectives. As mentioned earlier, it supplied a real wage increase, albeit with delayed benefits, but, compared to immediate cash payments, with lesser unwanted impact on inflation and employment. Additionally it provided for much greater self-provision for retirement funding, thus eventually leading to increased funds for consumption in the later years of life. Finally it afforded increased national savings (Dawkins, 1992)[5].

It is important to recognise that the government, in introducing the SG, did not see it as replacing the Age Pension, but instead, for some Australians, as a supplement to the pension as is illustrated by the following comment: "this statement reaffirms the Government's commitment, on grounds of equity and social justice, to assisting lower income workers to live better in retirement through a combination of the age pension supplemented with tax-assisted superannuation" (Dawkins, 1992, p. 1).

[4] The Treasury of the Australian Government is hereafter referred to as 'Treasury'.

[5] It is noted that the contribution of superannuation to national saving is of considerable academic interest but a detailed discussion of this topic is beyond the scope of this thesis.

Since 1992 there have been a series of changes to regulations governing superannuation, these changes including alteration of preservation rules, the introduction of transition-to-retirement pensions, provision for choice of superannuation provider, changes in taxation of both contributions and withdrawals, and change to the way superannuation wealth is assessed for the Age Pension means test (Nielson, 2010a, 2010b; Australian Government, 2013; Treasury, 2013).

Superannuation is now a major player in the Australian economy. As of 31 December 2012, total superannuation assets were estimated to be $1,510 billion, having grown from $245 billion in 1996 and $916 billion in 2006 (APRA, 2007a, 2013). These figures need to be considered with regard to both Australia's Gross Domestic Product (GDP) and the equity market capitalisation for the specified time. In 2006, superannuation assets were at the value of 20% of GDP, but by 2012 were at 115% of GDP, whilst, compared to equity market capitalisation, the figures were 18% and 113% respectively (ABS, 2012b; Australian Stock Exchange (ASX), 2013)

1.2.3 Assessment of Australian approach to retirement funding

For analysis of the provision of retirement funds, the pervasive analytical framework is that of the three pillars developed by a 1994 World Bank study. In 2004 Kingston argued that, over the decade since its publication, general consensus had developed that this framework provided international best practice. This view is supported by the number of academic articles and policy reviews that use this framework, examples being McGillivray (2000), Bateman and Piggott (2001), McMorrow and Roeger (2002), Knell (2005), de Mesa et al. (2006), Henry (2009), and Bateman (2009).

The purpose of the World Bank study was to develop a strategy for old age programs that would meet multiple goals, including provision of a minimum basic income in old age whilst encouraging people to save for retirement, and ensuring sustainability and transparency. The authors argued that a single pillar approach to retirement funding could not meet these objectives and proposed a three pillar framework. The purpose of the first pillar, by its nature publicly managed and tax-financed, is to alleviate poverty and thus has a redistributive and insurance focus. The second pillar is that of mandatory savings, which the authors argue, should be fully funded, privately managed, but publicly regulated. The third pillar is voluntary savings, either via employment or undertaken personally (World Bank, 1994)[6]. For the Australian system, pillar one is the Age Pension, in pillar two are the funds accumulated via the SG, and in pillar three are additional savings including contributions to superannuation beyond the SG, but also including savings and investments outside of the superannuation umbrella. The first and second pillars are discussed immediately below.

The Age Pension is Australia's first pillar. It is a means tested, non-contributory payment that allows only for a modest lifestyle, rather than a universal, non-means tested, flat rate as provided in some countries or a payment depending on contributions to the national social security system as provided in yet other countries (Organisation for Economic Co-operation and Development (OECD), 2011).

Australia's second pillar is the SG. As with the first pillar, the Australian approach is different to many countries. The Australian SG is privately managed with individual accounts for which the owner of the account determines the investment strategy and bears the risk. Approaches used by other countries for this pillar include those where people contribute to publicly managed funds for which the government bears the risk (Mitchell & Piggott, 2000).

On the surface, the Australian system does meet the requirements set out by the three pillars framework and, as stated by King, Walker and Harding (2001, p. 155) was "identified by the World Bank (1994) as a model system". The Treasury also viewed the World Bank's assessment of the Australian system as being a model for other countries, stating:

> This is reflected not the least in the World Bank's effective endorsement.... of Australia's three pillars as the approach which offered the best prospect of simultaneously being fiscally sustainable in an environment where the population is aging, of improving national saving, ensuring intergenerational equity and providing higher incomes in retirement. (Treasury, 2001, p. 66)

More recently Agnew (2013, p. 1) stated "Australia's retirement income system is regarded by some as among the best in the world. It has achieved high individual savings rates and broad coverage at reasonably low cost to government."[7]

---

[6] The World Bank continues to develop a policy framework for retirement funding, taking into account the various needs of countries at different stages of economic development. In particular, there is the work of Holzmann (2012) which proposes a five pillar approach.

[7] Whilst it is acknowledged that individual savings via superannuation have increased, it is contested as to whether national saving has increased (The Allen Consulting Group, 2007; Gruen & Soding, 2011; Bishop & Cassidy, 2012)

However analysis of the system does suggest some problems. Kingston (2004) argued that the efficacy of the system as a whole is limited, some reasons being the taxation regime applied to superannuation, excessive fees and charges on superannuation accounts, and liberal access to the Age Pension. Bateman (2009) identified the flaws as being under two broad headings: (i) risk and responsibility for retirement incomes are now largely with individual retirement savers and (ii) the policy design for decumulation of funds is flawed. Agnew (2013) particularly identifies the lack of annuitisation of retirement funds as of concern, and also highlights the incentives for ‘double dipping’ which is the process of using up second and third pillar retirement savings so as to access, at least in part, an Age Pension. The flaws set out above imply that individuals may reach retirement with less than optimal funds, and that these funds may be deployed sub optimally in retirement. Moreover, from a public policy perspective, the Age Pension is used to supplement the funds of individuals who could provide for their own retirement.

1.2.4 The Australian retirement system: intergenerational issues

As well as analysing the Australian retirement system from the perspective of appropriate savings structures, it is also necessary to understand the retirement system in relation to the population distribution. The Age Pension is funded directly from tax revenue, and thus it is necessary to consider the relative numbers of people paying taxation as opposed to those benefitting from cash transfers.

Australians are a steadily ageing population. In 1990 the median age of Australians was 32.1 years, but by June 2010 the median age had risen to 36.9 years. In this same time period the proportion of Australians aged 65 or older had risen from 11.1% to 13.6%. In particular, during this time the percentage of people aged 85 or more had grown by 171%, compared to the total population increasing by 31%. In 2006 Australians aged 85 years old or older formed 12% of the population aged 65 or greater but, with the ageing of the aged, this proportion had grown to 13.4% by 2010. Whilst in 2010 1.8% of the population were aged 85 or greater, it is expected that this segment of the population will comprise at least 5% of the population by 2056 (ABS, 2008b, 2010).

The Intergenerational Report (IGR) of 2010 states that the value of Age Pension and related payments in 2009/10 was estimated to be 2.7% of GDP, with these payments projected to increase to 3.9% of GDP by 2050 (Treasury, 2010a). As stated earlier, funding of the Age Pension has been from current revenue, and thus the economic burden for paying the pension for one generation falls to succeeding generations. The ABS projects that by 2056 around 24% of the population will be aged 65 or more, compared to the 13% in 2007. A century ago, when the Age Pension was introduced, only 4.3% of the population were aged 65 or older (ABS, 2008a, 2008b). This ageing of the Australian population has generated much discussion about the sustainability of succeeding generations financially supporting their elders, examples of this discussion being Kelly and Harding (2004), Guest (2008) and Chomik and Piggott (2012).

1.3 Attitude of Australians to retirement savings

Whilst, as discussed in Section 1.2.3, the academic assessment of Australia's retirement funding approach is broadly positive, this view of the situation is not shared by all Australians. In particular, superannuation is viewed as being alienating, confusing, complicated and risky. The Australian Institute of Superannuation Trustees (AIST) recently commissioned research that found that 40% of respondents believed superannuation is too complex to understand, nearly 60% saw it as being very risky and 25% stated that they did not see superannuation as being an important element of their retirement portfolio (AIST, 2013). A survey conducted for the Association of Superannuation Funds of Australia (ASFA) found that only 27% of respondents reported that they were satisfied with the superannuation industry as a whole (Clare, 2011). A survey of Australians aged 25-44, conducted by Galaxy Research during 2012, found that 60% of participants selected terms such as 'boring', 'baffling', 'difficult to understand' and 'for people older than me' whilst only 25% selected positive descriptors such as 'interesting' and 'motivating'. Moreover, three quarters of respondents saw that superannuation terminology made it difficult to engage with their superannuation provider (McMeekin, 2012).

This negative view of superannuation is often reinforced by commentary in the media. Alan Kohler, a financial analyst with a daily appearance on a national television news program, wrote "It doesn't take more than a few moments thought to understand that Australia's superannuation system is not the paragon it's cracked up to be" [8] (Kohler, 2012). Another damning critique of the superannuation system was provided by an

[8] Kohler's contention is that superannuation exposes savers and retirees to market and longevity risk, fees and charges are too high, and that older Australians are being encouraged in invest in assets that are too risky.

investment strategist, Chris Becker, who wrote in an article named ‘Simply stupid superannuation’:

> Superannuation is one of, if not the most difficult financial constructs of the modern age. Forget collaterised debt obligations, interest rate swaps or contracts for difference. The complexity involved for what should be a simple proposition – save some money for retirement so that the government doesn’t have to – has boiled over in a magma of confusing and continual policy changes, turgid legislation, overwhelming regulatory requirements, unreadable annual reports and a glossary of terminology that would have most physicists reeling. (Becker, 2012)

A major reason for this negativity is the complex set of decisions Australians have to make if they are be engaged with the system. As Bateman (2007) stated:

> The Australian private retirement saving arrangements (superannuation) require individual retirement savers to undertake an increasing number of choices. These include, choice of pension (superannuation) fund; choice of investment strategy (which may include choosing from a menu of multi manager diversified and specialized options, specific investment managers and/or asset classes); choice of whether to make additional voluntary contributions; and choice of type of retirement benefit. (pp. 25-6)

However, as this author argues in a later article:

> the public and private arena of Australia’s retirement income arrangements complement each other and together have the potential to provide cover against the main economic and financial risks faced in retirement. ... this potential will only be realised when retirement savers remain engaged and make appropriate retirement choices throughout their lives. (Bateman, 2009, p. 19)

It is not surprising that many Australians opt out of active participation. In particular it is the least financially secure section of the population that are not engaged (Hesketh and Griffin, 2010; Quine, Bernard and Kendig, 2006). Johnson (2008) reported that fewer than 10% of retirees had a formal financial plan, and that the trigger for developing such a plan was the decision to retire i.e. there is very little planning for retirement, even when Australians are aged around 50. When people do start to plan, there is evidence that at least some regret not saving more in their younger years.

However, saving for retirement means the taking a leap of faith, especially in the years of early adulthood. As Selnow (2004) states:

> Retirement savings advocates face one of the most daunting communications tasks imaginable. They seek to promote within the labour force a willingness to set aside scarce resources for some distant age that the worker may or may not reach for rewards that the worker may or may not achieve, at a price today that the worker may not wish to pay. (p. 43)

1.4 Aims of the thesis

From the discussion in this chapter, it can be seen that there are two perspectives in considering the Australian retirement funding approach in practice – the perspective of the individual[9] and the public policy perspective.

From the individual perspective, the key issues are: (i) how to accumulate retirement funds and (ii) how to use these funds for retirement. There are four key, interrelated factors:

- The percentage of wages, including the SG, which should be contributed into superannuation at each stage of the accumulation phase.
- The optimal consumption-savings decision for each stage of the accumulation phase.
- The amount of funds to be withdrawn at each stage of the decumulation phase.
- The optimal investment strategy for each stage of the decumulation phase.

From a public policy perspective, given it has always been the policy view that, for many Australians, retirement funding will comprise of both the Age Pension and private savings, it is appropriate to explore the interplay of Age Pension and private funding of retirement.

Given these issues, both for the individual household and for public policy, the research problem for this thesis is:

- From a financial perspective how can an Australian optimise financial decisions in order to provide for a comfortable retirement?

The specific objectives of the study are to:

1. Determine the optimal methods and rates of accumulation and decumulation for a range of representative segments of the population, assuming a rational, self-interested perspective.
2. Identify the gaps between optimal accumulation and decumulation, and sub-optimal accumulation and decumulation when behavioural attitudes influence selection of accumulation and decumulation options.

[9] Depending on the context, 'individual' may mean an individual person or individual household.

3. Determine the Superannuation Guarantee percentage that needs to be in place for average Australians to have their retirement funded to a comfortable level commensurate with average Australian standards by personal superannuation / savings, supplemented by the means-tested Age Pension.
4. Establish the characteristics of households that would be eligible for the Age Pension, given the selection of economic factors and policy options.

1.5 Methodology adopted in this thesis

The nature of the research problem demands a modelling approach. There is considerable research being carried out in Australia into retirement issues using such an approach. The Retirement and Income Modelling Unit (RIM) within the Australian Treasury uses three types of superannuation micro models – hypothetical tax benefit models at the individual and the couple level, cohort models (or actuarial models) and microsimulation models (Treasury, 2012). NATSEM (National Centre for Social and Economic Modelling) at University of Canberra has developed dynamic microsimulation models to investigate retirement issues (Kelly, Harding and Percival, 2002).

For a significant portion of Australian empirical research into retirement funding issues, standard econometric approaches are used, for example Ganegoda and Bateman (2008), Sy (2009), Cardak and Wilkins (2009) and Dobrescu (2012) Another approach is to use actuarial techniques, for example, Doyle, Mitchell and Piggott (2004). Simulation methods including bootstrapping are also used for example Basu and Drew (2010) and Hulley, McKibbin, Pedersen and Thorp (2013).

In studying the research problem set out above there is another investigative approach available – mathematical programming, which is essentially an optimisation technique. Mathematical programming is an umbrella term for such techniques as linear programming, non-linear programming and dynamic programming. These techniques are powerful in that an objective function incorporating a decision maker's preferences can be optimised under the constraints of individual circumstances. This approach is quite effective in accommodating variations in these circumstances, as a result of changing preferences or other constraints imposed by the environment. Government policies can be formulated as constraints to estimate their impacts on optimal decisions.

Further, an initial solution can be used to test sensitivity to the key variables and to estimate shadow prices, or opportunity costs of choices.

A particularly potent aspect of mathematical programming is that, under some circumstances, a globally optimal solution to the problem can be established. When this is the situation, all possible solutions can be judged in relation to this optimal solution. This potential for identifying optimal solutions does not apply to standard measurement approaches.

This study uses linear programming, together with its close variant mixed integer linear programming (MILP), as its method of analysis. These methods offer an effective approach to investigating the research problem and its specific objectives and have been used extensively in determining optimal solutions in many fields including agriculture, management, engineering and medicine, as well as in economics and finance. Examples of such studies include Walsh et al. (2003), Kuo et al. (2003), Naraharisetti, Karimi and Srinivasan (2008), Lee et al. (2011), Papahristodoulou (2004) and Barbosa and Pimentel (2001). The discovery of powerful algorithms for solving linear and integer programming has led to the development of desktop solving engines available at a reasonable price, providing details of optimal solutions in minutes.

Linear programming is an adaptable modelling method that allows multiple periods to be included in the decision horizon. Many of the model's relationships are by nature linear, but non-linear relationships are often able to be expressed as either a set of linear inequalities, or as a linear approximation over a short domain.

Whilst mathematical programming has been used in a limited manner to investigate life cycle issues[10], there is no evidence that mathematical programming, and in particular linear programming, has been used in researching investment and consumption decisions in the Australian context. Thus this thesis contributes to knowledge in that it investigates an important area of the Australian economy using a previously unused approach.

In this thesis discrete–time series models will be developed, each with a finite horizon and a finite number of states. These base models, together with appropriate sensitivity

[10] Two examples of such research are Cocco (2005) and Chai, Horneff, Maurer & Mitchell (2011). Neither are studies in the Australian context.

analysis, will be used to explore factors pertaining specifically to each of the research objectives.

1.6 Statement of significance

As demonstrated earlier in this chapter, financial provision for retirement is a topic of national importance. It is government policy, via the SG, that average Australians contribute substantially to their own retirement and that individuals bear the risk for investment returns in both the pre-retirement and retirement stages. Recent policy reviews concerning taxation, pensions and superannuation have provided policy recommendations, only some of which have been adopted. This research enables proposed and existing policy and policy recommendations to be modelled, with the results providing data as to the efficacy of such policy initiatives.

As stated previously, the nature of mathematical programming techniques provides for optimal solutions to be identified. These optimal solutions can be used in conjunction with results obtained from traditional econometric modelling. Thus at this broad policy level, this research is significant.

At a more specific level of detail, the model is able to be customised to reflect different and changing situations. Thus, further development of the model will allow financial planners to explain to their clients the relative importance of particular decision variables in providing a retirement lifestyle that is both sustainable economically and meets the preferences of retirees themselves.

1.7 Organisation of the thesis

This chapter gives an overview of retirement funding in Australia, providing data on the longevity of individual Australians and setting out some of the intergenerational issues facing Australia as it comes to terms with an ageing population. The approach for the provision of retirement funding is evaluated from an academic perspective, but also discussed from the point of view of ‘ordinary’ Australians. The research problem is identified and specific questions to be answered are delineated.

Chapter 2 examines both academic research and policy reviews and formulation relating to the thesis topic. Within Chapter 3, the conceptual framework for this research is developed and the methods of analysis set out specifically and in detail. The results of the analysis are discussed in Chapter 4. Chapter 5 consists of a summary of the research undertaken for this thesis, its implications and suggestions for further development.

Chapter 2 Literature review

As stated in Chapter 1, in investigating the problem of this thesis, the key question is that of how a household provides for consumption over a lifetime, ensuring funds are available at all times, including the retirement years i.e. the years when there is no labour income. This problem has been studied extensively with discussion informed by two frameworks: the standard economic model and the behavioural economic model[11]. It is also the subject of much policy debate and formulation, and thus, in some matters, legislation.

Chapter 1 introduced the subject matter of this thesis and articulated its objectives. The current chapter will discuss the theoretical issues and review the literature.

There are three sections in this literature review: (i) theory, (ii) practice and (iii) policy. In the first section, the relevant key theories of the two frameworks are set out. In the second section significant issues relating to a household providing for consumption over a lifetime are examined, with particular reference to these two frameworks. Finally there is a discussion of major policy issues relating to the topic.

2.1 Theoretical and conceptual issues

In undertaking academic research it is imperative to understand the key overarching theories of the field of concern. The *New Shorter Oxford English Dictionary* (1993 p.3274) has, as one of the definitions of the term 'theory', the explanation that it is "a system of ideas or statements explaining something, especially one based on general principles independent of the things to be explained". For this thesis two such systems of ideas i.e. the standard economic model and the behavioural economic model, are considered.

Both of these systems of ideas are positive in nature, being concerned with 'what is' rather than 'what should be'. Both postulate ways that a person behaves in an economic context i.e. a situation where it is necessary to allocate scarce resources to satisfy unlimited wants. These two models are discussed below.

---

[11] The terms 'standard economic model' and 'behavioural economic model' follow their use by Wilkinson (2007).

2.1.1 The standard economic model

The standard economic model (SEM) is the system of ideas used for a considerable percentage of investigation into consumption over a lifetime. Within this system, it is held that man acts rationally in self interest.

The relevant ideas of this model for this thesis are rational choice and self interest in economic decision making together with the associated concept of utility, utility and intertemporal choice, lifecycle theories of consumption and finance theory. These concepts are expanded in the following sections.

2.1.1.1 Rational choice, self interest and utility

In providing for consumption across a lifetime, what is fundamentally important to households is not the quantum of readily available cash to fund their consumption choices but the 'enjoyment' or 'well being' that these funds provide. As mentioned before, the fundamental premise of the SEM is that people act rationally and in self interest. Hence, using a standard economic framework, it can be expected that a household will be able to choose, in a rational manner, the pattern of consumption across the lifetime that gives the most pleasure or highest well being, subject to the limitations experienced by the household in funding such consumption.

The measure of pleasure or well being in an economic sense is known as utility, the initial views on utility having been put forward by the utilitarian philosopher Bentham and his followers. As stated by Read (2007, p. 46), Bentham's assumptions were "the goodness and badness of experience is quantifiable, and the quantities so obtained can be added across people".

Bentham's view of utility has been modified over the years with current thinking being that utility is an ordinal measure, i.e. a way to rank desirability or preference. With this view of utility, indifference curves can be set up to express the household's view of the utility of different choices such that choices that provide equal utility sit on the same indifference curve. Using the standard economic framework, the definition of rationality is that the axioms of completeness, transitivity and continuity hold. Completeness infers that the household is always able to state that, given two choices A or B, the household prefers A to B, or prefers B to A, or is indifferent between A and B. Transitivity ensures that if the household prefers A to B and B to C, then it follows that A is preferred to C.

Continuity infers that if the household prefers A to B, then the household will prefer a situation very close to A rather than one close to B (Varian, 2003).

Utility, as discussed immediately above, relates to situations with certainty, However providing for one's retirement and then consuming the retirement funds in the latter years of life involves making choices under risk and uncertainty. A key development in understanding preference under uncertainty was the work of von Neumann and Morgenstern, originally published in 1947, which described rational decision making in this circumstance through a set of four axioms, three of which are completeness, transitivity and continuity as described above but where A, B and C are now lotteries rather that defined outcomes. The fourth axiom is that of independence which means that the ranking of two lotteries is independent of any irrelevant alternative. Assuming these axioms, von Neumann and Morgenstern demonstrated mathematically that a utility function exists and this function satisfies the expected utility property. This expected utility theory (EUT) sets out that if a person undertakes a gamble with n different possible outcomes – g_1 g_2 g_3 ...g_n with associated probability p_1 p_2 p_3 ... p_n then the expected utility of the gamble is $u(g) = p_1u(g_1) + p_2u(g_2) + p_3u(g_3) + \ldots + p_nu(g_n)$ (von Neumann and Morgenstern, 1966).

EUT is useful in the practical analysis of retiree behaviour as choosing a method of investment is a gamble. As Venter (1984) explains, this function enables utility theory to move from the subjective consideration of well being to being able to be set up as a part of consistent decision making, taking risk preferences into account.

2.1.1.2 Utility and intertemporal choice

This thesis is concerned with choice across a lifetime. A person or household must make decisions at a particular time that will provide benefits and incur costs, not just at that point of time but also at points in the future. Invariably these decisions involve trade-offs.

As set out in Section 2.1.1.1, within the SEM it is assumed a person will act rationally to maximise utility. In a situation of intertemporal choice, maximising utility involves being able to combine, in some fashion, the utility of each period into a measure of utility across all periods. Frederick, Loewenstein and O'Donoghue (2002) proposed that, whilst there had been previous attention given to this issue of determining utility across several periods, it is the discounted utility model (DUM), set out by Samuelson (1937), that has captured the imagination of scholars adopting the SEM.

Samuelson proposed the existence of an intertemporal utility function, defined as the sum of the discounted utility of each period, where the discount factor for the n^{th} period is $(1/1+p)^n$ and *p*, the person's discount rate, is constant across all periods. By its nature, this measure of utility is cardinal, rather than ordinal. In the DUM, the axioms of expected utility theory i.e. completeness, transitivity and independence, hold. Further, the model assumes that a person's preference does not change over time and that the discount rate is constant over time.

Samuelson himself expressed reservations about his model. However, as stated by Frederick, Loewenstein and O'Donoghue (2002, p. 2), "despite Samuelson's manifest reservations, the simplicity and elegance of this formulation was irresistible, and the DUM was rapidly adopted as the framework of choice for analysing intertemporal decisions".

2.1.1.3 Lifecycle models

Other ideas, important for this thesis, emanating from the SEM, are those providing models for life time consumption.

In 1936 Keynes postulated that the level of consumption of individuals during a particular period is dependent on their disposable income in that period and thus any expected future income is ignored. Critical evaluation of this hypothesis led to two hypotheses being put forward to explain the income-consumption nexus i.e. Modigliani's Lifecycle Hypothesis (LCH) and Friedman's Permanent Income Hypothesis (PIH).

The LCH was originally put forward by Modigliani and Brumberg in 1954. Assuming rational decision making, it proposed that a person stages consumption over a lifetime to maximise lifetime utility. In the earlier stages of the lifecycle, the person will save for the retirement years when there will be no labour income, and thus consumption is smoothed. An implication of this hypothesis for the individual is that wealth is at its maximum at the point of time when the person retires and thus, for the macro economy, implications of this hypothesis include that national savings is not dependent on national income but on the growth of national income (Deaton, 2005) and the age distribution of consumers (Baranzini, 2005). As Deaton argues, the LCH has provided a framework to thinking about important issues such as how societies articulate strategies for an increasingly ageing society.

As with Modigliani, Friedman did not support Keynes' view that savings is dependent on current income. In response to substantial empirical evidence over many years that was in disagreement with Keynes' view, Friedman (1957) put forward the Permanent Income Hypothesis (PIH). Essentially Friedman proposed that, rather than consumption being determined by current income, consumers consume according to long term expectation of income. As with the LCH, the PIH assumes rational decision making. The LCH and the PIH can be considered as complementary with the LCH providing a framework for considering consumption over a lifetime, incorporating retirement, a period of no labour income, whilst the PIH provides a framework for an extended period where there is fluctuating income.

Since the PIH was put forward more than 50 years ago considerable theoretical and empirical study has used it as a framework. As Meghir (2004, p. F305) states, "the original idea has not only survived, but has formed the basis for developing a coherent analysis of consumption and savings".

The two hypotheses, the LCH and the PIH, provide a conceptual framework upon which ideas can be more fully formulated and empirical data tested. Scholars investigating questions pertinent to this thesis have used these hypotheses, often amalgamated as the LCPIH, to examine empirical data and propose further theories relating to retirement consumption.

2.1.2 The standard economic model - finance theory

Although the academic discipline of finance is considered distinct from the discipline of economics, Parada Daza (2008) argues that finance theory can be considered as a continuation of the SEM given that the central tenet of the SEM, i.e. a person will act rationally with self interest, holds for this body of theory, and is fundamental to it. Several key ideas of finance theory are relevant for this thesis – time value of money, modern portfolio theory, and choice of portfolio in a multi period situation. These theories are discussed immediately below.

2.1.2.1 Time value of money

The first principle of standard finance, the time value of money, is self evident. A dollar today is worth more than a dollar in the future, as the dollar today can be invested and thus be earning income immediately.

2.1.2.2 Modern portfolio theory: mean–variance optimisation

Within the standard finance approach, Merton (2003) identified the three major approaches to personal financial risk management as being hedging, diversification and insurance though he concedes that for retirement planning by far the major focus has been on diversification.

The foundation of diversification as a risk management approach for asset allocation is the seminal work of Markowitz (1952). Merton (1992, p. xiii) wrote that the discipline of finance in the years before Markowitz was "little more than a collection of anecdotes, rules of thumb and manipulation of accounting data". Markowitz recognised the power of diversification and that efficient investing involved understanding the relationship between risk and expected return of investment portfolios. His insight in identifying the risk of the portfolio as a function of the variance of the returns enabled the power of mathematical statistics to be invoked in understanding optimal portfolio choice (Miller, 1999).

2.1.2.3 Optimal portfolio selection across a lifetime

Markowitz's analysis of optimal portfolio selection was restricted to one period. The problem under discussion in this thesis is over a life time and is thus multi period with investment and consumption being considered together. Samuelson (1969) investigated optimal portfolio selection across multiple periods using a discrete time model where the portfolio consists of both a risk free asset and a risky asset and the returns on the risky asset are stochastic. He found that, for utility functions exhibiting constant relative risk aversion, optimal portfolio selection depends on the risk profile of the investor, not on the current stage of the lifecycle of the investor. As Samuelson discussed, the widely held view of investment at the time of his writing was that people in the early stages of their careers should invest in risky assets while elderly people should invest in safer assets.

Contemporaneously Merton (1969) examined the same situation as Samuelson (1969), but in a continuous time environment, and with a particular assumption as to the stochastic behaviour of the return on the risky asset. Again utility exhibiting constant relative risk aversion was assumed. Merton's findings are in agreement with Samuelson in that the decision with regard to portfolio selection is independent of any decision regarding consumption. Rather, the learning from Samuelson and Merton is that the portfolio selection depends on the individual's risk profile and not on age. In particular the view is that investment in risky assets is risky at all times, and that having such an investment over a long time does not ameliorate the risk.

Hakansson (1970), as with Samuelson (1969), explored portfolio selection and consumption in a discrete time model, but included in the same model the portfolio composition decision, the financing decision and the consumption decision for a situation where there is a known income stream. For a set of four utility functions, he established that the investment strategy for each period is independent of the investor's wealth at the beginning of the period, her income for the period, her age and her impatience to consume, but depends only on the probability distributions of the returns of the asset classes, the cost of borrowing and the investor's utility function of consumption for that period. The optimal consumption function is a linear function of both the investor's wealth for that period and the income for the period. Hakansson also demonstrated that, for three of the four utility functions, the optimal consumption function satisfies the LCPIH.

2.1.3 Behavioural economics and finance

As discussed in Section 2.1.1, the standard economic model (SEM) is based on the view that in all circumstances a person acts rationally to achieve maximum self interest. When faced with observed inconsistencies, scholars using this framework seek to reconcile the evidence by extending the theory. However, rather than trying to fit the observed data into this particular theory, other scholars have proposed an alternative theoretical approach.

An alternative system of ideas for explaining decision making under risk and uncertainty is that provided by the behavioural economic model (BEM). Scholars using this framework reject the SEM assumption stated above of self interest and narrowly defined rationality and instead insights from psychology are used to propose alternative theories of human behaviour in an economic context.

The literature relating to BEM is considerable. Discussion of BEM in this thesis is limited to four key ideas that are situated within this framework: bounded rationality, time inconsistent preferences, prospect theory, and mental accounting. These ideas are discussed below.

2.1.3.1 Bounded rationality

Simon (1955) proposed that human beings making decisions use processes not fully consistent with the rational framework, in particular a simplified pay-off function and streamlined information gathering, arguing that people "make rational adjustments that humans find "good enough" and are capable of exercising in a wide range of practical circumstances" (p.118). The term "satisfice" is used to describe satisfaction at this 'good enough' level (Simon, 1956, p.129), with an example of satisficing being the use of decision heuristics. In a situation of complexity and ambiguity with possibly both limited time and limited computational ability, the use of such mental shortcuts allows for 'good enough' decision making (Wilkinson, 2007). Simon's model of decision making has become known as bounded rationality (Simon, 1957).

2.1.3.2 Time-inconsistent preferences

As set out in Section 2.1.1.2, within the SEM, the approach used to explain choice in a multi period situation is the DUM. Within the BEM, there is considerable attention given to this issue, with scholars proposing models to explain observed decision making which exhibits behaviours such as procrastination, inertia and the implementation of measures to enforce future self control, behaviour that is inconsistent with the consistent time preference that underpins the DUM.

Strotz (1955) demonstrated that it is solely an exponential discount factor, as per the DUM, that provides for time consistent preference. Observing that not all people behave in this time consistent manner, he postulated that some people discount utility so that valuation of their utility falls rapidly for near future times but falls slowly for times in the far future. This form of utility discounting is now known in the literature as hyperbolic discounting. Since Strotz' publication, there has been significant development of theory pertaining to time inconsistent discounting (Frederick, Loewenstein & O'Donoghue, 2002; Wilkinson, 2007).

2.1.3.3 Prospect Theory

Kahneman and Tversky (1979) sought to explain persistent observed decision making under risk that is inconsistent with EUT. These scholars asserted that the empirical evidence demonstrates that, in making decisions involving risk, people are not concerned with their end state of wealth or welfare but in the change of their wealth or welfare brought about the result of their decision. In particular, losses are felt more keenly than gains and given this latter situation, the framing of the decision under consideration has an impact, given that sometimes a decision can be presented as a gain, or alternatively as a loss.

The theory set out by Kahneman and Tversky, known as Prospect Theory, proposes that person making a choice where risk is involved works through two phases. The first is an editing phase where the choices are transformed by several mental processes (coding, combining, segregating, cancelling, simplifying, and detecting dominance) into prospects that are more easily able to be evaluated. The second phase is that of the evaluation of the edited choices where these competing choices are assessed as to their subjective value and then this subjective value is transformed by the application of a decision weighting. Kahneman and Tversky propose that there are three factors contributing to the subjective value i.e. (i) the initial value of the asset as a reference point, (ii) the sign of the change of the asset value from the initial reference point, and (iii) the marginal subjective value, which decreases with increasing gains and losses. Regarding the decision weighting, Kahneman & Tversky assert that the decision weights are not objective probabilities, but rather a subjective weighting of probability. In a later paper, the authors extended this theory to situations of uncertainty (Tversky and Kahneman, 1992).

2.1.3.4 Mental accounting

In business, firms use an accounting system consisting of several steps with three of these steps being attributing value, assigning the attributed value to particular accounts and, at the end of some time frame, closing these accounts. Thaler (1985, 1999) proposed that persons making decisions about their own money engage in mental accounting, an activity parallel to business accounting. He argued that there are three components of this process i.e. ascribing value to a transaction, assigning the value to an account, and providing a timeframe at the end of which accounts are balanced.

Building upon Kahneman and Tversky's Prospect Theory, Thaler argued that, when a person is about to make a financial transaction, a value function as per Prospect Theory is used to inform the decision. This function values the transaction using some reference point with losses being perceived differently to gains of the same increment, starting at the same position, and thus the framing of the transaction has an impact on the assessment of value. Extending Prospect Theory, Thaler contended that people facing decisions where there is more than one outcome may either segregate or aggregate the outcomes, and that the decision to segregate or aggregate is predictable. Thaler named the value the decision maker ascribes to this transaction is as 'acquisition utility'. In addition, Thaler proposed, the value of the transaction is moderated by how the person perceives the fairness of the transaction, naming this value as 'transaction utility'. With regard to the second component of his theory of mental accounting, Thaler sets out that the ascribed value of a transaction is assigned to an 'account' for which a budget has been previously set. These mental accounts are defined not only by outcomes but also by the source of funds used in the transaction. Thaler proposes that these budgets are not fungible. The existence of these accounts assists in the person maintaining self control in economic matters. The third component of Thaler's theory relates to time frames. At some stage, a mental account is closed, with gains or losses being 'realised'. Thaler suggests that the timing of such closure is influenced by loss aversion and the persistence of sunk cost effects.

2.2 Provision of retirement funding

Thus far, the discussion has been concerned with economic theories. In this section, the literature relating to the provision of retirement funding is discussed.

Provision for retirement funding can be considered to have three stages: (i) accumulation, (ii) transition to retirement where there is conversion of accumulated funds and other assets into assets appropriate for decumulation, and (iii) decumulation. For the three stages there are key identifiable issues, each attracting considerable academic discussion. There are also some issues that are pertinent across the lifecycle: (i) risk-return considerations, (ii) home ownership, (iii) life insurance, (iv) the role of financial literacy and of the financial planning profession, and (v) leaving an estate.

Issues relating to the three stages and the five issues are discussed immediately following, taking into account insights provided by the two economic frameworks i.e. the SEM and BEM, as set out in Section 2.1. In Section 2.3 there is further discussion, from a public policy perspective, of some of the issues discussed in this section.

2.2.1 Provision of retirement funding - Accumulation

Australian households can grow wealth for retirement in several ways, including:

- Compulsory contributions from employers into a personal superannuation account. These contributions are known as Superannuation Guarantee Levy (SGL).
- Discretionary contributions to the personal superannuation account, either before tax (salary sacrifice) or post tax. There are limits as to how much can be contributed given the taxation benefits available.
- Risk free savings with financial institutions enjoying a level of government guarantee.
- Financial instruments of various risks i.e. stocks, bonds, managed funds.
- Investment housing.

In addition, an Australian household buying a dwelling for its own shelter is also purchasing an asset that provides a sink of funds that may be able to be converted into an income stream in the retirement years.

Not only is there a multitude of combinations of savings, using the above categories, but decisions have to be made over a significant time span. Given that employers are obliged to make SGL contributions for casual and part time employees, many Australians will have a superannuation account in their teenage years, and thus will need to be managing their assets in preparation for retirement until age 67 or beyond – a span of more than 50 years.

A related issue is, of course, the value of the assets that needs to be accumulated for a satisfactory retirement, and thus the amount that needs to be saved on a regular basis. As the answer to these questions depends to a great extent on the standard of living required for these retirement years, pertinent literature will be discussed in Section 2.2.3.2.

As stated in Chapter 1 Section 1.3, for the Australian approach to retirement saving to work optimally, there is a need to for Australians of all ages to be adequately engaged, making timely decisions as appropriate. However, there is considerable evidence that people find it difficult to demonstrate the level of engagement necessary.

The following discussion sheds light on some issues relating to accumulating funds for retirement. There is considerable evidence that many people, when faced with financial decision making, find themselves in the grip of inertia or procrastination. As well, when decisions are being made, many people find the choices available overwhelming and complicated, and as a result, may resort to using heuristics, some of which may be naive, leading to decisions that disadvantage the person. Other issues are those of people being influenced by the way decision making is facilitated or by the way the information is framed.

An example of a naive heuristic is given by Benartzi and Thaler (2001) who found that when employees needed to allocate their retirement savings amongst several different investment funds, the tendency was to use a rule of thumb, named by the authors as the 1/n heuristic, allocating evenly between all available funds. The results could mean quite different proportions of equity / non-equity investment depending on the types of funds made available. In a later article these authors provide evidence of investors being reluctant to choose just one fund, even when this fund was itself a portfolio of several funds targeted for a particular risk level (Benartzi & Thaler, 2007).

One example of the power of inertia is given by Madrian and Shea (2001) who reported on a company offering an employer pension scheme where there was a change in the way the company operated the scheme. Before the change, an employee needed to elect to join the scheme, after a qualifying period of employment. Additionally, she could actively choose a contribution rate and an investment fund, one of the combinations of choices being nominated as the default choice. After the change of procedure any new employee was immediately eligible for membership, with automatic enrolment together with an option to withdraw. All other aspects of enrolment and participation remained the same. The impact of the change of procedure was that automatic enrolment increased the participation rate from 37% for those needing to make an election to 86% for automatic enrolment, with the authors noting that the change in procedure resulted in even participation rates across all demographic groups. For the staff needing to elect for membership, there were marked differences in participation rates for some demographic groups. However another difference between the two groups was that, for the automatic enrolees, 61% did not make an active choice as to level of contribution or investment fund, opting for the default. The corresponding rate for employees needing to elect to join the scheme was 1%.

Another, particularly stark, example of inertia acting to the detriment of employees is that provided by Choi, Laibson and Madrian (2005). In this case study, employees could elect to contribute to a scheme where the employer would match the contribution dollar for dollar. The rules of the fund stipulated that people of a certain age could immediately withdraw both their own contributions and the employer contributions without penalty. Transaction costs were minimal and the time delay likewise was small, facts acknowledged by employees. However about 30% of employees of the particular age did not make the effort to participate, even after the situation was explained to them.

Sethi-Iyengar, Huberman and Jiang (2004) provide an example of the impact of overwhelming, complex information. Using data about the choices of nearly 800 000 employees in USA eligible to join an employer pension scheme, the authors analysed the participation rates in the scheme where, to join, the employee had to choose a specific investment fund. Where the employee had a choice of only two funds, 75% opted to participate, with the percentage of participation steadily declining as the number of funds increased. The lowest participation rate was for the company offering the most choices (59) where only 60% opted to join. The suggestion from this study is that the amount of complex information needing to be understood and acted upon can lead to inertia.

Carroll et al. (2009) provide an example of how organisational practices can influence financial decision making. The authors report on a USA company where new employees had the option to join a retirement savings scheme. Initially new employees were presented with a set of forms to be filled in, with tight deadlines for completion. Moreover, the new employees were reminded to return the forms shortly before the deadline. Only 5% of new employees did not return the form regarding the decision as to whether to join the savings scheme, and 70% of new staff opted to join the scheme. These results can be compared to later arrangements where new employees were told they could join the saving scheme but it was up to them to be pro-active in making arrangements and no election form was provided. In this later case only 40% joined the scheme.

The above situations cannot be explained using the SEM framework. However the BEM does shed light. Bounded rationality as espoused by Simon and discussed in Section 2.1.3.1 provides some explanation for the inability of people to make optimum choices when faced with complex information. Inertia and procrastination may be considered manifestations of time inconsistent preferences as described in Section 2.1.3.2 (O'Donoghue & Rabin, 1999). An alternative view in explaining these human traits is that of Mullainathan and Thaler (2000) who, extending Simon's idea of bounded rationality, propose that bounded self control contributes to behaviours such as inertia and procrastination.

Moreover, the BEM provides an explanation as to why some interventions and practices work to bring about positive change. One approach that has been shown to significantly increase savings is that of 'Save More Tomorrow' (Thaler & Benartzi, 2004). This plan provides for employees to elect to save a proportion of every future pay increase. Such a program takes into account the key behavioural issue identified by Kahneman and Tversky with Prospect Theory (as discussed in Section 2.1.3.3) where losses are judged more harshly than corresponding gains are appreciated. Thaler and Benartzi report that versions of this program have been used in USA with savings rates increasing significantly. Additionally the dropout rate for 'Save More Tomorrow' savings plans has been low, illustrating a positive impact of inertia.

Another practice that brings about increased saving for retirement is that of automatic enrolment, as illustrated by the article of Madrian and Shea (2001) discussed earlier in this section. 'Another example of such a scheme is that of KiwiSaver, the world's first national auto-enrolment scheme. Since 2007, all new New Zealand employees must be enrolled in a KiwiSaver account where the employee contributes 3% and the employer matches the savings. It is not a compulsory scheme in that an employee can actively choose to opt out within eight weeks of starting employment (St John, 2014)[12]. However, the level of continued enrolment is high at about 80% with only about 20% of

[12] Other features of KiwiSaver are: (i) savings beyond 3% are possible, as are lump sum deposits. (ii) contributors can take break from savings after 12 months of contributions, (iii) a person has only one KiwiSaver account, no matter how many employers or changes of employment, (iv) the individual has a choice of private provider for investing their savings and (v) standard taxation rates are applied on earnings (Inland Revenue, 2014).

new employees opting out (OECD 2014). Selnow (2004) suggests that it is inherently difficult to persuade people to save for retirement as the payoff is uncertain and far into the future, together with the fact that not saving today provides for more funds in the here and now, and argues that automatic enrolment overcomes the problem of following the path of least resistance in this climate of delayed and uncertain benefit and instant gratification, and that once people are enrolled in a savings plan, they stay enrolled, again an example of inertia in action.

As mentioned earlier, information overload, especially if the information is complex, can lead to sub-optimal results in saving for retirement. Thus, the way material is presented is important. Parrish and Delpachitra (2012) carried out an exercise where students were asked to choose a superannuation fund from a selection of six such funds, each with different risk profiles and fee structure. Four survey instruments were used, each providing the relevant information in different ways. The results of the study showed that the way the material was presented had a significant impact on the ability of the respondents to choose a fund appropriate to their situation, as determined by other questions answered in the exercise. In particular, risk labels such as 'aggressive', and 'medium high risk', were used more effectively than specific information such as risk probabilities and the expected number of years of negative returns. This reliance on what maybe subjective labelling was seen as a particular concern by the authors. There may be good reason for this concern. Gallery, Gallery and McDougall (2010) analysed the performance data of the default funds of more than 100 Australian superannuation providers[13] where the default account was named, and was either deemed 'balanced' or 'growth'. The result of the analysis was that the funds could not be distinguished by either target returns or performance

Given the propensity for inertia, and the impact of complex information on decision making, it is not surprising that more than 80% of Australian employees find themselves with a superannuation provider nominated as the default by the employer and having their contributions invested in a superannuation fund nominated as default

[13] For consistency, and to avoid confusion, the term 'superannuation provider' refers to organisations such as HESTA and MLC Superannuation, entities that provide superannuation products and services. The term 'superannuation fund' refers to specific investment options provided by the superannuation provider for contributions e.g. balanced, aggressive, Australian equities, cash. This distinction is made to be consistent with the language used in policy initiatives such as the Cooper Report (see Section 2.3.1.3). Regarding 'superannuation funds' an active investor can usually choose to use a combination of funds e.g. invest 50% of funds in 'balanced' and 50% in 'cash'.

by the fund trustees (Gallery, Gallery & McDougall, 2010). It is obvious that the design of defaults will have an impact on the retirement outcomes of many Australians. Such design is a key policy issue and is discussed in Section 2.3.3

2.2.2 Provision of retirement funding: transition to retirement

At some time there is a transition to retirement stage, a stage that may be no more than an instant or, alternatively, may range over several years depending on the household situation. A person contemplating retirement has to make decisions on how to structure wealth to fund these years of retirement, a span of time that may be considerable, with two particular issues needing to be considered at this time: (i) when to retire, and (ii) how to best structure assets to provide ‘maximum’ return, in particular whether to annuitise wealth, or at least a percentage of wealth.

2.2.2.1 Timing of retirement

As mentioned immediately above, a person may move from full time work to retirement overnight, or alternatively over a considerable period of time. How a person decides on a path may be determined or influenced by implemented policy, and this influence is discussed in Section 2.3.5. However, there are considerations not related to policy that impact on the decision to retire.

One consideration is having sufficient income to allow for the standard of living desired. Whilst sometimes this also is a policy issue, it may not be, especially for people providing for funding outside government pensions. McEvoy and Henderson (2012) studied the reasons why employees who were eligible to take up a private pension in their mid fifties continued to work. 40% of these employees cited the wages received, and 60% non-cash benefits[14], as key reasons for staying in their present job. In a USA longitudinal study Raymo et al. (2011), defining early retirement as that occurring before age 65, found that early retirement is negatively correlated with low paying jobs, and with jobs with no private pension coverage.

For people dependent on stock market returns, it might be expected that volatility of returns would influence timing of retirement. Pang, Warshawsky and Weitzer (2010), using data from the USA Health and Retirement Study (HRS), conclude that workers whose retirement benefits depend on defined contribution plans retire later than those

[14] Such benefits include health insurance, a specific concern of many in USA, but not of such concern for Australians where there is a universal health insurance scheme in place.

with defined benefits, and that the time of retirement is related to business cycles[15]. Goda, Shoven and Slavov (2010), also using HRS data covering the most recent stock market downturn, found that downturns do impact the retirement plans of those of an age close to retirement. However, whilst Kim and DeVaney (2005) using HRS data found that full retirement amongst the 51 – 61 year old participants in the survey was significantly associated with higher investment wealth and lower debt, this asset status was not correlated with part time employment, suggesting there are other reasons why older workers might continue in the workforce.

One such consideration is the enjoyment of work, and the self-esteem and identity associated with it. Parry and Taylor (2007), investigating why some people continue to work past the conventional age for retirement found that many professionals and people in creative roles do not see a time of retirement at all. Mears et al. (2004), discussing the retirement intentions of psychiatrists working in the public sector, reported that only 12% expected to be working in the same position at age 65, but most respondents expected to be working at that age in other related roles where the difficulties associated with full time managerial roles would be absent and they could practise their profession in a more amenable environment. deVries (2009, p. 4), reporting on the views of members of an Australian superannuation fund catering for academics and other university employees, stated that for a large proportion of members "the concept of retirement is irrelevant ... work is a passion and is closely linked to their personal identity and self-esteem". The research participants wanted a transition to full retirement process, incorporating working fewer days and/or fewer hours, and having semester-length breaks in employment. As well they desired fewer administrative duties and great opportunity for activities such as mentoring and research.

Even if people wish to work for a longer time, either to save more for their retirement years or for their own satisfaction, there may be situations that preclude them from doing so. Munnell, Soto and Golub-Sass (2008) questioned whether the health of some people would enable them to work until their mid sixties. Using USA data for people aged 50 they found that, on average, people in the lowest quartile health-wise have an expected life-without-disability of 14 years and thus, because of health issues, some

[15] The authors make the point that this situation does not help business. When the stock market is up, and business needs workers, a person of retirement age is more likely to resign, whilst when the stock market is in decline and business wants to downsize its workforce, workers at normal retirement age are more likely to want to retain their position.

people are forced into retirement earlier than they had wished or planned. McGarry (2002, p. 21) using USA HRS data found that "poor health continues to have a large and significant effect on the probability of continued work, an effect larger that the effects of financial variables". Kim and DeVaney (2005) found that some chronic health conditions led to the take up of part time work, whilst more serious illness led to complete retirement. In an Australian study, Warren and Oguzoglu (2010, p. 366), using data from the Household, Income and Labour Dynamics in Australia (HILDA) study regarding people aged between 55 and 70 came to a similar conclusion, especially for males, stating "for men ... having a long-term health condition or disability that has lasted for 6 months or more is the variable most strongly related to the decision to leave the labour force".

2.2.2.2 The annuity puzzle

During the transition stage to retirement the retiree or household has to decide on how to structure assets for retirement. This decision is important as, in the case of Australia, the way assets are structured may mean access, in some way, to the Age Pension, and thus a source of some regular income. This situation will be discussed under the heading of policy in Section 2.3.5.3.

One option available to a household or person on the brink of retirement is to purchase life-contingent annuities[16]. A life-contingent annuity is a regular payment until death in exchange for a premium. Such annuities may be fixed or variable, the difference being that for a variable annuity each payment depends on the performance of the underpinning assets, whilst for a fixed annuity the asset base is bonds, with the payments being guaranteed. Annuities may be nominal or real, so as to manage for inflation.

The purchase of a life-contingent annuity is a major step. Unlike other options for the investment of retirement funds, the purchase of such an annuity is irrevocable.

Yaari (1965), in the foundational work regarding annuities, demonstrated that, under certain conditions, a rational investor with no bequest motive and an unknown date of death should use all her wealth to buy an actuarially-fair annuity that will pay out until

[16] The word 'annuity' can mean a structured payment plan where a person pays an amount in return for a known payment for a defined number of payments. However, for this section of the literature review the term 'annuity' refers to a life-contingent annuity.

the investor dies. Davidoff, Brown and Diamond (2005) showed that, even when some of Yaari's conditions are relaxed, full annuitisation is still the optimum approach if there is no bequest motive.

There is considerable literature on the benefit of annuities, with the following discussion being limited to just a few articles. Blake, Cairns and Dowd (2003) used the UK regulation that retirement funds must be fully annuitised by age 75 to shape their research[17]. Their model consisted of a two phased approach to annuitisation in that, for retirees aged less than 75 years, the payments would come from a variable payment where the underlying securities would be a mix of both equities and risk free assets. At age 75, the retiree would take on an annuity backed solely by risk free assets. The authors found that the optimal plan for an individual depended on the risk aversion of the retiree with it being optimal for some retirees to invest fully in equities until age 75. Extending their analysis to allow non-annuitisation up to age 85 the authors found that the optimal age for annuitisation, assuming no bequest motive, reached age 79 for some retirees.

Milevsky and Young (2007), allowing for a gradual move from securities to annuities, found that retirees of all ages should always hold some annuities. However, there is benefit in delaying a full switch to annuitisation with the delay time depending on a person's risk aversion level and perceived health status.

Horneff et al. (2008) investigated the situation where a (potential) retiree can invest in variable annuities backed by a combination of bonds and equities. They found that, without a bequest motive, a person should start to move wealth into delayed payment annuities around the age of 40 with full annuitisation by age 65. For people with a bequest motive, it is optimum to move some wealth to annuities before retirement and to continue to move further wealth this way as retirement continues. These authors also found that the expectation of housing and health shocks had only a minimal impact on the optimum annuitisation decision.

The studies cited immediately above use a utility maximising approach. Using a different methodology, Ameriks, Veres and Warshawsky (2001) investigated partial annuitisation employing *Monte Carlo* analysis based upon historical data. Their focus

[17] It is noted that in March 2014 the UK requirement for compulsory annuitisation was abolished (Osborne, 2014)

was to examine, in the context of phased withdrawals, the failure rate of portfolios at particular times after retirement where failure was defined as the portfolio liquidation. They found that annuitising a substantial portion of wealth i.e. 25% or 50%, at the beginning of retirement reduced the likelihood of failure significantly for all levels of portfolio risk.

Looking at retirement from another perspective, it would seem also that there are psychological benefits for retirees to have a guaranteed source of consumption funds till death. As Merton (2003, p. 20) argues, "people in retirement who do not have real life annuities … can become worried about outliving their wealth, so they end up living more frugally than would be necessary, and leaving more money than they want to". The result of such a situation can lead to unplanned bequests, to be discussed in Section 2.2.8.

Given the research findings, it could be expected that there would be a thriving market for annuities. This is not the case. Indeed Brown (2004, p. 2) states: "If ever there were a prediction of economic theory that was blatantly violated by the empirical evidence, it is that of full annuitisation". As Hu and Scott (2007, p. 71) write "the insurance industry has long faced the dilemma that most retirees do not convert *any* retirement assets into annuities". This view is confirmed by evidence that annuities are not being purchased by retirees, at least in some countries including USA, Canada, UK and Australia (Blake, Cairns and Dowd, 2003; Brown, 2007). Bateman and Piggott (2011) report that, although close to 2000 life annuities were sold in Australia in 2001, in 2009 less than 20 were sold, whilst Ganegoda and Bateman (2008) report that, as at 2007, only four life insurance companies were active in the Australian annuity market.

Brown, Casey and Mitchell (2007) looked at the decision to annuitise from a different perspective. They used the USA HRS to investigate whether people would be prepared to give up part of a life contingent annuity for a lump sum. They found, it what they describe as 'striking' results that most respondents were prepared to swap half of their annuity for a lump sum of actuarially less value than the part annuity.

2.2.2.3 Explaining the annuity puzzle from the SEM perspective

As with other normative research, when there is a disconnect between the theoretical optimum and the observed practice, there is discussion as to why the gap occurs. An obvious reason for people not annuitising wealth is that of their perceived need for liquidity above that which the regular annuity payment would give. In particular there is evidence that, at least in USA, retirees are concerned with having ready liquidity to cope with health shocks (De Nardi, French and Jones, 2010; Palumbo, 1999; Yogo, 2009).

Another possible reason is that many retirees are part of a couple. Brown and Poterba (2000) found that annuities for married couples did not give the same degree of welfare enhancement that an annuity for a single person gives. Brown (2004) suggests that this situation for couples is a partial explanation for the annuity puzzle.

Another seemingly obvious reason given for lack of annuitisation is that retirees want to leave a bequest. The evidence is mixed. Brown (2001), using HRS data, found that a bequest motive did not explain annuitisation decisions. Vidal-Meliá and Lejárraga-García (2004) likewise found that a bequest motive, in isolation, is not a major factor in the theoretical consideration of buying an annuity. However, Lockwood (2012) found that the percentage of wealth that should be converted to an annuity decreased considerably in the presence of a bequest motive.

Another hypothesis is that the cost of annuities is unfair to potential purchasers. Mitchell et al. (1999) found that annuity price is impacted by adverse selection, but that this factor had lessened over time. Brown (2004) commenting on this (his own) research commented that the healthy should be prepared to pay even more for such annuities. In a study comparing the Australian annuity market to that of Singapore, Doyle, Mitchell and Piggott (2004) found that Australia's small market for annuities meant that the impact of adverse selection on price was marked, whereas in Singapore a higher rate of take up of annuities meant that adverse selection did not have the same bearing on price.[18]

The situation in Singapore as compared to Australia highlights another possibility for limited private annuitisation in some countries. As Gong and Webb (2010) argue, people in some countries already have annuitised wealth via government and, for some, private pensions. In Australia there is a means tested pension available to all whereas in Singapore this is not the case. It can be argued that the lack of a safety net of regular income predisposes people to convert their wealth to an annuity.

[18] It is noted that overheads and profit margins also contribute to the price of annuities.

When suspected contributing factors to non-annuitisation are considered separately, it does seem that there is an annuity puzzle. However some recent studies have considered the situation taking into account several possible factors concurrently.

Vidal-Melia and Lejarraga-Garcia (2006), with inputs based on Spanish conditions, investigated the use of annuities with contingent survivor benefits by couples already in receipt of some annuitised income and with a bequest motive. Their model used specified that entire wealth is to be annuitised, annuitisation is a once-only event and the annuity cost includes a loading. Under these conditions the author found that annuitisation would provide only a small increase in welfare.

Inkmann, Lopes and Michaelides (2011), using English data, developed a model with preference parameters including risk aversion, the strength of a bequest motive, elasticity of intertemporal substitution, and willingness to invest in the stock market. The authors conclude "there exist reasonable preference parameter configurations that generate very low annuity market participation, once an empirically reasonable initial wealth distribution is used to simulate the model" (p. 305).

2.2.2.4 Failure to annuitise: the BEM perspective

The discussion in the previous section provides evidence that the widespread antipathy to annuities is largely unexplained by the SEM framework. As set out in Section 2.1.3 of this literature review, the insights of behavioural finance can inform understanding of how people actually make financial choices, and in particular choices relating to retirement funding and consumption. It is appropriate to take up the suggestion from Ganegoda and Bateman (2008, p. 31), writing in an Australian context, who state "we need to seek alternative explanations for the miniscule demand for life annuities ... The answers may lie in the realms of behavioural finance".

Hu and Scott (2007), drawing on Thaler (1999), suggest that the strongest behavioural reasoning explaining the distaste for annuities is that of mental accounting. According to the authors the foremost question in the mind of the potential buyer of an annuity is whether she, the buyer, will live long enough to recoup the initial investment. Using the framework of mental accounting, Hu and Scott propose that the purchaser of the annuity segregates the annuity account from the rest of retirement consumption, and evaluates the annuity in isolation rather than evaluating the total financial retirement situation as an integrated whole.

Brown (2007) also argues that mental accounting is a key behavioural factor in avoiding annuities. He reports on focus group discussions where participants saw annuity purchase as “gambling on their lives” (p. 22). Brown raises other issues that influence against annuities, one of these issues being the desire of people to avoid regret. For instance, a person considering an annuity might imagine how she would feel if just subsequent to purchasing the annuity she found out she had only a short time to live. Brown argues that, even if the probability of being in this situation is small, the potential purchaser can easily imagine this situation and that easily imagined situations are given higher weighting than the objective probability suggests.

Three other behavioural factors are also raised by Brown in relation to avoidance of annuities. One of these issues, Brown suggests, is the feeling aroused by losing control of the purchase money which, according to the author, is related to illusion of control, a topic covered in depth in psychological literature. Another reason put forward is that buying an annuity is an insurance purchase and that people adopt a heuristic that insurance is for bad events, and living a long life is not a ‘bad event’. Brown does concede that a good marketing program, setting out the perils of being penniless at an advanced age, should be able to overcome this objection. The final reason proffered by Brown is that the decisions around buying an annuity are complex and need a high level of financial literacy, which, as discussed later in this review in Section 2.2.7, many of the population do not have.[19]

As discussed in Section 2.1.3.3, Kahneman and Tversky (1979) propose that the framing of financial information has a significant bearing on financial decision making. Brown et al. (2008) carried out an investigation where people aged 50 years or more were asked to give an opinion as to what was the better choice between an annuitised amount for life and one of four other alternatives these alternatives being a standard bank account, a perpetual bond, a thirty five year annuity and a twenty year annuity. All five choices were actuarially equivalent, a situation explained to the participants, and all

[19] A sophisticated investor considering the purchase of an annuity understands that such a financial instrument is risky, that inflation will lessen the spending power of future cash flows and that the timing of purchase within the economic cycle will influence the purchase price of the annuity. Such concerns could cause an investor to eschew such a purchase. However these concerns are not noted within the literature.

options were explained in non-technical terms. When the choice was expressed as an investment decision using investment language i.e. using words such as ‘invest’ and ‘earning’, the majority of individuals did not choose the life annuity, but when framed as a consumption decision using words such as ‘payment’ and ‘spend’, over 70% chose the annuity.

Benartzi, Previtero and Thaler (2011) considered the impact of framing from a different perspective. Examining data from defined benefit pension schemes where the retiree must make a choice of an annuity or a lump sum payment, the annuitisation rate was 53%. This rate was compared to the annuitisation rates for cash balance retirement funds[20] where the annuitisation rate was 41%. For the defined benefits fund, all communication with employees is couched in terms of future retirement income whereas for the cash balance funds, employees are kept appraised of their cash balance. The authors suggest that the difference in framing contributes to these different annuitisation rates.

As discussed in Section 2.1.3.1, consistent with the behavioural idea of bounded rationality is the use of heuristics. Duxbury et al. (2013) argue that people use simple heuristics to evaluate the worth of an annuity, and moreover, their view of an annuity is not as a longevity insurance product but rather as a way to manage a lump sum over their remaining life span. Thus, the authors propose, there are two distinct questions regarding the value of the periodical annuity payment i.e. (i) does this payment reflect appropriately the lump sum used for the purchase? and (ii) does the regular payment provide adequately for consumption needs? The evidence shows that annuities are perceived as poor value from both perspectives.

2.2.2.5 Failure to annuitise: some ways forward

From the above discussion it can be understood that the failure of individuals to at least partially annuitise their retirement wealth leaves the individual in an inferior position, financially speaking. Whilst it can be argued that the failure to annuitise is a failure in public policy, a viewpoint that will be discussed in Section 2.3.5.2, it might also be seen as a failure of the insurance companies to design and market saleable products. Thus it is useful to consider some possible annuity products.

[20] Cash balance retirement funds are hybrid plans having some of the features of both defined benefit funds and defined contribution funds. For these funds the investment risk is held by the employer i.e. employees are guaranteed a certain rate of return,

There are many varieties of annuities. One version of an annuity is that of an advanced life deferred annuity, where the annuity pays out only when the insured person reaches an advanced age, for example 85 years. Gong and Webb (2010) investigated such an annuity and found that the cost of such an annuity purchased at age 65 decreased the wealth of the retiree by only a small fraction. Such an annuity makes planning for the decumulation phase much more straight forward as longevity risk has been removed. It provides some surety for the retiree and so allows the retiree to consume more readily in the years before the deferred annuity begins, thus avoiding the prospect of living more frugally than necessary (Merton, 2003).

A major reason for the lack of willingness to annuitise is the retiree's desire to have access to ready cash in case of a catastrophe. Bodie (2003) and Merton (2003) suggest that bundled risk annuities need to be available for sale. Such an annuity would provide a life time payment, together with insurance for a health calamity, for example an end of life calamitous illness. The writers argue that such a combined annuity would mitigate the adverse selection issue around life contingent annuities.

2.2.3 Provision of retirement funding: decumulation

The retiree needs funds for consumption from the day of retirement right through until death, an unknown date. Her assets may include (i) an owner-occupied dwelling, owned outright or still with a mortgage, (ii) a superannuation account and (iii) some other investments outside of the superannuation envelope. As well, she may have already converted some funds to a life-contingent annuity and she may be eligible for a full or part Age Pension, depending on how her assets are structured and how she derives income from these assets. Her personal preference may include leaving a bequest. Given the interplay of these factors, the key issues relating to decumulation is the level of the regular income[21] is needed for consumption. In this section, the amount needed for retirement consumption will be discussed from two viewpoints (i) from an SEM perspective and (ii) from an empirical study of the needs of retirees.

2.2.3.1 Consumption and savings in retirement – the SEM perspective

From the SEM perspective the appropriate question is not 'what funds does a retiree need for consumption', for the LCPIH suggests that consumption will be smoothed over the lifecycle, with funds accumulated before retirement in portfolios appropriate to the

[21] Income in this context means money received from rent, interest, dividends, and draw down of wealth.

risk profile of the person being used to purchase, again as appropriate, life contingent annuities which will provided for this level of consumption until death, by which time the funds will be extinguished. However, the empirical data regarding actual consumption gives a conflicting picture, providing considerable evidence that (i) consumption is not smoothed in retirement, and (ii) many retirees save during retirement.

The evidence that consumption is not smooth during retirement gives rise to what is known in the literature as the retirement consumption puzzle. As the discussion following will show, some researchers continue to accept the LCPIH and provide possible reasons as to why the discrepancy is occurring while others suggest that the LCPIH is lacking as a conceptual framework for consumption in retirement.

Hamermesh (1984), using USA empirical data, found that the level of savings together with any pensions received was not sufficient to maintain consumption at the levels enjoyed before retirement. The evidence showed that, against what is suggested by the LCPIH, retirees have uneven consumption during the years of retirement, with consumption beyond long term means in the early years of retirement, and then considerably reduced consumption in later years. Another study based on USA data is that of Bernheim (1987). He adjusted wealth measures to incorporate annuities arising from pensions, and argued that his analysis showed the rates of spending could not be accounted for by the lifecycle hypothesis. It is interesting to note, however, that Hurd (1987a) in response to Bernheim, argued that his interpretation of Bernheim's data provides support for the lifecycle hypothesis.

Banks, Blundell and Tanner (1998), using empirical data from British households, identified a drop in consumption at retirement. They found that, although this drop in consumption could be partly explained by changing household demographics and changing leisure-labour status at this stage of life, there is still a substantial change that cannot be explained by these factors. They postulate that there are unanticipated shocks occurring around the time of retirement rather than these results "reflecting a lack of rationality in consumption choices over a lifetime" (p. 785).

The possibility that the retirement consumption puzzle might be explained by an unanticipated shock is explored by Smith (2006) who used British data to investigate spending on food in retirement, both for male retirees who anticipated retirement and for male retirees who had retirement thrust upon them as a result of redundancy or ill-health. Her findings are that food spending drops only for those retirees where retirement occurs as a result of an unanticipated shock, as proposed by Banks, Blundell and Tanner (1998).

Bernheim, Skinner and Weinberg (2001) studied the relationship between accumulated retirement wealth and consumption using USA data. They suggest that differences in savings amongst retirees with similar earning histories should theoretically be accommodated using LCPIH by three explanations: (i) correlation between accumulated wealth and consumption growth rate near retirement, (ii) correlation between accumulated wealth and a one-time decrease in consumption at the time of retirement and (iii) correlation between accumulated wealth and the level of consumption. The writers were not able to reconcile their findings to these expressions of the LCPIH and suggest that the results may be better interpreted outside of the lifecycle framework.

Aguiar and Hurst (2005) used food as a proxy for consumption in looking at the retirement puzzle. They note that the data shows there is a dramatic decline in the amount of money spent on food once people retire. Acknowledging the view of Becker (1965), they suggest that retirees combine market expenditure and time to produce value added goods. Using two different data sets, the first being the money value spent on buying food and the second being time on food production, Aguiar and Hurst establish that, as food expenditure declines, the time spent on food production increases so that retirees indeed do not experience a decline in food consumption at retirement, as time is substituted for expenditure.

Fisher and Marchand (2011), using USA data, found that the change in consumption at retirement is not even across the consumption distribution, with there being no statistically significant drop in the lowest fifth of this distribution. However, for the top two fifths of the distribution, there is a large, significant, decrease in consumption at the time of retirement. The authors suggest that inadequate savings may be the reason for this situation. They also call upon the work of Blau (2008) whose modified lifecycle model, incorporating uncertainty about the timing of retirement, predicts a drop in consumption at retirement for those experiencing the shock of unexpected retirement.

Thus far, the evidence cited for the retirement puzzle has come from USA and British data. Barrett and Brzozowski (2009) analysed data from the Australian HILDA study, finding that there is a significant drop in non-durable expenditure at retirement, as there is in other countries. In addition they used the data to investigate whether financial hardship was occurring at the time of retirement, with the evidence being inconclusive.

The above discussion of the LCPIH as it applies to retirement covers only some of the myriad discussion on this topic. The LCPIH provides such a fundamental conceptual base for the exploration of consumption over a lifetime including the latter years of life that, in the literature, there are robust discussions as to whether the empirical studies, as an entirety, support the hypothesis. Attanasio (1999) argued that the model, enriched by including demographic and labour variables, has been shown to be in accordance with the data, but only for household in their middle years. Hurst (2008), writing a decade later, argued that the empirical evidence as set out by numerous articles supports the LCPIH applying at the time of retirement. He proposed that there are two explanations for the drop in consumption, both consistent with the lifecycle model. The first explanation is that the drop in spending is in the area of food and work related expenses, whilst other expenditure on durables does not decrease. Moreover the decrease in spending on food does not equate to lesser food intake. The second explanation is that there is a wide range of spending amongst retirees and that people in the pre retirement phase who experience health shocks and thus prematurely and involuntarily retire are the people who experience the drop in consumption.

Some researchers have incorporated additional information and different assumptions to reconcile the LCPIH with the data. Haider and Stephens (2007) used the individual's expectation of a retirement date, as opposed to a set retirement age, in their analysis. Their results suggest that consumption does drop at retirement, a result not in concert with the LCPIH. However the drop is not as steep as that derived by studies using a set retirement age to predict the time of retirement.

The prevailing assumption used in most analyses is that utility is separable in leisure and consumption. Hurd and Rohwedder (2003) used a model that sees leisure and consumption as not separable. The data used showed that people close to retirement expect that consumption will drop, and that when retirement age is reached, actual consumption is in line with what the retirees expected. The writers argue that, rather than retirees being surprised by lack of financial resources at retirement and thus decreasing consumption, retirees have foreseen the situation and "if anything households seem to be pleasantly surprised by their level of resources" (p. 17).

Another violation of the LCPIH that attracts considerable discussion is that of saving during retirement. Mirer (1979), using USA data, found that wealth, excluding the value of any private or government pensions, increases with age. The author proposes that this situation must be because of either precautionary or bequest motives. Danziger et al. (1982)), also using USA data, found

> the elderly not only do not dissave to finance their consumption during retirement, they spend less on consumption goods and services (save significantly more) than the nonelderly at all levels of income. Moreover, the oldest of the elderly save the most at given levels of income. (p. 210)

However Hurd (1987b) disputed the interpretation of the evidence for wealth enhancement during retirement. He agreed that the data suggests the elderly appear to accumulate wealth, but proposed that the cross sectional nature of the surveys masks the situation of the poor dying at an earlier age than the wealthy, skewing the results. Hurd used longitudinal data for two five year periods and found that the elderly do decumulate real wealth.

Outside of the USA, there is also evidence of slow decumulation of wealth in the retirement years. Dobrescu (2013) investigated savings behaviour for three European regions, finding that indeed there is slow decumulation of wealth in all three regions, with the rich elderly dissaving at a slower rate than their poorer counterparts. Hulley et al. (2013) analysed HILDA data with respect to wealth decumulation for Australians receiving either a full or part Age Pension. These writers found that poorer pensioners were decumulating their wealth, whilst wealthier households (but in receipt of a part Age Pension) were adding to their savings, even though the means testing of the Age Pension provides a disincentive for such wealth accumulation.

As with the retirement consumption puzzle, academics have sought to reconcile the evidence of savings by the elderly with the LCPIH by incorporating into their analysis the impacts of factors such as a bequest motive, precautionary savings and longevity risk. Palumbo (1999) included both uncertain longevity and uncertain out of pocket medical expenses into a lifecycle model He found that these adjustments provided only partial explanation for savings by the elderly.

Love, Palumbo and Smith (2009) developed a measure they called annualized comprehensive wealth[22]. Using this measure, they established that, for all except those retirees with the lowest income, this measure rises significantly with increasing age over the retirement years. The writers compared these empirical results with results generated from a lifecycle model that incorporates the three factors mentioned immediately above, and found similarity between the two sets of results.

De Nardi, French and Jones (2010) developed a lifecycle model using USA data to establish preference parameters and probabilities of mortality and medical expenses. They found that medical expenditures are important in explaining the saving of the elderly, stating "if single people live to very advanced ages, they are almost sure to need very expensive medical care, and thus need to keep a large amount of assets ... to self-insure against this risk" (p. 72).

It might be thought that the absence of a universal health insurance system in the USA is the reason for precautionary saving by the elderly in case of a health shock. However Dobrescu (2013) found that, for the European countries studied, all with effectively universal health care, it is health, medical spending and health insurance that are the key factors in slow wealth decumulation by the elderly.

2.2.3.2 An empirical approach to determining consumption levels in retirement

Another approach to understanding the amount needed for consumption in retirement is to develop a budget that covers both required and discretionary spending. In Australia there has been significant development of representative budgets suitable for different groups of Australian retirees. Saunders (1998) set out the rationale for developing a set of budget standards, representing various standards of living for representative Australian households of all ages, with these standards being produced by the Social Policy Research Centre (SPRC) of University of NSW. A very detailed report provides the intensive methodology for developing the initial budgets (Saunders et al., 1998).

Of the 46 budgets developed, six were concerned with people in retirement, with two of these being modest but adequate (MBA) budgets, one for a couple and one for a single woman. The other four budgets, designated as low cost budgets, were targeted at

[22] 'Annualized comprehensive wealth' is described by the authors as an annual amount of household wealth that takes into account both financial and non-financial assets together with annuitised value of annuity-like assets such as defined benefit pensions and government payments

people whose sole source of income was the Age Pension. There are limitations to the budget estimates, a key one being that prices used were based on the situation in Sydney.

The 1998 budgets elicited support for more research. Saunders, Patulny and Lee (2004) provided updates regarding pricing for the six original budgets and the development of a standard for self-funded retirees[23]. As for the earlier budgets, the estimates for expenditure were based on ABS data and empirical studies with the proposed budgets being validated by focus groups. The new category, named comfortably affluent but sustainable (CAS), assumed home ownership as did the MBA category.

It is important to understand the level of consumption provided for by these two standards. The descriptions of these standards as provided by the researchers are:

> The CAS standard reflects a standard of living among older, healthy and fully active self-funded retired Australians that allows them to engage actively with a broad range of leisure and recreational activities without having to require a rapid or substantial disbursement of assets. It represents a lifestyle that is common amongst those in the top (income) quintile of the aged population.
>
> ...
>
> The MBA standard represents a standard that affords full opportunity to participate in contemporary Australian society and the basic options it offers. It is seen as lying between the standards of survival and decency, and those of luxury as these are commonly understood, corresponding in round terms to the median standard of living in the community as a whole. (Saunders, Patulny and Lee, 2004, p. i)

These indicative budgets, appropriately updated to meet changing consumer needs, are now costed every quarter by research sponsored by Westpac Bank and ASFA and thus data for two objective standards of living are available (ASFA, 2013).

As stated in Section 2.2.1, a key question in the accumulation stage is the amount of regular savings needed to have an appropriate living standard in retirement. The CAS and MBA standards give some information that allows estimation of regular savings to be made, assuming labour income level, the inflation rate and return on investments. For the CAS standard, the assumption is that the retiree will be self- funded, and the approach used by financial planners, as discussed in Section 2.2.7.2 may provide some illumination. For the MBA standard, it can be assumed that the retiree will be in receipt

[23] A self-funded retiree does not receive an Age Pension, either full or part.

of at least a part Age Pension. The impact of the Age Pension together with superannuation savings is a policy issue and is discussed in Section 2.3.5.3

2.2.4 Risk-return considerations

A person or household saving for retirement can actively decide on the risk level of the savings portfolio[24]. This risk level does not need to be static and indeed there is a significant level of discussion in both the popular press and in academic journals as to how portfolios should be structured at different stages of life.

2.2.4.1 Age phasing

For the SEM, the initial perspective is that Samuelson (1969), Merton (1969) and Hakansson (1970) who, as discussed in Section 2.1.2.3, proved that the risk level of a person's portfolio should depend on her risk profile and not on her age. These findings do not resonate with the widely held populist viewpoint that as people age they should invest a greater proportion of their wealth in risk free assets. Jagannathan and Kocherlakota (1996, p. 6) state "the life-cycle advice ... is now so widely known that it can be termed *folk wisdom*: older persons should invest less in stocks than younger people do". The general literature available to the ordinary person saving for retirement talks about 'age phasing' or 'life-cycle investing', phrases which can have a variety of meanings ranging from a simple recommendation to rely less on stocks over time to a prescriptive approach, stating the percentage of risky assets to be held as a function of age[25].

Within the standard economic and finance literature there are academic discussions that attempt to reconcile these findings of Samuelson, Merton and Hakansson, and the prevailing folk wisdom. One area of discussion that brings about some reconciliation is that of human capital.

2.2.4.2 Labour as an asset: a standard economics/ finance explanation of age phasing

Bodie, Merton and Samuelson (1992) provided an explanation that brought the academic result and folk wisdom closer together. They considered the present value of human capital in the form of future labour as a major asset for the individual concerned.

[24] 'Portfolio' in this context is not restricted to a portfolio of financial securities, but also includes property, either for shelter or purely for investment return.

[25] Examples of such literature include Bailey (2013) and Manning (2013).

If this human capital can be considered safe, then the person will invest in a higher percentage of risky financial assets than she would otherwise do so. As, in the main, human capital decreases with age, a person would logically decrease her exposure to risky financial assets as she ages, as her safe human capital is declining. A higher percentage of financial wealth will be invested in safe assets to maintain the overall portfolio in accordance with the risk profile.

The person's labour may be flexible, in that the person can determine the level of their labour supply, or fixed, or in some combination of both flexible and fixed. The level of flexibility of the labour is an important factor. Bodie, Merton and Samuelson argue that a person with flexible labour will prefer to invest a higher proportion of her labour in risky assets because she has the option to vary her labour supply at a later time in direct response to any shocks experienced.

In determining an investment mix of risky and risk free assets where there is both human capital and financial capital Bodie, Merton and Samuelson discussed the riskiness of human capital. Human capital cannot be considered homogeneous with some occupations having wage risks correlated with risky financial assets. According to the writers, such people, at each stage of their working life need to have lower exposure to risky financial assets than others their age.

2.2.4.3 Other SEM explanations of age phasing

As mentioned before, the resolution of the age phasing question has loomed large in SEM discussion. Samuelson (1989) revisited this asset allocation over a lifetime question, for a situation where an investor demands a minimum level of retirement wealth at all times during retirement. This situation demands that the investor commits some wealth to risk free investment. Samuelson proposed that this decision would result in the investor age phasing. In the same paper, he also proved what might seem a paradoxical result in that an investor demanding a minimum level of wealth across the total lifespan from youth to old age would have a tolerance for a greater proportion of risky assets as she aged.

McNaughton, Piggott and Purcal (2000) argued against Samuelson's reasoning, suggesting that isolating some funds in a risk free account to ensure a minimum level of funds is available for all stages of retirement would not lead to age phasing unless the returns on the risk free proportion of the portfolio were higher that the returns on the risky proportion, a situation that can be expected to occur less frequently than the alternative.

McNaughton, Piggott and Purcal (2000) adopted yet another approach to explain age phasing from a SEM perspective. However, to do so they first need to invoke a BEM perspective in that they suggest an investor with a long term horizon, rather than acting from a rational perspective, may adopt a savings rule e.g. saving a definite amount every year until retirement Such a stream of funds can be considered a safe asset, which has higher present value early in the lifecycle, decreasing to zero at retirement. To maintain the steady ratio of risky to safe assets as proposed by Samuelson (1969) and Merton (1969), there would need to be a decreasing proportion in risky assets over time.

Boscaijon (2005), arguing from a different perspective, proposed that age phasing is a rational approach in that, as a person ages, she begins to value increased leisure more than increased financial wealth and thus she will become more risk adverse. He modelled his proposal, incorporating increasing leisure and, as well, decreasing human capital over the lifetime, finding the relative allocation of assets will change to favour a greater proportion of investment in safe assets over time.

2.2.4.4 Risk tolerance as a function of age

The SEM approach as discussed above suggests that the risk of the portfolio should reflect the risk profile of the investor, not her age. The writers implicitly assume her risk profile is constant, and develop arguments as to why the risk of the portfolio may be decreasing. Thus, there needs to be consideration as to whether the risk profile is indeed steady. The evidence available is mixed.

An Australian study by Hallahan, Faff and McKenzie (2004) investigating the relationship between risk tolerance and various factors including age found that risk tolerance does decrease with age. In another Australian study, Bateman et al. (2010) conducted a survey where each respondent was told to imagine she had $1,000 to invest and given a choice of six portfolios. The results showed that the younger respondents were less risk tolerant than older participants. However, it needs to be noted that, in this study, participants were not using their own funds.

Bucciol and Miniaci (2011), using data from the USA household Survey of Consumer Finances (SCF) estimated risk preferences from the actual portfolios held by the respondents. The findings were that risk tolerance is negatively correlated with increasing age. Yao, Sharpe and Wang (2011) argue difference in risk tolerance of people of differing age is impacted by three effects i.e. an ageing effect, a generation effect and a period effect[26]. The authors found that risk tolerance does, in general, decrease as a person ages.

The studies discussed immediately above are not longitudinal in that they do not study how a particular individual's risk profile changes over time. Van de Venter, Michayluk and Davey (2012), using limited longitudinal data over four years, found that the average change in financial risk tolerance year to year was small, but positive, with the increase in age not being a significant factor. However, there is no discussion in the paper on any change in risk profile over all four years.

2.2.5 Home ownership

Whilst accumulating wealth that can later provide for consumption in the retirement years, a household must also provide shelter. An owner-occupied home, owned outright, can contribute to consumption in retirement in at least two ways. It can be used as security in a reverse mortgage arrangement, paying a regular annuity or giving a lump sum for a particular consumption requirement. It can be sold with the retiree moving to cheaper accommodation and the resulting price difference less taxes and costs being use to fund consumption. Thus a mortgage-free house may be considered a useful asset for retirees and it is important to evaluate the importance of home ownership across a lifetime.

Discussing the British situation Easterlow, Smith and Mallinson (2000, p. 372) state "owner occupation represents a store of wealth, a tax free investment, the prospect of cheap housing services in old age". The same argument for homeownership applies in Australia. Badcock and Beer (2000, p. 111) wrote "Australians have built up their housing wealth for good reasons. ... it offered a secure tax-advantaged investment that also provided significant welfare benefits in old age".

Sinai and Souleles (2005) analysed owner occupied housing as a hedge against rent risk. The authors state that conventional economic analysis finds that the owner-occupied

[26] The ageing effect is any change in risk tolerance due to increasing age. The generational effect is the impact of the shared experience of a generation i.e. the demographic, political and socioeconomic climate of the cohort's formative years. The period effect is the impact of a pivotal event for example the stock market crash of 1987.

home is a high risk asset because (i) it comprises such a high proportion of the owner's assets, (ii) its value is subject to considerable fluctuation and (iii) there is the impact of changing housing wealth on the owner's consumption. However, as the authors argue, shelter is a necessity and the alternative of rental has its own risks. Using a utility maximisation approach, their study finds that whether the owner-occupied housing risk is greater than the rent risk depends on the horizon of the home ownership traded off against the risk associated with the volatility of rents.

Owner-occupied housing is a significant proportion of household wealth accounting for 41% of all Australian household wealth and 58% of the wealth of average[27] Australians (ABS, 2011f). As discussed earlier, this wealth can be accessed in retirement via the use of reverse mortgages or by downsizing. With respect to downsizing, any funds released also need to be considered as part of the portfolio of wealth. However it needs also to be noted, that funds released by selling residential property can be relevant in changing a person's eligibility for the Age Pension and thus an Australian considering such a move would need to be cognisant of their particular situation.

Regarding reverse mortgages, Venti and Wise (1991) found that in the USA a reverse mortgage makes a difference only when the retiree is older than 85 years. They also argued that it is a myth that there are older people starving in magnificent homes citing evidence is that, generally, retirees with very low disposable incomes also have very low housing wealth, a view supported by Reed and Gibler (2003). Venti and Wise (2002) found that home ownership amongst retirees is stable with only retirees experiencing shocks such as a health shock, or death or admittance to a nursing home of one of the partners, tending to move, and then with little liquidation of assets. They argued that housing equity should not be considered as part of retirement consumption, but it can be thought of as an emergency reserve to be used in case of catastrophe. Using data from longitudinal studies, Davidoff (2010) found supporting evidence for the view of Venti and Wise (2002). He suggested that home equity may be substituting for long term care insurance, establishing that the value of housing equity is large in relation to long-term care costs, and that the timings of housing equity payouts are highly correlated to the timings of the beginning of being in long-term care.

[27] Average for this data is the third quintile wealth for households..

With regard to realising funds from housing, Beal (2001), in an Australian survey with participants of all ages, found that homeowners were equally divided as to whether they would consider selling their home to fund a better retirement. The two groups were shown to be significantly different in several aspects. People prepared to sell their homes were younger, had dependent family members, more highly educated and had higher income that those who would not consider such a move.

Olsberg and Winters (2005) in a large Australian survey of people aged 50 and older found that elderly Australians (aged more than 75) overwhelmingly want to stay in the same neighbourhood whilst the younger respondents (aged 50 -59) were more open to relocating and indeed saw attachment to place as a sign of old age and immobility. Whilst the respondents had high expectations regarding lifestyle, only 6% were prepared to enter into a reverse mortgage, with others expressing distrust of banks and financial institutions and seeing the costs as being exploitative.

Ong (2008) used Australian data to investigate how a reverse mortgage would assist in alleviating poverty amongst the aged. In terms of the Age Pension eligibility rules, funds released via a reverse mortgage are treated favourably in Australia when compared to some other countries. Ong found that the very elderly pensioner can benefit considerably from such a product, but the collateral risk, i.e. the risk that that amount owing will be greater than the value of the house at the death of the pensioner, may be considerable in some situations. Both the amount taken and the location of the house being mortgaged is a factor here, with greater collateral risk for residents of regions with low property values. Ong also notes that an older person with a reverse mortgage in place for a significant number of years may have little or even no equity in her property at a time of need[28].

Coronado, Maki and Weitzer (2007) in a USA study found that, at the time of their writing, the use of reverse mortgages had doubling every year. In examining data for people in their late sixties and older, the authors suggest that there is a trend to view the use of reverse mortgages more favourably and they suggest that baby boomers will be even more ready to use these products than previous generations. The authors also

[28] For example, a person who takes out a reverse mortgage at age 70 for 50% of her home equity will have no home equity by the age of 90, assuming a differential of 4% between the reverse mortgage rate and the housing growth rate. At this age she may need nursing home care, requiring a bond which now cannot be financed via the sale of her house.

gathered from the data that when people downsize their housing in situations not driven by a health or marital shock, there is on average a 10% drop in household housing equity.

Shan (2011) also provides evidence that the USA reverse mortgage market was growing in the years immediately prior to 2007. The writer established that the amount taken out in reverse mortgages was correlated with housing prices, which were increasing in the years 2004 – 2007. As well it was established that the profile of the person taking out a reverse mortgage changed in this time. In the years from 1989 to 2003, the borrower was more likely to be a single, very elderly woman, whereas from 2004 on, borrowers were much closer in age to 62[29], and more likely to be male or couples. Shan concludes by noting that house prices in USA plummeted from 2007 to 2009 and asks whether the reverse mortgage market will continue to grow. The evidence for the USA is that this market has shrunk (Consumer Financial Protection Bureau (CFPB), 2012). However, for Australia, Hickey (2012) reports that there was 10% growth in the amount lent in Australia via reverse mortgages in 2011, and 22.5% growth in the two years 2010-2011, with a steady rise in market size and number of loans from 2005 to 2011.

A reverse mortgage is not the only product that allows access to home equity to fund consumption. Other products are based on mortgage equity withdrawal where people of all ages who qualify can use home equity already established to re-borrow for non-housing consumption. Lee (2005) investigated the use of these products amongst USA baby boomers when this cohort was aged 40 – 55 finding that people using home equity products were more highly educated and with higher incomes than those not using such products. Parkinson et al. (2009) investigated the use of such products in both the UK and Australia remarking that housing wealth has become fungible and finding that the "inclination to engage in equity borrowing increases with youth not age" (p. 379). A salient issue with these products is that of the housing debt in place when a person reaches retirement age. In the past, most people in Australia have owned a house debt free by retirement[30], having steadily paid down a mortgage, and thus would have been eligible for a reverse mortgage. However, people withdrawing continuously against their mortgage might find that at retirement they still owe a significant amount on their

[29] 62 is the minimum age a person in USA can take out a reverse mortgage that is guaranteed by the USA Department of Housing and Urban Development (HUD) (CFPB, 2012).

[30] 83.4% of couples aged 65 or more own a house debt free, 5.4% have a mortgage, and 8.3% are renters, whilst the comparable figures for singles are 71.1%, 3.5% and 20.7% (ABS, 2011g)

house, and thus must continue to finance repayments as well as foregoing an opportunity for a reverse mortgage. Such a situation has occurred in USA. Munnell and Soto (2008) analysed the use of housing equity for consumption for the years 2001-06, finding that, for the age group 50-62, their housing values rose by 52%, and that 16% of this growth was extracted. Of this mortgage equity withdrawal, nearly 40% went towards consumption. The authors estimate that about 30% of this age group withdrew equity during these years, losing about 35% in net worth, concluding that “a significant proportion will now enter retirement with a fragile balance sheet in a time of depressed home prices and poor financial market returns” (Munnell & Soto, 2008, p. 21).

2.2.6 Life insurance

The purchase of life insurance is seen universally as being connected with premature mortality risk of persons providing ongoing income to a household. However there are two distinct ways of considering the issue.

One way is the traditional risk management approach where the policy payout value of life insurance to be purchased is aligned to both the debt the household is carrying and the cost of planned future large expenditures such as providing for children’s education (Holland, 2008). Lynch (2012, p. 30) argues from this view: “while money cannot eliminate grief like it can debt or take care of heartache like it does current expenses and future obligations, life insurance –generated dollars can further healing and facilitate moving forward with life after ultimate loss”. From this perspective, purchasing life insurance is a separate exercise from deciding upon an investment portfolio.

The alternative perspective is that of scholars working within the SEM. Here the view of life insurance is that its acquisition must be considered a “portfolio allocation problem akin to investment in stocks and bonds. ... life insurance is a hedge against the loss of human capital and portfolio hedging decisions should be made jointly, not independently” (Huang, Milevsky & Wang, 2008, p. 848). These authors argue that the optimal level of life insurance for a particular household depends on the volatility of its labour income so that where there is a relatively low level of riskiness of human capital, there is a need for a higher level of life insurance. They suggest a household should insure against losing labour income to a certain degree, no matter what the risk aversion of the family. Chen et al. (2006) also argue that the risk and return characteristics of labour income must be considered when deciding upon life insurance level and upon the ratio of risky to non risky assets held, and that these two decisions need to be made in concert and not separately.

The uptake of life insurance is not even across the community. Bernheim et al. (2003), using USA data, found that for couples approaching retirement, the level of life insurance held was not correlated with the projected financial vulnerability of the surviving spouse. Newberger and Coussens (2008), again in a USA study, found that people with lower incomes and people without access to mainstream financial service providers are significantly less likely to have access to any sort of insurance, including life insurance. It is important to note that in the Australian situation many superannuation providers make available both automatic and elective life insurance and income insurance. These schemes provide insurance for all and so people whose own risk aversion profile may mean they do not consider insurance valuable will have some cover.

2.2.7 Financial literacy and financial planning

Superannuation is Australia is typically defined contribution and thus it is the expectation that Australian households will manage their superannuation accounts appropriately from the time of first earning an income until death. It is useful for a person to have, at least to some degree, what has come to be known as ‘financial literacy’, one definition being “an individual’s ability to obtain, understand and evaluate the relevant information necessary to make decisions with an awareness of the likely financial consequences” (Mason & Wilson, 2000, p. 31). As well as one’s own efforts an Australian can also engage the services of members of the financial planning profession.

2.2.7.1 Role of financial literacy

There is considerable evidence that the standard of financial literacy in the community is not high. Lusardi and Mitchell (2007) provide an overview of several surveys into financial literacy and summarise “financial illiteracy is widespread: the young and older people in the United States and other countries appear woefully under-informed about basic financial concepts, with serious implications for saving, retirement planning, mortgages and other decisions” (p. 35). Guiso and Jappelli (2008), in an Italian study, investigated the relationship between an investor’s financial literacy and the lack of diversity in the investor’s portfolio, finding that only 17% of respondents could correctly answer both of two straightforward questions. They also found only weak correlation between an investor's self assessment of financial literacy, and the study's assessment of the individual's ability in this area.

The evidence is that the Australian situation is similar. Beal and Delpachitra (2003), in a study of the financial literacy of university students, found that only 50% of the respondents could correctly answer a simple question, not involving any calculation, regarding compound interest. Worthington (2008) found that only one third of people with superannuation accounts knew how to read their fund statements. He also found that the level of knowledge across the population is not uniform, with the young, the unemployed and the retired being the groups with the most deficiencies of skills and knowledge.

Gallery et al. (2011) investigated the financial literacy of the members of a public service superannuation fund. In comparison with all members of the particular fund, the respondents were older and had superannuation accounts of higher value balances than the average, factors that might indicate these respondents would have higher financial literacy than average. Nevertheless the results show that, while the majority of respondents scored highly with regard to both general financial matters and general investment matters, their knowledge of more sophisticated investment matters was low. For all three areas investigated, women, younger members of the fund, and people with lower education levels performed at a lower level.

Results from opportunities to develop financial literacy are mixed. Clark et al. (2003) found that participants had revised their goals after undertaking financial education, but were unable to say if the necessary steps to incorporate such changed goals had been taken. Choi et al. (2002) reported on a study for which a company provided an educational seminar on a specific retirement savings scheme where some employees had already become participants. The authors report that of non-participants attending the seminar, 100% stated after the seminar that they intended to join the scheme but only 14% followed though with the processes needed to participate. Of the attendees who were already participants, 36% decided as a result of the presentation that their fund allocation should be changed, but only 10% went on to effect the change.

Lusardi (2004), analysing data from the HRS, found that survey respondents who had taken up opportunities to attend retirement seminars were better educated and enjoyed higher income than average. She also found that such participation led to better outcomes in retirement funding, with the improvement most marked for participants with the least initial wealth. Mandell and Klein (2007), using data from a USA-wide survey of secondary schools, reported on the impact of financial literacy training in these schools, concluding that the effectiveness of such training in increasing financial literacy is dependent on the particular student’s understanding of the relevance of financial literacy to her own life. In another study, these authors found that, for an elective school-based financial literacy course, there was no demonstrated positive impact on the financial behaviour of participants five years later (Mandell & Klein, 2009).

In the Australian context, Ntalianis and Wise (2011) undertook a study of the response of tertiary education staff to financial literacy education initiatives provided by a superannuation provider. The authors found that, for the three learning opportunities provided, the response from survey participants was positive. The groups shown to be less likely to avail themselves of these educational opportunities were women, and young adults.

Not having an adequate level of financial literacy and confidence can lead to less than optimal asset allocation. In a Dutch study, van Rooij, Lusardi and Alessie (2011) found lack of economic knowledge led to lack of participation in the stock market. The authors argue that such lack of participation can lead to sizable welfare loss. Campbell (2006) found that even amongst relatively wealthy households in USA there was limited participation in equity markets, with the author arguing that this lack of participation may be a serious investment mistake. The author suggests that people who are consciously aware of their lack of financial sophistication will be wary of investing in shares. Cardak and Wilkins (2009), in an Australian study using HILDA data, found however that direct share ownership is widespread in Australia with 44% of households having such ownership. These authors established that financial literacy and awareness plays a pivotal role in participation in these markets.

2.2.7.2 Role of financial planning

Making decisions about retirement funding, no matter what stage of the lifecycle, is complex, and, as seen above in the discussion on financial literacy, intellectually taxing. Thus it is not surprising that there is demand for expert advice about these matters, with people seeking such advice looking to the personal financial planning profession. In some ways seeking financial planning advice can be compared to seeking preventive medical advice, in that the financial advice sought is how present and future financial assets should be managed to provide optimal benefits.

Warschauer (2002) and Cull (2009) discuss the growth of the financial planning profession in the USA and Australia respectively. Both articles use Warschauer's 2001 definition, as cited in Warschauer (2002, p. 204):

> Financial planning is the process that takes into account the client's personality, financial status and the socio-economic and legal environments and leads to the adoption of strategies and use of financial tools that are expected to aid in achieving the client's financial goals.

According to Warschauer (2002) the financial planning industry needs an affluent middle class to prosper, as such people can achieve long term financial goals with planning, whereas people with significant wealth can achieve their goals no matter what, and low income people are limited by their lack of financial resources to a short term horizon. Australia, as a developed country, certainly has such an affluent cohort, and, as Cull (2009) mentions, superannuation legislation impacting nearly all working Australians has further ensured that there is a market for the services offered by financial planning practitioners.

The knowledge and skills needed by financial planners arise from several academic areas. As Cull writes, financial planning draws on the knowledge base from the SEM such as modern portfolio theory, lifecycle theory, and the efficient market hypothesis. Likewise, insights gained from the BEM such as risk aversion (prospect theory) and framing (mental accounting) are incorporated into practice (Mitchell & Moore, 2011; Tomlinson, 2012). As well, successful financial planners need appropriate counselling and coaching skills, the theoretical base for which is psychology (Dubofsky & Sussman, 2010; Knutsen & Cameron, 2012).

Cull agreed with Warschauer (2002) and Black, Ciccotello and Skipper (2002) that the study of personal financial planning is not built on a coherent theoretical framework. As such, it may be considered by some that financial planning is not an academic discipline. However there are several refereed academic journals publishing the results of studies in this area. Perusing these journals gives evidence that a significant amount of the research carried out is around establishing 'what works' i.e. development of heuristics. Methods uses include *Monte Carlo* analysis, bootstrapping and other simulation techniques. As Cull (2009, p. 28) states “academics have much to offer in this area as they strive to synthesise the theoretical aspects through further research in the context of the social, cultural, economic and political environment”.

Two areas of concern for which people seek the advice of financial planners are (i) saving for retirement appropriately and (ii) drawing down wealth sustainably. The financial planning approach to both this wealth accumulation and decumulation is, as mentioned above, based on ‘what works’.

In the accumulation phase, for asset allocation Markowitz’s work has been highly influential (Altfest, 2004) but there is considerable ongoing discussion as to whether the mean-variance approach is still the most appropriate framework for such decisions (Basu, 2011b; Branning & Grubbs, 2009; Kitces, 2012; Miccolis& Goodman, 2012; Sumnicht, 2009; Swisher, 2009; Swisher & Kasten, 2005). With regard to the level of risk of a portfolio, most of the discussion in the financial planning literature is concerned with portfolios for people on the point of retirement, or past retirement age. Where there is consideration of how a person should be amassing a sufficient amount for retirement over a substantial period of time, sometimes age phasing is recommended, for example Basu (2005, 2011a) and Bengen (1996) and sometimes a set proportion of risky securities is suggested, for example Pfau (2011b).

The pivotal area of concern for financial planners, however, is the process of wealth decumulation, in particular a sustainable withdrawal strategy. In determining such a strategy, there are three variables involved i.e. asset allocation, asset returns and longevity of the retiree. In concert with this strategy is the need to establish the amount needed to fund consumption during the retirement stage. It is not surprising that there has developed a substantial body of work regarding heuristics for use in these processes.

In establishing the amount needed to fund consumption during the retirement phase, the typical financial planning approach is to assume that the retiree will desire a lifestyle similar to that enjoyed before retirement. A percentage of pre-retirement earnings is taken as the basis to achieve this lifestyle (Basu, 2005; McCarthy, 2002; Pfau, 2011b). Once the initial sustainable withdrawal amount is established it is simple arithmetic to compute the retirement funds needed at the start of retirement, assuming that the retiree is self funded. This target accumulated savings amount can be used to provide an indication of the regular savings needed during the accumulation phase.

With regard to establishing a sustainable rate of decumulation, the early work in this area was undertaken by Bengen (1994) who, using historical data, established a maximum sustainable withdrawal rate of 4% per annum over 30 years horizon, based on 50% to 75% of wealth being invested in risky assets. It is important to note that this recommended weight of investment in shares is considerably higher than the conventional financial planning age-phased approach. It is also interesting to note that, according to Ameriks, Veres and Warshawsky (2001), the advice to retirees in popular consumer magazines at that time was that retirees could draw down 5.3% of their wealth in a year

Bengen extended his work in several ways. Continuing his analysis with historical data he found that retirees could reduce their exposure to equities by 1% per year and maintain a yearly withdrawal from capital of 4% (Bengen, 1996). By broadening equity investment into a wider range of asset classes, the withdrawal rate could be increased to 4.3% (Bengen, 1997). Drawing on the views of Stein (1998) who argued that retirees have three distinct times of different consumption i.e. (i) early retirement, up to age 75, being the period of highest consumption during retirement, (ii) from age 75 to 85 where the retiree’s needs lessen and (iii) post 85 when needs reduce further, Bengen (2001) analysed the historical data to establish sustainable withdrawal rates with a particular non- constant pattern of yearly consumption. Based on this scenario Bengen estimated that the initial withdrawal rate could be as high as 4.4% per annum.

Since Bengen’s initial work, there has been considerable effort within the financial planning community to establish appropriate asset weightings and withdrawal rates that would provide for survival of portfolios beyond the life of the client. Changing circumstances such as varying inflation rates and the desire of clients to have higher income in the earlier years of retirement have been taken into account. As the basis for these studies is historical data, data from different periods has been used. Examples of these studies include Cooley, Hubbard and Walz (1999, 2003, 2011), Guyton (2004) and Guyton and Klinger (2006).

Given the literature cited above, it is not unexpected that there has come to be known a heuristic, known as the 4% rule, for decumulation of portfolios. This rule has been the subject of considerable critical analysis.

Within the financial planning community, Pfau (2011a) used regression analysis to predict long term returns for risky and safe assets, and for the inflation rate, based on historical market valuation and yield measures including the situation for the fifteen years from 1995 to 2009. He found that the 4% withdrawal rate cannot be considered sustainable once the data for portfolio returns for the most recent time period is included. Criticising the approach from another perspective, both Frank and Blanchett, and Stout and Mitchell argue that there is need for dynamic and adaptive approaches to decumulation. Stout and Mitchell (2006) suggest there needs to be regular adjustments to the withdrawal rate based on both portfolio performance and the (changing) life expectancy of the retiree. Their model, built to incorporate these changing factors, showed superior average withdrawal rates with reduced probability of financial ruin. Frank and Blanchett (2010) also argue for a dynamic approach to withdrawal rates, citing sequence risk and its impact on the probability of portfolio ruin as the key concern in avoiding a fixed withdrawal strategy.

Another criticism of the 4% heuristic is provided by Scott, Sharpe and Watson (2009). Arguing from an SEM perspective, the authors contend that this universally popular approach, whilst appealing in its simplicity, is wasteful on two counts, (i) the accumulation of unspent surpluses, at a cost, when markets overperform, and (ii) the withdrawal of amounts more than appropriate when markets underperform. The authors suggest that a more efficient approach is to use financial engineering, for example the purchase and sale of call options on the market portfolio. It can be argued that the approach suggested by Scott, Sharpe and Watson is not practical, as it is unrealistic to expect ‘average’ people to buy and sell options. Surely the recommendation should be to buy life-contingent annuities, as then it would be the insurance companies selling these annuities that undertake the appropriate financial engineering.

2.2.8 Leaving an estate

Many elderly die leaving an estate. This situation may be as a result of a deliberate bequest motive, or it may be accidental, for example as the result of precautionary savings not being needed. The bequest motive has already been discussed twice in this literature review, firstly as a limiting factor in the demand for life–contingent annuities (Section 2.2.2.2) and secondly as an explanation as to why retirees do not spend down their wealth as predicted by the LCPIH (Section 2.2.3.1). For this thesis it is useful to consider if indeed retirees do have a bequest motive. As will be seen in the following discussion, the evidence is mixed.

Bernheim (1991) argued, based on USA empirical data relating to both annuitisation and insurance purchase by retirees, that for a considerable segment of the population, there is a strong bequest motive. However, Hurd (1989), using the same data source, found most bequests to be accidental, having resulted from uncertainty as to the date of death. Dynan, Skinner and Zeldes (2002) quote USA survey data in support of the accidental bequest hypothesis, reporting that 40% of retired households state they save for emergency or illness, 28% save for future retirement needs but only 12% save towards leaving an estate.

Kopczuk and Lupton (2007), using their model developed to assess bequest motives, estimated that about three quarters of retired single people in the USA desire to leave a bequest, and that this desire translates into spending about 25% less on personal outlays. Whilst they estimate 79% of the elderly with children hold a bequest motive, the estimate for people without children is still considerable, at 63%. Lockwood (2011) developed a model specifically to separately identify precautionary and bequest motives for retirees who were slowly decumulating wealth, and used HRS data over 8 years to populate this model. The findings identified widespread bequest motives, but only modest precautionary motives. De Nardi, French and Jones (2010) looked at the situation from a different perspective and established from their model that, if the bequest motive is eliminated, savings change very little.

In another USA study Ameriks et al. (2007) argue that both the precautionary motive and the bequest motive are reasons why retirees save. The authors explain that the USA situation is complicated by the situation with health insurance. They suggest that one aspect of heath provision, Medicaid, is strongly disliked by retirees and thus retirees will accumulate savings as a precaution against having to use this government program. Their findings however show that people want to leave a bequest *and* to avoid reliance on Medicaid.

It is important to look at Australian research regarding bequests. Harris, Loundes and Webster (2002) found that only 8% of Australians aged over 65 considered leaving a bequest as a major reason for savings, whilst 28% cited precautionary motives. Olsberg and Winters (2005), in a study of preferred housing for Australians aged over 50, found that 33% of survey respondents aged 74 or less expected to use up all assets in their lifetime, whereas for those over 74, only 14% expected this situation. There is no specific mention of a bequest motive per se but the extensive reporting of participant responses suggests that most people see their assets as being available for significant expense near the end of life, and thus any bequest is accidental. Despite an intensive search no later literature relating to the bequest motives of Australians has been found. It would be interesting and useful to see if there is research evidence that Australian retirees have a similar attitude to USA retirees in having precautionary savings that if not needed will provide a bequest.

2.2.9 Conclusion – provision of retirement funding

Section 2.2 has been concerned with the literature relating to the provision of funding for retirement. Whilst the discussion has provided an in-depth review of a myriad of pertinent issues, it is useful to highlight the pivotal issues of this literature review:

- The ability of Australians to participate effectively in the Australian retirement income system, in both the accumulation and decumulation phases.
- Appropriate annuitisation of wealth on retirement.
- Recognition of an appropriate standard of living for the retirement years.
- The role of the owner –occupied dwelling in providing lifetime well being, but particularly during the retirement years.

These issues have been the concern of recent policy initiatives and legislation. Thus, it is now appropriate to review policy relating to provision of retirement funding.

2.3 Public policy initiatives

In this section of the literature review five recent policy initiatives are considered i.e. (i) the Pension Review, (ii) Australia’s Future Tax System Review, (iii) the Super System Review, (iv) the Future of Financial Advice reforms and (v) the 2010 Intergenerational Report. The first three of these initiatives are reviews initiated by a government minister and carried out by senior public servants, assisted by industry and community leaders, with each review drawing a response by the government, followed by (some) legislation. The fourth listed initiative i.e. the Future of Financial Advice (FOFA) reforms, were legislated following the deliberations of a parliamentary committee. The final initiative listed i.e. the 2010 Intergenerational Report (IGR), by its nature, does not suggest changes in policy but rather provides a commentary on the impact that implemented policy will make on Australian society and economy over the next forty years.

The structure of this section is as follows. Firstly, an overview of the five reports is provided, and then following, in Section 2.3.2, there is discussion of relevant policy issues related to the policy initiatives. As all five reports have a much wider scope than the scope of this thesis, any discussion in this chapter is limited to matters relating to consumption and retirement funding for 'average' Australians earning 'average' labour income.

2.3.1 Overview of reports

2.3.1.1 The Pension Review Report (Harmer Report)

The Pension Review Report, also known as the Harmer Report, was released in May 2009. Commissioned in May 2008, the review considered "measures to strengthen the financial security of seniors, carers and people with disability" (Harmer, 2009, p. xi). The government's initial response was via the budget of 2009/10 where the accepted recommendations were included, with legislation following later that year (Australian Government, 2009; Daniels, Buckmaster & Yeend 2009).

2.3.1.2 Australia's Future Tax System (Henry Report)

Australia's Future Tax System Review, also known as the Henry Report, was commissioned in 2008 following the Australian 2020 summit with a report specifically concerned with the retirement income system being provided in May 2009 (Henry, 2009), and the final report being made public in May 2010 (Henry, 2010a, 2010b, 2010c). The initial government response was provided via the 2010 budget, with only a few of the many recommendations being adopted immediately, several being rejected and other recommendations being put forward for debate (Swan & Rudd, 2010). A second response was issued in 2012 as part of that year's budget papers via the document known as the Tax Reform Road Map (Swan & Bradbury, 2012), this latter document providing discussion on taxation matters together with details of taxation reform, including some recommendations made by the Henry Report

2.3.1.3 The Super System Review (Cooper Report)

The Super System Review, also known as the Cooper Report, was commissioned in May 2009 following on from the publication of *Communique of Principles for Superannuation* issued in April 2009 (Sherry, 2009a, 2009b). Theformer document, a joint media release by the Australian Government and peak superannuation and financial planning organisations, set out the rationale for a review as follows:

> Compulsory superannuation is of immense benefit to the Australian community and economy and it is critical that Government and industry work to ensure public confidence in the system remains strong.
>
> ...
>
> After 20 years of compulsory superannuation and the development of numerous new features, often developed without systemic analysis, it is timely to ensure our system continues to operate with efficiency and sustainability. (Sherry, 2009a p.1)

The Cooper Report was provided to the Australian Government on 30 June 2010 and made public in early July that year (Cooper, 2010), with the government's response being made in the following December (Treasury, 2010b), and legislation and associated regulations being implemented since 2011 (Treasury, 2013).

2.3.1.4 The Future of Financial Advice (Ripoll report)

In February 2009 the Parliamentary Joint Committee on Corporations and Financial Services announced an inquiry into issues related to collapses of financial product and services providers with the committee providing its report in November of that year (Parliamentary Joint Committee on Corporations and Financial Services, 2009). The report, also known as the Ripoll Report, provided eleven recommendations as to the regulation of financial advisers and the financial planning industry.

In response, Minister Bowen announced reforms, known as the Future of Financial Advice (FOFA) in early 2010 (Bowen, 2010). The bills were finally passed in Parliament in June 2012 with the reforms to begin in July 2012 but the application of the provisions deemed voluntary until July 1 2013 (Shorten, 2012).

2.3.1.5 The 2010 Intergenerational Report (IGR)

The first IGR was published in 2002 for the purpose of providing assessment of the impact of the government's fiscal outlook over the long term with particular respect to issues related to an ageing population (Treasury, 2002, p. ii). Since this initial study, two further IGRs have been issued, the second in 2007 and the third in 2010 (Treasury, 2007, 2010a). The IGRs are judged to have made a significant contribution to robust fiscal projections:

> In earlier times, governments in Australia and elsewhere typically made spending commitment without any systematic attempt to estimate, or address, their long term fiscal consequences. The IGR has made an important contribution to changing this pattern of behaviour. (Gruen & Spender, 2012, p.2)

The 2010 IGR provided long term budget projections that show the impact of an ageing population, identifying that the key pressure for increased government spending over the next forty years will be health provision, especially for the aged, but that age related pensions and aged care will also demand an increased proportion of funding (Treasury, 2010a).

It is impossible in this thesis to discuss comprehensively the wealth of data that the IGRs provide. Chomik and Piggott (2012) provide an analysis of the intersection of the IGR projections with the impact of the SG and other policy initiatives related to ageing and an ageing population, noting the changes in projections over the three IGRs and stating that these changes can be partly attributed to changing policies during the period 2002-2010. The authors also argue that successive governments have not taken advantage of the IGR methodology to investigate the impact of particular policies, suggesting that undertaking such analysis could assist in understanding how the future could be shaped.

2.3.2 Public policy issue – appropriate rate of the SGL

In this and the following four sections, there is discussion of key policy issues emanating from the reports discussed in Section 2.3.1.

In Chapter 1 Section 1.2.2.2, a brief outline of the SGL contribution rate over the years is set out with the rate being 9% per annum in 2008. The Henry Report's document on strategic issues relating to the retirement income system discussed in detail the rate that the SGL should be[31]. Whilst it acknowledged that the 9% rate will not be sufficient to provide, by itself, a satisfactory retirement income for many people, the argument put forward is that many Australians will still be eligible for a part Age Pension[32] and, together, this part pension and the income generated by the SGL will provide for a reasonable replacement[33] of previous income. The document goes on to argue that the 9% rate provides a suitable balance between pre-retirement and post-retirement incomes, but that individuals are free to save more. Moreover, it suggests that if other recommendations made in the Report and in the Harmer Report were to be adopted, the final accumulated superannuation balance would be increased (Henry, 2009)

The initial government response to the Henry Report included an announcement that the SGL would be increased, in a phased approach, to 12% per annum (Swan & Rudd, 2010). However, it was also stated explicitly that there would be a three year lead time before the first increment, so that this increase could be factored in to future wage negotiations covering the period 2013 – 2019 by which time the full increase would be operative (Swan & Bowen, 2010). This policy initiative was re-emphasised in a further elucidation of the government's taxation approach (Swan & Bradbury, 2012).

2.3.3 Public policy issue – investment of retirement savings

The pivotal recommendation from the Cooper Report was that superannuation providers accepting SGL deposits be mandated to set up a default fund, to be known as MySuper with superannuation providers having such a fund being the only entities able to accept SGL contributions (Cooper, 2010). The very first of the Review Highlights, set out at the beginning of the document, states "Australians have contributions made to their super funds whether they like it or not. Members should not have to be interested, financially literate, or investment experts to get the most out of their super" (Cooper, 2010, p. 1). The recommendation to institute MySuper is based on both this outlook and

[31] There has been considerable discussion over the years as to the appropriateness of 9%, especially for some groups of workers. Kelly, Harding and Percival (2002) provided evidence that, assuming annuitisation of final wealth, baby boomers will have only minor income from their SGL due to their retirement, given that SGL was in place only for some of their working years. Moreover, these writers stress the situation for women is considerable poorer than for men, given their patterns of employment.

[32] This situation is supported by the IGR 2010 which proposes that that, while there will be a decline in the number of people obtaining the full Age Pension, the proportion of people obtaining a part Age Pension is expected to increase significantly, but there will only be a slight rise in the number of people receiving no Age Pension (Treasury, 2010a)

[33] The Henry Report suggests that a person earning average weekly ordinary time earnings (AWOTE) and working for 35 years would have a replacement rate of 63% when both SGL and a part pension are taken into account (Henry, 2009).

also the need to provide suitable superannuation funds for those who desire “a large low cost and well managed product where the investment strategy is designed and implemented by the trustee”[34] (Cooper, 2010, p. 11).

It is important to note that the report stated that MySuper should be a product for the whole lifecycle, and not just for the accumulation stage. This recommendation will be further discussed in Section 2.3.5.2

There is much discussion in the academic literature regarding the importance of appropriate default funds in retirement saving. The prevailing situation, set out in Section 2.2.1 where it is demonstrated that many people savings for retirement suffer from inertia or are overcome by complexity, results in default options to be the ‘option’ of many people. Beshears et al. (2009) provide examples from various countries regarding different public policy approaches to default options arguing that “defaults are not neutral – they can either facilitate or hinder better savings outcomes” (p. 192).

Gallery, Gallery and Brown (2004),discussing the Australian situation of that time, stated that, whilst about 80% of workers with superannuation accounts were with providers that allow fund choice, only 10% actively chose a fund. The authors went on to argue that, whilst financial education may provide sufficient education for some workers to begin to make choices, “education cannot be a panacea” (p. 62), and thus there needs to be some government regulation for default options, even to the extent of one regulated universal default option, although the authors conceded this would be politically untenable for the government and disliked by the superannuation industry.

Basu and Drew (2010) considered default options from a different perspective with their basic premise being “to question whether these default investment options are appropriately designed to meet the retirement goals of the participants” (p. 291). Three typical default strategies for analysis were developed, based upon the investment strategies on the default funds of seventeen highly rated superannuation entities. The authors developed terminal wealth projection employing both *Monte Carlo* and bootstrap simulation methods. Their results suggest “the appropriateness of strategies heavily tilted toward stocks to be nominated as default investment options in DC plans unless plan providers emphasize predictability of wealth options over adequacy of retirement wealth” (p. 290).

[34] The trustee referred to is the governance of the superannuation provider.

Sy (2009) takes yet another perspective, arguing that there should be a national default option, but that it should be one with a totally passive investment strategy known as the proportionate shareholding approach. The author asserts that such an approach would maximise overall retirement savings, and as well would be an optimal strategy for individuals. Additionally it is a simple and understandable approach and would provide a benchmark for performance of all Australian superannuation funds.

In terms of the suggestions for default funds made in the articles cited above, MySuper is not just one government default fund as suggested by Gallery, Gallery and Brown (2004), nor the one passive fund recommended by Sy (2009) but rather each provider is called upon to develop a fund suitable for its members. As the report states, “the aim of MySuper is lowering overall cost for members while supporting and encouraging a competitive market-based, private sector infrastructure for superannuation” (Cooper, 2010, p. 18). However the MySuper offerings will have sufficient in common to allow performance to be compared. In terms of the view put forward by Basu and Drew (2010) that, for many workers, there needs to be emphasis on stocks in portfolio selection to achieve a suitable terminal amount, the situation for MySuper is that it will be the management of the fund that would determine the appropriate portfolio choice.

The government response to the Cooper Report’s MySuper proposal is that each superannuation provider must provide a MySuper default fund with, in general, a single, diversified, investment strategy and a standard, transparent, set of fees. However, for employers with more than 500 employees, a superannuation provider can set up a specific MySuper fund for these workers. As well, although there is to be a standard set of fees, an employer will be able to negotiate a discount for its employees. With respect to the single investment strategy, such a strategy could include a lifecycle investment approach i.e. age phasing (Treasury, 2011b).

2.3.4 Public policy issues – taxation relating to retirement funding

There are several issues arising from taxation policies that, directly or indirectly, relate to retirement funding provision. These issues, discussed immediately below, are (i) taxation of contributions to and earnings of superannuation accounts, (ii) taxation of non-superannuation savings, (iii) the preferential taxation treatment of owner-occupied housing, and (iv) taxation of bequests. It is important to note that there is no discussion of taxation of superannuation benefits in the decumulation stage in the Henry Report as the terms of reference for this report specifically stated that “the review will reflect the Government’s policy ... preserve tax-free superannuation for the over 60s” (Henry, 2010a, p. viii). Likewise, the Cooper Report had in its terms of reference the exclusion from consideration of “taxation including taxation concessions and other incentives” (Sherry, 2009b, p.3).

2.3.4.1 Policy regarding taxation of superannuation contributions and earnings

At the time of release of the five policy reports, all superannuation contributions attracted a 15% taxation rate on entry to the fund and thereon all investment income and discounted capital gains within a superannuation accumulation fund were taxed at 15%, whilst funds held in a pension account attracted no taxation These rates applied for all Australians no matter what their marginal tax rate. Obviously these taxation arrangements provided greater benefits for high income earners, and penalised low income earners whose marginal tax rate was lower than 15%. The Henry Report provides several recommendations for change regarding the taxation of superannuation during this accumulation stage.

The Henry Report proposed “superannuation and owner-occupied housing should continue to be taxed at relatively low rates or be exempt from income tax” (Henry, 2010b, p. 13). This report suggested several directions regarding taxation of superannuation including:

- The tax on superannuation contributions in the fund should be abolished.
- Instead, employer superannuation contributions should be included in employee taxable income. Subject to annual limits, all contributions would attract a tax offset payable to contributors.
- All income and gains of superannuation funds should be taxed at a rate of 7.5 per cent, further increasing savings (Henry, 2010a, p. xxii).

The adoption of these directions would remove some of the advantages high income earners receive, when contributing to superannuation, relative to low income earners, whilst providing a low tax environment for superannuation savings.

The initial government response to these proposals was to endorse a concession for low income earners (Swan & Rudd, 2010). In a later response, it was announced that, from the 2012/13 tax year (i) low income earners would be provided with a superannuation contribution to their funds to offset the tax paid on the entry of their contributions and

(ii) very high income earners would pay 30% tax on contributions, rather than the previous 15% (Swan & Bradbury, 2012). In April 2013, a further announcement was made, stating that earnings of a pension fund above a threshold of $100,000 per annum, presently not taxed, would be taxed at 15% (Shorten & Swan, 2013b).

2.3.4.2 Policy regarding taxation of non-superannuation savings

As set out in Section 2.2.1, an Australian saving for retirement has several choices including the use of bank savings accounts, securities and investment housing. If these opportunities are held outside of the superannuation umbrella, the income tax applicable is different to that within superannuation. As cited immediately above, the Henry Report suggested that, while it is appropriate that owner-occupied housing and superannuation, the two principal forms of saving for retirement, should receive privileged tax treatment, it is also appropriate that other savings should not be taxed in the same way as labour income, albeit not as generously as superannuation and owner occupied housing (Henry, 2010a). Specifically the recommendation is to provide a 40% savings income discount to individuals for income from net savings and investment income, net rental income and capital gains[35] (Henry, 2010a). Implementation of this recommendation would mean that negative gearing for the purchase of both investment housing and securities would not be a attractive as at present, but that positive gearing would not be taxed as heavily as now.

The initial government response to these suggestions was to state emphatically that it would not, at any stage, implement a policy applying a discount to negative gearing deductions. However, with regard to improving incentives to save, the response was that the policy is attractive but needs more discussion (Swan & Rudd, 2010).

2.3.4.3 Policy regarding taxation benefits of owner-occupied housing

In Section 2.2.5, the benefit of acquiring a dwelling for occupancy was discussed in terms of eventual provision for retirement consumption. It is pertinent to note that owner occupied housing receives preferential taxation treatment in the following two

[35] For example, if a person is negatively gearing an investment property, with interest payments of $20,000 per annum, at present the total amount can be claimed as expenses, thus reducing tax paid. Under this proposal only $12,000 could be claimed. Similarly if income from the property is $20,000 per annum, if this proposal was implemented, only $12,000 would be treated as income, whereas under present arrangements the full $20,000 is considered income.

ways: (i) no capital gains taxation is levied on owner occupied housing and (ii) imputed rent is not classed as income.

The Henry Report states that "the family home has not been subject to income tax in Australia since the earlier part of the last century. Imputed rental income and capital gains from owner-occupied housing are generally exempt in the OECD countries" (Henry, 2010b, p. 13). Thus, the Henry Report does not propose any taxation on imputed rent or capital gains for owner occupied housing.

2.3.4.4 Policy regarding taxation of bequests

As discussed in Section 2.2.8 many people leave an estate, either because of a bequest preference or accidentally, for example because precautionary savings were not needed. There have been no federal taxes on bequests in Australia since 1979, and no such taxes in any state since 1984 (Reinhardt & Steel, 2006). The Henry Report suggested that this situation be reviewed and that there be community discussion and consultation, arguing that "a bequest tax would be an economically efficient way of raising revenue ... It would not affect savings decisions to fund an adequate standard in retirement" (Henry, 2010a, p. 37). The government response to this proposal was clear cut, stating that would not introduce such a policy at any stage (Swan & Rudd, 2010).

2.3.5 Public policy issue – funding in the retirement years

For the retirement years there are four areas of particular policy interest: (i) the age when retirement funding can be accessed, (ii) life-contingent annuities, (iii) the availability of the Age Pension, and (iv) reverse mortgages. These matters are discussed immediately below.

2.3.5.1 Policy issue - access to retirement funding.

In 2008, when both the Henry and Harmer reports were commissioned, the age of access to the Age Pension was 65 years for men. For women, up until 1994, the age of access was 60 years, but, at that time, a phased approach was begun to lift the age to 65 years. With regard to the SGL, transition to retirement pensions were available from age 55[36] (the then preservation age), with full withdrawal rights at age 65. Once attaining

[36] In the 1997 budget, the government of the day announced that the preservation age would be gradually increased from 55 years to 60 years over the years 2015 – 2025 (Nielson, 2010b).

age 60, no income tax was payable on either superannuation pension payments or lump sum withdrawals (Nielson, 2010a).

Both the Henry and Harmer reports recommended changes to the age of access to retirement funding. The Harmer Report suggested that consideration be given to increasing the Age Pension access age by two to four years, in a phased manner, whilst the Henry report recommended increasing the eligibility age for the Age Pension to 67. The Harmer report noted that such changes would need to be accompanied by policy changes regarding the access age to superannuation whilst the Henry report was definite in arguing that the access age for Superannuation should also be 67 (Harmer, 2009, p. xxi; Henry, 2009, p. 3).

The situation with these recommendations is that it was announced in the 2009 budget that the age of access to the Age Pension would be raised in a phased manner commencing in 2017, with the age to be 67 years by 2023 (Australian Government, 2009, p. 2). However, in a government response to the Henry Report, the recommendations regarding aligning the preservation age for superannuation to the age of access for the Age Pension were explicitly rejected (Swan & Rudd, 2010).

2.3.5.2 Policy issue – use of life-contingent annuities

Once a person accumulates retirement funds, the decision has to be made as to how to use this wealth to provide retirement income for the rest of the person's life. Essentially the choices are: (i) to use (some of) the accumulated funds to buy life-contingent annuities, (ii) to withdraw (some of) the funds as a lump sum, and (iii) to use (some of) the funds as an allocated pension[37]. This decision is complex, particularly so as the decision of the mix of options taken may either enable or preclude the obtaining of either a full or part Age Pension. It is also important to recognise that, in Australia at present, a person is completely free to adopt any mix of these options whatsoever, there

[37] An allocated pension is a financial product available to retirees to convert their superannuation savings into a regular income. It is drawn from a superannuation account which continues to be invested in the financial markets according to a selected strategy, examples being medium risk, high growth, capital guaranteed. The minimum withdrawal rates are defined by policy, and are age dependent (ASIC, 2013b).

being no legislation to insist a person takes even a small income stream[38]. Moreover the taxation regime is such that all monies withdrawn from a superannuation account after the age of 60 years are taken tax free, no matter what the withdrawal amount and no matter whether funds are taken as an income stream or a lump sum (Australian Securities and Investments Commission (ASIC), 2012a) and as mentioned previously, the terms of reference for both the Henry and Cooper reports precluded any change to this policy. In this section, policy issues relating to life-contingent annuities are discussed, whilst in the immediately following section, policy issues relating to access to the Age Pension are considered.

In Section 2.2.2.2 the academic consideration of life-contingent annuities was discussed. Essentially, a life-contingent annuity is the optimal use of retirement funding, from the SEM perspective, but in practice, these financial instruments are not popular with retirees.

In Henry's discussion on strategic issues for the retirement income system, a document issued in advance of his main report, there is analysis of the role of life-contingent annuities in retirement funding, in particular as to whether the purchase of such products should be voluntary or mandatory. The argument put forward against mandatory annuitisation is that such a scheme would be discriminatory against subsets of the population with lower life expectancy, for example indigenous Australians and low income earners, as their contributions to the pooled funds of such a scheme would finance the consumption of people who live to a greater age. However a voluntary system also has its issues, particularly that of adverse selection, where people with a higher than average life expectancy are those who would be more likely to purchase such products (Henry, 2009).

The Henry Report made two recommendations regarding life-contingent annuities. One is that the government should offer both an immediate life-contingent annuity and a deferred life-contingent annuity. The other recommendation is that the government further support the life-contingent annuity market, one means of support being the

[38] Bateman (2009) argues that there is a failure in policy in that life- contingent annuitisation of benefits, at least partial, is not mandated, and as people do not annuitise voluntarily, Australians are exposed to the risks of longevity and inflation. She comments on the moral hazard implications of the situation where people can manage their superannuation accounts to qualify for at least a partial Age Pension. However, she comments positively regarding the fact that the ability to take account-based allocated pensions provides the flexibility for a retiree to withdraw a sum to meet unexpected or particularly large costs such as medical expenses.

issuing long-term securities to assist product managers manage investment risk (Henry, 2010a).

It is interesting to note that the Henry Report took a position different to that of the Cooper Report (see Section 2.3.3), arguing for effort to develop greater financial literacy in the population:

> the level of awareness and engagement of individuals with the retirement income system should be improved. ... More needs to be done, particularly in building understanding of issues such as longevity risk. ... Government and the superannuation industry should share in the responsibility of assisting individuals to better understand and engage in the system. (Henry, 2009, p. 4)

However, given the Henry Report is concerned with taxation matters, no formal recommendation was given.

The Cooper Report did not make any specific recommendations regarding life-contingent annuities. However the Report's discussion on the retirement phase stated: "MySuper should be a whole of life product and include a single type of retirement income stream product, chosen by the trustee" (Cooper, 2010, p. 16). Such a product obviously could include a proportion of funds used to purchase a life-contingent annuity.

The government in its response to the Henry Report stated categorically that it would not be introducing a government annuity (Swan & Rudd, 2010).

There is no specific mention in either of the government responses regarding the recommendation that the government issue bonds to support suppliers of life-contingent annuities in managing longevity risk (Swan & Bradbury, 2012; Swan & Rudd, 2010). However, in 2009 the Treasury announced that capital indexed bonds would again be available, though the primary reason for this issue was for economic management in light of the global economic crisis (Australian Office of Financial Management (AOFM), 2009).

2.3.5.3 Policy issue – access to the Age Pension

At the institution of the SG the government of the day explicitly recognised that there would be considerable reliance on the Age Pension even with a mature SG system as is evidenced by the following statement:

> This government sees the age pension not just as a security net for future retirees but as the key-stone of its superannuation policies. It expects that most future

> retirees will continue to be eligible to the age pension (for example, through a part pension) which, with self-provides and tax-assisted superannuation, would allow a higher retirement income is now generally available (Dawkins, 1992, p. 2).

This view is supported by the IGR with the 2010 IGR stating that "the proportion of people with a part Age Pension is projected to increase significantly while the proportion of the eligible age group not receiving any Age Pension is projected to rise slightly" (Treasury, 2010a, p. 61).

It is instructive to see how the existence of the SGL might change retirement outcomes for Australians with average income and wealth. Kelly (2009) investigated the situation regarding Age Pension availability in conjunction with other private income. Writing at the same time that both the Henry and Harmer reports were being developed, and using 2006 data, he found that:

> (there are) two very different groups of Age Pensioners. The first group – representing the vast majority (around 90 per cent) – have very little. They exist on the Age Pension with almost no private supplementary income; they have few assets outside of the family home (if they have that). ... The second group of Age Pensioners[39] representing around 10 per cent has private income of $200 per week to add to their government benefits and often live in a household with a net worth of over $1 million. (p.19)

Most retirees represented by Kelly's data would have had very little, if any, wealth acquired via the SG.

However Piggott and Evans (2007) investigated expected retirement incomes in a mature SG environment, using life expectancy tables to estimate probabilities of longevity and the Age Pension and SGL arrangements in place at the time of publication. These authors argue that a couple on average earnings throughout life would have an asset level on retirement that allowed an Age Pension. Moreover they believe the retired couple would structure the income from their SG account to receive a part age pension at all times throughout the retirement phase so that the total amount allowed for the CAS level from the ASFA standard (discussed Section 2.2.3.2) would

[39] Kelly (2009, p. 20) asserts that there is a thriving financial planning business in advising the wealthier age pensioners as to how to structure their assets and income to receive even the smallest Age Pension arguing that a major reason for this situation is not that the person receives what often is a very small amount indeed from the Age Pension, but because receiving even very small amount provides for the benefits of the pension concession card. He proposes that all people over a designated age be given such a card, believing that this situation would stop some people from structuring assets and income inappropriately just to get the Age Pension, and would eventually reduce the amount of Age Pension being paid.

be attained The amount of the Age Pension received would gradually increase as the SGL portion was drawn down, with the model suggesting that such an arrangement could be funded for 35 years. For a single male with the same assumptions the time of funding would be 27 years and thus, for a single male retiring at age 65, funding above the Age Pension level could be expected until age 92.

Whether a person or household is eligible for either a full or part Age Pension is determined by the means test of both assets and income. Both the Henry Report and the Harmer Report provided recommendations as to how the means test should be structured.

The Harmer Report found that, for people receiving a part Age Pension but whose main source of income was from other sources, there was no evidence that the means test was working to prevent an overall adequate level of income. Thus it recommended that there be tightening of the assets test to provide the ability to improve the adequacy of pension payments for those who predominantly rely on the Age Pension (Harmer, 2009). In particular it found that the rate paid to single pensioners was too low when considered with the payments made to couples.

A salient finding from the Harmer Report in relation to the structuring of incomes in the retirement phase is that the current approach to assessing income from allocated superannuation pensions causes distortion. At present, for purposes of assessment, the full income taken as an allocated pension is reduced by a deduction calculated on the basis of life expectancy at the time of taking up the allocated pension. This deduction is meant to remove the portion of the income stream which is in fact a drawing down of wealth[40]. However the Harmer Report argues that this method of assessment makes it easier for a person in the earlier years of retirement to meet the income test, but harder in the later years. As well as this specific distortion, there is the overall situation that an allocated pension is treated differently and more generously than other financial assets are treated in assessing income. The recommendation is that such superannuation

[40] This deduction can be generous. A 67 year old male, thus with a life expectancy of 17 years, using funds from a superannuation account of $240,000 to generate an allocated pension of $12,000 per annum, would have a deductible of $(240,000/17) i.e. $14,120. Thus none of the yearly payment of $12,000 is assessable under the income means test. In this particular case, if the person has no other private income and also meets the assets test, he would receive a full Age Pension, presently about $19,000 per annum. Taking a pension of $12,000 per annum, growing at 3% per annum to allow for inflation, from an account worth $240,000 initially is sustainable for 25 years if the account has average yearly earnings of slightly more than 5% per annum.

accounts be assessed by deemed income as is done for other financial assets[41] (Harmer, 2009).

The Henry Report also made recommendations regarding means testing. The purpose of this recommendation is to avoid situations where persons having equal savings, but in different forms, are treated differently. The suggestion is that the assets means test be abolished and that the means test be solely income based, incorporating deemed income from any assets not presently generating income such as holiday homes, land and collections. Moreover the recommendation is to assess superannuation accounts using a deeming approach, the same approach recommended by the Harmer Report. The Henry Report specifically mentions that there would need to be resolution as to how income streams from life-contingent annuities would be treated[42] (Henry, 2009).

As mentioned in Section 2.3.4.3 the owner-occupied home receives favourable taxation treatment. Another favourable treatment of this asset is that its value is ignored for Age Pension assets means test purposes. The Henry Report recommended that an owner-occupied dwelling be exempt from any means testing, up to a very high limit. For the purposes of this thesis, it can be assumed that a household of average means would not have dwelling of such high value.

With regard to means test treatment of funds from reverse mortgages, the Harmer Report notes that income taken as a stream is not included in the income means test, and that lump sums taken are not assessed immediately under the assets test (Harmer, 2009). The Henry Report states that funds taken in a reverse mortgage are not taxed, and such funds are classed as a loan. Commenting on this situation, and the situation regarding the means testing of reverse mortgage payments in regard to the Age Pension, Henry

[41] In the example of Footnote 40, the deemed income at 4% would be $9,600. This amount alone would preclude a full Age pension, based on the income test applying in 2013. The person would receive a part Age Pension of about $16,000, rather than the full Age Pension of about $19,000, assuming all other income and asset test are met.

[42] Presently income from a life-contingent annuity is treated in the same way as that from allocated pensions. However there is a fundamental difference between the two arrangements. For a life-contingent annuity, there is no residual capital once the income stream stops, whilst for an allocated superannuation pension, depending on the investment strategy and the returns on these investments there may be a considerable asset existing when the pension payments cease.

argued "the tax and means test treatment of these products is already generous and should not be made more so" (Henry, 2010b, p. 120)[43].

The response to the Harmer Report recommendation regarding the level of the single Age Pension and the application of the means test was that, as at the 2009 budget, the payment for couples was increased, as was that for singles, but the increase for singles was proportionally greater and tied to a higher percentage of the couples rate. In conjunction with these changes, the application of the means test was adjusted by changing the tapering rates, thus making it harder for people receiving a small part pension to receive it at all (Australian Government, 2009).

There has not been any response from the government regarding the recommendation from the Henry report to rely solely on an income means test and to include deemed income from assets not producing income. The suggestion to include in means testing the value of an owner-occupied dwelling above a high threshold was rejected (Swan & Rudd, 2010). With regard to the recommendations made by both the Harmer and Henry Reports for changes in the way superannuation income streams are assessed, the government announced in April 2013 that, as of January 2015, assessment of these income streams would be deemed, in alignment with the way other assets are treated (Shorten & Swan, 2013a).

2.3.5.4 Legislation relating to reverse mortgages

Although policy relating to the regulation of reverse mortgages was not considered in any of the five policy initiatives discussed in Section 2.3.1, reverse mortgages have the potential to provide substantial income in the retirement years, albeit with some risk, and thus some details of recent legislation is provided immediately below.

Prior to September 2012, the regulatory environment for such products was the same as for other banking products (Bridge et al., 2009). Thus, depending on the lender, a situation could arise, after several years of a reverse mortgage, where the market value

[43] Take for example the situation set out in Footnote 40 where a male aged 67 uses a superannuation account of $240,000 to generate an income of $12,000 per annum, and is still able to receive a full Age Pension. If he is living in a mortgage free dwelling worth $600,000 in a suitable geographical area, he may be able to arrange a reverse mortgage of 40% of the value of the dwelling. Assuming this amount can be invested safely at 0.5% above the inflation rate, he would be able to draw down $10,000 per annum indexed at the inflation rate for 25 years, i.e. until he is 92. Thus he would have an income of $41,000 per annum. There is no tax payable on this amount. This amount of $41,000 is in line with the CAS retirement standard amount suggested by ASFA (see Section 2.2.3.2).

of the house would be less that the amount needed to pay out the loan. This situation caused householders to be concerned about such products, especially in regard to security of tenure (Beal, 2010). The industry association for equity release products for older Australians, Senior Australians Equity Release Association of Lenders (SEQUAL), had developed a code of practice for its members where such products needed to include the condition that there could not be a situation of negative equity when a reverse mortgage was finalised, but there is no discussion regarding security of tenure in its code of conduct (SEQUAL, 2013). However, legislation introduced in September 2012 has ensured statutory protection from negative equity on all new reverse mortgage contracts (ASIC, 2013c). Regarding security of tenure, this ASIC document advises that, where there are people living in the dwelling who are not title holders, it is necessary to discuss the situation with the lender before taking out the loan.

2.3.6 Public policy issue – managing the financial planning profession

In Section 2.2.7.2, the role of the financial planning industry was discussed. The Australian retirement funding landscape is complicated, the ordinary person can find it difficult to navigate through all the alternatives available, and thus, in this environment, the services of a financial planner can be of definite help.

The financial planning industry operates under the *Financial Services Reform Act 2002* (FSRA) which mandates that a financial services business is conducted by a person holding an Australian Financial Services Licence (AFSL) with these licences being administered by ASIC (ASIC, 2013a). As set out in Section 2.3.1.4, the Ripoll Report suggested further reforms to strengthen consumer protection. Legislation arising from this report is now in place with these reforms including (i) a ban on conflicted remuneration structures, including commissions, for financial advisers of retail clients (ii) the introduction for advisers of statutory fiduciary duty of care, and (iii) the requirement that clients must opt-in on a regular basis for ongoing financial advice. With regard to risk insurance, the ban on conflicted remuneration i.e. commissions, does not apply to risk insurance, except for insurance taken out within superannuation (Treasury, 2011a)

2.3.7 Conclusion – public policy initiatives

In Section 2.3 a discussion has been provided regarding recent reviews and subsequent implementation of policy relating to the provision of retirement funding in Australia.

Whilst it can be concluded that the policy reviews represent a significant investment of intellectual capital into the relevant issues, it can also be concluded that the legislation emanating from the reports has been based to a certain extent on the perceived political issues of the Australian electorate, rather than on a decision to provide a more cohesive system for retirement funding than existed when the reviews began. However, whilst the system for saving for retirement continues to present difficulties for a considerable number of Australians, the introduction of MySuper has the potential to make decision making easier for some.

2.4 Conclusion

In this chapter the literature relating to the provision of retirement funding has been reviewed. As well, key policy initiatives concerning this provision have been examined.

In Chapter 3, literature relating to the methodology is discussed. The conceptual design for the study is set out in full, as is detailed information as to how the models for this thesis have been set up.

Chapter 3 Conceptual framework and approach

In Chapter 2 academic literature relating to the research problem and objectives was discussed, as were recent Australian policy discussions and initiatives relating to the funding of retirement and associated issues. The purpose of this chapter is to provide the conceptual framework adopted by the study and to set out the approach used to meet its objectives.

The organisation of this chapter is as follows. Initially the conceptual framework relating to the theory of choice and to the accessibility of wealth over a lifetime is set out. Following on, information is provided as to methods available to solve the problem of this thesis, including a discussion of the reasons for choosing the particular approach used in this study. Some simplifying assumptions for the study are then stated. Finally information relating to the development of the models used in this study is given.

3.1 Conceptual framework

Prior to a detailed discussion on the framework, it is helpful at this stage to recall the problem that this thesis is addressing and its objectives. As set out in Chapter 1, the research problem for this thesis is: *From a financial perspective how can an Australian* *optimise financial decisions in order to provide for a comfortable retirement?* with the specific objectives being to:

1. Determine the optimal methods and rates of accumulation and decumulation for a range of representative segments of the population, assuming a rational, self-interested perspective.
2. Identify the gaps between optimal accumulation and decumulation, and sub-optimal accumulation and decumulation when behavioural attitudes influence selection of accumulation and decumulation options.
3. Determine the Superannuation Guarantee percentage that needs to be in place for average Australians to have their retirement funded to a comfortable level commensurate with average Australian standards by personal superannuation / savings, supplemented by the means-tested Age Pension.
4. Establish the characteristics of households that would be eligible for the Age Pension, given the selection of economic factors and policy options.

The research problem involves solving a multi-period consumption-investment problem, which is achieved via a multi-period linear programming model.

3.1.1 The economic theory of choice

From the SEM perspective, the research problem is essentially one of choice, and thus it is appropriate to consider initially the economic theory of choice which has been discussed in Chapter 2 Section 2.1.1.1 of this thesis.

The discussion following on the theory of choice draws upon Fama and Miller (1972).

3.1.1.1 Theory of choice under certainty in a one period situation

Firstly it is necessary to set out the theory of choice for an individual in a single period situation. In this case the individual has (limited i.e. constrained) choices and preferences regarding these choices. The choices are limited to an opportunity set, and the criterion is to maximise an underlying utility function. In the following discussion the notation $U(x)$ refers to the utility of choice x, which is the value of the utility function for a given value of x.

As discussed in Section 2.1.1.1 the SEM assumes that choice behaviour is rational with the axioms of completeness, and transitivity holding (Varian, 2003). For classical finance theory, it is assumed that, as well as these two attributes being in place, choice behaviour also has the following two attributes: non satiety of wants (monotonicity) and convexity (Fama and Miller, 1972).

Completeness means that the decision maker can make a choice between any pair of the available choices, or state indifference between the choices i.e. like or dislike the two choices equally i.e.

if x and y are choices then $U(x) > U(y)$ or $U(x) < U(y)$ or $U(x) = U(y)$.

Transitivity means that if decision maker prefers choice x to choice y and choice y to choice z then the decision maker must prefer choice x to choice z i.e.

if $U(x) > U(y)$ and $U(y) > U(z)$ then $U(x) > U(z)$

Monotonicity means that if choice x consists of n components and choice y also consists of the same n components in the same quantity except for that for one component there is more than for choice x, then the decision maker must prefer choice y or at least be indifferent to the two choices i.e.

if $x = (w_1, w_2, \ldots w_i, \ldots w_n)$ and

$y = (w_1, w_2, \ldots aw_i, \ldots w_n)$ and

$a > 1$

then $U(y) \geq U(x)$, provided $U(w_i) \geq 0$,

Convexity means that if there are two choices towards which the decision maker is indifferent, and there is a third choice which is a weighted average of the two choices, then the decision maker must prefer the third choice or at least be indifferent to the three choices i.e.

if $U(x) = U(y)$ and

$z = ax + (1\text{-}a)y$ where $0 \leq a \leq 1$

then $U(z) \geq U(x)$ and $U(z) \geq U(y)$

When considering choice, decisions between which the decision maker is indifferent can be represented graphically as indifference curves.

If it can also be assumed that, if x is a possible choice and y is another possible choice, and it follows that any weighted average of choice x and choice y is also a choice, then the set of choices, called the opportunity set, is said to be convex i.e.

if $x \in C$ and

if $y \in C$ where x and y are choices and C is the opportunity set consisting of all choices, and

if $0 \leq a \leq 1$,

then $z \in C$ where $z = ax + (1-a)y$

If the opportunity set is convex, and the four axioms of choice hold, then it can be demonstrated that the decision maker will choose a solution that lies on a boundary of the opportunity set, known as the efficiency frontier. Any solution not on this particular boundary will yield a solution of less utility than one somewhere on this boundary. Moreover it can be shown that the solution that provides the maximum utility lies at a point where one of the indifference curves is a tangent to the efficiency frontier.

3.1.1.2 Intertemporal allocation of resources – the two period situation

This study is multiperiod, and thus it is necessary to consider the theory of choice beyond a one period situation. Initially a two period situation is examined. In considering consumption over time, it can either be assumed that time occurs in discrete jumps or that time is continuous. In this study the approach taken is to use discrete time periods with decisions being made at the beginning of each period.

In the one period situation, decision making regarding consumption is obviously limited to choices from the opportunity set. However, in the two-period situation the decision maker faces additional complication as the problem now becomes one of consumption-investment. As well as the choice from the consumption options applying in each of the two periods, there is also the ability to invest or borrow. The decision maker can chose to defer (some) consumption to period 2, or alternatively bring (some) consumption forward from period 2 to period 1.

Let c_1 be consumption in discrete period 1 and c_2 be consumption in discrete period time 2. Each of c_1 and c_2 represents the individual's consumption in the respective period.

Assume there are n commodities that are bundled together in each period.

q_{i1} is the quantity of commodity i that is used in period 1

q_{i2} is the quantity of commodity i that is used in period 2

p_{i1} is the price of one item of commodity i that is used in period 1

p_{i2} is the price of one item of commodity i that is used in period 2

It follows that

$$c_1 = p_{11}q_{11} + p_{21}q_{21} +.... p_{i1}q_{i1} ....+ p_{n1}q_{n1}$$

$$c_2 = p_{12}q_{12} + p_{22}q_{22} +.... p_{i2}q_{i2} ....+ p_{n2}q_{n2}$$

Let V be the utility function of the quantities of commodities i.e.

$$V = V(q_{11},q_{21} .... q_{i1} ....q_{n1}, q_{12},q_{22} ....q_{i2} ....q_{n2})$$

Thus

$$U(c_1,c_2) = \max V$$

If the utility function V obeys all four choice axioms set out in Section 3.1.1.1, then it can be shown that $U(c_1,c_2)$ also obeys these axioms. Let:

y_1 be income for period 1 and a_1 be any financial assets existing at the beginning of period 1,

y_2 be income for period 2 and a_2 be the financial assets carried across from period 1 to period 2,

${}_1r_2$ be the interest rate at which the individual can either borrow or lend from period 1 to period 2 the one period interest rate, and ${}_1R_2 = (1+{}_1r_2)$,

Then it follows that

$$a_2 = [(y_1 + a_1) - c_1]\,{}_1R_2$$

As there are only two periods it must follow that

$$c_2 = y_2 + a_2$$

$$c_2 = y_2 + (y_1 + a_1)\ {}_1R_2 - c_1\ {}_1R_2$$

As y_1, y_2 and a_1 are given, and ${}_1r_2$ is known,

$$c_2 = K - c_1\ {}_1R_2$$

Thus

c_2 is a linear function of c_1,

$$\frac{\partial c_2}{\partial c_1} = -\ {}_1R_2$$

and the rate of change of c_2 with respect to c_1 is solely a function of the interest rate.

The straight line

$$c_2 = y_2 + (y_1 + a_1)\ {}_1R_2 - c_1\ {}_1R_2$$

is the opportunity set for c_1 and c_2, and, given the utility function $U(c_1,c_2)$ obeys the choice axioms (as discussed above) , the preferred allocation is the point on the straight line when it is a tangent to the appropriate indifference curve. This tangency situation means that, for some particular circumstances, the power of mathematical analysis can be used to establish explicit results.

3.1.1.3 Intertemporal allocation of resources – the n period situation

The situation with two periods can be extended to any situation where there is a finite horizon i.e. *n* periods. There is a complicating factor in that financial assets can now be carried across to later periods e.g. such assets could be carried across from period *i* to periods *i*+1, *i*+2, .. *i*+*j*,... *n*. However the assumption of perfect markets means that

$$(1+\ {}_ir_{i+1})\ (1+\ {}_{i+1}r_{i+2})\ \ldots\ (1+\ {}_{i+j-1}r_{i+j})\ \ldots\ (1+\ {}_{n-1}r_n) = (1+\ {}_ir_n)^{(n-i)}$$

where ${}_ir_n$ is the interest rate at which the individual can either borrow or lend from period i to period n.

This relationship between interest rates in different periods when perfect markets apply means that the relationship between c_1, c_2, ... c_i, ... c_n can be expressed entirely in terms of y_1, y_2, ... y_i, ... y_n and a_1, all of which are known.

Using the same notation as for the two period situation i.e. ${}_iR_n = (1+{}_ir_n)$,
it can be shown that the opportunity set (c_1, c_2, ... c_n) is such that

$$c_1 + c_2/{}_1R_2 + c_3/({}_1R_2\,{}_2R_3) \ldots + c_n/\,({}_1R_2\,{}_2R_3 \ldots {}_{n-1}R_n)$$
$$= a_1 + y_1 + y_2/{}_1R_2 + y_3/({}_1R_2\,{}_2R_3) \ldots + y_n/\,({}_1R_2\,{}_2R_3 \ldots {}_{n-1}R_n) \text{ – eqn. 3.1}$$

The objective is to maximise the utility of the particular set of choices (c_1,c_2,...c_n) and, using equation 3.1, it can be shown that

$$\frac{\partial U}{\partial c_1} = \frac{\partial U}{\partial c_2}\,{}_1R_2 = \frac{\partial U}{\partial c_3}\,{}_1R_2\,{}_2R_3 = \ldots = \frac{\partial U}{\partial c_n}\,{}_1R_2\,{}_2R_3 \ldots {}_{i-1}R_i \ldots {}_{n-1}R_n$$

where $\frac{\partial U}{\partial c_i}$ is the partial derivative of U with respect to c_i.

It follows that

$$\frac{\partial c_2}{\partial c_1} = -\,{}_1R_2$$ (as set out for the two period situation in Section 3.4 above),

$$\frac{\partial c_3}{\partial c_2} = -\,{}_2R_3$$

$$\frac{\partial c_3}{\partial c_1} = -\,({}_1R_2\,{}_2R_3)$$ and, in general,

$$\frac{\partial c_{i+j}}{\partial c_i} = -\,({}_iR_{i+1}\,{}_{i+1}R_{i+2} \ldots {}_{i+j-1}R_{i+j})$$

Thus, between any pair of periods, whether consecutive or not, the preferred allocation of consumption between the two periods is a tangency solution of the straight line in the appropriate plane with an indifference curve, where the gradient of the straight line is a function only of the interest rates. Again, these relationships allow for mathematical analysis to provide explicit solutions to the problem, given appropriate conditions.

3.1.1.4 Theory of choice in this study

What has been discussed above is for an individual consuming and saving across multiple periods under certainty. The savings-investments for each period have known interest rates-return rates applied. A more general situation is where, for each period, the individual has some wealth and must decide how to use this wealth. The wealth can be consumed, or invested in both risky assets and a risk free asset. For the risky assets the expected rate of return is known, as is the distribution of return. As with choice under certainty, the aim is to maximise the utility of consumption over a lifetime. As for the certainty situation, there is a body of theory setting out the problem, stating assumptions, and providing a representation that allows for mathematical analysis.

However, for this study, as is explained later in Section 3.3 the returns for each investment class are assumed to be known i.e. the approach for this study involves deterministic models, with risk being assessed via sensitivity analysis[44]. Superficially it could be thought that such a problem is trivial. This is not the case. Firstly, even given the simplifying assumptions set out later in this chapter in Section 3.3 the number of choices that can be made is large[45]. Examples of such choices are the amounts to invest in superannuation above the SGL for each period where there is labour income, the amount to save outside the superannuation umbrella for each period, the decision regarding housing for each period, and if owner occupied housing is chosen the amount

[44] Whilst, for the purposes of this study, it is assumed that the returns for each investment class are known, it is important to recognise that there is wide variation in the returns obtained by different assets, and in the returns earned by the same asset class but for different periods. In particular, for the Australian superannuation sector, there has been developed a significant body of literature examining the impacts on returns by fund type (i.e. retail funds, industry funds, corporate funds), fund size, fund expenses and asset allocation policies. Moreover, there are the impacts on earnings relating to the economic climate at particular times, such as interest rate risk and sequencing risk. The rates of return achieved at particular times can have a profound impact on the value of retirement funds for the individual, both at the time of retirement when the individual may require funds to purchase an income stream, and at all times following (Drew & Stanford, 2003; Ellis, Tobin & Tracey, 2008;Sy & Liu, 2010; Cummings, 2012; Basu, Doran & Drew, 2013;.Basu & Andrews, 2014)

[45] A simple arithmetic calculation gives an indication of the complexity of decision making. For a single person household during the accumulation stage,, assume there are 5 levels of owner-occupied housing that can be purchased, two choices regarding life insurance, three choices regarding amount that can be invested outside of superannuation, six choices as to amount that can be contributed to superannuation above SGL. In this very conservative estimate of choices available, there are 180 different combinations. Assuming that there are at least this number of discrete choices for each of the periods, and that there are 5 periods, there are now 180^5 different combinations i.e. 189 billion sets of choices.

of the purchase price and the amount to borrow, the decision as to whether to purchase life insurance, and decisions regarding how to draw down retirement wealth for consumption during retirement. As well there are many constraints, both internal and external, impacting upon the choices. Examples of external constraints are government regulation of some retirement savings schemes, means testing of the Age Pension, and limits applied to borrowing by lending institutions, whilst examples of internal constraints are the maximum value of owner-occupied housing at a particular stage of the lifetime, relative consumption across time periods to provide for consumption smoothing, and the minimum consumption possible for different stages of the lifetime.

3.1.2 Modelling wealth in a multiperiod situation

Immediately above, the conceptual framework for this study relating to choice theory for the general consumption-investment decision was set out. It is now appropriate to provide a conceptual framework for wealth held over a lifetime.

Given that the problem is one of choice over time, the approach used in considering wealth is one of (T+1) discrete time periods where the consumption-investment decision is made at the beginning of each of the first T periods. In period (T+1) the estate is finalised.

A specific characteristic of the problem of this study is that the consumption - investment decisions take place in two different phases i.e. the accumulation phase and the decumulation phase. In the accumulation phase the household earns labour income. This income may be consumed or alternatively invested, either in the superannuation asset, or in non-superannuation assets. For funds surplus to consumption that are invested in non-superannuation assets, the invested amounts together with any income and capital growth are available at the beginning of the subsequent period for consumption or further investment. However, for superannuation investments, income and capital growth cannot be realised, but must be preserved for the decumulation stage. In the decumulation phase all accumulated wealth is available but there is no labour income, but an Age Pension may be available.

3.1.2.1 Modelling wealth during the accumulation stage

Let wealth at discrete time t be w_t

This wealth is either accessible wealth or superannuation wealth, the latter being inaccessible wealth during the accumulation phase.

Let accessible wealth for discrete time t be wa_t

Let superannuation wealth for discrete time t be ws_t

Thus

$$w_t = wa_t + ws_t$$

During the discrete time t, an Australian household has income y_t and consumption c_t. For income, as for wealth, there is accessible income and inaccessible income, the latter being the SGL for period t.

Let accessible income for discrete time t be ya_t
Let SGL income for discrete time t be ys_t
Thus

$$y_t = ya_t + ys_t$$

Let residual wealth at discrete time t after income and consumption be rw_t.

Thus

$$rw_t = (w_t + y_t - c_t)$$

which can be broken down further i.e.

$$rw_t = [(wa_t + ya_t - c_t) + (ws_t + ys_t)]$$

The residual accessible wealth at time t can be invested in either the superannuation asset or in non-superannuation assets.

Let the amount of accessible wealth invested in the superannuation asset at time t be s_t.

The remaining residual accessible wealth is invested during discrete time t in a portfolio of j assets. The proportion p_i is invested in asset i so that $\sum_{i=1}^{j}(p_i) = 1$.

Each non-superannuation asset class has its own return, such that the growth (both earnings and capital growth) on asset *i* during discrete time *t* is g_i.

Thus, accessible wealth in time t+1 is

$$wa_{t+1} = (p_1)(wa_t + ya_t - c_t - s_t)(1 + g_1) + \ldots (p_i)(wa_t + ya_t - c_t - s_t)(1 + g_i) + \ldots + (p_j)(wa_t + ya_t - c_t - s_t)(1 + g_j) \quad \text{i.e.}$$

$$wa_{t+1} = \sum_{i=1}^{j} (p_i)(wa_t + ya_t - c_t - s_t)(1 + g_i)$$

The superannuation wealth, together with any residual wealth allocated to the superannuation asset, is invested during discrete time *t* to give a total return of r_t. This return comprises of both earnings and capital growth. Thus superannuation wealth in time t+1 is:

$$ws_{t+1} = (ws_t + ys_t + s_t)(1 + r_t)$$

Thus wealth at discrete time t+1 is:

$$w_{t+1} = wa_{t+1} + ws_{t+1} \quad \text{i.e.}$$

$$w_{t+1} = \sum_{i=1}^{j} (p_i)(wa_t + ya_t - c_t - s_t)(1+g_i) + (ws_t + ys_t + s_t)(1+ r_t)$$

3.1.2.2 Modelling wealth during the decumulation phase

For the decumulation stage, there is no longer a distinction between accessible wealth and inaccessible wealth as superannuation wealth is now accessible. There is no labour income but there may be income from a government pension. All income is accessible income.

Using a discrete time framework, the wealth of a person or household can be modelled as follows:

Let wealth at beginning of discrete time *t* be w_t

During the discrete time *t*, an Australian household has income y_t and consumption c_t.

Let residual wealth at discrete time *t* after income and consumption be rw_t.

Thus

$$rw_t = (w_t + y_t - c_t)$$

This residual wealth is invested during discrete time t in a portfolio of j assets. The proportion p_i is invested in asset i so that $\sum_{i=1}^{j}(p_i) = 1$.

Each asset class has its own return, such that the growth of asset i during discrete time t is g_i

Thus, beginning wealth in time t+1 is

$$w_{t+1} = (p_1)(w_t + y_t - c_t)(1 + g_1) + \ldots\ldots (p_i)(w_t + y_t - c_t)(1 + g_i) + \ldots + (p_j)(w_t + y_t - c_t)(1 + g_j)$$

$$w_{t+1} = \sum_{i=1}^{j}(p_i)(w_t + y_t - c_t)(1 + g_i)$$

3.1.3 The utility function

Thus far the conceptual framework has included both theory of choice and the consideration of wealth in a multiperiod situation. Another concept that needs to be further considered in particular light of this study is that of utility.

Obviously the solution is the one that provides for the maximum benefit for the household, measured as utility. The theory of choice explicitly uses the utility of consumption as the objective to be maximised. However, even though this thesis is concerned with ensuring that Australians have the best possible retirement from a financial perspective, it is not sufficient to consider retirement consumption in isolation. If generous consumption is possible in the retirement years but at the expense of adequate consumption during the working years, the overall utility of the savings-spending regime will be diminished. Thus an appropriate utility function for this multiperiod study is:

$$\text{maximise} \quad \sum_{t=1}^{T} U_t(C_t)$$

where U_t is a utility function in consumption.

However the utility function set out above is still very general, being simply a function that takes into account all consumption over the total period. It is helpful at this stage to consider the discussion from the literature review regarding lifecycle consumption.

As discussed in Chapter 2 section 2.1.1.3, Modigliani and Brumberg (1954) proposed that a rational person will stage consumption over a lifetime to maximise utility and thus save in younger days to provide for old age. Friedman (1957) proposed that consumers consume according to long term expectation of income. Implicit in both these theories of consumption and saving is that consumption is equally valuable to the consumer whenever it happens. It is reasonable to use these theories in this study, and thus a utility function used for this study needs to take into account consumption across a lifetime, with utility of consumption for each period weighted appropriately to have equitable recognition.

3.1.4 Bounded rationality

As discussed in Section 3.1.1.4, for accumulation and decumulating wealth for retirement, the number of different choices available over a lifetime is beyond comprehension. In Section 3.1.1 the theory of choice from an SEM perspective was set out. It is also instructive to consider choice from a BEM perspective.

As discussed in Section 2.1.3.1 Simon's theory of bounded rationality provides an approach that takes into account "the very limited information-gathering and computing capacity of human beings and their associated computers" (Simon, 1972, p. 176). This theory sets out that, if the opportunity set of choices is X^n, the limits of rationality (for reasons such as complexity and lack of information) imply that there is a more limited set of choices X^m where X^m is a subset of X^n . A person will make a search on the limited set of choices X^m until a choice that is adequate is found i.e. a satisficing choice (Simon, 1972).

3.2 Establishing optimal solutions for the consumption-investment decision

Thus far, what has been under consideration is the general problem of finding a solution for choice across time under certainty so that maximum utility across the time is achieved i.e. a constrained optimisation problem. The classical finance theory described above in Section 3.1.1 makes assumptions so that the powerful tools of mathematical analysis can be applied and explicit solutions found. However, although this SEM approach may provide elegant solutions from a mathematical viewpoint, there are two issues that often make such an approach unproductive.

Firstly, the taking of assumptions to provide a mathematical model that enables analytical solutions may be too restrictive when compared to an actual situation. Using 'reasonable' assumptions may result in a situation where semi-analytical or numerical methods need to be adopted. Secondly, as discussed in Section 3.1.4, the human condition may mean that people are prepared to accept a 'good enough' solution, and not be able to suitably appreciate solutions found explicitly, especially if such solutions are couched in general terms.

There are alternative approaches to finding solutions to the consumption-investment decision. Two approaches, microsimulation and operations research, are discussed immediately below.

3.2.1 Microsimulation

One approach to investigating optimal solutions to consumption-saving-income problems across several periods is that of microsimulation[46]. This method has been described by Williamson (2007, p. 1) as "A modelling technique that operates at the level of individual units such as persons, households vehicles or firms. ... A set of rules (transition probabilities) are then applied to these units leading to simulated changes in state and behaviour".

This method is used extensively in Australia to examine issues regarding retirement saving and funding. As mentioned briefly in Chapter 1 Section 1.5 NATSEM is an independent Australian research organisation using microsimulation to enable it to contribute to economic policy debate. Its major role is to provide reliable information about a current situation or about the situation that would arise as a result of policy change. NATSEM positions itself as:

> A centre for excellence for analysing microdata and constructing microsimulation models. Such data and models commence with records of real (but unidentifiable) Australians. Analysis typically begins by looking at either the characteristics or the impact of a policy change on an individual household, building up to the bigger picture by looking at many individual cases through the use of large datasets. (Kelly, 2009, p. 2)

Another, significant, user of microsimulation is the Treasury. Obviously the Australian government needs to understand the impact of policy decisions regarding retirement funding, both at an aggregate level and for the individual.

[46] For a brief history of microsimulation, together with a discussion regarding both the challenges and opportunities for this approach see Harding (2007).

The Retirement and Income Modelling Unit (RIM) within the Treasury has as its purpose the development of models to investigate the long term impact of retirement income policies. As stated in Chapter 1 Section 1.5, it uses three types of superannuation micro models – hypothetical tax-benefit models at the individual and the couple level, cohort models (or actuarial models) and static microsimulation models (Gallagher and Preston, 1993). The principal model, which operates at the individual/couple level, is RIMHYPO. This dynamic microsimulation model takes the individual/couple across the lifecycle from the time of beginning work until death, taking into account key life events, implementation of government policy and all sources of retirement funding (Treasury, 2012). Originally RIMHYPO was developed based on assumptions about future values of economic variables such as inflation, wage growth and investment returns. However, since 2009, the Treasury has further developed RIMHYPO, introducing stochastic volatility for these three variables (Price and Suryadi, 2011).

Microsimulation is essentially a measurement approach, and does not immediately provide an explicit optimal solution, though of course the results obtained can be used to identify the 'best' solutions from those generated by the modelling.

3.2.2 Operations Research

Other alternative approaches to identifying optimal solutions can be found under the broad heading of Operations Research. Morse and Kimball (1970, p. 1) define Operations Research as "a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control". Operations Research has a broad scope, encompassing many techniques including the various branches of mathematical programming, game theory, statistical and probabilistic analysis and simulation. Two of these approaches are discussed immediately below.

3.2.2.1 Simulation

Simulation is a method of analysis of a process or system where a computer is used to imitate the total process or system (Hillier and Lieberman, 2010). One particular simulation approach is *Monte Carlo* analysis. This method is used extensively by financial planners to investigate optimum approaches for saving and consumption in retirement, for example Bengen (1994,1996,1997,2001) and Guyton (2004).

3.2.2.2 Mathematical programming

Mathematical programming is an optimisation approach. Intriligator (1971, p. 2) defines the mathematical optimisation problem as "the choice of values of certain variables so as to maximise a function subject to constraints". This approach involves setting up a model to represent the decision variables, the constraints and the objective function, with the outcome the optimisation of the objective function. Linear programming, integer programming, nonlinear programming such as quadratic programming, stochastic programming and dynamic programming are all examples of mathematical programming, the particular term applying to a model depending on the way the model is set up. The discovery of powerful algorithms has meant that mathematical programming problems are able to be solved systematically, and the advent of easily accessible and inexpensive computer power has meant that these algorithms can be used to solve these problems quickly.

3.2.2.3 Linear programming

Within mathematical programming, linear programming is possibly the most used variant, and this is the method chosen for this study. It was Dantzig in 1947 who first set up a problem in the linear programming form including an objective function, and then secondly developed the simplex method, an algorithm to solve linear programming problems[47] (Dantzig, 1949, 2002). Dantzig's work is recognised today as one of the most important achievements of its time:

> (linear programming's) impact since just 1950 has been extraordinary. Today it is a standard tool that has saved many thousands or millions of dollars for many companies or businesses of even moderate size in the various industrialized countries of the world and its use in other sectors of society has been spreading rapidly. (Hillier and Lieberman, 2010, p. 23)

A linear programming problem is one that can be formulated in the following way:

Maximise $C^{T}X$

subject to

$$AX \leq B$$

$$X \geq 0$$

[47] An article by Albers, Reid and Dantzig (1986) sets out an interview with Dantzig and includes his reminiscences on the development of both linear programming and the simplex algorithm.

where:

X is an $n \times 1$ matrix with $x_1, x_2 .... x_n$ being the variables[48].

C is an $n \times 1$ matrix giving details of the objective function.

A is an $m \times n$ matrix setting out the left hand side of the constraints applying to the problem.

B is an $m \times 1$ matrix setting out the right hand side of the constraints applying to the problem.

Another way of setting out a linear programming problem is:

Maximise:

$$c_1x_1 + c_2x_2 + \cdots + c_nx_n$$

Subject to:

$$a_{i1}x_1 + a_{i2}x_2 + \cdots + a_{in}x_{in} \leq b_i, \forall i, i = 1, \dots, m$$

and:

$$x_j \geq 0, \forall j, j = 1, \dots, n$$

All equations above are linear.

The algebraic formulation as set out above is an expression of a problem where there is an optimisation objective i.e. maximise C^TX, subject to a set of constraints i.e. $AX \leq B$ and $X \geq 0$.

For this study, because of the existence of some constraints that permit a variable to be either 0 or greater than a minimum amount, it is necessary to introduce integer variables that must be either 0 or 1. The existence of these integer variables means that this study uses a version of linear programming known as Mixed Integer Linear Programming (MILP).

48 Historically, in linear programming, the term 'decision variables' has been used to describe the quantities needed to be determined to solve the problem. For the sake of clarity, for this study the term 'variables' is used, with the term 'decision variables' being reserved for the subset of variables that represent actual decisions. Section 3.4.2 provides further information.

As mentioned immediately above, Dantzig discovered the simplex algorithm in 1947. In the early days of linear programming this algorithm was used to solve suitable optimisation problems by hand, a time consuming process that limited the size of problems that could be investigated. The advent of powerful computing meant that larger problems could be solved very quickly. In addition further algorithms have been developed, some of which are able to solve variants such as MILP problems. The situation is now that there are software packages available for commercial and academic use that quickly solve large linear programming problems (for example with 8000 variables and 8000 constraints). The software package used for this study is Frontline Systems' Premier Solver Platform which works with Microsoft Excel. This program selects one of five different engines to solve the optimisation problem specified (Frontline Systems, 2011). As mentioned in Chapter 1, there is no evidence of linear programming being used to investigate investment and consumption decisions in the Australian context. The simplicity of the linear programming approach, together with the availability of a user-friendly software package, means that MILP is a suitably practical method with which to investigate the research problem.

3.3 Initial simplifying assumptions

The research problem set out at the beginning of this chapter is extremely broad and thus to make this study manageable, the following simplifying assumptions have been made for the initial investigation of the problem:

- The time span considered is from young adulthood, i.e. age 25, through to advanced old age i.e. up to 98 years.
- The unit of consumption is the household.
  - The household may consist of just one adult.
  - The household may consist of one adult with dependent children.
  - The household may consist of two adults with dependent children.
  - The same household changes over time e.g. a household with two adults and two toddlers is different from a household of two adults and two teenagers.
- The time of death of adults is known.
- All wealth derives from labour income. There is no inherited wealth nor windfalls, except for an initial starting amount at age 25.

- Labour income for the household type is known. For the principal wage earner in the household, labour income is median for gender and age. For households where there are two wage earners, the household labour income is median for this type of household.
- Consumption has two parts:
    - Non-housing consumption (NHC) consisting of all expenditure except for life insurance premiums, rental payments and mortgage payments.
    - Housing consumption – the household must own or be buying a dwelling, or must rent a dwelling. Thus housing consumption at a point in time may have been paid for in a previous period. Housing consumption is measured either as actual rent paid for a dwelling or as imputed rent calculated for owner-occupied housing.
- Minimum NHC is known for each household type. This level of consumption provides for sufficiency in both durables and non-durables.
- Rental costs for each household type are known.
- For purchased housing, both the minimum and maximum value for each household type at each period is known. In addition the capital growth rate for housing is known.
- Regarding a bequest motive, only a small bequest is desired. This amount is known.
- There are alternative ways to provide for consumption in the future:
    - Investment and savings available on call.
    - Defined contribution superannuation. There is the SGL, which is tied to labour income. As well the household can opt to make contributions over and above SGL, in accordance with Australian legislation and taxation rules. As the household ages, this superannuation provides an income which may be taken in different ways:
        - A lump sum
        - An allocated pension
        - A life-contingent annuity.
    - Life Insurance.

    - All return rates (earnings and capital growth) are known in advance for all savings options i.e. there is certainty regarding investment.
- Conditions for receiving the Age Pension are known.
- All money amounts are nominal and based on a constant inflation rate which is known.

Once the initial investigation is completed, some of the assumptions listed above will be relaxed to allow for sensitivity analysis of the solution to be carried out.

3.4 Model development

It is now appropriate to consider in detail the models that are used in this study. To provide for a range of representative segments of the Australian population, three linear programming models have been developed. These models are:

1. Couple with two children (Co2Ch) model, where the couple are of exactly the same age.
2. Single male (SM) model
3. Female with child (F1Ch) model.

For each model, a set of linear inequality expressions has been developed. Immediately following is a discussion of the development of these three models.

3.4.1 Overview of models

This section provides an overview on the models, concluding with schematic diagrams.

3.4.1.1 Model time periods

For the purposes of this study, for all three models in their initial incarnation, the time span has been divided into five periods. Period 1 covers age 25 to 42 – early career years and the years of child bearing if relevant. Period 2, the time of further career development for adults and the teenage years of children in the models, is for ages 43 to 56. Period 3 is from age 57 to 66, and is the stage of life when the adults are transitioning to retirement. The years 67 – 80, period 4, are the years of retirement during which it is assumed that the adults are healthy and active. Period 5 is the time of old age and declining health, the time from 81 to 98. Thus the models, in their base formulation, cover a span of 74 years. Note that the periods correspond to 18, 14, 10, 14 and 18 years respectively. There is no necessity for these periods to be equal and they have been chosen to reflect the reality that key decisions in terms of impact on ultimate whole of life wealth are generally made around transition to retirement. Shorter periods allow for greater weight allocation to this time.

The decision that period 5 extend to age 98 is deliberate. Living to this age is not common for Australians. However, one of the concerns expressed about the Australian retirement funding approach is that longevity is not adequately provided for. For credibility of results it is necessary to have models that provide for funding to an advanced age.

Whilst the five periods chosen do have an inherent logic, there are other sets of periods that would also reflect a life's journey. The number of five periods was chosen because there are enough periods to delineate between various situations whilst the number of periods is manageable for a study this size being undertaken by one person alone.

In using the models to investigate how to manage consumption and saving over a lifetime, sensitivity analysis is used. For some sensitivity analysis, the number of periods is reduced, to provide for the situation where the subject dies prematurely. However, in all models used, the age ranges specified above hold.

3.4.1.2 Overview of modelling decision making over a lifetime

As discussed immediately above, each of the models of decision making regarding consumption and investment over a lifetime have five periods. This section sets out these decisions and contingent results. As well as the written description, two schematic diagrams set out these decisions in pictorial form.

In periods 1 and 2, household labour income is earned, the amount of which is known. The household must provide shelter for itself, either through mortgaged owner-occupied housing or through rental. NHC must be provided for, with the model setting the minimum amount for each period. Life insurance may be purchased, with the estate of the owner of the policy receiving the policy's value if the person dies before age 81. The earning of labour income ensures that SGL is contributed to each adult member of the household's superannuation account, and as well each household member can contribute to superannuation beyond SGL, either pre or post taxation. As well as saving through superannuation, the household can save through non-superannuation investments, which may be realised at the end of the period, or carried forward into the next period. Borrowing for all or part of this investment is possible with an interest-only loan. Each adult member of the household pays income tax as appropriate.

In period 3, the same situation as with periods 1 and 2 applies, with two differences. For shelter, an owner-occupied home may be mortgage free, and additionally each adult of the household has the ability to choose use their superannuation savings to fund an allocated pension, as per superannuation legislation for Australians in the immediate period before retirement.

Periods 4 and 5 are the retirement periods. At the beginning of period 4, each household member must make decisions regarding the funds held in their individual superannuation accounts. The choices are (i) set up an allocated pension, (ii) withdraw a lump sum, and (iii) buy life-contingent annuities. It is possible to choose a combination of any of the three options, or to choose none but to leave the superannuation account intact.

During these final two periods, as with the previous three periods, the household must provide both for shelter, via rental or owner-occupied housing, and for NHC. There is the option to buy life insurance in period 4, with the estate being paid the value of the policy if the holder of the policy dies during this period. Owner-occupied housing may be mortgaged, but if such housing is mortgage free, there is the option to take out a limited reverse mortgage, thus providing funds for retirement living.

As for the first three periods, there is the option to invest in non-superannuation assets during periods 4 and 5. If desired, an interest-only loan may be taken to finance all or part of these investments.

Depending on the household’s financial situation, either a full or part Age Pension may be received in periods 4 and 5. Tax is paid as appropriate.

At the end of each period, any owner-occupied housing may be sold. The resulting funds, once any mortgage is paid out, can be used to buy another dwelling, or for consumption or for investment. Alternatively an owner-occupied dwelling may be improved in subsequent periods.

In Table 3-1 and Table 3-2, schematic representations of the models are provided. The SM model and the F1Ch model have the same structure and thus Table 3-2 applies for both these models.

Table 3-1 Schematic representation of Co2Ch model

	Period 1	Period 2	Period 3	Period 4	Period 5
Provide for NHC (household)					
Earn labour income (male)				N.A.	N.A.
Earn labour income (female)				N.A.	N.A.
Receive SGL compensation (male)				N.A.	N.A.
Receive SGL compensation (female)				N.A.	N.A.
Pay income tax (male)					
Pay income tax (female)					
Contribute to Superannuation before tax (male)				N.A.	N.A.
Contribute to Superannuation before tax (female)				N.A.	N.A.
Contribute to Superannuation after tax (male)				N.A.	N.A.
Contribute to Superannuation after tax (female)				N.A.	N.A.
Make a superannuation cash withdrawal (male)	N.A.	N.A.	N.A.		N.A.
Make a superannuation cash withdrawal (female)	N.A.	N.A.	N.A.		
Take a superannuation allocated pension (male)	N.A.	N.A.			
Take a superannuation allocated pension (female)	N.A.	N.A.			
Hold life-contingent annuity (male)	N.A.	N.A.	N.A.		N.A.
Hold life-contingent annuity (female)	N.A.	N.A.	N.A.		
Hold reversionary life-contingent annuity (male)	N.A.	N.A.	N.A.		
Hold reversionary life-contingent annuity (female)	N.A.	N.A.	N.A.		
Hold owner-occupied housing (household)					
Extend owner-occupied housing (household)	N.A.				
Hold a mortgage (household)					
Hold a reverse mortgage (household)	N.A.	N.A.	N.A.		
Rent a dwelling (household)					
Hold life insurance (male)					N.A.
Hold life insurance (female)					N.A.
Receive life insurance payout (male estate)	N.A.	N.A.	N.A.	N.A.	
Hold non-superannuation investment (household)					
Receive Age Pension Part 1 for couple	N.A.	N.A.	N.A.		N.A.
Receive Age Pension Part 2 for couple	N.A.	N.A.	N.A.		N.A.
Receive Age Pension couple rental supplement	N.A.	N.A.	N.A.		N.A.
Receive Age Pension Part 1 for single person	N.A.	N.A.	N.A.	N.A.	
Receive Age Pension Part 2 for single person	N.A.	N.A.	N.A.	N.A.	
Receive Age Pension single rental supplement	N.A.	N.A.	N.A.	N.A.	

	Parameter		Decision - range of values specified
	Decision - no specified value		Decision - maximum value specified
	Decision -minimum value specified		Contingent result
	Decision - exact value specified	N.A.	Not applicable

Table 3-2 Schematic representation of SM and F1Ch models

	Period 1	Period 2	Period 3	Period 4	Period 5
Provide for NHC					
Earn labour income				N.A.	N.A.
Receive SGL compensation				N.A.	N.A.
Pay income tax					
Contribute to Superannuation before tax				N.A.	N.A.
Contribute to Superannuation after tax				N.A.	N.A.
Make a superannuation cash withdrawal	N.A.	N.A.	N.A.		
Take a superannuation allocated pension	N.A.	N.A.			
Hold life-contingent annuity	N.A.	N.A.	N.A.		
Hold owner-occupied housing					
Extend owner-occupied housing	N.A.				
Hold a mortgage					
Hold a reverse mortgage	N.A.	N.A.	N.A.		
Rent a dwelling					
Hold life insurance					N.A.
Receive life insurance payout	N.A.	N.A.	N.A.	N.A.	N.A.
Hold non - superannuation investment					
Receive Age Pension Part 1 for single person	N.A.	N.A.	N.A.		
Receive Age Pension Part 2 for single person	N.A.	N.A.	N.A.		
Receive Age Pension single rental supplement	N.A.	N.A.	N.A.		

	Parameter		Decision - range of values specified
	Decision - no specified value		Decision - maximum value specified
	Decision - minimum value specified		Contingent result
	Decision - exact value specified	N.A.	Not applicable

3.4.2 Dimensions of the models

The dimensions of the three models are set out in Table 3-3.

Table 3-3 Model dimensions

	Co2Ch model	SM model	F1Ch model
Number of inequality expressions	954	781	781
Number of variables[49]	525	423	423
Number of decision variables	102	78	78

Variables that are not decision variables fall under one of the following headings: contingent result variable, parameter, system variable, intermediate value variable, transfer variable and binary flag. A list of the decision variables for each model is provided in Appendix A.

49 See footnote 48 in this chapter for a discussion of the use of terms ‘variables’ and ‘decision variables’.

3.4.3 Details of commonalities between all three models

Whilst the models obviously cater for different life situations, there are many features common to all three models.

3.4.3.1 Nominal values

For all models, nominal values are used. An inflation rate of 3% per annum is assumed. This figure is reasonable for two reasons, firstly that it is within the range of 2% to 3% that is the goal of the Reserve Bank of Australia (RBA) in executing monetary policy (RBA, 2013) and secondly because, based on inflation rates in Australia over the past 20 years, this rate is comparable to rates experienced in that time (ABS, 2011b).

3.4.3.2 Funds

As mentioned in section 3.3 the households in the models have access to some cash at the beginning of period 1, either as a result of personal savings or via family benevolence. Apart from this cash, the source of funds across the lifespan derives exclusively from labour income which is either consumed, or saved to provide funds either for that period or for later in life. Depending on the situation, in periods 4 and 5 there may be access to a full or part Age Pension.

3.4.3.3 Consumption

The household in each model must provide for two types of consumption – housing consumption and NHC.

Housing consumption involves either renting or purchasing a dwelling. The decision to rent or live in owner-occupied housing is made at the beginning of each period according to which leads to optimum wealth across a lifetime. Both a minimum and maximum value for owner-occupied housing is set for each period, taking into account the family composition for the household for that period and the cost of typical dwellings in Australia in 2011. With purchasing a dwelling, the purchase may be outright, or a mortgage may be taken. Indeed, if a dwelling is purchased, the model constrains household to having a mortgage in periods 1 and 2, a situation typical for an Australians of average means. If a purchased dwelling is retained from one period to the next there is the option to further develop the property with the decision again an outcome of the optimisation process. For the rental decision, an amount to be paid for each period is set, based on household structure for the period, and on representative rental costs for large Australian cities.

NHC is the amount of money spent per period on all consumer items except for life insurance premiums and rental and mortgage payments.

3.4.3.4 Methods of saving

The model is based upon the Australian situation in late 2011. In terms of saving income, funds can be treated in the following ways:

- Invested in savings / securities that can be realised at any time. For this study such investment is called non-superannuation investment. Typical investments under this heading are fixed term bank deposits, mortgage offset contributions, bonds and shares.
- For periods 1 – 3, invested in superannuation, either before tax as salary sacrifice or as a post tax amount. There are limits applied by legislation as to the amounts of investments made into superannuation because of the tax benefits that apply to some superannuants, depending on the marginal tax rate paid. It is important to note that, while this study is concerned with households, superannuation is held at the individual level.
- Used to purchase life insurance on an individual. The type of life insurance available is such that:
    - The only payment is a death payment,
    - The estate receives any payout, and
    - Such a payout is made only if the policy holder dies before the policy expiry date, which for this study is the day before the 81st birthday of the insured.

As well as the methods in the list above, under conditions prevalent in Australia over the past forty or more years, the purchase of a principal dwelling is also a vehicle for savings in that the capital gains on housing has been consistently higher that the inflation rate[50]. This favourable relativity, if maintained, means that any extra funds used to buy a dwelling over and above the minimum allowed provides for increased funds are available if the household make the decision to downsize its accommodation.

[50] See Section 3.4.5.8 for a discussion on the relativities between the inflation rate and the housing growth rate in Australia.

For each period, for each model, a small amount of cash is stipulated as being reserved for emergencies. This cash cannot be invested to give a return.

3.4.3.5 Retirement income in periods 4 and 5

In all models retirement income is provided from several sources as listed below. In all situations the decision as to whether this source will actually provide retirement income and, if included, the actual amounts from a source for a particular period, is made by the optimisation process which determines maximum wealth across a lifetime as measured by a specific objective function. These sources of funds are:

- Income from non-superannuation investments e.g. bank fixed deposits, securities.
- Lump sum from the realisation of non-superannuation investments at the end of the previous period.
- A lump sum withdrawn from an individual's superannuation account at the beginning of a period.
- Income from an allocated pension. Such a pension is drawn from a superannuation account which continues to be invested in the financial markets according to a selected strategy, examples being medium risk, high growth, capital guaranteed. The minimum withdrawal rates are defined by policy, and are age dependent (ASIC, 2013b). For this study, for all models there is a choice of three levels of pension to be taken, for each of periods 4 and 5.
- Income from life-contingent annuities. At the beginning of period 4 an individual can opt to buy life-contingent indexed annuities. For this study, purchase of annuities must be made from funds held superannuation accounts, due to tax advantages arising from such a purchase.
- Regular payments from a reverse mortgage. For a purchased dwelling that is owned outright, a reverse mortgage may be taken out. Such a reverse mortgage can be taken in the first instance at the beginning of period 4. At the beginning of period 5 the reverse mortgage may be able to be increased, or if not taken out in period 4, begun. It is assumed for this model that such a reverse mortgage, whilst negotiated at the beginning of the period, will be drawn down regularly over the length of the period.

- Lump sum from sale of owner-occupied dwelling. The models in this study allow for such a sale at the end of each period and thus there may be some retirement funds available from the sale at the beginning of periods 4 and 5. However it is important to note that the proceeds from the sale of a dwelling may be needed in entirely or in part for the purchase of another dwelling.
- Age Pension payments. There is the possibility of a full or part Age Pension in both periods 4 and 5 paid on a household basis. There are two means tests that must be passed to be granted this pension – an assets test and an income test. For this model, a full pension may be paid or a half pension, or no pension whatsoever, depending on the results of the means tests. Calculation of the assets test is based on assets held at the beginning of the relevant period, and it is assumed that the result will hold for the full length of the period. For the income test, the income used is that of the first year of the period, and again in is assumed that the result for the first year holds for the entire period. The restriction to a full, half or zero pension is a simplification but is adequate for current purposes. The full spectrum of partial pensions can be readily investigated in a further study.
- Age Pension rental subsidy. For recipients of an Age Pension, whether full or part, who are also renting a dwelling, there is a payment of a rental subsidy.

3.4.3.6 Transition to retirement pension

This model is based on the Australian situation of late 2011. Australians aged 55 and above who are still in the work force are able to withdraw some of the funds held in their superannuation account as a transition to retirement pension, which effectively is an allocated pension, albeit with more stringent rules and reduced tax advantages. It is not possible to withdraw a lump sum at this stage. Depending on the age of the superannuant taking the transition to retirement pension, tax may need to be paid (ASIC, 2012b). For these models it has been assumed that monies taken as such a pension are taken after the age of 60 when tax is not applied. As with the allocated pensions provided in periods 4 and 5, this model provided three choices of level of pension taken.

It needs to be recognised that in period 3 (transition to retirement) the subjects of all three models are still in the workforce and are thus receiving the SGL. Thus they still have the option of contributing extra to their superannuation account, either before tax or after tax.

3.4.3.7 Taxation

To reflect the taxation environment as it stood in 2011-12, the models apply income tax, at an individual level, on labour earnings, earnings from non-superannuation investments and savings, and the Age Pension. Capital gains tax is not payable on any capital gains made by the purchase and sale of the owner-occupied dwelling, but it is applicable on such gains on non-superannuation investment.

For the relevant periods, there is no income tax on payments received by the household as a result of taking out a reverse mortgage, or withdrawing a lump sum from superannuation, or taking a superannuation pension, or receiving the income from a life-contingent annuity. However, if these sums are invested in non-superannuation investment / savings, the earnings from such investments are taxable.

Income taxation as applied in Australia is progressive in that there is a yearly amount that is tax free, and then different rates are applied on the remainder. Thus the marginal income tax rate may be different to the average income tax rate paid by an individual. However for the purposes of this study, so as to keep the study manageable in scope, an indicative flat income tax rate has been used for each period, by gender and age, to reflect the average tax rates paid by people in each of the ten different categories.

Income tax on superannuation earnings is paid at a flat rate and is withdrawn from the individual’s account by the superannuation provider managing the investment. Deposits into the fund that have not been previously taxed are taxed on entry to the fund, but after tax contributions are not taxed any further on entry.

3.4.4 Details of differences between the models

As well as commonalities amongst the models, there are also significant differences. These differences are set out in the three tables below. Table 3-4 sets out demographic differences, whilst Table 3-5 highlights differences relating to sources and treatments of funds, and Table 3-6 provides differences in the treatment of the deceased estates.

Table 3-4 Demographic differences between the three models

	Co2Ch model	SM model	F1Ch model
Age when children born	First child born when both male and female aged 33, and second when aged 35	No children	Child born when female is aged 34
Age of death	On day before 81st birthday for male, on day before 99th birthday for female	On day before 99th birthday	On day before 99th birthday

Table 3-5 Differences regarding sources and treatment of funds between the three models

	Co2Ch model	SM model	F1Ch model
Household labour income	Labour income is median for household type, which implies that the couple are both not working full time. The assumption made is that the male, earning median male labour income, works full time until age 63, and then part time until retirement at age 67, and the female works full time till age 32, part time till retirement at age 67. The female's income is the difference between the median household income for the age and the median male income for the age.	Median male labour income based on full time work until age 63 and then part time until retirement at age 67.	Median female labour income based on full time work until age 33, part time for two years, full time until age 63 and then part time until retirement at age 67.
Age Pension	Paid at the couples rate while both parties are alive	Paid at singles rate	Paid at singles rate
Life-contingent annuities available	Two types of life-contingent annuities available. The first is the standard life-contingent annuity. The second is a reversionary life-contingent annuity where, on the death of the purchaser, 75% of the yearly payment is made to the surviving partner as long as the partner lives.	Standard life-contingent annuities only	Standard life-contingent annuities only
Taxation on earnings and capital gains	Earnings from non-superannuation savings applied equally to both partners. Capital gains realised from sale of investments applied equally to both partners.	All earnings and capital gains apply to the male	All earnings and capital gains apply to the female

Table 3-6 Differences of treatment of deceased estates

	Co2Ch model	SM model	F1Ch model
Owner-occupied housing	Joint ownership i.e. on death of one person, the survivor automatically assumes ownership of the property.	Individual ownership. On death of the male the net value of the property is paid to his estate	Individual ownership. On death of the female the net value of the property is paid to her estate
Savings and investments	Joint ownership i.e. on death of one person, the survivor automatically assumes ownership of the accounts / securities.	Individual ownership. On death of the male the net value of the savings / securities is paid to his estate	Individual ownership. On death of the female the net value of the savings / securities is paid to her estate
Life insurance	If insured is first deceased of the partnership the payout is to surviving partner, otherwise to estate of insured.	Payout is to estate	Payout is to estate
Residual super-annuation	If superannuation account owner is the first deceased of the partnership the residual is paid to surviving partner. No taxation is applied For the second deceased of the partnership, taxation is applied and residual funds paid into estate of the superannuant.	After taxation, the residual is paid into the estate of the superannuant	After taxation, the residual is paid into the estate of the superannuant

3.4.5 Data sources

Both numerical and non-numerical data is needed to build the models. Non-numerical data such as the necessary conditions for receipt of the Age Pension shape the structure of the models, whilst numerical data provides the information needed for constraints. Sources of data for this study are discussed immediately below.

3.4.5.1 Labour income data

The assumption for the models is that the principal wage earner for the household is in receipt of median labour income. For the SM model and the F1Ch model, data from both Average Weekly Earnings Australia data series and Employee Earnings, Benefits and Trade Union Membership data series is adapted to provide median labour income for individuals by age and gender. This data is also used for male labour in the Co2Ch model. For this latter model the ABS Household Income and Distribution data series is used to estimate median household labour. Because of the assumption for this model that the male of the partnership works full time, it follows that female labour is the difference between the household and male amounts (ABS, 2011a, 2011c, 2011e).

3.4.5.2 Non-housing consumption data

For every model, the minimum amount for non-housing consumption for each period provides a constraint, with the amounts being constructed using the 2008 median equivalised[51] value of non-durable expenditure by family type reported by HILDA as the starting point (Wilkins et al., 2011). For this study, these amounts were adapted for inflation to 2011 values, and allowances made to include durable expenses and to exclude imputed rent with a further adjustment being made to reweight the amounts to reflect actual consumption for a household. Once the amounts for 2011 were established, the amounts for later years were calculated using an inflation rate of 3% per annum, and taking into account which of the eight family types best described the household for that particular year.

3.4.5.3 Data relating to superannuation

Data relating to SGL rate, maximum superannuation contribution base, taxation of superannuation pensions and lump sum withdrawals, limits on salary sacrifice and post tax contributions to superannuation, and minimum rates of withdrawal from superannuation pension accounts is published by the Australian Tax Office (ATO 2011a). Detailed information regarding taxation of superannuation accounts in 2011, and of taxation of superannuation in deceased estates, is provided by the Parliamentary Library (Nielson 2010b). For indicative return rates for both superannuation accumulation and superannuation pension accounts, publicly available ratings data of returns post taxation was used (Chant West 2011a, 2011b; ASFA 2008).

[51] To recognise that a household's composition has a bearing on the amount of funds needed for consumption, an approach known as equivalised income is used (Wilkins et al, 2011). The HILDA Survey uses the 'modified OECD' equivalence scale as developed by Hagenaars, De Vos and Zaidi (1994) (Wilkins et al, 2011), this particular scale being also the one adopted by the ABS (2011e). The OECD-modified scale allocates points to a household according to the formula : the first adult is worth one point, each additional person aged 15 or more is allocated 0.5 points and children under 15 0.3 points

3.4.5.4 Non-superannuation investment data

Data relating to pre-tax returns for non-superannuation investment was sourced from an ASX report on long term investment i.e. 10, 20 and 25 years (Russell Investments, 2011). Indicative prices for borrowing for investment purposes were sourced from Canstar (2011b).

3.4.5.5 Life insurance data

For the life insurance options provided in the models, the cost data was supplied by a financial planner (Mr.Vern Fettke) in a personal communication. These costs relate to policies provided by AMP, purchased in the first instance at one of ages 25, 43, 57 and 67 i.e. the ages at the beginning of periods of the models. For each policy, the amount paid on the death of the insured is $400,000 (future value).

3.4.5.6 Life–contingent annuities data

Pricing data for life-contingent annuities was provided directly by Challenger Life Company Ltd. Data was provided for two types of annuities - one where payments are made until the death of the owner of the annuity and a reversionary annuity where a proportion of the annuity payment continues to be paid to a surviving spouse until that person’s death.

3.4.5.7 Taxation data

Australia has a progressive income tax scale. However, for the purposes of this study, a flat taxation rate has been applied, based on ATO data classified by age and gender (ATO, 2011b).

3.4.5.8 Housing data

For each model the household must provide shelter, either as rental housing or as owner-occupied housing. Rental housing costs used in the model based on Victorian statistics for June quarter 2011. This set of statistics also states that the long term average for the annual percentage change in rent is 5.6% with the rates for the previous two years being 4.4% and 5.2%. The index applies in this study is 5%, conservatively based on these figures (Department of Human Services (DHS), 2011).

For owner-occupied housing, minimum values are specified for each household type, based on NATSEM data (Phillips, 2011). With respect to housing capital growth, the

ABS has been publishing house price indexes for Australian capital cities, including a weighted average of all cities, since 1993 (ABS, 2011d). Abelson et al. (2005) draw upon this and other data to show that the rise in real house prices from 1970 to 2003 was 3.3% per annum. Stapledon (2010) provides evidence for a real rise of 2.6% per annum between 1974 and 1989, and for the period 1989 to 2008, a real rise of 3.4%. The ABS data from 2004 to 2011 gives a nominal rise for the weighted average of all capital cites of 5.2% per annum, and it is this rate that is used in this study Given that the inflation rate used in this study is 3% per annum, the nominal rate of 5.2% per annum is low. However it is thought appropriate that a conservative figure be used given that this study covers 74 years, and thus the rate is used for all of these years.

It is specified that for the first two periods each of the models must include a mortgage. Mortgage rates for owner-occupies housing was sourced from Canstar (2011a). It is assumed that the mortgage is amortised over 30 years.

The model allows for a reverse mortgage to be held in periods 4 and 5. Conditions related to the take up for such mortgages are based on information publically supplied by providers (Commonwealth Bank of Australia (CBA); 2011, St George Bank, 2011). Indicative costs of these products was sourced from Canstar (2011c)

3.4.5.9 Age Pension data

The model allows for a full or part Age Pension to be received in periods 4 and 5, subject to passing both an income and assets test. Details of amounts of payments were sourced from Centrelink (2011) whilst details of the assets and income tests was sourced from the *FirstTech 2011-2012 Super Guide* (Colonial First State, 2011).

3.4.6 Objective functions

In Section 3.4 thus far, an overview of the three models has been provided, details regarding assumptions made have been set out and sources of data identified. This information has been used to develop the sets of linear inequality expressions for each model. However, these sets of expressions are only one aspect of linear programming models. To meet the aims of this study it is necessary to establish optimal solutions. These solutions are found by solving the model using an objective function.

Each objective function represents a version of utility or benefit. As utility in the context of this study is subjective, one person might require some items to be included in the optimal bundle of benefits, whilst another person may consider some of these items to provide no benefit at all. Thus it is appropriate to set up several objective functions. However, as discussed in Section 3.1.3, each utility function, i.e. objective function, needs to be of the form $\sum_{t=1}^{T} U_t(C_t)$, where the utility of consumption for each period is weighted to give equitable recognition to consumption in each period i.e. the optimal solutions provide maximum wellbeing across a lifetime.

Consumption in this study for each of the five periods is considered under two headings, (i) housing consumption which is a measure of the benefit of either renting a dwelling or living in an owner-occupied home, and (ii) non-housing consumption (NHC) which is the amount spent per period on all consumer items except for life insurance premiums, mortgage payments and housing rental. NHC for each period is a monetary amount and the dollar value of NHC for each period is taken to be the utility for the period. For housing utility, if the housing option for the period is renting, likewise the dollar value of the amount paid for rental for the period is deemed to be the utility for the period. However, for owner-occupied housing, an annual imputed rent is calculated, using 5% of the dwelling's value for that year as the annual amount, with the annual amounts contributing to the value of the period. The value of 5% was chosen as this is the value used by the HILDA study to estimate housing consumption (Wilkins, Warren and Hahn, 2009).

To provide for equitable recognition of each period, given that nominal values are used in this study, value functions for each period have been determined, taking into account the length of each period, the time frame of the period with respect to the initial year of the study and the assumed constant inflation rate of 3% per annum.

For the purposes of setting out the objective functions, the following notation is used.

- The NHC amount decision for period t is represented by nhc_t
- The decision for the value of owner-occupied housing at beginning of period t is represented by h_t
- The rental amount decision for period t is represented by r_t

Three objective functions have been used in this study. All three functions are used with each of the three models, for a total of nine combinations.

3.4.6.1 Objective function 1

Objective function 1 uses NHC solely as the measure of utility. As minimum values for owner-occupied housing for each period is set out in the model, it can be taken that housing needs are catered for, albeit at a basic standard.

The objective function is the sum of the non-housing consumption, as present values, available for each of the five periods. It is necessary to use a present value factor that translates an aggregate amount for the period to a present value for that period. The present value factor for period t is designated as pv_t, and thus objective function 1 can be set out as:

$$\sum_{t=1}^{5} \boldsymbol{pv_t \times nhc_t}$$

Detailed information regarding the determination of these present value factors is given in Appendix B.

3.4.6.2 Objective function 2

Objective function 2 allows for the proposition that the quality of housing available adds to the utility of the household and thus this objective function combines values of both housing and NHC. As for objective function 1, the values used are present values with values for each of the five periods being included. For NHC, the same present value factors as used in objective function 1 can be applied, and, as the decision for the rental amount for a period is likewise an aggregate amount, these present value factors can be applied to the rental amount decision.

For the decision for owner-occupied housing for period t, it is necessary to use a factor that translates the value of the housing at the beginning of period t to imputed rent present value across all of period t. This imputed rent present value for period t is designated as $irpv_t$ and thus objective function 2 can be set out as:

$$\sum_{t=1}^{5} \boldsymbol{pv_t \times nhc_t + irpv_t \times h_t + pv_t \times r_t}$$

Detailed information regarding the determination of these present value factors is given in Appendix B.

3.4.6.3 Objective function 3

As set out in Section 3.4.5.8, for domestic housing data from the past forty years shows that a conservative estimate of annual capital growth is 5.2%, the initial value used in this model. The value used for inflation is 3% and thus the value of domestic housing has been growing at a faster rate than the rest of the economy. In the initial versions of the models, these historical rates are used, a situation that distorts the present value of housing, particularly for the later periods, and thus it is useful to consider the intrinsic current value of a dwelling i.e. the current, as of 2011, value of the dwelling as if the housing capital growth rate had been identical to the inflation rate used for all other aspects of the models. Table 3-7 below illustrates this situation.

Table 3-7 Relative housing prices – Co2Ch model

Beginning of Period	Future value minimum housing	Present value minimum housing	Intrinsic current value minimum housing
1	$ 418,000	$ 418,000	$418,000
2	$1,300,000	$ 763,613	$521,987
3	$2,643,000	$1,026,375	$521,907
4	$3,510,000	$1,014,247	$417,490
5	$5,710,000	$1,090,816	$334,000

An illustration of this distortion is set out immediately following. It can be seen from Table 3-7 that for the Co2Ch model, for period 5 the minimum value of owner-occupied housing permitted is $334,000 at 2011 housing prices. This amount as a nominal figure for the beginning of period 5 is $5.71million, which had a present value at 2011 of about $1.09 million. Thus, using objective function 2, the contribution of the present value of the imputed rent for period 5 will be more than three times the contribution if the housing growth rate was equal to the inflation rate.

The growth rate used in this model for rental accommodation is 5%, a figure based on historical records. Likewise the fact that this rate is much higher than the 3% inflation rate used also distorts later periods' housing consumption.

Because of this distorting situation, a third objective function has been set up. This function uses the present value factors set out in Section 3.4.6.1 for the coefficients for NHC. However, for both owner-occupied housing and rental housing, intrinsic current values has been developed to compensate for this distortion. The factor for the imputed rent intrinsic current value for period *t* is designated as $iricv_t$, whilst the factor for the intrinsic current value of rental housing is designates as $ricv_t$. Thus objective function 3 can be set out as:

$$\sum_{t=1}^{5} \boldsymbol{pv_t \times nhc_t + iricv_t \times h_t + ricv_t \times r_t}$$

Detailed information regarding the determination of these current value factors is given in Appendix B.

3.4.7 Overview of objective function co-efficients

The sections immediately above describe the three objective functions. Table 3-8 sets out the decision variables used in the three objective functions, together with the symbol for each coefficient and the value taken by each coefficient.

Table 3-8 Coefficients of the objective functions

		Coefficients applied to decision variables		
	Decision variables used in objective functions	Objective function 1	Objective function 2	Objective function 3
Period 1	Non-housing consumption decision for period 1 (nhc_1)	pv_1 0.768757	pv_1 0.768757	pv_1 0.768757
	Value of owner occupied housing beginning of period 1 decision (h_1)	N.A.	$irpv_1$ 1.083596	$iricv_1$ 0.9
	Rental decision for period 1 (r_1)	N.A.	pv_1 0.768757	$ricv_1$ 0.639832
Period 2	Non-housing consumption decision for period 2 (nhc_2)	pv_2 0.481293	pv_2 0.481293	pv_2 0.481293
	Value of owner occupied housing beginning of period 2 decision (h_2)	N.A.	$irpv_2$ 0.473438	$iricv_2$ 0.291070
	Rental decision for period 2 (r_2)	N.A.	pv_2 0.481293	$ricv_2$ 0.296822
Period 3	Non-housing consumption decision for period 3 (nhc_3)	pv_3 0.338748	pv_3 0.338748	pv_3 0.338748
	Value of owner occupied housing beginning of period 3 decision (h_3)	N.A.	$irpv_3$ 0.213935	$iricv_3$ 0.098734
	Rental decision for period 3 (r_3)	N.A.	pv_3 0.338748	$ricv_3$ 0.166853
Period 4	Non-housing consumption decision for period 4 (nhc_4)	pv_4 0.236764	pv_4 0.236764	pv_4 0.236764
	Value of owner-occupied housing beginning of period 4 decision (h_4)	N.A.	$irpv_4$ 0.232900	$iricv_4$ 0.083260
	Rental decision for period 4 (r_4)	N.A.	pv_4 0.236764	$ricv_4$ 0.092035
Period 5	Non-housing consumption decision for period 5 (nhc_5)	pv_5 0.146860	pv_5 0.146860	pv_5 0.146860
	Value of owner-occupied housing beginning of period 5 decision (h_5)	N.A.	$irpv_5$ 0.207006	$iricv_5$ 0.052646
	Rental decision for period 5 (r_5)	N.A.	pv_5 0.146860	$ricv_5$ 0.041636

3.5 Conclusion

In this chapter the conceptual framework for the study has been set out. The approach taken to meeting the objectives of the study i.e. MILP has been justified. Sources of data have been identified, and the objective functions used to identify optimal solutions have been specified.

In Chapter 4, the results from solving the models using these objective functions are set out followed by extensive sensitivity and scenario analysis of the optimal solutions.

Chapter 4 Results

4.1 Introduction

In Chapter 3, details of the development of the linear programming models were set out. These models reflect the situation for three representative segments of the population i.e. (i) a couple with two children (Co2Ch), (ii) a single male (SM) and (iii) a female with one child (F1Ch), where for all three household types the labour income received is median. For the research, many variants of each model have been set up, each variant taking into account some specific details for investigation, and the optimal solution for a particular objective function found. As discussed in Chapter 3, three different objective functions are used, all concerned with measuring lifetime wellbeing. As set out in Chapter 3, Section 3.4.6, the first objective function is concerned solely with non-housing consumption (NHC), the second with both NHC and the value of housing, and the third with both NHC and an adapted value of housing that takes into account any differential in the inflation rate and the housing capital growth rate. This chapter presents a discussion of the optimal solution of these models, in their various formulations.

The use of the model variants together with the three objective functions produced a wealth of results directly related to the four specific objectives of this study. These objectives, set out initially in Chapter 1 are to:

1. Determine the optimal methods and rates of accumulation and decumulation for a range of representative segments of the population, assuming a rational, self-interested perspective.
2. Identify the gaps between optimal accumulation and decumulation, and sub-optimal accumulation and decumulation when behavioural attitudes influence selection of accumulation and decumulation options.
3. Determine the Superannuation Guarantee percentage that needs to be in place for average Australians to have their retirement funded to a comfortable level commensurate with average Australian standards by personal superannuation / savings, supplemented by the means-tested Age Pension.
4. Establish the characteristics of households that would be eligible for the Age Pension, given the selection of economic factors and policy options.

Immediately following is a discussion on the approach taken to reporting of the research findings. Following this discussion, details about the organisation of the chapter are provided.

4.2 Approach to reporting the research findings

Both description and analysis of the research findings are provided in this chapter, with the analysis being provided by three aspects, named for this study as (i) post-optimality analysis, (ii) sensitivity analysis of key variables and (iii) scenario analysis. In undertaking analysis it is necessary to set an approach to discerning the significance of results, and as well to have a benchmark for assessing the standards of retirement living provided by the optimal solutions.

4.2.1 Post-optimality analysis

The mathematical structure of a pure linear programming model ensures that when such a problem is solved using a solving engine there is output, known as post-optimality analysis[52], which gives more detail and insight into both the solution and the model. For a standard linear programming model the information available includes:

- The range of the coefficients of the objective function for which the solution remains optimal.
- The impact of forcing a non-optimal variable into the solution.
- The range of constraints for which the solution remains optimal.
- The shadow price of a constraint. The shadow price gives the improvement on the value of the optimal solution if the constraint is relaxed by one unit, as long as the new shadow price is within the allowable range described in the dot point immediately above.

Each of the above analyses is carried out under 'ceteris paribus' conditions.

The output data as listed immediately above is only available if the problem can be expressed as a pure linear programming problem. However, for this study, to allow for non-contiguous values for some variables, a set of inequality expressions needed to be

[52] For a wide ranging discussion on the use of post optimality analysis when using linear programming see the text book *Introduction to Operations Research (*Hillier and Lieberman, 2010)

introduced for which some variables must be binary[53], and the existence in the model of these variables means the standard post-optimality analysis output is not available. However, it is possible to obtain this output data. The process to do so involves solving the original problem, and then using the solution output for the binary variables as equalities in a revised set of constraints. The solution to this revised problem provides the post-optimality analysis discussed in this thesis.

The models used for this study are across five periods of time and thus a considerable proportion of both the constraints and the variables are included to facilitate transfers between the periods. The post-optimality analysis for these constraints and variables is of very limited use. It also needs to be taken into consideration that for this study, as discussed in Section 3.4.5, the objective functions are always the sum of adjusted present values of some of the variables. Thus the information provided in standard post-optimality analysis as to the degree the coefficients in the objective function for each of variables can increase and decrease without the optimal set of decisions changing does not provide useful information. The other standard information provided by the post-optimality reports does provide useful information for some parameters and variables.

It is also important to recognise that the key outputs i.e. reduced cost and shadow price values are values at the limit, and given that this model is complex, the interplay of variables may mean that these reduced cost values and shadow price values hold only at points very close to the limit.

4.2.2 Sensitivity analysis

Using post-optimality analysis gives the detail as to how much a single variable or a single constraint value can increase or decrease before the solution changes. By definition, it provides information on one variable, or on one parameter, at a time, whilst holding the rest of the model constant. However, for this study it is useful to investigate how the solution changes when a situation involving several related parameters and variables change. An example of such a situation is that of investigating how the solution would change if the minimum value permissible for owner-occupied housing were to be increased consistently for all periods. In this particular situation

[53] An example of such a situation is the specification of minimum purchased housing. The subject(s) of the model can either buy a dwelling or not buy a dwelling for each period. However, to buy a dwelling, there is a minimum price \$H. In this case the decision variable can take on the value 0, or any value $\geq$ H. To program this situation involves introducing binary variables.

there are five relevant variables i.e. the value of owner-occupied housing for periods 1, 2, 3, 4 and 5. Such analysis needs to be carried out by changing a related group of constraints simultaneously. For this study such analysis is deemed sensitivity analysis.

4.2.3 Scenario analysis

As well as undertaking analysis by changing related groups of variables simultaneously, i.e. the sensitivity analysis described immediately above, it is also useful to carry out some broader analysis where unrelated variables are changed simultaneously i.e. scenario analysis.

4.2.4 Judging the significance of results

As a matter of pragmatism, the approach taken to significance in discussing the results set out in this chapter is that of materiality. The arbitrary figure of 5% is used to judge whether a change is material. For post-optimality analysis, an allowable increase or decrease of less than 5% of the constraint is deemed significant, whereas, for sensitivity analysis and scenario analysis, an increase or decrease of more than 5% of the objective function value is considered significant. For the shadow prices and reduced costs, which are obtained from post-optimality analysis, and for the NHC and housing values for each of the five periods which are obtained from sensitivity analysis, the interpretation depends on the context.

4.2.5 Assessing retirement standards of living

The optimal solutions were determined by maximising the particular objective function used. Each objective function value realised by solving the particular instance of a model represents lifetime wellbeing, as specified by the particular objective function. However, as well as using this lifetime wellbeing measure to assess outcomes, it is also important to assess each optimal solution in its parts. In discussing the results for the optimal solutions for all models, a key factor considered is that of the standard of living provided for the retirement years i.e. periods 4 and 5.

It is necessary to have a process to judge this standard of living. As discussed in Chapter 2, the commonly accepted approach to considering retirement standard of living is that which is now provided by ASFA (2013) but was originally provided by Saunders, Patulny and Lee (2004). Discussion of this work, including detailed descriptions of the MBA (modest but adequate) and CAS (comfortably affluent and sustainable) budgets, is set out in Section 2.2.3.2. The CAS budget is seen as providing a high standard of living for retired Australians whose self-funded income is within the top income quintile, whilst the MBA standard is perceived to be providing for households receiving either a full or part Age Pension with, as well, some other source of funds, for example superannuation. For both standards it is assumed that the household owns a debt-free dwelling.

It is important to note that the MBA standard does not demand extreme frugality as understood in Australia, but provides for a standard of living commensurate with the standard of living achieved by many Australians earning average wages. The MBA standard allows for, amongst other items, a level of private health insurance, owning, maintaining and running a car, membership of a social and sporting clubs, mobile phone and broadband access, and the upgrading of computer equipment. Some of the differences between the two standards are that the CAS standard allows for major home improvements, private health insurance at the top rate, and overseas holidays (ASFA, 2013). Both standards assume an owner-occupied dwelling, with no mortgage.

The annual NHC amounts needed for each standard as at the end of 2011, to match the timing of the dollar values this research, are set out in Table 4-1.

Table 4-1 Annual amounts for ASFA budget standards 2011

Age Pension (for reference)		MBA standard		CAS standard	
Couple	Single	Couple	Single	Couple	Single
$29,354	$19,469	$31,675	$21,930	$55,249	$40,407

Because of the substantial difference between the CAS standard and the MBA standard for both couples and singles, for some situations it is helpful to use the mid-point between the two standards as another marker of retirement living standards. This mid-point data is set out in Table 4-2.

Table 4-2 Further definitions of retirement living standards as at end of 2011

MBA standard		Mid-point between the two standards		CAS standard	
Couple	Single	Couple	Single	Couple	Single
$31,675	$21,930	$43,462	$31,169	$55,249	$40,407

4.2.6 Organisation of presentation of results.

Following the discussion of the base scenarios, two further scenarios, incorporating changed assumptions across several areas of decision making, are described and analysis provided, with particular emphasis on the difference in outcomes between the base scenarios and the further two scenarios. This analysis, found in Section 4.5 is in response to the second specific objective.

As discussed in Chapter 3 Section 3.4.5.8, for this study two initial assumptions made are that the housing capital growth rate is 5.2% per annum whilst the annual inflation rate is 3%. Because of the potential for this rate differential to distort results, some analysis of the optimal solutions for alternative housing capital growth rates is provided in Section 4.6.

In response to the third specific objective i.e. determining the appropriate SGL percentage for an adequately comfortable retirement, analysis is provided in Section 4.7. The fourth specific objective is concerned with determining the characteristics of households receiving the Age Pension in some form with analysis being provided in Section 4.8.

4.3 Description of results for the three base scenarios

This section provides descriptions of the optimal solutions for the base scenarios. These scenarios have been formulated to provide results to meet the first specific objective i.e. the determination of optimal methods and rates of accumulation and decumulation of representative segments of the population, assuming a rational, self interested perspective.

4.3.1 Review of assumptions for base scenarios

Given that the base scenarios reflect a rational, self-interested perspective, the specific assumptions for these scenarios are:

- All investment options and retirement products are available i.e. life-contingent annuities, reverse mortgages and risky non-superannuation investment.
- Only a small bequest is specified.

The common assumptions for all scenarios are set out in Chapter 3 Section 3.4.5. Key amongst these assumptions are:

- The inflation rate is 3% per annum, whilst the housing capital growth rate is 5.2% per annum[54].
- The labour income earned is median.
- The SGL is 9% per annum.

4.3.2 Description of optimal solutions for Co2Ch base scenario

The most pertinent details of the optimal solutions for the couple with two children base scenario are given in Table 4-3, with schematic representation provided in Appendix C. Discussion for the optimal solution for each of the three objective functions is provided in the commentary following the table. All the amounts discussed are present values as of 2011.

The labour income amounts for each of the first three periods, as set out in Table 4-3, are parameters of the model. All other amounts in this table are the decisions provided when the objective function is optimised, having being adjusted to provide the result as either an annual present value or, where the amount applies only at the beginning of the relevant period, as a present value.

[54] See Section 3.4.3.1 for discussion as to the appropriate inflation rate and Section 3.4.5.8 for discussion as to the appropriate housing capital growth rate.

Table 4-3 Comparison of indicative amounts – optimal solutions - Co2Ch base scenario

(all values are present values)

	Objective function 1		**Objective function 2**		**Objective function 3**	
	Period 1	Period 2	Period 1	Period 2	Period 1	Period 2
Household labour income p.a.	$97,571	$99,999	$97,571	$99,999	$97,571	$99,999
Income from non-superannuation savings p.a.	$4,000	$1,449	$4,000	$8,834	$4,000	$3,884
Cash realised from sale of dwelling, available beginning of period (amt)	N.A.	$0	N.A.	$0	N.A.	$0
Cash from realisation of investments available beginning of period (amt)	N.A.	$127,373	N.A.	$0	N.A.	$127,373
Non-housing consumption p.a.	$47,519	$63,345	$47,519	$59,928	$47,519	$59,928
Superannuation savings p.a.	$0	$287	$0	$0	$0	$0
Non-superannuation savings p.a.	$6,992	$3,290	$6,992	$3,901	$6,992	$8819
Value of owner-occupied dwelling beginning of period (intrinsic current value[55])	$418,000 ($418,000)	$765,659 ($523,386)	$418,000 ($418,000)	$763,613 ($521,987)	$418,000 ($418,000)	$765,659 ($523,386)
Deposit for purchase or extension of dwelling (amt)	$45,865	$146,460	$45,865	$19,088	$45,865	$146,460
Mortgage payment p.a.	$24,934	$8,775	$24,934	$17,725	$24934	$8,775
Tax paid p.a.	$21,170	$24,569	$21,770	$26,027	$21,170	$25,109
	Period 3		Period 3		Period 3	
Household labour income p.a.	$79,627		$79,627		$79,627	
Income from non-superannuation savings p.a.	$0		$25,539		$973	
Transition to retirement pension p.a.	$19,501		$19,359		$19,359	
Cash realised from sale of dwelling, available beginning of period (amt)	$964,742		$0		$0	
Cash from realisation of investments available beginning of period (amt)	$46,157		$0		$123,727	
Non-housing consumption p.a.	$79,658		$43,591		$75,361	
Superannuation savings p.a.	$2,867		$0		$0	
Non-superannuation savings p.a.	$0		$52,197		$3090	
Value of owner-occupied dwelling beginning of period (intrinsic current value)	$1.026m ($521,907)		$1.027m ($521,987)		$1.168m ($594,170)	
Deposit for purchase or extension of dwelling (amt)	$1.026m		$0		$139,203	
Mortgage payment p.a.	$0		$8,290		$4104	
Tax paid p.a.	$15,205		$20,296		$15,902	
	Period 4	Period 5	Period 4	Period 5	Period 4	Period 5
Age Pension income p.a.	$29,354	$19,468	$29,354	$19,468	$29,354	$19,468
Superannuation pension p.a.	$2,478	$1,884	$0	$0	$1,523	$1,544
Annuity payments p.a.	$5,483	$5,252	$7,841	$7,294	$9,210	$7,863
Reverse mortgage p.a.	$10,991	$17,083	$7,907	$4,342	$17,101	$17,083
Income from non-superannuation savings p.a.	$0	$0	$0	$0	$0	$0
Lump sum amount withdrawn from superannuation accounts (amt)	$123,634	$0	$98,595	$0	$33,006	$0
Cash realised from sale of dwelling, available beginning of period (amt)	$0	$1.273m	$1.191m	$0	$1.397m	$1.299,m
Cash from realisation of investments available beginning of period (amt)	$0	$0	$705,039	$0	$30,664	$0
Cash from estate of male (period 5 only)	N.A..	$0	N.A.	$0	N.A.	$0
Non-housing consumption p.a.	$55,443	$51,345	$43,500	$31,000	$57,059	$52,850
Non-superannuation savings p.a.	$0	$0	$0	$0	$0	$0
Value of owner-occupied dwelling beginning of period (intrinsic current value)	$1.268m ($521,907)	$1.091m ($334,006)	$2.007m ($826,095)	$2.698m ($826,095)	$1.461m ($601,366)	$1.154m ($347,639)
Deposit for purchase or extension of dwelling (amt)	$0	$1.091m,	$2.007m	$0	$1.461m	$1.135m
Mortgage payment p.a.	$0	$0	$0	$0	$0	$0
Mortgage payout, beginning of period (amt)	$0	$0	$0	$0	$0	$0
Tax paid p.a.	$0	$0	$910	$0	$0	$0

[55] The intrinsic current value of housing is provided for comparison purposes. This value is, by definition, the current, as at 2011, value of the dwelling if the housing capital growth rate is identical to the inflation rate used for all other aspects of the model - see Section 3.4.6.3.

4.3.2.1 Discussion of optimal solution for objective function 1

The discussion immediately following is for objective function 1. This function, as discussed earlier in Chapter 3 Section 3.4.6.1, comprises the sum of present values of NHC for all 5 periods, and thus the value of housing is not included in the objective function. Unless stated otherwise, all values discussed are present values.

In period 1, a period of 18 years when the couple is aged 25 to 42, the couple's funds arise from labour income of about $97,500 per year and from income from non-superannuation investments, this latter income being about $4,000 per year. To achieve these earnings from savings, the couple need to save about $7,000 for each of the eighteen years. At the beginning of the period they buy a dwelling for the minimum cost allowed by the model ($418,000) and pay the minimal amount against their mortgage – about $25,000 per annum. They do not make any extra contributions to their superannuation accounts beyond the SGL, nor do they buy any life insurance. Indeed the optimal solution does not allow for the purchase of life insurance at any time in the life cycle. At the beginning of period 2 the couple have available about $127,000 cash from the realisation of non-superannuation investments, which is put towards the improvements to their dwelling. Their dwelling now has a present value of $765,000, though it needs to be remembered that in this model housing is appreciating at a higher rate than the CPI and that the intrinsic current value of the housing held is about $525,000. This dwelling has value marginally above the minimum value for purchased housing stipulated in the model.

Period 2 is the period when the age of both of the couple is 43 to 56, a period of 14 years. The couple's combined labour income for this period is $100,000 per annum. They start to save again, using, on average, $3,300 per year to buy non-superannuation assets which return an average income of $1,500 per year over the 14 years. The female salary sacrifices $300 per annum into her superannuation account. During period 2 the couple pay the minimum possible on the mortgage, then sell the dwelling at the end of the period and pay out the mortgage.

During period 1 the couple have about $47,500 per annum available for NHC, the minimum specified in the model, whilst for period 2 this yearly amount is $63,300, which is greater than the minimum of $60,000 specified.

At the beginning of period 3, a time span of 10 years when each of the couple is aged 57 to 66, the couple each take a transition to retirement pension drawn down from their superannuation accounts. The male's pension is about $15,500 per year whilst the female's is $4,000 per year. Their combined labour income during this time is $80,000 per annum, reflecting the move to part time work during the latter part of these years. At the beginning of period 3 they use the funds realised from the sale of their period 2 dwelling, less those used to pay out the mortgage, together with realised non-superannuation savings, to buy outright a dwelling with value the minimum stipulated by the model, which is a little less value than previously held. The female salary sacrifices about $2,800 each year into superannuation but no other savings are made. The model allows for nearly $80,000 per annum in NHC, which is considerably more than the $43,500 minimum specified in the model.

At the beginning of period 4, the first stage of retirement when the couple is aged 67 to 80, the male withdraws a lump sum of $124,000 from his superannuation account and uses the remainder of his funds ($68,000) to buy a reversionary annuity which will pay $960 for each year of his life, and, on his death, $720 per annum to his female partner for as long as she lives. The female withdraws $90,700 from her superannuation account to buy a life-contingent annuity that will pay $4,520 per annum for as long as she lives. She uses the remaining $51,600 in her superannuation account to generate an allocated pension of $2,500 per year. The couple continue to live in the residence purchased at the beginning of period 3, taking out a reverse mortgage that is drawn down at $11,000 per year for the 14 years. The value of this dwelling is $200,000 more than the minimum purchased housing specified in the model for period 4 and is exempt from the assets test for the Age Pension. For the assets test, it is the assumption of the model that half of any lump sum available at the beginning of period 4 will be expensed immediately (e.g. major home repairs, overseas holiday) and the particular solution of housing, annuities, superannuation pension and lump sum withdrawal ensures that the assessable assets just satisfy the assets threshold.

With regard to the income test for the Age Pension, the stream of funds from the reverse mortgage is not income but a distribution of wealth. Likewise the means test views a considerable proportion of the annuities payments and the payments from the allocated pension as wealth distribution (Colonial First State, 2011). However, if the receipt of these funding streams result in an accumulation of wealth which leads to deemed[56] 'investment income', the income test may be breached, so for the purposes of this study it is assumed that funding streams are used for consumption as soon as they are received. Thus the income test is not breached for a full Age Pension.

The couple receive the full Age Pension of $29,300 per annum during period 4. Taking into account the income streams described above and the lump sum available, the model allocates $55,400 per annum for NHC for period 4. This compares favourably to the amount of $55,249 nominated by the ASFA analysis of the amount needed by a couple for the CAS standard of retirement living, as described previously in Section 4.2.5.

At the beginning of period 5, the male partner dies. For this period for which the surviving partner is aged 81 to 98, the widow receives each year the same amount ($4,520) from the annuity she purchased at the beginning of period 4, and also $720 from the reversionary annuity purchased by the male (now deceased). Her superannuation pension fund is worth $49,000 at the beginning of period 5, and she is able to generate an allocated superannuation pension of $1,900 per year. At the beginning of period 5 she sells the period 4 residence and downsizes to the minimum purchased housing allowed by the model, realising about $180,000 after the reverse mortgage is paid out. She immediately arranges a reverse mortgage on this property, which provides $17,000 per annum. Her late husband used all his superannuation monies with the lump sum withdrawal and the purchase of annuities, and so she has no bequest from this source. Likewise, as insurance was not purchased, there are no insurance payouts.

In period 5, the widow is also able to receive a full Age Pension of about $19,400 per year as neither the assets nor the income tests are breached. The asset value of the annuities policies have reduced substantially over the previous 14 years, as per the formula for assessing assets (Colonial First State, 2011), and the superannuation account value has decreased also due to the drawing down of a pension in period 4. Overall the value of assessable assets is marginally less than the assets means test threshold. In total the widow receives yearly about $51,000 for NHC, which is well

[56] For the income test for the Age Pension, any cash held is deemed to be held in a bank account that is receiving a deemed rate of interest (Colonial First State, 2011).

above the ASFA suggested amount of $40,407 per annum for the single person CAS standard as set out in Section 4.2.5.

At the end of period 5, at the death of the widow, her estate is worth about $470,000. This amount is comprised of a small amount ($5,000) remaining in the widow's superannuation account, together with the residual value of the dwelling after paying out the reverse mortgage and allowing for estate expenses.

4.3.2.2 Discussion of optimal solution for objective function 2

As stated in Chapter 3 Section 3.4.6.2 objective function 2 is the sum of the present values of NHC for all 5 years, together with the present value of any rent paid, plus the present value of the imputed rent[57] of purchased housing. This objective function gives recognition that housing above a minimum level may increase the wellbeing of the couple.

There are several decisions in common with the solution for objective function 1. The solution for period 1 is identical for both objective functions. Owner-occupied housing is used for all five periods, with the dwelling purchased in period 1 being improved in period 2. For both objective functions, reverse mortgages are in place for both periods 4 and 5, though the annual amount taken for the objective function 2 solution is less than for the objective function 1 solution. Life-contingent annuities are purchased by both the male and the female at the beginning of period 4 for both objective functions, but with higher value annuities being purchased for the objective function 2 solution. For both solutions there is a lump sum withdrawal for superannuation at the beginning of period 4. For neither objective function is life insurance purchased. A full Age Pension for both periods 4 and 5 is payable for both objective functions. However, in period 3, for objective function 2 the specified non-superannuation savings is $52,000 per annum as opposed to no such savings for objective function 1, with one impact being the different NHC amounts available for this period for the these objective functions, as is discussed immediately below.

Major differences between the two solutions are: (i) the value of owner-occupied housing specified for both periods 4 and 5 and (ii) the NHC provided for these two periods. In considering this difference it is useful to compare the outcomes for both

[57] As set out in Section 3.4.6, in computing the imputed rent, the HILDA approach is used i.e. the annual imputed rent is 5% of the market value of the dwelling (Wilkins, Warren, & Hahn, 2009).

objective function 1 and objective function 2 for both NHC and for housing values. These figures are set out in Table 4-4.

Table 4-4 Comparison of housing and NHC – obj. fns 1 and 2 – Co2Ch base scenario

	Objective function 1			Objective function 2		
	NHC $	Housing $		NHC $	Housing $	
Period	Optimal solution present value indicative per annum	Present value of solution	Intrinsic current value of solution	Optimal solution present value indicative per annum	Present value of solution	Intrinsic current value of solution
1	$47,519	$418,000	$418,000	$47,519	$418,000	$418,000
2	$63,345	$765,659	$523,386	$59,928	$763,613	$521,987
3	$79,658	$1.026m	$521,907	$43,591	$1,027m	$521,987
4	$55,433	$1.268m	$521,907	$43,500	$2.007m	$826,095
5	$51,345	$1.091m	$334,006	$31,000	$2.698m	$826,095

The NHC results for objective function 2 for periods 2 to 5 are lower than those for objective function 1 with the levels of consumption at periods 4 and 5 close to midway between the MBA standard and the CAS standard for retirement cost of living. As can be seen from Table 4-4, for objective function 2 the couple improves its housing quality substantially at the beginning of period 4, a time when many people would be thinking of downsizing, using non-superannuation savings to partially fund this purchase. Assessing the figures together, in periods 4 and 5 for both objectives, there is adequate NHC and adequate housing. However, objective function 2 provides a solution which could be considered asset rich, whilst objective function 1 provides for a significantly higher level of NHC but with modest housing.

4.3.2.3 Discussion of optimal solution for objective function 3

Objective function 3, described in Chapter 3 Section 3.4.6.3, compensates for the distorting[58] influence of housing prices and rental costs rising at a higher rate than inflation. It uses the intrinsic current value of housing as the basis for computing imputed rent. Details of the solution for this objective function are given in Table 4-3.

The set of decisions is very similar to those of objective function 1 with one of the difference being the pattern of savings. For objective function 3 there is non-superannuation investment saving from period 1 through to 3 whereas with objective function 1 this savings occurs only in periods 1 and 2. However for superannuation

[58] In these models housing values are rising by 5.2% per annum whilst the inflation rate used is 3%. By using 2011 housing values as 'intrinsic current values' objective function 3 compensates for the over-valued housing. However the model does require fund allocation to meet these hyper-inflated values, and thus there will be less funds available for non-housing consumption. See Section 4.6 for discussion regarding sensitivity analysis of housing capital growth rate.

savings for objective function 3 there is no savings beyond SGL in periods 1-3, whilst for objective function 1 the female uses salary sacrifice in periods 2 and 3 to boost her superannuation account. Another difference is the level of housing purchased. It is useful to compare the outcomes for both objective function 1 and objective function 3 for both NHC and for housing values. These figures are set out in Table 4-5.

Table 4-5 Comparison of housing and NHC – obj. fns 1 and 3 – Co2Ch base scenario

	Objective function 1			Objective function 3		
	NHC $	Housing $		NHC $	Housing $	
Period	Optimal solution present value indicative p.a.	Present value of solution	Intrinsic current value of solution	Optimal solution present value indicative p.a.	Present value of solution	Intrinsic current value of solution
1	$47,519	$418,000	$418,000	$47,519	$418,000	$418,000
2	$63,345	$765,659	$523,386	$59,928	$765,659	$523,386
3	$79,658	$1.026m	$521,907	$75,361	$1.168m	$594,170
4	$55,433	$1.268m	$521,907	$57,059	$1.461m	$601,366
5	$51,345	$1.091m	$334,006	$52,850	$1.135m	$347,639

A perusal of Table 4-5 above shows that the NHC for both objective functions is similar with objective function 1 providing for more consumption in periods 2 and 3, but objective function 3 providing marginally more consumption in periods 4 and 5. The housing values for objective function 1 are the minimum specified in the scenario, but for objective function 3 higher housing levels are provided for periods 4 and 5. With respect to retirement standard of living, as with objective function 1 objective function 3 provides for the CAS standard for both periods.

4.3.2.4 Observations – optimal solutions for Co2Ch base scenario

Both objective functions 1 and 3 provide optimal solutions where housing levels and NHC are in balance, as compared to objective function 2, where as stated in Section 4.3.2.2, the optimal solution is particularly asset rich. All three objective functions provide a retirement living standard well above the ASFA MBA level. As with objective function 1, objective function 3 provides amounts for consumption in periods 4 and 5 which exceed the level set out by the ASFA CAS retirement standard.

Given the way the scenarios have been specified, there are no surprising results. The deterministic nature of the model, together with the higher rates of return from non-superannuation investment when compared to the rate of returns used in this study for superannuation, predict that saving via extra contributions to superannuation will be avoided.

4.3.3 Description of optimal solutions for the SM base scenario

In discussing the optimal results for the base scenarios, the second model to be considered is the SM base scenario. As set out in Chapter 3 Section 3.4, the structure of the underlying model is essentially the same as for the Co2Ch model, adapted for a male who is single for all five periods. As for the Co2Ch base scenario, it is assumed that the subject of the model will act in a rational manner availing himself of all products and financial choices including reverse mortgages, life-contingent annuities and investment in risky assets. The same three objective functions as set out for the Co2Ch base scenario are used in establishing optimal solutions.

The most pertinent details of the optimal solutions for this SM base scenario are given in Table 4-6, with schematic representation provided in Appendix C. Discussion of the optimal solutions is provided in the commentary following the table. For this scenario the optimal solutions for both objective functions 1 and 3 are identical, and thus these solutions are discussed together. All the amounts discussed are present values.

Table 4-6 Comparison of indicative amounts - optimal solutions - SM base scenario (all values are present values)

	Objective functions 1 & 3		Objective function 2	
	Period 1	Period 2	Period 1	Period 2
Household labour income p.a.	$64,828	$70,060	$64,828	$70,060
Income from non-superannuation savings p.a.	$16,805	$55,111	$16,805	$45,570
Cash realised from sale of dwelling, available beginning of period (amt)	N.A.	$0	N.A.	$294,381
Cash from realisation of investments, available beginning of period (amt)	N.A.	$0	N.A.	$0
Non-housing consumption p.a.	$18,684	$21,961	$18,684	$18,684
Superannuation savings p.a.	$0	$0	$0	$0
Non-superannuation savings p.a.	$29,375	$57,259	$29,375	$35,594
Value of owner-occupied dwelling beginning of period (intrinsic current value)	$250,050 ($250,050)	$488,607 ($334,000)	$250,050 ($250,050)	$734,892 ($502,355)
Deposit for purchase or extension of dwelling (amt)	$30,541	$12,987	$30,541	$307,369
Mortgage payment p.a.	$14,738	$12,657	$14,738	$30,531
Tax paid p.a.	$18,219	$32,452	$18,219	$29,978
	Period 3		Period 3	
Household labour income p.a.	$52,403		$52,403	
Income from non-superannuation savings p.a.	$101,384		$3,370	
Transition to retirement pension p.a.	$8,202		$12,438	
Cash realised from sale of dwelling, available beginning of period (amt)	$0		$789,288	
Cash from realisation of investments, available beginning of period (amt)	$0		$1.053m	
Non-housing consumption p.a.	$39,385		$25,880	
Superannuation savings p.a.	$0		$0	
Non-superannuation savings p.a.	$83,913		$10,703	
Value of owner-occupied dwelling beginning of period (intrinsic current value)	$656,839 ($334,000		$2.053m ($1.044m)	
Deposit for purchase or extension of dwelling (amt	$0		$1.852m	
Mortgage payment p.a.	$5,920		$15,263	
Tax paid p.a.	$32,681		$15,406	
	Period 4	Period 5	Period 4	Period 5
Age Pension income p.a.	$0	$0	$19,468	$19,468
Superannuation pension p.a.	$0	$0	$0	$0
Annuity payments p.a.	$11,698	$11,698	$7,236	$7,236
Reverse mortgage p.a.	$0	$17,083	$3,162	$11,985
Income from non-superannuation savings p.a.	$129,972	$0	$0	$0
Lump sum amount withdrawn from superannuation account (amt)	$0	$0	$37,244	$0
Cash realised from sale of dwelling, available beginning of period (amt)	$0	$0	$0	$0
Cash from realisation of investments, available beginning of period (amt)	$0	$2,493,487	$106,216	$0
Non-housing consumption p.a.	$98,704	$128,287	$29,720	$38,627
Non-superannuation savings p.a.	$14,971	$0	$0	$0
Value of owner-occupied dwelling beginning of period (intrinsic cv)	$811,417 ($334,000)	$1.091m ($334,000	$2.536m ($1.044m)	$3.409m ($1.044m)
Deposit for purchase or extension of dwelling (amt)	$0	$0	$0	$0
Mortgage payment p.a.	$3,255	$0	$0	$0
Mortgage payout beginning of period (amt)	$0	$31,030	$143,460	$0
Tax paid p.a.	$24,676	$5,599	$0	$0

4.3.3.1 Discussion of optimal solution for objective functions 1 & 3

As can be seen from Table 4-6 the optimal solutions for objective functions 1 and 3 for the SM base scenario are identical. As with the couple with two children model, for objective function 1, only NHC, as present values, is considered in determining optimality. Minimum housing suitable for a single person, which maybe either a purchased dwelling or rented accommodation, is specified in the model, but is not included in the calculation of this objective function. However for objective function 3, again as for the Co2Ch model, both housing quality and NHC are included in the calculation of the objective function, but the housing value is adjusted to compensate for the distorting influence of housing prices, as discussed in Section 4.3.2.3 and rental rising more quickly than inflation by using the intrinsic current value of housing.

The median labour income for each of periods 1, 2 and 3 are parameters, with all other figures in Table 4-6 being determined from solving of the model. As set out in this table, for the optimal solution for both objective functions 1 and 3, the single man has labour income of about $65,000 per annum for period 1, and due to an aggressive savings program of, on average, $29,000 per year, has an average yearly income of about $17,000 from risky assets. He takes out a mortgage to buy a dwelling of minimum allowed value of $250,500 at the beginning of period 1, when he is aged 25, and pays the minimum on the mortgage during the 18 years of period 1. As expected, because the subject of the model has no dependents, no insurance products are purchased during period 1 or at any other time. There are no contributions to his superannuation account except for the mandated SGL payments during this period or in any other period. The NHC allowed in the optimal solution is about $18,500 per year, the minimum specified by the model.

In period 2, the subject has average labour income of about $70,000. He renovates his owner-occupied dwelling at the beginning of period 2, using both savings and an increased mortgage to finance this spending. He continues an investment program with a net $2,000 investment per year. The NHC amount provided by the optimal solution is about $22,000 per year which is $3,500 per annum greater than the minimum specified in the model.

During period 3, the single male takes out a transition to retirement pension of about $8,000 per year. He also has labour income of average $52,000 per year, this amount being lower than the period 2 amount to reflect the move to part-time work in the latter part of this period. The subject continues to live in the same dwelling, paying the mortgage, and also continues to have an aggressive investment plan, but by this stage in the lifecycle has a net income of an average of $17,000 per year from these investments. The amount of NHC allowed by the optimal solution is $39,500 per year.

At the beginning of period 4 at age 67, the subject of the model uses his entire superannuation balance, the present value of which is $235,000, to buy a life-contingent annuity which pays him $11,500 per year for the rest of his life i.e. 34 years. He continues to live in the original dwelling, still paying the mortgage. His continuing investment in risky assets provides him with an income of $130,000 p.a. His financial position is such that after paying tax he has $99,000 per annum available for NHC, an amount well above the $40,407 suggested by the ASFA CAS standard as needed for comfortably affluent retirement for a single person.

The subject's investments are realised at the beginning of period 5 providing $2.5 million. He pays out his mortgage of $144,000, and the remainder is used to provide funds over the next 18 years. As well, he receives an annual life-contingent annuity of $11,450 and takes out a reverse mortgage providing $17,000 per year. Overall his funds are such that he can provide $128,000 per annum for NHC, again an amount well above the CAS standard. Due to his considerable assets this male is not eligible for an Age Pension in either period 4 or 5.

4.3.3.2 Discussion of optimal solution for objective function 2

As with the couple with two children base scenario, objective function 2 is the sum of the present values of NHC for all 5 years, together with the present value of any rent paid, plus the present value of the imputed rent of purchased housing. This objective function gives recognition that housing above a minimum level may increase the subject's wellbeing. Unlike objective function 3 where the contribution to the objective function from the level of housing used is adjusted to compensate for housing prices rising at a higher rate than the CPI, objective function 2 uses the present value based on inflated housing prices and thus this objective function gives higher weight to housing than does objective function 3.

As set out in Table 4-6, for the optimal solution using objective function 2, this single male takes out a mortgage to buy a dwelling at the beginning of period 1, when he is aged 25. He sells this dwelling at the end of period 1 and buys a more expensive dwelling, increasing his mortgage. Likewise he sells the second dwelling at the end of period 2 and buys a yet more expensive dwelling, investing his wealth in housing. At the beginning of period 4 he pays out the mortgage. He maintains this dwelling for periods 4 and 5. This pattern of housing is different from the solution for objective functions 1 and 3 where a dwelling is purchased at beginning of period1, renovated at the beginning of period 2 and then retained until death at the end of period 5.

As well as paying the mortgage during periods 1 and 2, he makes non-superannuation investments, without taking out any loan to finance these investments, realising these investments at end of period 2, when he puts the cash made available into the deposit for the dwelling purchased in period 3. In period 3 he again invests in non-superannuation assets, realising these assets at the end of the period. As with objective functions 1 and 2, there is no investment in superannuation at any time, except for the mandated SGL contributed as a result of labour earnings. No insurance products are purchased at any time, as expected.

During period 3 the subject takes a transition to retirement pension. At the beginning of period 4, he takes a cash withdrawal from his superannuation account, and converts the remaining funds to a life-contingent annuity, receiving cash flows from this investment in periods 4 and 5. Because his funds are now wholly invested in annuities he does not receive a superannuation pension in these two periods. In both periods 4 and 5 he holds a reverse mortgage, which provides funds for each year of these periods. Due to his considerable investment in housing, his assessable assets are below the Age Pension threshold, as is his income, and thus he receives a full Age Pension in both periods 4 and 5, unlike the situation for objective functions 1 and 3 where no Age Pension is received for either periods 4 or 5. His standard of living for both periods is higher than the MBA standard but lower than the CAS standard.

4.3.3.3 Observations – SM base scenario

It is constructive to compare the outcomes for all three objective functions for both NHC and for housing values. These figures are set out in Table 4-7.

Table 4-7 Comparison of optimal results for all objective functions -SM base scenario

	Objective functions 1 & 3			Objective function 2		
	NHC $	Housing $		NHC $	Housing $	
Period	Optimal solution present value indicative p.a.	Present value of solution	Intrinsic current value of solution	Optimal solution present value indicative p.a.	Present value of solution	Intrinsic current value of solution
1	$18,684	$250,500	$250,500	$18,684	$250,500	$250,500
2	$21,961	$488,607	$334,000	$18,684	$734,892	$502,355
3	$39,385	$656,839	$334,000	$25,880	$2.053m	$1.044m
4	$98,704	$811,417	$334,000	$29,720	$2.536m	$1.044m
5	$128,287	$1.091m	$334,000	$38,627	$3.409m	$1.044m

Inspection of Table 4-7 shows that for objective functions 1 and 3, the optimal solution provides for modest housing, but, at the same time, NHC per annum is high for periods 4 and 5. With objective function 2, the situation is reversed with a very high standard of housing in periods 3, 4 and 5[59], but with low NHC in periods 3 and 4.

However, as can be seen from an inspection of Table 4-6 , to achieve either the high NHC amount available for the retirement years (objective functions 1 and 3) or the high standard of housing (objective function 2) there is a reliance on an aggressive non-superannuation savings program, investing in risky assets, in the early periods, especially for objective functions 1 and 3. As such a savings program can be considered unappealing to a person in those earlier years, sensitivity analysis has been carried out to investigate optimal solutions when such an investment program is not available as an option. These results are discussed in Section 4.5.4.2.

4.3.4 Description of optimal solutions for F1Ch base scenario

The third base scenario set up for this study is the F1Ch base scenario, where the subject of the model is a female who, from the time she is aged 34, has the sole responsibility for a child. As for the SM base scenario, it is assumed that the subject has median labour income for gender and age. However, built into the model is an adjustment for part time work for two years when the child is an infant and thus the labour income is adjusted for period 1.

The structure of this scenario is identical to that of the SM base scenario i.e. the variables are identical, as are the expressions setting out the constraints. The difference between the scenarios is in the data used to determine parameters. The female has a lower labour income in all three relevant periods, reflecting the lower average income

[59] As can be seen from Table 4-7, the optimal solution provides for a dwelling for this single male that is equivalent to a dwelling worth more than $1 million at the end of 2011.

received by females in Australia, and the household of mother and child has higher minimum consumption in periods 1,2, and 3. These differing amounts are set out in Table 4-8.

Table 4-8 Comparison of parameters - SM and F1Ch base scenarios
(future values)

Period	Variable	SM base scenario	F1Ch base scenario	Variable	SM base scenario	F1Ch base scenario
1	labour income	$1.518m	$1.412m	NHC	≥ $437,482	≥ $461,783
2		$2.038m	$1.799m		≥ $543,495	≥ $710,629
3		$1.547m	$1.418m		≥ $551,568	≥ $583,817

As well as the differences as set out in Table 4-8, the cost of insurance premiums are different for the male and female, as are the payments flowing from the purchase of life-contingent annuities. All other parameters and system variables are identical for the two models.

Despite the differences set out in Table 4-8, the optimal set of decisions for the F1Ch base scenario is essentially the same as for that of the SM, for all three objective functions, though of course the amounts associated with the decisions are different.

The most pertinent details of the optimal solutions for this F1Ch base scenario are given in Table 4-9 with discussion of the optimal solutions provided in the commentary following the table. Schematic representation for the optimal solutions is provided in Appendix C. Again, as for the SM base scenario, the optimal solutions for both objective functions 1 and 3 are identical, and thus these solutions are discussed together. All the amounts discussed, unless explicitly stated otherwise, are present values.

Table 4-9 Comparison of indicative amounts – optimal solutions - F1Ch base scenario
(all values are present values)

	Objective functions 1 & 3		Objective function 2	
	Period 1	Period 2	Period 1	Period 2
Household labour income p.a.	$60,298	$61,850	$60,298	$61,850
Income from non-superannuation savings p.a.	$15,461	$48,483	$15,461	$50,457
Cash realised from sale of dwelling, available beginning of period (amt)	N.A.	$0	N.A.	$0
Cash from realisation of investments, available beginning of period (amt)	N.A.	$0	N.A.	$0
Non-housing consumption p.a.	$19,722	$27,591	$19,722	$24,121
Superannuation savings p.a.	$0	$0	$0	$0
Non-superannuation savings p.a.	$27,025	$47,638	$27,025	$52,122
Value of owner-occupied dwelling beginning of period (intrinsic cv)	$250,500 ($250,500)	$488,607 ($334,000)	$250,500 ($250,500)	$496,660 ($339,505)
Deposit for purchase or extension of dwelling (amt)	$29,804	$11,735	$29,804	$11,735
Mortgage payment p.a.	$14,787	$12,763	$14,787	$13,338
Tax paid p.a.	$13,638	$21,573	$13,638	$21,959
	Period 3		Period 3	
Household labour income p.a.	$48,042		$48,042	
Income from non-superannuation savings p.a.	$89,100		$5,902	
Transition to retirement pension p.a.	$7,481		$14,099	
Cash realised from sale of dwelling, available beginning of period (amt)	$0		$578,529	
Cash from realisation of investments, available beginning of period (amt)	$0		$1.240m	
Non-housing consumption p.a.	$40,104		$19,777	
Superannuation savings p.a.	$0		$0	
Non-superannuation savings p.a.	$76,356		$18,746	
Value of owner-occupied dwelling beginning of period (intrinsic cv)	$656,839 ($334,000)		$2.053m ($1.044m)	
Deposit for purchase or extension of dwelling (amt	$0		$1.828m	
Mortgage payment p.a.	$5,969		$17,070	
Tax paid p.a.	$22,103		$11,546	
	Period 4	Period 5	Period 4	Period 5
Age Pension income p.a.	$0	$0	$19,468	$19,468
Superannuation pension p.a.	$0	$0	$0	$0
Annuity payments p.a.	$10,679	$10,679	$6,524	$6,524
Reverse mortgage p.a.	$0	$17,083	$2,504	$13,047
Income from non-superannuation savings p.a.	$115,959	$0	$0	$0
Lump sum amount withdrawn from superannuation account (amt)	$0	$0	$0	$0
Cash realised from sale of dwelling, available beginning of period (amt)	$0	$0	$0	$0
Cash from realisation of investments, available beginning of period (amt)	$0	$2.239m	$186,031	$0
Non-housing consumption p.a.	$89,916	$116,865	$29,989	$38,977
Non-superannuation savings p.a.	$15,722	$0	$0	$0
Value of owner-occupied dwelling beginning of period (intrinsic cv)	$811,417 ($334,000)	$1.091m ($334,000)	$2.536m ($1.044m)	$3.409m ($1.044m)
Deposit for purchase or extension of dwelling (amt)	$0	$0	$0	$0
Mortgage payment p.a.	$3,282	$0	$0	$0
Mortgage payout beginning of period (amt)	$0	$31,198	$157,440	$0
Tax paid p.a.	$17,654	$5,107	$0	$0

4.3.4.1 Discussion of optimal solution for objective functions 1 & 3

As for the SM base scenario, the optimal solution for both objective functions 1 and 3 are identical. For these two objective functions the optimal set of decisions is for the subject to take out a mortgage on owner-occupied housing at the beginning of period 1, to renovate this dwelling at the beginning of period 2, and then to maintain a mortgage until the end of period 4, when the loan is paid out. Again, substantial non-superannuation investments over this time are made. These investments are not realised until the beginning of period 5. As with the SM base scenario, there is no investment in superannuation at any time, except for the mandated SGL contributed as a result of labour earnings. No insurance products are purchased at any time.

For the optimal solution, during period 3 the female takes a transition to retirement pension. At the beginning of period 4, she uses her remaining superannuation funds to buy a life-contingent annuity receiving cash flows from this investment in periods 4 and 5. Because her funds are wholly invested in annuities she does not receive a superannuation pension in these two periods. No lump sum is withdrawn from her superannuation account at any time. As with the SM base scenario, this female takes out a reverse mortgage in period 5 and as well realises non-superannuation savings. Due to her considerable assets this female is not eligible for an Age Pension in either period 4 or 5. The standard of living she achieves in these retirement periods is well above the CAS standard.

4.3.4.2 Discussion of optimal solution for objective functions 2

As for the previous two base scenarios, objective function 2 is the sum of the present values of NHC for all 5 periods, together with the present value of any rental paid, plus the present value of the imputed rent of owner-occupied housing.

The optimal solution for objective function 2 for the F1Ch base scenario, set out above in Table 4-9 is essentially the same as for the SM base scenario with objective function 2, with only two differences in decision making. The first difference is that at the end of period 1 the female renovates her existing dwelling whereas the single male, who has access to more cash, sells his period 1 dwelling and purchases a substantially more expensive dwelling for period 2. The second difference is at the beginning of period 4 when the male withdraws a cash amount from his superannuation account, whereas the female does not. Making this withdrawal allows for this male to pass the assets means test and thus become eligible for a full Age Pension, where as the female’s situation is that the level of assets and income already ensure her eligibility.

As with the single male, the female in the model sells her dwelling at the end of period 2 and buys new owner-occupied housing at the maximum value allowed by the model.

During period 3 she pays out the mortgage, and maintains this dwelling for periods 4 and 5.

As for the SM base scenario with objective function 2, the solution depends on the female making considerable non-superannuation investments, realising these investments at end of period 2, and using the cash made available for the deposit for the dwelling purchased at the beginning of period 3. In period 3 she again invests in non-superannuation assets, realising these assets at the end of the period.

As with objective function 1, there is no investment in superannuation at any time, except for the mandated SGL contributed as a result of labour earnings. As expected, no insurance products are purchased at any time.

During period 3 this female takes a transition to retirement pension. At the beginning of period 4, she converts the remaining funds to a life-contingent annuity, receiving cash flows from this investment in periods 4 and 5. Because her funds are now wholly invested in annuities she does not receive a superannuation pension in these two periods. In both periods 4 and 5 she holds a reverse mortgage, which provides funds for each year of these periods. Due to her considerable investment in housing, her assessable assets are below the Age Pension threshold, as is her income, and thus she receives a full Age Pension in both periods 4 and 5. Her retirement funds for these periods are, as with the SM base scenario, above the MBA level but below the CAS level.

4.3.4.3 Observations – F1Ch base scenario

As for the two base scenarios already discussed, it is informative to compare the outcomes for all three objective functions for both NHC and for housing values. These figures are set out in Table 4-10

Table 4-10 Comparisons of results for all objective functions – F1Ch base scenario

	Objective functions 1 & 3			Objective function 2		
	NHC $	Housing $		NHC $	Housing $	
Period	Optimal solution present value indicative p.a.	Present value of solution	Intrinsic current value of solution	Optimal solution present value indicative p.a.	Present value of solution	Intrinsic current value of solution
1	$19,722	$250,500	$250,500	$18,684	$250,500	$250,500
2	$27,591	$488,607	$334,000	$24,121	$496,660	$339,505
3	$40,104	$656,839	$334,000	$19,777	$2.053m	$1.044m
4	$89,916	$811,417	$334,000	$29,989	$2.536m	$1.044m
5	$116,865	$1.091m	$334,000	$38,977	$3,409m	$1.044m

As with the SM base scenario, for objective functions 1 and 3, the optimal solution for the F1Ch base scenario provides for modest housing, but NHC per annum is high for periods 4 and 5, exceeding the amount needed for the CAS standard. With objective function 2, the situation is reversed with a very high standard of housing in periods 3, 4 and 5[60], but with low NHC in periods 3 and 4. For objective 2, the standard of living provided in retirement is in excess of the MBA standard but less than the CAS level.

Again, as with the SM model, to achieve either the high NHC amount available for the retirement years (objective functions 1 and 3) or the high standard of housing (objective function 2) there is a reliance in the early periods on an aggressive non-superannuation savings regime, investing in risky assets. Sensitivity analysis has been carried out to investigate optimal solutions when such a risky investment program is not acceptable to the subject of the model. These results are discussed in Section 4.5.4.3.

4.3.5 General comments about the solutions for all three base scenarios

The solutions for all three base scenarios have some decisions in common. For all scenarios with all objective functions, a dwelling is purchased at the beginning of period 1, and owner-occupied housing is used for all five periods. During period 1 NHC is kept to the minimum. Across all three periods of labour income, no use is made of superannuation saving, apart from the SGL, for both the SM and F1Ch base scenarios, and only a minimum for the Co2Ch base scenario.

With respect to retirement funding products, both reverse mortgages and life-contingent annuities feature in every optimal solution for all three base scenarios with each of the objective functions. With regard to reverse mortgages, this result is in accordance with the findings of Ong (2008) who established that such products can considerably improve the economic wellbeing of an elderly Australian[61]. Likewise, the result of this is in agreement with the demonstrated value to an Australian retiree of annuities, as established by Ganegoda and Bateman (2008).

The subjects of the models can opt to take a lump sum from superannuation account at either or both the beginnings of period 4 and period 5. There are four instances where the optimal solution forces this option i.e. at the beginning of period 4 for the Co2Ch

---

[60] The optimal solution provides for a dwelling for this female that is equivalent to a dwelling worth more than $1 million dollars at the end of 2011.

[61] As discussed in Section 2.2.5, Ong also highlights that householders entering a reverse mortgage arrangement can be exposed to considerable financial risk.

model for all three objective functions, and for the SM model with objective function 2, likewise at the beginning of period 4. In all cases, inspection of detailed results finds that the taking of the lump sum[62] ensures reduction of assets to a level where the means test for the Age Pension is not breached. As well the income test may be impacted, as the reduced value of the superannuation account leads to a smaller assessable income being calculated. This situation illustrates the value of the Age Pension in retirement and the worth of the effort of wealth structuring to receive it.

The major difference between the outcomes for the three base scenarios is that of NHC in periods 4 and 5, for objective functions 1 and 3. The single male has higher NHC, followed by the single mother, with the couple having the lowest level. Moreover, in period 4, this lowest NHC must provide for two people. For the Co2Ch base scenario with objective functions 1 and 3, these outcomes are contributed to significantly by the reception of a full Age Pension in both periods, whilst for the other two base scenarios for these objective functions, the pension is not received. This situation reflects the fact that, in periods 1 and 2, for the single male, one adult male wage supports one person, whereas for the single mother 93% of the male wage supports two people, and, for the couple, approximately 150% of the male wage supports four people.

4.3.6 Consideration of results in consideration of key economic theories

It is appropriate at this stage of the discussion to reflect on the optimal solutions in light of theory set out in the literature review. As the base scenarios for all household types have been set up to reflect a rational, self-interested perspective, it is not surprising that the results are, to a large extent, in concert with the key theories relating to the standard economic model set out in Section 2.1. Even though the models have been set up to force some consumption smoothing between periods, there is significant saving in the years from age 25 to 56 for all models and for all objective functions, reflecting Modigliani's lifecycle hypothesis that people save for retirement years. As well the optimal solutions show decisions being made that anticipate income from the Age Pension, reflecting Friedman's life cycle hypothesis that consumers consume according to long term expectations of income. Of course, for this study, policy settings are constant and thus the subjects of the model are making decisions based on the certainty

[62] The assumption built into model is that half the lump sum is expensed immediately, for example for use for a holiday, repairs to housing, and the other half is classed as an asset with deemed income for Age Pension assessment purposes.

of receive this pension as long as the specified conditions are met. In the actual Australian situation, a person preparing for retirement might factor into decision making the possibility that policies could change.

The subjects of the model build a portfolio of assets over time. This portfolio consists of superannuation savings, savings and investments outside the superannuation envelope, and possibly an owner occupied dwelling, though rental is an option. The optimal solutions all show portfolio selection that depends on the returns of the asset class, taking into account the preferences demonstrated by the particular objective function, where objective function 1 shows a preference for a minimum level of housing, whilst the other two objectives have a desire for both NHC and housing levels, in some proportion. As per the proposals from Samuelson, Merton and Hakansson that portfolio selection does not depend on age, the optimal solution reflects this situation, which is to be expected given the way the model was specified, and the objective functions set up. It is important to note that owner occupied housing is part of all optimal solutions, reflecting the housing capital growth rate which, when considered in conjunction with the tax advantages of housing, provides a comparable rate of return when compared to other asset classes.

Another theory pertinent to these results for models based on a rational, self-interested perspective is that of the purchase of annuities. As discussed in section 2.2.2.2, in the absence of a bequest motive, full annuitisation should occur. However these models have a small bequest specified. The optimal results for all three models with all three objective functions show some annuitisation, with payments from this income stream being in excess of the payments from the superannuation allocated pension in all situations, thus reflecting to a certain extent, the theoretical position on annuities.

4.4 Analysis of optimal solutions for base scenarios

Immediately above, descriptions of the optimal solutions for the three base scenarios are provided. The discussion which follows provides analysis of these optimal results, with post-optimality analysis being used where appropriate and, as well, sensitivity analysis. Given, for example, that the model for the Co2Ch base scenario consists of 525 variables and 954 constraints, the consideration of sensitivity has the potential to become unwieldy and confusing. Thus, to aid clarity, the analysis will be discussed under the following broad headings: initial funds available, housing variables, superannuation savings beyond the SGL and life insurance and labour income. Depending on the analysis being considered, the amounts for the variables being discussed may be present or future values, and may pertain either to a period as a whole or to a year within a period. The context of the discussion will usually make the situation clear, but for clarity, sometimes the situation will be made explicit. For lifetime wellbeing of the household, the measure used is the objective function value which is a present value incorporating the results across the life time.

4.4.1 Analysis for funds available at beginning of period 1

As stated in Chapter 3 Section 3.4.2.2, the household begins its existence with a cash amount, which may be savings provided by the subjects of the models, or a family gift, or from some other source. For the base scenario of the Co2Ch model the amount is set as $30,000 with an equality constraint in place to express this situation. For the other two scenarios the initial amount available is $20,000.

An initial view could be that having a higher level of funds at the beginning of the lifecycle should lead to better outcomes overall. Sensitivity analysis allows this view to be tested.

4.4.1.1 Post-optimality analysis for initial funds

Given that the amount of funds available at the beginning of period 1 is specified for all three models, and thus is expressed as an equality, this parameter must be included in the solution and take a value of either $30,000 or $20,000 as appropriate to the relevant model. Thus reduced cost data is irrelevant. However the shadow price results do give useful information.

The results for post-optimality analysis for this constraint for the three base scenarios are set out in Table 4-11.

Table 4-11 Post-optimality analysis - Shadow prices for initial funds

	Objective function	Initial amount available	Shadow Price	Allowable increase	% allowable increase	Allowable decrease	% allowable increase
Co2Ch base scenario	1	$30,000	$2.666	$1,313	4.38%	$865	2.88%
	2	$30,000	$16.987	$58,635	195.45%	$4,065	13.55%
	3	$30,000	$2.367	$25,216	84.05%	$865	2.88%
SM base scenario	1 & 3	$20,000	$8.554	$32,084	160.42%	$5,491	27.45%
	2	$20,000	$5.673	$14,181	70.91%	$5.491	27.45%
F1Ch base scenario	1 & 3	$20,000	$9.208	$32,821	164.11%	$4,754	23.77%
	2	$20,000	$6.421	$6,655	33.28%	$1,011	5.10%

The interpretation of Table 4-11, using objective function 1 for the Co2Ch base scenario as an example, is as follows: if the initial funds available to the couple is between $29,135 and $31,313 then the optimal set of decisions as found for solving the base scenario for this objective model stands. Moreover, for an additional $1 added to these initial funds, the objective function increases by the shadow price i.e. $2.666. This shadow price applies only at the limit.

Using the approach to significance set out in Section 4.2.4 , the allowable increase of the initial amount is significant only for the Co2Ch model using objective function 1, and the allowable decrease for the Co2Ch model using both objective functions 1 and 3. For all other instances the allowable increases and decreases are not significant.

Using the information provided by the allowable decrease amounts enables interrogation of the model to determine minimum amounts needed at the beginning of period 1 for feasible solutions to be found. These amounts are $25,935 for the Co2Ch model, $14,509 for the SM model and $15,246 for the F1Ch model. For amounts below these, the specifications of the models would need to be changed to find feasible solutions.

As the shadow prices are calculated at the limit, it is not possible to deduce the impact of a change in the initial amount from inspection of Table 4-11. Thus it is instructive to carry out sensitivity analysis.

4.4.1.2 Sensitivity analysis for initial funds available – all base scenarios

Sensitivity analysis has been carried out by observing the optimal solutions when the cash amount available at the beginning of period 1 is changed. The method used to judge the significance of each change is to compare the initial overall objective function value for the model with the objective function value of the optimal solution incorporating the changes when this initial amount is changed. The results of this analysis are set out in Table 4-12.

Table 4-12 Impact of different level of funds at beginning of period 1 – all base scenarios

	Co2Ch base scenario								
	Objective Function 1			Objective Function 2			Objective Function 3		
Initial funds	$30,000 base case	$40,000	$50,000	$30,000 base case	$40,000	$50,000	$30,000 base case	$40,000	$50,000
Objective function value	$4.239m	$4.274m	$4.339m	$9.472m	$9.642m	$9.812m	$5.972m	$6.040m	$6.078m
Improvement in lifetime wellbeing		0.83%	2.36%		1.79%	3.59%		0.88%	1.78%
	SM base scenario								
	Objective Function 1			Objective Function 2			Objective Function 3		
Initial funds	$20,000 base case	$30,000	$40,000	$20,000 base case	$30,000	$40,000	$20,000 base case	$30,000	$40,000
Objective function value	$4.729m	$4.814m	$4.900m	$9.700m	$9.757m	$9.813m	$5.889m	$5.975	$6.060m
Improvement in lifetime wellbeing		1.78%	3.62%		0.59%	1.16%		1.46%	2.90%
	F1Ch base scenario								
	Objective Function 1			Objective Function 2			Objective Function 3		
Initial funds	$20,000 base case	$30,000	$40,000	$20,000 base case	$30,000	$40,000	$20,000 base case	$30,000	$40,000
Objective function value	$4.505m	$4.597m	$4.689m	$9.552m	$9.615m	$9.677m	$5.665m	$5.757	$5.850m
Improvement in lifetime wellbeing		2.04%	4.08%		0.66%	1.31%		1.62%	3.27%

It can be seen from inspection of Table 4-12 that increasing the funds available at the beginning of period 1 does not bring about significant improvement in lifetime wellbeing for any of the three base scenarios, no matter what objective function is used to assess wellbeing.

4.4.1.3 Conclusion – analysis for funds available at beginning of period 1

The results from both the post-optimality analysis and the sensitivity analysis demonstrate that there is need for a minimum level of funds. However the value of the funds available at the beginning of period 1 do not play a major role in providing for wellbeing across all 74 years of the lifecycle.

4.4.2 Analysis for minimum non-housing consumption

Non-housing consumption (NHC) includes all consumption except for life insurance and payment of a mortgage or for housing rental. Thus household payments relating to housing provision such as electricity and other utilities are included in this amount as are purchase of durables, expenditure on food and entertainment and all other household expenditure. Obviously, provision for NHC is an essential part of any model.

The NHC allocated for each period by the solving of the model, and their combination over a lifetime is the crux of this study. For objective function 1, it is solely NHC that is considered when assessing the overall outcome, and, for the other two objective functions, NHC plays a significant role in determining optimality of the results. Thus it is appropriate to undertake significant analysis relating to NHC and discuss the results in detail.

For the previous situation discussed i.e. initial funds, this item is a parameter where the optimal solution must take on the specified value. For NHC, the minimum value is specified for each period but the actual NHC provided by the optimal solution may be greater than the specified parameter i.e. NHC itself is a variable.

As with the discussion for initial funds, analysis of NHC is provided by both post-optimality analysis and scenario analysis.

4.4.2.1 Post-optimality analysis for NHC – all base scenarios

As the specifications for all base scenarios dictate minimum NHC for all periods, reduced cost data provides no useful information. However useful shadow price data is available in some circumstances i.e. when the variable takes on the parameter value. Table 4-13 sets out the shadow price data together with allowable increase and decrease figures. It can be seen that the solution provides several occurrences of the NHC greater than the minimum specified, with consequently no shadow prices being available. However the solution does allow for data to be available for allowable increase/decrease for every period.

Table 4-13 Post-optimality analysis for NHC – all base scenarios

	Obj. Fn.	Period	Minimum NHC. (fv)	Optimal Solution NHC (fv)	Shadow Price (pv)	Allowable increase	% allowable increase	Allowable decrease	% allowable increase
Co2Ch base scenario	1	**1**	$1.113m	$1.113m	-$0.635	$1.357	0.12%	$2,493	0.22%
		2	$1.743m	$1.843m	N.A.	$99,395	5.70%	infinity	N.A.
		3	$1.287m	$2.352m	N.A.	$1.065m	82.74%	infinity	N.A.
		4	$2.572m	$3.278m	N.A.	$705,632	27.43%	infinity	N.A.
		5	$3,800m	$6.293m	N.A.	$2.494m	65.63%	infinity	N.A.
	2	**1**	$1.113m	$1.113m	-$8.723	$41,634	3.74%	$277,136	24.91%
		2	$1.743m	$1.743m	-$2.016	$74,861	4.29%	$684,716	39.28%
		3	$1.287m	$1.287m	-$0.674	$562,320	43.70%	$306,499	23.82%
		4	$2.572m	$2.572m	-$0.297	$275,831	10.72%	$188,237	7.32%
		5	$3,800m	$3.780m	-$0.013	$921,275	24.25%	$628,307	16.54%
	3	**1**	$1.113m	$1.113m	-$1.984	$1,357	0.12%	$48,323	4.34%
		2	$1.743m	$1.743m	-$0.284	$23,470	1.35%	$75,802	4.35%
		3	$1.287m	$2.225m	N.A.	$937,865	72.88%	infinity	N.A.
		4	$2.572m	$3.374m	N.A.	$801,767	31.17%	infinity	N.A.
		5	$3.800m	$6.478m	N.A.	$2,678,m	70.49%	infinity	N.A.
SM base scenario	1 & 3	**1**	$437,482	$437,482	-$3.998	$137,492	31.43%	$69,739	15.94%
		2	$543,495	$638,822	N.A.	$95,327	17.54%	infinity	N.A.
		3	$551,568	$1.163m	N.A.	$611,098	110.79%	infinity	N.A.
		4	$1.205m	$5.836m	N.A.	$4.631m	384.06%	infinity	N.A.
		5	$2.499m	$15.724m	N.A.	$13.224m	529.14%	infinity	N.A.
	2	**1**	$437,482	$437,482	-$2.367	$23,134	5.29%	$24,525	5.61%
		2	$543,495	$543,495	-$0.376	$84,609	15.57%	$51,999	9.57%
		3	$551,568	$763,983	N.A.	$212,415	38.51%	infinity	N.A.
		4	$1.205m	$1.757m	N.A.	$551,625	45.75%	infinity	N.A.
		5	$2.499m	$4.734m	N.A.	$2,235,169	89.43%	infinity	N.A.
F1Ch base scenario	1 & 3	**1**	$461,783	$461,783	-$4.411	$100,761	21.82%	$80,677	17.47%
		2	$701,629	$802,570	N.A.	$100,941	14.39%	infinity	N.A.
		3	$583,817	$1.184m.	N.A.	$600,070	102.78%	infinity	N.A.
		4	$1.142m	$5.316m	N.A.	$4,175,026	365.67%	infinity	N.A.
		5	$2.366m	$14.323m	N.A.	$11,957m	505.24%	infinity	N.A.
	2	**1**	$461,783	$461,783	-$2.837	$1,800	0.39%	$11,851	2.57%
		2	$701,629	$701,629	-$0.442	$7,029	1.00%	$46,282	6.60%
		3	$583,817	$583,817	-$0.013	$18,333	3.14%	$120,713	20.68%
		4	$1.142m	$1.773m	N.A.	$631,498	55.31%	infinity	N.A.
		5	$2.366m	$4.777m	N.A.	$2,411m	101.86%	infinity	N.A.

The interpretation of the data in Table 4-13 above follows that of the interpretation given previously for shadow prices in Section 4.4.1. As can be seen from inspection of this table, for example, for objective function 2 for the Co2Ch base scenario, the optimal solution provides that the NHC for each of the five periods is held to the minimum, and thus there is a shadow price for NHC for each of these periods. An example of the interpretation of shadow prices for this scenario and objective function 2 is that, for a $1 increase in NHC in period 1, there is a decrease in the value of objective function 2 by $8.72, all other constraints being held constant. An inspection of Table 4-13 shows that, when available, the shadow prices are greater in the earlier periods than in the later ones. However, as with other variables, these prices hold only at the limits, and this data provided limited information

For the Co2Ch base scenario, the post-optimality analysis regarding allowable increase and allowable decrease shows the sensitivity of this constraint for periods 1 and 2. For objective function 1 in period 1 the constraint on minimum NHC needs only to move outside the range $1,112,137 to $1,113,997, a range of $3850, for the structure of the solution to be different.

For the SM base scenario, the allowable increase and decrease information shows no sensitivity for any objective function to this minimum NHC parameter. For the F1Ch base scenario, for objective function 2, there is sensitivity for periods 1, 2 and 3.

4.4.2.2 Sensitivity analysis –minimum NHC

The post-optimality report data as discussed immediately above provides information based on one variable changing and all other variables being held constant. It is useful to go beyond this narrow analysis and carry out sensitivity analysis where related parameter is changed at the same time. In particular it is useful to see the impact on outcomes when minimum NHC is altered for some or all periods. Because of differences between the Co2Ch base scenario, and the other two base scenarios, it is appropriate to consider the Co2Ch base scenario separately.

Sensitivity analysis for minimum NHC - Co2Ch base scenario

If the minimum NHC for the couple with two children base scenario is increased by 5% for all periods, there is no feasible solution. Indeed, if the minimum NHC does need to be increased, other parameters of the model, such as minimum levels of housing, would need to be relaxed if a feasible solution is to be found. Thus, sensitivity analysis of NHC is restricted to decreasing the minimum allowed for each period. For this analysis, the base scenario was adapted so that the minimum NHC specified was reduced by 10% simultaneously for all five periods.

Table 4-14 gives an overview of increased lifetime wellbeing, as measured by the optimal result for each objective function. It can be seen that there is a significant increase for all three objective functions.

Table 4-14 Wellbeing change- decreased minimum NHC - Co2Ch base scenario

	Co2Ch base scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
	base scenario	10% decrease across all periods	base scenario	10% decrease across all periods	base scenario	$10% decrease across all periods
Objective function value	$4.239m	$4.852m	$9.472m	$10.959m	$5.972m	$6.448m
Increase in lifetime wellbeing		14.46%%		15.70%		7.97%

As well as considering the overall increase in wellbeing across the life cycle, it is instructive to set out the optimal results for the scenario specifically for each period. The NHC and the housing values for each period for the optimal solutions are given in Table 4-15. These results are shown as the per annum present value amount allowed by the solution for NHC for each period and as well the intrinsic current value of the owner-occupied housing held at that time.

Table 4-15 Optimal solutions – decreased minimum NHC – Co2Ch base scenario

	Period	Co2Ch base scenario			Minimum NHC reduced by 10%	
		Minimum allowable values	Solutions: Obj Fn 1	Solutions: Obj Fn 3	Minimum allowable values	Solution: Obj Fns 1&3
NHC(present value) p.a.	1	$47,519	$47,519	$47,519	$42,767	$42,767
	2	$59,928	$63,345	$59,928	$53,935	$53,935
	3	$43,591	$79,658	$75,361	$39,232	$40,532
	4	$43,500	$55,433	$57,059	$39,150	$95,272
	5	$31,000	$51,345	$52,850	$27,900	$88,244
Intrinsic current value housing	1	$418,000	$418,000	$418,000	$418,000	$418,000
	2	$521,987	$523,386	$523,386	$521,987	$521,987
	3	$521,987	$521,987	$594,170	$521,987	$521,987
	4	$417,490	$521,987	$601,366	$417,490	$417,490
	5	$334,000	$334,006	$347,639	$334,000	$334,006

	Period	Co2Ch base scenario		Minimum NHC reduced by 10%	
		Minimum allowable values	Solution: Obj Fn 2	Minimum allowable values	Solution: Obj Fn 2
NHC(present value) p.a.	1	$47,519	$47,519	$42,767	$42,767
	2	$59,928.	$59,928	$53,935	$53,935
	3	$43,591	$43,591	$39,232.	$39,232
	4	$43,500	$43,500	$39,150	$39,150
	5	$31,000	$31,000	$27,900.	$27,900
Intrinsic current value housing	1	$418,000	$418,000	$418,000	$418,000
	2	$521,987	$521,987	$521,987	$521,987
	3	$521,987	$521,987	$521,987	$521,987
	4	$417,490	$826,095	$417,490	$1,157m
	5	$334,000	$826,095	$334,000	$1,157m

Under these revised conditions the optimal solution for objective functions 1 and 3 is the same. The minimum NHC specified for periods 1 and 2 forms part of the solution, as it does for the base scenario. NHC for period 3 is reduced substantially for period 3, from between $75,000 - $80,000 per annum for each of the ten years for the base scenario to around $40,000 per annum when minimum consumption is reduced, but consumption for periods 4 and 5 is substantially increased from around $55,000 per annum for these periods to around $90,000 per annum. The housing levels for both the base scenario and the restricted consumption model for objective functions 1 and 3 are similar. In examining the revised optimal solution it is found that for this solution the Age Pension is not available due to both the assets and income tests being breached for both periods.

It is appropriate to ask how the household would view these results i.e. would it be considered reasonable for the increased consumption available in periods 4 and 5 to adequately compensate for the reduction in consumption in periods 1 to 3. It can be argued that at least some Australians would rather have the increased consumption in periods 1, 2 and particularly 3 and then rely on the Age Pension, together with other fund flows from superannuation and a reverse mortgage rather than have funds available in old age at twice the level suggested by ASFA CAS level.

For objective function 2, the revised optimal solution continues to provide only minimal NHC for all 5 periods. However the increased funds available from reduced consumption in the early years mean the housing provided by the revised solution is of an even higher standard than for the base solution. For this objective function the full Age Pension is available for this revised model as wealth is held in housing. As with the conclusion for the base scenario with this objective function, this solution provides for a situation which is particularly asset rich, and relatively cash poor.

Sensitivity analysis for minimum NHC - SM and F1Ch base scenarios

As discussed in Chapter 3, Section 3.4.4 the minimum amounts for NHC in the base scenarios were adapted from HILDA data for amounts used for consumption by respondents to the survey. When minimum consumption is reviewed taking the modified-OECD equivalence scale [63] into account, it can be seen that the minimum amounts specified for NHC for these two scenarios is low compared to the amounts

[63] The concept of equivalence and the modified-OECD equivalence scale are discussed in Chapter 3, Section 3.4.5.2. This scale allocates 1 point for the first adult, 0.5 points for each additional person aged 15 or more and 0.3 points for children under 15 (ABS, 2011e).

allowed for the couple with two children base scenario. Table 4-16 sets out these relationships.

Table 4-16 Comparison of minimum NHC for all base scenarios

	Minimum NHC for base scenarios			
Period	Co2Ch base scenario	SM base scenario	Proportion male to couple	Proportion suggested as per ABS equivalence
1	$1.113m	$437,482	0.39	0.56
2	$1.743m	$543,495	0.31	0.43
3	$1.287m	$551,568	0.43	0.57
	Minimum NHC for base scenarios			
Period	Co2Ch base scenario	F1Ch base scenario	Proportion female to couple	Proportion as suggested as per ABS equivalence
1	$1.113m	$461,783	0.42	0.64
2	$1.743m	$701,629	0.40	0.61
3	$1.287m	$583,817	0.45	0.63

Given that the specified minimum for NHC for both the SM base scenario and the F1Ch base scenario is low when considered against the proportion suggested by modified-OECD equivalence scale, it is appropriate to carry out sensitivity analysis on this variable by increasing the specified minimum consumption amount for periods 1 to 3 for both scenarios.

This analysis has been carried out for the SM base scenario by increasing the minimum NHC by both 10% and 20% for periods 1, 2 and 3[64]. For the F1Ch base scenario, sensitivity analysis has been carried out both by increasing minimum NHC by 10% and also by setting this consumption to 60% of the couple with two children model, as suggested by the ABS equivalence approach. This latter proportion would set the NHC at the same relative level as that used by a couple with two children. The results of this analysis are set out in Table 4-17.

[64] It is not necessary to increase minimum consumption for periods 4 and 5 as optimal solutions invariably provide for higher consumption in these periods. Also, for period 5 for the Co2Ch model, at this stage only one of the couple survives.

Table 4-17 Wellbeing change - increased minimum NHC - SM and F1Ch base scenarios

	SM base scenario								
	Objective Function 1			Objective Function 2			Objective Function 3		
	base scenario	10% higher periods 1-3	20% higher periods 1-3	base scenario	10% higher periods 1-3	20% higher periods 1-3	base scenario	10% higher periods 1-3	20% higher periods 1-3
Objective function value	$4.729m	$4.554m	$4.305m	$9.700m	$9.566m	$9.279m	$5.889m	$5.714m	$5.466m
Decrease in lifetime wellbeing		3.70%	8.95%		1.39%	4.35%		2.97%	7.19%
	F1Ch base scenario								
	Objective Function 1			Objective Function 2			Objective Function 3		
	base scenario	10% higher periods 1-3	60% of Co2Ch periods 1-3	base scenario	10% higher periods 1-3	60% of couples model periods 1-3	base scenario	10% higher periods 1-3	60% of couples model periods 1-3
Objective function value	$4.505m	$4.284m	$3.136m	$9.552m	$9.160m	$7.237m	$5.665m	$5.444m	$4.316m
Decrease in lifetime wellbeing		4.91%	30.39%		4.11%	24.24%		3.90%	23.81%

An inspection of Table 4-17 shows that, for the SM base scenario, increasing minimum consumption for the first three periods by 20% makes a significant impact on wellbeing across a lifetime. An even stronger impact is observed when the minimum consumption for the F1Ch base scenario for periods 1-3 is aligned to minimum consumption as specified for the Co2Ch base scenario, with for example a 30% decrease in wellbeing across a lifetime when objective function 1 is used.

As well as considering the wellbeing across a lifetime, it is useful to set out the yearly NHC and the housing levels allocated for the optimal solutions when minimum NHC is increased. This data is set out in Table 4-18 for the SM base scenario and Table 4-19 for the F1Ch base scenario.

Table 4-18 Optimal solutions – increased minimum NHC - SM base scenario

	Period	SM base scenario			Minimum NHC increased by 20%		
		Minimum allowable value	Solution		Minimum allowable value	Solution	
			Obj. Fn 1 & 3	Obj. Fn 2		Obj. Fns 1&3	Obj. Fn 2
NHC (present value) p.a.	1	$18,684	$18,684	$18,684	$22,421	$22,421	$22,421
	2	$18,684	$21,961	$18,684	$22,421	$22,421	$22,421
	4	$18,684	$39,385	$25,880	$22,421	$34,592	$22,421
	4	$20,391	$98,704	$29,720	$20,391	$86,691	$26,726
	5	$20,391.	$128,287	$38,627	$20,391	$112,674	$34,736
Intrinsic current value housing	1	$250,500	$250,500	$250,500	$250,500	$250,500	$250,500
	2	$334,000	$334,000	$502,355	$334,000	$334,000	$334,000
	3	$334,000	$334,000	$1,043,750	$334,000	$334,000	$862,771
	4	$334,000	$334,000	$1,043,750	$334,000	$334,000	$1,043,750
	5	$334,000	$334,000	$1,043,750	$334,000	$334,000	$1,043,750

For the SM base scenario, it can be seen from inspecting the data in Table 4-18 that for the solution for objective functions 1 and 3, the optimal decision regarding housing is to have owner-occupied housing at the minimum specified level, and, as expected, this is the solution when minimum NHC is increased by 20% for periods 1 to 3. The impact of specifying increased minimum amounts of NHC in periods 1 to 3 is that the allocated NHC amounts for periods 4 and 5 are decreased, compared to the solution for the base scenario. However, the annual amounts available for NHC are still very high compared to the optimal solution amounts for earlier periods.

Using objective 2 for this base scenario, Table 4-18 above sets out that increasing minimum NHC by 20% leads to the optimal solution having housing of reduced value in both periods 2 and 3, and reduced NHC in periods 3, 4, and 5. For both periods 4 and 5 the level of funds available is less that those specified by the CAS level but higher than the MBA level.

For all three objective functions, the structure of the solutions for this model with increased NHC consumption remains essentially the same, compared to base scenario solutions. For objective functions 1 and 3, for both the base scenario and the increased consumption model, this SM is a self funded retiree, but for objective function 2, a full Age Pension is available for both periods as wealth is held in owner-occupied housing. This sensitivity analysis provides only for minimum NHC to be changed, and thus the other features of the base model remain. The optimal solutions for these adapted models rely on an aggressive savings plan using risky assets, the same situation as for the base scenario.

The situation, set out in Table 4-19, for the F1Ch model for NHC where minimum consumption is aligned with the Co2Ch model is markedly different from that of the SM model with 20% increased NHC.

Table 4-19 Optimal solutions –increased minimum NHC amount - F1Ch base scenario

		F1Ch base scenario			Minimum NHC 60% of Co2Ch for periods 1- 3			
	Period	minimum allowable value	Variable solution		minimum allowable value	Variable solution		
			Obj. Fn 1 & 3	Obj. Fn 2		Obj. Fn 1	Obj. Fn 2	Obj. Fn 3
NHC (present value) p.a.	1	$19,722	$19,722	$19,722	$28,551	$28,551	$28,551	$28,551
	2	$24,121	$27,591	$24,121	$35,957	$35,957	$35,957	$35,957
	3	$19,777	$40,104	$19,777	$26,155	$26,155	$26,155	$42,432
	4	$19,309	$89,916	$29,989	$26,100	$49,679	$26,100	$40,901
	5	$19,309	$116,865	$38,977	$18,600	$64,569	$33,923	$52,509
Intrinsic current value housing	1	$250,500	$250,500	$250,500	$250,500	$250,500	$250,500	$250,500
	2	$334,000	$334,000	$339,505	$334,000	$334,000	$334,000	$334,000
	3	$334,000	$334,000	$1.044m	$334,000	$334,000	$334,000	$367,400
	4	$334,000	$334,000	$1.044m	$334,000	$334,000	$719,537	$591,718
	5	$334,000	$334,000	$1,044m	$334,000	$334,000	$719,537	$334,000

From Table 4-17 it can be seen that, for the F1Ch base scenario, increasing minimum NHC in line with the Co2Ch consumption amount results, on average, in a reduction in wellbeing of more than 25%. Table 4-19 sets out these solutions at a period level. Investigating the optimal solutions under these increased minimum NHC conditions shows that, for objective function 3, the changed constraints lead to an optimal solution that provides a full Age Pension in both periods 4 and 5, whilst for objective function 1, there would be a part Age Pension in period 5[65].

4.4.2.3 Conclusion – analysis for minimum NHC

Minimum NHC is a sensitive parameter for both the Co2Ch and the F1Ch base scenarios. Even a small change in the specification of this parameter in the early periods can lead to a change in the structure of the optimal solution, or indeed a situation where there is no feasible solution, as is the case with increasing minimum NHC for the Co2Ch base scenario by 5%.

It is not surprising that the models should be particularly sensitive to minimum NHC parameters for periods 1 and 2 as extra resources spent on consumption in early life mean less savings for later, with the timing factor having a compounding impact over a lifetime.

[65] For objective 2, the optimal solution for the base scenario provides for a full Age Pension in both periods 4 and 5, and of course this situation applies with increased NHC.

4.4.3 Analysis for housing variables

As has been discussed in Section 4.4.2, an essential feature of this model is ensuring that there are funds for NHC. Another essential aspect is the provision of housing. As set out in Chapter 3, Section 3.4.1.2 for any instance of any model used in this study, the household must provide housing for itself in each of the five periods. The housing provided may be a purchased dwelling or the household may choose to rent with the decision being able to be changed at the beginning of each period.

There are three sets of housing-related parameters in each model i.e. for each period, minimum and maximum values of owner-occupied housing if such a dwelling forms part of the optimal solution, and the designated rental to be paid each period if renting is the allocated option. There are two sets of housing variables i.e. for each period, the value of an owner-occupied dwelling, and again for each period the cost of renting a dwelling. As stated in Chapter 3 Section 3.4.5.8, the values used for parameters for housing in the model are derived from ABS and NATSEM data with projections for future value using a rate of 5.2% per annum capital growth increase. As also discussed in Section 3.4.5.8, the housing capital value growth rate is a conservative estimate based on data for the past 30 years. For these variables, analysis is provided via post-optimality analysis.

4.4.3.1 Post-optimality analysis for housing parameters

The discussion in Section 4.3 sets out that, for all three models with all three objective functions, housing for each period is provided via owner-occupied dwellings, and thus post-optimality analysis regarding reduced cost data for minimum and maximum values of owner-occupied housing provides no useful information. However, for both the minimum purchased housing and the maximum purchased housing parameters, there is some data from post-optimality analysis for shadow prices and for allowable increase/decrease in these parameters.

However, the optimal models do not include the rental option for housing for any period for any of the objective functions. Given this absence from the solution reduced cost data from the post-optimality analysis does not provide useful information.

Shadow prices - minimum value for owner-occupied housing

The minimum future value of this housing for each period is set out for each model. However, the way the models have been set up means that shadow price data relating to this minimum constraint is only available for periods 1 and 2.The shadow prices for these minimum constraints are set out in Table 4-20.

Table 4-20 Shadow prices for minimum value owner-occupied housing – all base scenarios

	Obj. Fn.	Period	Minimum housing (fv)	Solution (fv)	Shadow Price (pv)	Allowable increase	% allowable increase	Allowable decrease	% allowable increase
Co2Ch base scenario	1	1	$418,000	$418,000	-$1.157	$2,268	0.54%	$3,024	0.72%
		2	$1.300m	$1.303m	N.A.	$3,483	0.27%	infinity	N.A.
	2	1	$418,000	$418,000	-$6.000	$40,650	9.72%	$70,008	16.75%
		2	$1.300m	$1.300m	-$0.883	$61,352	4.72%	$128,979	9.92%
	3	1	$418,000	$418,000	-$1.203	$2,268	0.54%	$48,952	11.71%
		2	$1.300m	$1.303m	N.A.	$3,483	0.27%	infinity	N.A.
SM base scenario	1	1	$250,500	$250,500	-$3.471	$50,100	20.00%	$27,833	11.11%
		2	$831,821	$831,821	-$1.286	$103,978	12.50%	$124,773	15.00%
	2	1	$250,500	$250,500	-$1.079	$23,560	9.41%	$24,977	9.97%
		2	$831,821	$1.251m	N.A.	$419,284	50.41%	infinity	N.A.
	3	1	$250,500	$250,500	-$2.571	$50,100	20.00%	$27,833	11.11%
		2	$831,821	$831,821	-$0.523	$103,978	12.50%	$124,773	15.00%
F1Ch base scenario	1	1	$250,500	$250,500	-$4.093	$47,544	18.98%	$27,833	11.11%
		2	$831,821	$831,821	-$1.363	$103,978	12.50%	$124,773	15.00%
	2	1	$250,500	$250,500	-$1.725	$2,311	0.92%	$9,338	3.73%
		2	$831,821	$845,530	$0.000	$13,709	1.65%	infinity	N.A.
	3	1	$250,500	$250,500	-$3.193	$47,544	18.98%	$27,833	11.11%
		2	$831,821	$831,821	-$0.596	103,978	12.50%	$124,773	15.00%

As can be seen from the table above, for the Co2Ch base scenario, if a dwelling is purchased in period 1 it must be for a minimum of $418,000. For all three objective functions for this scenario, this constraint is binding. If this constraint were lowered by $1, then the objective function would increase by $1.16 for objective function 1, $6 for objective function 2 and $1.20 for objective function 3. Moreover it can be seen that, for objective functions 1 and 3, the allowable increase on the constraint limit is sensitive, as is the allowable decrease for objective function1. The allowable increase for this constraint for period 2 is sensitive for all objective functions.

For the SM model, it can be seen that, if a dwelling is purchased at the beginning of period 1, for $1 more than the minimum specified value of $250,500, then the optimal value of objective function will decrease by $3.47 for objective function 1, $1.08 for objective function 2 and $2.57 for objective function 3. The allowable increase and allowable decrease amounts show that these constraints are not sensitive. For the F1Ch model, the shadow prices available are similar to those of the SM model, with the allowable increases and decrease being sensitive only for objective function 2.

Shadow prices - maximum value of owner-occupied housing

As discussed in section immediately above, minimum values of purchased housing are specified, if indeed owner-occupied housing is part of the optimal solution. Likewise, for the base scenarios, maximum values for this variable are specified. As all base scenarios have optimal solutions that involve owner-occupied housing, the reduced cost data for this parameter of maximum housing value provides no useful information. However the post-optimality analysis data showing shadow prices and allowable increases and decreases des provide data for consideration. This data is set out in Table 4-21.

Table 4-21 Shadow prices for maximum value owner-occupied housing – all base scenarios

	Obj. Fn.	Period	Maximum housing (fv)	Solution (fv)	Shadow Price (pv)	Allowable increase	% allowable increase	Allowable decrease	% allowable increase
Co2Ch base scenario	1	1	$836,000	$418,000	N.A.	infinity	N.A.	$418,000	50.00%
		2	$3.250m	$1.303m	N.A.	infinity	N.A.	$1.947m	59.89%
		3	$6.608m	$2.463m	N.A.	infinity	N.A.	$3.965m	60.00%
		4	$10.969m	$4.388m	N.A.	infinity	N.A.	$6.581m	60.00%
		5	$22.305m	$5.710m	N.A.	infinity	N.A.	$16.595m	74.40%
	2	1	$836,000	$418,000	N.A.	infinity	N.A.	$418,000	50.00%
		2	$3.250m	$1.300m	N.A.	infinity	N.A.	$1.950m	60.00%
		3	$6.608m	$2.643m	N.A.	infinity	N.A.	$3.964m	59.99%
		4	$10.969m	$6.945m	N.A.	infinity	N.A.	$4.023m	36.68%
		5	$22.305m	$14.122m	N.A.	infinity	N.A.	$8.182m	36.68%
	3	1	$836,000	$418,000	N.A.	infinity	N.A.	$418,000	50.00%
		2	$3.250m	$1.303m,	N.A.	infinity	N.A.	$1.947m	59.89%
		3	$6.608m	$3.009m	N.A.	infinity	N.A.	$3.599m	54.46%
		4	$10.969m	$5.056m	N.A.	infinity	N.A.	$5.913m	53.91%
		5	$22.305m	$5.943m	N.A.	infinity	N.A.	$16.362m	73.36%
SM base scenario	1& 3	1	$835.000	$250,500	N.A.	infinity	N.A.	$584,500	70.00%
		2	$2.599m	$831,821	N.A.	infinity	N.A.	$1.768m	68.00%
		3	$5.286m	$1.691m	N.A.	infinity	N.A.	$3.594m	68.00%
		4	$8.775m	$2.808m	N.A.	infinity	N.A.	$5.967m	68.00%
		5	$17.843m	$5.710m	N.A.	infinity	N.A.	$12.134m	68.00%
	2	1	$835.000	$250,500	N.A.	infinity	N.A.	$584,500	70.00%
		2	$2.599m	$1.251m	N.A.	infinity	N.A.	$1.348m	51.87%
		3	$5.286m	$5.286m	$0.110	$256,506	4.85%	$516,974	9.78%
		4	$8.775m	$8.775m	$0.430	$0	N.A.	$348,334	3.97%
		5	$17.843m	$17,843m	$0.00	infinity	N.A.	$0	0.00%
F1Ch base scenario	1& 3	1	$835.000	$250,500	N.A.	infinity	N.A.	$584,500	70.00%
		2	$2.599m	$831,821	N.A.	infinity	N.A.	$1.768m	68.00%
		3	$5.286m	$1.691m	N.A.	infinity	N.A.	$3.594m	68.00%
		4	$8.775m	$2.808m	N.A.	infinity	N.A.	$5.967m	68.00%
		5	$17.843m	$5.710m	N.A.	infinity	N.A.	$12.133m	68.00%
	2	1	$835.000	$250,500	N.A.	infinity	N.A.	$584,500	70.00%
		2	$2.599m	$845,530	N.A.	infinity	N.A.	$1.754m	67.47%
		3	$5.286m	$5.286m	$0.100	$55,221	1.04%	$363,605	6.88%
		4	$8.775m	$8.775m	$0.428	$0	0.00%	$190,829	2.17%
		5	$17.843m	$17.843m	$0.000	infinity	N.A.	$0	0.00%

Inspection of Table 4-21 shows that, for objective functions 1 and 3, for all three base scenarios, the constraints regarding maximum value of purchased housed are not binding. However for objective function 2, for both the SM model and the F1Ch model, relaxation of these constraints in periods 3 and 4 would lead to an increased optimal objective function value.

Reduced costs - renting

As mentioned earlier, the optimal sets of decisions do not include the rental option for housing for any period for any of the objective functions. Given this absence from the solution, reduced cost data from the post-optimality analysis reports is available and is set out in Table 4-22

Table 4-22 Reduced costs – renting – all base scenarios

	Variable	Objective function 1	Objective function 2	Objective function 3
Co2Ch base scenario	Domicile housing rent paid in period 1	-$1.404	-$8.723	-$2.204
	Domicile housing rent paid in period 2	-$0.557	-$2.016	-$0.504
	Domicile housing rent paid in period 3	-$0.280	-$0.674	-$0.145
	Domicile housing rent paid in period 4	-$0.285	-$0.297	-$0.148
	Domicile housing rent paid in period 5	-$0.122	-$0.013	-$0.104
SM base scenario	Domicile housing rent paid in period 1	-$4.767	-$2.367	-$4.127
	Domicile housing rent paid in period 2	-$1.289	-$0.376	-$0.992
	Domicile housing rent paid in period 3	-$0.510	$0.000	-$0.347
	Domicile housing rent paid in period 4	-$0.211	-$0.113	-$0.119
	Domicile housing rent paid in period 5	-$0.111	$0.000	-$0.070
F1Ch base scenario	Domicile housing rent paid in period 1	-$5.180	-$2.837	-$4.631
	Domicile housing rent paid in period 2	-$1.317	-$0.442	-$1.020
	Domicile housing rent paid in period 3	-$0.494	-$0.013	-$0.327
	Domicile housing rent paid in period 4	-$0.198	-$0.113	-$0.106
	Domicile housing rent paid in period 5	-$0.102	$0.000	-$0.060

The interpretation of Table 4-22 is as follows: for the Co2Ch model, $1 spent on rent in period 1, as opposed to having an owner-occupied dwelling for that period, will reduce the objective function value by $1.40 for objective function 1, $8.72 for objective function 2 and $2.20 for objective function 3. It can be seen from the table that, for all base scenarios, renting in period 1, would have the greatest impact on the lifetime wellbeing of the household with the impact decreasing for successive periods. These reduced costs apply only at the limits.

4.4.3.2 Conclusion - analysis for housing variables

As set out earlier, there are three sets of housing parameters for each base scenario i.e. the minimum and maximum values of any owner-occupied housing for each period, and the cost of rental for each period. The results discussed immediately above show that it is some parameters for the early years that have the greatest impact. Reducing the allowable minimum value of owner-occupied housing for period 1 would lead to increased lifetime wellbeing for all base scenarios. Again, for all base scenarios, renting rather than using owner-occupied housing has the greatest impact if the rental decision is taken for period 1. However, for the maximum value for such housing, mostly, these parameters have no impact on lifetime wellbeing.

4.4.4 Post-optimality analysis for superannuation contributions above the SGL

One of the options in saving for retirement during periods 1, 2 and 3 is for contributions to be made to superannuation beyond the SGL. As set out in Chapter 3 Section 3.4.1.2 these contributions can be made from the person’s salary before income tax (salary sacrifice) or they can be made from funds available to individual (post tax).For both method of contribution, there are limits as to the amount that can be invested with more stringent limits being upon salary sacrifice contributions.

Consideration of the optimal solutions for all base scenarios finds that this option of extra contributions to superannuation is part of the solution for only the Co2Ch, and only when objective function 1 is used. In this case there is an allocation using salary sacrifice for the female partner in periods 2 and 3. Thus, within the optimal solutions, of the 36 opportunities for superannuation beyond SGL to be part of the optimal set of decisions, there are only two such instances where the decision to make further contributions is made.

Given that, mostly, extra contributions to superannuation are not part of the optimal solutions, the reduced cost data provides useful information. This data is set out in Table 4-23.

It can be seen from an inspection of Table 4-23 that the reduced cost ranges from less than $0.01 to $5.82. This latter case is for the Co2Ch base scenario, using objective function 2, where, if the male of the partnership were to salary sacrifice $1 in period 1 to his superannuation account, the overall objective function value would decrease by $5.82. As with all post-optimality analysis, reduce costs apply only at the limit.

Table 4-23 Reduced costs – non-SGL superannuation – all base scenarios

	Variable	Objective function 1	Objective function 2	Objective function 3
Co2Ch base scenario	SBT, period 1 (m)	-$0.23	-$4.25	-$1.18
	SBT, period 1 (f)	-$0.18	-$4.45	-$1.21
	SAT, period 1 (m)	-$0.39	-$5.82	-$1.62
	SAT, period 1 (f)	-$0.26	-$5.57	-$1.52
	SBT, period 2 (m)	-$0.02	-$0.41	-$0.15
	SBT, period 2 (f)	In solution	-$0.48	-$0.16
	SAT, period 2 (m)	-$0.09	-$0.81	-$0.28
	SAT, period 2 (f)	-$0.03	-$0.70	-$0.24
	SBT, period 3 (m)	-$0.03	-$0.11	-$0.03
	SBT, period 3 (f)	In solution	-$0.07	-$0.01
	SAT, period 3 (m)	-$0.06	-$0.20	-$0.06
	SAT, period 3 (f)	$0.00	-$0.10	-$0.02
SM base scenario	SBT, period 1	-$2.01	-$1.38	-$2.01
	SAT, period 1	-$2.78	-$1.90	-$2.78
	SBT, period 2	-$0.18	-$0.15	-$0.18
	SAT, period 2	-$0.38	-$0.29	-$0.38
	SBT, period 3	-$0.01	-$0.03	-$0.01
	SAT, period 3	-$0.04	-$0.06	-$0.04
F1Ch base scenario	SBT, period 1	-$2.66	-$1.86	-$2.66
	SAT, period 1	-$3.31	-$2.31	-$3.31
	SBT, period 2	-$0.33	-$0.24	-$0.33
	SAT, period 2	-$0.46	-$0.33	-$0.46
	SBT, period 3	-$0.05	-$0.05	-$0.05
	SAT, period 3	-$0.06	-$0.06	-$0.06

SAT = Superannuation after tax; SBT = Superannuation before tax

It is useful to consider why additional contributions to superannuation do not feature in optimal solutions, given that superannuation is afforded beneficial taxation treatment. One of the reasons is that funds contributed to superannuation cannot be accessed until age 60, and then only under limited conditions. Another reason is because of the relative rates of return specified in this model. In particular, for the base scenarios there is access to investment in risky assets that provide a higher return than superannuation. As well there can be investment in owner-occupied housing that provides considerable capital growth with no taxation impost.

4.4.5 Analysis for life insurance

The purchase of life insurance is an option included in all the base scenarios. As discussed in Chapter 3 Section 3.4.1.2, all life insurance policies, which lapse on the 81st birthday of the insured person, are priced for a payout of a future value of $400,000 on the death of the insured person. Policies may be taken out for each subject of a model in each of periods 1 to 4. If a policy is taken out in an earlier period, there is a choice as to whether to continue that policy in the subsequent period or let it lapse. Thus, in period 4 there could be four policies in place for the subject of the model, one purchased in period 1, another in period 2, the third in period 3 and the fourth in period 4.

As expected, purchase of life insurance does not feature in any solution for either the SM or the F1Ch base scenarios. For both these scenarios the subject lives to age 98, and so the estate would never receive an insurance payout. Moreover, for the SM base scenario, given that the subject has no dependents, there is no rational reason that would ever lead to buying this insurance.

For the Co2Ch model, again the purchase of life insurance does not feature in any solution. This is as expected for the female of the partnership who lives to be 98. However there is the possibility of a payout on the death of the male partner as his death is on the last day that a payout would occur if an insurance policy was held.

4.4.5.1 Post-optimality analysis - life insurance - reduced costs data

This situation of life insurance not being part of the optimal solution for any of the scenarios means that for the post-optimality analysis there are no shadow prices, but there are reduced costs. The reduced costs for each instance of insurance that could possibly be purchased are set out in Table 4-24. This data is provided only for the Co2Ch and F1Ch base scenarios given, as mentioned immediately above, the irrationality of such a purchase.

Table 4-24 Reduced costs for life insurance purchases - Co2Ch and F1Ch base scenarios

	Variable	Objective function 1	Objective function 2	Objective function 3
Co2Ch base scenario	life insurance premium paid at level 1 rate during period 1 (m)	-$1.403	-$9.492	-$2.753
	life insurance premium paid at level 1 rate during period 1 (f)	-$1.403	-$9.492	-$2.753
	life insurance premium paid at level 1 rate during period 2 (m)	-$0.557	-$2.497	-$0.800
	life insurance premium paid at level 1 rate during period 2 (f)	-$0.557	-$2.497	-$0.800
	life insurance premium paid at level 2 rate during period 2 (m)	-$0.557	-$2.497	-$0.800
	life insurance premium paid at level 2 rate during period 2 (f)	-$0.557	-$2.497	-$0.800
	life insurance premium paid at level 1 rate during period 3 (m)	-$0.280	-$1.012	-$0.311
	life insurance premium paid at level 1 rate during period 3 (f)	-$0.280	-$1.012	-$0.311
	life insurance premium paid at level 2 rate during period 3 (m)	-$0.280	-$1.012	-$0.311
	life insurance premium paid at level 2 rate during period 3 (f)	-$0.280	-$1.012	-$0.311
	life insurance premium paid at level 3 rate during period 3 (m)	-$0.280	-$1.012	-$0.311
	life insurance premium paid at level 3 rate during period 3 (f)	-$0.280	-$1.012	-$0.311
	life insurance premium paid at level 1 rate during period 4 (m)	-$0.285	-$0.534	-$0.240
	life insurance premium paid at level 1 rate during period 4 (f)	-$0.285	-$0.534	-$0.240
	life insurance premium paid at level 2 rate during period 4 (m)	-$0.285	-$0.534	-$0.240
	life insurance premium paid at level 2 rate during period 4 (f)	-$0.285	-$0.534	-$0.240
	life insurance premium paid at level 3 rate during period 4 (m)	-$0.285	-$0.534	-$0.240
	life insurance premium paid at level 3 rate during period 4 (f)	-$0.285	-$0.534	-$0.240
	life insurance premium paid at level 4 rate during period 4 (m)	-$0.285	-$0.534	-$0.240
	life insurance premium paid at level 4 rate during period 4 (f)	-$0.285	-$0.534	-$0.240
F1Ch base scenario	life insurance premium paid at level 1 rate during period 1	-$5.180	-$3.606	-$5.180
	life insurance premium paid at level 1 rate during period 2	-$1.316	-$0.923	-$1.316
	life insurance premium paid at level 2 rate during period 2	-$1.316	-$0.923	-$1.316
	life insurance premium paid at level 1 rate during period 3	-$0.494	-$0.352	-$0.494
	life insurance premium paid at level 2 rate during period 3	-$0.494	-$0.352	-$0.494
	life insurance premium paid at level 3 rate during period 3	-$0.494	-$0.352	-$0.494
	life insurance premium paid at level 1 rate during period 4	-$0.198	-$0.350	-$0.198
	life insurance premium paid at level 2 rate during period 4	-$0.198	-$0.350	-$0.198
	life insurance premium paid at level 3 rate during period 4	-$0.198	-$0.350	-$0.198
	life insurance premium paid at level 4 rate during period 4	-$0.198	-$0.350	-$0.198

Interpretation of Table 4-24 follows the interpretation of previous reduced costs tables. It is instructive to see that the reduced cost is exactly the same for each insurance premium purchase for a particular model, period and objective function. For example, for the Co2Ch base scenario using objective function 3, buying insurance in period 4, whether it is for the male or the female, and whether the policy was originally purchased in period 1 or 2 or 3, or is a new policy purchased in period 4, results in the maximum objective function being reduced by 23.98 cents for every dollar spent on such a purchase. The explanation for this situation is that spending funds on insurance means using less funds on some other option, and the option foregone by the insurance purchase is the same no matter what the particularities of this insurance purchase.

4.4.5.2 Sensitivity analysis - Co2Ch base scenario – life insurance with premature death

As well as considering the data given by the standard post-optimality reports it is useful to undertake some sensitivity analysis to understand the relevance of insurance to overall wealth when the subjects of the model are not long-lived. In this section, this analysis is carried out for the Co2Ch base scenario, and in the following section there is analysis for the F1Ch base scenario. Because of difference between the models, the approaches for the two analyses are different.

For the Co2Ch base scenario, versions of the model have been set up where the male dies prematurely i.e. at ages 42, 56 and 66. The purpose of these models is to investigate any beneficial impact of insurance under such circumstances. The optimal solutions are found for when insurance is available and when it is not.

The altered versions of the model have been set up to take into account the new situation regarding widowhood of the female, and thus minimum NHC and minimum housing levels have been adjusted to account for the new household structure in each case. As well, depending on the time of widowhood, allowance has been made for the female to earn median female earnings as per the F1Ch base scenario, discussed in Chapter 3 Section 3.3.

For all cases of premature death, the optimal solution when insurance is available is to purchase a policy in every possible period. Thus, for the male dying at age 66, three insurance policies are purchased, one each in periods 1, 2 and 3. The widow receives a payout of $1.2 million (future value) at the beginning of period 4. Likewise for male death at age 56, the widow receives a payout of $800,000 at the beginning of period 3, and for male death at age 42, the widow receives a payout of $400,000 at beginning of period 2. It needs to be noted also that the widow receives the superannuation balance of the male at the beginning of the relevant period. This amount will consist of SGL payments with related earnings, and also any salary sacrifice and post tax contributions made, with associated earnings. Any owner-occupied housing will become, on the death of the male, fully owned by his widow.

The table immediately below shows the objective function value for each situation. This value is a present value, and consists of the sum of the present values of all component parts of the objective function. As the objective functions are constructed differently, it is not appropriate to compare the values when two different functions are used, but it is appropriate to compare when the same objective function is used.

Table 4-25 Male premature death – Co2Ch base scenario – life insurance impact
(all values present values)

		Objective function 1		Objective function 2		Objective function 3	
		Life insurance available	Life insurance not available	Life insurance available	Life insurance not available	Life insurance available	Life insurance not available
Male dies age 66	insurance payout	$346,752	$0	$346,752	$0	$346,752	$0
	estate male superannuation	$100,851	$100,851	$100,851	$100,851	$100,851	$100,851
	objective function value	$4.335 m.	$4.172 m	$9.943 m	$9.378m	$6.022 m	$5.820 m
	reduction in lifetime wellbeing		3.77%		5.68%		3.36%
Male dies age 56	insurance payout	$230,670	$0	$230,670	$0	$230,670	$0
	male superannuation	$217,055	$217,055	$217,055	$217,055	$217,055	$217,055
	objective function value	$4.308 m	$3.930 m	$9.761 m	$8.857 m	$5.883 m	$5.514 m
	reduction in lifetime wellbeing		8.79%		9.27%		6.28%
Male dies age 42	insurance payout	$234,958	$0	$234,958	$0	$234,958	$0
	male superannuation	$102,568	$102,568	$102,568	$102,568	$102,568	$102,568
	objective function value	$4.266 m	$3.689 m	$9.474 m	$8.368 m	$5.637 m	$5.114 m
	reduction in lifetime wellbeing		13.52%		11.67%		9.28%

Inspection of Table 4-25 shows that for the Co2Ch base scenario, for all three objective functions, for all instances of male premature death, the purchase of insurance is advantageous when wellbeing of the household is considered over a lifetime. Moreover, the earlier the death, the more advantageous the purchase of insurance is for the household.

4.4.5.3 Sensitivity analysis – F1Ch base scenario – life insurance with premature death

Unlike the SM model, life insurance may be seen as useful for the single mother, as the child has ongoing need for support if the mother were to die prematurely. The model for the F1Ch base scenario is deterministic and set up so that the woman dies at age 98, and thus, according to the model, the child will have the support of the parent into adulthood. Thus, for all three objective functions, buying an insurance policy at any stage does not feature in the optimal set of decisions. However, looking at this situation from the perspective of a person in period 1 where life expectancy is not known, an obvious way to prepare for a situation of premature death of the parent is to buy life insurance. Conversely, the single mother may have other assets that can be realised for the child, and thus life insurance may not be the optimal choice to provide for child in these circumstances. Thus it is useful to investigate some alternative approaches.

In the model for this study, the child is born when the mother is 34 years old and thus will be 22 years old at the end of period 2. Thus it is reasonable to restrict purchase of life insurance to these two periods, as the purpose of this insurance is to provide for a child before maturity. As explained in Chapter 3 Section 3.4.1.2 for this model, life insurance policies that can be purchased are such that if the person whose life is insured dies before age 81, the estate receives $400,000 (future value) per policy.

Three different situations are explored in Table 4-26. The first is the base scenario where the optimal solution does not include life insurance for any of the three objective functions. The second is where the purchase of an insurance policy at the beginning of period 1 is mandated in the model. This insurance policy is maintained in period 2. Thus, if the single mother dies at the end of period 1, her estate receives $400,000 (future value). Likewise if the mother dies at the end of period 2, the estate receives $400,000. This situation is called ‘single insurance policy’.

The third situation is where the purchase of an insurance policy is mandated at the beginning of period 1, and a second insurance policy is mandated at the beginning of period 2. In this case the estate would receive $800,000 (future value) if the mother dies at the end of period 2. This situation is called ‘two insurance policies’.

Table 4-26 Female premature death – F1Ch base scenario –impact of life insurance
(all values present values)

	Situation	Optimal objective function for full lifecycle	Value of Estate end period 1 excluding insurance payout	Insurance payout end period 1	Value of estate end period 1 including insurance payout	Value of estate end period 2 excluding insurance payout	Insurance payout end period 2	Value of estate end period 2 including insurance payout
Objective function 1	Base scenario	$4,505m	$874,679	$0	$874,679	$1.905m	$0	$1,905m
	Single insurance policy	$4,463m (-0.92%)	$866,856	$234,958	$1.102m (+25.97%)	$1.888m	$155,335	$2,044m (+7.28%)
	Two insurance policies	$4.448m (-1.26%)	N.A.	N.A.	N.A.	$1.882m	$310,670	2,193m (+15.09%)
Objective function 2	Base scenario	$9.552m	$874,679	$0	$874,679	$1.974m	$0	$1,974m
	Single insurance policy	$9.514m (-0.40%)	$866,856	$234,958	$1.102m (+25.97%)	$1.956m	$155,335	$2,111m (+6.98%)
	Two insurance policies	$9.494m (-0.61%)	N.A.	N.A.	N.A.	$1.947m	$310,670	$2,258m (+14.41%)
Objective function 3	Base scenario	$5.665m	$874,679	$0	$874,679	$1.905m	$0	$1,905m
	Single insurance policy	$5.624m (0.73%)	$866,856	$234,958	$1,102m (+25.97%)	$1.888m	$155,335	$2,044m (+7.28%)
	Two insurance policies	$5.608m (-1.00%)	N.A.	N.A.	N.A.	$1.882m	$310,670	2,193m (+15.09%)

The interpretation of the above table is as follows. For objective function 1, if the woman uses the optimal solution, then she will not buy life insurance. Her utility over the 74 years of the model is $4.505million (present value). If she were to die at end of period 1, aged 42, then her estate would be worth $874,679 (present value) arising from cash held, the sale of her owner-occupied dwelling, her superannuation account, and realisation of investments.

However, if she were to opt to buy a single insurance policy for periods 1 and 2, the utility of the (reworked) optimal solution would now be $4.463 million, a reduction of 0.92% in lifetime wellbeing as measured by the objective function. If she were to die at age 42, her estate would be worth, in present value terms, $1.102 million, an increase of 25.97%. This estate arises from the same items as if there were no life insurance, together with the payout of $400,000 (future value) from the insurance policy.

If the woman were to opt to continue the period 1 life insurance policy and buy a second policy in period 2 (2 insurance policies), using objective function 2, the utility over the five periods of the model decreases by 0.61% and the estate at end of period 2 increases by 14.41%.

If the woman were to opt to continue in period 2 with the insurance policy purchased initially in period 1, but not buy the additional policy (1 insurance policy), using objective function 3, the utility over the five periods of the model decrease by 0.73% and the estate at end of period 2 increases by 7.28 %.

Buying a life insurance policy at the beginning of period 1 and then buying a further policy at the beginning of period 2 leads to an insignificant decrease in lifetime wellbeing until age 98 for the mother, from 0.6% to 1.3%, depending on the objective function. If only one insurance policy is purchased (at the beginning of period1) the decrease in lifetime wellbeing is, as expected, less i.e. from 0.4% to 0.9%. Looking back at Table 4-24, the reduced cost relating to buying one dollar of insurance in period 1 is $5.18, and in period 2 it is $1.32. However the cost of insurance when purchased initially as a young person is relatively small i.e. approximately $400 per year at age 25 for a coverage of $400,000, and thus the impact on lifetime wellbeing over a lifetime is not significant. The subject of the model might decide that this lessening of wellbeing over 74 years is worth the higher bequest to her child if she were to die prematurely. However, alternatively, she might decide that her estate, without an insurance policy payout at the end of both periods 1 and 2, would be sufficient to care for her child, given that her estate will have funds from her superannuation, her non-superannuation savings and the realisation of the dwelling she has purchased.

4.4.5.4 Conclusion – analysis for life insurance

For all the base scenarios, all subjects enjoy longevity. Thus it is expected that the post-optimality analysis sets out the negative impact of purchased life insurance on lifetime wellbeing. However sensitivity analysis does illustrate the lifetime benefit for the purchase of such insurance if there is premature mortality.

It is appropriate to consider these findings in comparison to other studies regarding the demand for life insurance in Australia. Kelly & Ngu (2010), investigating the economic outcomes of premature death for either the father or mother of young children, found that Australian families in this demographic were underinsured in that the bereaved family members would suffer a significant decline in economic wellbeing under these circumstances. The results given by the optimisation approach of this thesis shows the economic benefit of life insurance. However, other studies show that, at a national level, it is not the rational, self-interested approach to economic decision making that leads to the purchase of life insurance, but rather cultural attitudes such as the level of uncertainty avoidance, whether the society is individualist or collectivist, and whether there is a long term future orientation rather than a short term view (Chui & Kwok, 2009; Park & Lemaire, 2011)

4.4.6 Analysis of labour income

As stated in Section 3.3, a fundamental assumption for this study is that the principal wage earner of the household represented by the models receive median labour income, and that for a household with two adults, the household itself receives median household labour income. It is instructive to investigate how change in this income impacts the optimal solutions for the base scenarios and hence the following discussion sets out the results of this investigation.

For all three base scenarios, apart from the funds available at the beginning of period 1, the subjects of the scenarios rely solely on labour income earned during periods 1, 2, and 3, and on income arising from investment of this labour income. There are no injections of funds from bequests and windfalls. For the Co2Ch base scenario, both of the couple contribute labour income, whilst, obviously, for the other two models, there is only one person contributing such funds. As discussed in Chapter 3, for all base scenarios labour income for the particular period is a parameter. Because of the greater complexity with regard to labour income for the Co2Ch base scenario, its results take a different form than that of the other two scenarios, the results of which are discussed first. These results illuminate the results for the Co2Ch base scenario.

4.4.6.1 Analysis of labour income for SM and F1Ch base scenarios

Analysis for labour income for these two base scenarios involves both post-optimality analysis and sensitivity analysis.

Post-optimality analysis of labour income for SM and F1Ch models

For both the SM and F1Ch base scenarios, the labour income for each of periods 1 to 3 are equalities, and thus post-optimality analysis gives shadow prices for each of these three variables. These shadow prices, together with allowable increase and decrease data, are set out in Table 4-27. For this table the labour income and allowable increase and decrease figures are future values where as the shadow prices are present values.

As labour income for each of periods 1, 2 and 3 is a parameter for both models, and thus must be included in any optimal solution, there is no reduced cost data.

Table 4-27 Post-optimality analysis - labour income – SM and F1Ch base scenarios

	Objective function	Period	Labour income (fv)	Shadow Price (pv)	Allowable increase (fv)	% allowable increase	Allowable decrease (fv)	% allowable increase
SM base scenario	1&3	1	$1.518m	$3.882	$316,489	20.85%	$168,861	11.12%
		2	$2.038m	$1.031	$1,191m	58.45%	$635,529	31.19%
		3	$1.547m	$0.437	$2,812m	181.76%	$1.146m	74.08%
	2	1	$1.518m	$2.548	$30,200	1.99%	$28,488	1.88%
		2	$2.038m	$0.706	$144,380	7.08%	$136,192	6.68%
		3	$1.547m	$0.290	$263,762	17.05%	$248,803	16.08%
F1Ch base scenario	1&3	1	$1.412m	$4.418	$313,426	22.20%	$118,127	8.37%
		2	$1.799m	$1.131	$1,224,m	68.04%	$461,354	25.64%
		3	$1.418m	$0.447	$3,097m	218.35%	$1.014m	71.49%
	2	1	$1.412m	$3.075	$13,759	0.97%	$2,090	0.15%
		2	$1.799m	$0.793	$52,954	2.94%	$8,042	0.45%
		3	$1.418m	$0.319	$125,251	8.83%	$19,022	1.34%

As expected, for both scenarios, it is labour income in period 1 providing the highest shadow prices and thus the most impact on wellbeing over a lifetime. For the SM base scenario, for objective functions 1 and 3, an increase of $1 labour income in period 1, with all other aspects of the scenario being held constant, leads to an increase of $3.88 in the objective function, whereas for objective function 2, the increase is $2.55. For the F1Ch base scenarios, the comparable figures are $4.42 and $3.08.

For the allowable increase /decrease for objective function 2 for both scenarios, the optimal solutions are sensitive to changes in the specification of labour income for periods 1 and 2, and also for period 3 for the F1Ch base scenario. Thus, even minor changes in these parameters will change the structure of the optimal solutions. However, there is no sensitivity with regard to these parameters for the other two objective functions.

Sensitivity analysis - labour income changes - SM and F1Ch base scenarios

To assess the impact of a change in labour income over the working life of the subject of each model, sensitivity analysis was carried out for (i) labour income increasing by 10% in the three relevant periods, and (ii) labour income decreasing by 10% for each of the three periods. The results, measured by the value of the objective function which encompasses a lifetime, are set out in Table 4-28.

Table 4-28 Impact of labour income changes for SM and F1Ch base scenarios

	SM base scenario								
	Objective Function 1			Objective Function 2			Objective Function 3		
Labour income	base case	10% higher labour all periods	10% lower labour all periods	base case	10% higher labour all periods	10% lower labour all periods	base case	10% higher labour all periods	10% lower labour all periods
Objective function value	$4.729m	$5.596m	$4.900m	$9.700m	$10.401m	$8.783m	$5.889m	$6.756m	$4.992m
Change in wellbeing		+18.33%	-18.98%		+7.23%	-9.45%		+14.72%	-15.24%
	F1Ch base scenario								
	Objective Function 1			Objective Function 2			Objective Function 3		
Labour income	base case	10% higher labour all periods	10% lower labour all periods	base case	10% higher labour all periods	10% lower labour all periods	base case	10% higher labour all periods	10% lower labour all periods
Objective function value	$4.505m	$5.395m	$3.534m	$9.552m	$10.181m	$8.400m	$5.665m	$6.556m	$4.695
Change in wellbeing		+19.77%	-21.55%		+6.59%	-12.06%		+15.72%	-17.13%

The data in Table 4-28 shows that increasing or decreasing labour income by 10% for all three periods where there is labour income does have a significant impact, especially for objective functions 1 and 3.

4.4.6.2 Analysis of labour income for Co2Ch base scenario

It can be seen from the discussion immediately above that, as expected, the optimal solutions are significantly impacted by changing labour income when there is just one income earner. For the Co2Ch base scenario, the model structure is different. As set out in Chapter 3 Table 3-5 the model reflects an 'average' Australian family where there is one worker who works full time until close to retirement, while for years where there are family responsibilities, the other person works part time. As for the average Australian situation, for this scenario it is the male who works full time and the female part time. As discussed in Chapter 3 Section 3.4.5.1, initial parameter values were set up using ABS data to derive parameters for this scenario.

This model is set up using three statements relating to labour income. The first statement is an equality for the male labour income for the period with the second equation likewise being an equality for the household labour for the period. The third statement gives the female labour for the period and is dependent on the other two equations, the relationship being female labour for the period equals household labour for the period less male labour for the period. Thus there are two parameters for this model for labour income: (i) household labour income for the period and (ii) male labour income for the period.

Post-optimality analysis – Co2Ch base scenario

For both male labour income and household income, the post-optimality reports do give valuable information but they needs to be carefully interpreted in light of the structural situation describe in Section 4.4.6.2

Firstly, as all three equations are equalities, all equations are binding, and thus there is no reduced cost data.

For the parameter, male labour earnings (for the relevant period), the post-optimality report data is set out in Table 4-29 below.

Table 4-29 Post-optimality analysis - male labour earnings - Co2Ch base scenario

	Objective function	Period	Male Labour income (fv)	Shadow Price (pv)	Allowable increase (fv)	% allowable increase	Allowable decrease (fv)	% allowable increase
Co2Ch base scenario	1	1	$1.518m	-$0.071	$31,451	2.07%	$27,088	1.78%
		2	$2.038m	-$0.040	$275,423	13.51%	$58,972	2.89%
		3	$1.547m	-$0.019	$743,133	48.04%	$40,517	2.62%
	2	1	$1.518m	-$0.428	$766,653	50.51%	$535,273	35.26%
		2	$2.038m	-$0.168	$870,884	42.73%	$1,141m	56.02%
		3	$1.547m	-$0.060	$803,662	51.95%	$1,454m	93.97%
	3	1	$1.518m	-$0.126	$31,451	2.07%	$752,683	49.59%
		2	$2.038m	-$0.054	$689,846	33.85%	$1,605,	78.76%
		3	$1.547m	-$0.019	$678,595	43.87%	$1,547	100.00%

Because the parameter, household labour earnings (for the particular period) is being held constant whilst the parameter, male labour income, is being changed, the data in Table 4-29 is actually reporting what happens when the distribution of household income between the male and female partners changes. Thus for objective function 1, if the male labour in period 2 is increased by $1 (spread over the fourteen years of period 2) , and thus female labour is decreased by $1 for this period, and all other variables are held constant, the shadow price information sets out that the objective function value decreases by $0.040. This latter figure is a present value.

Inspecting the shadow prices for all nine situations in Table 4-29 shows that the impact of a change between the allocation of household labour earnings between the male and female partners has most impact when this reallocation occurs in period 1, and least in period 3.

The allowable increase and decrease data show how much the constraint can change whilst keeping the same set of decisions (but not the same amounts for each decision). The percentage results for the allowable increase and decrease of the constraint show that the model is particularly sensitive for period 1 when objective function 1 is used.

The parameter, male labour earnings, has been discussed immediately above. The second parameter for each period 1, 2 and 3 relating to labour income is household labour income. The post-optimality report data for this variable is set out in Table 4-30.

Table 4-30 Post-optimality analysis - Co2Ch base scenario-household labour earnings

	Objective function	Period	Household Labour income (fv)	Shadow Price (pv)	Allowable increase (fv)	% allowable increase	Allowable decrease (fv)	% allowable increase
Co2Ch base scenario	1	1	$2.285m	$1.248	$2,806	0.12%	$1,647	0.07%
		2	$2.909m	$0.489	$7,163	0.25%	$24,843	0.85%
		3	$2.351m	$0.256	$13,679	0.58%	$234,904	9.99%
	2	1	$2.285m	$8.135	$323,360	14.15%	$50,380	2.21%
		2	$2.909m	$2.160	$1.218m	41.87%	$92,830	3.19%
		3	$2.351m	$0.919	$1.641m	69.82%	$803,662	34.19%
	3	1	$2.285m	$2.367	$56,969	2.49%	$1,647	0.07%
		2	$2.909m	$0.690	$147,507	5.07%	$44,159	1.52%
		3	$2.351m	$0.285	$299,897	12.76%	$82,128	3.49%

As with the male labour income parameter, it is necessary to state explicitly what the shadow price data is demonstrating. An increase in the household labour income for any of periods 1-3, with all other variables being held constant, means that the male labour income parameter is also being held constant and thus the female labour income is increasing. An example of the interpretation of the above table for household income in period 1 using objective function 2 is that an increase of $1 household income above the constraint of $2.285 million, with the increase arising solely because of increased female labour income, leads to an increase in the objective function of $8.135. This latter figure is a present value. Again it needs to be noted that these shadow prices hold only at the limit and, given the complexity of model and thus the interplay of variables, it is not possible to extrapolate these figures beyond the immediate vicinity of the limit.

An inspection of the allowable increase and decrease of the constraints as set out in Table 4-30 shows that the constraint of household labour income is sensitive for both objective functions 1 and 3 for all three periods. The shadow price amounts show that the greatest impact on all three objective functions is the household labour income for period 1, as expected.

Sensitivity analysis - labour income changes - Co2Ch base scenario

Because of the complexity of the models, post-optimality analysis can only provide limited information and thus it is useful to undertake sensitivity analysis. In particular it is informative to see the impact on outcomes when labour income is increased for all three relevant periods. As there are substantial differences between the Co2Ch base scenario, and the other two base scenarios, it is appropriate to consider the Co2Ch base scenario separately.

Firstly, if labour income is reduced by even 5% for both the male and female for all three labour earning periods, there is no feasible solution. To use this model successfully with lower labour income, new specifications for NHC and housing would need to be made.

However, when labour income is increased, there is significant improvement in lifetime wellbeing. Sensitivity analysis has been carried out for a 10% increase in household labour income in each of periods 1-3. Such an increase can be achieved in an infinite number of ways, for example the male can earn more so that labour income increases in each period by 10%, or likewise the increase could come from increased female earnings, or from any combination of increased male and female earnings that gives a 10% increase overall. For this study three different combinations are used as per Table 4-31. For this analysis labour income amounts are reported as yearly present value amounts whereas, for the post-optimality reports discussed above, the labour income is reported per period as future values.

Table 4-31 Annual labour incomes when household labour income is increased by 10%

	Base scenario		Male & female labour income increases by equal proportions		Male labour increases Female labour steady		Female labour increases Male labour steady	
Period 1	male	female	male	female	male	female	male	female
	$64,828	$32,743	$71,311	$36,017	$74,585	$32,743	$64,828	$42,500
	household		household		household		household	
	$97,571		$107,328		$107,328		$107,328	
Period 2	male	female	male	female	male	female	male	female
	$70,066	$29,933	$77,073	$32,926	$80,066	$29,933	$70,066	$39,933
	household		household		household		household	
	$99,999		$109,999		$109,999		$109,999	
Period 3	male	female	male	female	male	female	male	female
	$52,403	$27,224	$57,643	$29,947	$60,366	$27,224	$52,403	$35,187
	household		household		household		household	
	$79,627		$87,590		$87,590		$87,590	

Table 4-32 below gives the optimal solution for objective functions 1, 2, and 3, for the three situations set out in Table 4-31 above where the labour income is increased by 10% in each relevant period.

In investigating the results for these situations, it is useful to consider both the value of the objective function, which is the measure that has been used to date in determining significance when using sensitivity analysis, and also the NHC and the value of housing for each period provided in the optimal solution of the scenario.

This information is set out in Table 4-32.

Table 4-32 Optimal solutions when household labour income is increased by 10%

	Period	**Base case solutions**			**Labour income increased by 10% solutions**					
					Objective Function 1 & 3			Objective Function 2		
		Objective function 1	Objective function 2	Objective function 3	Male and female increase	Male increase only	Female increase only	Male and female increase	Male increase only	Female increase only
NHC (pv) p.a.	1	$47,519	$47,519	$47,519	$47,519	$47,519	$47,519	$47,519	$47,519	$47,519
	2	$63,345	$59,928	$59,928	$59,928	$59,928	$59,928	$59,928	$59,928	$59,928
	3	$79,658	$43,591	$75,361	$48,990	$47,871	$48,990	$43,591	$43,591	$43,591
	4	$55,433	$43,500	$57,059	$113,37	$112,522	$115,152	$43,500	$43,500	$43,500
	5	$51,345	$31,000	$52,850	$105,014	$104,222	$106,658	$31,000	$31,000	$34,690
Intrinsic cv housing	1	$418,000	$418,000	$418,000	$418,000	$418,000	$418,000	$418,000	$418,000	$418,000
	2	$523,386	$521,987	$523,386	$521,987	$521,987	$521,987	$521,987	$521,987	$521,987
	3	$521,987	$521,987	$594,170	$521,987	$521,987	$521,987	$521,987	$521,987	$521,987
	4	$521,987	$826,095	$601,366	$417,490	$417,490	$417,490	$1.298m	$1.289m	$1.305m
	5	$334,006	$826,095	$347,639	$334,006	$334,006	$334,006	$1.298m	$1.289m	$1.305m
Objective function value		$4.239m	$9.472m	$5.972m	$5.654m (Obj fn1) $7.250m (Obj fn3)	$5.624m (Obj fn1) $7.220m (Obj fn3)	$5.716m (Obj fn1) $7.312m (Obj fn3)	$12.067m	$12.014m	$12.169m
Change in lifetime wellbeing		N.A.	N.A.	N.A.	33.39% (obj fn1) 21.20% (obj fn3)	32.67% (obj fn1) 20.90% (obj fn3)	34.84% (obj fn1) 22.44% (obj fn3)	27.40%	26.84%	28.47%

In reflecting upon the results set out in Table 4-32 above, consider firstly the situation with objective function 2. This objective function includes both NHC across all five periods, together with imputed housing consumption at an inflated level. The optimal solutions for all three ways of receiving a 10% increase in labour income are essentially the same. Comparing the solution for the base scenario with the result for the increased labour income, it can be seen that this extra income results in a much improved housing standard during the retirement periods 4 and 5, whilst the NHC remains the same as the base scenario. Again, as with the base scenario, this objective function leads to a solution that is asset rich, but with cash relatively poor.

When household labour income is increased by 10%, no matter how this increase is achieved, the optimal solutions are the same for both objective functions 1 and 3. Moreover, as with objective function 2, although there are minor differences between the solutions depending on whether the increase is obtained by both of the couple earning increased amounts, or just one of the couple earning extra, the outcomes are very similar indeed. These solutions provide for more than double the NHC for both retirement periods. Given that the base scenario provides well in excess of the CAS level of the ASFA standard, it can be considered that the standard of living provided would be very high indeed. However, the optimal solution also sets out that the NHC for period 3, the transition to retirement period, would be nearly halved when compared to the base scenario solution.

The reason for this situation is that, as with the base scenario, the financial affairs of the household can be arranged so that the Age Pension becomes an entitlement. For the base scenario the household takes superannuation transition to retirement pensions, and as well, does not make any non-superannuation payments in period. Such behaviour gives a high standard of living in this period, and also ensures that both the asset and income levels do not preclude eligibility for the Age Pension. However, for this sensitivity analysis with10% increased labour across all three periods , the optimal solution demands that the household make considerable non-superannuation savings during the ten years of period 3 – on average about $90,000 per year, which supplements non-superannuation savings already held. This investment provides for increased NHC in periods 4 and 5. However, by the beginning of period 4 the assets and income levels mean that the Age Pension is not available, nor is it available in period 5, where, for the base scenario, the Age Pension is available.

It is appropriate to suggest that a household, comparing the optimal solutions for the base scenario and the model where income is increased by 10%, may decide that the decreased NHC set out for period 3 would not compensate for the increased consumption allowed for in the retirement periods, given that the optimal solution specifies significant investment in a risky portfolio. However, the base scenario relies on the existence of the Age Pension to achieve the high standard of living. As discussed in Chapter 1, it has been policy that 'average' wage earners could be expected to receive at least part Age Pension but it might also be considered risky to assume that this pension with its present entitlement formulation will continue to exist into a far future.

4.4.6.3 Conclusion – labour income analysis

For all three base scenarios the level of labour income has a significant impact on retirement outcomes, with the level of income in period 1 having the greatest impact. Moreover, for all three scenarios with some objective functions, a small change in the parameter value will lead to a change in the structure of the decisions, and may even lead to the model not having a feasible solution.

4.4.7 Summation of results for base scenarios

In Sections 4.3 and 4.4 the optimal solutions for the three base scenarios have been discussed. These base scenarios represent a self-interested rational approach to decision making across a life time and thus the analysis of these results contributes to meeting specific objective 1 of this study. Whilst there is a great amount of detail within the discussion of results, there are some general comments that can be made. Contributing to superannuation beyond SGL is, predominantly, not part of optimum solutions for all base scenarios. Purchasing owner-occupied housing at the beginning of period 1 and maintaining home ownership across the lifetime is common to all optimal solutions, as is keeping NHC to a minimum in period 1. As expected, labour income is a sensitive parameter for all scenarios, but, again for all scenarios, the amount of funds available at the beginning of period 1 beyond the minimum does not lead to better lifetime outcomes.

When retirement outcomes are considered, for all three scenarios with all objective functions, the amount provided for NHC in periods 4 and 5 is greater than the ASFA MBA standard. For solutions when objective function1 and 3 are applied, the NHC provided for meets the CAS standard. These results for retirement funding appear encouraging. However it needs to be remembered that these outcomes are predicated upon the use of retirement products which Australians have, predominantly, mistrusted, and also the use of risky investment products for non-superannuation savings.

4.4.8 Consideration of results in consideration of key economic theories

As with the consideration of optimal solutions for the base scenarios in light of theory set out in the literature, it is appropriate to consider the optimal results for the conservative scenarios in terms of these ideas. For the conservative scenarios, the models have been set up to reflect the impact of some common behavioural approaches to financial decision making, as opposed to making these decisions based on a rational and self-interested approach taken with the base scenarios.

One aspect of the conservative scenarios is that life contingent annuities are not made available, reflecting the situation set out by Ganegoda and Bateman (2009) that Australians are not buying annuity products on retirement. As set out in Tables 4-36, 4-37 and 4-38, this unavailability leads to some lessening in lifetime wellbeing for all three household types with all three objective functions, in accordance with the theoretical position regarding annuities espoused by Yaari (1965) and Davidoff, Brown and Diamond (2005).

As with the optimal results for the base scenarios, the results for the conservative scenarios (set out in Appendix C) show that, for all household types with all objective functions, all subjects of these models are saving from ages 25 to 56, and also making decisions anticipating the availability of income from the Age Pension. Thus these results reflect the theoretical position of the LCPIH.

When compared with the base scenario, the conservative scenario limits choices for assets i.e. instead of the household being able to invest in risky assets outside of the superannuation envelope, the household is restricted to saving through risk free financial products. Thus the household can develop a portfolio consisting of superannuation assets, risk free savings and owner-occupied housing. As with the optimal results for the base scenario, the selection of assets at any time is not related to the age of household members, but to the level of returns provided by the asset class, thus reflecting the theoretical positions of Samuelson, Merton and Hakansson. This situation is only to be expected given the method used to solve the models. The specifications of the model reflect behavioural characteristics that lead to sub optimal decision making, but the process of solving a linear programming model ensures the most rational outcome, taking into account the specifications of the model.

4.5 An alternative approach to decision making

Thus far, the discussion of results has provided (i) a description of the optimal solutions for each of the three base scenarios for three different objective functions and (ii) some analysis of key variables, using both standard post-optimality reports and sensitivity analysis. These base scenarios have been set up assuming the household is self-interested and rational. In this section, further analysis is provided, using scenario analysis, where a further two scenarios are discussed, these scenarios representing an alternative approach to decision making.

This section is concerned with the second specific objective of this study i.e. to identify the gaps between optimal accumulation and decumulation, and sub-optimal accumulation and decumulation when behavioural attitudes influence selection of accumulation and decumulation options. For this objective, decision making, rather than being self-interested and rational as per the SEM as discussed in Chapter 2 Section 2.1.1, shows behavioural attributes as per the BEM as discussed in Section 2.1.3.

In the base formulation, two retirement funding products are available, i.e. life-contingent annuities and reverse mortgages. As well there is access to non-superannuation retirement saving via investment in risky assets. It is assumed that only a small bequest is needed.

However, as discussed in Sections 2.2.2.2 and 2.2.5 of Chapter 2, reverse mortgages and life-contingent annuities are retirement funding products that are presently generally mistrusted by Australian retirees. As discussed in Section 2.2.7, lack of financial literacy and awareness means that many Australians are cautious in investing retirement savings in risky non-superannuation investments. As well, as discussed in Section 2.2.8, it is likely that many households would see as beneficial to have a sizeable nest egg that could be realised in a catastrophe, and a proxy for this situation is to ensure that a bequest of a suitable value is mandated. Thus, models for a second scenario have been established, these models incorporating all four of the limitations that have just been listed. This scenario is named ‘conservative’ for the purposes of this thesis.

Schematic representations of the optimal solutions for the conservative scenario for each model-objective combination are provided in Appendix C.

4.5.1 Scenario analysis - conservative scenario - Co2Ch model

In Table 4-33 some aspects of the optimal solution for the conservative Co2Ch scenario are set out, together with comparative data for the base scenario. As with analysis of the base scenario outcomes, funds available for NHC in the retirement periods are assessed using the ASFA retirement standards, previously discussed in Chapter 2 Section 2.2.3.2 and in Section 4.2.5 of this chapter.

Table 4-33 Comparison - housing values and NHC - base and conservative Co2Ch scenarios

	Period	Objective function 1		Objective function 2		Objective function 3	
		Base scenario	Conservative scenario	Base scenario	Conservative scenario	Base scenario	Conservative scenario
NHC (present values) p.a.	1	$47,519	$47,519	$47,519	$47,519	$47,519	$47,519
	2	$63,345	$59,928	$59,928	$59,928	$59,928	$59,928
	3	$79,658	$68,405	$43,591	$43,591	$75,361	$64,001
	4	$55,433	$45,504	$43,500	$43,500	$57,059	$44,790
	5	$51,345	$40,249	$31,000	$31,000	$52,850	$41,486
Intrinsic current value housing	1	$418,000	$418,000	$418,000	$418,000	$418,000	$418,000
	2	$523,386	$521,987	$521,987	$548,739	$523,386	$541,539
	3	$521,987	$521,987	$521,987	$718,406	$594,170	$616,497
	4	$521,987	$550,732	$826,095	$662,175	$601,366	$564,797
	5	$334,006	$334,006	$826,095	$511,067	$347,639	$334,006
Objective function value		$4.239m	$3.768m	$9.472m	$8.281m	$5.972m	$5.504m
Reduction in lifetime wellbeing			11.11%		12.58%		7.83%

It can be seen that the removal of access to risky non-superannuation saving, limiting the retirement savings products available and mandating larger bequest leads to a significant reduction in lifetime wellbeing for the household ranging from a 7.8% reduction for objective function 3 to a 12.6% reduction for objective function 2. For this conservative scenario, the standard of living that can be achieved in the retirement years, for all objective functions, is well above the MBA standard for period 4, but below the CAS standard. For period 5, when the female has been widowed, the standard is at the CAS level for objective functions 1 and 3, and well above the MBA level for objective function 2, though, for the latter objective function, the value of owner-occupied housing is higher.

A detailed study of the results for the variables shows that for all three objective functions the household would receive the full Age Pension in period 4 and a part pension in period 5. This is different from the base scenarios solutions where for all three objective functions the household receives a full Age Pension in both periods 4 and 5. One of the reasons for this situation is the favourable assets treatment life-contingent annuities receive. A female buying an annuity at age 67 has a life expectancy of about 15 years and so such an annuity will have a very small residual asset value at the beginning of period 5, even though the female in this model will receive funds from the annuity for another 18 years.

4.5.2 Scenario analysis - conservative scenario - SM model

For the conservative scenario for the SM model, the results are set out in Table 4-34

Table 4-34 Comparison - housing values and NHC - base and conservative SM scenarios

	Period	Objective function 1		Objective function 2		Objective function 3	
		Base scenario	Conservative scenario	Base scenario	Conservative scenario	Base scenario	Conservative scenario
NHC (pv) p.a.	1	$18,684	$18,684	$18,684	$18,684	$18,684	$18,684
	2	$21,961	$18,684	$18,684	$18,684	$21,961	$18,684
	3	$39,385	$21,533	$25,880	$18,684	$39,385	$19,265
	4	$98,704	$53,964	$29,720	$20,391	$98,704	$48,281
	5	$128,287	$70,139	$38,627	$20,391	$128,287	$62,751
Intrinsic cv housing	1	$250,500	$250,500	$250,500	$305,410	$250,500	$305,410
	2	$334,000	$334,000	$502,355	$458,115	$334,000	$458,115
	3	$334,000	$334,000	$1.044m	$684,850	$334,000	$519,669
	4	$334,000	$334,000	$1.044m	$904,892	$334,000	$519,669
	5	$334,000	$334,000	$1.044m	$904,892	$334,000	$334,000
Objective function value		$4.729m	$2.831m	$9.700m	$8.024m	$5.889m	$4.116m
Reduction in lifetime wellbeing			40.13%		17.27%		30.11%

It can be seen from the table above that the imposition of this conservative scenario leads to significant reduced wellbeing across the lifetime for all three objective functions. However, for objective functions 1 and 3, the subject of the model will still have a very high standard of living in the retirement years, with annual NHC being well above the CAS standard. This is not the situation for objective function 2 where the male subject could be considered asset rich but cash poor.

4.5.3 Scenario analysis - conservative scenario -F1Ch model

For the conservative scenario for the F1Ch model, the results are set out in Table 4-35.

Table 4-35 Comparison - housing values and NHC - base and conservative F1Ch scenarios

	Period	Objective function 1		Objective function 2		Objective function 3	
		Base scenario	Conservative scenario	Base scenario	Conservative scenario	Base scenario	Conservative scenario
NHC (pv) p.a.	1	$19,722	$19,722	$19,722	$19,722	$19,722	$19,722
	2	$27,591	$25,106	$24,121	$24,121	$24,121	$25,842
	3	$40,104	$36,493	$19,777	$19,777	$19,777	$37,708
	4	$89,916	$64,021	$29,989	$19,309	$19,309	$32,580
	5	$116,865	$31,133	$38,977	$19,497	$19,497	$42,345
Intrinsic current value housing	1	$250,500	$250,500	$250,500	$298,044	$250,500	$298,044
	2	$334,000	$334,000	$339,505	$447,066	$334,000	$447,066
	3	$334,000	$334,000	$1.044m	$670,599	$334,000	$670,599
	4	$334,000	$334,000	$1.044m	$796,795	$334,000	$603,238
	5	$334,000	$334,000	$1.044m	$796,795	$334,000	$358,647
Objective function value		$4.504m	$2.528m	$9.552m,	$7.468m	$5.665m	$3.975m
Reduction in lifetime wellbeing			43.87%		21.81%		29.83%

Inspection of the above table shows a significant decrease in wellbeing across the lifetime for all objective functions. Likewise there is considerable reduction in the NHC for periods 4 and 5 for all objective functions. It is interesting to note that, for this conservative situation, there is a fundamental difference between the results for the SM model and the F1Ch model regarding eligibility for the Age Pension. For the SM model, for objectives 1 and 3, the optimal solution does not include the Age Pension, whereas, for the F1Ch model, either a part or full pension is available in both periods 4 and 5[66], depending on the particular objective function. In this situation of no annuities, no reverse mortgage, higher bequest and risk free savings, the Age Pension acts as a safety net for the woman who has had lower labour income and higher NHC in the first three periods, as compared to the single male.

4.5.4 Impact of individual aspects of conservative scenario

The conservative scenario models a situation where life-contingent annuities are not available, and neither are reverse mortgages. As well non-superannuation savings can access only a risk free instrument[67], and a higher bequest is mandated. It is helpful to consider the individual impact on lifetime wellbeing of each of these changes.

[66] For objective function 1, Age Pension eligibility is for no pension in period 4, and a full pension in period 5, whilst for objective function 3, eligibility is for a full pension in period 4 and a part pension in period5. For objective function 2 a full pension is received for both periods for the base scenario and also for both periods with this conservative scenario.

[67] Although risk free, the return on these savings is 5% per annum, but with no capital growth. This situation reflects both the availability of such bank savings accounts at the end of 2011, and the availability of flexible mortgages offering the ability to pay down loans in advance and then withdraw funds at a later date.

4.5.4.1 Impact of individual aspects of conservative scenario – Co2Ch base scenario

Models have been set up where there is only one change to the base scenario. The results from this analysis for the Co2Ch model are set out in Table 4-36

Table 4-36 Impacts of removing non-conservative options - Co2Ch base scenario

	Objective function 1	% decline from base	Objective function 2	% decline from base	Objective function 3	% decline from base
Base scenario	$4.239m		$9.472m		$5.972m	
No life-contingent annuities available	$4.216m	0.55%	$9.445m	0.29%	$5.922m	0.83%
Only risk free non-superannuation savings available	$4.159m	1.90%	$9.025m	4.72%	$5.873m	1.65%
Catastrophe bequest mandated	$4.031m	4.90%	$9.472m	0%	$5.937m,	0.59%
No reverse mortgage available	$3.911m	7.73%	$9,033m	4.64%	$5.640m	5.55%
Conservative scenario	$3.768m	11.11%	$8.281m	12.58%	$5.504m	7.83%

It can be seen from Table 4-36 that the availability of reverse mortgages has the most potential to improve the wellbeing of this Co2Ch household over a lifetime. However the absence of life-contingent annuities would make little difference. Likewise using only risk free non-superannuation savings products has little impact, this result being due to the situation that the couple have only a small amount to invest in the early years. It can also be seen that the impact of the conservative scenario as a whole is greater than expected for objective function 2, considering the impacts of the individual changes.

4.5.4.2 Impact of individual aspects of conservative scenario – SM base scenario

The data showing the impact on lifetime wellbeing for the SM base scenario when just one aspect of the model is changed, and all other options held constant, is set out in Table 4-37.

Table 4-37 Impacts of removing non-conservative options – SM base scenario

	Objective function 1	% decline from base	Objective function 2	% decline from base	Objective function 3	% decline from base
Base scenario	$4.729m		$9.700m		$5.889m	
No life-contingent annuities available	$4.691m	0.81%	$9.683m	0.18%	$5.851m	0.65%
Only risk free non-superannuation savings available	$3.595m	23.97%	$8.310m	14.33%	$3.595m	18.96%
Catastrophe bequest mandated	$4.567m	3.42%	$9.700m	0%	$5.728m	2.74%
No reverse mortgage available	$4.496m	4.92%	$9.440m	2.68%	$5.657m	3.95%
Conservative scenario	$2.832m	40.13%	$8.024m	17.27%	$4.116m	30.11%

It can be seen that, for all objective functions, it is the use of a risk free non-superannuation savings product that provides the greatest impact. This situation is the result of the male having significant spare funds to invest after paying the mortgage and providing for NHC. Again the impact of absence of life-contingent annuities is small. However the impact of the other three changes taken together is also significant for objective functions 1 and 3, even though considering these options in isolation is not significant.

4.5.4.3 Impact of individual aspects of conservative scenario – F1Ch base scenario

For the F1Ch base scenario, the data showing the impact on lifetime wellbeing when just one aspect of the model is changed, and all other options held constant, is set out in Table 4-38.

Table 4-38 Impacts of removing non-conservative options – F1Ch base scenario

	Objective function 1	% decline from base	Objective function 2	% decline from base	Objective function 3	% decline from base
Base case	$4.504m		$9.552m		$5.665m	
No life-contingent annuities available	$4.477m	0.60%	$9.532m	0.21%	$5.638m	0.49%
Only risk free non-superannuation savings available	$3.186m	29.27%	$7.719m	19.18%	$4.361m	23.02%
Catastrophe bequest mandated	$4.357m	3.27%	$9.552m	0.00%	$5.530m	2.39%
No reverse mortgage available	$4.292m	4.72%	$9.292m	2.72%	$5.452m	3.76%
Conservative scenario	$2.528m	43.87%	$7.468m	21.81%	$3.975m	29.83%

As with the SM base scenario, the main contribution to the decreased lifetime wellbeing in the conservative F1Ch scenario is that of limiting non-superannuation savings to a non-risky asset. Again the impact of unavailability of life-contingent annuities is small.

4.5.4.4 Impact of unavailability of innovative retirement products for all household types

In December 2013, the Treasurer of the recently elected Coalition government commissioned the Financial System Inquiry (FSI), with one of the terms of reference being the requirement for the inquiry to recommend policy options to meet the needs of users with appropriate financial products and services (Hockey, 2013). In July 2014 the interim report was issued, with the preliminary assessment observing that the decumulation phase of superannuation is underdeveloped, and calling for further investigation into the appropriate approach to the provision of annuity products and to access to home equity (Murray, 2014a). In December 2014 the final report was issued, and whilst there is no mention of home equity products, the report calls for the introduction of a comprehensive income products for retirement (CIPR), with these products incorporating annuities. As well the final report called for the use of behavioural biases in discussions relating to retirement products to encourage the selection of products providing for longevity risk (Murray, 2014b)

As discussed in Section 4.5, the conservative scenarios for all household types reflect the situation where behavioural attitudes influence the selection of both accumulation and decumulation options. With regard to decumulation options, the two products considered in this study are the use of life contingent annuities and the use of reverse mortgages, both of which are considered by the FSI. The policy issues raised by the FSI reports are particularly pertinent when considering the results of this study as to the removal of the two products with the results set in in Tables 4-36, 4-37 and 4-38 showing the reduction in lifetime wellbeing due to the unavailability of these products.

4.5.5 Conservative with higher consumption scenario

As discussed in Section 4.4.2.2, the minimum NHC set out for the base SM and F1Ch scenarios for periods 1, 2 and 3 is low when compared to the Co2Ch base scenario. Thus another scenario has been set up for these two models. This scenario combines increased minimum NHC for these three periods with the conservative scenario as described above. For this study, this scenario is called the traditional scenario.

Schematic representations of the optimal solutions for this traditional scenario for each model-objective combination are provided in Appendix C.

4.5.5.1 Scenario analysis – traditional scenario – SM model

For the SM model, this scenario has as constraints minimum NHC at 20% higher than that specified in the base scenario, together with the situation that neither life-contingent annuities nor reverse mortgages are available, a higher bequest is mandated, as a proxy for having access to funds for a catastrophe, and any non-superannuation savings option is not risky. The results for this scenario are set out in Table 4-39, with the corresponding data for the conservative scenario also included.

Table 4-39 Housing values and NHC - conservative and traditional SM scenarios

	Period	Objective function 1		Objective function 2		Objective function 3	
		Conservative scenario	Traditional scenario	Conservativ e scenario	Traditional scenario	Conservativ e scenario	Traditional scenario
NHC (pv) p.a.	1	$18,684	$22,421	$18,684	$22,421	$18,684	$22,421
	2	$18,684	$22,421	$18,684	$22,421	$18,684	$25,082
	3	$21,533	$22,421	$18,684	$22,421	$19,265	$44,982
	4	$53,964	$45,863	$20,391	$24,469	$48,281	$33,305
	5	$70,139	$59,610	$20,391	$24,469	$62,751	$42,654
Intrinsic current value housing	1	$250,500	$250,500	$305,410	$305,410	$305,410	$305,410
	2	$334,000	$334,000	$458,115	$458,115	$458,115	$458,115
	3	$334,000	$334,000	$684,850	$644,812	$519,669	$617,440
	4	$334,000	$334,000	$904,892	$761,823	$519,669	$586,048
	5	$334,000	$334,000	$904,892	$761,823	$334,000	$335.507
Objective function value		$2.831m	$2.657m	$8.024m	$7,482m	$4.116m	$4.055m
Reduction in lifetime wellbeing			6.16%		6.76%		1.47%

From Table 4-39 it can be seen that, comparing the traditional scenario to the conservative scenario, the reduction in wellbeing across a lifetime is significant for objective function 1 and 2 but not for objective function 3. Checking the optimal solution for objective function 3 when minimum consumption is increased shows that, with the increase allocated to consumption in periods 1 to 3 and consequent reduction in assessable assets and income in periods 4 and 5, the subject of the model is now eligible for a full Age Pension in period 4 and a part Age Pension in period 5. The impact of the availability in periods 4 and 5 of the Age Pension, subject to a means test, is discussed further in Section 4.8.

4.5.5.2 Scenario analysis – traditional scenario – F1Ch model

As with the SM model, the traditional scenario has been analysed for the F1Ch model. The level of higher consumption used for the analysis is 60% of the NHC of the Co2Ch base scenario, as per the discussion in Section 4.4.2.2. The results are set out in Table 4-40.

Table 4-40 Housing values and NHC - conservative and traditional F2Ch scenarios

	Period	Objective function 1		Objective function 2		Objective function 3	
		Conservative scenario	Traditional scenario	Conservative scenario	Traditional scenario	Conservative scenario	Traditional scenario
NHC (pv) p.a.	1	$19,722	$28,511	$19,722	$28,511	$19,722	$28,511
	2	$25,106	$38,232	$24,121	$35,957	$25,842	$35,957
	3	$36,493	$44,309	$19,777	$26,155	$37,708	$42,304
	4	$64,021	$29,350	$19,309	$26,100	$32,580	$28,022
	5	$31,133	$31,133	$19,497	$22,193	$42,345	$31,133
Intrinsic current value housing	1	$250,500	$250,500	$298,044	$250,500	$298,044	$298,044
	2	$334,000	$334,000	$447,066	$375,750	$447,066	$408,755
	3	$334,000	$334,000	$670,599	$527,277	$670,599	$447,577
	4	$334,000	$395,264	$796,795	$495,513	$603,238	$395,690
	5	$334,000	$334,000	$796,795	$497,513	$358,647	$334,421
Objective function value		$2.528m	$2.463m	$7.468m	$6.064m	$3.976m	$3.748m
Reduction in lifetime wellbeing			2.58%		18.81%		5.70%

In comparing the results for the traditional scenario with the conservative scenario for the F1Ch model, it can be seen from Table 4-40 that this increased minimum consumption has a significant impact for objective function 2, where the level of housing has decreased for all five periods. It is pertinent to note that for this traditional scenario, the female in the model is eligible for a full Age Pension in both periods 4 and 5 for all three objective functions. Again, the Age Pension is providing a safety net.

4.5.6 Superannuation contributions beyond the SGL

As discussed in Section 4.4.4, for the base scenario for all three models, there are only two instances where the optimal solutions provide for extra superannuation savings i.e. for the female in the Co2Ch model for periods 2 and 3 when objective function 1 is used. The situation for the conservative and traditional scenarios is different. As can be seen from the schematic representations set out in Appendix D, for the Co2Ch base scenario, again for objective function 1, there are only two instances of further savings, in this instance for the male in periods 2 and 3. However for the F1Ch and especially the SM models for both the conservative and traditional scenarios, contribution to superannuation above the SGL does play a part in optimal solutions. The situation is set out in Table 4-41.

As can be seen from Table 4-41, for objective function 1 for the SM conservative and traditional scenarios, salary sacrifice contributions for all three periods is part of the optimal solution, as are post tax contributions in periods 2 and 3. The same result applies for the conservative scenario for objective function 3. For the F1Ch conservative scenario for objective function 1, the optimal solution also involves salary sacrifice contributions in all periods and post tax contributions in periods 2 and 3.

Table 4-41 Superannuation contributions above the SGL – SM and F1Ch models

	SM Model																	
	Objective Function 1						Objective Function 2						Objective Function 3					
Period	1		2		3		1		2		3		1		2		3	
Contribution type	SS	PT	SS	PT	SS	PT	SS	PT	SS	PT	SS	PT	SS	PT	SS	PT	SS	PT
Base scenario																		
Conservative scenario	■		■	■	■	■	■				■		■		■	■	■	■
Traditional scenario	■		■	■	■	■			■		■				■			
	F1Ch Model																	
	Objective Function 1						Objective Function 2						Objective Function 3					
Period	1		2		3		1		2		3		1		2		3	
Contribution type	SS	PT	SS	PT	SS	PT	SS	PT	SS	PT	SS	PT	SS	PT	SS	PT	SS	PT
Base scenario																		
Conservative scenario	■		■	■	■	■	■						■					
Traditional scenario	■		■															

SS	salary sacrifice	■	contribution made
PT	post tax		contribution not made

These results reflect the availability of savings options for the conservative and traditional scenarios, where risky investments are not possible. Objective function 1 does not include housing in its calculation, and thus investment in an owner-occupied dwelling is not rewarded. Thus the superannuation option for saving is preferred in the solution. Objective function 3 does give some weight to housing, but not to the same degree as objective function 2. For the latter function, savings are achieved through the purchase of housing well above the minimum standard specified.

The difference between the results for the conservative scenario and the traditional scenario can be explained as the consequence of having fewer funds for savings given the higher NHC specified. This situation applies especially for the F1Ch traditional scenario. It also should be noted that the absence of superannuation contributions above SGL for the Co2Ch conservative scenario also reflects on the limited funds available to the household given the level of labour income of the couple.

It is interesting to note, as set out in Appendix C, that, for the traditional scenarios, when all savings options are taken into account i.e. superannuation contributions beyond the SGL, savings through a risk free financial product and investment in higher value owner-occupied housing, for both the two household types for this scenario in conjunction with all three objective functions, households are saving during the years of age 25 to 56. This situation is aligned with the theory espoused by the LCPIH.

With respect to the different optimal savings regimes established for men and women by this study, the results reflects the findings of Basu and Drew (2009) who found that there is a strong case for designing a gender – specific superannuation system that takes into account the different work patterns over a lifetime for men and women. However such an approach would mean that, for the periods when women are working, they would be required to contribute at a higher rate. Such a situation is acknowledged by Basu and Drew as being problematic in that many women would have difficulty financially in contributing at a higher rate, a situation reflected in the results obtained in this study for the optimal savings for the F1Ch conservative model as compared to the SM conservative model.

4.5.7 Summation of results for alternative approaches to decision making.

The purpose of Section 4.5 is to identify the difference in outcomes when a behavioural approach is used for decision making, rather than a rational self-interested approach, and thus it is concerned with the second specific objective of this study. To meet this objective it is helpful to set out the change in lifetime wellbeing when all three of the base scenario, the conservative scenario and the traditional scenario are considered. This data is provided in Table 4-42.

Table 4-42 Change in lifetime wellbeing - conservative scenarios

	Co2Ch model								
	Objective Function 1			Objective Function 2			Objective Function 3		
Scenario	Base	Conservative		Base	Conservative		Base	Conservative	
Objective function value	$4.239m	$3.768m		$9.472m	$8.281m		$5.972m	$5.504m	
Decrease in lifetime wellbeing		11.11%			12.58%			7.83%	
	SM model								
	Objective Function 1			Objective Function 2			Objective Function 3		
Scenario	Base	Conservative	Traditional	Base	Conservative	Traditional	Base	Conservative	Traditional
Objective function value	$4.729m	$2.831m	$2.656m	$9.700m	$8.024m	$7.482m	$5.889m	$4.116m	$4.055m
Decrease in lifetime wellbeing		40.13%	43.84%		17.27%	22.87%		30.11%	31.14%
	F1Ch model								
	Objective Function 1			Objective Function 2			Objective Function 3		
Scenario	Base	Conservative	Traditional	Base	Conservative	Traditional	Base	Conservative	Traditional
Objective function value	$4.505m	$2.528	$2.463	$9.552m	$7.468m	$6.064m	$5.665m	$3.975m	$3.748m
Decrease in lifetime wellbeing		43.87%	45.33%		21.81%	36.52%		29.83%	33.84%

Inspection of the above table shows that adopting a decision making approach based on behavioural attitudes as opposed to a rational and self-interested approach has least impact for the Co2Ch model, where the reduction in lifetime wellbeing ranges between 7.8% and 12.6%, depending on the objective function in use. For the other two models, the reduction in lifetime wellbeing is higher. For objective function 1, where wellbeing is based solely on the level of NHC that can be achieved, the reduction is greater than 40% for both models, where as for objective function 2 where housing value plays a much greater part, the reduction is around 20%. The results for the comparison between the outcomes for the base scenarios and the traditional scenarios for the two relevant models show a further decrease in wellbeing as expected, particularly marked for the F1Ch model when objective function 2 is used.

The particularly marked reduction in lifetime wellbeing for the SM and the F1Ch models when this change in decision making is adopted can at least be partly contributed to the relative amount of funds available. For the Co2CH model, in the early years, once the mortgage payments are made and NHC provided for, there is little spare cash for saving for retirement. However, for the other two models, where the income per person supported is higher than for theCo2Ch model, there are funds available for investment. As noted several times earlier, achieving the optimal solution for the SM and F1Ch base scenarios depends on an aggressive savings regime where these savings are invested in risky assets. This interpretation is supported by the data giving details of the contribution of individual factors to reduction in wellbeing where, for the Co2Ch model the absence of reverse mortgages has most impact, whilst for the other two models it is the unavailability of risky investment products.

It needs to be noted as well that whilst life-contingent annuities feature in all optimal solutions of all base scenarios, the absence of this product contributes very little indeed to the reduction in lifetime wellbeing.

The optimal solutions for all three scenarios will be further analysed in Section 4.8 when considering eligibility for the Age Pension.

4.6 Impact of housing capital growth rate on solutions

Before continuing with the analysis of results, it is appropriate at this stage of the discussion to consider the impact of using a capital growth rate for purchased housing of 5.2% per annum. As discussed in Chapter 3 Section 3.4.5.8, this rate represents a conservative interpretation of the average growth rate of housing in Australia over the past 30 years but it is considerably higher than the inflation rate of 3% per annum used for this study. It could be considered that having such a discrepancy in rates might cause distortion of results. Whilst the use of 5.2% per annum growth for housing is defensible, it is also appropriate to investigate how lower housing capital growth rates would impact on optimal solutions. Thus some analysis has been carried out using annual growth rates of 4% and 3%.

When populating the base scenario versions of the models, the growth rate per annum for rental costs was set at 5%, in line with average rates as per data as discussed in Chapter 3. In examining the impact of different capital growth it has been assumed that the rental costs will increase by the same amount as the housing capital growth.

To comprehend the impact of different housing capital growth rates, it is necessary to understand the impact of these rates on both future housing values and on cash realised by the selling of a dwelling at a later time. Table 4-43 sets out the future values for the three different rates for a dwelling purchased at the beginning of period 1 for $500,000.

Table 4-43 Future value of housing for different housing capital growth rates

	Annual percentage housing capital growth rate		
Future value of dwelling:	5.20%	4%	3%
beginning period 1	$500,000	$500,000	$500,000
beginning period 2	$1.245m	$1.013m	$851,217
beginning period 3	$2.532m	$1.754m	$1.288m
beginning period 4	$4.204m	$2.596m	$1.730m
beginning period 5	$8.548m	$4.496m	$2.617m

It can be seen from Table 4-43 that a dwelling purchased for $500,000 at the beginning of period 1 would have a future value of $4.204 million at the beginning of period 4 if the growth rate is 5.2% per annum whilst the future value if the growth rate is 3% would only be $1.730 million. This considerable differential has two impacts. The first impact is with regard to the (future value) funds that would be required to purchase a dwelling in later periods. To buy a dwelling at the beginning of period 4 when the growth rate is 5.2%, it would be necessary to pay two and a half times the amount that would be needed to purchase the same dwelling if the growth rate were to be 3% per annum. Thus, having parity of housing when the capital growth rates are different leads to different proportions of available funds needing to be allocated to housing and, following on, NHC.

The second impact is that of the realisation of funds when the household downsizes. Table 4-44 gives an example of such an impact for a situation where the household buys a dwelling for $500,000 at the beginning of period 1, holds the dwelling for three periods and fully pays out the mortgage in during this time, and then downsizes to a dwelling worth 60% of the original dwelling at the beginning of period 4.

Table 4-44 Future value of cash realised by downsizing for different housing growth rates

	Annual percentage housing capital growth rate		
	5.20%	4%	3%
Purchase price beginning period 1	$500,000	$500,000	$500,000
Sale price beginning period 4	$4.204m	$2.596m	$1.730m
Cash available after downsizing by 40%	$1.681m	$1.039m	$692,139

It can be seen from Table 4-44 that, if a dwelling is purchased at the beginning of period 1 and sold at the beginning of period 4, the amount of cash available if the growth rate is 5.2% per annum will be more than twice the cash generated if the growth rate were 3% per annum. This cash, available because of downsizing, would be used to fund NHC over the remaining two periods.

Given that three different annual housing capital growth rates are under consideration, and three objective functions are used in this study, there are nine different comparisons that can be made for every instance of each of the three base scenarios. With the additional scenarios discussed in Section 4.5, there are 24 sets of comparisons that could be made. In this discussion reference will be made only to a selection of instances.

4.6.1 Impact of housing capital growth rates - Co2Ch base scenario

The first situation to be examined from the perspective of changing housing growth rates is that of the Co2Ch base scenario for objective function 1. The optimal solution for each growth rate is shown in Table 4-45. As objective function 1 involves only NHC, and ignores any utility of housing, in this situation it is possible to include the objective function value in the comparison of the rates as this function is calculated consistently across all three growth rates.

Table 4-45 Impact of differing housing growth rates – Co2Ch base scenario

	Co2Ch base scenario					
	Objective function 1					
	Housing capital growth rate per annum					
	5.20%		4%		3%	
Period	Present value NHC p.a.	Housing intrinsic current value	Present value NHC p.a.	Housing intrinsic current value	Present value NHC p.a.	Housing intrinsic current value
1	$47,519	$418,000	$47,519	$418,000	$47,519	rent
2	$63,345	$523,386	$59,928	$521,765	$59,928	rent
3	$79,658	$521,907	$68,798	$521,765	$43,591	rent
4	$55,433	$521,907	$53,810	$417,502	$67,994	rent
5	$51,345	$334,000	$49,841	$334,000	$62,979	$334,000
	$4.239m		$4.033m		$4.216m	
	Objective function value					

The optimal solution in this situation for a growth rate of 3% per annum is the only instance in the total study where there is a preference for the household to rent a dwelling rather than to live in owner-occupied housing. However by period 5, the optimal solution does show a preference for purchased housing. The set of optimal decisions for this scenario with this objective function includes an aggressive savings regime in periods 1 to 4, investing in a risky asset returning 5.4% per annum and having 3.5% yearly capital growth. This risky investment provides a much greater return after income tax than does investment in housing at 3% per annum growth, even though the latter is not subject to any tax.

It is worthwhile to investigate as to why the optimal solution provides for purchasing a dwelling in period 5 when rental is the preferred option for the other four periods. Studying this situation shows there is not one singular reason for this results, but that the optimal solution is the result of the interplay in period 5 between the cost of purchasing a dwelling, the rent on such a dwelling, the capital gain available on the dwelling over the 18 years of period 5 and the availability of a reverse mortgage taken out against the purchased dwelling.

With the results reported in Table 4-45, it is pertinent to note that for the 5.2% per annum housing capital growth rate, the couple will receive a full Age Pension in period 4 and the widow will receive the full pension in period 5. For the other two growth rates, the household is not eligible for an Age Pension in either period 4 or period 5. Studying the optimal yearly NHC amounts for the 5.2% rate suggests that extra consumption is provided for in period 3 so that the assets and income tests for the pension will not be breached in the later periods. For the other two growth rates there may be solutions that do provide for a pension or part pension, but the presence of the two solutions shown show that the maximum benefit to the household, using objective function 1, is to manage the household affairs without manipulating assets and income to obtain the pension. There is further discussion of eligibility for Age Pension in Section 4.8.

4.6.2 Impact of housing capital growth rates – SM base scenario

Objective function 3 is the objective function that takes into account the present value of the NHC for each of the five periods, together with a measure of the utility provided by housing, based on the intrinsic current value of the dwelling if purchased housing is used. For a housing capital growth rate of 3%, there is no longer a discrepancy between it and the inflation rate, and thus the optimal solution using objective function 3 is identical to the optimal solution using objective function 2. Table 4-46 sets out the optimal results for the SM base scenario using objective function 3.

Table 4-46 Impact of differing housing growth rates – SM base scenario

	SM base scenario					
	Objective function 3					
	Housing capital growth rate per annum 5.20%		4%		3%	
Period	Present value NHC p.a.	Housing intrinsic current value	Present value NHC p.a.	Housing intrinsic current value	Present value NHC p.a.	Housing intrinsic current value
1	$18,684	$250,500	$18,684	$250,500	$18,684	$250,500
2	$21,961	$334,000	$21,049	$334,000	$19,930	$334,000
3	$39,385	$334,000	$37,749	$334,000	$35,741	$367,400
4	$98,704	$334,000	$94,604	$334,000	$89,572	$463,406
5	$128,287	$334,000	$122,959	$598,853	$116,418	$1.044m

It can be seen that, for this scenario, having lower housing capital growth rates leads to a higher intrinsic level of housing in period 5, but decreased NHC in periods 3 to 5. It needs to be noted that, for all three rates for this objective function, the male is not eligible for an Age Pension of any form in periods 4 and 5. Because of the way the objective function is calculated, incorporating a measure for housing, it is not possible to compare the value of the objective functions.

4.6.3 Impact of housing growth rates – F1Ch conservative scenario

As set out in Section 4.5 the conservative scenario is that for which there are neither reverse mortgages nor life-contingent annuities available, and for which the available non-superannuation savings instrument is risk-free, and where there is a mandated bequest suitable to provide for a catastrophe. Table 4-47 sets out the optimal solutions, using objective function 2, for the three housing growth rates for this conservative scenario for the F1Ch model.

Table 4-47 Impact of differing housing growth rates – F1Ch conservative scenario

	F1Ch conservative scenario					
	Objective function 2					
	Housing capital growth rate per annum					
	5.20%		4%		3%	
Period	Present value NHC p.a.	Housing intrinsic current value	Present value NHC p.a.	Housing intrinsic current value	Present value NHC p.a.	Housing intrinsic current value
1	$19,722	$298,044	$19,722	$298,044	$19,722	$298,044
2	$24,121	$447,066	$24,121	$447,066	$24,121	$447,066
3	$19,777	$670,599	$19,777	$670,599	$27,931	$977,124
4	$19,309	$796,795	$19,309	$1.044m	$22,395	$1.044m
5	$19,497	$796,795	$20,664	$1.044m	$27,699	$1.044m

For this scenario with this objective function, the female receives a full Age Pension in both periods 4 and 5 for all three rates and thus there is no distortion on the results due to the reception of this benefit. Inspection of the table shows that both housing levels and NHC improve as the housing growth rate decreases. It needs to be remembered that, while the intrinsic value of the housing is increasing as the rate declines, the actual amount paid for the dwelling may be decreasing. An illustration of this situation is for period 4 housing. For the optimal solution for all three rates, the dwelling used in period 3 is sold and a new dwelling purchased. Table 4-48 sets out the intrinsic current value of the dwelling purchased together with the future value of the funds that are needed for the sale.

Table 4-48 Future values of owner-occupied housing for alternative housing growth rates

	F1Ch conservative scenario		
	Objective function 2		
	Housing capital growth rate per annum		
	5.2%	4%	3%
Intrinsic current value of dwelling	$796,795	$1.044m	$1.044m
Purchase price beginning period 4 - future value	$13.622m	$9.386m	$5.464m

4.6.4 Conclusion – differing housing growth rates

Whilst only three examples of the impact of changed housing capital growth rates are discussed here, tables setting out the results for the base scenario and for the conservative scenario for all three models are provided in Appendix D. Apart from the solution for the Co2Ch base scenario using objective function 1, which shows an optimal solution to rent for periods 1 to 4 if the growth rate is 3% per annum, there are no stark differences between the results for different growth rates when the model type and the objective function are the same. Indeed many of the solutions are very similar. Thus it is reasonable to believe that that sensitivity analysis results discussed earlier in this chapter, where the annual growth rate is 5.2%, would also shed light on the particular comparison if the housing capital growth rate per annum is in the range 3% to 5%.

4.7 Impact of SGL rate on retirement living standards

As stated at the beginning of this chapter, the third specific objective of this study is to determine the SGL rate that needs to be in place for average Australians to have their retirement funded to a comfortable level commensurate with average Australian standards by personal superannuation / savings, supplemented by the means-tested Age Pension.

The level of SGL that is appropriate is contested. As discussed in Chapter 2 Section 2.3.2, the recommendation from the Henry Report was that the SGL continues at 9%, but the government announced in 2010 that it would be increasing the SGL in a phased approach to 12% (Swan & Rudd, 2010). In May 2013, an election year, the opposition party announced that if it were to take government later in 2013, it would delay any increase in the SGL for two years (Coorey & Massola, 2013). In September 2014, legislation was passed limiting the SGL to 9.5% until 2020, and then gradually raising it to 12% by 2025 (Parliament of the Commonwealth of Australia, 2014). In this section, there is assessment of retirement living standards for both 9% SGL and 12% SGL, using the framework set in Section 4.2.5. For this analysis, the housing capital growth rate is set as 5.2% per annum.

4.7.1 Funding an increase of SGL from 9% to 12%

Before discussing the impact of raising the SGL from 9% to 12% per annum, it is useful to consider how such a change would be funded. There is no assurance that this rise of SGL would be funded from what would be effectively an increase in labour income. Wage negotiations might mean that the total compensation remains the same but the allocation between take home pay and deferred pay changes. To give an indication as to how this increase might impact total wellbeing over a life time, the SM base scenario is used as an example to provide data for three different ways of financing this increase. The results of this analysis are set out in Table 4-49.

Table 4-49 Impact of SGL at 12% for different funding approaches – SM base scenario

	SM base scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
SGL position	Objective function value	Change in lifetime wellbeing	Objective function value	Change in lifetime wellbeing	Objective function value	Change in lifetime wellbeing
9% SGL	$4.729m		$9.700m		$5.889m	
12% SGL, 100% funded from existing compensation	$4.635m	-1.99%	$9.629m	-0.73%	$5.796m	-1.58%
12% SGL 50% funded from increased compensation	$4.753m	+0.51%	$9.710m	+0.10%	$5.914m	+0.42%
12% SGL 100% funded from increased compensation	$4.871m	+3.00%	$9.788m	+0.91%	$6.032m	+2.43%

As can be seen from Table 4-49, if the funding for this increase in SGL is to come from existing wages, the outcomes across the lifetime are worse for all objective functions. If the situation is that the increase is fully funded by an increase in compensation, there would be there would be increased wellbeing across a lifetime, ranging from 1% to 3% depending on the objective function.

4.7.2 Comparison of outcomes for 9% SGL and 12% SGL

Further analysis has been undertaken on the impact of this change, assuming the best case scenario from the household's perspective i.e. the rise is fully funded from increased compensation, in effect a 2.75% per annum rise in labour income. Two measures are used to assess the impact of the increased SGL (i) improved wellbeing across the lifecycle and (ii) retirement funding amounts for the retirement periods.

4.7.2.1 Improvement in lifelong wellbeing across a lifetime from increased SGL

The percentage increase in lifetime wellbeing has been established for each of the base, conservative, and traditional scenarios for all three objective functions. This rise gives an improvement in wellbeing across the lifecycle of between 0.85% and 5.12%, with the median rise being 3.00%. The data is set out in Table 4-50.

Table 4-50 Difference in lifetime wellbeing resulting from increase in SGL rate
(funded by increase in compensation)

	Co2Ch base scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
SGL rate	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Objective function value	$4.239m	$4.378m	$9.472m	$9.870m	$5.972m	$6.109m
Improvement in lifetime wellbeing		3.28%		4.20%		2.29%
	Co2Ch conservative scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
SGL rate	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Objective function value	$3.768m	$3.885m	$8.281m	$8.651m	$5.504m	$5.627m
Improvement in lifetime wellbeing		3.11%		4.47%		2.22%
	SM base scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
SGL rate	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Objective function value	$4.729m	$4.871m	$9.700m	$9.788m	$5.889m	$6.032m
Improvement in lifetime wellbeing		3.00%		0.91%		2.43%
	SM conservative scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
SGL rate	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Objective function value	$2.831m	$2.962m	$8.024m	$8.274m	$4.116m	$4.249m
Improvement in lifetime wellbeing		4.63%		3.12%		3.23%
	SM traditional scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
SGL rate	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Objective function value	$2.657m	$2.793m	$7.482m	$7.727m	$4.055m	$4.130m
Improvement in lifetime wellbeing		5.12%		3.28%		1.85%
	F1Ch base scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
SGL rate	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Objective function value	$4.505m	$4.627m	$9.552m	$9.633m	$5.665m	$5.788m
Improvement in lifetime wellbeing		2.71%		0.85%		2.17%
	F1Ch conservative scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
SGL rate	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Objective function value	$2.528m	$2.640m	$7.468m	$7.692m	$3.975m	$4.044m
Improvement in lifetime wellbeing		4.43%		3.00%		1.74%
	F1Ch traditional scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
SGL rate	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Objective function value	$2.463m	$2.528m	$6.064m	$6.287m	$3.748m	$3.821M
Improvement in lifetime wellbeing		2.64%		3.68%		1.95%

4.7.2.2 Comparison - retirement standards of living - 9% SGL and 12% SGL

The second approach to assessing the impact of an increase from 9% per annum SGL to 12%, where funding is via increased compensation, is to consider amounts allocated in the optimal solutions to NHC for the retirement periods. These amounts are set out in Table 4-51. As discussed in Section 4.2.5 retirement funding for each year is classified as being in one of four categories:(i) at the CAS standard, (ii) at the higher end of the MBA standard, (iii) at the lower end of the MBA standard and (iv) at the Age Pension standard. For the MBA and CAS standards the assumption is that the household has owner-occupied housing, and this is indeed the situation for all optimal solutions under consideration.

It must be noted that the figures set out in Table 4-51 below apply to optimal solutions across a lifetime, and thus are not the optimal amounts that can be obtained for the specific period. For example, taking the Co2Ch conservative scenario and using objective function 1, the NHC allocated for period 4 is $45,504. This amount is part of the optimal lifetime solution, and it is possible that a higher amount for this particular period could be allocated, which of course would mean that other allocations in other periods would have to change.

Table 4-51 Comparison of retirement standard of living for different SGL rates

Period	Co2Ch - **SGL 9%**								
	Base scenario			Conservative scenario					
	Obj fn 1	Obj fn 2	Obj fn 3	Obj fn 1	Obj fn 2	Obj fn 3			
4	$55,443	$43,500	$57059	$45504	$43,500	$44,790			
5	$51,345	$31,000	$52,850	$40,429	$31,000	$41,486			
	Co2Ch - **SGL 12%**								
	Base scenario			Conservative scenario					
	Obj fn 1	Obj fn 2	Obj fn 3	Obj fn 1	Obj fn 2	Obj fn 3			
4	$73,268	$43500	$67,240	$51,276	$43,500	$47,990			
5	$67,663	$31,000	$62,281	$40,819	$31,000	$41,486			
	Single Male - **SGL 9%**								
	Base scenario			Conservative scenario			Traditional scenario		
	Obj fn 1	Obj fn 2	Obj fn 3	Obj fn 1	Obj fn 2	Obj fn 3	Obj fn 1	Obj fn 2	Obj fn 3
4	$98,704	$29,720	$98704	$53,64	$20391	$48281	$45,863	$24,69	$33,305
5	$128,287	$38,627	$128,287	$70,139	$20391	$62751	$59,,610	$24,469	$42,654
	Single male - **SGL 12%**								
	Base scenario			Conservative scenario			Traditional scenario		
	Obj fn 1	Obj fn 2	Obj fn 3	Obj fn 1	Obj fn 2	Obj fn 3	Obj fn 1	Obj fn 2	Obj fn 3
4	$101,912	$30,039	$101912	$57,127	$20,391	$51,181	$49,505	$24,469	$33,305
5	$132,458	$39,042	$132458	$74,249	$20,412	$66,520	$64,342	$24,469	$42,654
	F1Ch - **SGL 9%**								
	Base scenario			Conservative scenario			Traditional scenario		
	Obj fn 1	Obj fn 2	Obj fn 3	Obj fn 1	Obj fn 2	Obj fn 3	Obj fn 1	Obj fn 2	Obj fn 3
4	$89,916	$29,714	$89,916	$64,021	$19,309	$32,580	$29,350	$26,100	$28,022
5	$116,865	$38,977	$116,865	$31,133	$19,497	$42,345	$31,133	$22,193	$31,133
	F1Ch - **SGL 12%**								
	Base scenario			Conservative scenario			Traditional scenario		
	Obj fn 1	Obj fn 2	Obj fn 3	Obj fn 1	Obj fn 2	Obj fn 3	Obj fn 1	Obj fn 2	Obj fn 3
4	$92,567	$29,714	$92,576	$46,523	$19,309	$32,580	$29,350	$26,100	$28,022
5	$120,311	$38,620	$120,311	$60,467	$19,497	$42,345	$31,133	$22,193	$31,133

	At or above CAS standard
	Above midpoint of MBA standard but below CAS standard
	Within lower half of MBA standard
	At Age Pension standard

In considering the data set out in Table 4-51, it is useful to consider firstly the retirement funding amounts available when the annual SGL rate is 9%.

From inspection of Table 4-51 it can be seen that, at an SGL level of 9%, for all three base scenarios, for all three conservative scenarios, and for the two traditional scenarios, there is at least one objective function that provides for the MBA standard. Thus, with 9% SGL it is possible to achieve an adequate standard of living in the retirement years. Moreover, for all three base scenarios and for the SM conservative scenario, all set up for median labour income and with no inherited or windfall wealth, it is possible to achieve the CAS standard, which as noted earlier, has been developed for the top quintile for income.

As is expected, the amounts for 12% SGL generally show a similar pattern to the amounts for 9% SGL, with most amounts being higher due to the increased funding.

However for the F1Ch conservative scenario with objective function 1, the NHC for period 4 is lower for 12% than for 9% SGL. An inspection of the full solution shows an impact of eligibility of the Age Pension being established with 9% SGL but not with 12% SGL. There is further discussion of the availability of the Age Pension in Section 4.8. Where inspection of the two sets of results shows identical amounts for both periods, consideration of the overall results show either increased housing levels or higher NHC in the earlier periods. In terms of receiving the CAS standard the results are exactly the same for the 12% rate as for the 9% SGL i.e. for all three base scenarios and for the single male conservative scenario, the CAS standard can be reached for both SGL rates. However the extra SGL does not raise the standard that can be reached for the other models considered i.e. the Co2Ch and the F1Ch conservative scenarios, and the two traditional scenarios.

4.7.3 Conclusion – Appropriate SGL rate

The results set out is this section show an increase of the SGL from 9% per annum to 12%, with the increase emanating from increased compensation, does not offer significant improvement in retirement funding or wellbeing across a lifetime. Depending on how the increase is funded, there may even be a decrease in overall lifetime wellbeing as the increase forces savings into the superannuation stream rather than allowing for such savings to be invested elsewhere. Moreover the optimal solution may be that there is increased NHC in earlier periods. In response to the third specific objective for this study, it can be concluded that 9% SGL provides for an adequate retirement funding, and that raising this rate to 12% offers only limited benefit, if any benefit at all, to the household earning median labour income, depending on the objectives of the particular household.

This result is in agreement with the recommendation of the Henry report, discussed in Section 2.3.2. However this view of 9% as an appropriate rate is far from universally shared. Piggott & Evans (2007) argued that based on the probability of significant longevity for at least one of a couple, the 9% rate would result in only a modest standard of living being possible. Kelly, Harding and Percival (2002) arguing from a position of more than 10 years ago, proposed that early baby boomers would be retiring with small fund balances due to the limited number of years of participation in superannuation, and that increasing the rate would improve outcomes for these people, especially for women who tend to have uneven patterns of employment. Basu and Drew (2009) take up this gender issue, and argue that the contribution rates for women may need to be different, given the pattern of their working life, but these authors also point out the problems with having a gender-differentiated system.

4.8 Analysis of eligibility for the Age Pension

The fourth specific objective of this study i.e. establish the characteristics of households that would be eligible for the Age Pension, given a selection of economic factors and policy options, is the focus of this section. Given the evidence is that current arrangements provide for adequate and even, in some circumstances, a comfortably affluent older age for Australians with average labour income, it is imperative to understand the contribution made to this state of affairs by the availability of the Age Pension. The results pertaining to this objective are an important contribution to the development of public policy, as they provide quantitative evidence as to the impact of policy decisions.

In Chapter 2 Section 2.2.3.2 there was discussion around the level of comfort reached in old age. The developers of the CAS standard saw this level as being a standard for the self–funded retiree. However, of the four instances that can provide this level of comfort i.e. all base scenarios and the single male conservative scenario, the optimal solutions for the Co2Ch base scenario include the reception of a full Age Pension for both periods 4 and 5. Thus, in some instances, the availability of the Age Pension assists in the provision of a very high living standard indeed.

As discussed in Chapter 1 Section 1.2.1, the Age Pension provides a safety net for Australian over the age of 66[68]. This pension is means tested both on assets held and income being received. It is possible to receive a part pension, which may range from a very small payment to close to the full pension. For the purposes of this study, a simplified approach has been used, with the part pension available being half of the full pension, and the eligibility criteria for both means tests being adapted proportionally[69].

[68] At the time of writing (i.e. early 2014) , as discussed in Chapter 2 Section 2.3.5.1, eligibility for Age Pension is age 65, with this age gradually rising so the age of eligibility will be 67 from 2023.

[69] See Chapter 3 Section 3.4.3.5 for a more detailed explanation of approach used to modelling the Age Pension.

4.8.1 Scope of this discussion

The linear programming approach used in this study allows a multitude of factors to be modelled. Because of the limitations of size of this thesis, the discussion regarding factors impacting the availability of the Age Pension is restricted to (i) the impact of different housing capital growth rates and (ii) two policy issues, i.e. (a) the legislated SGL rate and (b) the approach to means testing the value of a superannuation account. Following this discussion of factors impacting the presence of the Age Pension in optimal solutions, there is a discussion of sensitivity analysis carried out when (i) access to the Age Pension is limited because of more stringent asset and income tests than are in place today and (ii) no Age Pension is available.

4.8.2 Impact of housing capital growth rates on eligibility for Age Pension

The first factor to be considered for its impact on the inclusion of the Age Pension in optimal solutions is the housing capital growth rate. As discussed in Chapter all scenarios use 5.2% annual growth rate for housing. It was demonstrated in Section 4.6 that different housing growth rates have minimal impact on results with regard to optimal solutions from the perspective of individual households. However, to better understand the implications for public policy, it is appropriate to ask if different housing growth rates have an impact on Age Pension inclusion in optimal solutions. For a higher housing capital growth rate, Australians will need to spend more proportionally on housing, leaving less for other consumption, but balancing this impact is the impact of higher growth rate on the value of housing assets in the retirement years. A housing asset can be converted to consumption in later years via the use of reverse mortgages or by downsizing housing requirements.

Table 4-52 sets out pictorially the Age Pension situation for all three models and for all three objective functions, for three housing capital growth rates. For each of the models, data is provided for the base and conservative scenarios. As well, for the SM and for the F1Ch models, data is provided for the traditional scenario.

Table 4-52 Eligibility for Age Pension – changing housing capital growth rates

		Co2Ch model						SM model						F1Ch model					
	Housing growth rate	5.2%		4%		3%		5.2%		4%		3%		5.2%		4%		3%	
	Period	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5
Base scenario	Obj. Fn 1	Full	Full	Part	Full	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Obj. Fn 2	Full	Full	Full	Full	Full	Full	Full	Full	No	Part	No	No	Full	Full	Full	Part	No	No
	Obj. Fn 3	Full	Full	Full	Full	Full	Full	No	No	No	No	No	No	No	No	No	No	No	No
Conservative scenario	Obj. Fn 1	Full	Part	Full	Part	Full	Part	No	No	No	No	No	No	No	Full	No	No	No	No
	Obj. Fn 2	Full	Part	Full	Part	Full	Part	Full	Full	Full	Full	Full	Full	Full	Full	Full	Full	Full	Full
	Obj. Fn 3	Full	Part	Full	Part	Full	Part	No	No	Full	Full	Full	Full	Full	Part	Full	Full	Full	Full
Traditional scenario	Obj. Fn 1							No	No	No	No	No	No	Full	Full	Full	Full	Full	Full
	Obj. Fn 2							Full	Full	Full	Full	Full	Full	Full	Full	Full	Full	Full	Full
	Obj. Fn 3							Full	Part	Full	Full	Full	Full	Full	Full	Full	Full	Full	Full

ull pension	Part pension	No pension

An inspection of Table 4-52 shows that, in most instances, a change in the housing growth rate does not change the situation as to whether the optimal solution involves receiving a full or part Age Pension. One example of this situation is that of the Co2Ch base scenario using objective function 2, where, for all three growth rates, a full Age Pension forms part of the optimal solution. Likewise, for the Co2Ch conservative scenario, the optimal solution for all three objective functions includes a full pension in period 4 and a part pension in period 5. However a change of housing growth rate does impact the role of the Age Pension for some situations. An example of such a situation is for the F1Ch base scenario where, for objective function 2, a full Age Pension would form part of the optimal solution if the housing growth rate is 5.2% per annum. There would be only a part pension in Period 5 and no pension in period 4 if the yearly rate is 4%, and there would be no pension at all in either period if the rate is 3%. However, for the SM conservative scenario using objective function 3, the trend is in the opposite direction with there being no pension at all in the optimal solution when the housing growth rate is 5.2% per annum, but a full pension when the growth rate is 4%.

The results as set out in Table 4-52 mostly show patterns that are intuitive. For the F1Ch traditional scenario the optimal solution for each of the three objective functions for all housing growth rates includes a full Age Pension in both periods 4 and 5. This result is unsurprising given the lack of ability for the subject of the model to save in the early years. For the SM conservative scenario, the optimal set of decisions leads to receiving a full Age Pension in both periods for all three housing growth rates if objective function 2 is used, but if objective function 1 is applied, the Age Pension does not feature at all in the optimal solution. Again this result is unsurprising as these two contrasting situations reflect the emphasis of the two different objective functions in that objective function 2 includes owner-occupied housing, excluded from the assets means test, whereas objective function 1 does not.

One surprising result is shown in the comparison of optimal results for the Co2Ch base and conservative scenarios. With the conservative scenario, for all objective functions and for all housing growth rates, the optimal result includes a full pension in period 4 and a part pension in period 5. However for the base scenario, for objective functions 2 and 3 for all growth rates, and for objective function 1 with a housing growth rate of 5.2%, the optimal solutions include a full pension for both periods 4 and 5. Investigation of the situation shows that the base scenario provides for greater opportunity to structure wealth and income so as to be able to pass the means tests for the Age Pension. In particular the base scenario provides for the purchase of life-contingent annuities, including reversionary annuities that provide an income to the surviving partner on the death of one of the couple. When such annuities are valued at the beginning of period 5, the algorithm used for this valuation, based on life expectancy when the annuity was purchased at the beginning of period 4, ensures that the asset value of the annuity is much diminished (Colonial First State, 2011). However, when annuities are not available, on the death of the male at the end of period 4 the balance of his superannuation account is transferred to the female. This amount, together with the asset value of the female's superannuation account, is such that the assets test for a full pension is not passed.

Table 4-52 provides evidence that, for both 5.2% and 4% annual housing growth, for all versions of all scenarios considered, it is possible to structure income and assets to receive at least a part Age Pension in both periods 4 and 5, with the solution being an optimal one for at least one of the objective functions being used. This situation also applies for both the base and conservative scenarios for the Co2Ch model when the growth rate is 3%. For both the SM and the F1Ch models, with a 3% annual housing growth rate, a part pension can be achieved within the conservative scenarios. It could possibly be achieved within the base scenario, but these would not be optimal solutions for either of the two objective functions used with this housing growth rate.

As set out in Chapter 2, Section 2.3.5.3, there is considerable policy discussion regarding access to the Age Pension. The evidence from this study suggests that if Australians earning median labour income aim to receive at least a part pension, it is possible to achieve this goal.

4.8.3 Impact of increasing SGL from 9% to 12% on eligibility for Age Pension

In Section 4.7 the impact on the individual household from an increase in SGL from 9% to 12% was discussed. In the discussion immediately following, the impact upon eligibility for the Age Pension, either in full or part, is considered. This consideration is important as it provides an indication of the impact of changing public policy. If the change in the SGL amount leads to a lower rate of eligibility, with fewer retirees being granted the Age Pension, there would be a lessening of the cost of this pension to the Australian economy. The results of the analysis are set out in Table 4-53.

Table 4-53 Comparison of eligibility for Age Pension for different SGL rates

	Objective Function 1		Objective Function 2		Objective Function 3	
Co2Ch model						
Base scenario	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Age Pension Period 4	full	none	full	full	full	full
Age Pension Period 5	full	part	full	full	full	part
Conservative scenario	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Age Pension Period 4	full	full	full	full	full	full
Age Pension Period 5	part	part	part	part	part	part
SM model						
Base scenario	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Age Pension Period 4	none	none	full	full	none	none
Age Pension Period 5	none	none	full	full	none	none
Conservative scenario	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Age Pension Period 4	none	none	full	full	none	none
Age Pension Period 5	none	none	full	full	none	none
Traditional scenario	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Age Pension Period 4	none	none	full	full	full	full
Age Pension Period 5	none	none	full	full	part	part
F1Ch model						
Base scenario	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Age Pension Period 4	none	none	full	full	none	none
Age Pension Period 5	none	none	full	full	none	none
Conservative scenario	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Age Pension Period 4	none	none	full	full	full	full
Age Pension Period 5	full	none	full	full	part	part
Traditional scenario	9% SGL	12% SGL	9% SGL	12% SGL	9% SGL	12% SGL
Age Pension Period 4	full	full	full	full	full	full
Age Pension Period 5	full	full	full	full	full	full

full	part	none
Full pension	Part pension	No pension

In Table 4-52, the eligibility for the Age Pension is provided for the optimal solutions for each of the 3 models for the relevant 3 scenarios and 3 objective functions. There are 24[70] instances where comparisons are made between the eligibility for the optimal solution for 9% SGL and 12% SGL, and in only two of these instances is there any change in eligibility. For the Co2Ch model for the base scenario using objective function 1, with 9% SGL the household is eligible for the full Age Pension in both

[70] The traditional scenario applies only for the SM and F2Ch models.

periods 4 and 5, whilst for 12% SGL it would be ineligible for this pension in period 4 and would receive a part pension only in period 5. For the F1Ch model with the conservative scenario using objective function 1, for both SGL rates, the female is not eligible for a pension in period 4. However for period 5, a full pension would be available for 9% SGL, but she would be ineligible for any pension at all in period 5. It is important to note that these two differences apply for the optimal solutions. It is possible that, by electing to take a sub-optimal solution, the household could arrange its affairs to obtain the same Age Pension eligibility for the two rates.

This analysis suggests that, assuming the means test remains the same, a change from a SGL of 9% to 12% will not cause a significant change to uptake of the Age Pension. Households understand the value of the Age Pension and will arrange financial affairs to obtain this payment.

4.8.4 Assessment of impact of policy change to asset assessment

As discussed in Section 2.3.5.3 both the Harmer and Henry Reports recommended changing the income assessment method of allocated pensions from a drawdown of wealth approach to a deemed income calculation. In the budget of May 2013 it was announced that these recommendations would be adopted (Shorten & Swan, 2013b).

Analysis has been carried out to assess the impact of this change with two tables setting out the results of this analysis. Table 4-54 sets out the decrease in wellbeing across a lifetime for all models, scenarios and objective functions. Table 4-55 sets out the eligibility for the Age Pension for every combination of model, scenario and objective function for both the wealth drawdown and the deeming approach to this income assessment. For all analysis, the SGL rate is 9% per annum and the housing growth rate is 5.2% per annum.

Table 4-54 Difference in lifetime wellbeing - deemed superannuation pension accounts

	Objective Function 1		Objective Function 2		Objective Function 3	
	Co2Ch model					
Scenario	Base	Base May 2013	Base	Base May 2013	Base	Base May 2013
Objective function value	$4.239m	$4.215m	$9.472m	$9.472mm	$5.972m	$5.940m
Decrease in lifetime wellbeing		0.57%		0%		0.54%
Scenario	Conservative	Conservative May 2013	Conservative	Conservative May 2013	Conservative	Conservative May 2013
Objective function value	$3.768	$3.740m	$8.281	$8.219m	$5.504m	$5.483m
Decrease in lifetime wellbeing		0.74%		0.75%		0.38%
	Single male model					
Scenario	Base	Base May 2013	Base	Base May 2013	Base	Base May 2013
Objective function value	$4.729m	$4.729m	$9.700m	$9.700m	$5.889m	$5.889m
Decrease in lifetime wellbeing		0%		0%		0%
Scenario	Conservative	Conservative May 2013	Conservative	Conservative May 2013	Conservative	Conservative May 2013
Objective function value	$2.831m	$2.831m	$8.024m	$8.024m	$4.116m	$4.116m
Decrease in lifetime wellbeing		0%		0%		0%
Scenario	Traditional.	Traditional May 2013	Traditional.	Traditional May 2013	Traditional.	Traditional May 2013
Objective function value	$2.657m	$2.657m	$7.482m	$7.456m	$4.055m	$4.002m
Decrease in lifetime wellbeing		0%		0.35%		1.31 %
	F1Ch model					
Scenario	Base	Base May 2013	Base	Base May 2013	Base	Base May 2013
Objective function value	$4.504m	$4.729m	$9.551m	$9.700m	$5.665m	$5.889m
Decrease in lifetime wellbeing		0%		0%		0%
Scenario	Conservative	Conservative May 2013	Conservative	Conservative May 2013	Conservative	Conservative May 2013
Objective function value	$2.528m	$2.513m	$7.468m	7.468m	3.975m	3.927m
Decrease in lifetime wellbeing		0.59%		0%		1.21%
Scenario	Traditional.	Traditional May 2013	Traditional.	Traditional May 2013	Traditional.	Traditional May 2013
Objective function value	$2.463m	$2.415m	$6.063m	$6.048m	$3.748m	$3.696m
Decrease in lifetime wellbeing		1.95%		0.25%		1.39%

Base	Base scenario	Base May 2013	Base scenario, with deemed superannuation
Conservative	Conservative scenario	Conservative May 2013	Conservative scenario, with deemed superannuation
Traditional	Traditional scenario	Traditional . May 2013	Traditional scenario, with deemed superannuation

As can be seen from an inspection of Table 4-54, there is little impact from the implementation of this policy change to lifetime wellbeing. Of course, for optimal solutions that do not involve receiving any Age Pension, there is no change. However for the 17 instances where the original optimal solution involves at least some pension, the decrease in well being ranges from 0% to 1.95%, with the median change being a decrease of 0.54%.

Investigating the impact of change in assessment approach from the perspective of the optimal solution including the Age Pension, an inspection of Table 4-55 below shows that there is only one instance of the 24 model-scenario-objective function instances where there is a change to such eligibility. For the F1Ch model for the conservative scenario applying objective function 1, with the present assessment approach the optimal solution provided no pension in period 4 abut a full pension in period 5. With a deeming approach the optimal solution does not include the Age Pension at all. Of course, as mentioned several times previously, this is the situation for the optimal solution. If the female of the model desires an Age Pension, there are sub-optimal ways to achieve this outcome.

Taking into account the analysis from both the reduction in lifetime wellbeing and the eligibility of the Age Pension perspectives, the adoption of the deeming approach will make very little difference to the number of Australians of average means receiving the Age Pension.

Table 4-55 Age Pension eligibility – deemed superannuation pension accounts

	Objective Function 1		Objective Function 2		Objective Function 3	
	Co2Ch model					
Scenario	Base	Base May 2013	Base	Base May 2013	Base	Base May 2013
Age Pension Period 4	full	full	full	full	full	full
Age Pension Period 5	full	full	full	full	full	full
Scenario	Conservative	Conservative May 2013	Conservative	Conservative May 2013	Conservative	Conservative May 2013
Age Pension Period 4	full	full	full	full	full	full
Age Pension Period 5	part	part	part	part	part	part
	Single male model					
Scenario	Base	Base May 2013	Base	Base May 2013	Base	Base May 2013
Age Pension Period 4	none	none	full	full	none	none
Age Pension Period 5	none	none	full	full	none	none
Scenario	Conservative	Conservative May 2013	Conservative	Conservative May 2013	Conservative	Conservative May 2013
Age Pension Period 4	none	none	full	full	none	none
Age Pension Period 5	none	none	full	full	none	none
Scenario	Traditional	Traditional May 2013	Traditional	Traditional May 2013	Traditional	Traditional May 2013
Age Pension Period 4	none	none	full	full	full	full
Age Pension Period 5	none	none	full	full	part	part
	F1Ch model					
Scenario	Base	Base May 2013	Base	Base May 2013	Base	Base May 2013
Age Pension Period 4	none	none	full	full	none	none
Age Pension Period 5	none	none	full	full	none	none
Scenario	Conservative	Conservative May 2013	Conservative	Conservative May 2013	Conservative	Conservative May 2013
Age Pension Period 4	none	none	full	full	full	full
Age Pension Period 5	full	none	full	full	part	part
Scenario	Traditional	Traditional May 2013	Traditional	Traditional May 2013	Traditional	Traditional May 2013
Age Pension Period 4	full	full	full	full	full	full
Age Pension Period 5	full	full	full	full	full	full

Base	Base scenario	Base May 2013	Base scenario, with deemed superannuation
Conservative	Conservative scenario	Conservative May 2013	Conservative scenario, with deemed superannuation
Traditional	Traditional scenario	Traditional May 2013	Traditional scenario, with deemed superannuation

full	part	none
Full pension	Part pension	No pension

4.8.5 Impact of tightening of asset and income tests for the Age Pension

One obvious way in which the contribution of the Age Pension to retirement funding might be lessened is by tightening the means test. To investigate how the asset and income tests impinge upon availability of the Age Pension, several versions of each combination of model and scenario were set up, steadily reducing all asset and income thresholds in equal increments. A housing growth rate of 5.2% and 9% SGL per annum were assumed. It is important to recognise that, though the means test is made harsher, the amounts paid by the Age Pension are not changing i.e. the amounts paid both for a full pension and a part pension are the same as for the original means test. Some details of this analysis are provided in Table 4-56.

Table 4-56 Pension status & reduction in lifetime wellbeing - means test changes

Model	Scenario	Objective Function	Status quo	20% reduction	40% reduction	60% reduction	80% reduction
Co2Ch	Base	1		1.47%	3.22%	4.61%	4.61%
		2		0.00%	0.61%	1.73%	6.88%
		3		0.93%	1.86%	2.88%	4.01%
	Conservative	1		2.36%	10.22%	10.43%	10.43%
		2		0.66%	10.72%	13.52%	13.52%
		3		1.52%	7.31%	9.14%	9.14%
SM	Base	1		0.00%	0.00%	0.00%	0.00%
		2		0.00%	0.00%	0.00%	2.38%
		3		0.00%	0.00%	0.00%	0.00%
	Conservative	1		0.00%	0.00%	0.00%	0.00%
		2		0.00%	0.00%	0.00%	13.00%
		3		0.00%	0.00%	0.00%	0.00%
	Traditional	1		0.00%	0.00%	0.00%	0.00%
		2		0.35%	0.64%	14.07%	14.07%
		3		2.44%	3.31%	3.31%	3.31%
F1Ch	Base	1		0.00%	0.00%	0.00%	0.00%
		2		0.00%	0.00%	0.00%	3.37%
		3		0.00%	0.00%	0.00%	0.00%
	Conservative	1		0.50%	0.50%	0.50%	0.50%
		2		0.00%	0.00%	0.00%	8.34%
		3		2.37%	3.58%	4.37%	4.37%
	Traditional	1		1.73%	4.43%	10.05%	12.17%
		2		0.04%	0.64%	10.74%	10.74%
		3		1.16%	2.51%	8.46%	9.45%

Full pension p4 & p5	Full pension p4 Part pension p5	Full pension p4 No pension p5	Part pension p4 Full pension p5	Part pension p4 & p5	Part pension p4 No pension p5	No pension p4 Full pension p5	No pension p4 Part pension p5	No pension p4 & p5

It can be seen from inspection of Table 4-56 that, even with a reduction of 40% of the values of the Age Pension means test thresholds, for every combination of model, and scenario, there is at least one objective function that provides for some Age Pension in the optimal solution. For the base scenario for all three models the optimal solution includes at least a part Age Pension at some stage in retirement when the means test thresholds have been reduced by 80%. This situation of inclusion in the optimal solution illustrates the point that the benefits of the Age Pension are such that it is worth constructing drawdown of wealth to achieve such a payment. However the situation for the conservative scenario and the traditional scenario do not produce this result. The opportunities for wealth organisation via the use of life-contingent annuities, available for the base scenario but not for the other two scenarios, contribute significantly to effective structuring of wealth.

The model and scenario combination where there is most availability of the Age Pension is that of the traditional scenario for the F1Ch model. This is not surprising as in such a situation the subject of the model will have had less chance to save in the years between 25 and 56, given her need to spend funds on consumption for her child and herself during this time. As well her income is less that a male’s for all three labour income periods.

In addition to the pension status for each combination of model, scenario and objective function, Table 4-56 provides the reduction in lifetime wellbeing for each instance as the means test thresholds are steadily reduced. Whilst this measure is primarily an approach to assess individual lifetime wellbeing, it is useful from the political perspective in that it gives an understanding of the impact on individuals, a key electoral concern. At a 40% reduction in thresholds the maximum reduction in lifetime wellbeing is 10.72% with a mean reduction of 2.06%. The corresponding figures for an 80% reduction are 14.07% and 5.43%. It is interesting to note that, for both reduction percentages, it is objective function 2 which provided the greatest decrease in lifetime wellbeing. This is not surprising as the reduction in funding from the Age Pension has been replaced with private funding, which, in the present circumstances of Age Pension availability, has been used to provide a higher standard of housing. The standard of housing is the major contributor to Objective Function 2, given the impact of 5.2% housing growth used in this model.

As well as analysing the impact of decreasing means test thresholds, it is constructive to examine the impact of the total unavailability of the Age Pension. Assuming a housing growth rate of 5.2% and SGL of 9% per annum, analysis has been carried out for all three scenarios with all relevant models. The reduction in lifetime wellbeing has been calculated for each instance. The results are set out in Table 4-57.

Table 4-57 Difference in lifetime wellbeing - unavailability of Age Pension

	Co2Ch base scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
Age Pension status	Status quo	No pension	Status quo	No pension	Status quo	No pension
Objective function value	$4.239m	$4.044m	$9.472m	$8.353m	$5.971m	$5.638m
Decrease in lifetime wellbeing		4.61%		11.81%		5.57%
	Co2Ch conservative scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
Age Pension status	Status quo	No pension	Status quo	No pension	Status quo	No pension
Objective function value	$3.768m	$3.375m	8.281m	$7.161m	$5.504m	$5.001m
Decrease in lifetime wellbeing		10.43%		13.52%		9.14%
	SM base scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
Age Pension status	Status quo	No pension	Status quo	No pension	Status quo	No pension
Objective function value	$4.729m	$4.729m	$9.700m	$9.298m	$5.889m	$5.889m
Decrease in lifetime wellbeing		0%		4.14%		0%
	SM conservative scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
Age Pension status	Status quo	No pension	Status quo	No pension	Status quo	No pension
Objective function value	$2.831m	$2.831m	$8.024m	$6.982	$4.116m	$4.116m
Decrease in lifetime wellbeing		0%		13%		0%
	SM traditional scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
Age Pension status	Status quo	No pension	Status quo	No pension	Status quo	No pension
Objective function value	$2.657m	$2,657m	$7.482m	$6.429m	$4.055m	$3.921m
Decrease in lifetime wellbeing		0%		14.07%		3.31%
	F1Ch base scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
Age Pension status	Status quo	No pension	Status quo	No pension	Status quo	No pension
Objective function value	$4.504m	$4.504m	$9.551m	$8.946m	$5.665m	$5.665m
Decrease in lifetime wellbeing		0%		6.34%		0%
	F1Ch conservative scenario					
	Objective Function 1		Objective Function 2		Objective Function 3	
Age Pension status	Status quo	No pension	Status quo	No pension	Status quo	No pension
Objective function value	$2.528m	$2.515m	$7.468m	$6.417m	$3.975m	$3.801
Decrease in lifetime wellbeing		0.50%		14.07%		4.37%
	F1Ch traditional					
	Objective Function 1		Objective Function 2		Objective Function 3	
Age Pension status	Status quo	No pension	Status quo	No pension	Status quo	No pension
Objective function value	$2.463m	$2.054m	$6.063m	$4.977m	$3.748m	$3.228m
Decrease in lifetime wellbeing		16.58%		17.93%		13.88%

Inspection of the table shows that for all combinations of models and scenarios, the impact from unavailability of the Age Pension is most marked when objective function 2 is used. This is the objective function with the greatest emphasis on the value of owner-occupied housing. If the value of housing is not incorporated into the objective function, i.e. objective function 1, the reduction in wellbeing is significant for only the Co2Ch conservative scenario and the F1Ch conservative with higher consumption scenario. This dependence upon the objective function used to measure lifetime wellbeing is another illustration of the impact of the special treatment of owner occupied housing in assessment for eligibility for the Age Pension[71].

4.8.6 Conclusion - impact of eligibility for Age Pension

In response to the fourth specific objective of this study, the results presented in Section 4.8 demonstrate that there is little impact on eligibility for the Age Pension with a lower housing capital growth rates. As well, the impact on eligibility for this payment by either increasing the SGL from 9% to 12% per annum, or by introducing a deeming approach for income calculation is minimal. Making the means test more difficult by a factor of 40% also does not change the availability of the pension significantly, though there is more marked change if the thresholds are reduced by 80%. The pension amount provides such a benefit that it is worth restructuring wealth and income to receive it.

It is useful at this stage to reconsider policy reviews and empirical studies that have considered the appropriateness of the means test for the Age Pension. As mentioned earlier in Chapter 2 both the Henry and Harmer reviews saw the need to target payments towards people with low wealth, with one way to do this being to alter the way the drawdown of some superannuation wealth is assessed as income. However, as discussed in Section 4.8.4, the results of this study showed the proposed method to bring about this change would be ineffectual. Murray (2014a) in the interim report of the FSI gave examples as to how retirees can drawdown considerable wealth, spend these funds in ways that do not impact the means test, and then collect the Age Pension, at least in part. The results set out in this thesis support Murray's contention. Hulley et al. (2013) investigated decumulation of assets using HILDA data. They found that wealthy Australians do not decumulate wealth rapidly, and may even continue to accumulate wealth into retirement but households with wealth that is marginally above that of the means test do decumulate at a rapid rate. This result is in agreement with the findings of this thesis.

[71] It is useful to consider the study by Cho and Sane (2013) who investigated the impact on wellbeing of the exemption of the home from the Age Pension means test using a general equilibrium model. They found that such a policy change would decrease housing consumption but there would be an increase in overall wellbeing for most of the population because of the large increase in NHC. Perhaps paradoxically, it would be the wealthiest quintile which would not benefit from such a reform.

Of course, removing Age Pension eligibility altogether for the subjects of this study i.e. people who have median incomes, would make a significant difference to the number of people receiving this payment and thus to the amount paid from government funds. Inspection of Table 4-57 shows that the scenarios most impacted are (i) the F1Ch traditional scenario and (ii) the Co2Ch conservative scenario. This situation is not surprising as these are the two scenarios when the subjects are most vulnerable, from a financial perspective. Additionally it can be seen from Table 4-57 that it is the optimal results for objective function 2 that are most impacted. This objective function rewards a high value of owner-occupied housing. It can be argued that, without the availability of the Age Pension, storing wealth in housing so as to achieve some pension payment no longer is a useful strategy, and thus it could be expected that there would be a change in attitudes as to the value of housing held into old age.

However these models where there is no Age Pension are based on people understanding from young adulthood that provision for retirement funding lies solely with themselves. There would need to be a long period of introduction for such a regime. If there does come a time when Australia want to reduce its spending significantly on the Age Pension, severely limiting eligibility may be the only way to achieve this situation. However there would need to be in place a safety net, for people with minimal assets and income. This is the situation with the USA basic benefit, known as supplemental security income, where benefits are limited to those with only a home, and less than $2,000 in assets (OECD, 2011).

4.9 Overall conclusion

In Chapter 2, when reviewing the pertinent literature, the pivotal issues recognised were (i) the ability of Australians to participate effectively in the Australian retirement income system, in both the accumulation and decumulation phases, (ii) appropriate annuitisation of wealth on retirement.(iii) recognition of an appropriate standard of living for the retirement years and (iv) the role of the owner –occupied dwelling in providing lifetime well being, but particularly during the retirement years.

The concerns at the forefront of academic study are reflected in the Australian policy deliberations also discussed in Chapter 2. The key concerns raised in the policy reviews are: (i) investment of superannuation assets to achieve optimal results in retirement, (ii) the appropriate rate for SGL, (iii) the need for the use of retirement savings to provide for considerable longevity for a high proportion of the population, (iv) the tax-privileged role of owner-occupied housing across the lifecycle, (v) appropriate targeting of the Age Pension, together with ensuring it provided an adequate amount for people fully dependent upon this benefit and (vi) intergenerational issues regarding the funding of Age Pension. It can be seen immediately that the concerns of academia dovetail with these policy issues.

The results set out in this chapter relate directly to the issues described immediately above. The overall research problem, as stated in Chapter 1, is to determine the optimal financial decisions that provide for a comfortable retirement. The study has determined these decisions for some representative Australian groups and shown that a comfortably adequate retirement can be achieved for these groups of people, and that in some cases a higher standard of living can be achieved.

With respect to an appropriate standard of living and the SGL rate that is needed to achieve this standard, this study has shown the rate of 9% per annum will meet the needs of these groups and that raising the rate to 12% does not provide a significantly better outcome.

It has been established that owner-occupied housing has a profound impact upon financial wellbeing for all groups considered. Such housing features in all but one of the hundreds of the instances of the models investigated in this study. Moreover it provides a source of retirement funds that has been shown to have significant impact upon retirement living standards if Australians are prepared to use reverse mortgages.

The role of life-contingent annuities, products that provide insurance against longevity, has been explored and it has been found that these retirement products do feature in optimal solutions for all groups. However, it has also been found that the lifetime benefit arising from these products is considerably less than the benefits arising from the use of reverse mortgages or from the willingness to invest savings in risky assets.

The eligibility of the representative segments of the Australian population for the Age Pension groups has been investigated. The key finding from the study is that, in a great number of situations, the Age Pension provides such a level of benefits that it is financially worthwhile to structure income and wealth to avail of this payment. Owner-occupied housing provides one method of structure wealth, but so does the ability to withdraw in early retirement, without penalty or taxation, cash amounts from superannuation savings. Moreover, it has been established that particular initiatives to reduce reliance on the Age Pension, such as increasing the SGL rate or changing the way assets and income are assessed, have minimal impact for the population segments considered in this study. This situation has intergenerational ramifications.

In Chapter 5, both limitations and suggestions for further development and extensions of the study will be discussed. Based on the findings from the literature review and the policy considerations from Chapter 2, and the results established and set out in this chapter, recommendations for both Australian households and for policy makers will be set out.

Chapter 5 Summary, implications, limitations and future directions

5.1 Introduction

This chapter provides a summary of the research undertaken together with conclusions drawn from the results obtained. It then sets out implications arising from the results, followed by recommendations. Finally, there is discussion of the limitations of the study, together with suggestions for further research and development.

5.2 Summary of research and conclusions

5.2.1 Summary of research

As set out in Chapter 1, the research problem for this study is:

- How can an Australian optimise financial decisions in order to provide for a comfortable retirement?

The specific objectives of the study arising from the problem are to:

1. Determine the optimal methods and rates of accumulation and decumulation for a range of representative segments of the population, assuming a rational, self-interested perspective.
2. Identify the gaps between optimal accumulation and decumulation, and sub-optimal accumulation and decumulation when behavioural attitudes influence selection of accumulation and decumulation options.
3. Determine the Superannuation Guarantee percentage that needs to be in place for average Australians to have their retirement funded to a comfortable level commensurate with average Australian standards by personal superannuation / savings, supplemented by the means-tested Age Pension.
4. Establish the characteristics of households that would be eligible for the Age Pension, given the selection of economic factors and policy options.

To provide for a manageable study, the research was restricted to the situation of Australians earning median income. The representative segments of the population chosen for study are (i) a couple with two children (ii) a single male and (iii) a single female, raising a child by herself.

This study is concerned with establishing optimal approaches to savings and consumption over a lifetime with the constrained optimisation technique of linear programming being chosen as the most appropriate one to achieve the objectives of the study. The optimal solutions were obtained under three commonly adopted strategies by decision makers in Australia. The first considers only non-housing consumption (NHC), the second considers together both housing consumption and NHC, whilst the third uses a combined measure of NHC and intrinsic housing worth.

5.2.1.1 Overview of optimal decisions for specific demographic groups

Before presenting the conclusions for this study it is useful to set out, for each demographic group together with each strategy for decision making, the choices that provide optimal solutions[72]. Tables 5-1 to 5-8 provide this information. As well as the decisions detailed in these tables, it is important to note that every optimal solution involves limiting consumption to the minimum specified for the particular situation until the subjects of the model are in their early 40s.

[72] Some of these optimal decisions reflect the constraints built into the models. An example of such a situation is that the minimum specified value of owner-occupied housing is lower for households of age 25 to 42 than it is for other age groups, and thus if the optimal solution specifies modest housing in the early years, the optimal solution for owner-occupied housing in later years must involve an upgrade.

Table 5-1 Decisions giving optimal result – Couple with two children model – Full use of financial products

Demographic segment: Couple with two children. Male earning median labour income for males by age. Female working part time. Median household income. Male dies at age 80, female at age 98.

Approach: Open to use of all financial products. No requirements for bequest.

Strategy and decisions		
Maximise consumption, subject to a minimum level of housing	Maximise, in concert, consumption and housing value	Maximise, in concert, consumption and intrinsic housing worth
• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s, downsize minimally[73] in 50s and moderately in 80s. • Pay out mortgage by mid 50s. • Make moderate non-superannuation savings until mid 50s. • Make minimal superannuation savings beyond SGL. • Take moderate transition to retirement pension. • At retirement, buy life-contingent annuities, take out reverse mortgage, set up superannuation pension, and withdraw lump sum from superannuation. • Wealth structuring enables full Age Pension for all 32 post-retirement years.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s, and substantially in 60s. • Pay out mortgage by retirement. • Make moderate non-superannuation savings until mid 50s, further substantial savings until retirement. • No superannuation savings beyond SGL. • Take moderate transition to retirement pension. • At retirement, buy life-contingent annuities, take out reverse mortgage, and withdraw lump sum from superannuation. Note – no superannuation pension. • Wealth structuring enables full Age Pension for all 32 post-retirement years.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s and in 50s, upgrade minimally in 60s and downsize moderately in 80s. • Pay out mortgage by retirement. • Make moderate non-superannuation savings until mid 50s and minimal such savings until retirement. • No superannuation savings beyond SGL. • Take moderate transition to retirement pension. • At retirement, buy life-contingent annuities, take out reverse mortgage, set up superannuation pension, and withdraw lump sum from superannuation. • Wealth structuring enables full Age Pension for all 32 post-retirement years.

[73] The terms ‘minimal’, ‘moderate’ and ‘substantial’ are, by their nature, subjective. They have been adopted to provide a relative understanding of the impact of the decisions needing to be made to obtain an optimal result across a lifetime.

Table 5-2 Decisions giving optimal result – Couple with two children model – Limited use of financial products

Demographic segment: Couple with two children. Male earning median labour income for males by age. Female working part time. Median household income. Male dies at age 80, female at age 98.

Approach: Not prepared to use reverse mortgage, annuities or risky investments. Requirement for substantial bequest (proxy for funds for catastrophe).

Strategy and decisions		
Maximise consumption, subject to a minimum level of housing	Maximise, in concert, consumption and housing value	Maximise, in concert, consumption and intrinsic housing worth
• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s and minimally in 60s downsize moderately in 80s. • Pay out mortgage by mid 50s. • Make moderate non-superannuation savings until early 40s. • Make minimal superannuation savings beyond SGL from 40s till retirement. • Take moderate transition to retirement pension. • At retirement, set up superannuation pension, and withdraw lump sum from superannuation. • Full Age Pension till death of male. Part Age Pension for widow.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s and again in 50s. Downsize minimally at retirement, and moderately in 80s. • Pay out mortgage by retirement. • Make moderate non-superannuation savings until early 40s. • No superannuation savings beyond SGL • Take moderate transition to retirement pension. • At retirement, set up superannuation pension, and withdraw lump sum from superannuation. • Wealth structuring enables full Age Pension for all 32 post-retirement years.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s and again in 50s.Downsize minimally in 60s and moderately in 80s. • Pay out mortgage by retirement. • Make minimal non-superannuation savings until early 40s. • No superannuation savings beyond SGL Take moderate transition to retirement pension. • At retirement, set up superannuation pension, and withdraw lump sum from superannuation. • Full Age Pension till death of male. Part Age Pension for widow.

Table 5-3 Decisions giving optimal result – Single male model – Full use of financial products

Demographic segment: Single male earning median labour income for males by age. Subject dies at age 98.
Approach: Open to use of all financial products. No requirements for bequest.

Strategy and decisions		
Maximise consumption, subject to a minimum level of housing	Maximise, in concert, consumption and housing value	Maximise, in concert, consumption and intrinsic housing worth
• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s, hold dwelling till death. • Pay out mortgage by age 80. • Make substantial non-superannuation savings until retirement, and moderate such savings in early retirement. • No superannuation savings beyond SGL. • Take moderate transition to retirement pension. • At retirement, buy life-contingent annuities. • In early 80s, take out reverse mortgage. • No Age Pension received. Significant income from non-superannuation investments during retirement.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade substantially in 40s, and again in 50s. Hold dwelling until death • Pay out mortgage by retirement. • Make substantial non-superannuation savings until mid 50s, and moderate such savings until retirement. • No superannuation savings beyond SGL. • Take moderate transition to retirement pension. • At retirement, buy life-contingent annuities, take out reverse mortgage, and withdraw lump sum from superannuation. Note – no superannuation pension. • Wealth structuring enables full Age Pension for all 32 post-retirement years.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s, hold dwelling till death. • Pay out mortgage by age 80. • Make substantial non-superannuation savings until retirement, and moderate such savings in early retirement. • No superannuation savings beyond SGL. • Take moderate transition to retirement pension. • At retirement, buy life-contingent annuities. • In early 80s, take out reverse mortgage. • No Age Pension received. Significant income from non-superannuation investments during retirement.

Table 5-4 Decisions giving optimal result – Single male model – Limited use of financial products

Demographic segment: Single male earning median labour income for males by age. Subject dies at age 98.
Approach: Not prepared to use reverse mortgage, annuities or risky investments. Requirement for substantial bequest (proxy for funds for catastrophe).

Strategy and decisions		
Maximise consumption, subject to a minimum level of housing	Maximise, in concert, consumption and housing value	Maximise, in concert, consumption and intrinsic housing worth
• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s, hold dwelling till death. • Pay out mortgage by mid 50s • Make moderate non-superannuation savings until early 40s, and minimal such savings until mid 50s. • Make substantial superannuation savings beyond SGL until retirement. • Take substantial transition to retirement pension. • At retirement, set up superannuation pension. • No Age Pension received.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade substantially in 40s and 50s, and moderately in 60s. Hold dwelling until death. • Pay out mortgage by retirement. • Make moderate non-superannuation savings until mid 50s, and minimal such savings until early 80s. • Make minimal superannuation savings beyond SGL until early 40s, and substantial such savings until retirement. • Take substantial transition to retirement pension. • At retirement, set up superannuation pension. • Wealth structuring enables full Age Pension for all 32 post-retirement years.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade substantially in 40s, and moderately in 50s. Downsize moderately in 80s. • Pay out mortgage by age 80. • Make moderate non-superannuation savings until mid 50s. • Make modest superannuation savings beyond SGL until early 40s, and substantial such savings until retirement. • Take substantial transition to retirement pension. • At retirement, set up superannuation pension. • No Age Pension received.

Table 5-5 Decisions giving optimal result – Single male model – Limited use of financial products –Higher consumption

Demographic segment: Single male earning median labour income for males by age. Subject dies at age 98.
Approach: Not prepared to use reverse mortgage, annuities or risky investments. Requirement for substantial bequest (proxy for funds for catastrophe). Need for relatively higher consumption from age 25 to 56.

Strategy and decisions		
Maximise consumption, subject to a minimum level of housing	Maximise, in concert, consumption and housing value	Maximise, in concert, consumption and intrinsic housing worth
• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s, hold dwelling till death. • Pay out mortgage by retirement. • Make moderate non-superannuation savings until early 40s and minimal such savings until mid 50s. • Make moderate superannuation savings beyond SGL until early 40s and substantial such savings until retirement. • Take substantial transition to retirement pension. • At retirement, set up superannuation pension. • No Age Pension received.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade substantially in 40s, and moderately in 50s and 60s .Hold dwelling until death. • Pay out mortgage by retirement. • Make moderate non-superannuation savings until mid 50s. • Make significant superannuation savings beyond SGL from early 40s to mid 50s. • Take moderate transition to retirement pension. • At retirement, set up superannuation pension. • Wealth structuring enables full Age Pension for all 32 post-retirement years.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade substantially in 40s, and moderately in 50s. Downsize minimally at retirement and moderately in 80s. • Pay out mortgage by retirement • Make moderate non-superannuation savings until mid 50s. • Make substantial superannuation savings beyond SGL from early 40s to mid 50s. • Take substantial transition to retirement pension. • At retirement, set up superannuation pension, and withdraw lump sum from superannuation. • Wealth structuring enables full Age Pension until early 80s and part pension thereafter.

Table 5-6 Decisions giving optimal result – Female with child model – Full use of financial products

Demographic segment: Female with sole responsibility for a child. Earning median labour income for females by age. Some reduction in income when child an infant. Subject dies at age 98

Approach: Open to use of all financial products. No requirements for bequest.

Strategy and decisions		
Maximise consumption, subject to a minimum level of housing	Maximise, in concert, consumption and housing value	Maximise, in concert, consumption and intrinsic housing worth
• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s. Hold dwelling till death. • Pay out mortgage by age 80. • Make substantial non-superannuation savings until early 80s. • No superannuation savings beyond SGL • Take modest transition to retirement pension. • At retirement, buy life-contingent annuities. • In early 80s, take out reverse mortgage. • No Age Pension received. Significant income from non-superannuation investments during retirement.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s, and substantially in 50s. Hold dwelling until death. • Pay out mortgage by retirement. • Make substantial non-superannuation savings until retirement. • No superannuation savings beyond SGL • Take moderate transition to retirement pension. • At retirement, buy life-contingent annuities, take out reverse mortgage Note – no superannuation pension. • Wealth structuring enables full Age Pension for all 32 post-retirement years	• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s, hold dwelling till death. • Pay out mortgage by age 80. • Make substantial non-superannuation savings until early 80s. • No superannuation savings beyond SGL • Take modest transition to retirement pension. • At retirement, buy life-contingent annuities. • In early 80s, take out reverse mortgage. • No Age Pension received. Significant income from non-superannuation investments during retirement.

Table 5-7 Decisions giving optimal result – Female with child model – Limited use of financial products

Demographic segment: Female with sole responsibility for a child. Earning median labour income for females by age. Some reduction in income when child an infant. Subject dies at age 98

Approach: Not prepared to use reverse mortgage, annuities or risky investments. Requirement for substantial bequest (proxy for funds for catastrophe).

Strategy and decisions		
Maximise consumption, subject to a minimum level of housing	Maximise, in concert, consumption and housing value	Maximise, in concert, consumption and intrinsic housing worth
• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s. Hold dwelling till death. • Pay out mortgage by mid 50s • Make minimal non-superannuation savings until mid 50s. • Make moderate superannuation savings beyond SGL until early 40s and substantial such savings until retirement. • Take substantial transition to retirement pension. • At retirement, set up superannuation pension. • No Age Pension received.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade substantially in 40s and again in 50s, and moderately at retirement. Hold dwelling until death. • Pay out mortgage by retirement. • Make substantial non-superannuation savings until retirement. • Make moderate superannuation savings beyond SGL until early 40s. • Take moderate transition to retirement pension. • At retirement, set up superannuation pension, and make lump sum withdrawal from superannuation. • Wealth structuring enables full Age Pension for all 32 post-retirement years.	• Take out a mortgage on a modest dwelling in mid-20s, upgrade substantially in 40s and again in 50s, Downsize minimally at retirement and moderately in 80s. • Pay out mortgage by retirement. • Make substantial non-superannuation savings until mid 50s. • Make minimal superannuation savings beyond SGL until early 40s. • Take moderate transition to retirement pension. • At retirement, withdraw lump sum from superannuation and set up superannuation pension. • Wealth structuring enables full Age Pension until early 80s and part pension thereafter.

Table 5-8 Decisions giving optimal result – Female with child model – Limited use of financial products –Higher consumption

Demographic segment: Female with sole responsibility for a child. Earning median labour income for females by age. Some reduction in income when child an infant. Subject dies at age 98

Approach: Not prepared to use reverse mortgage, annuities or risky investments. Requirement for substantial bequest (proxy for funds for catastrophe). Need for relatively higher consumption from age 25 to 56.

<table>
<tr><th colspan="3">Strategy and decisions</th></tr>
<tr><th>Maximise consumption, subject to a minimum level of housing</th><th>Maximise, in concert, consumption and housing value</th><th>Maximise, in concert, consumption and intrinsic housing worth</th></tr>
<tr>
<td>• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s. Hold dwelling till death.
• Pay out mortgage by retirement.
• Make moderate non-superannuation savings until early 40s, and again from mid 50s until retirement.
• Make substantial superannuation savings beyond SGL until early 40s and moderate such savings until mid 50s.
• Take moderate transition to retirement pension.
• At retirement, set up superannuation pension, and withdraw lump sum from superannuation.
• Wealth structuring enables full Age Pension for all 32 post-retirement years.</td>
<td>• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s, and again in 50s. Downsize minimally at retirement and hold till death.
• Pay out mortgage by retirement.
• Make moderate non-superannuation savings until mid 50s.
• No superannuation savings beyond SGL.
• Take moderate transition to retirement pension.
• At retirement, set up superannuation pension.
• Wealth structuring enables full Age Pension for all 32 post-retirement years.</td>
<td>• Take out a mortgage on a modest dwelling in mid-20s, upgrade moderately in 40s and minimally in 50s Downsize moderately both at retirement and in 80s.
• Pay out mortgage by retirement.
• Make moderate non-superannuation savings until early 40s.
• No superannuation savings beyond SGL.
• Take moderate transition to retirement pension.
• At retirement, withdraw lump sum from superannuation and set up superannuation pension.
• Wealth structuring enables full Age Pension for all 32 post-retirement years.</td>
</tr>
</table>

5.2.1.2 Optimal solutions from perspective of the objectives of the study

With respect to Objective 1, where the subjects of the models act from a rational, self-interested perspective, for all three population sectors and for all three considerations of optimality the optimal solutions involve the use of owner-occupied housing at all times. This mode of housing provision allows for the use of a reverse mortgage in the retirement years, contingent upon the payout of the mortgage. Another common finding is that optimal solutions involve minimum NHC whilst the subjects of the models are aged in their 20s and 30s. For saving for retirement, for the great majority of optimal solutions, no use is made either of salary sacrificing or post-tax deposits into superannuation, but rather the approach set out by the solution is for savings to be placed in risky investments. Labour income is found to be a sensitive variable, whereas the initial amount of funds available to the young adult / household does not impact on lifetime wellbeing.

Objective 2 is concerned with establishing the impact on lifelong wellbeing when subjects of the model are not prepared to act in a rational self-interested way, but instead hold to some behavioural attitudes that limit choices. In particular, the behavioural attitudes assumed for the study are that reverse mortgages and life-contingent annuities are not acceptable, any savings must be via salary sacrifice or post-tax deposit into superannuation, or through the use of a risk free savings account, and that there must be access to significant funds in the case of a catastrophe in old age. The findings from the study show that, for these choice limitations, all optimal solutions involve owner-occupied housing across the life-cycle. There is a reduction in lifetime wellbeing associated with this outlook ranging from 7.8% reduction for a couple with two children where their measure of optimality involves both NHC and intrinsic housing worth to a reduction of 43.9% for the female with a child whose measure of optimality is restricted to NHC only. The results show that, for the Co2Ch model, it is the absence of reverse mortgages that makes the major impact, whilst for the other two models it is the inability to invest in risky assets that is most responsible for this downturn in wellbeing.

As mentioned in Section 4.7, the appropriate level of the SGL is contested. Objective 3 of this study is concerned with establishing the appropriate level to provide for a comfortable retirement in line with community standards, assuming the availability of the Age Pension under present conditions. This study has determined that, for

Australians earning median labour income, increasing the level from 9% of wages per annum to 12% does not bring about significant improvement in the amount of funds available for retirement nor for increased wellbeing across a lifetime.

The fourth objective of this study is to investigate the eligibility for the Age Pension for the subjects of the models of the study under various economic conditions and policy options. In examining the optimal solutions for both the situation where rational self interest prevails and also the situation of limited choice due to behavioural considerations, many of these solutions involve the reception of either a full or part pension. It can safely be said that, for the three population sectors considered in this study, it is possible to arrange financial affairs to receive the Age Pension, and that, for many of the scenarios considered in this study, reception of this payment is part of the optimal solution.

5.2.2 Conclusions drawn

Taking into account the evidence provided from the results relating to the four specific objectives, this study has demonstrated, in answer to the research question that for the representative groups of the population considered, a comfortably adequate retirement standard can be achieved, given the present policy decisions relating to retirement savings, taxation and the Age Pension.

There are four major conclusions that can be drawn from the results of the study. The first is the pivotal role of owner-occupied housing. For optimal wellbeing, such housing is required at all stages of the lifecycle for all three representative groups. The second conclusion is that increasing the SGL rate to 12% per annum will not improve the retirement outcomes for the segments of the Australia population considered in this study.

The third conclusion is the substantive role of the Age Pension in securing wellbeing across a lifetime, again for all three representative groups. For the Co2Ch model, where one of the partners works only part time and the household income is median, the Age Pension, either in part or full, features in all optimal solutions. For the other two models, there are examples of optimal solutions not involving the Age Pension at all, but these solutions rely on considerable savings in the early years with these savings being invested in risky assets. However, depending on the view of what makes for optimality, many of the optimal solutions for these groups do involve access to the Age Pension in some form. Given the downside potential of high risk investments, it is fair to conclude that the eventual availability of the Age Pension combined with the desire for earlier consumption might lead such Australians to manage their affairs so as to avail themselves of at least a part pension payment.

The fourth conclusion is that there needs to be careful consideration of retirement funding products. The study has shown that neither salary sacrificing into superannuation nor depositing post-tax savings during the working years feature in most optimal solutions. As well, it has been demonstrated that reverse- mortgages can significantly improve retirement outcomes for Australians. Life-contingent annuities whilst appearing in many optimal solutions, do not significantly improve the level of funds available to individuals.

5.3 Implications

The results of this study have implications for both individual Australian earning median labour income and for policy in the area of provision for retirement funding for Australians.

5.3.1 Implications for individual Australians

For Australian earning median labour income, there are several clear implications arising from this study, assuming that current policy regarding retirement savings, access to the Age Pension and income tax arrangements remain as they are now.

Firstly, high priority needs to be given to buying a dwelling for own occupation. This owner-occupied housing needs to be fully paid for before the retirement years, thus allowing for the use of a reverse mortgage in old age. Secondly, there needs to be recognition that consumption in the years up until age 40 needs to be restricted. Such behaviour provides for better outcomes across the lifecycle. Thirdly, for this income range, there is considerable financial benefit in structuring wealth so as to avail the household of the Age Pension.

With regard to saving for retirement, there will be funds accumulated in superannuation though the payment of the SGL. As to whether further savings should be invested in superannuation, either directly or via salary sacrifice, the results of the study suggest this choice is dependent upon the existence of considerable surplus funds, together with a decision making strategy that accepts a minimum standard of owner-occupied housing. Thus, for most households considered in this thesis, savings should be invested in risky assets or in a risk free financial product, with the use of both these approaches leading to a more optimal result than investment in superannuation. The mode chosen, and therefore the set of decisions, will depend on the individual's risk profile.

5.3.2 Implications for retirement funding policy

The study suggests several implications in the area of policy for retirement funding. These implications are discussed below.

5.3.2.1 Implications for retirement funding policy: owner-occupied housing

The optimal solutions emerging in this study involve owner-occupied housing across the lifecycle. This option is relevant to a considerable extent because of the favoured treatment of this asset, i.e. no capital gains tax liability, no income tax on imputed rent, and exclusion from consideration in the application of the assets and income tests for the Age Pension. These present policy positions, together with the situation that Australia has population growth, partly due to positive net migration, means that housing prices consistently appreciate at a rate in excess of inflation. If policies were to change in this area, there could be significant impact of retirement income and hence retirees' well being.

Another aspect of policy relating to housing is that of policy regarding reverse mortgages. These financial products feature significantly in all optimal solutions established in this study. The deterministic nature of the model used in this study together with the parameters used to populate it, ensure that the use of a reverse mortgage in an optimal solution has no possibility of incurring a negative impact. However this is not the case in reality. The use of a reverse mortgage can lead to a householder having very low equity, and even to a negative equity situation[74]. This situation has been taken onboard by policy makers and, as discussed in Chapter 2 Section 2.3.5.4, since September 2012 reverse mortgages have been subject to increased regulation including statutory protection from negative equity.

[74] Such a situation can arise when a reverse mortgage is taken out over a long period, rather than for a few years as is the case when the very elderly avail themselves of such product. As well negative housing growth can lead to such a situation.

As discussed in Chapter 2 Section 2.2.5 there is evidence that Australians are using home equity across the life cycle to provide consumption funds. This situation, together with the negative possibilities of the use of reverse mortgages, suggests the usefulness of an education program on the responsible use of home equity. Firstly, Australians need to be aware of the usefulness of reverse mortgages, used appropriately, but that a necessary condition for access to such a product is that the dwelling is mortgage free. Thus, the importance of owning a dwelling outright before retiring needs to be emphasised. Further, home owners should be made aware of the potential for reverse mortgage arrangements to result in negative outcomes. In particular, it needs to be stressed that the likelihood of negative outcomes decreases significantly as the homeowner ages and that reverse mortgages should ideally not be considered until advanced old age.

5.3.2.2 Implications for retirement funding policy: access to the Age Pension

As mentioned several times in this study but particularly in Chapter 2 Section 2.3.5.3, it has been the stated policy position over two decades that there would be continued reliance on the Age Pension for many Australians, even with universal superannuation. The view has been that the funds from superannuation will allow for an increased standard of living beyond the basic standard possible if the only source of funds is the pension.

It has been demonstrated in this study that, for people earning median labour income, not only is being in receipt of a pension or part pension an achievable aim, but that such a payment is part of the optimal solution in many situations. However, to demonstrate eligibility for the Age Pension, it may be necessary to structure retirement assets and income appropriately to meet the assets and income tests. As set out in Chapter 4 Section 4.3.5, for a majority of the optimal solutions where there is receipt of at least a part Age Pension, a necessary decision for the individual to gain this benefit is the withdrawal of a lump sum from his or her superannuation account. The benefits lost from carrying this sum into retirement are more than compensated for by the Age Pension payment received. A key question for policy makers is whether this situation of withdrawals of lump sums to manipulate eligibility for the Age Pension is sustainable.

Moreover, this study has demonstrated that, to reduce the reliance on receiving the pension, there would have to be significant restructuring of the assets and income tests. Merely reducing eligibility in a stepwise manner will not have such effect.

If there were to be a change in policy with the aim of decreasing reliance on the Age Pension, there would need to be a significant time lag to allow Australians to adjust their approach to preparing for retirement.

5.3.2.3 Implications for retirement funding policy: compulsory annuitisation

In Chapter 2 Section 2.2.2.2, the benefits of annuitisation from an academic perspective were set out, together with the recognition that in practice there is little annuitisation. In Section 2.3.5.2, this issue was discussed from the perspective of the various retirement policy reviews occurring in Australia recently.

This results of this study show that the purchase of life-contingent annuities features in every optimal solution for which the model permits such products. Paradoxically, the study also shows that the loss in overall lifetime wellbeing if such products are disallowed is not high when compared to loss of reverse mortgages and risky investment products. It is important to note that the subjects of the models in this study experience considerable longevity and thus it would be expected that the benefits for segments of the population with a shorter life span would be less.

From the perspective of policy makers, some form of annuitisation is desirable as annuitisation ensures that retirement savings are preserved for the breadth of the retirement years. Given the results of this study and the prolific existing evidence that retirees do not voluntarily annuitise, policy makers would need to convince retirees of the benefits of annuitisation. An education program set up to frame annuitisation as a positive way to manage the risk of inadequate funds in advanced old age may be appropriate.

5.3.2.4 Implications for retirement funding policy: level of SGL

In Chapter 2 Section 2.3.2 the appropriate level of the SGL is discussed from a policy perspective. As stated elsewhere in this study, the current level is contested. The results of this study suggest that, for the representative population groups used for this study, increasing the SGL to 12% does not result in any advantages. Thus this study supports the policy position taken by the Henry Report, a position which was rejected by the government in power at the time of the report.

5.3.3 Reflection on issues raised in literature and policy reviews

At this stage of considering the implications of the results of this study, it is appropriate to reflect upon the issues raised in the academic literature and in reviews of policy relating to retirement for Australians

In Chapter 4, the overall conclusion summed up the concerns of the literature as being:

- The ability of Australians to participate effectively in the Australian retirement income system, in both the accumulation and decumulation phases (Concern 1).
- The adoption of appropriate annuitisation of wealth on retirement (Concern 2).
- Recognition of an appropriate standard of living for the retirement years (Concern 3).
- The role of the owner–occupied dwelling in providing lifetime well being, but particularly during the retirement years (Concern 4).

The concerns raised in the policy reviews were determined as:

- Investment of superannuation assets to achieve optimal results in retirement (Concern 5).
- The appropriate rate for SGL (Concern 6).
- The need for the use of retirement savings to provide for considerable longevity for a high proportion of the population (Concern 7).
- The tax-privileged role of owner-occupied housing across the lifecycle (Concern 8).
- Appropriate targeting of the Age Pension, together with ensuring it provided an adequate amount for people fully dependent upon this benefit (Concern 9).
- Intergenerational issues regarding the funding of Age Pension (Concern 10).

Concerns 4 and 8 relate to issues around owner-occupied housing, Concern 6 relates to the appropriate rate for SGL, Concern 9 relates to the provision of the Age Pension and

Concerns 2 and 7 involve appropriate annuitisation of wealth in the retirement years. Thus six of these concerns have already been discussed previously in this chapter.

Concern 3 – the recognition of an appropriate standard of living in retirement – was assumed in this study. As discussed in Section 4.2.5, the MBA standard set out by ASFA was judged the minimum standard for the subjects of this model. As discussed in Section 4.7.2.2, this standard is achievable for all population segments considered with all definitions of optimality. Indeed a much higher standard of living is achievable, depending on the definition of optimality adopted.

Concern 10 - intergenerational issues regarding the funding of the Age Pension – is not considered explicitly in this study. However, implicit in the discussion of policy implications regarding access to the Age Pension is concern for the ability of future generations to provide the Age Pension in some form to the great majority of people in the appropriate age group. The results of this study suggest that (nearly) all people earning median labour income will receive at least a part pension if current policies are maintained.

The two remaining concerns can be considered together. Concern 1 questions the ability of Australians to participate effectively in the Australian retirement income system, in both the accumulation and decumulation phases. Concern 5 - the need for investment of superannuation assets to achieve optimal results in retirement - is related to concern 1. As discussed in Section 2.3.3, the Cooper Report proposed the introduction of default funds, incorporating both the accumulation and decumulation phases, with each superannuation provider setting up such a fund for their clientele. Such a fund would provide for Concerns 1 and 5 for the population sectors for this study. The existence of a lifecycle fund as proposed by Cooper is implicit in this study. There is only one option for superannuation investment in the model, and the assumption is that this fund is the most appropriate for the model subjects.

5.4 Recommendations

Based on the implications arising from this study and the consideration of concerns raised by the literature and recent policy reviews, the following recommendations are provided:

5.4.1 Recommendations for Australians earning median income

1. Limit consumption when aged in the 20s and 30s. Adopt a strong savings habit.

2. In young adult years, purchase a dwelling for own occupation. Ensure this dwelling is mortgage-free by retirement.

3. Understand the household's risk profile and invest savings appropriately. Consider carefully the limitation of savings through contributions to superannuation beyond the SGL.

4. Develop enough financial literacy to understand the advantages and disadvantages of retirement products such as reverse mortgages and life-contingent annuities.

5. In the years immediately before retirement, structure wealth so as to avail the household of at least a partial Age Pension.

5.4.2 Policy recommendations

1. Maintain the present SGL rate, as recommended by Henry (2009).

2. Provide public education on the benefit of having a mortgage-free dwelling before retirement, and the risk of using housing equity to finance consumption in the years before retirement.

3. Provide public education on both the benefits and disadvantages of the use of housing equity to finance consumption in retirement. Such education needs to stress the reduction in risk when this source of funds is reserved for advanced old age.

4. Provide public education on the benefits of life-contingent annuities. Such education needs to be framed positively, using terms such as 'peace of mind', and 'ensuring your money lasts as long as you do'.

5. Supplement the MySuper accumulation offering, introduced as a result of the Cooper Report, with a decumulation fund offering life-contingent annuities[75].

[75] The Henry Report recommended the government offer a life contingent annuity whilst the Cooper Report recommended that MySuper be a whole of life product (see Section 2.3.5.2).

6. Limit the ability for retirees to withdraw large lump sums from superannuation at retirement. As this recommendation is likely to cause public unease, it would need to be introduced in a phased way.

5.5 Limitations and future directions

There are many limitations associated with this study. However, the study can be judged as a successful initial foray into the use of mathematical programming in studying retirement funding in Australia, and, as such, there are clear future directions that can be taken, both in an academic research setting and for development for use by policy makers and by financial planners advising individual Australians.

5.5.1 Limitations

The limitations of this study are major and manifest. These limitations are discussed immediately below, under various headings.

5.5.1.1 Limitations of the method

Firstly, it is appropriate to consider the limitations of the method. Linear programming, the method adopted, does provide for an optimisation approach. It was used for this study because it has demonstrated its power in solving analogous problems in other disciplines, and because there are powerful solving engines that are both available at a reasonable price for use on desktop computer and that provide details of optional solutions in a timely manner. However, there are more sophisticated programming approaches available, such as non-linear programming, stochastic programming, and control theory based optimisation techniques. Non-linear programming would allow for more accurate modelling of some constraints, whilst stochastic programming would provide for a probabilistic model, whereas the model used in this study is deterministic. This, however, has been partly considered by post optimal sensitivity analysis.

5.5.1.2 Limitations of scope

A significant limitation of this study is that models were built for only three population segments, where, for all three segments, the principal wage earner labour income is median, and for the couple segment, the household also is in receipt of median household income. Another limitation is the number of financial products available for retirement funding. For the models used, there is only one superannuation investment product available, and likewise only one option for one non- superannuation investment.

With regard to the population segments, the model could be adapted for other groups. However, there would need to be review of all the parameters used to judge their suitability for these populations. More savings options could be introduced into the present models. Examples of possible options include splitting non-superannuation savings into separate categories such as guaranteed deposits, investment housing, government bonds and shares

5.5.1.3 Limitations of modelling

The model was set up to have only five periods cover the years from 25 years to 98 years. Modelling of the Age Pension is simplistic, as there are only three options i.e. a full pension, a half pension and no pension. Modelling of taxation is also simplistic as a single representative rate for each period by gender is applied to taxable earnings. The model was constructed with these limitations to allow for a person building the model alone with a limited time frame. However, it is quite feasible to build a more sophisticated model with several more time periods, greater delineation of Age Pension outcomes and a variable taxation rate. Such a model would have significantly more decision variables and constraints.

5.5.1.4 Limitations imposed by the time span

By its very nature, a model that spans 74 years has significant limitations. The assumption is made that policy, and the approach to implementation of policy, remains constant over this period.

5.5.1.5 Data limitations

There are significant limitations regarding the use of data in the model. In particular, constant rates for parameters such as the inflation rate, the housing growth rate and rates of return for various investments are used for all periods. The pricing of life-contingent annuities is based on the market returns occurring at the end of 2011. The data for median labour income for the population segments by age and gender as used in the model is also based on 2011 figures. This labour income reflects the relationship between the economy and the labour market at that time.

It is certainly possible to develop a model where different data is used for different periods. As with other limitations, incorporating such differences into the model would lead to greater complexity.

5.5.1.6 Limitations of analysis

Whilst, as discussed immediately above, there are significant limitations in this study, another limitation is that of the amount of analysis undertaken of the results generated for the actual models and scenarios. To keep this study at a manageable size, only a selection of combinations of parameters was considered. Further sensitivity analysis could be undertaken without any further extensions of the model, but merely by changing some parameters. An example of such a situation is the use of alternative minimum and maximum owner-occupied housing values for the different periods.

5.5.2 Future directions

This study provides a solid base for further academic research. It also provides an approach that could be adopted for analysis by policy makers. As well, the conceptual framework and the empirical model could be commercialised as a tool to be used by personal financial planners in explaining the outcomes of various financial decisions to their clients.

For further academic research, the discussion under the heading of limitations provides many possibilities for extension of this study. In particular, the adoption of stochastic programming with a more delineated model would provide results with a higher degree of confidence that the results set out in this study. The use of a stochastic approach would allow for the incorporation of changing parameters across the lifecycle, a much more realistic situation than for this study where parameters are constant.

Another obvious way the study could be extended is to develop models for different subsets of the Australian population. Such a study would be particularly useful in understanding some policy issues, for example the ability of Australians earning labour income at a certain level to be eligible for a part or full Age Pension.

Outside of academia, this study shows the viability of using a mathematical programming approach as an adjunct to modelling approaches presently used by policy making bodies. As mentioned in Section 1.5, the Treasury of the Australian Government uses actuarial and microsimulation approaches for testing policy initiatives. The adoption of a mathematical programming approach would allow for this analysis to supplement present analysis.

Another possible development that could arise from this thesis is the development of a tool for personal financial planners as well as for individuals with sufficient levels of financial literacy and quantitative skills. The speed at which the optimising software can generate optimal solutions using a basic desktop computer makes such a tool feasible. The strength of the approach used in this study is that the optimal solution for a particular objective is found. At present, financial planners can generate results for sets of decisions, and the outcome for each decision can be compared to another decision. However, with this present approach, there is no way of knowing if the optimal solution is even being considered. Once an optimal result is generated, it would be then possible to look at solutions close to the optimal solution, taking into account specific behavioural considerations pertinent to the client.

References

Abelson, P, Joyeux, R, Milunovich, G & Chung, D 2005, 'Explaining House Prices in Australia: 1970 – 2003: Consumption Versus Expenditure', *The Economic Record* vol. 81, no. 255, pp. S96-103.

Agnew, J 2013, 'Australia's Retirement System: Strengths, Weaknesses and Reforms', Center for Retirement Research at Boston College Brief 2013-5, viewed 22 Apr 2013, <http://crr.bc.edu/briefs/australia%E2%80%99s-retirement-system-strengths-weaknesses-and-reforms-2/>.

Aguiar, M & Hurst, E 2005, 'Consumption Versus Expenditure', *Journal of Political Economy*, vol. 113, no. 5, pp. 919-48.

Albers, DJ, Reid, C & Dantzig, GB 1986, 'An Interview with George B. Dantzig: The Father of Linear Programming', *The College Mathematics Journal*, vol. 17, no. 4, pp. 293-314.

Altfest, L 2004, 'Personal Financial Planning: Origins, Developments and a Plan for Future Direction', *The American Economist*, vol. 48, no. 2, pp. 53-60.

Ameriks, J, Caplin, A, Laufer, S & Van Nieuwerburgh, S 2007, 'The Joy of Giving or Assisted Living? Using Strategic Surveys to Separate Bequest and Precautionary Motives', NBER Working Paper, no. 13105, National Bureau of Economic Research, Cambridge, Massachusetts.

Ameriks, J, Veres, R & Warshawsky, MJ 2001, 'Making Retirement Income Last a Lifetime', *Journal of Financial Planning*, vol. 14, no. 12, pp. 60-76.

ANOP Research Services 2001, *Report on Community Attitudes to Saving for Retirement*, Association of Superannuation Funds of Australia (ASFA), Sydney.

Association of Superannuation Funds of Australia (ASFA) 2008, *Super Returns – Putting Them Into Perspective*, ASFA Background Paper August 2008, viewed 29 Nov 2011, <http://www.superannuation.asn.au/ArticleDocuments/116/ASFA-BP0808-SuperReturns.pdf.aspx>.

—— 2013, *The ASFA Retirement Standard*, ASFA, Sydney.

Attanasio, O 1999, 'Consumption', in JB Taylor and M Woodford (eds), *Handbook of Macroeconomics*, North-Holland Publishing Company, Amsterdam, pp. 741-812.

Australian Bureau of Statistics (ABS) 2008a, *Australian Historical Population Statistics 2008*, cat.no. 3105.0.65.001, viewed 17 Apr 2013, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3105.0.65.0012008?OpenDocument>.

—— 2008b, *Population Projections Australia, 2006 to 2101*, cat.no. 3222.0, viewed 17 Apr 2013, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3222.02006%20to%202101?OpenDocument>.

—— 2010, *Population by Age and Sex, Australian States and Territories, Jun 2010*, cat.no. 3201.0, viewed 22 Apr 2013, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/3201.0Main+Features1Jun%202010?OpenDocument>.

—— 2011a, *Average Weekly Earnings, Australia, Aug 2011*, cat.no. 6302.0 , viewed 25 Nov 2011, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/CD8B821AF434F448CA2579AC000D5D46?opendocument>.

—— 2011b, *Consumer Price Index, Australia, Jun 2013*, cat.no. 6401.0, viewed 26 Aug 2011, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/3E263FB203221FE1CA2579340011D9A3?opendocument>.

—— 2011c, *Employee Earnings, Benefits and Trade Union Membership August 2010*, cat.no. 6310.0, viewed 25 Nov 2011, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/7D82DAC2427DEE99CA2579EC00154049?opendocument>.

—— 2011d, *House Price Indexes: Eight Capital Cities, Jun 2011*, cat.no. 6416.0, viewed 26 Aug 2011, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/F7424B26B37B0BC1CA25793A000ECAA7?opendocument>.

——2011e, *Household Income and Income Distribution, Australia*, 2009-10 , cat.no. 6523.0 , viewed 25 Nov 2011, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6523.02009-10?OpenDocument>.

—— 2011f, *Household Wealth and Wealth Distribution,* cat.no. 6554.0 , viewed 17 Apr 2013, <http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/51342DFD54324472CA257928001107B4/$File/65540_2009-10.pdf>.

—— 2011g, *Housing Occupancy and Costs, 2009-10*, cat. no. 4130.0, viewed 19 Feb 2013, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4130.0200910?OpenDocument>.

—— 2012a, *Life Tables, States, Territories and Australia, 2009-2011,* cat.no. 3302.0.55.001, viewed 25 Jan 2013, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3302.0.55.0012009-2011?OpenDocument>.

—— 2012b, *Year Book Australia, 2012,* Industry Structure and Performance, Value of Goods and Services Produced by Australian Industry, cat.no. 1301.0 viewed 20 Apr 2013, <http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1301.0~2012~Main%20Features~Value%20of%20goods%20and%20services%20produced%20by%20Australian%20Industry~240>.

Australian Government 2009, *Budget Overview*, Australian Government, Canberra.

—— 2013, *Budget 2013-14 Budget Overview*, Australian Government, Canberra.

Australian Institute of Superannuation Trustees (AIST) 2013, *60% of Australian Think Super is Risky and Worry about the Performance of their Fund: Poll*, Media Release, AIST, 19 Mar, viewed 24 Apr 2013, <http://www.aist.asn.au/media-new/media-releases/2013-releases/60-of-australians-think-super-is-risky-and-worry-about-the-performance-of-their-fund-poll.aspx>.

Australian Office of Financial Management (AOFM) 2009, *Treasury Indexed Bonds - Resumption of Issuance and Participation in Syndicate*, Operational Notice, Treasury, Canberra 7 Aug, viewed 19 Apr 2013, <http://www.aofm.gov.au/content/notices/15_2009.asp>

Australian Prudential Regulation Authority (APRA) 2007a, 'Highlights from 10 years of superannuation data - 1996-2006', *APRA Insight*, vol. 2007, no. 2, pp. 11-62.

—— 2007b, 'A Recent History of Superannuation in Australia', *APRA Insight*, vol. 2007, no. 2, pp. 3-10.

—— 2013, *Quarterly Superannuation Performance*, Statistics December 2012, APRA, Sydney.

Australian Securities and Investments Commission (ASIC) 2012a, *Moneysmart: Tax & Super*, ASIC, viewed 29 Jun 2012, <https://www.moneysmart.gov.au/superannuation-and-retirement/how-super-works/tax-and-super>.

—— 2012b, *Moneysmart: Transition to Retirement*, ASIC, viewed 29 June 2012, <https://www.moneysmart.gov.au/superannuation-and-retirement/income-sources-in-retirement/income-from-super/transition-to-retirement>.

—— 2013a, *AFS Licensing*, ASIC, viewed 4 Apr 2013, <http://www.asic.gov.au/asic/ASIC.NSF/byHeadline/Licensing#>.

—— 2013b, *Moneysmart: Account-based Pensions*, ASIC, viewed 2 July 2013, <https://www.moneysmart.gov.au/superannuation-and-retirement/income-sources-in-retirement/income-from-super/account-based-pensions>.

—— 2013c, Moneysmart: *Reverse Mortgages Selling the Home from Under Your Feet,* ASIC, viewed 1 March 2013, <https://www.moneysmart.gov.au/superannuation-and-retirement/income-sources-in-retirement/home-equity-release/reverse-mortgages>.

Australian Stock Exchange (ASX) 2013, *Historical Market Statistics*, Australian Stock Exchange, viewed 20 April 2013, <http://www.asx.com.au/research/historical_equity_data.htm#>.

Australian Taxation Office (ATO) 2011a, *Key Superannuation Rates and Thresholds,* ATO, Canberra, viewed 16 Dec 2011, <http://www.ato.gov.au/rates/key-superannuation-rates-and-thresholds?#>.

—— 2011b, *Taxation Statistics 2008-09 2008*, Table 11: Personal Tax, Selected Items, by Age, Sex, Taxable Status and Taxable Income, viewed 14 Dec 2011, <http://www.ato.gov.au/About-ATO/Research-and-statistics/Previous-years/Tax-statistics/Taxation-statistics-2008-09/?page=8#Personal_tax>.

Badcock, BA & Beer, AP 2000, *Home Truths : Property Ownership and Housing Wealth in Australia*, Melbourne University Press, Carlton, Victoria.

Bailey, M 2013, 'The Rise of Life-cycle Super Funds is Long Overdue', *Business Review Weekly,* 4 Apr, viewed 16 Jun 2013, <http://www.brw.com.au/p/investing/the_rise_of_life_cycle_super_funds_VjYaC6JNdQOqoMV60eB9SN>.

Banks, J, Blundell, R & Tanner, S 1998, 'Is There a Retirement-Savings Puzzle?', *American Economic Review*, vol. 88, no. 4, pp. 769-88.

Baranzini, M 2005, 'Modigliani's Life-cycle Theory of Savings Fifty Years Later', *Banca Nazionale del Lavoro Quarterly Review*, vol.58, no. 233/4, pp.109-72.

Barbosa, PS & Pimentel, PR 2001, 'A Linear Programming Model for Cash Flow Management in the Brazilian Construction Industry', *Construction Management and Economics,* vol. 19, no. 5, pp. 469-79.

Barrett, GF & Brzozowski, M 2009, 'The Retirement - Consumption Puzzle Downunder', paper presented to the HILDA Survey Research Conference 2009, Melbourne Institute of Applied Economic and Social Research, University of Melbourne, Melbourne, 16-17 Jul 2009.

Basu, A & Andrews, S 2014, 'Asset Allocation Policy, Returns and Expenses of Superannuation Funds: Recent Evidence Based on Default Options', *Australian Economic Review*, vol. 47, no. 1, pp. 63-77.

Basu, AK, Doran, BM & Drew, ME 2013, 'Sequencing Risk: The Worst Returns in Their Worst Order', *The Finsia Journal of Applied Finance,* issue. 4, pp. 7-13.

Basu, AK & Drew, ME 2009, 'The Case for Gender-Sensitive Superannuation Plan Design', *The Australian Economic Review*, vol. 42, no. 2, pp. 177-89.

Basu, AK & Drew, ME 2010, 'The Appropriateness of Default Investment Options in Defined Contribution Plans: Australian Evidence', *Pacific-Basin Finance Journal*, vol. 18, no. 3, pp. 290-305.

Basu, S 2005, 'Age Banding: A Model for Planning Retirement Needs', *Financial Counseling & Planning*, vol. 16, no. 1, pp. 29-36.

—— 2011a, 'Holistic Next-Generation Thoughts in Planning for Retirement Needs', *Journal of Financial Service Professionals*, vol. 65, no. 3, pp. 7-9.

—— 2011b, 'Modern Portfolio Heuristics', *Journal of Financial Service Professionals*, vol. 65, no. 6, pp. 13-6.

Bateman, H 2007, 'Old Age Income Protection in Australia', Centre for Pensions and Superannuation University of NSW Discussion Paper 06/2007, viewed 29 Apr 2013, <http://www.asb.unsw.edu.au/research/cps/Documents/H.%20Bateman%20-%20Old%20Age%20Income%20Protection%20in%20Australia%20.pdf>.

—— 2009, 'Retirement Income Provision in Australia - Outstanding Design Issues in a Mature Sytem', Centre for Pensions and Superannuation University of NSW Discussion Paper, viewed 29 Apr 2013, <http://wwwdocs.fce.unsw.edu.au/fce/Research/ResearchMicrosites/CPS/retirement.pdf>.

Bateman, H, Louviere, J, Thorp, S, Islam, T & Satchell, S 2010, 'Investment Decisions for Retirement Savings', *Journal of Consumer Affairs*, vol. 44, no. 3, pp. 463-82.

Bateman, H & Piggott, J 2001, 'The Australian Approach to Retirement Income Provision', paper presented to International Seminar on Social Security Pensions, Hitotsubashi University, Tokyo, 5-7 Mar 2001.

—— 2011, 'Too Much Risk to Insure? The Australian (non-) Market for Annuities', in OS Mitchell, J Piggott and N Takayama (eds), *Securing Lifelong Retirement Income : Global Annuity Markets and Policy* Oxford University Press, New York, pp. 81-105.

Beal, DJ 2001, 'Use of Housing Wealth by Older Australians', *Australasian Journal on Ageing*, vol. 20, no. 3, pp. 127-32.

—— 2010, 'Home Equity Conversion in Australia—Issues, Impediments and Possible Solutions', *Economic Papers: A Journal of Applied Economics and Policy*, vol. 20, no. 4, pp. 55-68.

Beal, DJ & Delpachitra, SB 2003, 'Financial Literacy Among Australian University Students', *Papers: A Journal of Applied Economics and Policy*, vol. 22, no. 1, pp. 65-78.

Becker, C 2012, 'Simply Stupid Superannuation', *Macrobusiness*, weblog, viewed 23 Apr 2013, <http://www.macrobusiness.com.au/2012/10/simple-super/>.

Becker, GS 1965, 'A Theory of the Allocation of Time', *Economic Journal,* vol. 75, no. 299, pp. 493-517.

Benartzi, S, Previtero, A & Thaler, RH 2011, 'Annuitization Puzzles', *Journal of Economic Perspectives*, vol. 25, no. 4, pp. 143-64.

Benartzi, S & Thaler, RH 2001, 'Naive Diversification Strategies in Defined Contribution Saving Plans', *American Economic Review*, vol. 91, no. 1, pp. 79-98.

—— 2007, 'Heuristics and Biases in Retirement Savings Behavior', *Journal of Economic Perspectives*, vol. 21, no. 3, pp. 81-104.

Bengen, WP 1994, 'Determining Withdrawal Rates Using Historical Data', *Journal of Financial Planning*, vol. 7, no. 4, pp.171-80.

—— 1996, 'Asset Allocation for a Lifetime', *Journal of Financial Planning*, vol. 9, no. 4, pp. 58-67

—— 1997, 'Conserving Client Portfolios During Retirement, Part III', *Journal of Financial Planning*, vol. 10, no. 6, pp. 84-97.

—— 2001, 'Conserving Client Portfolios During Retirement, Part IV', *Journal of Financial Planning*, vol. 14, no. 5, pp. 110-9.

Bernheim, BD 1987, 'Dissaving after Retirement: Testing the Pure Life Cycle Hypothesis', in Z Bodie, JB Shoven and DA Wise (eds), *Issues in Pension Economics*, University of Chicago Press, Chicago, pp. 237-74.

—— 1991, 'How Strong are Bequest Motives? Evidence Based on Estimates of the Demand for Life Insurance and Annuities', *Journal of Political Economy*, vol. 99, no. 5, pp. 899-927.

Bernheim, BD, Forni, L, Gokhale, J & Kotlikoff, LJ 2003, 'The Mismatch between Life Insurance Holdings and Financial Vulnerabilities: Evidence from the Health and Retirement Study', *The American Economic Review*, vol. 93, no. 1, pp. 354-65.

Bernheim, BD, Skinner, J & Weinberg, S 2001, 'What Accounts for the Variation in Retirement Wealth Among U.S. Households?', *American Economic Review*, vol. 91, no. 4, pp. 832-57.

Beshears, J, Choi, JJ, Laibson, D & Madrian, BC 2009, 'The Importance of Default Options for Retirement Saving Outcomes', in JR Brown, J Liebman and DA Wise (eds), *Social Security Policy in a Changing Environment*, University of Chicago Press, Chicago, pp. 167–95.

Bishop, J & Cassidy, N 2012, 'Trends in National Saving and Investment ed', *Reserve Bank of Australia Bulletin*, March Quarter 2012, pp. 9-18.

Black, K, Ciccotello, CS & Skipper, HD 2002, 'Issues in Comprehensive Personal Financial Planning', *Financial Services Review*, vol. 11, no. 1, pp. 1-9.

Blake, D, Cairns, AJG & Dowd, K 2003, 'Pensionmetrics 2: Stochastic Pension Plan Design During the Distribution Phase', *Insurance: Mathematics and Economics*, vol. 33, no. 1, pp. 29-47.

Blau, DM 2008, 'Retirement and Consumption in a Life Cycle Model', *Journal of Labor Economics*, vol. 26, no. 1, pp. 35-71.

Bodie, Z 2003, 'An Analysis of Investment Advice to Retirement Plan Participants', in OS Mitchell and K Smetters (eds), *The Pension Challenge: Risk Transfers and Retirement Income Security*, Oxford University Press, New York, pp. 19-32.

Bodie, Z, Merton, RC & Samuelson, WF 1992, 'Labour Supply Flexibility and Portfolio Choice in a Life Cycle Model', *Journal of Economic Dynamics & Control,* vol. 16, no. 3/4, pp. 427-49.

Borowski, A, Schulz, J & Whiteford, P 1987, 'Providing Adequate Retirement Income:What Role Occupational Superannuation?', *Australian Journal on Ageing*, vol. 6, no. 1, pp. 3-13.

Boscaijon, B 2005, 'Maximizing Retirement Income and Leisure Time', *Journal of Financial Planning*, vol. 18, no. 7, pp. 46-53.

Bowen, C 2010, *The Future of Financial Advice*, Parliamentary Speech, Treasury, Canberra, 23 June, viewed 25 Mar 2013, <http://ministers.treasury.gov.au/DisplayDocs.aspx?doc=speeches/2010/014.htm &pageID=005&min=ceba&Year=&DocType=>.

Branning, JK & Grubbs, MR 2009, 'Modern Retirement Theory: Reaching Client Goals in Every Market', *Journal of Financial Planning*, pp. 14-17.

Bridge, C, Mathews, M, Phibbs, P & Adams, T 2009, 'Reverse Mortgages and Older People, Growth Factors and Implications for Retirement Decisions', Australian Housing and Urban Research Institute (AHURI) Positioning Paper no. 123, viewed 15 Mar 2013, <http://www.ahuri.edu.au/publications/p70512/>

Brown, JR 2001, 'Private Pensions, Mortality Risk, and the Decision to Annuitize', *Journal of Public Economics*, vol. 82, no. 1, pp. 29-62.

—— 2004, 'Life Annuities and Uncertain Lifetimes', *NBER Reporter*, Research Summary, Spring.

—— 2007, 'Rational and Behavioral Perspectives on the Role of Annuities in Retirement Planning', NBER Working Paper, no. 13537, National Bureau of Economic Research, Cambridge, Massachusetts.

Brown, JR, Casey, MD & Mitchell, OS 2007, 'Who Values the Social Security Annuity? New Evidence on the Annuity Puzzle', NBER Aging Program Paper NB07-02, National Bureau of Economic Research, Cambridge, Massachusetts.

Brown, JR, Kling, JR, Mullainathan, S & Wrobel, MV 2008, 'Why Don't People Insure Late-Life Consumption? A Framing Explanation of the Under-Annuitization Puzzle', *American Economic Review*, vol. 98, no. 2, pp. 304-9.

Brown, JR & Poterba, JM 2000, 'Joint Life Annuities and Annuity Demand by Married Couples', *Journal of Risk & Insurance*, vol. 67, no. 4, pp. 527-53.

Brown, L 1993, *The New Shorter Oxford English Dictionary*, 4th edn, Clarendon Press, Oxford.

Bucciol, A & Miniaci, R 2011, 'Household Portfolios and Implicit Risk Preference', *Review of Economics & Statistics*, vol. 93, no. 4, pp. 1235-50.

Campbell, JY 2006, 'Household Finance', *The Journal of Finance*, vol. 61, no. 4, pp. 1553-604.

Canstar 2011a, *Compare Home Loan Rates*, Canstar, Brisbane, viewed 26 Aug 2011, <http://www.canstar.com.au/interest-rate-comparison/compare-home-loan-rates.html>.

—— 2011b, *Compare Margin Loan Interest Rates*, Canstar, Brisbane, viewed 15 Dec 2011, <http://www.canstar.com.au/interest-rate-comparison/compare-220K-margin-rates.html>.

—— 2011c, *Compare Reverse Mortgage Rates*, Canstar, Brisbane, viewed 26 Aug 2011, <http://www.canstar.com.au/interest-rate-comparison/compare-reverse-mortgage-rates.html>.

Cardak, BA & Wilkins, R 2009, 'The Determinants of Household Risky Asset Holdings: Australian Evidence on Background Risk and Other Factors', *Journal of Banking & Finance*, vol. 33, no. 5, pp. 850-60.

Carroll, GD, Choi, JJ, Laibson, D, Madrian, BC & Metrick, A 2009, 'Optimal Defaults and Active Decisions', *Quarterly Journal of Economics*, vol. 124, no. 4, pp. 1639-74.

Centrelink 2011, *Centrelink Rate Charts 1 July to 20 September 2011*, Australian Government, Canberra.

Chai, J, Horneff, W, Maurer, R & Mitchell, OS 2011, 'Optimal Portfolio Choice over the Life Cycle with Flexible Work, Endogenous Retirement, and Lifetime Payouts', *Review of Finance,* vol. 15, pp. 875 - 907.

Chant West 2011a, *Investment Returns Pension Funds*, Chant West, Sydney, viewed 29 Nov 2011, <http://www.chantwest.com.au/cwInvPerfPenGrowth.aspx?MenuItemID=744>.

—— 2011b, *Investment Returns Super Funds*, Chant West, Sydney, viewed 29 Nov 2011, <http://www.chantwest.com.au/cwInvPerfSuperGrowth.aspx?MenuItemID=708>.

Chen, P, Ibbotson, RG, Milevsky, MA & Zhu, KX 2006, 'Human Capital, Asset Allocation, and Life Insurance', *Financial Analysts Journal*, vol. 62, no. 1, pp. 97-109.

Cho, S & Sane, R 2013, 'Means –Tested Age Pensions and Homeownership: Is There a Link', *Macroeconomic Dynamics*, vol. 17, no. 6, pp. 1281-1310.

Choi, JJ, Laibson, D & Madrian, BC 2005, '$100 Bills on the Sidewalk: Suboptimal Investment in 401(k) Plans', NBER Working Paper, no. 11554, National Bureau of Economic Research, Cambridge, Massachusetts.

Choi, JJ, Laibson, D, Madrian, BC & Metrick, A 2002, 'Defined Contribution Pensions: Plan Rules, Participant Choices, and the Path of Least Resistance', in JM Poterba (ed.), *Tax Policy & the Economy* vol.16, MIT Press, Cambridge, Massachusetts, pp. 67-113.

Chomik, R & Piggott, J 2012, 'Pensions, Ageing and Retirement in Australia: Long-Term Projections and Policies', *Australian Economic Review*, vol. 45, no. 3, pp. 350-61.

Chui, A, & Kwok, C 2009, 'Cultural Practices and Life Insurance Consumption: an International Analysis Uing GLOBE Scores', *Journal of Multinational Financial Management*, vol. 19, pp. 273-90.

Clare, R 2011, *Consumer Attitudes to Superannuation and Super Policy Issues*, Association of Superannuation Funds of Australia (ASFA), Sydney, viewed 20 Apr 2013, <http://www.superannuation.asn.au/policy/reports>.

Clark, RL, d'Ambrosio, MB, McDermed, AA & Sawant, K 2003, 'Financial Education and Retirement Savings', TIAA -CREF Institute Working Paper 11-020103, viewed 8 Jan 2013, <http://www.tiaa-crefinstitute.org/ucm/groups/content/@ap_ucm_p_tcp_docs/documents/document/tiaa02029661.pdf>

Colonial First State 2011, *FirstTech 2011-12 Super Guide*, Colonial First State, Sydney.

Cocco, JF 2005, 'Portfolio Choice in the Presence of Housing', *Review of Financial Studies*, vol. 18, pp. 535-67.

Commonwealth Bank of Australia (CBA) 2011, *Equity Unlock Loan for Seniors Fact Sheet*, CBA, Sydney, viewed 21 Nov 2011, <http://www.commbank.com.au/personal/home-loans/fact-sheets/Equity_Unlock_Loan_for_Seniors.pdf>.

Consumer Financial Protection Bureau (CFPB) 2012, *Reverse Mortgages: Report to Congress*, United States Government, Washington.

Cooley, PL, Hubbard, CM & Walz, DT 1999, 'Sustainable Withdrawal Rates From Your Retirement Portfolio', *Journal of Financial Counseling and Planning*, vol. 10, no. 1, pp. 40 - 51.

—— 2003, 'A Comparative Analysis of Retirement Portfolio Success Rates: Simulation Versus Overlapping Periods', *Financial Services Review*, vol. 12, no. 2, pp. 115-28.

—— 2011, 'Portfolio Success Rates: Where to Draw the Line', *Journal of Financial Planning*, vol. 24, no. 4, pp. 48-60.

Cooper, J 2010, *Super System Review Final Report Part One Overview and Recommendations*, Australian Government, Canberra.

Coorey,P & Massola, J 2013, 'Abbott Delays Super to Fund Carbon Compo', *Australian Financial Review*, 17 May , viewed 30 Jun 2013, < https://www.google.com.au/#q=coorey+massola+sgl>.

Coronado, JL, Maki, D & Weitzer, B 2007, 'Retiring on the House? Cross-Cohort Differences in Housing Wealth', in BC Madrian, OS Mitchell and BJ Soldo (eds), *Redefining Retiremen: How Will Boomers Fare?*, Oxford University Press, New York, pp. 296 -308.

Cull, M 2009, 'The Rise of the Financial Planning Industry', *Australasian Accounting Business & Finance Journal*, vol. 3, no. 1, pp. 26-37.

Cummings, JR 2012, 'Effect of Fund Size on the Performance of Australian Superannuation Funds', APRA Working Paper, Sydney.

Daniels, D, Buckmaster L & Yeend, P 2009, *Social Security and Other Legislation Amendment (Pension Reform and Other 2009 Budget Measures) Bill 2009*, Bills Digest 179 2008-09, Parliamentary Library, Parliament of Australia, Canberra.

Dantzig, GB 1949, 'Programming of Interdependent Activities: II Mathematical Model', *Econometrica*, vol. 17, no. 3/4, pp. 200-11.

—— 2002, 'Linear Programming', *Operations Research*, vol. 50, no. 1, pp. 42-7.

Danziger, S, Gaag, JVD, Smolensky, E & Taussig, MK 1982, 'The Life-Cycle Hypothesis and the Consumption Behavior of the Elderly', *Journal of Post Keynesian Economics*, vol. 5, no. 2, pp. 208-27.

Davidoff, T 2010, 'Home Equity Commitment and Long-Term Care Insurance Demand', *Journal of Public Economics*, vol. 94, no. 1, pp. 44-9.

Davidoff, T, Brown, JR & Diamond, PA 2005, 'Annuities and Individual Welfare', *American Economic Review*, vol. 95, no. 5, pp. 1573-90.

Dawkins, J 1992, *Security in Retirement : Planning for Tomorrow Today,* Australian Government Public Service, Canberra.

de Mesa, AA, Bravo, D, Behrman, JR, Mitchell, OS & Todd, PE 2006, ‘The Chilean Pension Reform Turns 25: Lessons from the Social Protection Survey’, NBER Working Paper, no. 12401, National Bureau of Economic Research, Cambridge, Massachusetts.

De Nardi, M, French, E & Jones, JB 2010, 'Why Do the Elderly Save? The Role of Medical Expenses', *Journal of Political Economy*, vol. 118, no. 1, pp. 39-75.

Deaton, A 2005, 'Franco Modigliani and the Life-Cycle Theory of Consumption', paper presented to Convegno Internazionale Franco Modigliani, AccademiaNazionale de Lincei. Institute of Actuaries of Australia Biennal Convention, Sydney, 17-18 Feb 2005.

Department of Human Services (DHS) 2011, *Current Rental Report*, DHS, Melbourne, viewed 21 Nov 2011, <http://www.dhs.vic.gov.au/about-the-department/documents-and-resources/research,-data-and-statistics/current-rental-report>

deVries, R 2009, 'Pathways to Retirement: Older University Workers' Attitudes and Intentions Towards Retirement', *The Journal of Superannuation Management*, vol. 3, no. 2, pp. 49-54.

Dixon, J 1977, *Australia's Policy Towards the Aged : 1890-1972*, Canberra Series in Administrative Studies, Canberra College of Advanced Education, Canberra.

Dobrescu, LI 2013, 'To Love or to Pay: Savings and Health Care in Older Age', Centre of Excellence in Population Ageing Research (CEPAR) University of NSW Working Paper 2013/18, viewed 29 Jul 2013, <http://www.cepar.edu.au/media/116277/to_love_or_to_pay_2013-18.pdf>

Doyle, S, Mitchell, OS & Piggott, J 2004, 'Annuity Values in Defined Contribution Retirement Systems: Australia and Singapore Compared', *Australian Economic Review*, vol. 37, no. 4, pp. 402-16.

Drew, ME & Stanford, JD 2003, 'Is There a Positive Relationship Between Superannuationn Fund Costs and Returns?', *Economic Papers*, vol. 22, no. 3, pp. 74-84.

Dubofsky, D & Sussman, L 2010, 'The Bonding Continuum in Financial Planner-Client Relationships', *Journal of Financial Planning*, vol. 23, no. 10, pp. 66-78.

Duxbury, D, Summers, B, Hudson, R & Keasey, K 2013, 'How People Evaluate Defined Contribution, Annuity-based Pension Arrangements: A Behavioural Exploration', *Journal of Economic Psychology*, vol 34, pp.256-69.

Dynan, KE, Skinner, J & Zeldes, SP 2002, 'The Importance of Bequests and Life-Cycle Saving in Capital Accumulation: A New Answer', *The American Economic Review*, vol. 92, no. 2, pp. 274-8.

Easterlow, D, Smith, SJ & Mallinson, S 2000, 'Housing for Health: The Role of Owner Occupation', *Housing Studies*, vol. 15, no. 3, pp. 367-86.

Ellis, K, Tobin, A, & Tracey, B 2008, 'Investment Performance, Asset Allocation and Expenses of Large Superannuation Funds’, APRA Working Paper, Sydney.

Fama, EF & Miller, MH 1972, *The Theory of Finance*, Holt, Rinehart and Winston, New York.

Fisher, JD & Marchand, J 2011, 'Does the Retirement Consumption Puzzle Differ Across the Distribution?', US Census Bureau Center for Economic Studies Working Paper No. 11-09, viewed 10 Feb 2013, <http://ideas.repec.org/p/cen/wpaper/11-09r.html>

Frank, LR & Blanchett, DH 2010, 'The Dynamic Implications of Sequence Risk on a Distribution Portfolio', *Journal of Financial Planning*, vol. 23, no. 6, pp. 52-61.

Frederick, S, Loewenstein, G & O'Donoghue, T 2002, 'Time Discounting and Time Preference: A Critical Review', *Journal of Economic Literature*, vol. 40, no. 2, pp. 351-401.

Friedman, M 1957, *A Theory of the Consumption Function*, Princeton University Press, Princeton.

Frontline Systems 2011, *Frontline Solvers User Guide*, v.11.5, Frontline Systems, Incline Village, Nevada.

Gallagher, P & Preston, A 1993, 'Retirement Income Modelling and Policy Development in Australia', paper presented to Economics Modelling Bureau of Australia Conference on the Asia-Pacific Economy, Palm Cove, 27 Aug 1993.

Gallery, G, Gallery, N & Brown, K 2004, 'Superannuation Choice: The Pivotal Role of the Default Option', *Journal of Australian Political Economy*, no. 53, pp. 44-66.

Gallery, N, Gallery, G, Brown, K, Furneaux, C & Palm, C 2011, 'Financial Literacy and Pension Investment Decisions', *Financial Accountability & Management*, vol. 27, no. 3, pp. 286-307.

Gallery, G, Gallery, N & McDougall, L 2010, 'Don't Judge a Superannuation Default Investment Option by Its Name', *Australian Accounting Review*, vol. 20, no. 3, pp. 286-95.

Ganegoda, A & Bateman, H 2008, 'Australia’s Disappearing Market for Life Annuities', Centre for Pensions and Superannuation University of NSWDiscussion Paper 01/08, viewed 20 Jul 2009, <http://wwwdocs.fce.unsw.edu.au/fce/Research/ResearchMicrosites/CPS/cpsdp200801.pdf>

Goda, GS, Shoven, JB & Slavov, SN 2010, 'Does Stock Market Performance Influence Retirement Expectations?', NBER Working Paper, no. 16211, National Bureau of Economic Research, Cambridge, Massachusetts.

Gong, G & Webb, A 2010, 'Evaluating the Advanced Life Deferred Annuity—An Annuity People Might Actually Buy', *Insurance: Mathematics and Economics*, vol. 46, no. 1, pp. 210-21.

Gruen, D & Soding, L 2011, ‘Compulsory Superannuation and National Saving’, *Economic Roundup*, Issue 3, pp. 45-56.

Gruen, D & Spender, D 2012, 'A Decade of Intergenerational Reports:Contributing to Long Term Fiscal Sustainability', paper presented to Intergen +10 Workshop, Melbourne Institute of Applied Economic and Social Research, University of Melbourne, Melbourne, 11 May, 2012.

Guest, R 2008, 'Evaluating Public Policy Responses to the Economic Burden of Population Ageing with Application to Australia', *Journal of Population Research*, vol. 25, no. 2, pp. 99-118.

Guiso, L & Jappelli, T 2008, 'Financial Literacy and Portfolio Diversification', European University Institute Department of Economics Working Paper ECO 2008/31, viewed 7 Jan 2013, http://cadmus.eui.eu/handle/1814/9811

Guyton, JT 2004, 'Decision Rules and Portfolio Management for Retirees: Is the 'Safe' Initial Withdrawal Rate Too Safe?', *Journal of Financial Planning*, vol. 17, no. 10, pp. 54-62.

Guyton, JT & Klinger, WJ 2006, 'Decision Rules and Maximum Initial Withdrawal Rates', *Journal of Financial Planning*, vol. 19, no. 3, pp. 48-58.

Hagenaars, A, De Vos, K & Zaidi, A (1994), *Poverty Statistics in the Late 1980s*, Eurostat, Luxembourg.

Haider, SJ & Stephens, M 2007, 'Is There a Retirement - Consumption Puzzle? Evidence Using Subjective Retirement Expectations. ', *Review of Economics & Statistics*, vol. 89, no. 2, pp. 247-64.

Hakansson, NH 1970, 'Optimal Investment and Consumption Strategies Under Risk for a Class of Utility Functions', *Econometrica*, vol. 38, no. 5, pp. 587-607.

Hallahan, TA, Faff, RW & McKenzie, MD 2004, 'An Empirical Investigation of Personal Financial Risk Tolerance', *Financial Services Review*, vol. 13, no. 1, pp. 57-78.

Hamermesh, DS 1984, 'Consumption During Retirement: The Missing Link in the Life Cycle', *Review of Economics & Statistics*, vol. 66, no. 1, pp. 1-7.

Hamilton, M & Hamilton, C 2006, “Baby Boomers and Retirement’, The Australian Institute Discussion Paper no. 89, viewed 19 Apr 2013, <http://www.tai.org.au/documents/dp_fulltext/DP89.pdf>.

Harding, A 2007, 'Challenges and Opportunities of Dynamic Microsimulation Modelling', paper presented to the 1st General Conference of the International Microsimulation Association, Vienna, 21 Aug 2007.

Harmer, J 2009, *Pension Review Report*, Department of Families, Housing, Community Services and Indigenous Affairs, Canberra.

Harris, MN, Loundes, J & Webster, E 2002, 'Determinants of Household Saving in Australia', *Economic Record*, vol. 78, no. 241, pp. 207-23.

Henry, K 2009, *Australia's Future Tax System The Retirement Income System: Report on Strategic Issues*, Treasury, Canberra.

Henry, K 2010a, *Australia's Future Tax System Report to the Treasurer Part 1 Overview*, Treasury, Canberra.

—— 2010b, *Australia's Future Tax System Report to the Treasurer Part Two Detailed Analysis Volume 1 of 2*, Treasury, Canberra.

—— 2010c, *Australia's Future Tax System Report to the Treasurer Part Two Detailed Analysis Volume 2 of 2*, Treasury, Canberra.

Hesketh, B & Griffin, B 2010, *Retirement Planning Survey*, NSW Department of Premier & Cabinet, Sydney.

Hickey, J 2012, 'Australia's Reverse Mortgage Market Continues its Double Digit Growth', *inFinance*, vol. 126, no. 3, pp. 26-7.

Hillier, FS & Lieberman, GJ 2010, *Introduction to Operations Research*, 9th edn, McGraw-Hill, New York.

Hockey, J 2013, *Financial System Inquiry*, Media Release, Treasury, Canberra, 20 Dec, viewed 18 Jan 2015, < http://jbh.ministers.treasury.gov.au/media-release/037-2013/>

Holland, DS 2008, 'The Emotional Value of Life Insurance in the Financial Planning Process', *Journal of Financial Planning*, vol. 21, no. 12, pp. 14-5.

Holzmann, R 2012, 'Global Pension Systems and Their Reform: Worldwide Drivers, Trends, and Challemnges', The World Bank Social Protaction & Labor Discussion Paper 1213, viewed 6 Jan 2015, <http://siteresources.worldbank.org/SOCIALPROTECTION/Resources/SP-Discussion-papers/Pensions-DP/1213.pdf

Horneff, WJ, Maurer, RH, Mitchell, OS & Stamos, MZ 2008, 'Asset Allocation and Location over the Life Cycle with Survival-Contingent Payouts', *Journal of Banking & Finance,* vol. 33, no. 9, pp. 1688-99-5.

Hu, W-Y & Scott, JS 2007, 'Behavioral Obstacles in the Annuity Market', *Financial Analysts Journal*, vol. 63, no. 6, pp. 71-82.

Huang, H, Milevsky, MA & Wang, J 2008, 'Portfolio Choice and Life Insurance: The CRRA Case', *Journal of Risk & Insurance*, vol. 75, no. 4, pp. 847-72.

Hulley, H, McKibbin, R, Pedersen, A & Thorp, S 2013, 'Means-Tested Public Pensions, Portfolio Choice and Decumulation in Retirement', *Economic Record*, vol.89, no. 284, pp.31-51.

Hunter, W, Wang, W & Worsley, A 2007, 'Retirement Planning and Expectations of Australian Babyboomers', *Annals of the New York Academy of Sciences,* vol. 1114, pp. 267-78.

Hurd, MD 1987a, 'Comment: Dissaving after Retirement: Testing the Pure Life Cycle Hypothesis ', in Z Bodie, JB Shoven and DA Wise (eds), *Issues in Pension Economics*, University of Chicago Press, Chicago, pp. 275-9.

—— 1987b, 'Savings of the Elderly and Desired Bequests', *The American Economic Review*, pp. 298-312.

—— 1989, 'Mortality Risk and Bequests ', *Econometrica*, vol. 57, no. 4, pp. 779-813.

Hurd, MD & Rohwedder, S 2003, 'The Retirement-Consumption Puzzle: Anticipated and Actual Declines in Spending at Retirement', NBER Working Paper, no. 9586, National Bureau of Economic Research, Cambridge, Massachusetts.

Hurst, E 2008, 'The Retirement of a Consumption Puzzle', NBER Working Paper, no. 13789, National Bureau of Economic Research, Cambridge, Massachusetts.

Inkmann, J, Lopes, P & Michaelides, A 2011, 'How Deep Is the Annuity Market Participation Puzzle?', *Review of Financial Studies*, vol. 24, no. 1, pp. 279-319.

Inland Revenue 2014, *KiwiSaver in a Nutshell*, New Zealand Government, Wellington, viewed 6 Jan 2015, <http://www.kiwisaver.govt.nz/new/about/summary/>

Intriligator, MD 1971, *Mathematical Optimization and Economic Theory*, Prentice-Hall series in Mathematical Economics, Prentice-Hall, Englewood Cliffs, N.J.

Jagannathan, R & Kocherlakota, NR 1996, 'Why Should Older People Invest Less in Stocks Than Younger People', *Federal Reserve Bank of Minneapolis Quarterly Review*, vol. 20, no. 3, pp.11-23.

Johnson, M 2008, 'Quality of Life Aspirations: Exploring Baby-Boomer Financial Means-End Goal Structures', *Journal of Financial Services Marketing*, vol. 13, no. 3, pp. 245-58.

Kahneman, D & Tversky, A 1979, 'Prospect Theory: An Analysis of Decision under Risk', *Econometrica*, vol. 47, no. 2, pp. 263-91.

Kelly, P 2000, ‘The Politics of Economic Change in the 1980s and 1990s’, in D Gruen and S Shrestha (eds) *The Australian Economy in the 1990's*, Reserve Bank of Australia, Sydney, pp. 222-34.

Kelly, SJ 2009, *Reform of the Australian Retirement Income System*, National Centre for Social and Economic Modelling (NATSEM), University of Canberra, Canberra.

Kelly, SJ & Harding, A 2004, 'Funding the Retirement of the Baby Boomers', *Agenda*, vol. 11, no. 2, pp. 99-112.

Kelly, SJ, Harding, A & Percival, R 2002, 'Live Long and Prosper? Projecting the Likely Superannuation of the Baby Boomers in 2020', paper presented to Australian Conference of Economists Business Symposium, Adelaide, 4 Oct 2002.

Kelly, S & Ngu VQ, 2010, *The Lifewise / NATSEM Underinsurance Report*: *Understanding the Social and Economic Cost of Underinsurance,* Research Report, NATSEM, University of Canberra,Canberra.

Keynes, JM 1936, The General Theory of Employment, Interest and Money, Macmillan, London.

Kim, H & DeVaney, SA 2005, 'The Selection of Partial or Full Retirement by Older Workers', *Journal of Family and Economic Issues*, vol. 26, no. 3, pp. 371-94.

King, A, Walker, A & Harding, A 2001, 'Perspectives on Australian Retirement Incomes', *Australian Economic Review*, vol. 34, no. 2, pp. 155-69.

Kingston, G 2004, 'Superannuation: A Guide to the Field for Australian Economists', *Economic Analysis & Policy*, vol. 34, no. 2, pp. 203-26.

Kitces, ME 2012, 'The Rise of Tactical Asset Allocation', *Journal of Financial Planning*, vol. 25, no. 6, pp. 28-9.

Knell, M 2005, 'Demographic Fluctuations, Sustainability Factors and Intergenerational Fairness–an Assessment of Austria’s New Pension System', *Monetary Policy & the Economy*, vol. 1, pp. 23-42.

Knutsen, J & Cameron, R 2012, 'The Financial Coaching Advice Model: An Exploration into how it Satisfies Expectations of Quality Advice', *Australasian Accounting Business & Finance Journal*, vol. 6, no. 4, pp. 31-45.

Kohler, A 2012, 'Australia's Super System is a National Disgrace', *The Drum*, 31 Oct, viewed 23 Apr 2013, <http://www.abc.net.au/news/2012-10-31/kohler-australia-super-disgrace/4343108>.

Kopczuk, W & Lupton, JP 2007, 'To Leave or Not to Leave: The Distribution of Bequest Motives', *Review of Economic Studies*, vol. 74, no. 1, pp. 207-35.

Kuo, PC, Schroeder, RA, Mahaffey, S & Bollinger, RR 2003, 'Optimization of Operating Room Allocation using Linear Programming Techniques', *Journal of the American College of Surgeons*, vol. 197, no. 6, pp. 889-95.

Lee, J, Labat, C, Jain, AK, Song, DY, Burdette, EC, Fichtinger, G & Prince, JL 2011, 'REDMAPS: Reduced-Dimensionality Matching for Prostate Brachytherapy Seed Reconstruction', *IEEE Transactions on Medical Imaging*, vol. 30, no. 1, pp. 38-51.

Lee, YG 2005, 'Baby Boomers and Home Equity Borrowing', *Financial Counseling & Planning*, vol. 16, no. 2, pp. 49-61.

Lockwood, LM 2011, 'The Importance of Bequest Motives: Evidence from Long-term Care Insurance and the Pattern of Saving', paper presented to Risk Theory Society Annual Seminar, University of Arkansas, Little Rock, 15-17 April 2011.

—— 2012, 'Bequest motives and the Annuity Puzzle', *Review of Economic Dynamics*, vol. 15, no. 2, pp. 226-43.

Love, DA, Palumbo, MG & Smith, PA 2009, 'The Trajectory of Wealth in Retirement', *Journal of Public Economics*, vol. 93, no. 1, pp. 191-208.

Lusardi, A 2004, 'Saving and the Effectiveness of Financial Education', in OS Mitchell and SP Utkus (eds), *Pension Design and Structure : New Lessons from Behavioral Finance*, Oxford University Press, New York, pp. 157-84.

Lusardi, A & Mitchell, OS 2007, 'Financial Literacy and Retirement Preparedness: Evidence and Implications for Financial Education', *Business Economics*, vol. 42, no. 1, pp. 35-44.

Lynch, JT 2012, 'Fundamentals Are Forever', *Journal of Financial Service Professionals*, vol. 66, no. 6, pp. 30-2.

Madrian, BC & Shea, DF 2001, 'The Power of Suggestion : Inertia in 401(k) Participation and Savings Behavior', *Quarterly Journal of Economics*, vol. 116, no. 4, pp. 1149-87.

Mandell, L & Klein, LS 2007, 'Motivation and Financial Literacy', *Financial Services Review*, vol. 16, no. 2, pp. 105-16.

—— 2009, 'The Impact of Financial Literacy Education on Subsequent Financial Behavior', *Journal of Financial Counseling & Planning*, vol. 20, no. 1, pp. 15-24.

Manning, J 2013, 'Lifecycle Investing: Is It the Answer?' in *MyConsultant*, JANA Investment Advisers, viewed 16 Jun 2013, <http://www.mlc.com.au/resources/MLC/Implemented%20Consulting/Static%20 Files/pdf/myconsultant_feb2013.pdf>.

Markowitz, H 1952, 'Portfolio Selection', *The Journal of Finance*, vol. 7, no. 1, pp. 77-91.

Mason, CLJ & Wilson, RMS 2000, 'Conceptualising Financial Literacy', Loughborough University Business School Research Series, Paper 2000:7, viewed 7 Jan 2013, https://dspace.lboro.ac.uk/dspace-jspui/handle/2134/2016

McCarthy, E 2002, 'The Evolution of Retirement Planning', *Journal of Financial Planning*, vol. 15, no. 5, pp. 60-6.

McEvoy, GM & Henderson, S 2012, 'The Retention of Workers Nearing Retirement: A Job Embeddedness Approach', *Journal of Workplace Behavioral Health*, vol. 27, no. 4, pp. 250-71.

McGarry, K 2002, 'Health and Retirement: Do Changes in Health Affect Retirement Expectations?', NBER Working Paper, no.9317, National Bureau of Economic Research, Cambridge, Massachusetts.

McGillivray, W 2000, 'Pension Reform: Where Are We Now?', *International Social Security Review*, vol. 53, no. 1, pp. 3-10.

McMeekin, A 2012, 'Superannuation Jargon is a Barrier for Australians, A Survey Found', *Daily Telegraph*, 30 Mar , viewed 24 Apr 2013, <http://www.dailytelegraph.com.au/news/superannuation-jargon-is-a-barrier-for-australians-a-survey-found/story-e6freuy9-1226314215629>.

McMorrow, K & Roeger, W 2002, 'EU Pension Reform - An Overview of the Debate and an Empirical Assessment of the Main Policy Reform Options', Economic Papers, no.162, European Commission Directorate General Economic and Financial Affairs, European Commission, viewed 29 Apr 2013, <http://ec.europa.eu/economy_finance/publications/publication_summary1996_en.htm>

McNaughton, T, Piggott, J & Purcal, S 2000, 'Growing Old Gracefully: Age-Phasing, Targets and Saving Rules', *The Journal of Wealth Management*, vol. 2, no. Spring 2000, pp. 20-4.

Mears, A, Kendall, T, Katona, C, Pashley, C & Pajak, S 2004, 'Retirement Intentions of Older Consultant Psychiatrists', *Psychiatric Bulletin*, vol. 28, no. 4, pp. 130-2.

Meghir, C 2004, 'A Retrospective on Friedman's Theory of Permanent Income', *Economic Journal*, vol. 114, no. 496, pp. F293-306.

Merton, RC 1969, 'Lifetime Portfolio Selection under Uncertainty: The Continuous-Time Case', *The Review of Economics and Statistics*, vol. 51, no. 3, pp. 247-57.

—— 1992, *Continuous-time Finance*, Revised edn, Blackwell, Cambridge, Massachusetts.

—— 2003, 'Thoughts on the Future: Theory and Practice in Investment Management', *Financial Analysts Journal*, vol. 59, no. 1, pp. 17-23.

Miccolis, JA & Goodman, M 2012, 'Dynamic Asset Allocation: Using Momentum to Enhance Portfolio Risk Management', *Journal of Financial Planning*, vol. 25, no. 2, pp. 35-42.

Milevsky, MA & Young, VR 2007, 'Annuitization and asset allocation', *Journal of Economic Dynamics and Control*, vol. 31, no. 9, pp. 3138-77.

Miller, MH 1999, 'The History of Finance, An Eyewitness Account', *Journal of Portfolio Management*, vol. 25 no. 4, pp. pp.95-101.

Mirer, TW 1979, 'The Wealth-Age Relation among the Aged', *The American Economic Review*, vol .69, no.3, pp. 435-43.

Mitchell, JB & Moore, AJ 2011, 'Lifetime Individual Retirement Arrangements: An Application of Thaler and Sunstein's NUDGE', *Journal of Accounting & Finance*, vol. 11, no. 2, pp. 16-25.

Mitchell, OS & Piggott, J 2000, 'Developments in Retirement Provision: Global Trends and Lessons from Australia and the US', The Pension Research Council, Wharton School, University of Pennsylvania, Working Paper 2000-2, viewed 29 Apr 2013, <http://www.pensionresearchcouncil.org/publications/papers.php?year=2000>

Mitchell, OS, Poterba, JM, Warshawsky, MJ & Brown, JR 1999, 'New Evidence on the Money's Worth of Individual Annuities', *American Economic Review*, vol. 89, no. 5, pp. 1299-318.

Modigliani, F & Brumberg, R 1954, 'Utility Analysis and the Consumption Function: An Interpretation of Cross-section Data', in KK Kurihara (ed), *Post-Keynesian Economics*, Rutgers University Press, New Brunswick, pp. 388-436

Morse, PM & Kimball, GE 1970, *Methods of Operations Research*, 1st edn, M.I.T. Press, Cambridge, Massachusetts.

Mullainathan, S & Thaler, RH 2000, 'Behavioral Economics', NBER Working Paper, no. 7948, National Bureau of Economic Research, Cambridge, Massachusetts.

Munnell, AH & Soto, M 2008, 'The Housing Bubble and Retirement Security', Center for Retirement Research at Boston College Working Paper 2008 -13, viewed 18 Feb 2013, <http://crr.bc.edu/working-papers/the-housing-bubble-and-retirement-security-2/>

Munnell, AH, Soto, M & Golub-Sass, A 2008, 'Will People Be Healthy Enough to Work Longer?', Center for Retirement Research at Boston College Working Paper 2008 -11, viewed 18 Feb 2013, <http://crr.bc.edu/working-papers/will-people-be-healthy-enough-to-work-longer-2/>

Murray, D 2014a, *Financial System Inquiry Interim Report*, Treasury, Canberra.

—— 2014b, *Financial System Inquiry Final Report*, Treasury, Canberra.

Naraharisetti, PK, Karimi, IA & Srinivasan, R 2008, 'Supply Chain Redesign Through Optimal Asset Management and Capital Budgeting', *Computers & Chemical Engineering*, vol. 32, no. 12, pp. 3153-69.

Newberger, R & Coussens, M 2008, 'Insurance and Wealth Building Among Lower-Income Households', *Chicago Fed Letter: Essays on Issues, No. 251*, Federal Reserve Bank of Chicago, Chicago.

Nielson, L 2010a, *Chronology of Superannuation and Retirement Income in Australia*, Parliamentary Library, Parliament of Australia, Canberra.

—— 2010b, ‘Superannuation 2010-2011’, Parliament of Australia Research Paper 3 2010-11, Parliament of Australia, Canberra.

Ntalianis, M & Wise, V 2011, 'The Role of Financial Education in Retirement Planning', *Australasian Accounting Business & Finance Journal*, vol. 5, no. 2, pp. 23-37.

O'Donoghue, T & Rabin, M 1999, 'Doing It Now or Later', *American Economic Review*, vol. 89, no. 1, pp. 103-24.

Organisation for Economic Co-operation and Development (OECD) 2011, *Pensions at a Glance 2011: Retirement Income Systems in OECD Countries*, OECD Publishing, Paris.

—— 2014, *OECD Pensions Outlook 2014*, OECD Publishing, Paris.

Olsberg, D & Winters, M 2005, ‘Ageing in Place: Intergenerational and Intrafamilial Housing Transfers and Shifts in Later Life’, Australian Housing and Urban Research Institute (AHURI) Final Report, no. 88, viewed 5 Mar 2010, <http://www.ahuri.edu.au/publications/projects/p70223>

Ong, R 2008, 'Unlocking Housing Equity Through Reverse Mortgages: The Case of Elderly Homeowners in Australia', *European Journal of Housing Policy*, vol. 8, no. 1, pp. 61-79.

Osborne, G 2014, *Pensions Freedom for 400,000 Hardworking Perople from Today*, Media Release, HM Treasury, London, 27 March, viewed 6 Jan 2015, <https://www.gov.uk/government/news/pensions-freedom-for-400000-hardworking-people-from-today>

Palumbo, MG 1999, 'Uncertain Medical Expenses and Precautionary Saving Near the End of the Life Cycle', *Review of Economic Studies*, vol. 66, no. 227, pp. 395-421.

Pang, G, Warshawsky, MJ & Weitzer, B 2010, 'The Retirement Decision: Current Influences on the Timing of Retirement Among Older Workers', in M Micocci, GN Gregoriou and GB Masala (eds), *Pension Fund Risk Management : Financial and Actuarial Modeling*, Chapman & Hall/CRC Boca Raton, Fl, pp. 287-314.

Papahristodoulou, C 2004, 'Option Strategies with Linear Programming', *European Journal of Operational Research*, vol. 157, no. 1, pp. 246-56.

Parada Daza, JR 2008, 'Finance and Theory of Knowledge', *International Research Journal of Finance & Economics*, no. 15, pp. 31-43.

Park, S & Lemaire, J 2011, 'HumanCulture Matters: Long-Term Orientation and the Demands for Life Insurance ', *Asia-Pacific Journal of Risk and Insurance*, vol. 5, no. 2, pp. 1-21.

Parkinson, S, Searle, BA, Smith, SJ, Stoakes, A & Wood, G 2009, 'Mortgage Equity Withdrawal in Australia and Britain: Towards a Wealth-Fare State?', *European Journal of Housing Policy*, vol. 9, no. 4, pp. 365-89.

Parliament of the Commonwealth of Australia 2014, *Minerals Resource Rent Tax Repeal and Other Measures Bill 2014 Supplementary Explanatory Memorandum*, Parliament of the Commonwealth of Australia, Canberra, viewed 16 Jan 2015, http://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/Bills_Search_Results/Result?bId=r5327

Parliamentary Joint Committee on Corporations and Financial Services 2009, *Inquiry into Financial Products and Services in Australia*, Parliament of Australia, Canberra.

Parrish, T & Delpachitra, S 2012, 'On Selection of Superannuation Fund: Impact of Choice and Information', *Economic Papers: A Journal of Applied Economics and Policy*, vol. 31, no. 3, pp. 369-79.

Parry, J & Taylor, RF 2007, 'Orientation, Opportunity and Autonomy: Why People Work after State Pension Age in Three Areas of England', *Ageing and Society*, vol. 27, no. 04, pp. 579-98.

Pfau, WD 2011a, 'Can We Predict the Sustainable Withdrawal Rate for New Retirees?', *Journal of Financial Planning*, vol. 24, no. 8, pp. 40-7.

—— 2011b, 'Safe Savings Rates: A New Approach to Retirement Planning over the Life Cycle', *Journal of Financial Planning*, vol. 24, no. 5, pp. 42-50.

Phillips, B, 2011, *The Great Australian Dream_Just a Dream?* AMP.NATSEM Income and Welath Report 29, NATSEM, University of Canberra,Canberra.

Piggott, J & Evans, J 2007, 'SGL Adequacy and Retirement: Longevity and Economic Impacts', Centre for Pensions and Superannuation University of NSW Discussion Paper 13/2007, viewed 5Aug 2009, http://www.asb.u.edu.au/research/cps/Documents/J.%20Piggott%20and%20J.%20Evans%20-%20SGL%20Adequacy%20and%20Retirement.pdf

Price, B & Suryadi, A 2011, 'New Treasury Stochastic Modelling of Australian Retirement Incomes', paper presented to Institute of Actuaries of Australia Biennal Convention, Sydney, 10-13 Apr 2011.

Quine, S, Bernard, D & Kendig, H 2006, 'Understanding Baby Boomers' Expectations and Plans for Their Retirement: Findings from a Qualitative Study', *Australasian Journal on Ageing*, vol. 25, no. 3, pp. 145-50.

Raymo, JM, Warren, JR, Sweeney, MM, Hauser, RM & Ho, J-H 2011, 'Precarious Employment, Bad Jobs, Labor Unions, and Early Retirement', *Journals of Gerontology Series B: Psychological Sciences & Social Sciences*, vol. 66B, no. 2, pp. 249-59.

Read, D 2007, 'Experienced Utility: Utility Theory from Jeremy Bentham to Daniel Kahneman', *Thinking & Reasoning*, vol. 13, no. 1, pp. 45-61.

Reed, R & Gibler, KM 2003, 'The Case for Reverse Mortgages in Australia–Applying the USA Experience', paper presented to 9th Annual Pacific Rim Real Estate Society Conference, Brisbane, 19-22 Jan 2003.

Reinhardt, S & Steel, L 2006, 'A Brief History of Australia's Tax System', *Economic Roundup*, Winter edition, pp. 1-26.

Reserve Bank of Australia (RBA) 2013, *About Monetary Policy*, RBA, Canberra, viewed 14 Jul 2013, http://www.rba.gov.au/monetary-policy/about.html

Russell Investments 2011, *Long-Term Investing Report Comparing 10, 20 and 25 Year Performance of Various Investments to December 2010*, Australian Stock Exchange, Sydney.

Salt, B & Mikkelsen, S 2009, *Monash Baby Boomer Study*, KPMG, viewed 19 Apr 2013, <http://www.kpmg.com/AU/en/IssuesAndInsights/ArticlesPublications/Documents/Monash-Baby-Boomer-Study.pdf>.

Samuelson, PA 1937, 'A Note on Measurement of Utility', *The Review of Economic Studies*, vol. 4, no. 2, pp. 155-61.

—— 1969, 'Lifetime Portfolio Selection By Dynamic Stochastic Programming', *The Review of Economics and Statistics*, vol. 51, no. 3, pp. 239-46

—— 1989, 'A Case At Last for Age-Phased Reduction in Equity', *Proceedings of the National Academy of Sciences*, vol. 86, no. 22, pp. 9048-51.

Saunders, P 1998, 'Using Budget Standards to Assess the Well-being of Families', paper presented to 6th Australian Institute of Family Studies Conference, Melbourne, 25-27 Nov 1998.

Saunders, P, Chalmers, J, McHugh, M, Murray, C, Bittman, M & Bradbury, B 1998, ‘Development of Indicative Budget Standards for Australia’, Social Policy Research Centre, University of NSW Research Paper 74, viewed 5 Mar 2013, <https://www.sprc.unsw.edu.au/media/SPRCFile/22_DSS_Report74_BudgetStandards.pdf>

Saunders, P, Patulny, R & Lee, A 2004, *Updating and Extending Indicative Budget Standards for Older Australians*, Report 2/04, Social Policy Research Centre, University of NSW,Sydney.

Scott, JS, Sharpe, WF & Watson, JG 2009, 'The 4% Rule—At What Price?', *Journal of Investment Management*, vol. 7, no. 3, pp. 31-48.

Selnow, GW 2004, 'Motivating Retirement Planning: Problems and Solutions', in OS Mitchell and SP Utkas (eds), *Pension Design and Structure New Lessons from Behavioral Finance*, Oxford University Press, New York, pp. 43-51.

Senior Australians Equity Release Association of Lenders (SEQUAL) 2013, *SEQUAL Code of Conduct*, SEQUAL, Eastwood, NSW, viewed 1 Mar 2013, <http://www.sequal.com.au/about-sequal/code-of-conduct>.

Sethi-Iyengar, S, Huberman, G & Jiang, W 2004, 'How Much Choice is Too Much? Contributions to 401(k) Retirement Plans', in OS Mitchell and SP Utkus (eds), *Pension Design and Structure : New Lessons from Behavioral Finance*, Oxford University Press, New York, pp.83-95.

Shan, H 2011, 'Reversing the Trend: The Recent Expansion of the Reverse Mortgage Market', *Real Estate Economics*, vol. 39, no. 4, pp. 743-68.

Sherry, N 2009a, *Communique of Principles for Superannuation*, Media Release, Treasury, Canberra, 28 April, viewed 25 Mar 2013, <http://ministers.treasury.gov.au/DisplayDocs.aspx?doc=pressreleases/2009/041.htm&pageID=003&min=njs&Year=&DocType=>

Sherry, N 2009b, *Expert Panel and Terms of Reference for Review into the Governance, Efficiency and Structure and Operation of Australia's Superannuation System,* Media Release, Treasury, Canberra, 29 May, viewed 25 Mar 2013, <http://ministers.treasury.gov.au/DisplayDocs.aspx?doc=pressreleases/2009/066.htm&pageID=003&min=njs&Year=&DocType=>.

Shorten, B 2012, *Government's Financial Advice Reforms Pass the Parliament,* Media Release, Treasury, Canberra, 20 Jun, viewed 19 Apr 2013, <http://ministers.treasury.gov.au/DisplayDocs.aspx?doc=pressreleases/2012/034.htm&pageID=003&min=brs&Year=&DocType=0>

Shorten, B & Swan, W 2013a, *Reforms to Make the Superannuation System Fairer*, Media Release, Treasury, Canberra, 5 Apr, viewed 19 Apr 2013, <http://ministers.treasury.gov.au/DisplayDocs.aspx?doc=pressreleases/2013/020.htm&pageID=003&min=brs&Year=&DocType=>

—— 2013b, *Tax Treatment of Earnings on Superannuation Assets Supporting Income Streams*, Media Release, Treasury, Canberra, 5 Apr, viewed 19 Apr 2013, <http://ministers.treasury.gov.au/DisplayDocs.aspx?doc=pressreleases/2013/021.htm&pageID=&min=brs&Year=&DocType=0>

Simon, HA 1955, 'A Behavioral Model of Rational Choice ', *Quarterly Journal of Economics*, vol. 69, no. 1, pp. 99-118.

—— 1956, 'Rational Choice and the Structure of the Environment', *Psychological Review*, vol. 63, no. 2, pp. 129-38.

—— 1957, *Models of Man: Social and Rational* : *Mathematical Essays on Rational Human Behavior in a Social Setting*, Wiley, New York.

—— 1972, 'Theories of Bounded Rationality', in CB McGuire and R Radner (eds), *Decision and Organization: A Volume in Honor of Jacob Marschak*, North-Holland Publishing Company, Amsterdam, pp.161-76.

Sinai, T & Souleles, NS 2005, 'Owner-Occupied Housing as a Hedge Against Rent Risk', *Quarterly Journal of Economics*, vol. 120, no. 2, pp. 763-89.

Smith, S 2006, 'The Retirement-Consumption Puzzle and Involuntary Early Retirement: Evidence from the British Household Panel Survey*', *The Economic Journal*, vol. 116, no. 510, pp. C130-48.

Stapledon, N 2010, 'A History of Housing rices in Australia 1880-2010', School of Economics University of NSW Discussion Paper 2010/18, viewed 10 Jan 2014, < http://econpapers.repec.org/paper/swewpaper/2010-18.htm>.

St. George Bank 2011, *Seniors Access Home Loan*, St. George Bank, Sydney, viewed 5 Sep 2011, <http://www.stgeorge.com.au/personal/home-loans/our-home-loans/specialist/seniors-access-home-loan>.

St John, S 2014, 'What Has New Zealand's Retirement Policy Framework to Offer the International Debate?' *Policy Quarterly*, vol. 10, no. 3, pp. 29-34.

Stein, MK 1998, *The Prosperous Retirement Guide to the New Reality*, EMSTCO Press, Boulder.

Stout, RG & Mitchell, JB 2006, 'Dynamic Retirement Withdrawal Planning', *Financial Services Review*, vol. 15, no. 2, pp. 117-31.

Strotz, RH 1955, 'Myopia and Inconsistency in Dynamic Utility Maximization', *The Review of Economic Studies*, vol. 23, no. 3, pp. 165-80.

Sumnicht, V 2009, 'MPT Principles Valid After 5 Decades', *Journal of Financial Planning*, Trends in Investing supplement, vol. 22, no. 6, pp. 16-8.

Swan,W & Bowen, C 2010, *Stronger, Fairer, Simpler Superannuation Banking the Benefits of the Boom*, Media Release, 2 May, Treasury, Canberra, viewed 17 Mar 2013, <http://www.treasurer.gov.au/wmsDisplayDocs.aspx?doc=pressreleases/2010/027.htm&pageID=003&min=wms&Year=2010&DocType=0>.

Swan, W & Bradbury, D 2012, *Tax Reform - Road Map*, Budget Paper, Australian Government, Canberra.

Swan, W & Rudd, K 2010, *Stronger, Fairer, Simpler: A Tax Plan for Our Future*, Media Release, Treasury, Canberra, 2 May, viewed 17 Mar 2013, <http://www.treasurer.gov.au/DisplayDocs.aspx?doc=pressreleases/2010/028.htm&pageID=003&min=wms&Year=&DocType>.

Swisher, P 2009, 'MPT Was Never Alive', *Journal of Financial Planning*, Trends in Investing supplement, vol. 22, no. 6, pp. 16-8.

Swisher, P & Kasten, GW 2005, 'Post-Modern Portfolio Theory', *Journal of Financial Planning*, vol. 18, no. 9, pp. 74-85.

Sy, W 2009, 'Towards a National Default Option for Low-Cost Superannuation', *Accounting Research Journal*, vol. 22, no. 1, pp. 46-67.

Sy, W & Liu, K 2010, 'Improving the Cost Efficiency of Australian Pension Management', *Rotman International Journal of Pension Management*, vol. 3, no. 1, pp. 38-47.

Thaler, RH 1985, 'Mental Accounting and Consumer Choice', *Marketing Science*, vol. 4, no. 3, pp. 199-214.

—— 1999, 'Mental Accounting Matters', *Journal of Behavioral Decision Making*, vol. 12, no. 3, pp. 183-206.

Thaler, RH & Benartzi, S 2004, 'Save More Tomorrow™: Using Behavioral Economics to Increase Employee Saving', *Journal of Political Economy*, vol. 112, no. S1, pp. S164-87.

The Allen Consulting Group 2007, *Australia's National Saving Revisited: Where Do We Stand Now?* Report to IFSA, viewed 6 Jan 2015, < http://www.acilallen.com.au/cms_files/acgnationalsavingrevisited2007.pdf>.

Tomlinson, JA 2012, 'A Utility-Based Approach to Evaluating Investment Strategies', *Journal of Financial Planning*, vol. 25, no. 2, pp. 53-60.

Treasury 2001, 'Towards Higher Retirement Incomes for Australians: a History of the Australian Retirement Income System Since Federation', *Economic Roundup*, Centenary edition, pp. 65-92.

—— 2002, *Intergenerational Report 2002-03*, Budget Paper no.5, Australian Government, Canberra.

—— 2007, *Intergenerational Report 2007*, Australian Government, Canberra.

—— 2010a, *Australia to 2050: Future Challenges*, Intergenerational Report 2010, Australian Government, Canberra.

—— 2010b, *Stronger Super*, Government Response to the Super System Review, Australian Government, Canberra.

—— 2011a, *Future of Financial Advice 2011*, Information Pack, Australian Government, Canberra.

—— 2011b, *Stronger Super*, Information Australian Government, Canberra.

—— 2012, *Retirement and Income Modelling*, Treasury, Canberra, viewed 4 Dec 2012, <http://rim.treasury.gov.au/content/models.asp>.

_____ 2013, *Stronger Super*, Legislation and Regulations, Treasury, Canberra, viewed 17 Mar 2013, <http://strongersuper.treasury.gov.au/content/Content.aspx?doc=legislation.htm>.

Tversky, A & Kahneman, D 1992, 'Advances in Prospect Theory: Cumulative Representation of Uncertainty', *Journal of Risk & Uncertainty*, vol. 5, no. 4, pp. 297-323.

Van de Venter, G, Michayluk, D & Davey, G 2012, 'A Longitudinal Study of Financial Risk Tolerance', *Journal of Economic Psychology*, vol. 33, no. 4, pp. 794-800.

van Rooij, M, Lusardi, A & Alessie, R 2011, 'Financial Literacy and Stock Market Participation', *Journal of Financial Economics*, vol. 101, no. 2, pp. 449-72.

Varian, HR 2003, *Intermediate Microeconomics : A Modern Approach*, 6th edn, W.W. Norton, New York.

Venter, GG 1984, 'Utility with Decreasing Risk Aversion', *Proceedings of the Casualty Actuarial Society*, vol. LXX, No. 133 & 134, Casualty Actuarial Society, New York, pp. 144-55.

Venti, SF & Wise, DA 1991, 'Aging and the Income Value of Housing Wealth', *Journal of Public Economics*, vol. 44, no. 3, pp. 371-97.

—— 2002, 'Aging and Housing Equity', in OS Mitchell, Z Bodie, PB Hammond and S Zeldes (eds), *Innovations in Retirement Financing*, University of Pennsylvania, Philadelphia, pp. 254 -81.

Vidal-Meliá, C & Lejárraga-García, A 2004, 'The Bequest Motive and Single People’s Demand for Life Annuities', *Belgian Actuarial Bulletin*, vol. 4, no. 1, pp. 4-15.

—— 2006, 'Demand for Life Annuities from Married Couples with a Bequest Motive', *Journal of Pension Economics and Finance*, vol. 5, no. 02, pp. 197-229.

von Neumann, J & Morgenstern, O 1966, *Theory of Games and Economic Behavior*, 3rd edn, Wiley, New York.

Walsh, ME, Daniel, G, Shapouri, H & Slinsky, SP 2003, 'Bioenergy Crop Production in the United States: Potential Quantities, Land Use Changes, and Economic Impacts on the Agricultural Sector', *Environmental and Resource Economics*, vol. 24, no. 4, pp. 313-33.

Ward, W 2000, 'Superannuation: The Sting in the Accord's Tail', *International Journal of Employment Studies*, vol. 8, no. 2, pp. 61-93.

Warren, D & Oguzoglu, U 2010, 'Retirement in Australia: A Closer Look at the Financial Incentives', *Australian Economic Review*, vol. 43, no. 4, pp. 357-75.

Warschauer, T 2002, 'The Role of Universities in the Development of the Personal Financial Planning Profession', *Financial Services Review*, vol. 11, no. 3, pp. 201-216.

Wilkins, R, Warren, D & Hahn, M 2009, *Families, Incomes and Jobs, Volume 4: A Statistical Report on Waves 1 to 6 of the Household, Income and Labour Dynamics in Australia Survey*, Melbourne Institute of Applied Economic and Social Research , University of Melbourne, Melbourne.

Wilkins, R, Warren, D, Hahn, M & Houng, B 2011, *Families, Incomes and Jobs, Volume 6: A Statistical Report on Waves 1 to 8 of the Household, Income and Labour Dynamics in Australia Survey*, Melbourne Institute of Applied Economic and Social Research , University of Melbourne, Melbourne.

Wilkinson, N 2007, *An Introduction to Behavioral Economics*, Palgrave Macmillan, Basingstoke.

Williamson, P 2007, 'The Role of the International Journal of Microsimulation', *International Journal of Microsimulation*, vol. 1, no. 1, pp. 1-2.

World Bank 1994, *Averting the Old Age Crisis: Policies to Protect the Old and Promote Growth*, Oxford University Press, New York.

Worthington, A 2008, 'Knowledge and Perceptions of Superannuation in Australia', *Journal of Consumer Policy*, vol. 31, no. 3, pp. 349-68.

Yaari, ME 1965, 'Uncertain Lifetime, Life Insurance, and the Theory of the Consumer', *Review of Economic Studies*, vol. 32, no. 90, pp. 137-50.

Yao, R, Sharpe, DL & Wang, F 2011, 'Decomposing the Age Effect on Risk Tolerance', *Journal of Socio-Economics*, vol. 40, no. 6, pp. 879-87.

Yogo, M 2009, 'Portfolio Choice in Retirement: Health Risk and the Demand for Annuities, Housing, and Risky Assets', NBER Working Paper, no. 15307, National Bureau of Economic Research, Cambridge, Massachusetts.

Appendix A Variables

As discussion in Section 3.2.2.3 states, a linear programming problem is one that can be formulated in the following way:

Maximise $C^{T}X$

subject to

$AX \leq B$

$X \geq 0$

where:

X is an $n \times 1$ matrix with x_1, x_2.... x_n being the variables.

C is an $n \times 1$ matrix giving details of the objective function.

A is an $m \times n$ matrix setting out left hand side of the constraints applying to the problem.

B is an $m \times 1$ matrix setting out the right hand side of the constraints applying to the problem.

The variables are the quantities needing to be determined to solve the optimisation problem.

For the Co2Ch model, there are 525 variables whilst for the SM and F1Ch models the number of variables is 423. However, many of these variables do not represent decisions made by the subjects of the models, but rather are variables needed to facilitate the setting up of the inequality expressions set out in matrices *A* and *B*.

The decision variables represent actual decisions made by the subjects of the model. These decision variables are listed in Table A-1 for the Co2Ch model and Table A-2 for the SM and F1Ch models. The number of decisions for each period is also provided. For the Co2Ch model there are 102 decision variables, whereas for the SM and F1Ch models, each model has 78 such variables.

Table A-1 Decision variables for Co2Ch model

Decision variable	Number of decisions				
	Period 1	Period 2	Period 3	Period 4	Period 5
Non-housing consumption amount	1	1	1	1	1
Amount of salary sacrifice superannuation saving	2	2	2	N.A.	N.A.
Amount of superannuation saving post tax	2	2	2	N.A.	N.A.
Purchase price of owner-occupied housing	1	1	1	1	1
Value of mortgage taken on new owner-occupied housing	1	1	1	1	1
Amount paid for incremental owner-occupied housing	N.A.	1	1	1	1
Increment to mortgage for incremental owner-occupied housing	N.A.	1	1	1	1
Amount paid during period against mortgage	1	1	1	1	1
Market value of owner-occupied housing at end of the period after realisation decision (i.e. sell or retain decision)	1	1	1	1	N.A.
Housing rental amount	1	1	1	1	1
Life insurance premiums paid during period	2	4	6	8	N.A.
Purchase price non-superannuation investments	1	1	1	1	1
Loan amount taken for purchase of new non-superannuation investments	1	1	1	1	1
Market value of non-superannuation investments end of period after realisation decision (i.e. realise or retain decision)	1	1	1	1	N.A.
Lump sum amount withdrawn from superannuation pension fund at beginning of period	N.A.	N.A.	N.A.	2	1
Amount used to purchase individual lifetime annuities at the beginning of period	N.A.	N.A.	N.A.	4	N.A.
Amount transferred from superannuation accumulation fund to superannuation pension fund at beginning of period	N.A.	N.A.	2	2	1
Income from superannuation pension fund during period	N.A.	N.A.	2	2	1
Amount taken as a reverse mortgage for the period	N.A.	N.A.	N.A.	1	1

Table A-2 Decision variables for SM and F1Ch models

Decision variable	Number of decisions				
	Period 1	Period 2	Period 3	Period 4	Period 5
Non-housing consumption amount	1	1	1	1	1
Amount of salary sacrifice superannuation saving	1	1	1	N.A.	N.A.
Amount of superannuation saving post tax	1	1	1	N.A.	N.A.
Purchase price of owner-occupied housing	1	1	1	1	1
Value of mortgage taken on new owner-occupied housing	1	1	1	1	1
Amount paid for incremental owner-occupied housing	N.A.	1	1	1	1
Increment to mortgage for incremental owner-occupied housing	N.A.	1	1	1	1
Amount paid during period against mortgage	1	1	1	1	1
Market value of owner-occupied housing at end of the period after realisation decision (i.e. sell or retain decision)	1	1	1	1	N.A.
Housing rental amount	1	1	1	1	1
Life insurance premiums paid during period	1	2	3	4	N.A.
Purchase price non-superannuation investments	1	1	1	1	1
Loan amount taken for purchase of new non-superannuation investments	1	1	1	1	1
Market value of non-superannuation investments end of period after realisation decision (i.e. realise or retain decision)	1	1	1	1	N.A.
Lump sum amount withdrawn from superannuation pension fund at beginning of period	N.A.	N.A.	N.A.	1	1
Amount used to purchase individual lifetime annuities at the beginning of period	N.A.	N.A.	N.A.	1	N.A.
Amount transferred from superannuation accumulation fund to superannuation pension fund at beginning of period	N.A.	N.A.	1	1	1
Income from superannuation pension fund during period	N.A.	N.A.	1	1	1
Amount taken as a reverse mortgage for the period	N.A.	N.A.	N.A.	1	1

Appendix B Process for determining coefficients for objective functions

As stated in Chapter 3, Section 3.2.2.3 a linear programming problem can be set out as;

Maximise:

$$c_1x_1 + c_2x_2 + \cdots + c_nx_n$$

Subject to:

$$a_{i1}x_1 + a_{i2}x_2 + \cdots + a_{in}x_{in} \leq b_i \forall i, i = 1, \ldots, m$$

and:

$$x_j \geq 0, \forall j, j = 1, \ldots, n$$

The expression $c_1x_1 + c_2x_2 + \ldots + c_nx_n$ is a general form of an objective function, where x_is are the decision variables and c_is are the coefficients assigned to the decision variables. These coefficients represent the contribution of a unit of each variable to the value of the objective function. For this study, the variables in the objective function range from 423 for SM and the F1Ch models to 525 for the Co2Ch model. The number of decision variables, however, range from 73 to 102, respectively.

For the objective functions used in this study, only fifteen decision variables from each model are used. These decision variables are the value of non-housing consumption for each of the five periods, the value of owner-occupied housing at the beginning of each of the five periods and the value of rental housing for each of the five periods.

There are four coefficients that need to be determined:

- The co-efficient for aggregate amounts for a period. Application of this coefficient provides a summation of present values for all years of the particular period for both consumption and rental housing.
- The co-efficient, applied to the beginning value of an owner-occupied dwelling that provides a summation of present values of imputed rent for all years of a period. The use of imputed rent allows for the value of an owner-occupied home to contribute to consumption for a period.

- The coefficient, applied to the beginning value of an owner-occupied dwelling that provides an intrinsic current value of imputed rent for all years of the designated period.
- The coefficient that provides a summation for all years of a period for an intrinsic current value for rental housing.

The process for establishing each coefficient is set out below.

B.1 Converting an aggregate value to a present value

To determine the coefficient needed to convert an aggregate value for a period to a present value amount for the period, the following approach was taken. Let:

pv_t be the required present value factor,

t be the period number: $t \in \{1, 2, 3, 4, 5\}$,
n_t be the number of years in period t,
s_t be the number of years from initial time for the first year of the period t, and
a_t be the aggregate amount for period t.

Table B-1 sets out the relationships between t, n_t and s_t

Table B-1 Relationship between t, n_t and s_t

t	n_t	s_t
1	18	1
2	14	19
3	10	33
4	14	43
5	18	57

Given the total nominal consumption for period t, and an inflation rate of 3%, the portion that applies to the first year of period t is:

$$a_t \times \left(\sum_{i=0}^{n_t-1} 1.03^i\right)^{-1}$$

The year 1 portion of period t amount is a future value. Assuming an inflation rate of 3% per annum, a period present value factor of 1.03^{-s_t+1} must be applied to ensure present value. Thus the present value of the portion of the aggregate value for period t assigned to the first year of this period is:

$$a_t \times \left(\sum_{i=0}^{n_t-1} 1.03^i\right)^{-1} \times 1.03^{-s_t+1}$$

As there are n_t years in period t, the present value of the aggregate amount for all of period t is:

$$n_t \times a_t \times \left(\sum_{i=0}^{n_t-1} 1.03^i\right)^{-1} \times 1.03^{-s_t+1}$$

Thus the present value factor for period t can be expressed as:

$$\boldsymbol{pv_t = n_t \times \left(\sum_{i=0}^{n_t-1} 1.03^i\right)^{-1} \times 1.03^{-s_t+1}}$$

The values for component parts of the above equation are set out in the table below:

Table B-2 Co-efficients for aggregate values - determining present value

t	n_t	s_t	1.03^{-s_t+1}	$\left(\sum_{i=0}^{n_t-1} 1.03^i\right)^{-1}$	pv_t
1	18	1	1	0.0427087	0.768757
2	14	19	0.5873946	0.0585263	0.481293
3	10	33	0.3883370	0.0872305	0.338748
4	14	43	0.2889592	0.0585263	0.236764
5	18	57	0.1910361	0.0427087	0.146860

B.2 Converting an initial year owner-occupied housing value to an imputed rent present value

For owner-occupied housing, the appropriate decision variable for the objective function is the value of this housing at the beginning of the relevant period. To determine the coefficient needed to convert this value for a period to a present value of imputed rent for all years of particular period, the following approach was taken. Let:

$irpv_t$ be the required factor,
t be the period number: $t \in \{1, 2, 3, 4, 5\}$,
n_t be the number of years in period t,
s_t be the number of years from initial time for the first year of the period t, and
y_{ti} be the year number.

$y_{1i} \in \{1, 2, 3, \dots 17, 18\}$
$y_{2i} \in \{19, 20, 21, \dots 31, 32\}$
$y_{3i} \in \{33, 34, 35, \dots 41, 42\}$
$y_{4i} \in \{43, 44, 45, \dots 55, 56\}$

$y_{5i} \in \{57, 58, 59, \ldots 73, 74\}$

h_t be the value of owner-occupied housing at beginning of period t

Assume an inflation rate of 3% per annum and a housing growth rate of 5.2% per annum

It follows that the imputed rent for year y_{ti} is

$$h_1 \times 1.052^{y_{ti}-1} \times 0.05$$

and that the present value of imputed rent for year y_{ti} is:

$$h_1 \times 1.052^{y_{ti}-1} \times 0.05 \times 1.03^{-y_{ti}+1}$$

which can be rewritten as:

$$h_1 \times 0.05 \times (1.052/1.03)^{y_{ti}-1}$$

It follows that the present value of the imputed rent for period t is

$$h_1 \times 0.05 \times \sum_{y_{ti}=s_t}^{s_t+n_t} \left(\frac{1.052}{1.03}\right)^{y_{ti}-1}$$

But the value of owner occupied housing h_t at the beginning of period t is:

$$h_1 \times 1.052^{s_t-1}$$

and thus the present value of the imputed rent for period t is:

$$h_t \times 0.05 \times \sum_{y_{ti}=s_t}^{s_t+n_t} \left(\frac{1.052}{1.03}\right)^{y_{ti}-1} \times (1.052^{s_t-1})^{-1}$$

Thus the required imputed rent present value factor for period t, $irpv_t$, is:

$$\boldsymbol{irpv_t = 0.05 \times \sum_{y_{ti}=s_t}^{s_t+n_t} \left(\frac{1.052}{1.03}\right)^{y_{ti}-1} \times (1.052^{s_t-1})^{-1}}$$

The values for component parts of the above equation are set out in the table below:

Table 5-3 Co-efficients for owner-occupied housing - determining present value

t	n_t	s_t	$\sum_{y_{ti}=s_t}^{s_t+n_t}\left(\frac{1.052}{1.03}\right)^{y_{ti}-1}$	$\left(1.052^{s_t-1}\right)^{-1}$	imputed rent rate	$irpv_t$
1	18	1	21.6719206	1	0.05	1.083596
2	14	19	23.5817810	0.4015288	0.05	0.473438
3	10	33	21.6678428	0.1974678	0.05	0.213935
4	14	43	39.1616485	0.1189430	0.05	0.232900
5	18	57	70.7773419	0.0584949	0.05	0.207006

B.3 Converting an initial year owner-occupied housing value to an imputed rent intrinsic current value

For objective function 3, one of the contributing factors is the current value of the imputed rent for the lifetime for the intrinsic current value of the owner-occupied dwelling. The intrinsic current value is the value of the dwelling in the base year, 2011. As in Section B.2, the appropriate decision variable to use in the function is the result for value of the housing at the beginning of each period and thus it is necessary to determine an expression for the factor to apply to this decision variable. Let:

$iricv_t$ be the required factor.

t be the period number: $t \in \{1, 2, 3, 4, 5\}$

n_t be the number of years in period t

s_t be the number of years from initial time for the first year of the period t.

h_t be the value of owner-occupied housing at beginning of period t

The intrinsic current value of a dwelling for period t, based on housing values as at 2011, is:

$$h_t \times 1.052^{-s_t+1}$$

The intrinsic current value of the imputed rent for year 1 of period t is

$$0.05 \times h_t \times 1.052^{-s_t+1}$$

In period t, there are n_t years. Thus the intrinsic current value of the imputed rent for all years of period t is

$$n_t \times 0.05 \times h_t \times 1.052^{-s_t+1}$$

Thus the intrinsic imputed rent current value factor is

$$\boldsymbol{iricv_t = 0.05 \times n_t \times 1.052^{-s_t+1}}$$

The values for component parts of the above equation are set out in the table below:

Table B-4 Co-efficients for owner-occupied housing – determining intrinsic current value

t	n_t	s_t	1.052^{-s_t+1}	Imputed rent proportion	$iricv_t$
1	18	1	1	0.05	0.9
2	14	19	0.4015288	0.05	0.281070
3	10	33	0.1974678	0.05	0.098734
4	14	43	0.1189430	0.05	0.083260
5	18	57	0.0584949	0.05	0.052645

B.4 Converting an aggregate housing rental amount to an intrinsic current value

For objective function 3, one of the contributing factors is the intrinsic current value of housing rental paid for a period. The models are such that solutions must provide for either owner-occupied housing or for rental, where the rental amount is specified exactly for each period. As these specified values are based on rents increasing by 5% per year, and objective function 3 provides for intrinsic current values, it is necessary to establish a factor that converts the aggregate rental for a period into the intrinsic current value for each period. Let:

$ricv_t$ be the required factor.

t be the period number: $t \in \{1, 2, 3, 4, 5\}$

n_t be the number of years in period t

s_t be the number of years from initial time for the first year of the period t.

r_t be total rent paid for all of period t

The rent for period t that applies to the first year of period t is:

$$r_t \times \left(\sum_{i=0}^{n_t-1} 1.05^i\right)^{-1}$$

The intrinsic current value of this rent for the first year of a period is

$$1.05^{-s_t+1} \times r_t \times \left(\sum_{i=0}^{n_t-1} 1.05^i\right)^{-1}$$

As there are n_t years in period t the rental intrinsic current value for period t is:

$$n_t \times 1.05^{-s_t+1} \times r_t \times \left(\sum_{i=0}^{n_t-1} 1.05^i\right)^{-1}$$

Thus the rental intrinsic current value factor for period *t* is

$$\boldsymbol{ricv_t = 1.05^{-s_t+1} \times n_t \times \left(\sum_{i=0}^{n_t-1} 1.05^i\right)^{-1}}$$

The values for component parts of the above equation are set out in the table below:

Table B-5 Co-efficients for rental housing - determining intrinsic current value

t	n_t	s_t	$\mathbf{1.05^{-s_t+1}}$	$\left(\sum_{i=0}^{n_t-1} \mathbf{1.05^i}\right)^{-1}$	$ricv_t$
1	18	1	1	0.0355462	0.639832
2	14	19	0.4155207	0.0510240	0.296821
3	10	33	0.2098662	0.0795046	0.166853
4	14	43	0.1288396	0.0510240	0.092035
5	18	57	0.0650728	0.0355462	0.041636

Appendix C Schematic representations of optimal solutions

The representations set out below show the sets of decisions that provide the optimal solution for each objective function with each of the three scenarios i.e. (i) the base scenario, (ii) the conservative scenario and (iii) the traditional scenario. The latter scenario relates only to the SM and F1Ch models, whilst the first two scenarios apply to all three models.

C.1 Co2Ch base scenario

C.1.1 Objective function 1 optimal solution

	Co2Ch base scenario				
	Objective function 1				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner – occupied housing	Buy	Upgrade	Downsize	Hold	Downsize
Mortgage status					
Rental housing					
Life insurance (male)					N.A.
Life insurance (female)					N.A.
Salary sacrifice superannuation (male)				N.A.	N.A.
Salary sacrifice superannuation (female)				N.A.	N.A.
Additional superannuation post tax (male)				N.A.	N.A.
Additional superannuation post tax (female)				N.A.	N.A.
Non-superannuation investment					
Investment loan status					
Superannuation cash withdrawal (male)	N.A.	N.A.	N.A.		N.A.
Superannuation cash withdrawal (female	N.A.	N.A.	N.A.		
Superannuation pension (male)	N.A.	N.A.			N.A.
Superannuation pension (female)	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.		
Life-contingent annuities (male)	N.A.	N.A.	N.A.		
Life-contingent annuities (female)	N.A.	N.A.	N.A.		
Age Pension part 1 (couple)	N.A.	N.A.	N.A.		
Age Pension part 2 (couple)	N.A.	N.A.	N.A.		
Age Pension rental supplement (couple)	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$47,519	$63,345	$79,658	$55,433	$51,345
Intrinsic current value housing	$418,000	$523,386	$521,907	$521,907	$334,000

N.A.				
Not Applicable	Decision - choose	Decision - not choose	Contingent result - receive $$	Contingent result - not receive $$

C.1.2 Objective function 2 optimal solution

	Co2Ch base scenario				
	Objective function 2				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner – occupied housing	Buy	Upgrade	Hold	Upgrade	Hold
Mortgage status					
Rental housing					
Life insurance (male)					N.A.
Life insurance (female)					N.A.
Salary sacrifice superannuation (male)				N.A.	N.A.
Salary sacrifice superannuation (female)				N.A.	N.A.
Additional superannuation post tax (male)				N.A.	N.A.
Additional superannuation post tax (female)				N.A.	N.A.
Non-superannuation investment					
Investment loan status					
Superannuation cash withdrawal (male)	N.A.	N.A.	N.A.		N.A.
Superannuation cash withdrawal (female	N.A.	N.A.	N.A.		
Superannuation pension (male)	N.A.	N.A.			N.A.
Superannuation pension (female)	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.		
Life-contingent annuities (male)	N.A.	N.A.	N.A.		
Life-contingent annuities (female)	N.A.	N.A.	N.A.		
Age Pension part 1 (couple)	N.A.	N.A.	N.A.		
Age Pension part 2 (couple)	N.A.	N.A.	N.A.		
Age Pension rental supplement (couple)	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$47,519	$59,928	$43,591	$43,500	$31,000
Intrinsic current value housing	$418,000	$521,987	$521,987	$826,095	$826,095

N.A.				
Not Applicable	Decision - choose	Decision - not choose	Contingent result - receive $$	Contingent result - not receive $$

C.1.3 Objective function 3 optimal solution

	Co2Ch base scenario				
	Objective function 3				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner – occupied housing	Buy	Upgrade	Upgrade	Upgrade	Downsize
Mortgage status					
Rental housing					
Life insurance (male)					N.A.
Life insurance (female)					N.A.
Salary sacrifice superannuation (male)				N.A.	N.A.
Salary sacrifice superannuation (female)				N.A.	N.A.
Additional superannuation post tax (male)				N.A.	N.A.
Additional superannuation post tax (female)				N.A.	N.A.
Non-superannuation investment					
Investment loan status					
Superannuation cash withdrawal (male)	N.A.	N.A.	N.A.		N.A.
Superannuation cash withdrawal (female	N.A.	N.A.	N.A.		
Superannuation pension (male)	N.A.	N.A.			N.A.
Superannuation pension (female)	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.		
Life-contingent annuities (male)	N.A.	N.A.	N.A.		
Life-contingent annuities (female)	N.A.	N.A.	N.A.		
Age Pension part 1 (couple)	N.A.	N.A.	N.A.		
Age Pension part 2 (couple)	N.A.	N.A.	N.A.		
Age Pension rental supplement (couple)	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$47,519	$59,928	$75,361	$57,059	$52,850
Intrinsic current value housing	$418,000	$523,386	$594,170	$601,366	$347,639

N.A.				
Not Applicable	Decision - choose	Decision - not choose	Contingent result - receive $$	Contingent result - not receive $$

C.2 Co2Ch conservative scenario

C.2.1 Objective function 1 optimal solution

	Co2Ch conservative scenario				
	Objective function 1				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner – occupied housing	Buy	Upgrade	Hold	Upgrade	Downsize
Mortgage status					
Rental housing					
Life insurance (male)					N.A.
Life insurance (female)					N.A.
Salary sacrifice superannuation (male)				N.A.	N.A.
Salary sacrifice superannuation (female)				N.A.	N.A.
Additional superannuation post tax (male)				N.A.	N.A.
Additional superannuation post tax (female)				N.A.	N.A.
Non-superannuation investment					
Investment loan status					
Superannuation cash withdrawal (male)	N.A.	N.A.	N.A.		N.A.
Superannuation cash withdrawal (female	N.A.	N.A.	N.A.		
Superannuation pension (male)	N.A.	N.A.			N.A.
Superannuation pension (female)	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities (male)	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities (female)	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1 (couple)	N.A.	N.A.	N.A.		
Age Pension part 2 (couple)	N.A.	N.A.	N.A.		
Age Pension rental supplement (couple)	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$47,519	$59,928	$68,405	$47,504	$40,249
Intrinsic current value housing	$418,000	$521,987	$521,987	$550,732	$334,000

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.2.2 Objective function 2 optimal solution

	Co2Ch conservative scenario				
	Objective function 2				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner – occupied housing	Buy	Upgrade	Upgrade	Downsize	Downsize
Mortgage status					
Rental housing					
Life insurance (male)					N.A.
Life insurance (female)					N.A.
Salary sacrifice superannuation (male)				N.A.	N.A.
Salary sacrifice superannuation (female)				N.A.	N.A.
Additional superannuation post tax (male)				N.A.	N.A.
Additional superannuation post tax (female)				N.A.	N.A.
Non-superannuation investment					
Investment loan status					
Superannuation cash withdrawal (male)	N.A.	N.A.	N.A.		N.A.
Superannuation cash withdrawal (female	N.A.	N.A.	N.A.		
Superannuation pension (male)	N.A.	N.A.			N.A.
Superannuation pension (female)	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities (male)	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities (female)	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1 (couple)	N.A.	N.A.	N.A.		
Age Pension part 2 (couple)	N.A.	N.A.	N.A.		
Age Pension rental supplement (couple)	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$47,519	$59,928	$43,591	$43,500	$31,000
Intrinsic current value housing	$418,000	$548,739	$718,406	$662,175	$511,067

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.2.3 Objective function 3 optimal solution

	Co2Ch conservative scenario				
	Objective function 3				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner – occupied housing	Buy	Upgrade	Upgrade	Downsize	Downsize
Mortgage status					
Rental housing					
Life insurance (male)					N.A.
Life insurance (female)					N.A.
Salary sacrifice superannuation (male)				N.A.	N.A.
Salary sacrifice superannuation (female)				N.A.	N.A.
Additional superannuation post tax (male)				N.A.	N.A.
Additional superannuation post tax (female)				N.A.	N.A.
Non-superannuation investment					
Investment loan status					
Superannuation cash withdrawal (male)	N.A.	N.A.	N.A.		N.A.
Superannuation cash withdrawal (female	N.A.	N.A.	N.A.		
Superannuation pension (male)	N.A.	N.A.			N.A.
Superannuation pension (female)	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities (male)	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities (female)	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1 (couple)	N.A.	N.A.	N.A.		
Age Pension part 2 (couple)	N.A.	N.A.	N.A.		
Age Pension rental supplement (couple)	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$47,519	$59,928	$64,001	$44,790	$41,486
Intrinsic current value housing	$458,650	$541,539	$616,497	$564,797	$334,000

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.3 SM base scenario

C.3.1 Objective functions 1 & 3 optimal solution

	SM base scenario				
	Objective functions 1 & 3				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Hold	Hold	Hold
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status					
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.		
Life-contingent annuities	N.A.	N.A.	N.A.		
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$18,684	$21,961	$39,385	$98,704	$128,287
Intrinsic current value housing	$250,500	$334,000	$334,000	$334,000	$334,000

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.3.2 Objective function 2 optimal solution

	SM base scenario				
	Objective function 2				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Upgrade	Hold	Hold
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status					
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.		
Life-contingent annuities	N.A.	N.A.	N.A.		
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$18,684	$18,684	$25,880	$29,720	$38,627
Intrinsic current value housing	$250,500	$502,355	$1.044m	$1.044m	$1.044m

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.4 SM conservative scenario

C.4.1 Objective function 1 optimal solution

Decision	SM conservative scenario – Objective function 1: Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Hold	Hold	Hold
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status	N.A.	N.A.	N.A.	N.A.	N.A.
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$18,684	$18,684	$21,533	$53,964	$70,139
Intrinsic current value housing	$250,500	$334,000	$334,000	$334,000	$334,000

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.4.2 Objective function 2 optimal solution

Decision	SM conservative scenario – Objective function 2 Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Upgrade	Upgrade	Hold
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status	N.A.	N.A.	N.A.	N.A.	N.A.
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$18,684	$18,684	$18,684	$20,391	$20,391
Intrinsic current value housing	$305,410	$458,115	$684,850	$904,892	$904,892

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.4.3 Objective function 3 optimal solution

Decision	SM conservative scenario Objective function 3 Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Upgrade	Hold	Downsize
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status	N.A.	N.A.	N.A.	N.A.	N.A.
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$18,684	$18,684	$19,265	$48,281	$62,751
Intrinsic current value housing	$305,410	$458,115	$519,669	$519,669	$334,000

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.5 SM traditional scenario

C.5.1 Objective function 1 optimal solution

	SM traditional scenario				
	Objective function 1				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Hold	Hold	Hold
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status	N.A.	N.A.	N.A.	N.A.	N.A.
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$22,421	$22,421	$22,421	$45,863	$59,610
Intrinsic current value housing	$250,500	$334,000	$334,000	$334,000	$334,000

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.5.2 Objective function 2 optimal solution

	SM traditional scenario				
	Objective function 2				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Upgrade	Upgrade	Hold
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status	N.A.	N.A.	N.A.	N.A.	N.A.
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$22,421	$22,421	$22,421	$24,469	$24,469
Intrinsic current value housing	$305,410	$458,115	$644,812	$761,823	$761,823

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.5.3 Objective function 3 optimal solution

	SM traditional scenario				
	Objective function 3				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Upgrade	Downsize	Downsize
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status	N.A.	N.A.	N.A.	N.A.	N.A.
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$22,421	$25,082	$44,982	$33,305	$42,654
Intrinsic current value housing	$305,410	$458,115	$617,440	$586,048	$335,507

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.6 F1Ch base scenario

C.6.1 Objective functions 1 & 3 optimal solution

	F1Ch base scenario				
	Objective functions 1 & 3				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Hold	Hold	Hold
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status					
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.		
Life-contingent annuities	N.A.	N.A.	N.A.		
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$19,722	$27,591	$40,104	$89,916	$116,865
Intrinsic current value housing	$250,500	$334,000	$334,000	$334,000	$334,000

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.6.2 Objective function 2 optimal solution

	F1Ch base scenario				
	Objective function 2				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Upgrade	Hold	Hold
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status					
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.		
Life-contingent annuities	N.A.	N.A.	N.A.		
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$19,722	$24,121	$19,777	$29,989	$38,977
Intrinsic current value housing	$250,500	$339,505	$1.044m	$1.044m	$1.044m

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.7 F1Ch conservative scenario

C.7.1 Objective function 1 optimal solution

	F1Ch conservative scenario				
	Objective function 1				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Hold	Hold	Hold
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status	N.A.	N.A.	N.A.	N.A.	N.A.
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$19,722	$25,106	$36,493	$64,021	$31,133
Intrinsic current value housing	$250,500	$334,000	$334,000	$334,000	$334,000

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.7.2 Objective function 2 optimal solution

	F1Ch conservative scenario				
	Objective function 2				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Upgrade	Upgrade	Hold
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status	N.A.	N.A.	N.A.	N.A.	N.A.
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$19,722	$24,121	$19,777	$19,309	$19,497
Intrinsic current value housing	$298,044	$447,066	$670,599	$796,795	$796,795

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.7.3 Objective function 3 optimal solution

	F1Ch conservative scenario				
	Objective function 3				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Upgrade	Hold	Downsize
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status	N.A.	N.A.	N.A.	N.A.	N.A.
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$19,722	$25,942	$37,708	$32,580	$42,345
Intrinsic current value housing	$298,044	$447,066	$670,599	$603,238	$358,647

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.8 F1Ch traditional scenario

C.8.1 Objective function 1 optimal solution

	F1Ch traditional scenario				
	Objective function 1				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Hold	Hold	Hold
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status	N.A.	N.A.	N.A.	N.A.	N.A.
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$28,511	$38,232	$44,309	$29,350	$31,133
Intrinsic current value housing	$250,500	$334,000	$334,000	$334,000	$334,000

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.8.2 Objective function 2 optimal solution

	F1Ch traditional scenario				
	Objective function 2				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Upgrade	Upgrade	Hold
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status	N.A.	N.A.	N.A.	N.A.	N.A.
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$28,511	$35,957	$26,155	$26,100	$22,193
Intrinsic current value housing	$259,500	$375,750	$527,277	$497,513	$497,513

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

C.8.3 Objective function 3 optimal solution

	F1Ch traditional scenario				
	Objective function 3				
Decision	Period 1	Period 2	Period 3	Period 4	Period 5
Owner –occupied housing	Buy	Upgrade	Upgrade	Downsize	Downsize
Mortgage status					
Rental housing					
Life insurance					N.A.
Salary sacrifice superannuation				N.A.	N.A.
Additional superannuation post tax				N.A.	N.A.
Non-superannuation investment					
Investment loan status	N.A.	N.A.	N.A.	N.A.	N.A.
Superannuation cash withdrawal	N.A.	N.A.	N.A.		
Superannuation pension	N.A.	N.A.			
Reverse mortgage	N.A.	N.A.	N.A.	N.A.	N.A.
Life-contingent annuities	N.A.	N.A.	N.A.	N.A.	N.A.
Age Pension part 1	N.A.	N.A.	N.A.		
Age Pension part 2	N.A.	N.A.	N.A.		
Age Pension rental supplement	N.A.	N.A.	N.A.		
NHC (per annum, present value)	$28,511	$35,957	$42,304	$35,957	$28,511
Intrinsic current value housing	$298,044	$408,755	$447,577	$395,690	$334,321

N.A.				
Not Applicable	Decision - choose	Decision – not choose	Contingent result – receive $$	Contingent result - not receive $$

Appendix D Optimal solutions - various housing growth rates.

The tables set out below show the optimal solutions for each model with each of the three objective functions for both the base and conservative scenarios for three housing growth rates i.e. 5.2% per annum, 4% per annum and 3% per annum.

Justification is provided in Chapter 3 Section 3.4.5.8 as to why the rate of 5.2% per annum is the rate adopted for the study. The tables below allow the impact of changed rates to be observed.

D.1 Co2Ch base scenario

	Co2Ch base scenario					
	Objective function 1					
	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$47,519	$418,000	$47,519	$418,000	$47,519	rent
2	$63,345	$523,386	$59,928	$521,765	$59,928	rent
3	$79,658	$521,907	$68,798	$521,765	$43,591	rent
4	$55,433	$521,907	$53,810	$417,502	$67,994	rent
5	$51,345	$334,000	$49,841	$334,000	$62,979	$334,000
	Objective function 2					
	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$47,519	$418,000	$47,519	$418,000	$47,519	$418,000
2	$59,928	$521,987	$59,928	$521,765	$59,928	$521,606
3	$43,591	$521,987	$43,591	$521,765	$43,591	$521,606
4	$43,500	$826,095	$43,500	$1.032m	$43,500	$1.304m
5	$31,000	$826,095	$38,330	$1.032m	$41,812	$1.304m
	Objective function 3					
	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$47,519	$418,000	$47,519	$418,000	$47,519	$418,000
2	$59,928	$523,386	$59,928	$521,765	$59,928	$521,606
3	$75,361	$594,170	$43,591	$521,765	$43,591	$521,606
4	$57,059	$601,366	$43,500	$1.016m	$43,500	$1.304m
5	$52,850	$347,639	$49,841	$1.016m	$41,812	$1.304m

D.2 SM base scenario

	SM base scenario					
	Objective function 1					
	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$18,684	$250,500	$18,684	$250,500	$18,684	$250,500
2	$21,961	$334,000	$21,804	$334,000	$21,721	$334,000
3	$39,385	$334,000	$39,103	$334,000	$38,953	$334,000
4	$98,704	$334,000	$97,997	$334,000	$97,621	$334,000
5	$128,287	$334,000	$127,368	$334,000	$126,881	$334,000
	Objective function 2					
	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$18,684	$250,500	$18,684	$250,500	$18,684	$250,500
2	$18,684	$502,355	$18,684	$334,000	$19,930	$334,000
3	$25,880	$1.044m	$26,724	$334,000	$35,741	$367,400
4	$29,720	$1.044m	$66,973	$1.044m	$89,572	$463,406
5	$38,627	$1.044m	$87,046	$1.044m	$116,418	$1.044m
	Objective function 3					
	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$18,684	$250,500	$18,684	$250,500	$18,684	$250,500
2	$21,961	$334,000	$21,049	$334,000	$19,930	$334,000
3	$39,385	$334,000	$37,749	$334,000	$35,741	$367,400
4	$98,704	$334,000	$94,604	$334,000	$89,572	$463,406
5	$128,287	$334,000	$122,959	$598,853	$116,418	$1.044m

D.3 F1Ch base scenario

F1Ch base scenario

Objective function 1

	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$19,722	$250,500	$19,722	$250,500	$19,722	$250,500
2	$27,591	$334,000	$27,378	$334,000	$27,379	$334,000
3	$40,104	$334,000	$39,895	$334,000	$39,790	$334,000
4	$89,916	$334,000	$89,448	$334,000	$89,225	$334,000
5	$116,865	$334,000	$116,257	$334,000	$115,968	$334,000

Objective function 2

	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$19,722	$250,500	$19,722	$250,500	$19,722	$250,500
2	$24,121	$339,505	$24,121	$334,000	$25,405	$334,000
3	$19,777	$1.044m	$26,219	$334,000	$36.927	$367,400
4	$29,989	$1.044m	$58,785	$1.044m	$82,793	$400,800
5	$38,977	$1.044m	$76,404	$1.044m	$107,608	$1,044m

Objective function 3

	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$19,722	$250,500	$19,722	$250,500	$19,722	$250,500
2	$27,591	$334,000	$26,528	$334,000	$25,405	$334,000
3	$40,104	$334,000	$38,560	$334,000	$36.927	$367,400
4	$89,916	$334,000	$86,453	$334,000	$82,793	$400,800
5	$116,865	$334,000	$112,365	$598,853	$107,608	$1,044m

D.4 Co2Ch conservative scenario

	Co2Ch conservative scenario					
	Objective function 1					
	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$47,519	$418,000	$47,519	$418,000	$47,519	$418,000
2	$59,928	$521,987	$59,928	$521,765	$59,928	$521,987
3	$68,405	$521,987	$62,640	$521,765	$62,640	$521,987
4	$47,504	$550,732	$43,500	$701,531	$43,500	$809,060
5	$40,249	$334,000	$38,983	$334,000	$34,028	$334,000
	Objective function 2					
	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$47,519	$418,000	$47,519	$418,000	$47,519	$418,000
2	$59,928	$548,739	$59,928	$521,765	$59,928	$521,606
3	$43,591	$718,406	$43,591	$573,959	$43,591	$573,989
4	$43,500	$662,175	$43,500	$833,758	$43,500	$1.038m
5	$31,000	$511,067	$31,000	$573,665	$31,000	$594,977
	Objective function 3					
	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$47,519	$418,000	$47,519	$418,000	$47,519	$418,000
2	$59,928	$541,539	$59,928	$521,765	$59,928	$521,606
3	$64,001	$616,497	$43,591	$625,204	$43,591	$573,989
4	$44,790	$564,797	$43,500	$829,256	$43,500	$1.038m
5	$41,486	$334,000	$40,291	$422,238	$31,000	$594,977

D.5 SM conservative scenario

	SM conservative scenario					
	Objective function 1					
	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$18,684	$250,500	$18,684	$250,500	$18,684	$250,500
2	$18,684	$334,000	$18,684	$334,000	$18,684	$334,000
3	$21,533	$334,000	$22,087	$334,000	$22,469	$334,000
4	$53,964	$334,000	$55,352	$334,000	$56,310	$334,000
5	$70,139	$334,000	$71,942	$334,000	$73,187	$334,000
	Objective function 2					
	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$18,684	$305,410	$18,684	$250,500	$18,684	$250,500
2	$18,684	$458,115	$18,684	$718,555	$18,864	$855,048
3	$18,684	$684,850	$18,684	$808,479	$30,399	$1.056m
4	$20,391	$904,892	$20,391	$1.044m	$22,508	$1.044m
5	$20,391	$904,892	$26,362	$1.044m	$27,873	$1.044m
	Objective function 3					
	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$18,684	$305,410	$18,684	$250,500	$18,684	$250,500
2	$18,684	$458,115	$18,684	$718,555	$18,864	$855,048
3	$19,265	$519,669	$18,684	$808,479	$30,399	$1.056m
4	$48,281	$519,669	$27,163	$1.018m	$22,508	$1.044m
5	$62,751	$334,000	$31,133	$899,007	$27,873	$1.044m

D.6 F1Ch conservative scenario

F1Ch conservative scenario

Objective function 1

	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$19,722	$250,500	$19,722	$250,500	$19,722	$250,500
2	$25,106	$334,000	$24,121	$334,000	$24,121	$334,000
3	$36,493	$334,000	$20,003	$334,000	$20,393	$334,000
4	$64,021	$334,000	$44,848	$334,000	$45,722	$334,000
5	$31,133	$334,000	$58,289	$334,000	$59,425	$334,000

Objective function 2

	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$19,722	$298,044	$19,722	$298,044	$19,722	$298,044
2	$24,121	$447,066	$24,121	$447,066	$24,121	$447,066
3	$19,777	$670,599	$19,777	$670,599	$27,931	$977,124
4	$19,309	$796,795	$19,309	$1.044m	$22,395	$1.044m
5	$19,497	$796,795	$20,664	$1.044m	$27,699	$1.044m

Objective function 3

	Housing growth rate per annum					
	5.20%		4%		3%	
Period	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value	Present value nhc p.a.	Housing intrinsic present value
1	$19,722	$298,044	$19,722	$298,044	$19,722	$298,044
2	$25,942	$447,066	$24,121	$447,066	$24,121	$447,066
3	$37,708	$670,599	$19,777	$670,599	$27,931	$977,124
4	$32,580	$603,238	$23,952	$988,707	$22,395	$1.044m
5	$42,345	$358,647	$31,130	$869,972	$27,699	$1.044m