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ESTIMATION OF RETIREMENT ADEQUACY TARGETS FOR ONE- AND TWO-ADULT HOUSEHOLDS FROM OFFICIAL SOUTH AFRICAN DATA

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A dissertation submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science

Johannesburg, 2011

DECLARATION

I declare that this dissertation is my own unaided work. It is being submitted for the Degree of Master of Science to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.



Date: 7 October 2011

ABSTRACT

Retirement adequacy targets provide an indication as to how much wealth is needed at retirement to provide for an adequate retirement income. These targets have design and strategy implications for social security systems and retirement funds and can be used by individuals to assess their preparedness for retirement. The primary aim of this research was to estimate retirement adequacy targets for one- and two-adult households from Statistics South Africa's Income and Expenditure Survey 2005/2006. Retirement adequacy targets were expressed as wealth-earnings ratios, defined as the multiple of salary at retirement required for a comfortably adequate retirement. The targets would be sufficient to provide for the higher of the pre-retirement lifestyle or subsistence living. An important subsidiary aim was to examine consumption behaviour at and in retirement. Non-healthcare consumption was not found to change at retirement if income levels remained at pre-retirement levels. For certain households, healthcare expenditure may increase on retirement and may be funded from the contributions to retirement savings that are no longer required in retirement. The retirement adequacy targets decreased with retirement age but there was not a clear relationship between retirement savings rates and the targets. Retirement adequacy targets decreased with income but were complex functions of household composition, sex of the head of the household, type of settlement, age, home ownership and the retirement savings rate. Where household members retired at different times, the earnings of the younger person during the semi-retirement phase reduced the targets substantially. The retirement adequacy targets estimated implied that the replacement ratio targets used by retirement funds and those suggested in the literature would not provide an adequate retirement income for most households. The results may thus have a significant impact on retirement planning in the future.

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TABLE OF CONTENTS

DECLARATION I
ABSTRACT II
ACKNOWLEDGEMENTS III
TABLE OF CONTENTS IV
LIST OF FIGURES XII
LIST OF TABLES XIII
LIST OF ACRONYMS XV
GLOSSARY XVI
1 INTRODUCTION 1
1.1 Background 1
1.2 Problem statement 3
1.3 Exposition of research 4
2 LITERATURE REVIEW 5
2.1 Introduction 5
2.2 Defining adequacy 5
2.2.1 Minimally adequate, consumption-smoothing and comfortably adequate definitions 5
2.2.2 Utility maximisation definitions 7
2.2.3 Subjective adequacy definitions 8
2.2.4 Deprivation-based definitions 8
2.2.5 Pension-to-wage definitions 8
2.2.6 Summary 9
2.3 The expression of retirement adequacy targets 9
2.3.1 Replacement ratios 10
2.3.2 Wealth-earnings ratios 10
2.3.3 Consumption-consumption ratios 11
2.3.4 Other formats 12
2.3.5 Summary 12
2.4 Estimating minimally adequate underpins for comfortably adequate targets 13
2.5 Estimating the consumption-smoothing component of comfortably adequate targets 13
2.5.1 Consumption-smoothing models 14
2.5.2 Allowing for housing expenditure 15
2.5.3 Allowing for pre-retirement savings 17
2.5.4 The bequest motive, gifts and savings 18
2.5.4.1 Bequests 18
2.5.4.2 Gifts and the bequest motive 18
2.5.4.3 Savings patterns and the bequest motive 19
2.5.4.4 Modelling bequests 20
2.5.5 Reduction in household consumption on widowhood 21
2.5.6 Projection of current consumption to retirement age 22
2.5.7 Projection sample definition 23
2.5.7.1 Employment types 23
2.5.7.2 Age 23
2.5.7.3 Hypothetical or actual households 23

2.5.8 Summary 24
2.6 Estimating consumption change at and in retirement 25
2.6.1 Defining age- and work-related consumption and expenditure items 26
2.6.2 Control variables for estimating age- and work-related consumption 28
2.6.3 Consumption changes at retirement 28
2.6.3.1 Cohort and longitudinal data sources 28
2.6.3.2 Consumption changes at retirement from longitudinal data 29
2.6.3.3 Consumption changes at retirement from cohort data 30
2.6.4 Consumption changes during retirement 31
2.6.4.1 Consumption changes during retirement from longitudinal data 31
2.6.4.2 Consumption changes during retirement from cohort data 32
2.6.5 Estimates of changes in consumption for specific items 33
2.6.5.1 Healthcare 33
2.6.5.2 Food 33
2.6.5.3 Housing 34
2.6.6 Declining consumption as a matter of choice or necessity 34
2.6.7 Equivalence scales and consumption change 35
2.6.8 Summary 36
2.7 The impact of savings rates and retirement ages on retirement adequacy targets 38
2.8 Factors influencing retirement adequacy targets 38
2.8.1 Income 38
2.8.2 Household composition 39
2.8.3 Sex 40
2.8.4 Home ownership 40
2.8.5 Debt 40
2.8.6 Socio-economic group 41
2.8.7 Education 41
2.8.8 Health-status 41
2.8.9 Geographic region 41
2.8.10 Summary 42
2.9 Estimated targets in the literature 42
2.10 Synthesis of literature reviews 44
3 OVERVIEW OF STATISTICAL METHODS 48
3.1 Introduction 48
3.2 Techniques used in previous studies 48
3.2.1 Imputation 48
3.2.2 Changes in consumption at and in retirement 48
3.2.3 Differences in retirement adequacy targets 49
3.3 CHAID 49
3.3.1 Description 49
3.3.2 Software and approach 50
3.4 Regression 51
3.4.1 Requirements and assumptions 51
3.4.2 Software and approach 51
3.5 Repeated measures ANOVA 52
3.5.1 Description 52

3.5.2 Software and approach 52
3.6 Application of statistical methods 52
3.6.1 Imputation 52
3.6.2 Testing for changes in consumption and non-retirement savings at and in retirement 53
3.6.3 Exploring retirement adequacy target estimates 53
3.6.4 Assessing the impact of retirement savings rate and retirement age on retirement adequacy targets 53
4 DATA 55
4.1 Introduction 55
4.2 Description of IES 2005/2006 55
4.2.1 Design of IES 2005/2006 55
4.2.2 Data quality concerns 57
4.2.2.1 Imputed rental and interest on mortgage loans 57
4.2.2.2 Expenditure 57
4.2.2.3 Tax 57
4.2.2.4 Income 57
4.2.2.5 Number of rooms 58
4.2.2.6 Debt 58
4.2.2.7 Age 58
4.2.3 Implications of the IES 2005/2006 limitations 58
4.3 IES 2005/2006 data files 59
4.4 Initial data checks 59
4.4.1 Elimination of households not relevant to the study 59
4.4.2 Data checks from Person_Info and House_info tables 60
4.4.3 Cross-checks and corrections using IES table data 60
4.4.4 Summary 61
4.5 Model development sample and target estimation sample 62
4.5.1 Size of the model development sample 62
4.5.2 Use of the model development sample 62
4.5.3 Deriving the target estimation sample from the model development sample 63
4.5.4 Use of the target estimation sample 64
4.5.5 Sample reconciliation 65
4.6 Variables 65
4.7 Corrections, adjustments and imputations 69
4.7.1 Missing rent data 69
4.7.2 Non-retirement savings 69
4.7.3 Smoothing of estimated vehicle consumption 69
4.7.3.1 Vehicle expenditure 69
4.7.3.2 Adjustment approach 70
4.7.4 Income share 70
4.7.4.1 Incomplete data at person level 70
4.7.4.2 Imputation results 71
4.7.5 Mortgage data 72
4.7.5.1 Poor mortgage data 72
4.7.5.2 Imputation approach 72

4.7.5.3 Imputation results and reasonability checks 74
4.8 Descriptions of model development and target estimation samples 75
4.8.1 Work-status for the model development sample 76
4.8.2 Household composition and gender 76
4.8.3 Age 77
4.8.4 Geographic region 78
4.8.5 Education 78
4.8.6 Income and dwelling values 79
4.8.7 Consumption and expenditure 80
4.8.8 Savings rates, home ownership and mortgages 81
4.9 Other sources of data 82
4.10 Summary 84
5 THE TARGET ESTIMATION MODEL 85
5.1 Introduction 85
5.2 Target expression 85
5.3 Estimating adequacy targets at a household level 86
5.4 Step 1: Estimation of current consumption at the current age 87
5.4.1 Calculating actual consumption 87
5.4.2 Adjusting expenditure to derive consumption 87
5.4.3 Further adjustment to consumption for hypothetical retirement savings 88
5.5 Step 2: Estimating consumption at retirement 89
5.5.1 Overview 89
5.5.2 South African personal income taxation in brief 90
5.5.2.1 Tax brackets 91
5.5.2.2 Rebates 91
5.5.2.3 Married couples 91
5.5.2.4 Investment income 91
5.5.2.5 Retirement savings 91
5.5.2.6 Medical expenses 92
5.5.3 Simplifying tax assumptions 92
5.6 Step 3: Calculation of the outstanding mortgage at retirement and associated tax 93
5.6.1 Outstanding mortgage at retirement 93
5.6.2 Tax on debt settlement 94
5.7 Step 4: Change in consumption at and during retirement 95
5.7.1 Changes in consumption and savings at retirement 95
5.7.2 Changes in consumption and savings during retirement 95
5.7.3 Allowances for loss of economies of scale 95
5.8 Step 5: Estimation of income needed to be funded from retirement savings at each age in retirement 96
5.8.1 Overview 96
5.8.2 Treatment of savings 96
5.8.3 Estimating minimally adequate income in retirement 97
5.8.4 Adjusting for wages and salaries in semi-retirement 97
5.9 Step 6: Calculation of the expected present value of income needs 98
5.10 Step 7: Adjustment for outstanding mortgage debt 98
5.11 Step 8: Calculation of wealth-earnings ratios 98

6 TESTS FOR CHANGES IN CONSUMPTION AND NON-RETIREMENT SAVINGS AT AND IN RETIREMENT 99
6.1 Introduction 99
6.2 Methodology 99
6.3 Estimation of the change in healthcare expenditure at and in retirement 99
6.4 Estimation of the change in non-healthcare consumption at and in retirement 102
6.4.1 Gifting 102
6.4.2 General non-healthcare consumption 104
6.5 Estimation of the change in non-retirement savings at and in retirement 106
6.6 Summary 106
7 PARAMETERISING THE TARGET ESTIMATION MODEL 108
7.1 Introduction 108
7.2 Inflation 108
7.3 Salary inflation 109
7.3.1 Inflation-related salary increases 109
7.3.2 Promotional salary increases 110
7.3.3 Total salary inflation 111
7.4 Tax projection basis 112
7.4.1 Personal income tax brackets 112
7.4.2 Primary and secondary personal income tax rebates 112
7.5 Mortgage-related assumptions 112
7.5.1 Fees on mortgages 112
7.5.2 Tax on debt settlement 113
7.6 Minimum income level 113
7.7 Changes in consumption at retirement 114
7.8 Changes in consumption in retirement 115
7.8.1 Inflationary changes 115
7.8.1.1 Healthcare inflation 115
7.8.1.2 Non-healthcare inflation 115
7.8.1.3 Capping of the healthcare budget share 116
7.8.2 Loss of economies of scale 116
7.9 Assumptions relating to the annuitisation of the post-retirement income 116
7.9.1 Post-retirement investment return assumptions 116
7.9.1.1 Purchased annuity approach 117
7.9.1.2 Index-linked bond yields 117
7.9.1.3 Balanced portfolio approach 117
7.9.1.4 Investment return assumptions 117
7.9.2 Insurer's profit margin 118
7.9.3 Non-investment expenses 118
7.9.4 Mortality 118
8 HOUSEHOLDS NOT INCENTIVISED TO SAVE 120
8.1 Introduction 120
8.2 Households not benefitting from retirement savings 120
9 STATISTICAL MODELS FOR RETIREMENT ADEQUACY TARGETS 123
9.1 Introduction 123
9.2 Best estimate targets without salary support 123

9.2.1 Categorical data analysis 123
9.2.2 Regression analysis 129
9.2.2.1 Group 1 households 129
9.2.2.2 Group 2 households 129
9.2.3 Interquartile ranges 130
9.3 The effect of salary support on the targets on a best estimate basis 131
9.3.1 Categorical data analysis 131
9.3.2 Regression analysis 131
9.3.3 Interquartile ranges 132
9.4 Sensitivity of the results to the interest rate 132
9.5 Repeated measures ANOVA and *post-hoc* tests for retirement age effects 133
9.6 Repeated measures ANOVA and *post-hoc* tests for retirement savings rate and retirement age effects 134
10 DISCUSSION 136
10.1 Definitions of adequacy and expression of the adequacy targets 136
10.1.1 Definition of adequacy 136
10.1.2 Expression of retirement adequacy targets 136
10.2 Changes in consumption and savings at retirement 137
10.2.1 Methodology 137
10.2.2 Healthcare expenditure 138
10.2.3 Non-healthcare consumption, including gifting 138
10.2.4 Non-retirement savings 139
10.2.5 Tax 140
10.2.6 Summary 140
10.3 Estimation of targets 140
10.3.1 Data quality and sample size 140
10.3.2 Sample definition 141
10.3.3 Sensitivity to assumptions 141
10.4 Effect of retirement age and retirement savings rate on the target 142
10.4.1 Retirement age 142
10.4.2 Retirement savings rate 143
10.4.2.1 Reporting errors 144
10.4.2.2 Confounding and spurious selection 144
10.4.2.3 Model error 144
10.4.2.4 Summary 145
10.5 Factors that influence the targets 145
10.5.1 Factors that influence the targets without salary support 145
10.5.1.1 Income 146
10.5.1.2 Age 146
10.5.1.3 Home ownership 146
10.5.1.4 Female head of household 147
10.5.1.5 Living in a rural area 148
10.5.2 Factors that influence the effect of salary support on the targets 148
10.5.2.1 Age gap 148
10.5.2.2 Income 148
10.5.2.3 Percentage of income earned by the older person 148

10.5.2.4 Years of education of the household head 149
10.5.2.5 Female head of household 149
10.6 The level of the targets suggested by South African data 149
10.6.1 Relative to published targets 149
10.6.1.1 Group 1 households 149
10.6.1.2 Group 2 households 150
10.6.2 Relative to other household compositions 150
10.6.3 Relative to targets used by South African retirement funds 150
10.6.4 Relative to what is obtainable through saving 151
10.6.5 Heuristics 153
11 FINDINGS, IMPLICATIONS AND SUMMARY 155
11.1 Conclusions and findings 155
11.2 Implications 156
11.2.1 A change in vocabulary may improve the usefulness of retirement adequacy targets for individuals 156
11.2.2 Retirement adequacy targets may be higher than previously suggested which may require remedial action 156
11.2.3 It is unlikely there is a single target that is appropriate for all households 157
11.2.4 Later retirement ages may improve the feasibility of meeting the targets 158
11.2.5 The retirement adequacy targets should be updated regularly 158
11.2.6 It could be difficult to apply the target estimation model to retirement funds 158
11.3 Limitations 158
11.3.1 Sample size 158
11.3.2 Non-saving households 159
11.3.3 Healthcare data concerns 159
11.4 Areas for further research 159
11.4.1 How would changes to the taxation regime affect retirement adequacy targets? 159
11.4.2 Who should be saving for retirement? 159
11.4.3 Does longitudinal data suggest a change in expenditure at retirement? 160
11.4.4 How do real households respond to increases in retirement savings rates? ... 160
11.4.5 What are the retirement adequacy targets for non-saver households? 160
11.4.6 What pensioner mortality assumptions are appropriate for households incentivised to save for retirement? 161
11.4.7 What do stochastic target estimation models suggest about retirement adequacy targets? 161
11.4.8 How does health-status impact on retirement adequacy targets? 161
11.4.9 What is the impact of home ownership and mortgage holding on retirement adequacy targets? 162
11.4.10 Will South Africans accumulate enough wealth to retire comfortably? 162
11.4.11 How do children affect household spending pre- and post-retirement? 162
11.4.12 How can retirement adequacy targets for the self-employed be calculated? 162
11.5 Summary 163
REFERENCES 166
APPENDIX A: ANNUITY BASIS 178
APPENDIX B: CHAID ILLUSTRATIVE EXAMPLE 179

Appendix C: Technical information for tests on age and work-status effects on healthcare expenditure 181
Appendix D: Technical information for tests on age and work-status effects on gifting 183
Appendix E: Technical information for tests on age and work-status effects on non-healthcare consumption 184
Appendix F: Technical information for tests on age and work-status effects on non-retirement saving 185
Appendix G: Model basis summary 187
Appendix H: Promotional salary scale 188
Appendix I: SOAG-implied minimum income support 189
Appendix J: Differences in least square means for target estimates 190

LIST OF FIGURES

Figure 2.1 Changes in age- and work-related expenses 31
Figure 2.2 Optimal wealth-earnings ratios from the TSE Model (retirement age 65) 44
Figure 4.1 Dendrogram of income share to the head of household 71
Figure 4.2 Household compositions by sample 77
Figure 4.3 Head of households' highest educational attainments 79
Figure 5.1 Reported retirement ages by cohort 90
Figure 6.1 Dendrogram of healthcare expenditure rate 100
Figure 6.2 Dendrogram of the gifting rate 103
Figure 6.3 Dendrogram of non-healthcare consumption rate 105
Figure 6.4 Dendrogram of non-retirement savings rate 106
Figure 7.1 Actual and assumed gross wage inflation 110
Figure 7.2 Salary projections under different total salary inflation bases 111
Figure 8.1 Dendrogram of consistent disincentivised, borderline disincentivised and incentivised households 122
Figure 9.1 Dendrogram of targets for retirement age 60 124
Figure 9.2 Dendrogram of targets for retirement age 63 125
Figure 9.3 Dendrogram of targets for retirement age 65 126
Figure 9.4 Dendrogram of targets for retirement age 67 127
Figure 9.5 Dendrogram of targets for retirement age 70 128
Figure 10.1 Retirement age 65 retirement adequacy target cumulative distribution function on a replacement ratio scale 151
Figure B.1 Illustrative CHAID dendrogram 179

LIST OF TABLES

Table 2.1 Age- and work-related consumption components 27
Table 2.2 Wealth-earnings ratio equivalents to replacement ratio retirement adequacy targets (retirement age 65) 43
Table 2.3 Optimal wealth-earnings ratios and savings rates (retirement age 65) 43
Table 4.1 Distribution of retirement savings rates as a percentage of income p.p.p.a. 64
Table 4.2 Reconciliation of the data samples 65
Table 4.3 Continuous variables 67
Table 4.4 Categorical variables 68
Table 4.5 Percentage of household income earned by the head of the household 72
Table 4.6 Percentage of current mortgage holders expected to be mortgaged at retirement 74
Table 4.7 Projected real mortgage debt as a percentage of dwelling value 75
Table 4.8 Mean age statistics 78
Table 4.9 Average income and income (including income in kind) for the samples 80
Table 4.10 Consumption and expenditure rates by sample 80
Table 4.11 Savings rates as a percentage of income (including income in kind) p.p.p.a. 81
Table 4.12 Distribution of target estimation sample retirement savings rates 81
Table 4.13 General data 82
Table 4.14 Data used in parameterising the model 83
Table 6.1 Mean healthcare expenditure rate by leaf and work-status 101
Table 6.2 Mean gifting rates by leaf and work-status 104
Table 7.1 Tax rates applicable on nominal retirement lump sums 113
Table 7.2 Healthcare consumption increases on retirement 114
Table 8.1 Percentage of households disincentivised to save 120
Table 9.1 Regression parameters for Group 1 households 129
Table 9.2 Regression parameters for Group 2 households earning R50 000 p.p.p.a. or more ... 130
Table 9.3. Interquartile ranges for best estimate targets without salary support 130
Table 9.4 Seventy-fifth percentile of the best estimate retirement adequacy targets 131
Table 9.5 Regression parameters for the effect of salary support on the targets on a best estimate basis 132
Table 9.6 Interquartile ranges for the effect of salary support on the targets 132
Table 9.7 Interquartile ranges of targets for various interest rate assumptions 133
Table 9.8 Interquartile ranges of the effects of salary support for various interest rate assumptions 133
Table 9.9 Test for retirement age fixed effect 134
Table 9.10 Change in target least square mean for a change in retirement age 134
Table 9.11 Tests for fixed effects of hypothetical retirement savings rate and retirement age .. 135
Table 10.1 Reduction in the best estimate target for deferred retirement 142
Table 10.2 Median reduction in the best estimate target due to salary support 143
Table 10.3 Savings rates required to meet a given wealth-earnings ratio target 152
Table 11.1 Sign of regression coefficients for modelling retirement adequacy targets 164
Table 11.2 Seventy-fifth percentile of the best estimate retirement adequacy targets 165
Table A.1 Annuity basis items 178
Table C.1 Healthcare expenditure definition 181
Table C.2 Healthcare expenditure categorisation 182

Table D.1 Gifting definition 183
Table D.2 Gifting rate categorisation..... 183
Table E.1 Non-healthcare consumption categorisation 184
Table E.2 Mean non-healthcare consumption rates by leaf 184
Table F.1 Non-retirement savings definition 185
Table F.2 Non-retirement savings categorisation 186
Table F.3 Non-retirement savings by leaf..... 186
Table G.1 Basis 187
Table H.1 Promotional salary scale 188
Table I.1 SOAG data..... 189
Table J.1 Group 1 households..... 190
Table J.2 Group 2 households earning less than R50 000 p.p.p.a. 195
Table J.3 Group 2 households earning R50 000 p.p.p.a. or more..... 202

LIST OF ACRONYMS

ANOVA	Analysis of Variance
CAMS	Consumption and Activities Mail Survey
CES	Consumer Expenditure Survey
CHAID	Chi-Square Automatic Interaction Detection
COICOP	Classification of Individual Consumption by Purpose
CPI	Consumer Price Index
CRRA	Constant Relative Risk Aversion
DC	Defined Contribution
FSB	Financial Services Board
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
HRS	Health and Retirement Survey
IAN	International Actuarial Notation
IES	Income and Expenditure Survey
IES 2005/2006	Income and Expenditure Survey 2005/2006
LRHS	Longitudinal Retirement History Survey
NCA	National Credit Act (Act 34 of 2005)
p.p.p.a.	Per Person Per Annum
p.p.p.m.	Per Person Per Month
PSID	Panel Study of Income Dynamics
RHS	Retirement History Survey
SAIFL98	South African Annuitant Standard Mortality Tables 1996–2000 Female Lives
SAIML98	South African Annuitant Standard Mortality Tables 1996–2000 Male Lives
SARS	South African Revenue Service
SOAG	State Old Age Grant
TS	Tax and Savings
TSE	Tax, Savings and Expenditure
UK	United Kingdom
US	United States
USA	United States of America

GLOSSARY

In general, terms used in this research take their plain language meaning. The following terms, unless the context indicates otherwise, bear the meaning set out below.

Bequest motive	The desire to leave an inheritance in a will.
Budget share	The percentage of the household budget allocated to a particular good or service or class of goods or services.
Comfortably adequate	Sufficient to provide for the higher of the pre-retirement living standard and a socially acceptable standard of living.
Consumption	The use of a good or service. The timing of the usage need not correspond with the timing of the payment for the good or service.
Consumption-smoothing	The avoidance of involuntary changes in consumption at retirement, which should allow for the pre-retirement living standard to be maintained.
Current age	The midpoint of the five-year age band recorded in the IES 2005/2006 data rounded down to the nearest whole number.
Disincentivised	Describes households where the income needed to smooth consumption lies consistently below the income level where income support is provided via the SOAG. These households would be economically disadvantaged and lose the means-tested SOAG benefits should they save for retirement.
Dissave	To spend accumulated savings.
Equivalence scale	The ratio of household incomes required for two households of different compositions to have equal welfare.
Expenditure	The payment for a good or service.

Female-female household	A two-person household where there is a female head and a female partner.
Female-male household	A two-person household where there is a female head and a male partner.
Gifts	Presents to persons living outside the household or transfers in cash or kind to persons living outside the household.
Group 1 households	Single female, male-female and female-male households. This grouping was determined by a CHAID analysis.
Group 2 households	Single male, male-male and female-female households. This grouping was determined by a CHAID analysis.
Household	One or two people living together as a unit most of the time, who have done so for at least four weeks and who share resources.
Household composition	The mix of males and females in the household, in terms of number of people of each sex and the sex of the head of the household.
Imputed rental	The rental a home owner would pay if they rented their own home.
Leaf	The final node in a CHAID model. Each leaf represents a defined group that has a distribution of the dependent variable that is distinctly different to the distribution for any other group.
Male-female household	A two-person household where there is a male head and a female partner.
Male-male household	A two-person household where there is a male head and a male partner.
Minimally adequate	Sufficient to provide for consumption at the subsistence level,

	or to maintain a minimum socially acceptable standard of living.
Minimum Reserve Regulations	Board Notice 37 in terms of the Pension Funds Act No. 24 of 1956 (2007).
Model development sample	The household consumption data set, derived from IES 2005/2006, required for testing for changes in consumption at and in retirement.
Replacement ratio	The ratio between the annualised income in the month after retirement and the salary for the year prior to retirement.
Reservation wealth	The wealth level at which individuals are indifferent between work and retirement.
Retired household	Either a one-person household where the person is retired or a two-person household where both people are retired.
Retirement funds	Collective term for pension funds, provident funds and retirement annuity funds.
Salary support	The wages or salary earned by the working member of the household during semi-retirement.
Same-sex household	A female-female or male-male household.
Semi-retired household	A two-person household where one person is retired and the other is working.
Target estimation sample	The household data set, derived from IES2005/2006, from which retirement adequacy targets were calculated.
The 2008 Regulations	Government Notice R898 (2008).
The Act	The Income Tax Act (Act 58 of 1962).
The Increase Notices	Government Notice 919 (1997), Government Notice 882 (1998), Government Notice 814 (1999), Government Notice 570 (2001), Government Notice 1491 (2002), Government

	Notice 409 (2004), Government Notice 294 (2006), Government Notice 253 (2007), Government Notice 1243 (2008), Government Notice 212 (2009) and Government Notice 261 (2010).
The SOAG Regulations	Government Notice 591 (1994) and the 2008 Regulations.
Underpin	Minimum level.
Utility	Satisfaction derived from different consumption decisions.
Wealth	The expected present value of comfortably adequate income at the retirement date. In other words, the lump sum at retirement that would be expected to secure a comfortably adequate income during retirement.
Working household	Either a one-person household where the person is employed or a two-person household where both people are employed.

1 INTRODUCTION

1.1 Background

According to the Life Cycle Hypothesis, individuals accumulate savings during their working lives in order to smooth consumption in later life when they are unable to earn through working (Banks, Blundell & Tanner, 1998). Determining how much should be saved during this accumulation phase is a function of the wealth, or accumulated assets, required at retirement to meet retirement needs sufficiently (Mitchell & Moore, 1998). This wealth measure is termed a retirement adequacy target. Retirement savings rates, and by implication retirement adequacy targets, are important for financial planning at a household level (Bernheim, Forni, Gokhale & Kotlikoff, 2000; Tacchino & Saltzman, 1999; Groyer & Holtzhausen, 2006).

Adequacy targets are required to assist retirement fund stakeholders with issues such as benefit design and contribution rates (Groyer & Holtzhausen, 2006), and are particularly important in setting investment strategies (Groyer & Holtzhausen, 2006; Dietz, 1968). The role of adequacy targets in investment strategies has been noted in official policy reports and regulation. In the United Kingdom (UK), Myners (2001) recommended that Defined Contribution (DC) retirement fund trustees offer investment choices that meet the reasonable risk and return profiles of members. In South Africa, the Financial Services Board (FSB) stated that investment returns are a key determinant of retirement benefit adequacy and stated that the needs of members, which presumably include benefit adequacy needs, must be considered when setting an investment strategy (Financial Services Board, 2007).

Retirement adequacy targets have particular relevance in South Africa given the South African government's intention to reform the retirement fund industry as part of wider social security reforms. Given that persons over the age of 55 formed 10.8% of the South African population in 2009 (Statistics South Africa, 2009), and the ASSA 2003 AIDS and Demographic Model (Actuarial Society of South Africa, 2005) suggested this proportion was expected to grow to 14.9% by 2029, public or private retirement provision is, and will remain, relevant to many South Africans. While a number of reasons have been cited for the reforms, both the Department of Social Development (2007a) and the National Treasury (2004) have cited inadequacy of

retirement benefits in the current system as evidence of the necessity for reforms. National Treasury (2004) and the Department of Social Development (2007a) suggested replacement ratio adequacy targets of 75% and 40% respectively, where the replacement ratio can be defined as the annualised income in the month after retirement to salary for the year prior to retirement (McGill, Brown, Haley & Schieber, 1996). In the second drafts of the National Treasury and Department of Social Development discussion documents, no retirement adequacy targets were stated (National Treasury, 2007; Department of Social Development, 2007b). Hence, despite the critical nature of retirement adequacy targets to the reforms, there was no consensus between key stakeholders on retirement adequacy targets.

This lack of consensus may result from the fact that there is a lack of published research relating to adequacy targets in South Africa (Groyer & Holtzhausen, 2006). Even in the United States of America (USA) and UK, where there has been considerable research into adequacy targets, Burns & Widdows (1990) stated that formulae or heuristics for individuals to use to assess their planning needs are scarce.

The results of this research are significant for the following five reasons:

- This may be the first major study on retirement adequacy targets in South Africa.
- The adequacy targets derived were based on 'comfortably adequate' income. This was defined, for the purposes of this research, to be that required to maintain the higher of the pre-retirement living standard and a socially acceptable standard of living. Maintenance of the pre-retirement living standard in retirement would necessitate consumption being smoothed between the pre- and post-retirement phases and hence this part of the adequacy definition was termed the 'consumption-smoothing' element. The level of income sufficient to maintain only the minimum socially acceptable standard of living was termed 'minimally adequate'. Although some literature suggested the use of comfortably adequate targets, which may be extremely useful for low-income households, this research may represent the first time it has been used in a study on retirement adequacy targets.

- Most literature consulted considered either the change in consumption on or during retirement, or establishing possible retirement adequacy targets. This research considered both.
- In previous research, retirement adequacy targets were modelled on hypothetical household savings. This research used actual household savings rates and found that the relationship between retirement savings rates and retirement adequacy targets was materially different to what could be demonstrated using hypothetical household savings rates.
- Automatic Interaction Detection techniques were used in estimating age and work-status consumption effects, which present a possible refinement of the basic matched-pairs methodology.

1.2 Problem statement

This research presents estimates of retirement adequacy targets based on official South African data. The study was limited to employed one-adult households and two-adult households where both adults were employed, subject to certain restrictions on income sources. The targets were derived from households that were saving for retirement and that were projected to have comfortably adequate benefit needs too high to be satisfied by relying on the State Old Age Grant (SOAG) alone and who may hence benefit from private retirement provision.

The research questions addressed were:

i) How can adequacy be defined, and how can retirement adequacy targets be expressed?
ii) How can the consumption-smoothing and minimally adequate elements of adequacy targets be estimated?
iii) How does consumption change at and during retirement?
iv) How do savings rates and retirement ages influence the target levels?
v) What demographic factors influence the level of the targets?
vi) What do South African data suggest retirement adequacy targets should be?

1.3 Exposition of research

The first and second research questions are addressed by a literature review. The analysis of the literature relevant to all six research questions is set out in Chapter 2. The third research question is addressed by using Chi-Square Automatic Interaction Detection (CHAID) techniques that address some of the limitations of previous techniques used in the literature. CHAID and other statistical techniques used in this research are set out in Chapter 3. The largest official data set that contained information relevant to these research questions was the Income and Expenditure Survey 2005/2006 (IES 2005/2006) (Statistics South Africa, 2007). IES 2005/2006 was used to answer the third to sixth research questions. The data are discussed in Chapter 4.

In order to estimate the retirement adequacy targets, a deterministic target estimation model was created. This model is described in Chapter 5. Chapter 6 sets out the results of the third research question: how consumption changes at and in retirement. It also considers the change in non-retirement savings at and during retirement. Chapter 7 describes how the target estimation model was parameterised. Chapter 8 sets out the results of the investigation into which households were expected to benefit from saving for retirement. Chapter 9 sets out statistical models for the targets, which address the fourth, fifth and sixth research questions. Chapter 10 sets out the discussion of the results, and Chapter 11 contains the implications and areas for future research.

2 LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature relevant to addressing the research questions, namely the definition of adequacy; the expression and modelling of retirement adequacy targets; the change in consumption at and during retirement; and the influence of retirement age, retirement savings rates and other factors on retirement adequacy targets. This chapter also includes estimated retirement adequacy targets from the literature.

Retirement adequacy targets are a complex area of research. Most studies reviewed tended to cover more than one research question but failed to cover all six. Consequently, this discussion is set out by research question as opposed to providing an analysis of each paper in turn. Foremost to a discussion on retirement income adequacy targets is the definition of adequacy, which is set out in Section 2.2. The literature regarding the expression of the targets is then set out in Section 2.3. The minimally adequate underpin is discussed in Section 2.4 before the theoretical and practical issues around estimating the smoothed-consumption element of the targets are covered in Section 2.5. Whether consumption changes at and in retirement is explored in Section 2.6. Section 2.7 sets out the literature on the effect of savings rates and retirement ages on retirement adequacy targets. Section 2.8 elaborates on the factors expected to influence the targets. The chapter concludes with the presentation of the targets from the literature in Section 2.9 and a short synthesis of the literature reviews in Section 2.10.

2.2 Defining adequacy

There were five main approaches to defining an adequate retirement income in the literature, which are discussed in this section.

2.2.1 Minimally adequate, consumption-smoothing and comfortably adequate definitions

The first approach related to the plain language definition of adequacy. The Oxford English Dictionary (1989) defined adequate as “equal or amounting to what is required, fully sufficient”.

The literature used two standards of sufficiency and implied a third that could be used to define an adequate income.

The first was an income sufficient to provide for a minimum standard of living in retirement, which was the standard that the United States (US) Federal Government proposed in the 1960s (Dietz, 1968). Chia & Tsui (2003) derived minimally adequate retirement adequacy targets for households in Singapore. Hence both Dietz (1968) and Chia & Tsui (2003) used minimally adequate targets, where this is defined, for the purposes of this research, as an income sufficient to provide for consumption at the subsistence level, or to maintain a minimum socially acceptable standard of living.

In contrast, Schieber (1996), in his critique of adequacy models, questioned the relevance of minimally adequate targets and adopted the approach that a retirement income is adequate if it is sufficient for the pensioner to smooth consumption; that is, maintain his or her pre-retirement standard of living. This was the second standard of sufficiency considered. Targets based on consumption-smoothing originate from the Life Cycle Hypothesis which states that people save during their working lives in order to provide for consumption in their retirement (Banks, Blundell & Tanner, 1998). Consumption-smoothing was explicitly used to set retirement adequacy targets by Yuh, Hanna & Montalto (1998), Palmer (1989; 1992; 1994; 2008) and Mitchell & Moore (1998). The consumption-smoothing approach was implicitly adopted by Hatcher (1997), who proposed that at the reservation wealth level, a person would be indifferent between work and retirement. This implied that rational individuals would only retire voluntarily once the reservation wealth level is exceeded and they have sufficient wealth to provide an income that meets their retirement consumption needs.

The third standard was an income that would secure consumption-smoothing subject to a minimally adequate underpin, which was suggested by Palmer (1989). This hybrid definition of adequacy was defined in this research as ‘comfortably adequate’.

2.2.2 Utility maximisation definitions

The second approach to defining adequacy, taken by Robb & Burbidge (1989), Chai, Horneff, Maurer & Mitchell (2010), Kotlikoff, Spivak & Summers (1982) and Engen, Gale & Uccello (1999; 2005), was to consider a target adequate if it allowed for consumption patterns that maximised the household's utility, or satisfaction from different consumption decisions (Cochrane & Bell, 1956).

Robb & Burbidge (1989), Chai *et al* (2010), Kotlikoff, Spivak & Summers (1982) and Engen, Gale & Uccello (2005) all used variants of the Constant Relative Risk Aversion (CRRA) model with time separable utility functions and constant intertemporal elasticity of consumption.

Mitchell & Moore (1998), Chai *et al* (2010) and Kotlikoff, Spivak & Summers (1982) have noted that utility maximisation targets are very sensitive to the parameters used in the estimation. When modelling optimal household behaviour, parameterisation would be complicated given that household behaviour may be neither optimal nor rational (Engen, Gale & Uccello, 2005). Consequently, there was little consensus between Davies (1981), Mitchell & Moore (1998) and Engen, Gale & Uccello (2005) as to the appropriate parameter value for the coefficient of relative risk aversion. This difference in parameterisation may have had a significant impact on the optimal consumption paths, and hence the required wealth at retirement identified in these studies.

There was also little consensus as to the form of the utility function and the treatment of pre-retirement leisure: some utility functions incorporated leisure explicitly (Chai *et al*, 2010; Engen, Gale & Uccello, 2005) and others did not, which implied full employment before retirement (Robb & Burbidge, 1989; Kotlikoff, Spivak & Summers, 1982).

The Merrill Lynch Baby Boomer Retirement Index developed by Bernheim (Mitchell & Moore, 1997) was unique among the utility maximisation models considered in that it used a utility function that included a consumption underpin, or floor level of consumption. Hence, Bernheim linked the concept of minimal sufficiency, discussed in Section 2.2.1, to utility theory and implied the acceptability of a minimally adequate underpin.

Thus, while utility maximisation approaches to estimation of retirement consumption have been used in practice by a number of authors, they can be extremely difficult to paramaterise and, with the exception of Bernheim (Mitchell & Moore, 1997), produced consumption targets that were optimal in terms of utility theory as opposed to sufficient to meet household needs. Hence, targets derived from utility maximisation approaches may not satisfy the intuitive, plain language definition of adequacy.

2.2.3 Subjective adequacy definitions

The third approach relied upon the opinions of individuals. Cooper (2002) developed a savings model that used subjective adequacy targets based on the perceived spending requirement for an "easy" or "difficult" life in retirement as recorded in the 1999 NatWest survey. Subjective measures were found to be highly correlated with wealth and income by Litwin & Sapir (2009) and Stoller & Stoller (2003). Subjective estimates of income adequacy have been shown to be robust estimators of income adequacy for all but the very elderly (Litwin & Sapir, 2009). Hence, subjective adequacy targets were identified as likely to be highly correlated with comfortably adequate targets.

2.2.4 Deprivation-based definitions

The fourth approach involved the consideration of deprivation, defined as lack of access to goods and services, as opposed to low income or low expenditure (Lelli, 2005; Klasen, 2000). However, setting adequacy targets using the deprivation approach may lead to similar results to those derived using consumption-smoothing approaches as higher expenditure, and hence consumption, is associated with lower deprivation levels (Klasen, 2000).

2.2.5 Pension-to-wage definitions

The fifth approach to defining adequacy involved comparing pension benefits to wages of the current working population (McGill *et al*, 1996). At a societal level, the pension-to-wage target provides an indication of the present wellbeing of current pensioners relative to current workers and hence featured prominently in studies on poverty and inequality such as those by Streak, Yu & Van der Berg (2009), Burniaux, Dang, Fore, Förster, D'Ercole & Oxley (1998) and Hauser

(1998). The resultant implications from the literature are that pension-to-wage targets provide for an assessment of current pensioner wellbeing as opposed to providing insight into the adequacy of retirement incomes for future pensioners. Even if a suitable projection basis were found, at a household level this approach is complicated by the need to make a comparison between the household and a suitable subset of the working population (McGill *et al*, 1996).

2.2.6 Summary

The literature offered a variety of definitions of adequacy. Consumption-smoothing adequacy definitions dominated the literature. Combining this with the minimally adequate definition used by Dietz (1968) and Chia & Tsui (2003) gave the hybrid definition of comfortably adequate. The use of a comfortably adequate definition was supported by Palmer (1989) and Bernheim's model (Mitchell & Moore, 1997).

Utility maximisation models were found to be highly complex to parameterise and do not relate directly to sufficiency. Pension-to-wage definitions were not found to be suitable for the development of household-level targets. Targets derived using a comfortably adequate definition were expected to be highly correlated with those derived from deprivation-based definitions. As consumption and income are typically positively correlated, comfortably adequate targets were also expected to be correlated with subjective adequacy targets.

Hence, given the complexities involved in utility maximisation, the unsuitability of pension-to-wage definitions and the high correlation of comfortably adequate targets with targets set using other definitions, a comfortably adequate definition was adopted for the purposes of this research.

2.3 The expression of retirement adequacy targets

Just as there are a variety of ways to define adequacy, the literature indicates that there are a number of ways to express the retirement adequacy targets. The relative merits of replacement ratios and other representations are discussed in turn in Sections 2.3.1 to 2.3.4.

2.3.1 Replacement ratios

The replacement ratio can be defined as the annualised income in the month after retirement to salary for the year prior to retirement (McGill *et al*, 1996). Replacement ratios have been used by Palmer (1989; 1992; 1994; 2008), Burns & Widdows (1990), Mitchell & Moore (1998) and Chia & Tsui (2003).

However, replacement ratios have a number of limitations. Banks, Blundell & Tanner (1998), Chia & Tsui (2003) and Palmer (2008) all suggested that retirement needs may vary with age, highlighting the limitation that the replacement ratio only considers income immediately after retirement. This limitation led Schieber (1996) to suggest that a variety of pension increase levels should be catered for in the annuity factor used for calculating replacement ratios. However, pensioners with good longevity were found to hold precautionary savings even in the presence of developed annuity markets, which suggested that a life annuity that exactly matches the needs of the pensioner may not be available (Banks, Blundell & Tanner, 1998). A further concern with replacement ratios is the lack of standardisation in how the term is used. For example, Antler & Kahane (1987) refer to a net replacement ratio as being net of tax while Palmer (1989) uses the same term to refer to the replacement ratio excluding social security benefits but gross of tax. Definitional inconsistencies can result in misleading comparisons; Antler & Kahane (1987) found that differences in taxation before and after retirement can be significant: a gross replacement ratio of 70% can be equivalent to a net replacement ratio of 100%.

2.3.2 Wealth-earnings ratios

The wealth-earnings ratio can be defined as total required wealth to either current (Moore & Mitchell, 1997; Engen, Gale & Uccello, 1999) or lifetime income (Engen, Gale & Uccello, 2005). The wealth measure can be defined as the lump sum required either to smooth marginal consumption over time (Engen, Gale & Uccello, 1999; Engen, Gale & Uccello, 2005) or to produce post-retirement net income equal to pre-retirement net income (Moore & Mitchell, 1997) which would allow for consumption-smoothing if tax and savings were unchanged before and after retirement.

There was some debate in the literature as to whether current or lifetime earnings were more appropriate. Moore & Mitchell (1997) used current earnings and Engen, Gale & Uccello (1999) used average current earnings for the person's education profile. Engen, Gale & Uccello (2005), when investigating the preparedness of Americans for retirement, defined earnings as the present value of lifetime earnings to date. Engen, Gale & Uccello (2005) stated the lifetime earnings definition was preferable as firstly, current earnings could be volatile creating short-term distortions in the results and, secondly, post-retirement consumption was assumed more likely to be based on career-average earnings than earnings in any given year.

Engen, Gale & Uccello (2005) had access to complete household income histories due to the dataset being linked to tax-return records. However, in most cohort studies, earnings histories are unavailable and in longitudinal studies, the histories tend to be too short and income disclosure is unreliable (Klasen, 2000). Burns & Widdows (1990) found that using current or average earnings made no difference to the savings rates required to provide for an adequate retirement income, which implied that the practical difficulties associated with wealth-earnings ratios could be managed by using current earnings.

Engen, Gale & Uccello (2005) have demonstrated that replacement ratios are easily converted to wealth-earnings ratios and vice-versa. This was also demonstrated by Chia & Tsui (2003) who calculated the adequacy targets in terms of wealth and then calculated a theoretical annuity price with an assumed annuity profit loading that was used to convert the result to the more traditional replacement ratio format.

2.3.3 Consumption-consumption ratios

Kotlikoff, Spivak & Summers (1982) considered the present value of future consumption and then modelled the percentage of this consumption expected to be incurred in the retirement phase. This is a consumption-consumption ratio as it related consumption during retirement to future lifetime consumption. Diamond & Hausman (1984) stated that the Life Cycle Hypothesis is forward-looking which means that this measure is theoretically sound. However, Shefrin & Thaler (1988) contradicted Diamond & Hausman (1984) by suggesting that a person's ability to make consumption decisions regarding future earnings or wealth is extremely limited. For

example, Shefrin & Thaler (1988) gave evidence of savings reducing current expenditure even though these savings will increase future expenditure. Hence, there are concerns around whether the theory underpinning consumption-consumption ratios applies in practice.

2.3.4 Other formats

Cooper (2002) expressed retirement incomes as a multiple of the level of spending recorded for the lowest income quartile in the Office of National Statistics Family Spending Survey 1998-1999. This measure would be expected to change over time as new survey results became available.

Yuh, Hanna & Montalto (1998) assessed retirement readiness by considering the absolute value of expenditure. Chia & Tsui (2003) presented their minimally adequate consumption findings as a lump-sum wealth measure. This measure is problematic due to the fact that the effect of inflation is not explicitly controlled.

2.3.5 Summary

The literature shows that many studies concerned with defining income adequacy, including Palmer (1989; 1992; 1994; 2008), Mitchell & Moore (1998) and Chia & Tsui (2003), use the replacement ratio. However, inconsistent use of the term in practice (Antler & Kahane, 1987) and difficulties associated with the choice of the annuity factor (Schieber, 1996) can result in information being obscured by this representation.

The wealth-earnings ratio avoided these difficulties while still allowing comparisons to published adequacy measures expressed as replacement ratios (Engen, Gale & Uccello, 2005; Chia & Tsui, 2003). However, these comparisons require an annuity factor (Chia & Tsui, 2003) which would need to be carefully chosen or calculated. The literature indicated that using current earnings for the wealth-earnings ratio could provide an appropriate result (Burns & Widdows, 1990).

Other formats were not thought to provide a stable result over time and hence wealth-earnings ratios using current earnings were used for the purposes of this research.

2.4 Estimating minimally adequate underpins for comfortably adequate targets

As discussed in Section 2.2, comfortably adequate targets involve consumption-smoothing and minimally adequate elements. Chia & Tsui (2003) used a minimally adequate consumption definition of the sum of the subsistence consumption level for the general population rounded up to the nearest $100 and an additional amount for healthcare consumption from a longitudinal study by Chan (2001). These consumption levels could then be used to derive a minimally adequate income level. Consultation on an official income level sufficient to provide for a subsistence consumption level for the general South African population is ongoing (National Treasury, 2010) and it is possible that there will be more than one poverty line adopted (Statistics South Africa & National Treasury, 2007). Statistics South Africa had suggested lower- and upper-bounds of R4 966.32 and R9 145.92 per person per annum (p.p.p.a.) respectively in March 2006 terms (Woolard & Liebbrandt, 2006; Statistics South Africa, 2010b).

As an alternative measure to traditional poverty lines, Woolard & Liebbrandt (2006) argued that the maximum and minimum benefit levels and means-tests associated with certain social security benefits, which would include the SOAG, could be used to imply an income level below which income support is provided.

In summary, South Africa currently lacks a single official poverty line to use to derive the minimally adequate income level, although the means-testing of the SOAG provides an implicit official measure that could be used as an alternative.

2.5 Estimating the consumption-smoothing component of comfortably adequate targets

Consumption-smoothing was introduced in Section 2.2 as an element of comfortably adequate targets. The relationships between consumption, expenditure and income are important to understanding the consumption-smoothing component and associated models. Kay, Keen &

Morris (1984) explained that consumption refers to commodities actually consumed while expenditure reflects spending behaviour. Expenditure was modelled as income less tax and savings by Palmer (1989). Section 2.5.1 sets out the models for estimating the income required to secure consumption-smoothing. Sections 2.5.2 to 2.5.7 delineate some of the technical issues to consider when developing these models. Section 2.5.8 provides a summary.

2.5.1 Consumption-smoothing models

The literature on consumption-smoothing adequacy targets is largely based on the models described in Palmer (1989). The Tax and Savings (TS) model in Palmer (1989) is an income-led model that estimates post-retirement consumption from pre-retirement consumption adjusted only for changes in tax and savings at the retirement date. The Tax, Savings and Expenditure (TSE) model attributable to Dexter (1984) allows for an additional adjustment for age- and work-related expenditure. Palmer (1989, 1992, 1994, 2008) did not make adjustments for the timing differences between expenditure and consumption and hence, technically, smoothed expenditure as opposed to consumption. However, in general terms, expenditure can be adjusted to reflect consumption and hence the TS and TSE models can be used to smooth consumption, as has been demonstrated by Mitchell & Moore (1998) and Yuh, Hanna & Montalto (1998).

In the TS model, pre- and post-retirement consumption are assumed equal while in the TSE model, post-retirement consumption is equal to pre-retirement consumption plus an age- and work-related expenditure adjustment which may be positive or negative (Palmer, 1989). In the TS and TSE models used by Palmer, pre-retirement consumption was defined as pre-retirement income less taxes and savings (Palmer, 1989), which is technically expenditure and not consumption. Both models defined post-retirement income as post-retirement consumption plus taxes (Palmer, 1989). The calculation of pre-retirement consumption from income instead of expenditure data may have been influenced by the President's Commission on Pension Policy which took place in the US in the early 1980s which recommended an income-led approach (Schieber, 1996).

Mitchell & Moore (1998) adjusted expenditure data for the timing differences between housing consumption and expenditure and modelled smoothed consumption using the TS model. Mitchell

& Moore (1998) modelled expenditure as income less tax and savings. Consequently, there was an inverse relationship between savings and expenditure, and hence between savings and the retirement adequacy targets. Due to the inter-dependence between savings and the retirement adequacy targets, Mitchell & Moore (1998) solved simultaneously for optimal retirement savings rates and retirement adequacy targets but used the TSE targets from Palmer (1989; 1992; 1994) to obtain the initial solutions.

Yuh, Hanna & Montalto (1998) used a two-step modelling process, in that consumption was estimated using regression before being used in a TS model. The consumption data were adjusted for changes in taxation in retirement to give the post-retirement income required to provide the given level of consumption. This was an alternative TS model but the TSE model targets from Palmer (1994) were used as alternatives to regression-modelled consumption. This was despite the fact that an examination of Palmer (1994) indicated the TSE targets were lower than the corresponding TS targets that would have been appropriate given the assumptions in Yuh, Hanna & Montalto (1998) for nine of the ten earnings brackets.

It was noted that although Mitchell & Moore (1998) and Yuh, Hanna & Montalto (1998) used the output from TSE models in their TS models, these models have very different underlying assumptions with respect to changes in consumption at retirement.

The development of the models requires careful consideration of a number of technical issues. Authors have taken different approaches in the treatment of housing consumption, savings, bequests, consumption reduction on widowhood, projection of consumption to retirement and the specification of the data sample as discussed in turn in Sections 2.5.2 to 2.5.7.

2.5.2 Allowing for housing expenditure

Retirement adequacy targets provide an indication of the level of income required to provide a given level of consumption. There may be inconsistencies between the timing of consumption and expenditure, particularly on durable goods (Kay, Keen & Morris, 1984). Hence, if expenditure on a durable good that would be consumed during retirement is incurred pre-retirement, expenditure may be higher pre-retirement than post-retirement even though

consumption is the same. In this case, the post-retirement income requirement to smooth consumption would be lower than the pre-retirement income. Hence, when developing consumption-smoothing models, care should be taken when estimating consumption to be smoothed, and then in estimating the income required to provide this level of consumption.

The literature identified housing (Engen, Gale & Uccello, 1999; Burns & Widdows, 1990; Robb & Burbidge, 1989) and vehicles (Robb & Burbidge, 1989) as items where consumption and expenditure may be mismatched. Burns & Widdows (1990) found that retirement savings rates required to provide an adequate retirement income were very sensitive to the adjustment for housing consumption.

Palmer (1989) made no adjustment for expenditure on housing being lower than actual housing consumption after mortgages were repaid, and treated mortgage payments entirely as savings, which under-estimated pre-retirement consumption (Scheiber, 1996). Burns & Widdows (1990) argued that any savings definition must be net of debts, including mortgages, and stated that home equity can be treated as wealth or can be accounted for by adjusting required expenditure. Mitchell & Moore (1998) offered a practical solution to the housing expense problem by splitting mortgage payments into a rental equivalent amount, termed 'imputed rental' and a savings element. The imputed rental was then added to the other elements of consumption when calculating post-retirement consumption but could be subtracted again when deriving post-retirement income needs (Mitchell & Moore, 1998). The savings element did not need to be replaced in retirement on the assumption that all mortgage debt was repaid before retirement (Mitchell & Moore, 1998).

However, it cannot be assumed that mortgage debt is repaid before retirement. Although Lee, Lown & Sharpe (2007) found that US mortgage holders over 65 were much more likely to be working than retired, Aizcorbe, Kennickell & Moore (2003) found that 19.6% of retired households had mortgage debt, using 2001 data.

Hence, the literature suggested that consumption and savings adjustments were required for home owners with and without mortgages and the level of debt at retirement required special consideration.

2.5.3 Allowing for pre-retirement savings

Pre-retirement savings are an important component in TS and TSE models. Palmer (1989) defined pre-retirement savings in seven elements:

- Net acquisition of stocks and bonds;
- Net investment in a farm or business;
- Net changes in bank accounts;
- Net changes in savings bonds;
- Net changes in money the household is owed;
- Amounts received on surrender of insurance policies; and
- Amounts contributed to retirement savings plans

However, this definition was considered to be problematic for several reasons. Firstly, housing debt was not included as an item in money owed by the household which had implications for the treatment of housing consumption as discussed in Section 2.5.2 (Schieber, 1996). Secondly, Schieber (1996) indicated that treating policy lapsation as savings would result in double counting if the proceeds were reinvested. Schieber (1996) also stated that ignoring investment income not reinvested was a limitation of this definition. Thirdly, this savings definition was found to be extremely volatile and resulted in very volatile replacement ratios in the first three Palmer studies (Palmer, 2008), prompting the modelled savings rates to be based on savings rates averaged over ten and eleven years in the 2004 and 2008 studies respectively (Palmer, 2008).

The first limitation could be addressed by the adjustments discussed in Section 2.5.2, but the second and third highlighted the difficulty in assessing savings rates from survey data.

2.5.4 The bequest motive, gifts and savings

Yaari (1965) highlighted the importance of the bequest motive, or the desire to leave an inheritance in a will. The literature suggested that, when estimating retirement adequacy targets, bequests may be catered for explicitly, (Cooper, 2002), via gifts (Joulfaian, 2005; Stoller & Stoller, 2003) or via pre- and post-retirement savings behaviour (Modigliani, 1986; Hurd, 1987; Mitchell & Moore, 1998).

2.5.4.1 Bequests

Cooper (2002) allowed explicitly for the bequest motive in her model by setting it to a multiple of the value of the individual's home. However, there is little to prove an intentional bequest motive distinct from gifts and pre- and post-retirement savings patterns. Hamermesh (1984) suggested that consumption data did not allow differentiation between a bequest motive and risk-averse behaviour and similarly Engen, Gale & Uccello (1999) stated that there is little to prove intentional bequest motives.

2.5.4.2 Gifts and the bequest motive

Gifts can be defined as transfers of goods and cash to others (Palmer, 1992) and may reflect the bequest motive (Joulfaian, 2005; Stoller & Stoller, 2003). Stoller & Stoller (2003) considered gifts only to family and friends but Cook & Settersten (1995) distinguished between individual giving, philanthropic giving and political giving.

Dexter (1984) and Palmer (1994; 2008) deliberately suppressed gift increases on retirement in order to suppress discretionary behaviour and the large increase in retirement adequacy targets that would have resulted. However, Palmer (1989) and Palmer (1994) did not suppress this effect and the literature provided some theoretical justification for allowing for gifts, and bequests through gifting. Firstly, the argument that gifting is discretionary was not valid given that TS and TSE models include other discretionary items such as leisure travel (Schieber, 1996). Secondly, gift-giving in old age may be a tax-efficient way of distributing assets before death. Joulfaian (2005) has shown that the tax regimes applicable to gifts and estates may influence the timing of transfers of wealth to family members. Hence, ignoring increases in gift-giving on retirement in wealthier households, where both gifting (Palmer, 1992; Joulfaian, 2005; Cook & Settersten,

1995) and the bequest motive (Modigliani, 1986) were likely to be strongest may result in the preferences of this group being ignored and their needs in retirement understated.

There was mixed evidence from the literature as to the determinants of gifting behaviour which would indicate whether gifts are used as bequests in practice. Cook & Settersten (1995) found there was an age effect on general gift-giving only in middle- and lower-middle-income homes. Income was found to be a much more significant determinant of gifts than age (Cook & Settersten, 1995). Cook & Settersten (1995) also found an age-related effect for philanthropic giving only for the most well-to-do households, where older pensioners give more generously. The income effect was significant over different age bands with wealthier individuals giving more, particularly to individuals (Cook & Settersten, 1995). Stoller & Stoller (2003) cited evidence that inter-generational transfers which begin in the pre-retirement years may continue as long as they can be afforded. Hence, the literature indicated that there was mixed evidence as to whether gifting is age-related as opposed to being determined by affordability and income.

2.5.4.3 Savings patterns and the bequest motive

Hurd (1987) and Modigliani (1986) both suggested post-retirement savings can be used to allow implicitly for bequests as accumulated savings will be transferred to the next generation and Cooper (2002) allowed for post-retirement savings as distinct from bequests when modelling post-retirement income needs.

Although there have been a number of studies on the issue of post-retirement savings and wealth accumulation in retirement, there was mixed evidence as to whether pensioners save or spend accumulated savings (Bernheim, 1987). This was not surprising given savings rates are a complex function of habit, changes in income and expected changes in future income levels (Alessie & Lusardi, 1997).

There was some evidence that pensioners continue to save or draw down precautionary savings at a modest rate, which suggested a bequest motive. Modigliani (1986) cited evidence of modest dissaving. Stoller & Stoller (2003) found a very high propensity to save additional income among the elderly. This may be a generational effect as many of the pensioners surveyed in their

study would have experienced the Great Depression (Stoller & Stoller, 2003). A broader sample, the Longitudinal Retirement History Survey (LRHS) showed that almost 50% of households continue to save and build wealth some eight years into retirement (Tacchino & Saltzman, 1999).

In contrast, Hurst, Luoh & Stafford (1998) considered whether there was any evidence to support the bequest motive by considering the savings patterns of individual pensioners with children, who should have a stronger bequest motive, and those without, who should have a weaker bequest motive. Hurst, Luoh & Stafford (1998) found that individuals over 65 have very high savings and wealth accumulation rates. Even higher savings rates were found for families where the head of the household was between 55 and 65 and there were no children in the household. Hence, Hurst, Luoh & Stafford (1998) confirmed positive post-retirement savings rates but found that these may not be bequest-related.

Another finding from the literature was that the elderly dissave, which would be contraindicative of a bequest motive. Hurd (1987) found that the elderly dissave at a rate of 3.2% p.a. and that retired individuals with children did not save more than those without. Disney (1996) suggested that dissaving does not occur for the first 12 years of retirement but savings are rapidly spent thereafter. Bernheim (1987) suggested that macro-economic and demographic factors played a significant role in savings behaviour and in a study using the LRHS data found that couples tended not to draw down savings in retirement but that single males and females spend between 3% and 6% of their wealth each year. When household composition was not controlled for, Bernheim (1987) found that a third of the working sample dissave whereas 40% of the retired sample continued to save. Diamond & Hausman (1984) investigated individual discretionary savings behaviour based on the National Longitudinal Study of Mature Men which ran from 1966 to 1976 and found that the average rate of decumulation of wealth in retirement was about 5% p.a. However, Bernheim (1987) contended the sample for this study may contain an overly large percentage of early retirees.

2.5.4.4 Modelling bequests

Mitchell & Moore (1998) concluded that people are entering retirement with less in terms of assets to be bequeathed, supporting the view of Modigliani (1986) that these assets tend to be

accumulated before retirement. This also suggested that bequests are a type of pre-retirement saving that is not continued in retirement (Mitchell & Moore, 1998). Yaari (1965) suggested the bequest motive is strongest during middle age and not in later life, supporting the view that bequests are accumulated before, not in, retirement (Mitchell & Moore, 1998).

Post-retirement savings may be positive (Stoller & Stoller, 2003; Hurst, Luoh & Stafford, 1998), negative (Diamond & Hausman, 1984; Hurd, 1987), related to household composition (Bernheim, 1987) or age-related (Disney, 1996). Gifting may increase in retirement (Palmer, 1994; Cook & Settersten, 1995) or remain constant after controlling for income (Stoller & Stoller, 2003). Hence, the literature provides mixed evidence as to whether post-retirement saving and gifting behaviour may be bequest-related.

In summary, there were a number of competing views in the literature as to if and how bequests, gifts and post-retirement savings patterns should be included in consumption-smoothing models.

2.5.5 Reduction in household consumption on widowhood

A number of studies investigated the effect of a loss of economies of scale in two-person households when one person died. This adjustment is necessary in consumption-smoothing models, as after the death of a spouse, a higher income per person may be required due to loss of economies of scale.

Casey & Yamada (2002) estimated that widowhood, and the corresponding loss of economies of scale, can reduce disposable income by between 7% and 37% for women between 65 and 74 and between 13% and 37% for women over 75 (Casey & Yamada, 2002). On average, loss of economies of scale reduced disposable income by 29% (Casey & Yamada, 2002). Warshawsky & Ameriks (2001), who investigated the output of a financial planning model to ascertain savings adequacy, assumed that consumption drops only 20% on the death of a spouse, implying a 60% increase in consumption per person on widowhood.

Equivalence scales provide ratios of the household income required for two households of different sizes and compositions to be equally well-off (Lancaster & Ray, 1998). There is

significant variation in published equivalence scales: Atkinson (1992) cited 44 unique scales for comparing two-adult households to one-adult households and indicates that estimates of economies of scale range from 6.0% to 51.0%. A nutritional needs equivalence scale, comparing the costs of subsistence food packages, indicated that living as a couple can reduce expenditure by approximately 5.4% (Klasen, 2000) although Streak, Yu & Van der Berg (2009) argued there is no reason to believe that non-food expenditure will follow the same ratio as food expenditure. Yatchew, Sun & Deri (2003) estimated that two adults living together in South Africa would save approximately 25.0% per person on their living expenses relative to living alone. This result was similar to that implied by the original OECD scale and the "economy" scale (Klasen, 2000). A study of the Household Subsistence Level data implied the saving was approximately 9.25% (Streak, Yu & Van der Berg, 2009).

In contrast, it has been suggested that due to the apparent insensitivity of poverty levels to the equivalence scale used, that a simple per capita adjustment could be used to estimate poverty levels in South Africa (Streak, Yu & Van der Berg, 2009; Woolard & Liebbrant, 2006; Statistics South Africa & National Treasury, 2007). The standardisation of the SOAG means-test for single pensioners and married couples was consistent with this view (Government Notice R898, 2008) ('the 2008 Regulations') that for very low income and consumption levels an adjustment for economies of scale is not required.

Hence, there is a considerable range of possible economies of scale adjustments per the literature reviewed.

2.5.6 Projection of current consumption to retirement age

TS and TSE models involve the smoothing of consumption at retirement where this consumption level is projected from current consumption.

Hamermesh (1984), Diamond & Hausman (1984), Shefrin & Thaler (1988), Robb & Burbidge (1989), Burns & Widdows (1990) and Palmer (1989; 1992; 1994) all assumed that consumption moves in line with after-tax earnings. Diamond & Hausman (1984) and Burns & Widdows (1990) assumed post-tax earnings and hence pre-retirement consumption were constant in real

terms. A 6% wage growth assumption was used in Palmer (1989) and Palmer (1992). Palmer, 1994) and the subsequent studies used a national wage growth index (Palmer, 1994).

However, Engen, Gale & Uccello (1999) suggested that due to earnings uncertainty, if family size was held constant, optimal consumption rose with age until retirement and then declined due to mortality uncertainty.

2.5.7 Projection sample definition

The literature provided some guidance as to which households to exclude from the sample used for the projection process.

2.5.7.1 Employment types

To improve accuracy, Robb & Burbidge (1989) and Hamermesh (1984) excluded households deriving income from self-employment or farming activities. Robb & Burbidge (1989) deemed these exclusions necessary as self-employed and farming households typically have very unreliable income and consumption data as they are unable to distinguish clearly between their own cashflows and those of their businesses.

2.5.7.2 Age

Palmer (1989; 1992; 1994; 2008) restricted his study to households where the head of the household was aged 50 or more. Diamond & Hausman (1984) only considered projections from age 45. Burns & Widdows (1990) restricted their studies to households with a head 39 or older as they stated that couples tend not to plan for retirement until after their child-bearing years and there were no missing observations for these older households. Yuh, Hanna & Montalto (1998) considered projections from age 35. Robb & Burbidge (1989) considered household heads that were aged between 25 and 75. Therefore, there was little consensus as to the minimum age to apply to the projection sample.

2.5.7.3 Hypothetical or actual households

Palmer (1989; 1992; 1994; 2008) considered hypothetical households where the only information derived from the data was the net change in age- and work-related expenditure.

Similarly, Mitchell & Moore (1998) did not use actual household consumption data directly. In contrast, Yuh, Hanna & Montalto (1998) used consumption data from actual households to develop consumption models.

2.5.8 Summary

The TS and TSE models were used by a number of authors such as Palmer (1989; 1992; 1994; 2008), Mitchell & Moore (1998) and Yuh, Hanna & Montalto (1998) in order to estimate the wealth required at retirement to smooth consumption. However, the development of the models requires careful consideration of a number of technical issues.

The first technical issue related to the treatment of durables, where consumption and expenditure are typically mismatched. It was suggested that the consumption and savings elements of mortgage payments should be separated in the calculation of pre-retirement savings and consumption (Schieber, 1996; Mitchell & Moore, 1998). The housing consumption element can be an imputed rental (Mitchell & Moore, 1998). When considering consumption and savings, it cannot be assumed that all mortgage debts will be repaid by retirement (Aizcorbe, Kennickell & Moore, 2003). The literature also suggested that vehicle consumption required similar consideration (Robb & Burbidge, 1989).

The second technical issue related to whether the model should allow for a bequest motive. The literature suggested that an explicit bequest motive during the retirement period could reasonably be ignored (Mitchell & Moore, 1998; Modigliani, 1986; Yaari, 1965) so long as post-retirement savings patterns (Modigliani, 1986) and gifts (Joulfaian, 2005) were considered.

The third technical issue was if and how allowance should be made for a loss of economies of scale that might arise on the death of a spouse. International studies suggested that the loss of economies of scale on widowhood lay between 6.0% and 60.0% (Atkinson, 1992; Warshawsky & Ameriks, 2001) while South African studies suggested a factor between 0.0% and 25.0% (Streak, Yu & Van der Berg, 2009; Woolard & Liebbrant, 2006; Yatchew, Sun & Deri, 2003).

The fourth technical issue was how to derive consumption at retirement from current consumption. The bulk of the literature suggested that pre-retirement consumption moves in line with net income (Palmer, 1989; Palmer, 1992; Palmer, 1994; Palmer, 2008; Hamermesh, 1984; Robb & Burbidge, 1989; Shefrin & Thaler, 1988; Burns & Widdows, 1990; Diamond & Hausman, 1984). Palmer (1994; 2008) suggested that salaries could be adjusted using a wage index.

The final technical issue was how to define the household sample to use to derive retirement adequacy targets. Households deriving income from self-employment or farming activities should be excluded due to the data from such households being considered particularly inaccurate (Robb & Burbidge, 1989). The minimum age for a head of household used in the projection sample ranged from 25 (Robb & Burbidge, 1989) to 50 (Palmer, 1989; Palmer, 1992; Palmer, 1994; Palmer, 2008), which indicated a lack of consensus as to whether very young households should be excluded from projections. Studies have used hypothetical (Palmer, 1989; Palmer, 1992; Palmer, 1994; Palmer, 2008) and actual household data (Yuh, Hanna & Montalto, 1998).

2.6 Estimating consumption change at and in retirement

As indicated in Section 2.5.1, allowance for a change in consumption at retirement is the distinguishing feature between TS and TSE models. The change at retirement is typically considered a work-status effect. Changes during retirement complicate the use of replacement ratios introduced in Section 2.3.1. Some of the changes in consumption in retirement may be as result of widowhood as introduced in Section 2.5.5, but other changes may be age-related. This section provides an analysis of the literature on the topic of estimating consumption change at and during retirement. Sections 2.6.1 to 2.6.5 set out the detail of how various authors defined the consumption items and controlled for spurious effects before setting out their findings. Section 2.6.6 considers whether changes in consumption are a matter of choice or necessity. Section 2.6.7 sets out an equivalence scale approach to investigating the change in consumption at and during retirement, and then a summary is given.

2.6.1 Defining age- and work-related consumption and expenditure items

Key to understanding changes in consumption at and in retirement is identifying items expected to change with age and work-status. Table 2.1 contains a comparison of age- and work-related expenditure definitions.

Apart from housing, most of the items are non-durable and hence consumption and expenditure on these items would be similar. A possible exception is healthcare, where public-sector subsidies and health insurance make true healthcare consumption difficult to gauge however Miniaci, Monfardini & Weber (2003) indicated that examination of healthcare expenditure provided useful insights into healthcare consumption.

Banks, Blundell & Tanner (1998) defined work-related expenditure as canteen and restaurant meals, transport and adult clothing. Cook & Settersten (1995) included recreational goods and services, gifts and essentials where the latter included food, clothing, housing, healthcare and transport in their study. Miniaci, Monfardini & Weber (2003) classified meals out, clothing, transport and domestic services as work-related, and healthcare, housing, food at home and fuel as age-related. Bernheim, Skinner & Weinberg (2001) considered only expenditure on food at and away from home and actual or imputed housing rental as consumption indicators when testing for changes in consumption. Hurd & Rohwedder (2005) used data from the Consumption and Activities Mail Survey (CAMS), which asked questions about changes in the following at retirement: trips, travel or vacations; clothing, "eating out/food and beverages" [sic], new home, home repairs or household items; entertainment, sports and hobbies and automobile expenses (Hurd & Rohwedder, 2005: 10). Palmer (1989) identified items expected to be age-related, items expected to be work-related and gifts. Age-related expenditure items were defined as: healthcare including insurance, shelter including insurance, domestic services and repairs, entertainment, reading and education. Work-related expenditure was defined as: food eaten at and away from home; apparel, transport including repairs and leisure travel and occupational expenses, including union dues and uniforms. Tacchino & Saltzman (1999) defined age- and work-related expenditure as healthcare, food, housing and transportation. Engen, Gale & Uccello (1999) identified transport, clothing and childrearing costs as age- and work-related.

Table 2.1 Age- and work-related consumption components

Item	Banks, Blundell & Tanner (1998)	Cook & Settersten (1995)	Miniaci, Monfardini & Weber (2003)	Bernheim, Skinner & Weinberg (2001)	Hurd & Rohwedder (2005)	Palmer (1989)	Tacchino & Saltzman (1999)	Engen, Gale & Uccello (1999)
Food at home		✓	✓	✓	✓	✓	✓	
Food away from home	✓	✓	✓	✓	✓	✓	✓	
Transport and travel	✓	✓	✓		✓	✓		✓
Adult clothing	✓	✓	✓			✓		✓
Healthcare		✓	✓			✓	✓	
Recreation		✓				✓		
Hobbies						✓		
Gifts		✓				✓		
Housing		✓	✓	✓	✓	✓	✓	
Household items					✓			
Domestic services			✓					
Occupational expenses						✓		

2.6.2 Control variables for estimating age- and work-related consumption

The literature suggested that in order to test for changes in consumption and expenditure, certain variables needed to be carefully controlled.

Cook & Settersten (1995) found that age and income were statistically significant control variables when testing the work-status effect.

Banks, Blundell & Tanner (1998) found that even though retirement typically resulted in a smaller drop in income than unemployment, the decrease in consumption in retirement was greater. Banks, Blundell & Tanner (1998) found that weighted average age for the household and work-status, controlling for unemployment, were statistically significant determinants of consumption in their analysis.

Income and socio-economic status were found to be statistically significant determinants of healthcare costs in retirement by Chia & Tsui (2003) and Case & Deaton (2005). Analysis by Robb & Burbidge (1989) suggested that socio-economic status was significant in determining changes in general consumption at retirement.

Hurd & Rohwedder (2005) found that household composition and health-status were important control variables.

2.6.3 Consumption changes at retirement

2.6.3.1 Cohort and longitudinal data sources

Jianakoplos, Menchik & Irvine (1989) have warned against inaccuracies introduced by using cohort instead of longitudinal data. Jianakoplos, Menchik & Irvine (1989) argued that wealthier households with lighter mortality will be over-represented in the retired samples. This would be partially offset by the fact that if wages increased in real terms then workers would have higher incomes in real terms than their retired counterparts would have had during their working lifetimes (Jianakoplos, Menchik & Irvine, 1989). Jianakoplos, Menchik & Irvine (1989) found

the latter effect to be stronger using National Longitudinal Survey data between 1966 and 1981. This implied that cohort data would overstate the drop in consumption at retirement.

2.6.3.2 Consumption changes at retirement from longitudinal data

Hamermesh (1984) and Kotlikoff, Spivak & Summers (1982) indicated that consumption dropped sharply at retirement.

Haider & Stephens (2007), in contrast, found mixed evidence when using three sets of US time-series data to assess whether decreases in consumption at retirement were fully anticipated and the extent of these decreases in consumption. The three series used were the Retirement History Survey (RHS), the Health and Retirement Survey (HRS) and the Panel Study of Income Dynamics (PSID). The drop in consumption at retirement was estimated to be between 7.0% and 11.0%, although the HRS did not indicate a significant fall in consumption at retirement. Similarly, Bernheim, Skinner & Weinberg (2001) used the PSID data to estimate consumption changes at retirement. The PSID suggested that consumption dropped by 12% or less at retirement and the sample did not support the hypothesis that the drop in consumption at retirement was due to decreased work-related expenditure (Bernheim, Skinner & Weinberg, 2001). An analysis of Consumer Expenditure Survey (CES) data by Bernheim, Skinner & Weinberg (2001) showed a lower budget share for work-related expenditure after retirement; where budget share can be defined as the proportion of the household budget allocated to a particular item or class of items.

In contrast, Hurd & Rohwedder (2005) found that the change in consumption at retirement depended on household characteristics. Hurd & Rohwedder (2005) used information from CAMS and HRS 2000 and found that the drop in consumption for married pensioners was 11.6% while single pensioners spent 16.8% less in retirement. Hurd & Rohwedder (2005) found that pensioners in good health had a much smaller drop in consumption at retirement.

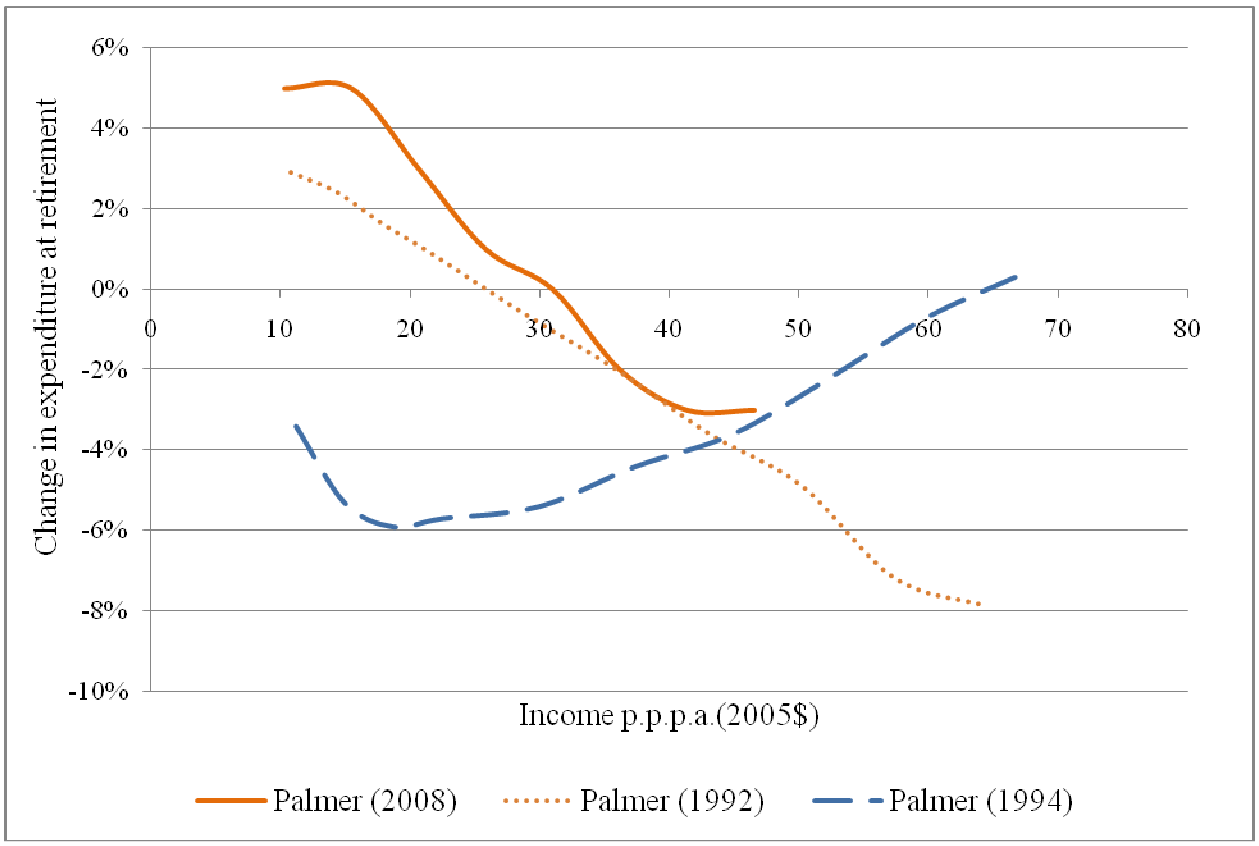
2.6.3.3 Consumption changes at retirement from cohort data

Miniaci, Monfardini & Weber (2003) found no significant decline in non-durable consumption on retirement based on a cohort analysis of Italian budget data where cohorts were determined by the age of the household head only.

Certain authors found that the change in consumption depended on household characteristics. Robb & Burbidge (1989) estimated from Canadian Family Expenditure Survey data that consumption for blue-collar married couples dropped 15.0% at retirement but was largely unchanged for white collar married couples (Robb & Burbidge, 1989). Kotlikoff, Spivak & Summers (1982) investigated optimal spending patterns in retirement and found the least risk averse pensioners may increase utility by having increased consumption in the early years of retirement relative to what could be obtained with an annuity. Similarly, Cook & Settersten (1995) found that having a working head of household resulted in significantly lower combined expenditure on food, clothing, healthcare and transport relative to not working.

The matched-pairs methodology adopted by Palmer (1989; 1992; 1994; 2008) was described in Palmer (1989). Households were divided into working (not retired and not unemployed and where the breadwinner was aged 50-64) and retired (head of household aged 62-74) (Palmer, 1989). For each group, disposable income was defined in terms of income less pre-retirement savings less applicable tax (Palmer, 1989). Households were then matched by disposable income and the differences in work-related and age-related expenditures were examined (Palmer, 1989). A significant problem with this methodology was that property taxes were found to be significantly higher in the retired group despite the rebates for retirees. This indicated that the retirees perhaps earned more while working than the working group, highlighting the mortality bias suggested by Jianakoplos, Menchik & Irvine (1989). This mortality bias suggested the drop in consumption at retirement may have been under-estimated (Palmer, 1989; Schieber, 1996). An analysis of Palmer (1992), Palmer (1994) and Palmer (2008) revealed that the estimates were subject to volatility and did not show a consistent relationship with income. Consequently, an eleven year average was used in the 2008 Palmer study (Palmer, 2008). Figure 2.1 shows the variation in age- and work-related expenditure in three Palmer studies for households consisting

of a wage earner, with a spouse who is three years younger and who did not work. The 1989 study was excluded due to a different treatment of changes in gift expenditure in retirement.



(Palmer, 1992; Palmer, 1994; Palmer, 2008; United States Department of Labor, 2010)

Figure 2.1 Changes in age- and work-related expenses

Moore & Mitchell (1997) acknowledged that there may be an age- and work-related expenditure difference but assumed that expenditure was determined by income which was, in turn, determined by their model. This avoided any explicit assumption or estimation of the change in consumption at retirement. Yuh (1998), and hence Yuh, Hanna & Montalto (1998), assumed that the change in work-related expenditure will exactly offset the change in age-related expenditure.

2.6.4 Consumption changes during retirement

2.6.4.1 Consumption changes during retirement from longitudinal data

Hamermesh (1984) found that the RHS-Social Security linked data implied that consumption exceeded income in early retirement by about 14.0% and that consumption decreased later in

retirement due to unsustainability. Hamermesh (1984) estimated that consumption for retired households dropped by over 9% in real terms between 1973 and 1975 while nationwide spending increased by 3% over the same period which could indicate that consumption in retirement is inversely related to age (Hamermesh, 1984).

2.6.4.2 Consumption changes during retirement from cohort data

Banks, Blundell & Tanner (1998) analysed UK date of birth cohort data by age, sex, household composition and work status and found that consumption dropped by approximately 3.0% p.a. from age 55 to age 80. This was attributed to shocks, such as finding too little savings, as opposed to being planned or anticipated by the household (Banks, Blundell & Tanner, 1998). Banks, Blundell & Tanner (1998) also found that decreased consumption at retirement was not limited to items traditionally regarded as work-related but included basics such as food.

The estimated change in consumption at retirement from Banks, Blundell & Tanner (1998) was considerably lower than estimates from longitudinal US data sets. Banks, Blundell & Tanner (1998) suggested that this was due to free healthcare in the USA only being available to persons over 65 as opposed to universally in the UK. But the Commonwealth Fund Commission found that 72.0% of elderly persons in the USA purchased private health insurance to provide for benefits not covered by the public health system which should have reduced this effect (Cook & Settersten, 1995).

Palmer (2008) implied that spending may decline in very old age. Kotlikoff, Spivak & Summers (1982) assumed that constant real consumption in retirement was acceptable where annuities were available, which was acknowledged as a limitation by the authors. In the case of no annuities, it was found that having a continually decreasing consumption level during retirement improved utility levels, particularly for the least risk-averse pensioners (Kotlikoff, Spivak & Summers, 1982).

2.6.5 Estimates of changes in consumption for specific items

2.6.5.1 Healthcare

Petertil (2005) stated that healthcare costs increase with age and Engen, Gale & Uccello (1999) found estimated wealth adequacy rates to be very sensitive to estimated healthcare costs in retirement. Petertil (2005) estimated that the rate of increase in retirement healthcare costs to insurers, as opposed to individuals, was highest between 60 and 64 and decreased to zero at age 90. This corresponded with Cook & Settersten (1995), who found that the healthcare budget share increased with age and decreased by income for 65-74 year olds but income had no effect for people over 75. Stoller & Stoller (2003) found that healthcare costs rose with age irrespective of insurance coverage. Madrian, Burtless & Gruber (1994) estimated that household healthcare costs increased by more than 50% between the age groups 55-64 and 65-74.

Case & Deaton (2005) highlighted that age is not the only determinant of healthcare consumption and proposed that health deterioration was a function of occupational type. Case & Deaton (2005) showed that the health of manual workers declined during their working career as opposed to in retirement. Case & Deaton (2005) suggested that higher-income earners experienced health deterioration until about age 80 while lower-income earners did not experience health deterioration after 60. Anderson & Burkhauser (1985) also described the close relationship between work-status, age and health. Anderson & Burkhauser (1985) reported significantly worse health among non-workers than among the employed even after controlling for wealth, income, age and family structure.

Paulin (2000) found that budget share for healthcare costs have increased over time. This trend was more marked for older people and older single men in particular. Acs & Sabelhaus (1995) similarly found an increase in healthcare consumption in US households between 1980 and 1992.

2.6.5.2 Food

Although Cook & Settersten (1995) found no significant change in food expenditure on retirement, Banks, Blundell & Tanner (1998) and Tacchino & Saltzman (1999) concluded that food budget share decreased in retirement. According to Hausman & Paquette (1987) food consumption dropped 10.0% on voluntary retirement.

Tacchino & Saltzman (1999) found that healthcare, food, housing and transportation expenditure all changed in retirement and that increased healthcare expenditure was paid for by decreased food, housing and transportation expenditure.

2.6.5.3 Housing

The CAMS survey showed that housing was one of the most invariant expenditure categories at retirement (Hurd & Rohwedder, 2005). If housing was taken to include domestic services, Miniaci, Monfardini & Weber (2003) showed that the decrease in housing expenditure in old age was at least partially offset by increased consumption of domestic services. Tacchino & Saltzman (1999) found that housing expenditure decreased in retirement.

2.6.6 Declining consumption as a matter of choice or necessity

A number of studies suggested reduced consumption in retirement was not a matter of choice. Cooper (2002) concluded from NatWest Survey data that drops in consumption at retirement tend to be matters of necessity not choice. Similarly, Hamermesh (1984) indicated that consumption dropped sharply in retirement due to unsustainability. Shefrin & Thaler (1988) suggested that decreased consumption in retirement was not due to decreased need but rather due to circumstance, and concluded that the elderly respond to inadequate saving by reduced consumption. Alternatively, individuals may be less inclined to spend savings or annuity income than salary income and hence consumption may have dropped at retirement simply because salary income had fallen (Shefrin & Thaler, 1988).

In contrast, Banks, Blundell & Tanner (1998) and Haider & Stephens (2007) only considered planned retirements and concluded that if consumers were rational, an individual would plan to save enough not to have a drop in consumption at retirement, if this were desired. Similarly, Tacchino & Saltzman (1999) suggested that the 1990 and 1991 CES data indicated that consumption declined voluntarily in retirement and Kotlikoff, Spivak & Summers (1982) also indicated a drop in consumption but suggested the decline in consumption was voluntary.

2.6.7 Equivalence scales and consumption change

As introduced in Section 2.5.5, equivalence scales provide ratios of the household income required for two households of different sizes and compositions to be equally well-off (Lancaster & Ray, 1998). Equivalence scales, by definition, typically control for household welfare by matching consumption of baskets of goods, before assessing the incomes for various household compositions.

Engel's first law holds that the welfare of adults is inversely related to the percentage of household budget spent on food (Lancaster & Ray, 1998). In contrast, the Rothbarth model is based on the premise that welfare is directly related to budget share for adult goods (Lancaster & Ray, 1998). Lancaster & Ray (1998) indicated that the results are typically sensitive to the classification of adult goods and that there was no universal definition. Lancaster & Ray (1998) defined adult goods as food eaten away from home, alcohol, adult clothing, adult education, entertainment and tobacco. Deaton, Ruiz-Castillo & Thomas (1989) defined adult goods as adult clothing, adult education, alcohol, alcohol out, entertainment, healthcare, meals out, personal care, tobacco, transport, insurance, subscriptions, taxes, funeral services, payments for financial services and personal services. Lancaster & Ray (1998) stated that the presence of children in the household complicate the application of the Engel and Rothbarth models due to the Engel scale over-estimating consumption by children, and the Rothbarth scale under-estimating it.

Equivalence scales could be derived by considering baskets of necessities, such as food, rent and fuel together (Nelson, 1993) and food and rent expenditure (Yatchew, Sun & Deri, 2003). Hulchanski (1995) indicated that any attempts to create rules from housing expenditure are subject to gross generalisation; however Nelson (1993) argued that this is also true for food expenditure.

In summary, equivalence scales control for household welfare by assessing the income requirement for households with different compositions so that, per person, they are able to consume the same baskets of goods. The corollary that households that differed with respect to work-status, but had the same income level, welfare and composition, could be matched and overall consumption compared was problematic. This was because the expenditure on items

typically used in equivalence scales such as food (Lancaster & Ray, 1998), housing (Nelson, 1993; Yatchew, Sun & Deri, 2003) or adult goods (Lancaster & Ray, 1998; Deaton, Ruiz-Castillo & Thomas, 1989) was expected to change on retirement. Although housing costs were expected to be reasonably stable or decrease slightly at retirement as discussed in Section 2.6.5.3, there was no theoretical justification for using an equivalence scale based on housing expenditure alone.

2.6.8 Summary

As set out in Table 2.1, various authors have suggested that consumption of the following items may change at and in retirement:

- Food at home;
- Food away from home;
- Transport and travel;
- Adult clothing;
- Healthcare;
- Recreation;
- Hobbies;
- Gifts;
- Housing;
- Household items;
- Domestic services; and
- Occupational expenses.

Hamermesh (1984) indicated a drop in consumption at retirement. Haider & Stephens (2007) and Bernheim, Skinner & Weinberg (2001) found that some data sets suggested a drop in consumption while others did not. Hurd & Rohwedder (2005) found that consumption declined at retirement for single pensioners but not married ones. Miniaci, Monfardini & Weber (2003) found, and Yuh, Hanna & Montalto (1998) assumed, no decline in consumption at retirement. Robb & Burbidge (1989) found that consumption declined for blue collar workers but not for white collar workers. Palmer (1992; 1994; 2008) did not establish a consistent pattern in changes

in consumption at retirement over time. Hamermesh (1984) and Banks, Blundell & Tanner (1998) suggested that consumption declined during retirement. Palmer (2008) implied that spending was expected to decline in very old age. Kotlikoff, Spivak & Summers (1982) found that optimal spending patterns in terms of utility theory involved a decline in expenditure during retirement.

However, healthcare costs were found to increase in retirement (Petertil, 2005; Cook & Settersten, 1995; Stoller & Stoller, 2003; Madrian, Burtless & Gruber, 1994) although this may have been a function of occupation (Case & Deaton, 2005). Paulin (2000) and Acs & Sabelhaus (1995) identified an increase in healthcare costs in real terms over time. Banks, Blundell & Tanner (1998) and Tacchino & Saltzman (1999) found, and Engen, Gale & Uccello (1999) stated, that food budget shares declined in retirement although Cook & Settersten (1995) did not find the same result. Miniaci, Monfardini & Weber (2003) and Tacchino & Saltzman (1999) found that housing consumption decreased in retirement although Hurd & Rohwedder (2005) found that housing budget share was insensitive to work-status.

In investigating changes in consumption on retirement, it was found that it was necessary to control for age (Banks, Blundell & Tanner, 1998; Cook & Settersten, 1995), work-status (Banks, Blundell & Tanner, 1998), income (Cook & Settersten, 1995), socio-economic group (Chia & Tsui, 2003; Case & Deaton, 2005; Robb & Burbidge, 1989), household composition (Hurd & Rohwedder, 2005) and healthcare (Hurd & Rohwedder, 2005).

There were conflicting findings as to whether any observed changes in consumption were voluntary (Banks, Blundell & Tanner, 1998; Haider & Stephens, 2007; Tacchino & Saltzman, 1999; Kotlikoff, Spivak & Summers, 1982) or a matter of necessity (Cooper, 2002; Shefrin & Thaler, 1988; Hamermesh, 1984).

Equivalence scale techniques could not be used to test for changes in consumption at and in retirement. This implied that a possible approach to assessing the changes using cohort data was to match households that differed only by work-status. This would require refinement of the matched-pairs methodology used by Palmer (1989) that matched only by income.

2.7 The impact of savings rates and retirement ages on retirement adequacy targets

Moore & Mitchell (1997) demonstrated mathematically that if all income were either saved or consumed, a higher savings rate would lower the retirement adequacy target due to reduced consumption.

Mitchell & Moore (1998) indicated that increasing retirement age from 62 to 65 resulted in increased retirement adequacy targets for married couples and single females although the savings rates for attaining these targets were lower. Mitchell & Moore (1998) indicated that the targets for single males decreased with retirement age.

2.8 Factors influencing retirement adequacy targets

The research reviewed suggested a range of factors that may influence retirement adequacy targets.

2.8.1 Income

Palmer (1989) used eight income bands that were expanded to ten in later studies (Palmer, 1992). Using the TSE model, Palmer (1989; 1994 2008) implied that targets declined as one moved from low- to middle-income but at some income level, the retirement adequacy target began to rise again. Palmer (1992) found the traditionally accepted negative relationship between income and adequacy targets using the TSE model. If the TS model were used, Palmer (1989), Palmer (1992) and Palmer (1994) all showed targets decreased with income up to a point, thereafter income had no further effect. The 2008 data set from Palmer (2008) showed that, for higher incomes, targets might increase with income.

Hatcher (1997) used income as a regression variable to model the reservation wealth level, described as the wealth level at which a person would be indifferent between work and retirement. Using the model from Hatcher (1997), for a 55 year old married man with 12 years of education, the retirement adequacy target when earning $40 000 was about 22.9% lower than if he were earning $30 000. The drop in adequacy targets when moving from $70 000 to $80 000

was approximately 10.3% (Hatcher, 1997). Palmer's models suggested that, when assessed against the same income levels, the target decreased by between 3.8% and 5.6% and increased by 1.3% respectively (Palmer, 1994; Palmer, 2008). Yuh (1998) found that income, particularly when considered with age, was significant in determining consumption. The model in Yuh (1998) suggested that a man currently 55 years old spending more than his income of $40 000 per annum and with only a spouse at home would need a retirement adequacy target 15.2% lower than if he were earning $30 000. Repeating the calculations on the same basis but assuming the household does not overspend, showed a 12.1% reduction.

Therefore, previous research indicated that income is a statistically significant determinant of retirement adequacy targets.

2.8.2 Household composition

Palmer (1989; 1992; 1994; 2008) controlled very carefully for different household compositions due to tax and social security arrangements. This resulted in the earnings split and ages of the household members being extremely important. Only one household composition was considered in Palmer (1989) but four household compositions were considered in Palmer (1994) and subsequent studies, namely:

- One male breadwinner, with a homemaker spouse three years younger than the male;
- One male breadwinner, with a homemaker spouse the same age as the male;
- Single workers (with no differentiation by gender); and
- Two wage-earner families, where there was a three year age gap between the spouses and the older spouse earned 60% of the family income.

Palmer (1994) suggested that a single person would need a lower retirement adequacy target than a couple at lower income levels but a higher target at higher income levels. These differences were, however, small and may not have been statistically significant. Mitchell & Moore (1998) modelled results for single and married workers separately. As the earnings profiles for married and single workers were very different, the impact of household composition on the targets in their study could not be estimated. Hatcher (1997) considered married couples with and without

dependents. Yuh, Hanna & Montalto (1998) considered the number and age of dependents. Yuh, Hanna & Montalto (1998) found that marital status had no impact on consumption but that having a household of four or more where the household used debt to finance consumption, increased estimated consumption sharply. Stoller & Stoller (2003) similarly found that perceptions of income adequacy were influenced by number of dependents but that marital status had no significant effect.

2.8.3 Sex

The NatWest Survey indicated that women set their subsistence income levels some 35% lower than men and specified the income required for an easy life to be about 20% lower than the estimates given by men (Cooper, 2002). Sex was considered significant by Mitchell & Moore (1998), however the data indicated that the women earned about 30% less than the men in the study and hence a comparison on the basis of gender alone could not be made. Chia & Tsui (2003) controlled for sex in their study. Palmer (1994; 2008) did not distinguish targets by sex. Yuh, Hanna & Montalto (1998) found that sex was not statistically significant when analysing retirement wealth adequacy. Hence, there is inconclusive evidence as to whether and how sex affects retirement adequacy targets.

2.8.4 Home ownership

Yuh, Hanna & Montalto (1998) used home ownership status as a categorical regression variable. For households that consumed more than their income, households that were still paying off a mortgage did not have statistically significantly different consumption to households that owned their homes in full (Yuh, 1998). For households living within their means, retirement adequacy targets were about 9.5% higher for renters and about 17.9% higher for mortgaged home owners relative to households that owned their homes outright (Yuh, 1998).

2.8.5 Debt

Yuh, Hanna & Montalto (1998) found debt had such a strong influence on consumption that separate consumption regression models were developed for households that spent more than their income and those that spent less.

2.8.6 Socio-economic group

Chia & Tsui (2003) used dwelling size to control for socio-economic status. Additionally, Hatcher (1997) considered whether the person had ever worked in managerial or professional occupations but found this was not statistically significant in determining reservation wealth.

2.8.7 Education

Hatcher (1997) found that education was a statistically significant determinant of reservation wealth for singles, but for couples only the woman's level of education was significant. For example, depending on the current age and wage level, extrapolating from Hatcher (1997) suggested that increasing years of education from 12 to 16 raised the reservation wealth level by as much as 15.1% for a single man earning $80 000 per annum. Yuh (1998) found that education had a statistically significant impact on consumption even after taking income into account. For households that were overspending, a college graduate would have had a retirement adequacy target 31.1% higher than a person with a high school diploma or less. For households living within their means, a high school graduate would have had a target 8.0% higher than someone with less education and a college graduate would have had a target approximately 8.3% higher than a person with just a high school education.

When exploring household saving adequacy, Engen, Gale & Uccello (2005) considered education level as a control variable, implying its significance.

2.8.8 Health-status

Health-status was not found to be significant by Hatcher (1997) but was found to be a significant determinant of perceived income adequacy by Stoller & Stoller (2003).

2.8.9 Geographic region

Yuh (1998) did not find geographic region to be a significant determinant of retirement adequacy targets.

2.8.10 Summary

A variety of different factors were considered to potentially impact on retirement adequacy targets. Hatcher (1997), Yuh, Hanna & Montalto (1998) and Palmer (1992) found that retirement adequacy targets decreased with income although Palmer (1989; 1994; 2008) suggested that there may be a positive relationship at very high income levels. The authors had conflicting findings as to the size of the impact.

Household composition was an important control variable in Palmer (1989; 1992; 1994; 2008), Mitchell & Moore (1998) and Hatcher (1997) but no strong relationships between household composition and the retirement adequacy target could be established. Yuh, Hanna & Montalto (1998) and Stoller & Stoller (2003) found that for households with no dependents, the targets for singles and couples were not significantly different. Cooper (2002) and Mitchell & Moore (1998) implied that sex was an important control variable, however Yuh, Hanna & Montalto (1998) found that it was not statistically significant.

Yuh (1998) found that for households that consume more than their income, having a mortgage did not increase the targets. However, for households living within their means, mortgage-free home owners had lower targets than renters who had lower targets than mortgage holders. Yuh, Hanna & Montalto (1998) found debt had a highly significant impact on the targets.

Socio-economic status was controlled for by Chia & Tsui (2003) but was not found to be statistically significant by Hatcher (1997). Hatcher (1997) and Yuh (1998) found a positive relationship between years of education and the targets. Health-status was not found to be significant by Hatcher (1997) but was found to be a significant determinant of perceived income adequacy by Stoller & Stoller (2003). Finally, Yuh (1998) did not find geographic region to be a significant determinant for retirement adequacy targets.

2.9 Estimated targets in the literature

Burns & Widdows (1990) stated that replacement ratios of between 65% and 80% were often suggested. Malroutu & Xiao (1995) stated that a 70% replacement ratio was an appropriate

target. Greninger, Hampton, Kitt & Jacquet (2000) reached a target replacement ratio range of 70% to 89% in a Delphi study of financial planners. Engen, Gale & Uccello (1999) stated that recommended replacement ratios were usually between 65% and 85% and estimated that the optimal replacement ratios were between 70% and 80%. Kotlikoff, Spivak & Summers (1982) implied that a ratio of 80% was acceptable. Table 2.2 shows these summarised results for different household compositions converted to wealth-earnings ratios using annuity factors calculated by the target estimation model presented in Chapter 5 and using a basis described in Appendix A. For the purposes of the projection, households were assumed to be 25 years away from retirement.

Table 2.2 Wealth-earnings ratio equivalents to replacement ratio retirement adequacy targets (retirement age 65)

	Replacement ratio					
	65%	**70%**	**75%**	**80%**	**85%**	**89%**
Single male	8.4	9.0	9.7	10.3	11.0	11.5
Couple (same age)	9.3	10.0	10.7	11.5	12.2	12.7
Couple (wife 3 years younger)	9.7	10.4	11.2	11.9	12.6	13.2
Single female	9.9	10.6	11.4	12.1	12.9	13.5

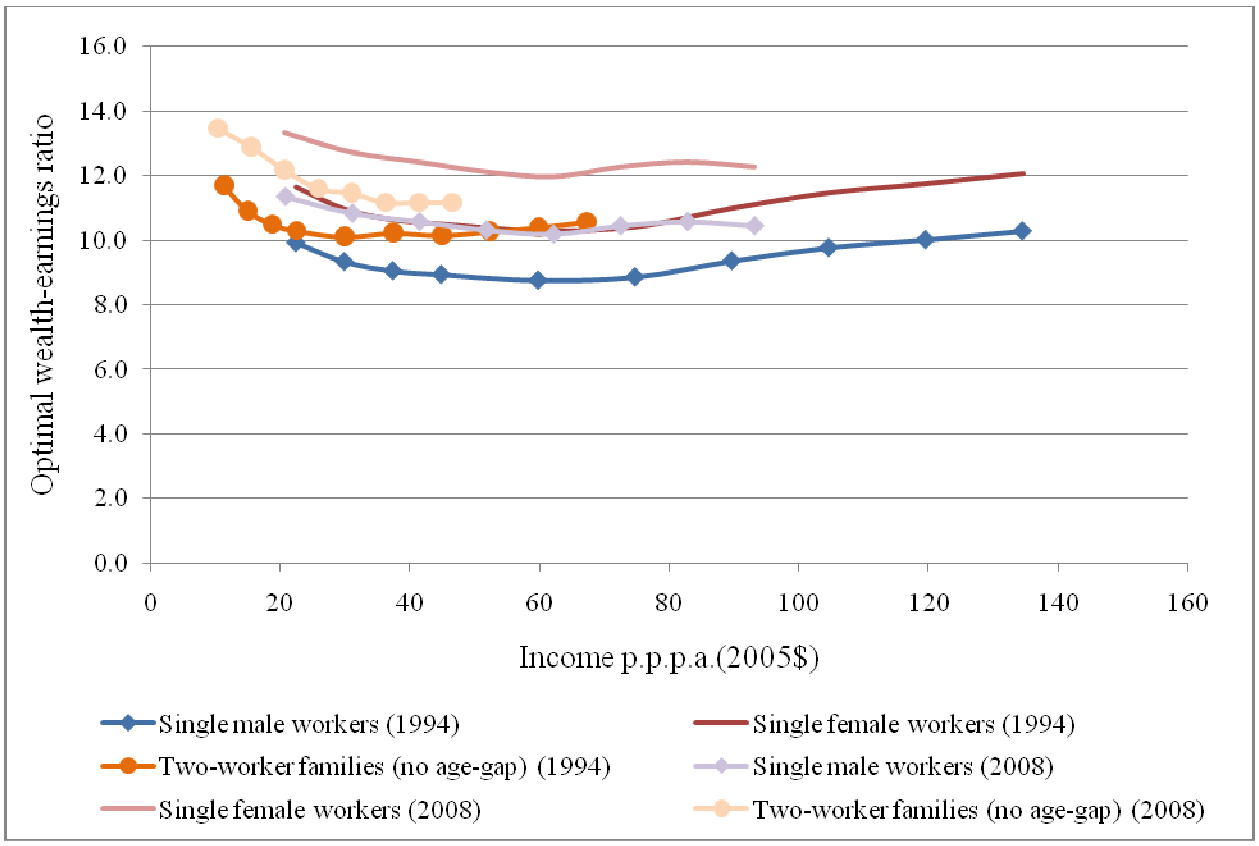
The targets for single females were higher than targets for other household compositions due to the annuity factor being highest for single females. The results from Mitchell & Moore (1998) are shown in Table 2.3.

Table 2.3 Optimal wealth-earnings ratios and savings rates (retirement age 65)

	Wealth-earnings ratio target	**Savings rate**	**Average earnings (2005$)**
Single male	8.1	17.6%	33 130
Couple (same age)	10.2	12.2%	60 692
Couple (wife 3 years younger)	10.6	12.2%	60 692
Single female	9.6	18.8%	22 968

(Mitchell & Moore, 1998; United States Department of Labor, 2010)

The inflation adjusted results for the Palmer studies for fully-employed households are shown in Figure 2.2.



(Palmer, 1994; Palmer; 2008; United States Department of Labor, 2010)

Figure 2.2 Optimal wealth-earnings ratios from the TSE Model (retirement age 65)

Hence, the literature consistently suggested that adequacy targets for a retirement age of 65 would be in the region of 8.0 to 14.0 times annual salary.

2.10 Synthesis of literature reviews

Although Palmer (1989; 1992; 1994; 2008), Yuh, Hanna & Montalto (1998), Mitchell & Moore (1998) and Hatcher (1997) defined adequacy in terms of consumption-smoothing, Chia & Tsui (2003) used a minimally adequate definition. Palmer (1989) and Moore & Mitchell (1997) mentioned that it may be appropriate to include a minimally adequate underpin when defining adequacy. A comfortably adequate definition, which allows for a target sufficient to provide for consumption smoothing between work and retirement, as well as an underpin of minimally adequate consumption, was proposed as preferable to the alternatives.

Although targets were typically presented as replacement ratios in the literature, Schieber (1996) pointed out that the pattern of the annuity payment is critically important to assessing if the target meets the needs of the pensioner. Palmer (2008) suggested that consumption was stable and then declined in very old age whereas Hamermesh (1984) and Banks, Blundell & Tanner (1998) suggested a steady decline. Healthcare expenditure, which was found to generally increase in retirement (Petertil, 2005; Cook & Settersten, 1995; Stoller & Stoller, 2003; Madrian, Burtless & Gruber, 1994), was also found to be increasing in real terms over time (Paulin, 2000; Acs & Sabelhaus, 1995). The wealth-earnings ratio, where earnings refer to earnings at retirement and wealth was defined as the expected present value of adequate consumption in retirement, was considered theoretically sound (Moore & Mitchell, 1997; Burns & Widdows, 1990). It is also easily comparable with other measures (Engen, Gale & Uccello, 1999).

The chosen adequacy definition required the calculation of a minimum income underpin. Woolard & Liebbrandt (2006) implied that using the SOAG means-test formula was an acceptable approach as South Africa lacked an official poverty line (National Treasury, 2010).

The retirement adequacy target could be estimated using a TS model (Palmer, 1989; Palmer, 1992; Palmer, 1994; Palmer; 2008) or a TSE model (Palmer, 1989; Palmer, 1992; Palmer, 1994; Palmer; 2008; Mitchell & Moore, 1998; Yuh, Hanna & Montalto, 1998). However, the choice of the model should be determined by whether consumption was expected to change at retirement. Hamermesh (1984) suggested that such a change was likely to occur. Miniaci, Monfardini & Weber (2003) could not support this hypothesis. Hurd & Rohwedder (2005), Kotlikoff, Spivak & Summers (1982) and Robb & Burbidge (1989) found that consumption dropped for some households and not others and other authors found mixed evidence (Palmer, 1992; Palmer, 1994; Palmer, 2008; Haider & Stephens, 2007; Bernheim, Skinner & Weinberg, 2001). As the items on which consumption was expected to change at retirement matched the items commonly used for equivalence scales, comparing similar households that differed only by work-status and age was identified as the most suitable methodology for estimating changes in consumption at and during retirement, respectively.

The literature also provided some insight into technical issues to be considered in developing TS and TSE models. Housing consumption estimates for mortgage holders required careful adjustment to ensure that pre-retirement savings were not overstated and housing consumption services in retirement were properly accounted for (Mitchell & Moore, 1998). The change in consumption on widowhood was often ignored in adequacy studies but may be as high as 60.0% (Warshawsky & Ameriks, 2001). South African estimates range from 0.0% (Streak, Yu & Van der Berg, 2009; Woolard & Liebbrant, 2006; Statistics South Africa & National Treasury, 2007) to 25.0% (Yatchew, Sun & Deri, 2003). The literature suggested that consumption could rise with net wage inflation to retirement (Palmer, 1994; Robb & Burbidge, 1989; Shefrin & Thaler, 1988). Although studies consistently excluded farming households and those deriving income from self-employment for data reasons (Robb & Burbidge, 1989), there was no consensus in the literature as to whether younger households should be excluded from projections.

Gifts would need to be considered separately given that Palmer (1992) found the increase in gifting at retirement was disproportionately large but gifting may be an expression of the bequest motive (Joulfaian, 2005) as may post-retirement savings (Hurd, 1987; Modigliani, 1986). Allowing for bequests was considered theoretically sound by Modigliani (1986).

Moore & Mitchell (1997) stated that savings rates and retirement adequacy targets were inversely related. Moore & Mitchell (1997) found that higher retirement ages were associated with higher targets for couples and single females but lower targets for males.

The literature suggested investigating whether the following have an impact on retirement needs: income, household size, sex, home ownership, debt, education, dwelling size, years of education, health and location. Income, socio-economic group, household composition and health may be useful for testing for changes in age- and work-related consumption.

The literature suggested that retirement adequacy targets, expressed as wealth-earnings ratios, for people retiring at 65 would be in the range of 8.0 to 14.0 times annual salary.

In conclusion, the literature provided justification for defining adequate benefits as sufficient to provide for the higher of the pre-retirement living standard and a minimum socially acceptable standard of living. It also provided justification for using wealth-earnings ratios to express retirement adequacy targets. There was mixed evidence as to whether and how consumption changed at and in retirement. Increased retirement savings rates were expected to decrease retirement adequacy targets, as were increasing retirement ages. Previous studies identified a number of factors that were expected to influence the level of the retirement adequacy targets and the targets for a retirement age of 65 found in previous work ranged from 8.0 to 14.0 times annual salary depending on household composition.

3 OVERVIEW OF STATISTICAL METHODS

3.1 Introduction

Statistical techniques were used for various purposes in this research, including imputation of missing values, testing for changes in consumption at and in retirement, and differences in the retirement adequacy targets for various groups.

Section 3.2 of this chapter sets out a brief explanation of statistical tests and techniques used in previous studies. The three main statistical techniques used in this research are then described. CHAID analysis is described in Section 3.3, regression techniques in Section 3.4, and repeated measures analysis of variance (ANOVA) in Section 3.5. A brief explanation of how these techniques were applied in this research is given in Section 3.6.

3.2 Techniques used in previous studies

3.2.1 Imputation

Data imputation was not discussed in the literature surveyed. Imputation can be described as deriving a value for a data point that is missing (Little & Rubin, 2002) or probably incorrect (Groves, Fowler, Couper, Lepkowski, Singer & Tourangeau, 2004). Imputation was considered preferable to discarding observations where there was item non-response or inconsistent data, as the latter would have reduced the sample size and biased the results if errors and missing values were not entirely random (Little & Rubin, 2002). When imputing missing values in the IES 2005/2006 data file, which was used for this research, Statistics South Africa identified households with similar profiles to the household with missing data and took the average observed value (Statistics South Africa, 2008a).

3.2.2 Changes in consumption at and in retirement

Yuh, Hanna & Montalto (1998), Mitchell & Moore (1998) and Cooper (2002) assumed that there was no change in consumption at or in retirement. Chia & Tsui (2003) used an unpublished result to model the impact of age on healthcare expenditure.

Tests for changes in consumption at retirement typically involved testing for changes in consumption with respect to work-status. Similarly, tests for changes in consumption and non-retirement saving during retirement were conducted by assessing if there was an age effect.

Palmer (1989; 1992; 1994; 2008) tested for the effect of age and work-status simultaneously by using a matched-pairs methodology, described in Section 2.6.3.3, where households that differed by work-status and age were matched by disposable income and the consumption levels compared. It was unclear if any statistical tests were performed to test for significance in these comparisons.

Stoller & Stoller (2003) and Bernheim, Skinner & Weinberg (2001) used regression to determine age- and work-related changes in consumption. Tobit analysis, which provides for a regression model where the dependent variable is subject to upper- and lower-bounds (Tobin, 1958), was used by Paulin (2000) to analyse changes in healthcare consumption. The Tobit analysis involved two steps. The first was to estimate the probability of making any purchase in an expenditure category and the second was to estimate the expenditure, given that some expenditure was made (Paulin, 2000). However, the Tobit analysis is of little use when negative rates occur (Paulin, 2000), and hence could not be used to identify savings rates, which could be negative.

3.2.3 Differences in retirement adequacy targets

Palmer (1989; 1992; 1994; 2008) did not appear to use any statistical tests to ascertain if targets differed between demographic groups.

3.3 CHAID

3.3.1 Description

CHAID results in observations, such as households in the case of this research, being separated into exclusive and exhaustive sets, where the characteristics of these sets are predictive of a dependent variable (Kass, 1980).

The CHAID algorithm requires that the dependent variable is categorical. In this research, when the dependent variable was continuous, it was split into interpretable bin ranges such that each contained a relatively large number of observations. It was noted that turning a continuous variable into a categorical variable would necessarily result in a loss of statistical power.

The CHAID algorithm is described in Hill & Lewicki (2006) as including the following steps:

- Continuous independent variables are converted to categorical variables by dividing the range so that there are a similar number of observations in each bin range.
- For each independent variable, pairs of categories are compared using a chi-squared test and pairs that are not statistically significantly different are merged, starting with the least significant. Where significant differences are detected, Bonferroni-adjusted p-values are calculated.
- The observations are then split into statistically significant categories using the most significant independent variable.
- The cycle repeats until no significant differences are detected.

For the purposes of this research, the CHAID output was termed a 'tree' and the resultant sets of observations were termed 'leaves' (SAS®/STAT 9.2 Users' Guide, 2008). The appropriate interpretation of the CHAID trees, presented graphically as dendrograms, was critical to this research and an illustrative example is given in Appendix B.

3.3.2 Software and approach

The Tree Node module in SAS 9.2 Enterprise Miner (SAS®/STAT 9.2 Users' Guide, 2008) was used.

All the data were used to develop the tree, and to prevent the tree becoming too large a multiplicity adjustment was made both for the number of leaves and the number of sub-groups that could be created from each group, termed 'branches', as per Kass (1980). The minimum leaf size was set to 20 observations. This resulted in larger leaf sizes than were used by Hill, Delaney & Roncal (1997), who ran a CHAID on trauma data where cells larger than 20 were subject to

further segmentation, but smaller leaves than Haughton & Oulabic (1993) who recommend a minimum leaf size of 50. A 5% significance level was applied generally, except for when the CHAID was used for imputation, where a 15% significance level was applied. The different significance level is discussed in more detail in Section 3.6.1.

3.4 Regression

3.4.1 Requirements and assumptions

Regression techniques seek to model relationships between variables and require a continuous dependent variable that is normally distributed or can be transformed so that it is normally distributed (Montgomery & Peck, 1982). Regression also requires underlying assumptions of constant error variance, uncorrelated error terms and normality of the error terms (Montgomery & Peck, 1982).

3.4.2 Software and approach

The Linear Regression module in SAS 9.2 Analyst (SAS®/STAT 9.2 Users' Guide, 2008) was used with the backward stepwise elimination variable selection procedure and a 5% significance threshold. Backward stepwise elimination is described in Montgomery & Peck (1982) as involving the following steps:

- A regression model is created with all independent variables.
- Each independent variable is removed and the partial F-statistic calculated. These are compared and the least significant independent variable is removed.
- The process is repeated until all remaining independent variables are found to have significant partial F-statistics.

It was also noted that different variable selection procedures for regression can give very different answers for highly correlated independent variables (Montgomery & Peck, 1982).

Residual plots and normal plots were examined to test for constant error variance and normality of error terms respectively. In order to identify outliers, dffits statistics, which measure the change in the predicted value by deleting single observations (SAS®/STAT 9.2 Users' Guide,

2008), were used with a cut-off of 1.5. The cut-offs provided in statistics texts for the dffits tests are only suggestions (Neter, Kutner, Nachtsheim & Wasserman, 1996) and hence the 1.5 cut-off adopted was based on the average of the suggested cut-offs of 1 in Neter *et al* (1996), and 2 in the SAS®/STAT 9.2 Users' Guide (2008). The adjusted-R^2 statistic was used to suggest whether the model had reasonable fit.

3.5 Repeated measures ANOVA

3.5.1 Description

ANOVA tests, as described by Hill & Lewicki (2006), can be used to test if there is a significant difference for at least one pair of means. The ANOVA test involves comparing the ratio of the variance between groups of test subjects to the variance within the groups. If this ratio exceeds a pre-determined critical value using the F-test, then statistically, there is at least one pair of means that differ from each other. If the F-statistic exceeds the critical value, then *post-hoc* testing should be performed to assess which pairs of means differ (Hill & Lewicki, 2006).

For situations where the responses from the same test subject are obtained under different control conditions, a repeated measures ANOVA test is appropriate for identifying if the control conditions are statistically significant (Hill & Lewicki, 2006).

3.5.2 Software and approach

The ANOVA module in SAS 9.2 Analyst (SAS®/STAT 9.2 Users' Guide, 2008) was used. The Bonferroni adjustment was made in the *post-hoc* test in line with the adjustment made in the CHAID analysis, as per Kass (1980). The Bonferroni adjustment effectively adjusts the significance level for the number of tests performed and hence prevents erroneously identifying non-significant effects as significant (Hill & Lewicki, 2006).

3.6 Application of statistical methods

3.6.1 Imputation

For consistency, missing or improbable values were imputed by identifying households with similar profiles to the household with missing data and taking the average observed value. This

was the same technique as was adopted by Statistics South Africa in the preparation of IES 2005/2006 (Statistics South Africa, 2008a).

A CHAID analysis was used to identify similar households as per Kuzmicich & Wigbout (2001). Instead of a 5% significance level, it was assumed that a 15% significance level would be more suitable for the purposes of imputation. This was because using the average observed value would greatly reduce the standard deviation of the dependent variable once the imputed values were included (Little & Rubin, 2002). Hence, using a higher p-value to assess splits may have increased the number of leaves, and resulted in the effect of the reduction in the standard deviation being less than what it would have been had there been fewer leaves.

3.6.2 Testing for changes in consumption and non-retirement savings at and in retirement

Given that many of the explanatory variables discussed in Sections 2.6.2 and 2.8 were categorical and expected to be highly correlated, a CHAID analysis was used to test if age or work-status had a statistically significant effect on consumption. No regression analysis was possible as the assumption of normality of error terms was violated, and normality could not be obtained through transformation of the variables.

3.6.3 Exploring retirement adequacy target estimates

Regression techniques were used to explore retirement adequacy targets. However, Yuh (1998) also found that models could be significantly different for households with different characteristics. This suggested a need to determine model hierarchies before regression models were used. Hence, a CHAID analysis was used to suggest possible segmentation of the data. The smallest number of splits was used that produced regression models where the underlying regression assumptions were found to be valid. Backward stepwise elimination was used to determine the regression variables rather than CHAID.

3.6.4 Assessing the impact of retirement savings rate and retirement age on retirement adequacy targets

Retirement adequacy targets could only be estimated for hypothetical retirement ages. The regression models discussed in Section 3.6.3 were constructed using actual household retirement

savings rates. However, as discussed in Section 2.5.3, savings rates may be difficult to derive from survey data. Hence, hypothetical savings levels were determined and the observed household consumption adjusted accordingly, as described in Section 5.4.3. Targets were then recalculated based on the hypothetical retirement savings rates and retirement ages, and repeated measures ANOVA applied with *post-hoc* testing.

4 DATA

4.1 Introduction

The main data requirements for this research were the household consumption data required to test for changes in consumption at and in retirement, and data for working households from which to estimate retirement adequacy targets. The data set used for the first purpose was termed the 'model development sample' and the second data set was termed the 'target estimation sample'. Both the model development sample and target estimation sample were derived from the IES 2005/2006 (Statistics South Africa, 2007).

An understanding of the methodology adopted in the IES 2005/2006 and concerns around the IES 2005/2006 data were critical to the development of the target estimation model and an overview is given in Section 4.2. The data files are described briefly in Section 4.3. Section 4.4 sets out how the model development sample and target estimation sample were derived from the IES 2005/2006 data and how each sample was used. A large number of variables were used in the statistical analysis. These are set out in Section 4.6. Despite rigorous data checks, certain data needed to be imputed. Section 4.7 sets out the results of the imputation process. Descriptions of the model development and target estimation samples are given in Section 4.8 while Section 4.9 describes the other sources of data. The chapter concludes with a summary.

4.2 Description of IES 2005/2006

4.2.1 Design of IES 2005/2006

At the time of writing, Statistics South Africa monitored South African income and expenditure patterns at five-yearly intervals using the Income and Expenditure Survey (IES). IES 2005/2006 was the most recent survey at time of writing and covered the period from September 2005 to August 2006 (Statistics South Africa, 2007).

The IES 2005/2006 sampled 24 000 dwelling units (Statistics South Africa, 2008a). The sample was spread evenly over 12 months and was nationally representative in each quarter (Statistics South Africa, 2008a). Data were collected from 21 144 households (Statistics South Africa,

2008a). A ‘household’ was defined as a group of people who lived together at least four days a week for at least the four weeks prior to the survey date and who shared resources (Statistics South Africa, 2008a). This was the definition of a household for the purposes of this research.

A two-stage weighting process was used by Statistics South Africa to apply weights at a household level (Statistics South Africa, 2008a). The first stage involved calculating a weight based on the probability of the household being selected and responding (Statistics South Africa, 2008a). In the second stage, the weights were benchmarked so that the weighted population profile corresponded to the modified 2006 mid-year population estimates (Statistics South Africa, 2008a).

For each household, the IES 2005/2006 data were obtained over a period of one month. This was the first IES conducted using a diary system in conjunction with a recall system (Statistics South Africa, 2008a). Respondents were given four consumption diaries which were to be completed on a daily basis for one month with each diary covering one week (Statistics South Africa, 2008a). Durable and semi-durable consumption information was collected in a face-to-face interview and covered the eleven months prior to the survey month (Statistics South Africa, 2008a). Previously, only the recall method was employed and this resulted in the IES 2005/2006 being difficult to compare with previous IES results (Statistics South Africa, 2008d). Additional household information was obtained through five face-to-face interviews conducted over the survey month (Statistics South Africa, 2008a).

IES 2005/2006 saw a departure from the use of interest on mortgage bonds as housing costs for home owners. IES 2005/2006 used annual imputed rental defined as 7.0% of the value of the dwelling (Statistics South Africa, 2008a). This agreed with market research available to Statistics South Africa at the time (Statistics South Africa, 2008a) but Statistics South Africa subsequently used actual rentals for equivalent dwellings in calculating the Consumer Price Index (Statistics South Africa, 2008b).

Diary data were imputed if the household failed to submit one or two diaries (Statistics South Africa, 2008a). The averages of the submitted diaries were used to estimate the monthly data

(Statistics South Africa, 2008a). Missing individual income, imputed rental for home owners and rent data for non-home owners were imputed using data from households with similar characteristics (Statistics South Africa, 2008a).

Different sampling methodologies were used for the IES in 1995, 2000 and 2005/2006 (Statistics South Africa, 2002; 2008a) and hence the same households would only have been resampled by chance. In addition, Statistics South Africa scrambled some of the digits in the unique household identifiers before releasing data sets to the public (Shabalala, 2010).

4.2.2 Data quality concerns

4.2.2.1 Imputed rental and interest on mortgage loans

One reason given by Statistics South Africa for the move from interest on mortgage bonds to imputed rental as a measure of housing consumption services was the poor quality of the interest data received (Statistics South Africa, 2008a; Statistics South Africa, 2008b).

4.2.2.2 Expenditure

Aliber (2009) noted that food expenditure in IES 2005/2006 for the poorest decile was low in comparison to other surveys and information gathered regarding own production of food was not credible. Streak, Yu & Van der Berg (2009) stated that food expenditure was known to be understated in IES 2005/2006. Medical scheme membership implied in IES 2005/2006 was approximately half of that reported by the Council for Medical Schemes (2006; 2007) (Statistics South Africa, 2010a; 2010b).

4.2.2.3 Tax

Statistics South Africa (2008d) found the personal income tax reported in the IES 2005/2006 to be low relative to that reported by the South African Revenue Service (SARS).

4.2.2.4 Income

Similarly, Statistics South Africa (2008d) demonstrated that the total weighted income reported in IES 2005/2006 was about 28% lower than in the National Accounts.

In addition, Statistics South Africa averaged the incomes of the ten highest earning households to protect confidentiality (Statistics South Africa, 2008c). This resulted in certain anomalies such as negative income in kind.

4.2.2.5 Number of rooms

Dwelling size was poorly captured in the IES 2005/2006, with an analysis of the data revealing that a weighted average of 17.0% of households recorded a total room size of zero.

4.2.2.6 Debt

No distinction was made in the IES 2005/2006 between missing observations and observations with a value of zero. In addition, the IES 2005/2006 did not capture changes in debt levels over the survey period accurately due to respondents not distinguishing between the level of and changes in debt (Shabalala, 2010).

4.2.2.7 Age

The actual ages of the members of the household were not recorded. Instead the data contained an indicator as to the appropriate five-year age band.

4.2.3 Implications of the IES 2005/2006 limitations

Due to differences in sampling methodologies, deriving longitudinal data from the three IESs was impossible.

Both income and expenditure data in IES 2005/2006 may have been understated. Part of the expenditure under-reporting related to self-produced food or very low income households and excluding farming households, as discussed in Section 2.5.7.1, was expected to alleviate part of this under-reporting. Given the poor debt data, expenditure was considered more reliable than income for the purposes of modelling consumption.

Due to the tax under-reporting, tax needed to be calculated for each household from the reported income and relevant tax tables. Ages had to be approximated from the five-year age band information.

4.3 IES 2005/2006 data files

The SPSS data were supplied by the South African Data Archive and were imported into Microsoft Access.

The data were arranged in 6 tables:

- House_info: data about the dwelling and the number of occupants;
- Person_Income: data about income earned at a person level;
- Person_Info: demographic information;
- Purchase_Place: data on where the household bought goods;
- Supported_Persons: data on people outside the household supported by the household; and
- IES: income and expenditure data.

The following supporting documents were received with the data files:

- The explanatory table of the Classification of Individual Consumption by Purpose (COICOP) codes; and
- The Metadata report (v2) which contained the coding guide.

4.4 Initial data checks

Data from the Person_Info and House_info tables were drawn and checked before being cross-checked against data from the IES table for inconsistencies and errors.

4.4.1 Elimination of households not relevant to the study

The research considered only one- and two-adult households. There were 7 204 one- or two-person households in IES 2005/2006. To improve accuracy, households deriving income from self-employment or farming activities were excluded (Robb & Burbidge, 1989; Aliber, 2009). In order to control for work-status, households containing unemployed people who were not old enough to be retired were removed from the sample in line with Banks, Blundell & Tanner (1998). Households with persons aged 20 or under were removed from the sample to eliminate children. The youngest people in the sample were thus aged between 20 and 25. This was

significantly younger than the samples used by Burns & Widdows (1990), Palmer (1989; 1992; 1994; 2008) and Yuh, Hanna & Montalto (1998) but only slightly younger than the sample used by Robb & Burbidge (1989).

4.4.2 Data checks from Person_Info and House_info tables

After the non-relevant records were omitted, the sample of 3 617 households was checked for errors and inconsistencies.

Firstly, 17 household records were removed because the age of at least one person in the household was not known. Then two household records were removed due to the implied income in kind being negative. A possible reason for these negative values was set out in Section 4.2.2.4.

Certain records were removed due to inconsistencies in the data. There was one household where the person numbers did not correspond with the household size. A further 33 household records were removed because it was unclear whether the dwelling was rented or owned. Twelve household records were removed due to the highest education level of at least one person not being specified.

Thus, after performing data checks using Person_Info and House_info tables, there were 3 552 useable household records corresponding to 4 500 person records.

4.4.3 Cross-checks and corrections using IES table data

The income and expenditure data from the IES table were then considered and it was found that 117 households indicated that they were renting property but did not record a rental amount. Of these, 20 households were lodgers living in only part of a dwelling. Rent could not be imputed and hence these 20 observations were removed from the sample. For the remaining 97 records, rent was estimated at 7.0% of the value of the dwelling and used to adjust consumption upwards. This was consistent with the approach used by Statistics South Africa to estimate imputed rental for home owners in IES 2005/2006 (Statistics South Africa, 2008a).

A further 142 households received income from hobbies or self-employment and hence needed to be excluded for data integrity reasons.

40 households indicated that they not only had a mortgage but paid rent which would have been possible if the household had more than one home. This combination of responses was problematic for two reasons. Firstly, it could have indicated a data error. Secondly, the value of the imputed rental required to calculate the retirement income need would have been difficult to ascertain. Hence, these households were removed from the sample.

In order to screen for income under-reporting, savings and expenditure rates were calculated as a percentage of income (including income in kind) p.p.p.a. The sum of non-retirement savings, retirement savings, non-healthcare expenditure and healthcare expenditure should have summed to less than 100% in order to allow for taxation. However, a large number of households were observed where this was well over 100%, even though non-healthcare expenditure was adjusted to reflect housing consumption instead of expenditure. Values in excess of 100% could be attained if elements were recorded incorrectly, if housing consumption exceeded expenditure as would have been the case where housing debt had been paid off or if the household were financing consumption with debt. Alternatively, this could have been as a result of income under-reporting. It was decided to exclude 629 households where the sum of non-retirement savings, healthcare expenditure and non-healthcare consumption exceeded 150% as these were likely to reflect combinations of income under-reporting and consumption and saving over-reporting.

As a final check, the recorded total consumption variable for each household was compared to the sum of the COICOP codes classified as consumption or consumption in kind. Allowing for rounding errors, the consumption variable for each household corresponded to that derived from the individual COICOP codes.

4.4.4 Summary

Hence, a number of data checks were performed to ensure that only household records that were reasonably free from error and that were appropriate for the purposes of exploring changes in

consumption were used. Although a larger sample may have appeared more statistically credible, any results derived from using data with errors or data that the literature indicated should be removed would not have been more reliable than estimates derived from using an appropriate but small sample.

4.5 Model development sample and target estimation sample

The household records remaining after performing the data checks and refinements described in Section 4.4 were termed the 'model development sample'. The size and use of the model development sample and how it was refined to create the target estimation sample, used to estimate the targets, is discussed below.

4.5.1 Size of the model development sample

There were 2 721 household records in the model development sample corresponding to 3 521 person records. In 2 094 households, no one in the household was retired. These were termed 'working households'. A further 93 household records related to households where one person worked and one was retired. These were termed 'semi-retired' households. The remaining 534 households were 'retired' households, where everyone was retired.

4.5.2 Use of the model development sample

The full model development sample was used to test for changes in consumption at and during retirement. The semi-retired and retired households in the model development sample were also used to assess the reasonability of the mortgage imputations but were not used for any other purpose.

The working households in the model development sample were then used to assess which households were incentivised to save by performing an initial run of the target estimation model where hypothetical household savings rates were used instead of the actual savings rates. These results were used to refine the sample for the estimation of targets using actual savings rates.

4.5.3 Deriving the target estimation sample from the model development sample

The departure point for the target estimation sample was the working households in the model development sample.

Targets were required only for households that were incentivised to save in that they would be better off making provision for retirement than relying on the SOAG according to the initial model run. The results of a preliminary investigation into incentivised households are presented in Chapter 8 but, in brief, households earning R24 424.50 p.p.p.a. and above were assumed to be incentivised.

Large age gaps in two-person households were not found to alter the results of the investigation into changes in consumption due to age and work-status significantly. However, households with large age gaps were found to have anomalous target estimates in initial model runs. Statistics South Africa (2010c) indicated that a four year age difference was expected between marriage and civil union partners. This was confirmed by Budlender, Chobokoane & Simelane (2004). However, when considering remarriages of widows and widowers, this age difference could be as high as 16 years (Statistics South Africa, 2010c). There was no official data on age gaps for cohabiting couples but Budlender, Chobokoane & Simelane (2004) suggested that between 81.6% and 89.7% of couples living together were, in fact, married and not cohabiting. Households where the calculated age gap was larger than 20 years were excluded, which may have excluded a few genuine partnership arrangements but also removed single parents living with working children from the target estimation sample.

It was decided to exclude another 24 households that had excessively high retirement adequacy targets on the initial model run. The targets for households were calculated at the maximum retirement age of 70 and a hypothetical retirement savings rate of 12.5% and allowed for the income required in retirement to be reduced by the salary earned by the younger spouse in the semi-retirement phase. Households with targets of over 22.0 times annual salary were excluded as these households represented outliers which may have otherwise distorted the results.

After these adjustments, there were 1 036 households left in the sample. The distribution of savings rates for these 1 036 households was highly skewed with a large number of households not saving for retirement as shown in Table 4.1.

Table 4.1 Distribution of retirement savings rates as a percentage of income p.p.p.a.

Retirement savings rate	**Total**
0.0%	39.7%
(0.0%, 5.0%)	19.9%
[5.0%, 10.0%)	19.0%
[10.0%, 12.5%)	6.3%
[12.5%, 15.0%)	5.2%
[15.0%, 17.5%)	2.8%
[17.5%, 20.0%)	2.4%
20% or more	4.7%
Count	1 036

This research aimed to estimate retirement adequacy targets for households that should save for retirement and are making retirement provision. As the literature suggested that the targets may be influenced by savings rates, including households that do not save in the target estimation sample may have created misleading results. Hence, non-saving households were excluded. The 625 remaining households formed the target estimation sample of which 14 contained a household member over the age of 60 and could not be used for analysis for retirement age 60.

4.5.4 Use of the target estimation sample

The target estimation sample was used to estimate retirement adequacy targets and establish factors that affected them. Retirement adequacy targets were estimated using the actual savings rates. However, the targets were also estimated using hypothetical savings rates in order to test for the impact of retirement savings rates on adequacy targets.

4.5.5 Sample reconciliation

The reconciliation of the IES 2005/2006 to the sample is given in Table 4.2.

Table 4.2 Reconciliation of the data samples

	Household records	**Person records**
IES 2005/2006	21 145	84 978
Households of three or more	13 941	74 288
Self-employed and commercial farmers	871	1 418
Subsistence farmers	16	24
Unemployed	2 663	4 605
Households with children	37	54
Sample after removing non-relevant records	3 617	4 589
Age unspecified	17	23
Income mis-specified	2	3
Household size contradiction	1	2
Home ownership status unclear	33	44
Highest education unknown	12	17
Sample after data checks before cross-checks	3 552	4 500
Lodgers removed due to missing rent data	20	26
Self-employed and commercial farmers	142	185
Mortgage inconsistencies	40	55
Probable income under-reporting	629	713
Model development sample	2 721	3 521
Retired and semi-retired households	627	880
Households earning less than R24 450.50 p.p.p.a	1 013	1 300
Age gaps of 25 years or more	21	42
Extremely large retirement adequacy targets	24	28
Non-savers	411	498
Target estimation sample	625	773

4.6 Variables

As discussed in Sections 2.6.2 and 2.8, the literature provides justification for using the following demographic variables in modelling changes in consumption at and in retirement and retirement adequacy targets:

- Sex (Mitchell & Moore, 1998; Cooper, 2002)

- Household composition (Mitchell & Moore, 1998; Hatcher, 1997; Yuh, Hanna & Montalto, 1998; Stoller & Stoller, 2003; Palmer, 1989; 1992; 1994; 2008)
- Income (Hatcher, 1997; Yuh, Hanna & Montalto, 1998; Palmer, 1989; 1992; 1994; 2008)
- Home ownership status (Yuh, Hanna & Montalto, 1998)
- Education of head of house and partner, where applicable (Hatcher, 1997; Yuh, 1998)
- Geographic region (Yuh, 1998)
- Dwelling value (Schieber, 1996)

Although debt (Yuh, Hanna & Montalto, 1998), health-status (Stoller & Stoller, 2003) and the number of rooms in the dwelling (Chia & Tsui, 2003) were used in the literature, data limitations meant these factors could not be used in this research. As discussed in Section 2.7, the retirement age and retirement savings rate were expected to influence the retirement adequacy targets. As the retirement age for working households was not known, hypothetical retirement ages were used. Both the actual retirement savings rates and four levels of hypothetical retirement savings rates were used. The levels of the hypothetical savings rates are discussed further in Section 5.4.

The continuous and categorical variables used are given in Tables 4.3 and 4.4 respectively. The age variables were calculated from the 'current age', defined as the midpoint of the five-year age band recorded in the IES 2005/2006 data rounded down to the nearest whole number.

Table 4.3 Continuous variables

Variable name	Description
AGE1	The age of the head of the household
AGE2	The age of the partner in two-person households, coded as the head's age in one- person households
AGEGAP	Age gap in a two-person household
AGEOLD	Age of the oldest person in the household
AGEYOUNG	Age of the youngest person in the household
AVGAGE	Arithmetic average of ages for two-person households and household head's age for one-person households
HEXPR	Healthcare expenditure rate
INCPER1	Percentage income earned by the household head
INCPOLD	Percentage income earned by the oldest person in the household
JOINTAGE	Geometric average of ages for two-person households and household head's age for one-person households
NHCONSR	Non-healthcare consumption rate
PPINCOME	Cash income p.p.p.a.
PPINKINDINC	Income (including income in kind) p.p.p.a.
RSR	Actual retirement savings rate
RSR_k	Hypothetical retirement savings rate of *k*%
VDWELL	Value of the dwelling
YRSED1	Years of education of the head of the household

Table 4.4 Categorical variables

Variable name	Description	Value	Coding
EDUC1	Highest educational attainment of the household head	NOSCHOOL	No schooling
		PRIM	Pre-primary or primary
		SOMESEC	Some secondary
		SEC	Completed secondary
		HIGHER	Any further education
FEMALE1	Sex of household head	1	Female head
		0	Male head
HCOMP	Household composition	Male-female	Male head-female partner
		Female-male	Female head-male partner
		Male-male	Two males
		Female-female	Two females
		Single female	Female alone
		Single male	Male alone
HEDUC	Household educational attainments	EDUC1_LESS	Partner has less education than EDUC1
		EDUC1_SAME	Both have EDUC1
		EDUC1_MORE	Partner has more education than EDUC1
		EDUC1_0	One-person household
HOWNER	Home ownership	1	Home owned
		0	Home rented
HSIZE2	Household size	1	Two-person
		0	One-person
MEDSCMR	Medical scheme membership	1	At least one person in the household is a medical scheme member
		0	No medical scheme members in household
MORT	Mortgage holding	1	Home mortgaged
		0	Home owned outright
RURAL	Type of settlement	1	Rural
		0	Urban
WORKSTAT	Work-status	W	Working
		SR	Semi-retired
		R	Retired

4.7 Corrections, adjustments and imputations

4.7.1 Missing rent data

Missing rents were assumed to be 7.0% of the dwelling value.

4.7.2 Non-retirement savings

Consumption data from the IES 2005/2006 data reflected imputed rental for home owners. However, the non-retirement savings data included the full mortgage repayment. According to Mitchell & Moore (1998) the mortgage repayment component needed to be reduced to reflect only the amount in excess of the imputed rental and hence the data were adjusted accordingly.

4.7.3 Smoothing of estimated vehicle consumption

4.7.3.1 Vehicle expenditure

Robb & Burbidge (1989) suggested smoothing cashflows relating to vehicle purchases. In the context of IES 2005/2006, where vehicle purchases over the year prior to the interview were recorded, not smoothing would have created artificially high consumption rates for households that purchased vehicles in the previous year and artificially low consumption for households that owned vehicles but purchased the vehicle more than one year prior to their interview month.

There were 442 households in the model development sample that were assumed to be vehicle owners due to reflecting one or more of the following: identifying themselves as owning a motor vehicle, having debt on a vehicle or purchasing a vehicle in the previous year. Of these households, 131 had bought new or used motor vehicles in the survey period, of which 21 had vehicle debt exceeding the value of their current vehicle. This difference was assumed to relate to a prior purchase. Vehicle debt information was available for a further 86 households that did not buy vehicles in the last year. Hence information was available for 217 households of the 442 that owned vehicles.

The seventh schedule to the Income Tax Act (Act 58 of 1962) (‘the Act’) set the value of private usage of a motor vehicle at 2.5% of the value of the vehicle for each month. This was equivalent to an annual amount of 30.0% of the value of the vehicle.

4.7.3.2 Adjustment approach

The value of private vehicle consumption was set at 15.0% for the value of vehicles purchased in the year prior to the survey month. This assumed the vehicle was purchased on average six months previously and that there was no vehicle consumption prior to this point. For vehicles where there was debt outstanding, vehicle consumption was taken to be 30.0% of the value outstanding. This would over-estimate consumption for loans in their early durations but under-estimate consumption for vehicles near the end of their repayment period as the capital repayment rate would exceed the depreciation rate. For vehicles where no loan amount was outstanding, no addition for transport consumption could be made. In total, 129 downward adjustments and 88 upward adjustments were required.

4.7.4 Income share

4.7.4.1 Incomplete data at person level

In order to model the change in income patterns in two-person households where the household members do not retire at the same time, it was necessary to model income for working households at a person level.

The IES 2005/2006 captured income at a person level in the Person_Income table. This data should, in theory, have allowed the apportionment of household income between household members, where relevant. The person-level recorded income was not inflation-adjusted to March 2006 rand terms as the household income was. However, for the purposes of calculating the income split, the ratio of income earned by the head of the household to the partner's earnings was assumed constant over the sample period. However, the person-level income data showed significant item non-response where one or both people living in a household failed to record their incomes even though the household recorded an income. Of the 547 two-person working households, 42 (7.7%) required imputation of the percentage of the household income earned by the head of the household. The imputation approach was discussed in Section 3.6.1.

4.7.4.2 Imputation results

The CHAID analysis indicated that the household composition was by far the most significant determinant of the income split. For households where partners were not of the same sex, the cash income per person also played a significant role. For lower-income male-female households based in rural areas, there are differences in the earning patterns relative to an equivalent urban household. The CHAID dendrogram is given in Figure 4.1.

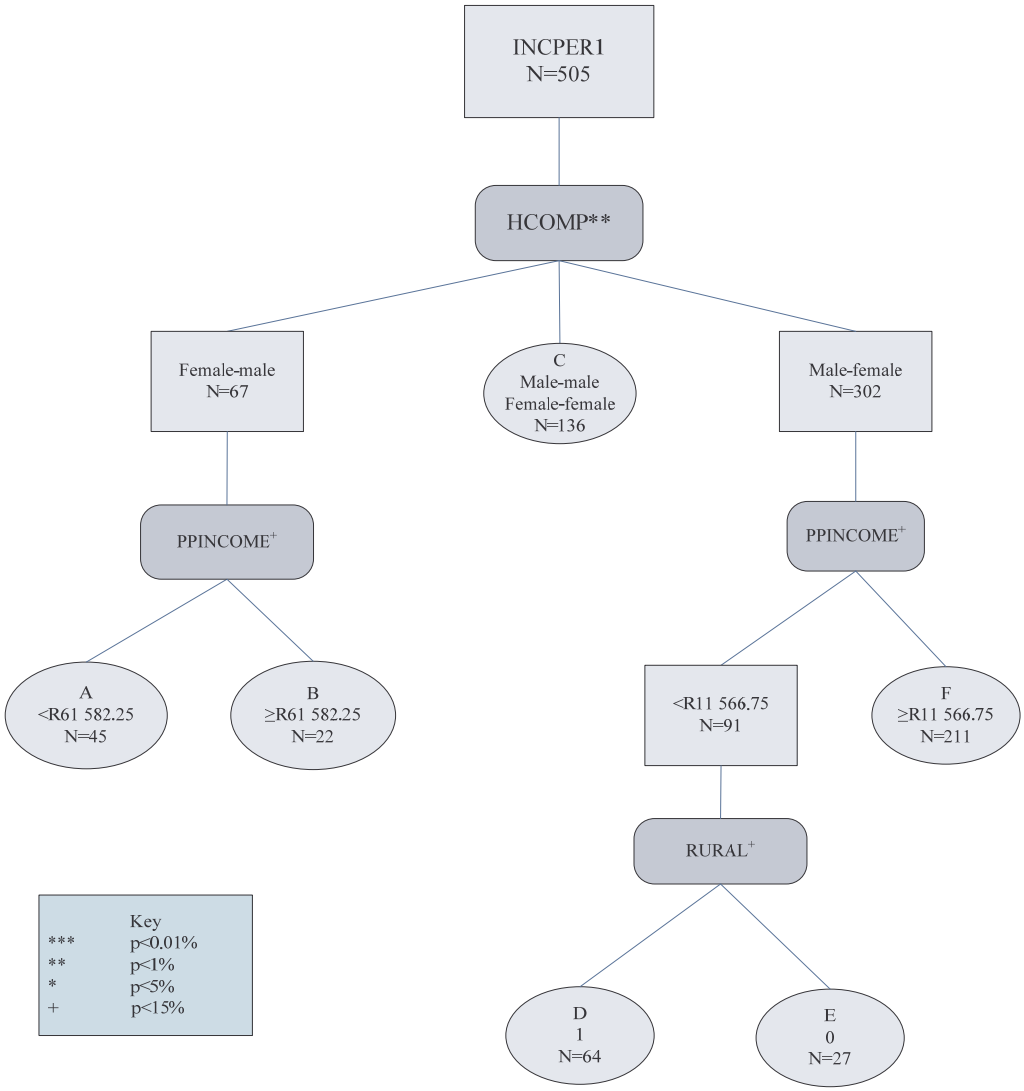


Figure 4.1 Dendrogram of income share to the head of household

The income split for each leaf is given in Table 4.5.

Table 4.5 Percentage of household income earned by the head of the household

Leaf	Number households	Mean	Standard deviation
A	45	46.0%	17.5%
B	22	58.5%	16.0%
C	136	56.3%	17.0%
D	64	59.7%	12.2%
E	27	53.4%	17.5%
F	211	62.9%	15.6%

4.7.5 Mortgage data

4.7.5.1 Poor mortgage data

The IES 2005/2006 data was known to have poor data regarding mortgages (Statistics South Africa, 2008a). The data contained 127 working households with mortgages for which the estimated mortgage at retirement needed to be estimated to ascertain how much of the retirement lump sum would be needed to settle this debt. This calculation is described in Section 5.6.1.

Of the 127 households with mortgage records, 52 households with mortgages required data to be imputed as:

- Instalment information was missing in 42 cases;
- Five households reflected monthly instalments but had no balance outstanding recorded;
- Four households recorded inconsistent balances outstanding relative to the instalments and value of the dwellings; and
- One household had an implausibly high instalment-to-income ratio.

4.7.5.2 Imputation approach

The ratio of households with plausible data to implausible or missing data was relatively low, which invalidated CHAID techniques. Hence, imputation was done by inspection and by consideration of the financial mathematics behind mortgage loans.

Eleven cases were corrected by inspection. For the cases where figures seemed inconsistent, in four of the five cases where imputation was required it was assumed that there was a decimal point missing or a zero omitted. As the maximum mortgage term is typically 30 years, where the

mortgage holder was 27 years or younger, it was assumed that the mortgage outstanding at retirement was zero. This resolved one case where the balance outstanding was missing, one case with inconsistent instalment, balance and dwelling value figures and five cases where the instalment information was missing.

For the remaining 41 cases, the omissions could be estimated by considering the mathematics of the mortgage and using this to assess which households may have similar mortgage instalments or balances outstanding. The imputed value could then be found by using average values from the most similar households. The most basic mortgage equation is given by equation (4.1).

$$B_0 = M \times a_{\overline{12N}|i^{(12)}} \qquad (4.1)$$

Where:

B_0 is the initial amount borrowed;

M is the monthly instalment;

N is the initial loan term;

$i^{(12)}$ is the monthly interest rate; and

$a_{\overline{N}|i}$ is an annuity payable in arrears for n periods at interest rate i as per International Actuarial Notation (IAN) (Institute of Actuaries, 1949).

Hence, loan instalments are directly proportional to the amount borrowed, all other things being equal. Higher lending rates would increase the instalment amount exponentially.

The IES 2005/2006 data could not be used to estimate the interest on mortgages due to poor reporting. The predominant interest rates on new mortgages during the survey period and the thirty years immediately prior to the survey period ranged between prime less 5.0% and prime plus 2.8% (South African Reserve Bank, 2010c). The modal interest rate was prime (South African Reserve Bank, 2010c). It was decided to assume that all mortgages attracted the prime interest rate. It was acknowledged that at any given time households identified as good financial risks for the lending institution may have received more favourable rates and poor financial risks may have been given less favourable rates.

The balance outstanding at any point would be positively correlated with the value borrowed and the interest rate, and negatively correlated with the number of years since the loan was issued and the instalment. The best proxy for the amount borrowed in the data was assumed to be the recorded dwelling value.

In order to calculate missing balances outstanding, the data were separated by age of the mortgage holder. If mortgage holders were of similar ages when the mortgage was taken out, older mortgage holders should have repaid more of their loans than younger mortgage holders, all other things being equal. The data were then sorted by instalment and dwelling value to find like households. The average value of the balance outstanding to the dwelling value was calculated for groups of like households where the data quality was good and this was used to impute values for similar households where necessary.

4.7.5.3 Imputation results and reasonability checks

Once the values were imputed, projected mortgages at retirement for the full working population in the model development sample were compared with mortgage balances held by retired and semi-retired households in the model development sample.

The percentage of mortgage holders at retirement for households that did and did not require imputation is given in Table 4.6.

Table 4.6 Percentage of current mortgage holders expected to be mortgaged at retirement

	Projected retirement age				
	60	**63**	**65**	**67**	**70**
Non-imputed	14.7%	12.0%	10.7%	8.0%	4.0%
Imputed	17.3%	13.5%	9.6%	5.8%	1.9%

An analysis of retired and semi-retired households in the model development sample indicated that only 1.2% of homeowner households still had a mortgage. Given the sharp increase in household debt after 1994 and the consequent decline in savings described in Aron & Muellbauer (2000), these projections did not appear unreasonable.

The average mortgage debt to dwelling value ratios for households with debt that did and did not require imputation were not very different except for the projections at age 60 as shown in Table 4.7.

Table 4.7 Projected real mortgage debt as a percentage of dwelling value

	Projected retirement age				
	60	**63**	**65**	**67**	**70**
Non-imputed	26.5%	36.7%	29.0%	22.3%	18.2%
Imputed	36.8%	35.6%	28.3%	25.8%	16.2%

For both the imputed and non-imputed households, where the mortgage holder was under 40, all debts were calculated to be repaid by the projected retirement age.

96.2% of working households were projected to have repaid their housing debt by age 57 while only 86.4% of retired and semi-retired households were found to have done so. 97.6% of retired and semi-retired households were found to be mortgage-free by age 62 while the projections suggested 97.9% of currently working households would be. For a retirement age of 67, 100.0% of retired households were found to be mortgage-free while 98.8% of currently working households were projected to be mortgage-free by retirement age. Thus, for older ages, the projections fitted actual experience for retired households but might have under-estimated the mortgage at younger retirement ages due to, *inter alia,* the assumption that mortgage holders paid their monthly instalments timeously and no further mortgage debt was incurred.

4.8 Descriptions of model development and target estimation samples

This section provides a basic description of the characteristics of the model development and target estimation samples after completing the correction and imputation process described in Section 4.7. These descriptions were important in the context of this research for two reasons. Firstly, they indicated that the characteristics of the samples are reasonable and corresponded to other publicly available statistics. Secondly, these characteristics should be considered before

applying the results to a population as a significant difference in demographic profile may limit the applicability of the targets.

4.8.1 Work-status for the model development sample

The majority (77.0%) of households in the model development sample were working. A further 19.6% were retired with the remaining 3.4% of households being semi-retired. This corresponded to a count of 2 094, 534 and 93 households respectively.

4.8.2 Household composition and gender

Apart from semi-retired households, which were two-person households by definition, most households contained just one person. In the model development sample and target estimation sample, 70.6% and 76.3% of households respectively were one-person households. The ratio of people living in two-person households relative to one-person households was much lower than suggested by the weighted IES 2005/2006 data, which suggested that 64.3% of households are two-person households. This was unsurprising given that households where one person was unemployed and households consisting of a single parent and their only child were excluded.

It was noted that the retired and semi-retired households in the model development sample had a larger proportion of females to working households: 62.1% and 53.8% respectively relative to 34.5% for working households. Only 33.2% of people in the target estimation sample were female. The 2006 mid-year estimates for people aged 20 and older (Statistics South Africa, 2006b) suggested that women should comprise 51.6% of the total headcount. Instead, only 41.0% of the model development sample was female. This may have been a due to individuals in the working population being employed by definition. In 2006, only 49.6% of women were part of the labour force relative to 62.9% of the male population (Statistics South Africa, 2006c). Of the female labour force participants, only 69.7% were employed relative to the male employment rate of 78.4% (Statistics South Africa, 2006c). Hence this result was fully consistent with national statistics.

Approximately one-quarter of working households in the samples were female-headed, however this increased to 59.1% and 52.6% for semi-retired and retired households respectively. The full weighted IES 2005/2006 data suggested that 38.9% of households nationally were female-headed.

The household compositions for the samples are given in Figure 4.2.

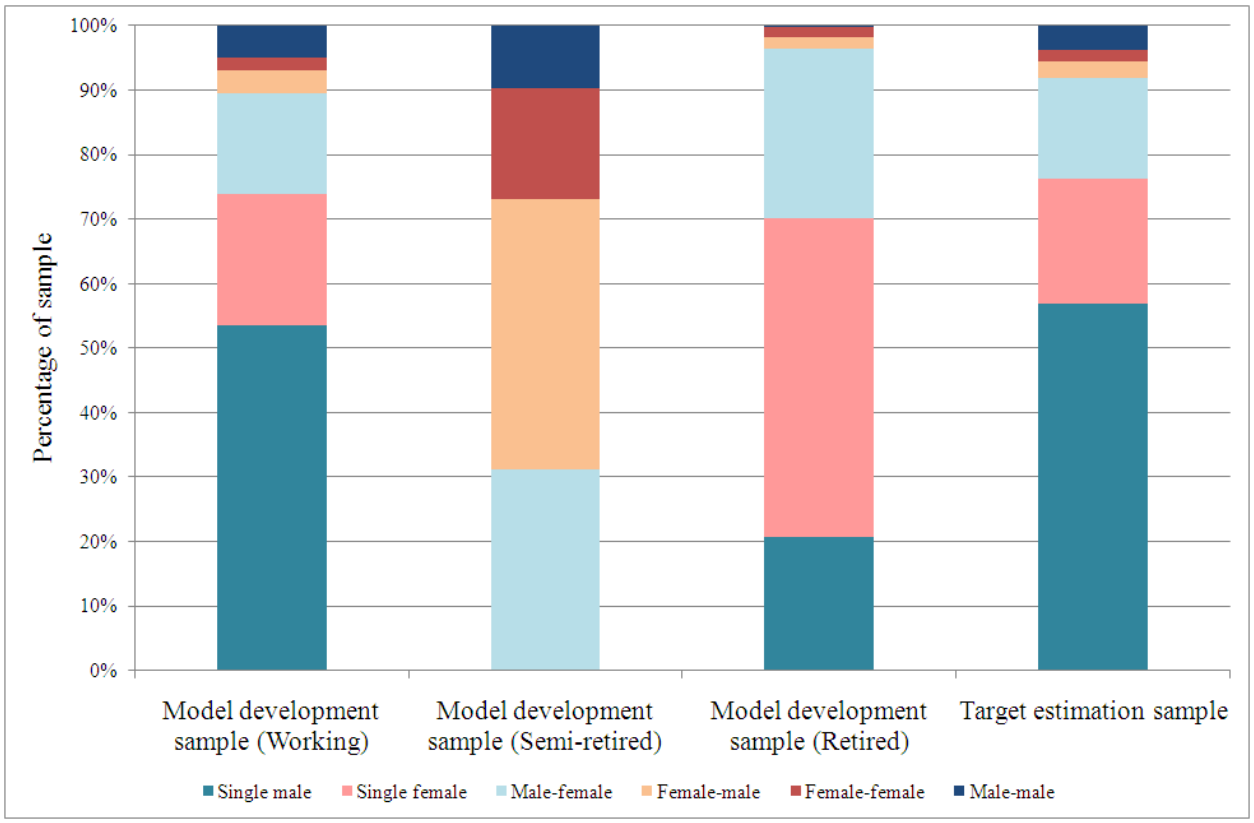


Figure 4.2 Household compositions by sample

4.8.3 Age

If age were considered per person, as opposed to per household, the average age in the model development sample was 37.8 which was lower than the national average for persons aged 20 and above of 39.8 (Statistics South Africa, 2006b).

An analysis of the different household age statistics suggested that the retired households were considerably older than the working and semi-retired households. The target estimation sample

was found to be young relative to the age limits imposed in Palmer (1989; 1992; 1994; 2008) and Diamond & Hausman (1984).

The observed age gap for semi-retired households was fairly large. While, by definition, semi-retired households must have an age gap while other household types do not, the very large observed age gap suggested that at least some households in the semi-retired sample may involve parents living with adult children. The age analysis is given in Table 4.8.

Table 4.8 Mean age statistics

	Model development sample				**Target estimation sample**
	Working	**Semi-retired**	**Retired**	**Total**	
AVGAGE	38.1	55.4	70.7	45.1	39.6
JOINTAGE	38.0	53.0	70.7	44.9	39.5
AGEYOUNG	37.3	42.9	69.9	43.9	39.0
AGEGAP	6.8	27.3	5.9	9.0	4.8

4.8.4 Geographic region

Most households in both the model development and target estimation samples were urban with 38.3% and 24.6% of households respectively being based in rural areas.

4.8.5 Education

Heads of households in the model development sample had, on average, 9.0 years of education. However, the retired households in this group had only 6.4 years of education on average. Households in the target estimation sample had 11.8 years of education on average. The retired and semi-retired households of the model development sample were less educated than for the general population according to the full weighted IES 2005/2006 data. However, the target estimation sample tended to be better educated than average. The distribution of the highest educational attainments by household heads is given in Figure 4.3.

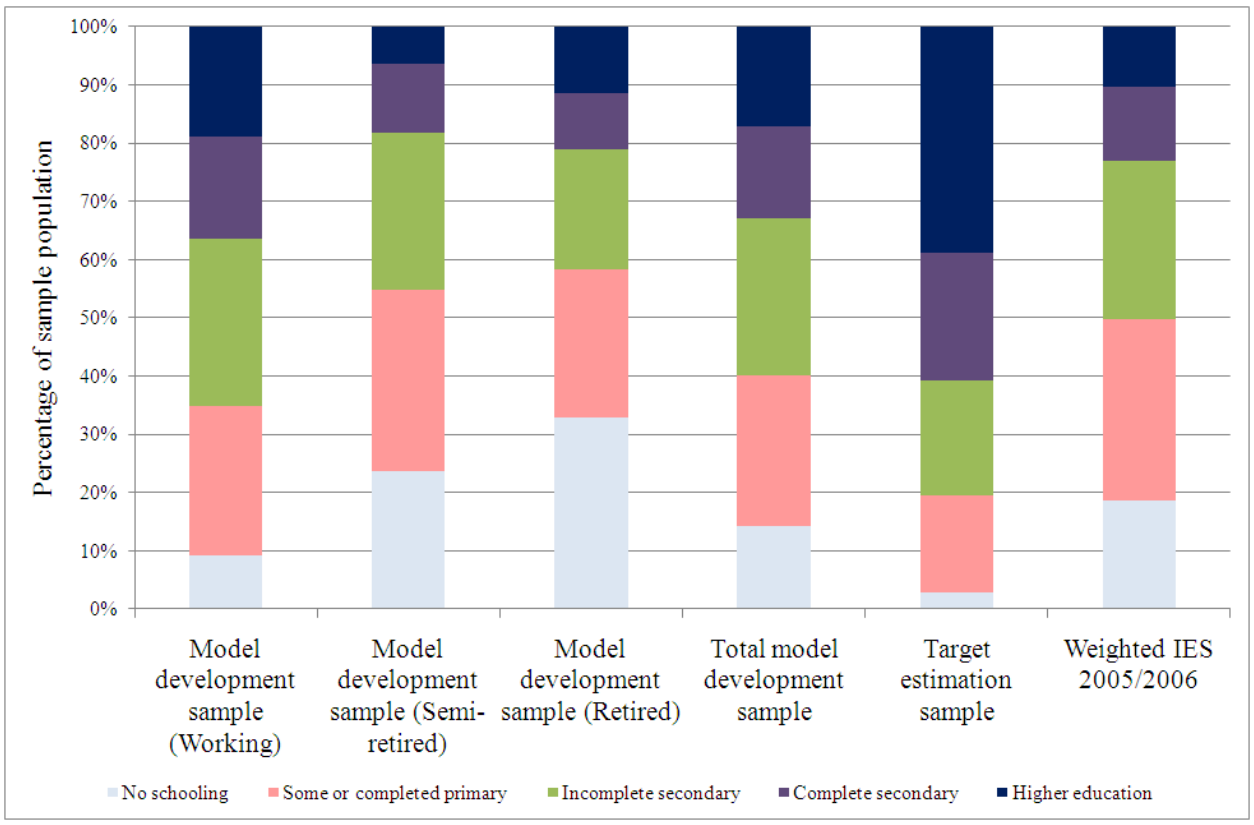


Figure 4.3 Head of households' highest educational attainments

4.8.6 Income and dwelling values

As expected given the differences in educational attainments, retired and semi-retired households had much lower incomes than working households in the model development sample. The average income of households in the model development sample was slightly under R45 000 p.p.p.a. The target estimation sample had considerably higher average incomes and income (including income in kind) than the model development sample due to being comprised entirely of working households earning more than R24 424.50 p.p.p.a. An analysis of average incomes is given in Table 4.9.

Table 4.9 Average income and income (including income in kind) for the samples

	Model development sample				Target estimation sample
	Working	**Semi-retired**	**Retired**	**Total**	
Income p.p.p.a.	R 48 845.55	R 35 506.20	R 31 499.09	R 44 985.36	R 93 748.47
Income (including income in kind) p.p.p.a.	R 51 704.19	R 37 382.31	R 32 306.03	R 47 407.78	R 100 337.94

In two-person households, the household head tended to be the older person. In the average two-person household in the model development sample, the oldest person earned 59.1% of the household income with the household head earning 61.7%.

As was consistent with Palmer (1989), dwelling values were substantially higher for retired and semi-retired households despite having much lower incomes than working households. Dwelling values for semi-retired households and retired households were approximately 112.1% and 58.3% higher than for working households in the model development sample.

4.8.7 Consumption and expenditure

Total expenditure rates in the model development sample were remarkably similar across work-statuses despite the differing income profiles. As expected, the wealthier target estimation sample consumed less of their income (including income in kind) than the model development sample. Working households were more generous than semi-retired and retired households with gifts. The consumption and expenditure patterns are summarised in Table 4.10.

Table 4.10 Consumption and expenditure rates by sample

	Model development sample				Target estimation sample
	Working	**Semi-retired**	**Retired**	**Total**	
Healthcare expenditure rate	2.8%	3.4%	3.4%	2.9%	5.6%
Non-healthcare consumption rate	75.0%	63.9%	75.6%	74.8%	63.7%
Total expenditure rate adjusted for housing and vehicle consumption	77.8%	67.3%	79.0%	77.7%	69.2%
Gifting rate	13.2%	2.0%	2.5%	10.7%	13.8%

The higher healthcare expenditure in the target estimation sample may be due to the higher medical scheme membership rates in the target estimation sample where 51.6% of households have at least one medical scheme member relative to 20.5% in the model development sample.

4.8.8 Savings rates, home ownership and mortgages

Savings rates as a percentage of income (including income in kind) p.p.p.a., given in Table 4.11, were substantially above zero, even for retired households, which indicated a measure of precautionary savings.

Table 4.11 Savings rates as a percentage of income (including income in kind) p.p.p.a.

	Model development sample				Target estimation sample
	Working	**Semi-retired**	**Retired**	**Total**	
Non-retirement savings rate	5.5%	4.4%	3.2%	5.0%	10.4%
Retirement savings rate	2.8%	1.7%	0.3%	2.3%	7.7%

However, a considerable proportion of households in the target estimation sample directed less than 10% of their income p.p.p.a, which excluded income in kind, to retirement savings. This is illustrated in Table 4.12.

Table 4.12 Distribution of target estimation sample retirement savings rates

Retirement savings rate	**Single female**	**Single male**	**Male-female**	**Female-male**	**Male-male**	**Female-female**	**Total**
(0.0%, 5.0%)	26.3%	31.6%	40.2%	50.0%	37.6%	54.6%	33.0%
[5.0%, 10.0%)	38.5%	27.9%	38.2%	12.4%	41.7%	18.2%	31.5%
[10.0%, 12.5%)	9.0%	12.0%	4.1%	25.0%	8.4%	9.1%	10.5%
[12.5%, 15.0%)	8.2%	9.4%	7.2%	6.3%	4.1%	18.1%	8.6%
[15.0%, 17.5%)	4.1%	5.9%	2.1%	0.0%	4.1%	0.0%	4.6%
[17.5%, 20.0%)	2.4%	4.5%	4.1%	6.3%	4.1%	0.0%	4.0%
20% or more	11.5%	8.7%	4.1%	0.0%	0.0%	0.0%	7.8%
Count	122	355	97	16	24	11	625

About 18.4% of households in the target estimation sample owned their homes outright with a further 14.4% having mortgages. The proportion of renters in the target estimation sample was

relatively high given that a similar percentage of home owners were found in the model development sample.

4.9 Other sources of data

Data were also used to convert items to real values, to assess population structures, to check the IES 2005/2006 data and to assess scenarios on which to run the model. These data items are listed in Table 4.13. Data were also used in the parameterisation of the target estimation model. A list of these data items is presented in Table 4.14.

Table 4.13 General data

Use	Specific item	Name of data series or item	Reference
Historic inflation	South African inflation	Consumer Price Index - Headline: P0141.1	Statistics South Africa (2006a)
		Consumer Price Index History Table A: P0141.	Statistics South Africa (2010a; 2010b)
	US inflation	Consumer Price Index History Table	United States Department of Labor (2010)
Hypothetical retirement savings rate validation	Hypothetical retirement savings rates	Member Watch™ Survey 2010: Contributions	Alexander Forbes (2010a)
Population estimates	Current population	Mid-Year Population Estimates: Statistical Release P0302	Statistics South Africa (2009)
	Current and future population	ASSA AIDS and Demographic Model	Actuarial Society of South Africa (2005)
IES 2005/2006 data validity assessment	Demographic comparisons	Census 2001	Statistics South Africa (2005)
		Mid-Year Population Estimates: Statistical Release P0302	Statistics South Africa (2006b)
	Medical scheme membership	Medical scheme membership	Council for Medical Schemes (2006)
			Council for Medical Schemes (2007)
Retirement age scenario validation	Retirement age	Actual age of work cessation	Human Sciences Research Council (2000)

Table 4.14 Data used in parameterising the model

Specific item	Name of data series or item	Reference
Expenses and profit loadings	Charges	Old Mutual (2010a)
Inflation	Index-linked gilt yield	Financial Services Board (2010)
	Long-term bond yields	OMIGSA (2010a; 2010b)
Investment returns	Historic with-profit annuity increases	Old Mutual (2010a)
Minimally adequate income	Levels of benefits and parameters for the means-test	Government Notice 591 (1994)
		Government Notice 919 (1997)
		Government Notice 882 (1998)
		Government Notice 814 (1999)
		Government Notice 570 (2001)
		Government Notice 1491 (2002)
		Government Notice 409 (2004)
		Government Notice 294 (2006)
		Government Notice 253 (2007)
		The 2008 Regulations
		Government Notice 1243 (2008)
		Government Notice 212 (2009)
		Government Notice 261 (2010)
Mortality	South African Annuitant Standard Mortality Tables 1996-2000	Dorrington & Tootla (2007)
	ASSA AIDS and Demographic Model	Actuarial Society of South Africa (2005)
Mortgage interest rate	Predominant Rate on New Mortgage Loans: Banks - Dwelling Units (Home Mortgage Rate):KBP2011M	South African Reserve Bank (2010c)
Salary Inflation	Best estimate salary inflation basis for valuations	Alexander Forbes (2010b)
	PEN scale	Faculty of Actuaries & Institute of Actuaries (2002)
	Labour Productivity in the Non-Agricultural Sectors: KPB7014L	South African Reserve Bank (2010a)
	Nominal Unit Labour Costs in the Non-Agricultural Sectors: KPB7015J	South African Reserve Bank (2010b)
Tax	Income tax tables	The Act
		Taxation Laws Amendment Act (Act 30 of 2002)
		Small Business Tax Amnesty and Amendment of Taxation Laws Act (Act 9 of 2006)
		Taxation Laws Amendment Act (Act 8 of 2007)
		Taxation Laws Amendment Act (Act 17 of 2009)

Government Notice 919 (1997), Government Notice 882 (1998), Government Notice 814 (1999), Government Notice 570 (2001), Government Notice 1491 (2002), Government Notice 409 (2004), Government Notice 294 (2006), Government Notice 253 (2007), Government Notice 1243 (2008), Government Notice 212 (2009) and Government Notice 261 (2010) were collectively referred to as 'the Increase Notices' and Government Notice 591 (1994) and the 2008 Regulations were collectively referred to as 'the SOAG Regulations' for the purposes of this research.

4.10 Summary

Although IES 2005/2006 was the largest and most recent official data set suitable for this research, data problems and the necessity of a strict sample definition meant the data samples used were relatively small. However, the samples were still large enough for meaningful analysis. Imputed values were found to be reasonable relative to other available data and households with imputed values were not detected as significantly different to other households in subsequent analysis.

A total of 16 continuous and 10 categorical variables were used. The large number of variables relative to the number of useable observations strengthened the case for using CHAID in conjunction with regression techniques.

There were considerable differences in the wealth, education and earnings profiles of retired and semi-retired households relative to working households, as well as differences in household composition. The target estimation sample had higher income and more education than the national average.

Data were also gathered from other official sources in order to parameterise the target estimation model.

5 THE TARGET ESTIMATION MODEL

5.1 Introduction

This chapter provides an overview of the TSE model that was developed in order to calculate the adequacy targets at a household level and some of the model design considerations. All items in the TSE model were calculated in terms of March 2006 rands. The way that the target was expressed is discussed in Section 5.2. Section 5.3 gives an overview of the model, which can be divided into eight steps. These steps and the main considerations around their design are given in Sections 5.4 to 5.11. The parameterisation of the model is discussed in Chapter 7.

5.2 Target expression

A discussion of the various forms the adequacy measure could take was given in Section 2.3.

Although McGill *et al* (1996) alluded to the fact that the salary used in the replacement ratio may not reflect all earnings, the literature did not stress the fact that replacement ratios can be expressed as retirement income as a percentage of pensionable salary, which could be much smaller than total salary. In South Africa, pensionable salary is not a legal term although it can be considered equivalent to income from retirement funding employment as defined in terms of Section 1 of the Act, which allows employers to determine how this amount is calculated subject to certain limits. It is thus open to significant variation at the employer level. If the pensionable salary were a low percentage of earnings, even a high replacement ratio may not produce a comfortably adequate retirement income.

In order to avoid the potential difficulties of the choice of annuity factor and the distortions introduced as a result of the use of pensionable salaries, and to provide greater consistency with the benefit representation in DC retirement funds, wealth-earnings ratios were adopted. 'Wealth' was defined as the expected present value at retirement of the comfortably adequate income required in retirement. The wealth-earnings ratio was defined as wealth divided by salary at retirement, before tax but excluding member contributions to retirement savings and medical scheme contributions made on the employee's behalf. Lifetime earnings were not used due to lack of longitudinal data.

5.3 Estimating adequacy targets at a household level

The overall target estimation model objective was to calculate a target wealth-earnings ratio per household that would provide a comfortably adequate income in retirement.

Calculations were performed at a household level, which was consistent with Palmer (1989; 1992; 1994; 2008) and Mitchell & Moore (1998).

A cashflow model was adopted in line with Chia & Tsui (2003) and Milevsky & Robinson (2000), who used a stochastic version of the discounted cashflow model to estimate the probability of wealth being depleted during the pensioner's lifetime.

A deterministic model was adopted and the extension of the model to allow for stochastic mortality and investment returns was left for future research.

In order to treat housing expenditure for home owners appropriately, it was decided to assume that if there was outstanding mortgage debt when the oldest person in the household retired, the mortgage would be paid in full on the retirement date.

The model used consumption data at the current age to project household consumption pre- and post-retirement, adjusting for changes in consumption at retirement. An expenditure requirement was calculated and the income level gross of tax required to provide for that expenditure was then calculated. The expected present value of the income was calculated at the retirement age. This discounted income need was then increased for the mortgage outstanding at retirement, and divided by earnings at retirement to give a wealth-earnings ratio.

The model was run first using hypothetical savings rates as suggested by Mitchell & Moore (1998) and then again using actual household savings rates and a modified mortality basis. Five different retirement ages were considered.

The target estimation model had eight principle steps listed below with the relevant section given in parenthesis:

- Step 1: Estimation of current consumption (Section 5.4);
- Step 2: Estimation of consumption at retirement (Section 5.5);
- Step 3: Calculation of outstanding mortgage at retirement and associated tax (Section 5.6);
- Step 4: Adjustment for the change in consumption at and during retirement (Section 5.7);
- Step 5: Estimation of the comfortably adequate income required at each age of retirement (Section 5.8);
- Step 6: Calculation of the expected present value of minimally and comfortably adequate incomes (Section 5.9);
- Step 7: Adjustment of the expected present value of comfortably adequate incomes for the mortgage outstanding at retirement (Section 5.10); and
- Step 8: Calculation of the minimally and comfortably adequate wealth-earnings ratios (Section 5.11).

5.4 Step 1: Estimation of current consumption at the current age

5.4.1 Calculating actual consumption

Consumption models could be income-led (Palmer, 1989; 1992; 1994; 2008; Mitchell & Moore, 1998) or expenditure-led (Robb & Burbidge, 1989).

Given that incomes are typically subject to volatility and under-reporting (Klasen, 2000) and the problems with income and debt data in IES 2005/2006 discussed in Sections 4.2.2.4 and 4.2.2.6 respectively, an expenditure-led model was adopted. In order to arrive at a consumption estimate, expenditure needed to be adjusted.

5.4.2 Adjusting expenditure to derive consumption

As the expenditure data in the IES 2005/2006 already contained an adjustment for imputed rental for home owners, actual consumption was obtained from the expenditure data by adjusting for the expenditure on transport during the survey period that related to past and future consumption. This transport adjustment was discussed in Section 4.7.3. Healthcare expenditure was taken to be equal to healthcare consumption. As indicated in Section 2.6.1, healthcare expenditure can be considered an appropriate indicator of healthcare consumption.

5.4.3 Further adjustment to consumption for hypothetical retirement savings

In order to assist with testing the impact of savings rates on the adequacy target, four hypothetical savings rates were considered: 0.0%, 12.5%, 15.0% and 17.5%. Given that approximately 80% of members in retirement funds administered by Alexander Forbes, a large pensions consultancy, have retirement fund contributions of between 10.0% and 17.5% of pensionable salary (Alexander Forbes, 2010a), this range of contribution rates as a percentage of total salary was assumed to be reasonable. It was acknowledged that a uniform savings rate across all households would not be realistic and household savings rates would be influenced by a number of factors as per Alessie & Lusardi, (1997). Diamond & Hausman (1984) found that pre-retirement saving was influenced by earnings, race, education, marital status, number of dependents and health. Shefrin & Thaler (1988) argued that saving increased with permanent income.

The impact of a change in retirement savings on disposable income, Δ_k, was calculated according to equation (5.1), in line with Mitchell & Moore (1998).

$$\Delta_k = T_k + S_k - T - S \qquad (5.1)$$

Where:

S_k is the hypothetical value of annual contribution to retirement savings given a hypothetical savings rate of $k\%$ p.a;

T_k is the hypothetical annual personal income tax that would be paid given the value of S_k;

S is the actual value of the annual contribution to retirement savings; and

T is the actual household personal income tax paid.

A positive value of Δ_k would mean that the personal income tax and contributions towards retirement savings under the hypothetical scenario would exceed the actual personal income tax and contributions towards retirement savings. Hence, disposable income would decrease by Δ_k. Although Mitchell & Moore (1998) suggested adjusting consumption downwards directly by Δ_k, this presented a problem for households with very low consumption and retirement savings rates who would then have had negative consumption rates. Aron & Meullbauer (2000) suggested that if the accumulated value of their savings rose, households would cut back on savings. In other words,

it was suggested that households targeted a level of wealth generally, and hence non-retirement savings was more likely to decrease in response to increased retirement savings, than consumption.

Consequently, non-retirement savings, which had already been adjusted for housing consumption as described in Section 4.7.2, were adjusted downwards by Δ_k, subject to a minimum level of zero. In cases where the non-retirement savings were insufficient to cover the savings and tax effect, consumption was adjusted for the amount that could not be met by non-retirement savings. Any change in consumption was assumed to be entirely attributable to non-healthcare consumption.

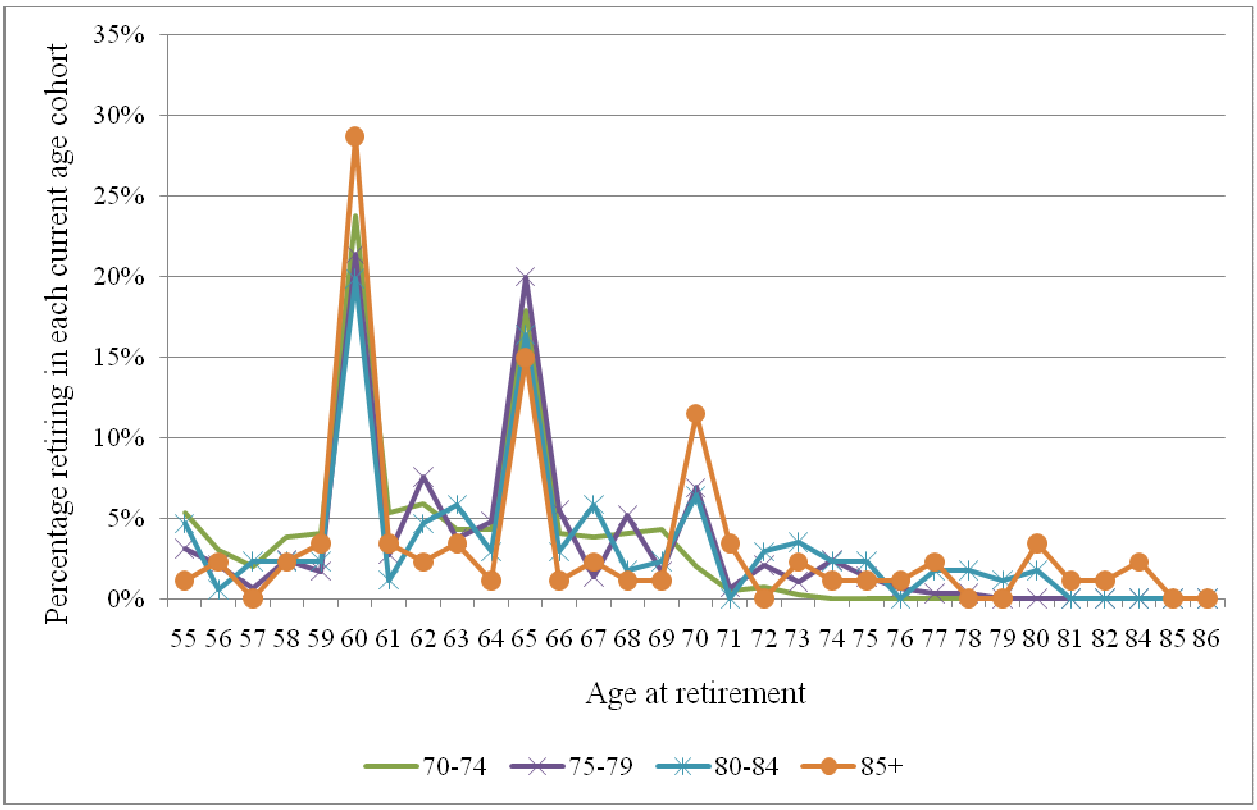
After this adjustment, ten households recorded negative consumption when retirement savings rates were set to 17.5%, and two of these households had negative consumption when retirement savings rates were set to 12.5%. It was decided to exclude households from projections involving scenarios where they had negative non-healthcare expenditure.

5.5 Step 2: Estimating consumption at retirement

5.5.1 Overview

The adjusted consumption was projected to retirement age using salary growth net of income tax as suggested by Diamond & Hausman (1984), Robb & Burbidge (1989), Hamermesh (1984) and Shefrin & Thaler (1988).

Five retirement ages (60, 63, 65, 67 and 70) were selected based on the frequencies with which people reported that they ceased working at these ages in the Multidimensional Survey of Elderly South Africans (Human Sciences Research Council, 2000), as depicted in Figure 5.1.



(Human Sciences Research Council, 2000)

Figure 5.1 Reported retirement ages by cohort

Although 62 appeared to be a more common retirement age than 63 for some cohorts from Figure 5.1, data from South African retirement funds suggested that 63 is a more common fund retirement age (Alexander Forbes, 2010a). The rate of net salary growth was calculated by estimating the net of tax salary at retirement and dividing by the current net of tax salary. Income tax was calculated by applying South African tax tables to the household income, and the approach to taxation is discussed in Section 5.5.2. Inflation-related and promotional salary increases were used in the projections.

5.5.2 South African personal income taxation in brief

The tax structure applied in the model was based on information and rates applicable up to and including the 2010/2011 tax year, that is the tax year ended 28 February 2011. The sections below summarise the structure and levels of personal income tax applicable from the projection month of March 2006 to the 2010/2011 tax year.

5.5.2.1 Tax brackets

A six bracket tax scale, with a minimum tax rate of 18% and a maximum rate of 40%, was introduced by the Taxation Laws Amendment Act (Act 30 of 2002).

5.5.2.2 Rebates

Section 6(2) of the Act provided for a primary tax rebate that was given irrespective of age and individuals over 65 enjoyed an additional secondary rebate. These were the only rebates applicable between March 2006 and the 2010/2011 tax year.

5.5.2.3 Married couples

Section 7(2A) of the Act allowed couples married in community of property to average their income. There were no official statistics on the prevalence of each matrimonial property regime but as marriage in community of property was the default, it was assumed that all couples, including same sex couples, were married in community of property.

5.5.2.4 Investment income

Section 10 of the Act allowed for a certain amount of investment income to be tax-free. Dividend income was income tax exempt according to Section 10(1)(k) of the Act, while rental income was fully taxable after allowing for certain deductions and provided that the owner was not living on the property (23(1)(a) of the Act). According to Section 10(1)(i)(xv) of the Act, other investment income was only taxable above a threshold.

5.5.2.5 Retirement savings

Tax deductions for retirement savings only apply to savings made in the specific classes of retirement savings vehicles mentioned in the Act, namely pension funds, provident funds and retirement annuity funds. These three types of vehicles were collectively referred to as ‘retirement funds’.

According to Section 11(l) of the Act, all employer contributions to retirement funds were tax-deductible up to 10% of salary bill, although in practice, deductions for employee benefit contributions of up to 20% of salary bill were allowed by SARS (Hanekom, 2011).

According to Section 11(k(i)) employee contributions to pension funds had a deduction equal to the greater of:

- R1 750; and
- 7.5% of retirement funding income.

According to Section 11(n) of the Act, a further 15% of non-retirement funding income was deductible by individuals contributing to a retirement annuity fund, subject to a minimum of the greater of:

- R3 500 less employee contribution to a pension fund; and
- R1 750.

Ignoring a change necessary to allow married women to be taxed, the sublimits in Section 11 were at the same nominal levels in 2010 as they were in 1990 (the Act).

5.5.2.6 Medical expenses

Section 18 of the Act allowed for deductions in respect of contributions to medical schemes, medical expenses and donations. The deductions for healthcare-related expenditure were set out in Section 18 of Schedule I of the Act and the form of these deductions had not changed over the period 1 March 2006 to 28 February 2011. All medical costs, including contributions to medical schemes, were tax-deductible for people over 65 and for people with disabilities. For people under 65, contributions to medical schemes were tax-deductible up to a fixed rand limit per person for the member and a partner. This subsidy had broadly kept pace with inflation since its introduction in 2006 (the Act; Statistics South Africa, 2006a; Statistics South Africa, 2010a; Statistics South Africa, 2010b). Under the Act, additional medical costs were deductible to the extent that they exceed 7.5% of taxable income for persons under 65.

5.5.3 Simplifying tax assumptions

It was assumed that contributions toward medical schemes and contributions towards retirement savings were the only tax deductions. Disability status was not included in the data, and hence it was assumed that no-one in the target estimation sample was disabled.

It was assumed that retirement savings were tax deductible up to 17.5% of total salary, subject to a minimum deduction of R1 750 fixed in nominal terms for persons contributing more than 17.5% of total salary. For some retirement savings arrangements, such as households where the employer did not contribute towards the pension or retirement annuity fund or households that did not use retirement funds for retirement savings purposes, this would understate the tax burden.

It was assumed for tax purposes that healthcare consumption was divided equally between the household inhabitants and the deductibility limits applied at an individual level.

It was assumed that all rental income was offset by allowable deductions and that all interest income was exempt. All other investment income was assumed tax-exempt. This assumption was necessary given that the asset allocation of the savings of each household was not known. While this may have understated the tax liability for some, only 0.6% of the sample would have exceeded the interest exemption limit in March 2006.

The brackets and rebates were projected forward to avoid households experiencing progressively higher marginal tax rates due to inflation-related salary increases.

5.6 Step 3: Calculation of the outstanding mortgage at retirement and associated tax

5.6.1 Outstanding mortgage at retirement

The mortgage at retirement was estimated in real terms by accumulating the balance outstanding at the survey date together with the monthly fees and then subtracting the accumulated value of the monthly contributions. A number of simplifying assumptions were made.

Firstly, it was assumed that the mortgage holder paid each instalment at the end of each month with no instalments being late or early. It was assumed that no additional capital payments were made. Although the latter assumption was not realistic, it could be argued that additional capital payments were more likely to be made by more financially organised individuals. These people were also more likely to plan to pay off their home loan before retirement and hence would have had no mortgage outstanding at retirement even without additional capital lump sums.

Secondly, it was assumed that the monthly instalment would be altered to reflect any changes in the mortgage interest rate.

Thirdly, it was assumed the original term of the loan would not be altered and no additional debt would be incurred. This would preclude people from selling one home and purchasing a new one of a different value.

Fourthly, it was assumed that there was one mortgage holder per household and that the mortgage would be settled when this person retired, if not before. This person was assumed to be the eldest person in the household. It was hence assumed that the balance in IES 2005/2006, or imputed balance outstanding, applied at the end of the month prior to the survey month.

Finally, an implicit assumption was made that the gap between the model inflation assumption and the actual prime interest rate at the survey date would be maintained until retirement.

5.6.2 Tax on debt settlement

It was assumed that individuals with outstanding mortgages at retirement would use accumulated retirement savings to settle the balance. The Taxation Laws Amendment Act (Act 17 of 2009) introduced the practice that all withdrawals made subsequent to 1 March 2009 would be considered for the purposes of calculating the tax payable on the most recent withdrawal. In order to simplify calculations, it was assumed that there were no withdrawals from the retirement fund before retirement. This would be consistent with a system with compulsory preservation. It was assumed that the tax on withdrawal was funded from salary income or other savings and did not attract tax as a withdrawal from retirement savings. Hence no further tax was calculated on the tax amount payable.

5.7 Step 4: Change in consumption at and during retirement

5.7.1 Changes in consumption and savings at retirement

A non-parametric analysis was carried out to test for changes in consumption due to age and work-status and the results are set out in Chapter 6.

5.7.2 Changes in consumption and savings during retirement

Healthcare consumption and non-healthcare consumption were modelled separately to allow for different inflation rates for each. Based on the analysis set out in Chapter 6, it was decided not to allow for any changes in budget share between healthcare and non-healthcare consumption during retirement other than that caused by inflation. In order to prevent the healthcare budget share from becoming too large, the model allowed for a cap on healthcare budget share.

5.7.3 Allowances for loss of economies of scale

The comfortably adequate consumption need per person was adjusted for a loss of economies of scale on widowhood. No adjustment was made to the minimally adequate income need on widowhood.

5.8 Step 5: Estimation of income needed to be funded from retirement savings at each age in retirement

5.8.1 Overview

Step 5 involved the calculation of the income that would need to be provided from retirement fund savings. This would be the income that the household required for an adequate retirement in excess of any earnings by the younger partner in the semi-retirement phase.

The income required for an adequate retirement was defined as the maximum of the minimally adequate income level and the income required to smooth consumption pre- and post-retirement. The income required to meet the consumption-smoothing level of consumption was calculated in two steps. Firstly, expenditure was derived from the consumption level calculated in Step 4 by subtracting the imputed rental. Then, the income required in order to meet that expenditure level was calculated by adding back the desired level of post-retirement savings and the tax that the gross income would attract.

The three most significant technical issues considered in this step were the treatment of post-retirement savings, the estimation of the minimally adequate income level and the adjustment for earnings in the semi-retirement period.

5.8.2 Treatment of savings

Savings made during the early part of retirement can, in theory, be drawn down later to meet consumption needs (Modigliani, 1986). A non-parametric analysis, described in Section 6.5, indicated that there was no age or work-status impact on non-retirement savings, and an age at which decumulation would start could not be detected. It was assumed that there was no drawdown of pre-retirement savings during retirement and, similarly, there was no allowance for post-retirement savings. This corresponds with an implicit allowance for bequests via savings patterns as suggested by Mitchell & Moore (1998), Modigliani (1986) and Yaari (1965).

5.8.3 Estimating minimally adequate income in retirement

The means-test formula for the SOAG was used to ascertain the minimum income level at which no income support was provided in retirement.

This minimum was applied per person. It could be argued that this would need to be further adjusted to allow for the fact that the elderly person may live with people other than his or her spouse (Woolard & Liebbrandt, 2006). According to the 2001 Census, 71% of South Africans aged 65 or older lived in households of three or more (Statistics South Africa, 2005). However, consideration of larger households was beyond the scope of this research which focused only on one-and two-person households. Regardless of how the state expected these funds to be shared in multi-generational families, as of 2010, the SOAG was not a function of family size and to make an adjustment for family size would distort the income level at which one- and two-person households receive income support in their old age.

This approach was different from that adopted by Chia & Tsui (2003) who adapted a general poverty line and then made explicit adjustments for age-related healthcare expenditure. It was expected that the design of the SOAG will take increased healthcare expenditure into account. Hence, it should be correct on average even though these costs will be overstated for younger pensioners and understated for older pensioners.

5.8.4 Adjusting for wages and salaries in semi-retirement

In 67.6% of the two-person households in the model development sample, the two adults were in different age groups. Under the model, these two people would not retire at the same time. Hence there would be a period where part of the household needs would be met by retirement income and part of the household needs would be met by the wages of the younger partner. Therefore, the income needed from retirement savings was reduced by the wage income earned, which was termed the ‘salary support’. During the semi-retirement period, it was assumed that consumption was constant in real terms.

5.9 Step 6: Calculation of the expected present value of income needs

The expected present value of the income needs was calculated using pessimistic, best estimate and optimistic discount rates.

The model made allowance for an insurer's profit margin, administration fees and commission.

Mortality could be modelled stochastically using a Gompertz distribution, parameterised by using a standard mortality table (Milevsky & Robinson, 2000). However, it was decided to follow a deterministic approach. One advantage of the deterministic approach was that using expected mortality aligned the model with the approach used to price annuities by insurers. This consistency was important as self-annuitisation was shown by Albrecht & Maurer (2002) and Kotlikoff & Spivak (1981) to be less efficient than purchase of life annuities due to uncertainty around life expectancies.

5.10 Step 7: Adjustment for outstanding mortgage debt

The outstanding mortgage debt at retirement and associated tax was added to the comfortably adequate wealth level.

5.11 Step 8: Calculation of wealth-earnings ratios

The wealth calculated in Section 5.10 was divided by the earnings at retirement calculated, as described in Section 5.2.

6 TESTS FOR CHANGES IN CONSUMPTION AND NON-RETIREMENT SAVINGS AT AND IN RETIREMENT

6.1 Introduction

The estimation of consumption changes at and in retirement was an important subsidiary aim of this research. The target estimation model described in Chapter 5 required assumptions regarding the change in consumption and non-retirement savings at and in retirement. As described in Section 3.6.2, this involved testing for effect of age and work-status.

Section 6.2 of this chapter considers the methodology adopted. Thereafter, the results of the analysis into the age and work-status effects on healthcare expenditure are set out. Healthcare expenditure, which was treated as equivalent to healthcare consumption for the purposes of the target estimation model, was given special consideration because of the well-documented age effect on healthcare expenditure set out in Section 2.6.5.1. Section 6.4 sets out the results of the analysis into non-healthcare consumption in general, as well as a specific analysis on gifts. Section 6.5 sets out the analysis of the effect of age- and work-status on non-retirement saving. The chapter concludes with a summary.

6.2 Methodology

As discussed in Section 3.6.2, a CHAID analysis was used. This approach was broadly similar to the matched-pairs methodology described in Palmer (1989) but allowed for more than one criterion to be adopted in the matching process.

6.3 Estimation of the change in healthcare expenditure at and in retirement

As outlined in Section 5.4.2, healthcare consumption was taken as equal to the change in healthcare expenditure for the purposes of estimating the retirement adequacy targets. Healthcare expenditure was identified as a reasonable indicator of healthcare consumption by Miniaci, Monfardini & Weber (2003). For the purposes of this research, it was assumed that the change in healthcare expenditure at and during retirement would provide a reasonable approximation for the corresponding change in

the level of income required at and during retirement to meet healthcare needs. Hence, this analysis focussed on healthcare expenditure as opposed to healthcare consumption. Healthcare expenditure was defined in terms of 36 COICOP codes given in Table C.1 in Appendix C, and was divided by income (including income in kind) to obtain a healthcare expenditure rate. The ranges used to convert the continuous healthcare expenditure rate into categorical variables for use in CHAID is given in Table C.2 in Appendix C. The CHAID dendrogram, given in Figure 6.1, indicated that the most significant determinant of healthcare expenditure was medical scheme membership. Households with no medical scheme members had a significantly smaller healthcare budget share than households with at least one medical scheme member.

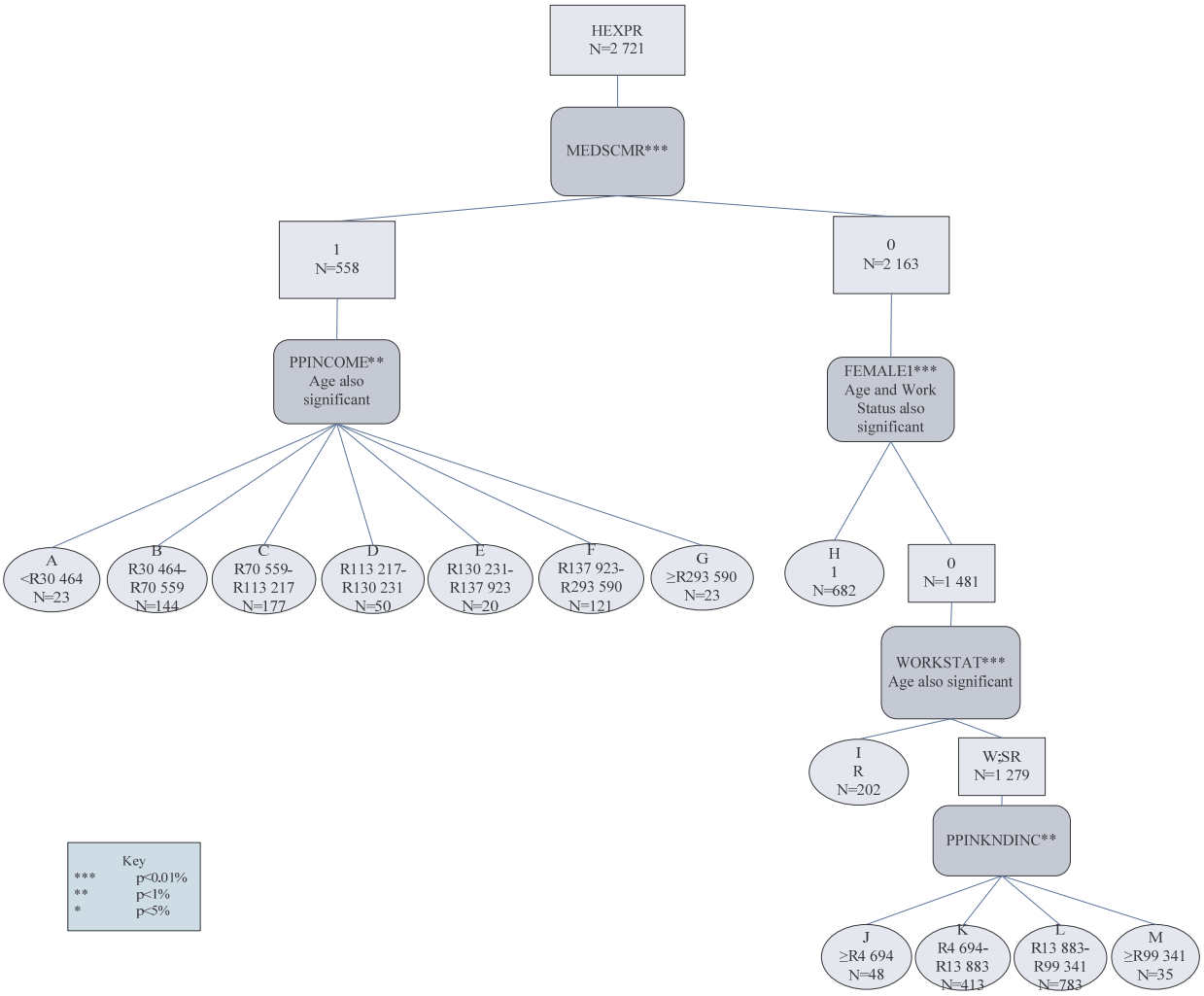


Figure 6.1 Dendrogram of healthcare expenditure rate

For medical scheme members, age ceased to be significant after income was considered. This may be because under the Medical Schemes Act (Act 131 of 1998) medical scheme contributions do not vary by age. Hence, even in declining health, the increase in healthcare expenditure was not significant due to the fact that these costs only related to the increase in expenditure not insured by the medical scheme.

For households with no medical scheme members, the next most important determinant of healthcare expenditure was sex of the head of the household, although age and work-status were also significant. Male-headed households spent significantly less than female-headed households. Considering only male-headed households with no medical scheme members, healthcare budget share was much higher in retired households. The mean healthcare expenditure rates are shown in Table 6.1.

Table 6.1 Mean healthcare expenditure rate by leaf and work-status

Leaf	Working and semi-retired households		Retired households		% increase in healthcare budget share on retirement
	Number	Mean budget share	Number	Mean budget share	
A	5	9.7%	18	14.0%	44.3%
B	31	12.8%	113	13.2%	2.4%
C	30	10.1%	147	11.2%	10.4%
D	7	8.7%	43	7.2%	-17.9%
E	1	10.2%	19	10.5%	2.6%
F	10	6.9%	111	7.0%	1.2%
G	2	3.3%	21	2.4%	-27.6%
H	246	1.4%	436	2.0%	41.2%
I-J	202	1.6%	48	1.9%	18.7%**
I-K	202	1.0%	413	1.9%	100.9%**
I-L	202	0.7%	783	1.9%	187.1%**
I-M	202	0.7%	35	1.9%	184.3%**

* Significant at the 5% level
** Significant at the 1% level
*** Significant at the 0.01% level

Hence, it could be concluded that the model development sample suggested that there was no age effect on healthcare expenditure, and for some households healthcare expenditure increased significantly on retirement.

6.4 Estimation of the change in non-healthcare consumption at and in retirement

6.4.1 Gifting

Gifting was analysed separately, as Dexter (1984) and Palmer (1994; 2008) found very large increases in gifting at retirement, as discussed in Section 2.5.4.2.

The gifting rate was defined as gift expenditure divided by income (including income in kind). Gift expenditure was defined according to the four COICOP codes which are given Table D.1 in Appendix D, and 'gifts' can be broadly described as cash or in kind maintenance of or remittance to family members and gifts to non-household members. The categorisation used for gifting is given in Table D.2 in Appendix D.

The CHAID analysis indicated that gifting behaviour was highly complex, with cash income identified as the most important predictor. For some categories, work-status was highly significant although for others, controlling for home ownership, total income (including income in kind), educational attainments of the household and dwelling value removed this effect. Any age effect could be completely eliminated by controlling for these factors. The dendrogram is given in Figure 6.2.

A comparison of the means for all leaves suggested that, in most cases, there was a substantial and statistically significant reduction in gifting on retirement. For some households with very high incomes and very high dwelling values, however, gifting increased in retirement. For three of the 16 cases, there were two or fewer retired or semi-retired households in the sub-sample, making any comparisons statistically meaningless. The results are given in Table 6.2, and from these it can be concluded that there was no statistically significant increase in gifting on retirement.

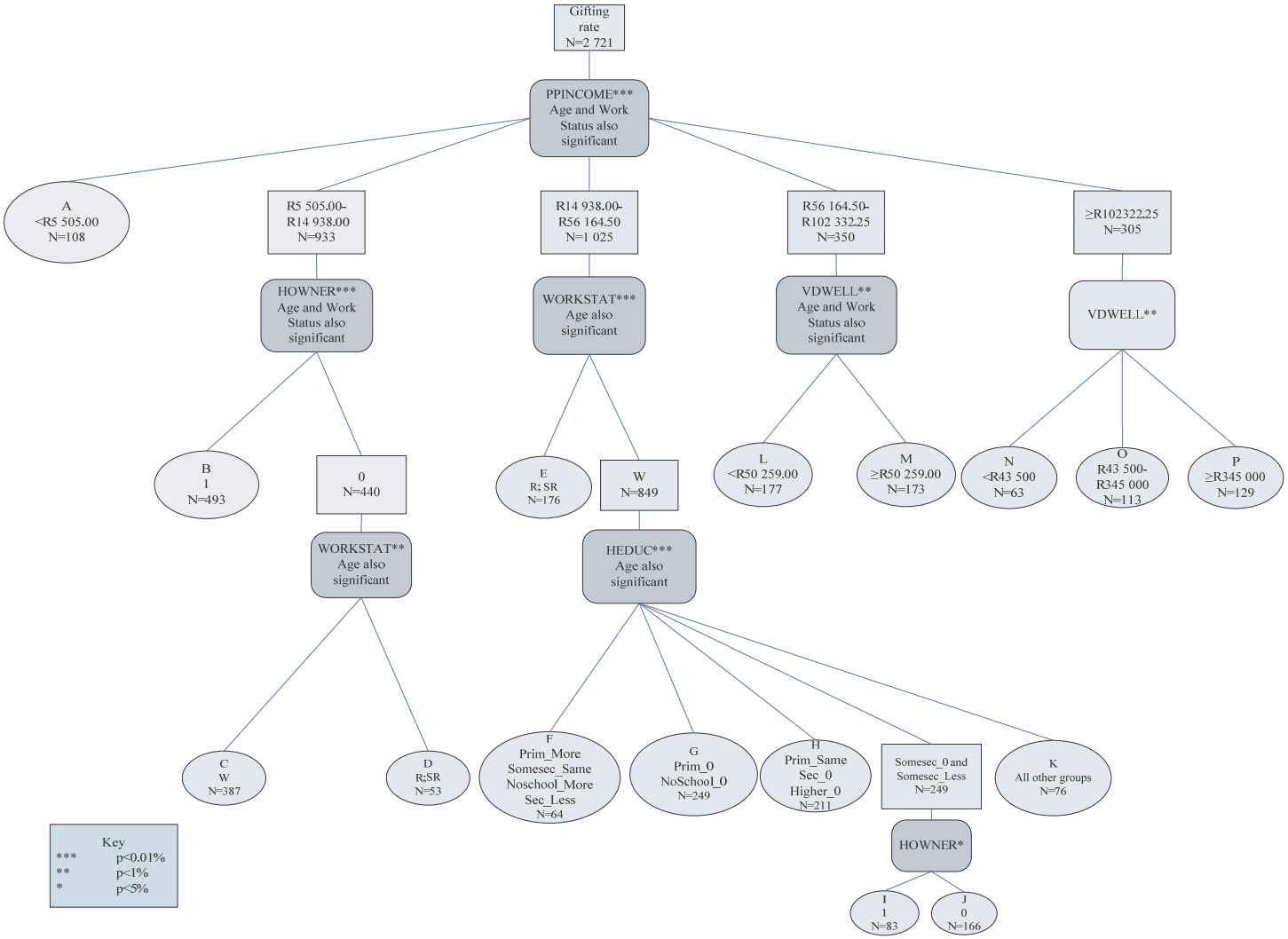


Figure 6.2 Dendrogram of the gifting rate

Table 6.2 Mean gifting rates by leaf and work-status

Leaf	Working households		Semi-retired or retired households		% reduction gifting in retirement
	Number	Mean gifting rate	Number	Mean gifting rate	
A	106	5.2%	2	0.2%	95.5%
B	202	6.7%	294	2.6%	61.9%
C-D	389	17.4%	53	3.2%	81.6%**
E-F	63	8.6%	176	2.7%	68.5%***
E-G	248	11.7%	176	2.7%	77.0%***
E-H	210	25.7%	176	2.7%	89.5%***
E-I	82	5.3%	176	2.7%	49.5%***
E-J	165	11.5%	176	2.7%	76.5%***
E-K	76	13.2%	176	2.7%	79.6%***
L	175	12.9%	2	0.5%	96.0%
M	110	5.8%	63	1.0%	83.0%
N	63	9.0%	0	-	Not calculated
O	105	4.2%	8	0.5%	89.2%
P	100	1.6%	29	1.7%	-6.0%

* Significant at the 5% level
** Significant at the 1% level
*** Significant at the 0.01% level

6.4.2 General non-healthcare consumption

Non-healthcare consumption was defined as total consumption of items not related to healthcare, and thus included expenditure on gifting. The categorisation for non-healthcare consumption is given in Table E.1 in Appendix E.

The CHAID analysis indicated that, controlling for income, household composition and dwelling were extremely important, and that after these variables were taken into account there was neither an age effect nor a work-status effect. The dendrogram is given in Figure 6.3. Hence, it could be concluded that there was no decrease in non-healthcare consumption at or in retirement.

There was no clear decrease in consumption as income rose, as shown in Table E.2 in Appendix E.

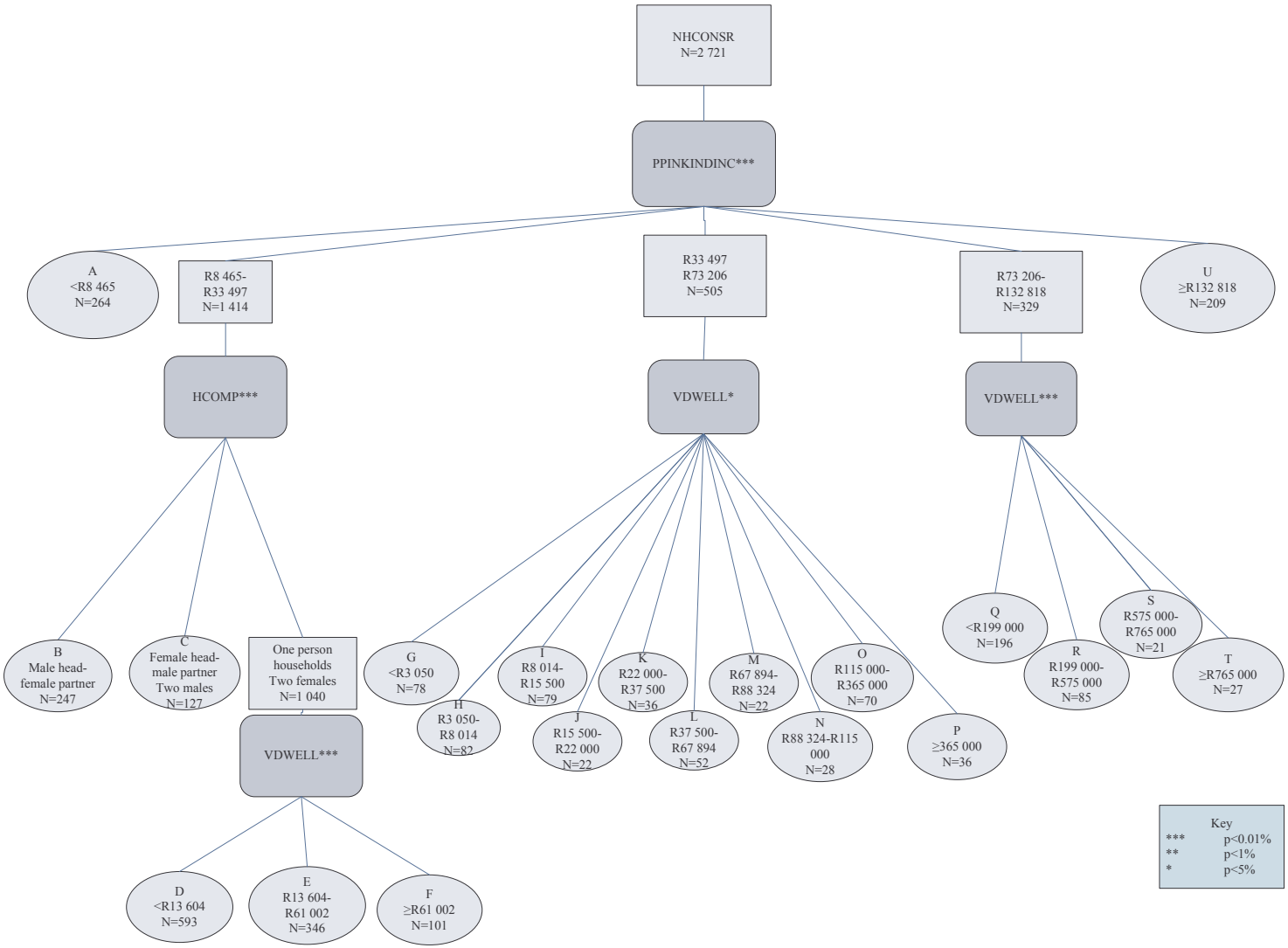


Figure 6.3 Dendrogram of non-healthcare consumption rate

6.5 Estimation of the change in non-retirement savings at and in retirement

Non-retirement savings were calculated as savings excluding those to retirement funds, net of dissavings and adjusted for mortgage payments in excess of imputed rental for home owners, as described in Section 4.7.2. The actual COICOP codes used are given in Table F.1 in Appendix F, and the categorisation used for non-retirement savings is given in Table F.2 in Appendix F. Savings were then divided by income (including income in kind) to give a non-retirement savings rate.

The CHAID analysis suggested that non-retirement savings, once adjusted for the fact that part of the mortgage expenditure was consumption, were not influenced by age or work-status. The dendrogram is given in Figure 6.4

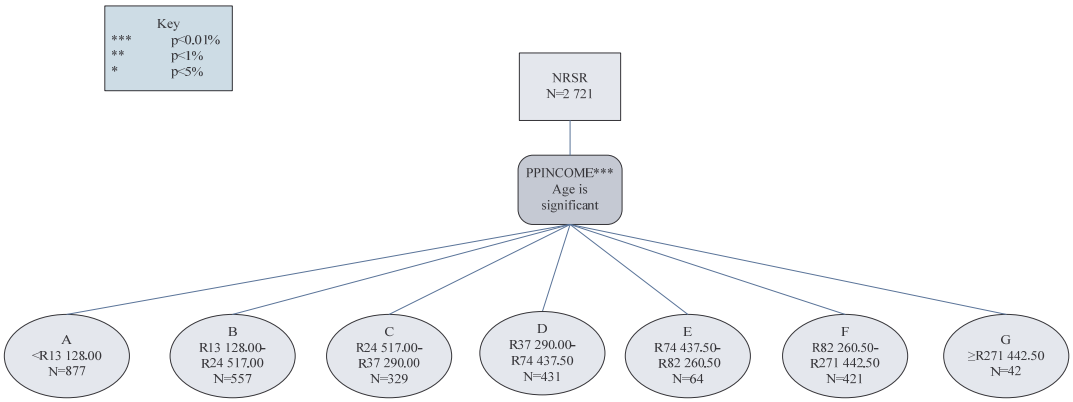


Figure 6.4 Dendrogram of non-retirement savings rate

The analysis by leaf can be found in Table F.3 in Appendix F. The model development sample did not provide any indication that non-retirement savings would be influenced by age or work-status after controlling for income.

6.6 Summary

The CHAID analysis indicated that there was no significant change in non-healthcare consumption on retirement. When gifting rates were considered separately, it was found that in most cases there was no work-status effect. However, where a statistically significant effect was found, it indicated that gifting decreased on retirement.

Households where at least one person was a medical scheme member did not experience a significant increase in healthcare expenditure as age increased or work-status changed. For households without medical scheme insurance, retirement was associated with an increase in healthcare expenditure, which was significant for some households.

It was noted that healthcare expenditure was not predicted by non-healthcare consumption or non-retirement savings. Similarly, non-healthcare expenditure was not predicted by healthcare expenditure or non-retirement savings, and non-retirement savings was not influenced by expenditure. This presented a paradox as healthcare expenditure was seen to increase significantly at retirement for some groups but there was neither corresponding reduction in other consumption nor reduction in non-retirement savings to fund it. It was, in theory, possible for at least part of this increased healthcare budget share to come from the retirement savings that are eliminated in retirement.

7 PARAMETERISING THE TARGET ESTIMATION MODEL

7.1 Introduction

Considerable care was taken with the parameterisation of the target estimation model. The assumptions are addressed in this chapter in the order that they were required in terms of the steps for the target estimation model as set out in Chapter 5. The inflation assumption is justified in Section 7.2. The salary inflation assumptions are discussed in Section 7.3. Section 7.4 sets out the tax projection basis, while the assumptions required to calculate mortgage at retirement are given in Section 7.5. The assumption for the minimum income level is set out in Section 7.6. Sections 7.7 and 7.8 outline the consumption changes at and in retirement and Section 7.9 elaborates on the assumptions relating to the annuity factor. As the model calculates items in real terms, the resultant retirement adequacy targets would not be particularly sensitive to the inflation assumption. A summarised basis can be found in Appendix G.

7.2 Inflation

Given that the target estimation model calculated items in real terms, the retirement adequacy targets would not have been very sensitive to the inflation assumption. A market-consistent approach of considering the difference in yields between conventional and index-linked bonds was adopted. The BESA All Bond yield for bonds with durations of 12 years or more was 9.1% on 31 March 2010 (OMIGSA, 2010a) and the weighted average yield on long-dated index-linked gilts as published by the Financial Services Board was 3.3% on the same date (Financial Services Board, 2010). This gives an implicit inflation assumption of 5.8%. The implicit inflation assumption rose to 5.9% in April 2010 (OMIGSA, 2010a; Financial Services Board, 2010) and 6.2% in May 2010 (OMIGSA, 2010b; Financial Services Board, 2010). Rusconi (2005) used inflation of 5.0%. An inflation assumption of 6.0% p.a. was adopted in line with these empirical estimates and the upper limit of the South African Reserve Bank's inflation targeting policy (Wörgötter, Barnard & Lysenko, 2010).

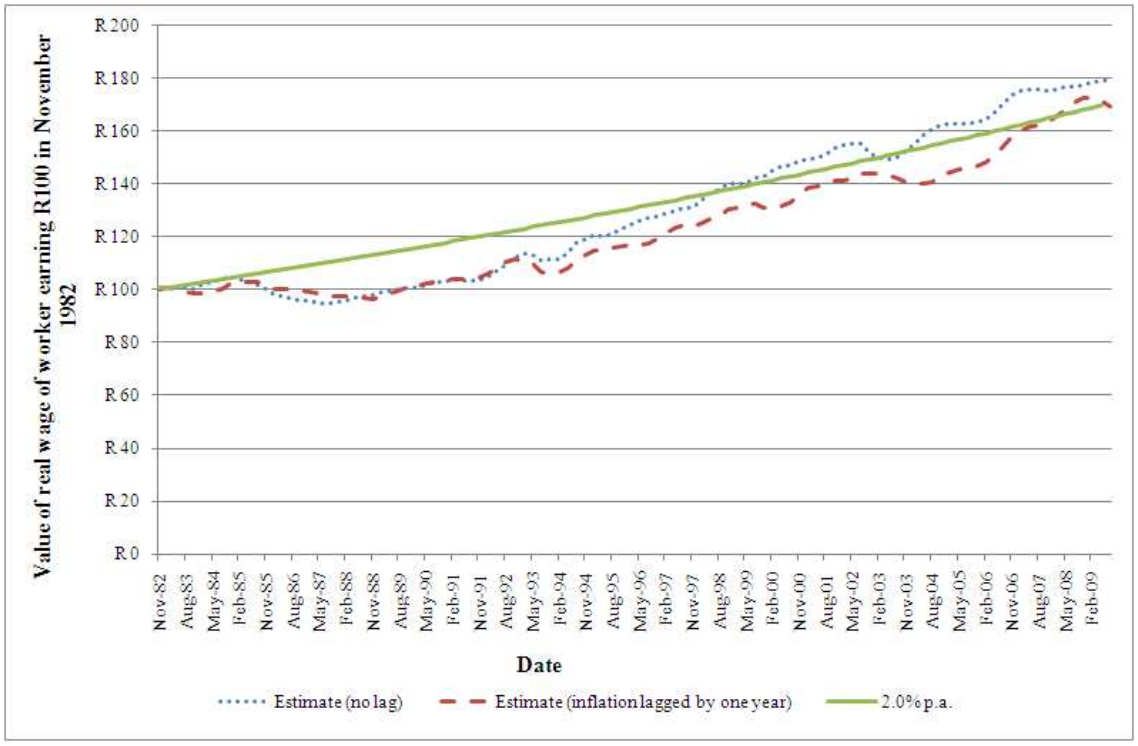
7.3 Salary inflation

The salary inflation basis required assumptions for inflation-related salary increases and promotional salary increases. The former related to the salary increases in excess of inflation that applied to the general population and the latter related to performance-related increases that applied at an individual level. These two elements were summed to give the general salary inflation assumption.

7.3.1 Inflation-related salary increases

Rusconi (2005) used wage inflation equal to price inflation plus a margin of 2.0%, when modelling the impact of fees on retirement savings product returns, and stated that this reflected past experience and future expectations.

The relationship between inflation and wage-inflation is complex, hence allowance was made for lagged inflation when analysing historic patterns as per Fedderke & Schaling (2005). Wage inflation over the five years to the third quarter of 2009 was 2.2% in real terms, using non-lagged CPI, and 3.8% p.a. using CPI lagged by 1 year (Statistics South Africa, 2010a; Statistics South Africa, 2010b; South African Reserve Bank, 2010a; South African Reserve Bank, 2010b). The historic progression of the real wage allowing for both lagged and non-lagged CPI is graphed against the assumption of inflation-related salary increases of 2.0% p.a. in Figure 7.1.



(Statistics South Africa, 2010a; Statistics South Africa, 2010b; South African Reserve Bank, 2010a; South African Reserve Bank, 2010b)

Figure 7.1 Actual and assumed gross wage inflation

If there have been no changes to the productivity of the working population that would require promotional increases, the wage inflation data would correspond to inflation-related increases only. This was not an unreasonable assumption given that real productivity declined slightly over the five years to the third quarter of 2009 (South African Reserve Bank, 2010a). Hence, the data used to chart Figure 7.1 suggested that the inflation-related salary increases were approximately 2.0% p.a. in real terms.

7.3.2 Promotional salary increases

There were no published South African promotional salary scales, however a UK "example" salary scale (PEN) (Faculty of Actuaries & Institute of Actuaries, 2002) was found to be similar to the promotional salary increases in the best estimate valuation basis adopted by Alexander Forbes (Alexander Forbes, 2010b) after the rate of promotional increase on PEN was adjusted upwards by multiplying by 1.01. In the interests of transparency, the adjusted PEN scale was used. The promotional scale could be extrapolated to age 69 by assuming the

absence of promotional salary growth after age 64. The extrapolated promotional salary scale is given in Appendix H.

7.3.3 Total salary inflation

The Assumptions for the Determination of Minimum Individual Reserves of Members of Defined Categories of Pension Funds (Board Notice 37 in terms of the Pension Funds Act No. 24 of 1956, 2007) ('the Minimum Reserve Regulations') provided some insight into the assumptions favoured by the regulatory authorities. The inflation-related salary increase assumption suggested in the Minimum Reserve Regulations was 1.0% p.a. However, the adoption of an inflation-related salary increase assumption of 2.0% provided a closer match to historic experience as well as yielding a total salary inflation basis that was not dissimilar to the best estimate valuation basis adopted by Alexander Forbes (Alexander Forbes, 2010b). This is shown in Figure 7.2.

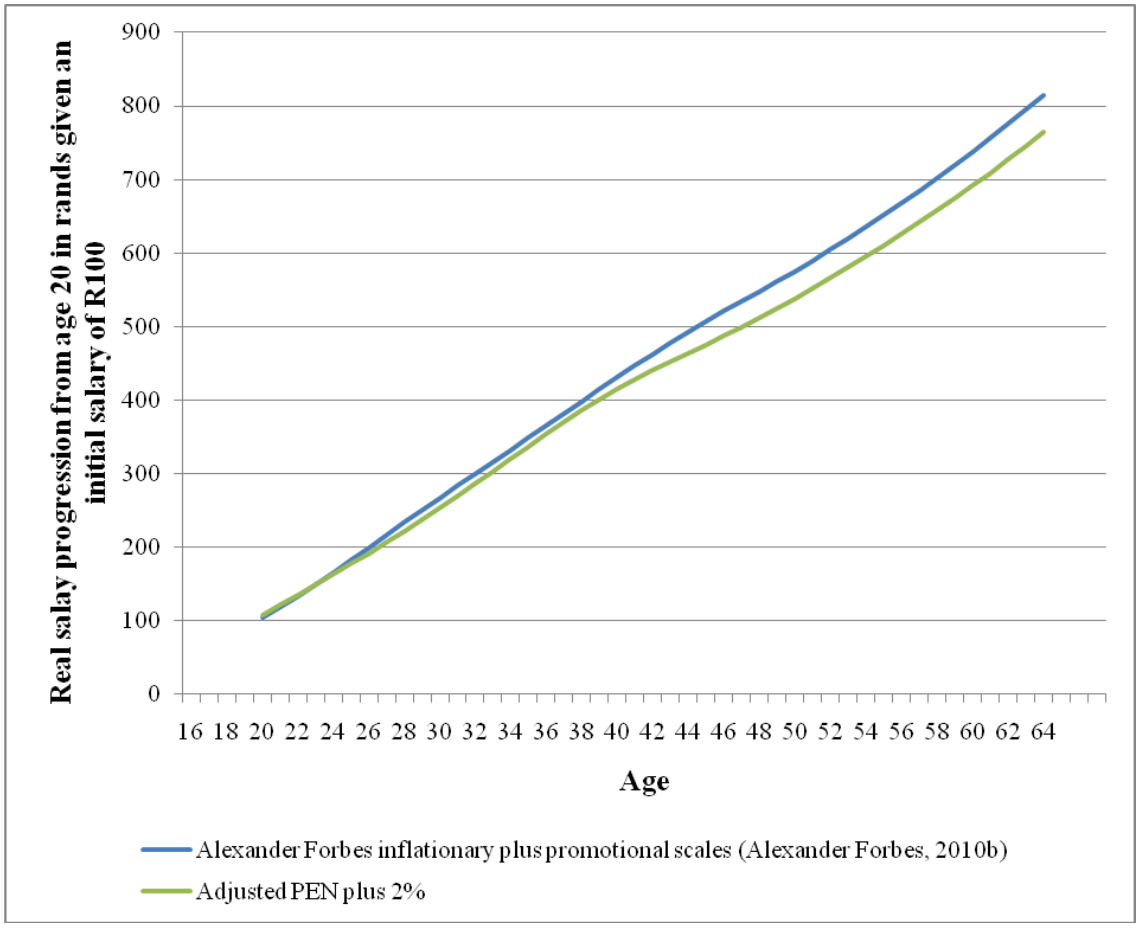


Figure 7.2 Salary projections under different total salary inflation bases

The combined inflation-related and promotional scale adopted for this research provided for real increases of approximately 4.5% p.a. from age 20 to 64. An individual's salary in real terms at age 64 was projected to be approximately 7.1 times their salary at age 20.

7.4 Tax projection basis

The tax parameters applied in the model were based on information and rates applicable up to and including the 2010/2011 tax year, that is the tax year ended 28 February 2011.

7.4.1 Personal income tax brackets

In order to avoid fiscal drag, the brackets and primary rebate needed to be adjusted for wage inflation. Consideration of the actual adjustments to the brackets between 2002 and 2010 under the Act suggested that these adjustments are not directly linked to inflation from year-to-year, but that there is a longer-term link to inflation. Hence, it was decided to increase the brackets in real terms by 2.0% p.a., which was the inflation-related salary increase assumption as set out in Section 7.3.1. It was acknowledged that this would not take account of the widening of the fourth and fifth tax brackets which had taken place between 2004 and 2010.

7.4.2 Primary and secondary personal income tax rebates

The real increase in the level of the primary rebate was assumed to be 2.0% p.a., which was in line with inflation-related salary increases and the personal income tax brackets and corresponded with historical increases under the Act. The secondary rebate was increased sharply in real terms between 2004 and 2005 and subsequently declined in real terms under the Act. The secondary rebate had increased by approximately 0.5% less than the primary rebate between 2003 and 2010, under the Act. Hence it was decided to increase the modelled secondary rebate by 1.5% p.a. in real terms.

7.5 Mortgage-related assumptions

7.5.1 Fees on mortgages

Fee structures on standard mortgages were obtained from ABSA Bank Limited, First National Bank (a division of FirstRand Bank Limited), Nedbank Limited and Standard Bank

of South Africa Limited. These four banks had a combined market share of 94.8% (Heyns, 2007). Fees were provided for the 2010 calendar year due to the reluctance of the banks to provide historic fee structures although in many cases, different fees were charged for loans predating the National Credit Act (Act 34 of 2005) ('the NCA'). As the NCA came into effect after the IES 2005/2006 sample was taken, all mortgages would attract the pre-NCA fees. Average fees, adjusted for inflation, weighted by market share given in Heyns (2007), were then calculated for different salary and outstanding balance profiles. The monthly fees ranged from R17.21 to R28.63 per month in March 2006 rands.

7.5.2 Tax on debt settlement

The income required to settle the mortgage at retirement attracted tax according to the scale set out in Table 7.1.

Table 7.1 Tax rates applicable on nominal retirement lump sums

Lump sum taken at retirement	Tax rate
R0-R300 000	0%
R300 001-R600 000	R0 + 18% of balance between R300 000 and R600 000
R600 001-R900 000	R54 000 + 27% of balance between R600 000 and R900 000
R900 001 or more	R135 000 + 36% of the balance above R900 000

(Taxation Laws Amendment Act (Act 17 of 2009))

As of the 2010/2011 tax year, the tax table had been modified in format only since its introduction on 1 October 2007 by the Taxation Laws Amendment Act (Act 8 of 2007) and the tax brackets have not been adjusted for the impact of inflation.

It was assumed that the tax brackets would remain constant in real terms. Assuming positive real salary growth, this would result in increasing tax rates over time should individuals choose to take a fixed percentage of their retirement benefit as a lump sum. This would be consistent with an intention to deter individuals from dipping into their retirement savings.

7.6 Minimum income level

Since 22 August 2008, the SOAG payable has been based only on income earned and not a combination of income and assets (the 2008 Regulations). Details of the formula are given in Appendix I. The income below which no support was provided has averaged R1 852 per

person per month (p.p.p.m.) or R22 224 p.p.p.a. in March 2006 rands over the period between August 2008 and April 2010 (the Increase Notices; the SOAG Regulations). This level of income would not be taxable based on the SARS 2006/2007 tax tables, according to the Small Business Tax Amnesty and Amendment of Taxation Laws Act (Act 9 of 2006). The minimally adequate income was assumed constant in real terms and no adjustment was made on the death of a spouse.

7.7 Changes in consumption at retirement

Given the results discussed in Chapter 6, it was decided to allow for increases in healthcare consumption at retirement for male-headed households without any medical scheme members, according to Table 7.2, which was derived from Table 6.1.

Table 7.2 Healthcare consumption increases on retirement

Income p.p.p.a.	**Increase**
Less than R4 694	18.7%
R4 694-R13 883	100.9%
R13 883-R99 341	187.1%
R99 341 or more	184.3%

It was decided to affect this increase on the date of the oldest person's retirement. This was because if salary support were to be ignored, the semi-retirement period would also be eliminated and households would move straight from the working state to the retired state and would experience the corresponding increase in healthcare costs when the oldest person retired. If salary support were taken into account, there would be a semi-retirement period. However, there were relatively few semi-retired households in the sample used to derive these estimates and all 23 earned between R4 694 and R99 431 p.p.p.a. Delaying the increase in healthcare consumption until the second retirement may hence have been spuriously accurate and may have overstated the value of salary support, due to the increase in healthcare costs being deferred.

Although a phasing-in of this increase in healthcare consumption may have been intuitively more sensible, the CHAID analysis in Section 6.3 did not suggest that there was a statistically significant age impact on healthcare expenditure. Hence, there was no statistical justification

from the model development sample that phased-in increases in healthcare consumption would be more appropriate.

No other changes in consumption at retirement were modelled in line with the findings from Chapter 6.

7.8 Changes in consumption in retirement

Although a statistically significant age effect on consumption was not detected using the CHAID analysis set out in Chapter 6, it was necessary to allow for changes in consumption due to inflation, and due to loss of economies of scale on death of a spouse.

7.8.1 Inflationary changes

The real change in consumption during retirement was modelled as a function of the healthcare and general inflation rates, and the healthcare budget share.

7.8.1.1 Healthcare inflation

Although Chia & Tsui (2003) did not differentiate between healthcare inflation and general price inflation, South African experience suggested that healthcare inflation exceeded price inflation. Healthcare inflation between December 2001 and December 2008 was approximately 4.0% p.a. above consumer price inflation but was only 1.4% above consumer price inflation between December 2005 and December 2008 (Statistics South Africa, 2006a; 2010a). Consequently, it was decided to use assumption that healthcare inflation was 2.5% above price inflation. It was acknowledged that future healthcare inflation is highly unpredictable due to the mooted National Health Insurance that could be introduced in 2012 (African National Congress, 2010).

7.8.1.2 Non-healthcare inflation

Given that healthcare inflation was set at CPI+2.5% and healthcare consumption formed 6.9% of the CPI basket (Statistics South Africa, 2010a), non-healthcare inflation was calculated as CPI-0.19%.

7.8.1.3 Capping of the healthcare budget share

Due to the higher inflation on healthcare consumption than non-healthcare consumption, over time the modelled budget share for healthcare would grow to dominate the non-healthcare budget share unless capped. Hence, it was decided to limit the healthcare budget share to 10%. This was similar to the 10% of income threshold mentioned in Russel (2005) and Xu, Evans, Kawabata, Zeramdini, Klavus & Murray (2003) in their studies on healthcare expenditure affordability.

7.8.2 Loss of economies of scale

It was assumed that the per person consumption increased by 9.25% on widowhood in line with Streak, Yu & Van der Berg (2009). This implied an immediate decrease in housing consumption on widowhood which may not be realistic. No adjustment was made to the minimally adequate income need on widowhood.

7.9 Assumptions relating to the annuitisation of the post-retirement income

Step 6 of the target estimation model, discussed in Section 5.9, involved finding the expected present value of the adequate income in retirement. The literature indicated that for at least some individuals, purchase of an annuity was preferable to self-insurance (Levitan, Dolya & Rusconi, 2010; Albrecht & Maurer, 2002; Kotlikoff & Spivak; 1981). Hence, the discounting process incorporated not only assumptions regarding post-retirement investment return and mortality, but an allowance for an insurer's profit margin. The assumptions required to calculate the price of an annuity that would be appropriate for the post-retirement cashflows are detailed in the following sections.

7.9.1 Post-retirement investment return assumptions

Three approaches were considered in setting the post-retirement interest rate: a rate consistent with a purchased annuity, a rate consistent with index-linked bond yields and a rate consistent with investment returns on a balanced l portfolio approach. These are discussed in Sections 7.9.1.1 to 7.9.1.3.

7.9.1.1 Purchased annuity approach

In order to estimate the net real return on investments, the pension increases granted for a participating (with-profits) annuity series offered by a large South African insurer were considered together with disclosed fees and the after-retirement interest rate. The estimated real investment return net of investment fees and gross of other expenses averaged approximately 4.0% p.a. over the eight years to 2010 (Old Mutual, 2010a).

7.9.1.2 Index-linked bond yields

An index-linked bond portfolio should provide a matching asset portfolio to an annuity that is level in real terms. The weighted average yield on long-dated index-linked gilts was 3.0% on 31 May 2010 (Financial Services Board, 2010). Under the Minimum Reserve Regulations, the FSB allowed for an adjustment for management fees of 0.3%, giving a net real return of 2.7%.

7.9.1.3 Balanced portfolio approach

Using a model parameterised with Canadian data, Milevsky & Robinson (2000) suggested that an ideal post-retirement investment mix was 80% equity and 20% bonds, yielding an expected real return of approximately 6.0% p.a. An even more aggressive investment mix was suggested by Chai *et al* (2010) who suggested an equity exposure of over 97.0%. In sensitivity testing this ideal exposure level fell to 32.1%.

In South Africa, annuities that are paid directly from retirement funds would be subject to the prudential investment guidelines in Regulation 28 which limits exposure to asset classes that offer a high expected return but are subject to volatility (Government Notice R183, 2011). Hence, it is possible that the constrained portfolio would have a lower expected return than the optimal portfolio suggested by Milevsky & Robinson (2000). In the context of institutional retirement investing, Rusconi (2005) used an assumption of 5.0% p.a. before fees, which he stated to be consistent with past experience and future expectations of real investment returns on a balanced portfolio.

7.9.1.4 Investment return assumptions

The three approaches yielded three post-retirement investment return assumptions ranging from approximately 3.0% to approximately 5.0%. The best estimate real investment return

assumption was thus taken as 4.0% and was consistent with purchased annuity investment returns. The pessimistic estimate of 3.0% was taken from the bond yields. An optimistic real investment return of 5.0% was consistent with assumed returns on balanced portfolios (Rusconi, 2005).

7.9.2 Insurer's profit margin

With-profits annuity data (Old Mutual, 2010a) suggested that an annuity with a pricing interest rate of 3.5% and net investment returns of 4.0% delivered a fixed real benefit which implied that the 0.5% margin covered profit margins and other costs not disclosed in the pricing basis. This was estimated to be equal to an upfront profit loading of between 5.1% and 5.3% depending on the sex and age of the annuitant. This was not unreasonable given that Chia & Tsui (2003) allowed for an expense and profit loading of between 4.0% and 10.0% and the calculated profit loading would include all the costs not explicitly given in the publicly available pricing basis. The insurer's profit margin was hence taken to be 0.5% p.a.

7.9.3 Non-investment expenses

Administration fees were set at 2.04% of each annuity payment. The maximum commission on life annuities of 2.0% (excluding VAT) was also levied on the expected present value of monthly income needs. It was not levied on the wealth required to settle the mortgage outstanding at retirement. These assumptions were consistent with disclosed fees and commissions on with-profits annuities (Old Mutual, 2010a).

7.9.4 Mortality

Mortality was ignored in the household before the oldest person retired.

For retired persons, the South African Annuitant Standard Mortality Tables 1996-2000 Male Lives (SAIML98) and the South African Annuitant Standard Mortality Tables 1996-2000 Female Lives (SAIFL98) developed by Dorrington & Tootla (2007) were used for male and female lives respectively.

Mortality improvements were factored through a reduction of one year of age for every twenty years projected from 1998 (Dorrington & Tootla, 2007). Projections were done on an annual basis thus avoiding the need for estimating monthly mortality rates.

For simplicity, mortality was not adjusted for different income bands even though Preston (1975) stated that it was self-evident that income was inversely related to mortality.

SAIML98 and SAIFL98 have a minimum age of 40 which presented a problem for two-person households in the initial model run where some lives would be under the age of 40 when the oldest person retired. Consequently, in the initial model run, the mortality rates from the ASSA 2003 AIDS and Demographic Model (Actuarial Society of South Africa, 2005) were used for persons under the age of 40, the SAML98 and SAIFL98 rates were used for individuals over the age of 60 and the mortality rates were linearly blended between ages 40 and 60. In general, two-person households where there was no age gap had average incomes higher than households where there was an age gap. Households with a five year age gap had incomes 29.3% higher than households with larger age gaps. Hence, there was some justification in blending the SAIML98 and SAIFL98 rates with the heavier ASSA 2003 AIDS and Demographic model (Actuarial Society of South Africa, 2005) rates of mortality.

In the model run performed to estimate the retirement adequacy targets, the minimum age for any individual when the oldest person in the household retired was 40 and hence SAIML98 and SAIFL98 mortality was used without blending.

8 HOUSEHOLDS NOT INCENTIVISED TO SAVE

8.1 Introduction

The primary aim of the research was to estimate targets for households who should be, and are, saving for retirement. Hence, it was important to exclude households that would not benefit from retirement saving. This identification was achieved by performing an initial model run using hypothetical retirement savings rates. For each hypothetical retirement savings rate, the income required to smooth consumption from work to retirement was compared to the minimally adequate income level, both of which were described in Section 5.8. If the minimally adequate income was higher than the consumption-smoothing income at each age in retirement, then the household would be better off relying on the SOAG than smoothing consumption. Due to the means-testing on the SOAG, every rand the household receives as income from pre-retirement savings would decrease the SOAG. These households, described as 'disincentivised', would therefore be economically disadvantaged if they saved for retirement and retirement savings are required to be taken as income.

This result was independent of the post-retirement interest rate and mortality assumptions.

8.2 Households not benefitting from retirement savings

Disincentivised households accounted for between 12.2% and 18.4% of the sample. There was a greater disincentive for lower retirement ages and for higher hypothetical savings rates. The former was a result of the assumption that consumption increases more rapidly pre-retirement than post-retirement and the latter effect was due to savings suppressing pre-retirement consumption. This is shown in Table 8.1.

Table 8.1 Percentage of households disincentivised to save

	Savings rate			
Retirement age	**0.0%**	**12.5%**	**15.0%**	**17.5%**
60	14.8%	17.2%	17.8%	18.4%
63	14.2%	16.4%	16.9%	17.3%
65	13.3%	15.6%	16.0%	16.5%
67	12.7%	14.9%	15.6%	15.8%
70	12.2%	14.2%	15.0%	15.5%

For some households, the disincentivisation was ‘consistent’ for all retirement ages and retirement savings rates. Where the household would benefit from saving under certain scenarios and not in others, it was termed ‘borderline’.

Consistent and borderline disincentivised households represented 12.1% and 7.1% of the sample respectively.

A CHAID analysis indicated that the chief determinant of whether a household would be disincentivised was income followed by age. When considering the dendrogram in Figure 8.1, it was noteworthy that the upper bound for the South African poverty line in March 2006 rands was R9 145.92 p.p.p.a. (Woolard & Liebbrandt, 2006; Statistics South Africa, 2010b).

In order to exclude consistent and borderline disincentivised households, it was decided to exclude households earning under R24 424.50 p.p.p.a. from the target estimation sample.

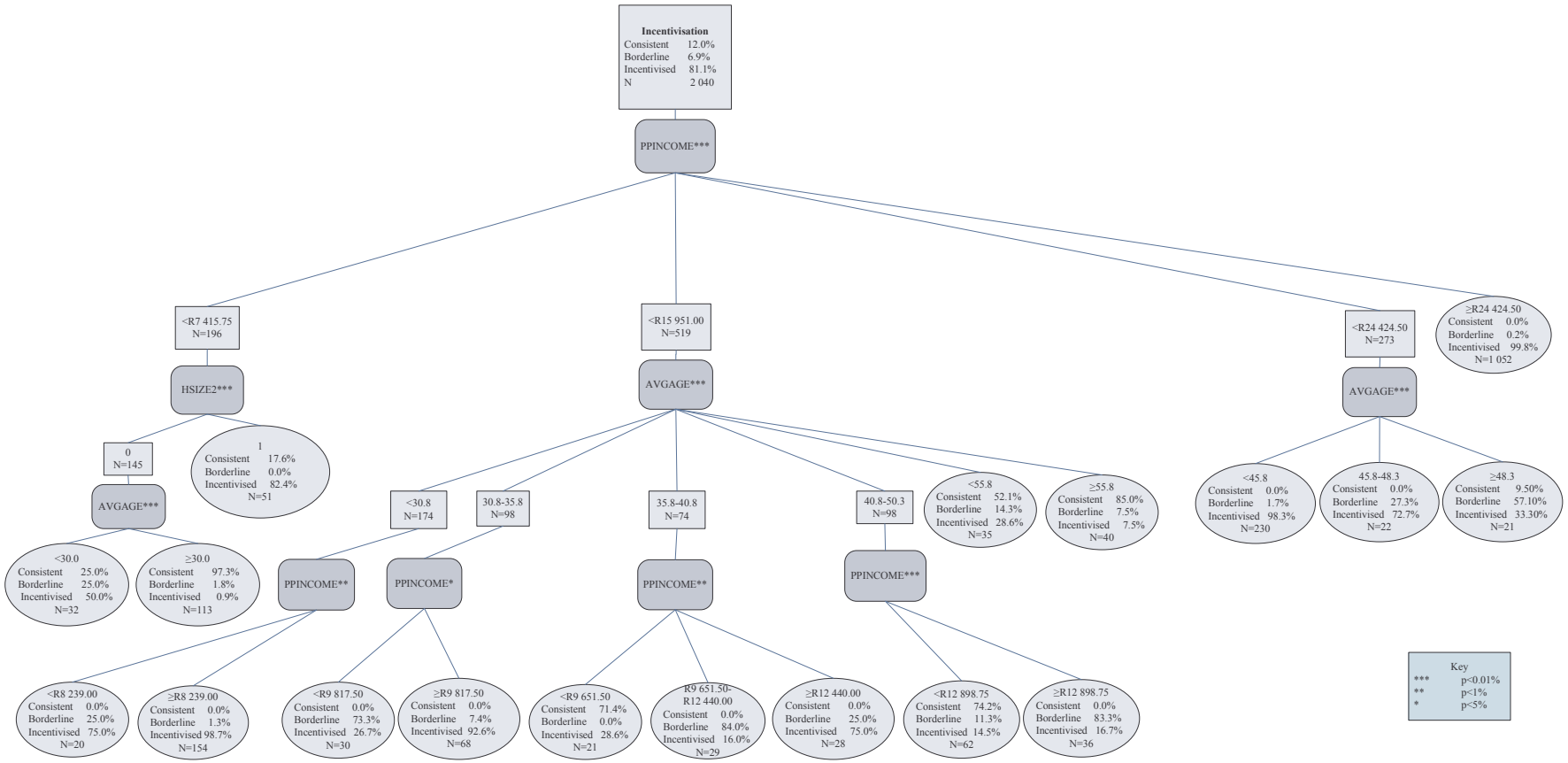


Figure 8.1 Dendrogram of consistent disincentivised, borderline disincentivised and incentivised households

9 STATISTICAL MODELS FOR RETIREMENT ADEQUACY TARGETS

9.1 Introduction

This chapter sets out regression models and interquartile ranges for the retirement adequacy targets. Statistical tests for the sensitivity of the targets to changes in the retirement age and the retirement savings rate are also discussed. Section 9.2 details the results for the best estimate targets without salary support, while Section 9.3 contains the estimates of the value of salary support. Section 9.4 shows how the interquartile ranges vary with the change in the interest rate. Sections 9.5 and 9.6 set out the results of tests to establish how retirement age and retirement savings rates affect the best estimate retirement adequacy targets without salary support.

9.2 Best estimate targets without salary support

As set out in Section 3.6.3, it was necessary to perform a CHAID analysis to detect if the data should be segmented prior to regression modelling. Thereafter, regression analysis was performed and the interquartile ranges of the observed retirement adequacy targets examined.

9.2.1 Categorical data analysis

The CHAID analysis indicated that for retirement ages 63, 65, 67 and 70 households should be segmented into two groups based on household compositions that had statistically significantly different retirement adequacy targets at the 0.01% level:

- Female alone, male-female and female-male households ('Group 1'); and
- Male alone and same-sex couples ('Group 2').

For retirement age 60, income was found to be more significant than household composition but the same household groups were identified as significant at the 5% level for a large sub-group. The dendrograms are given in Figure 9.1 to Figure 9.5.

Hence, using the statistical approach set out in Section 3.6.3, households were segmented into Group 1 and Group 2 households for the regression analysis. For Group 2, the CHAID analysis indicated that segmentation by income p.p.p.a. at the R50 000, R90 000 and R180 000 levels might be necessary.

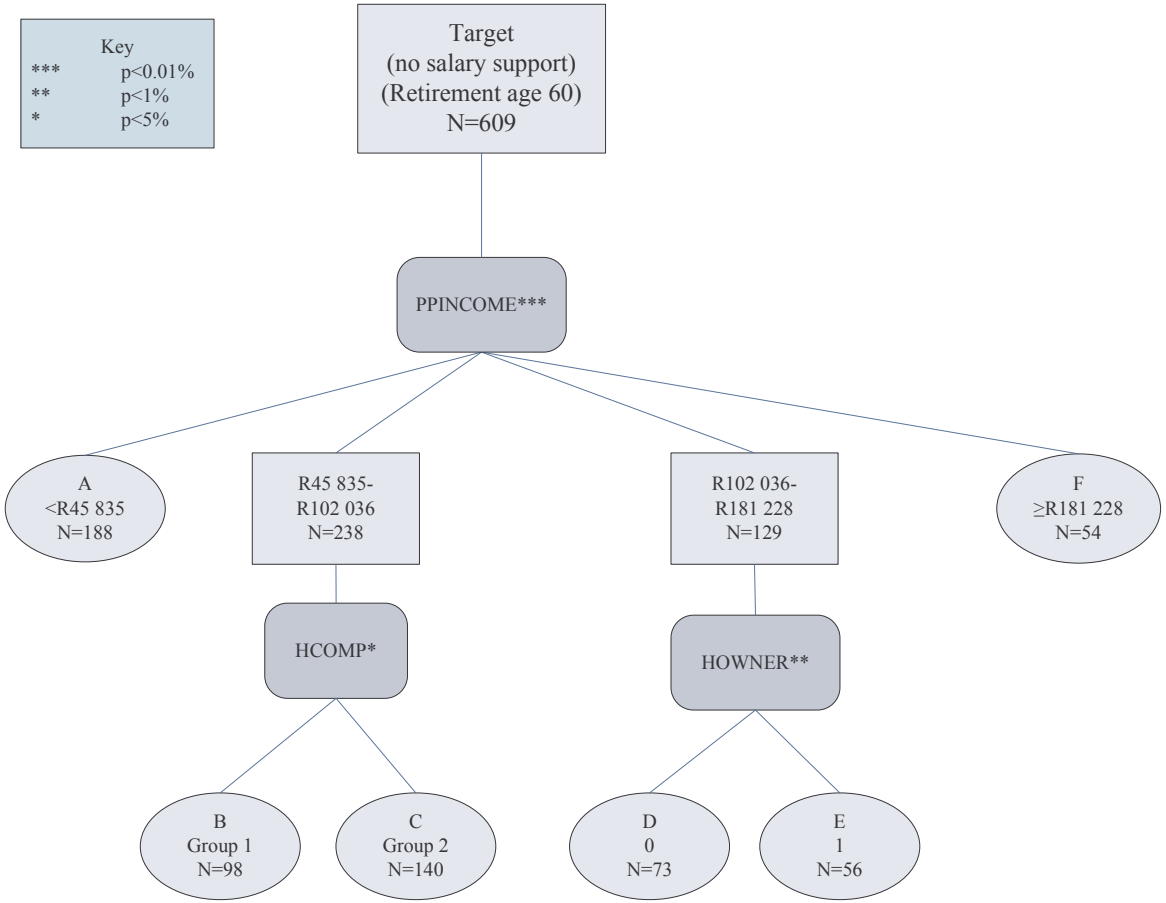


Figure 9.1 Dendrogram of targets for retirement age 60

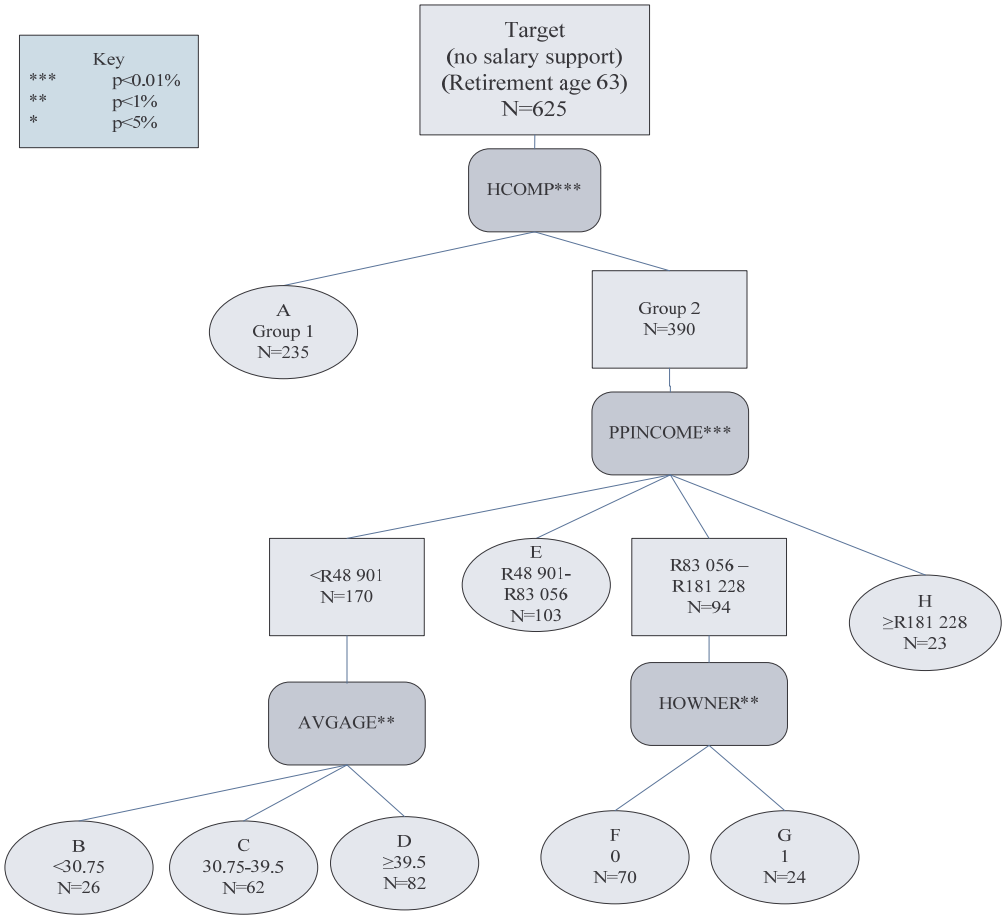


Figure 9.2 Dendrogram of targets for retirement age 63

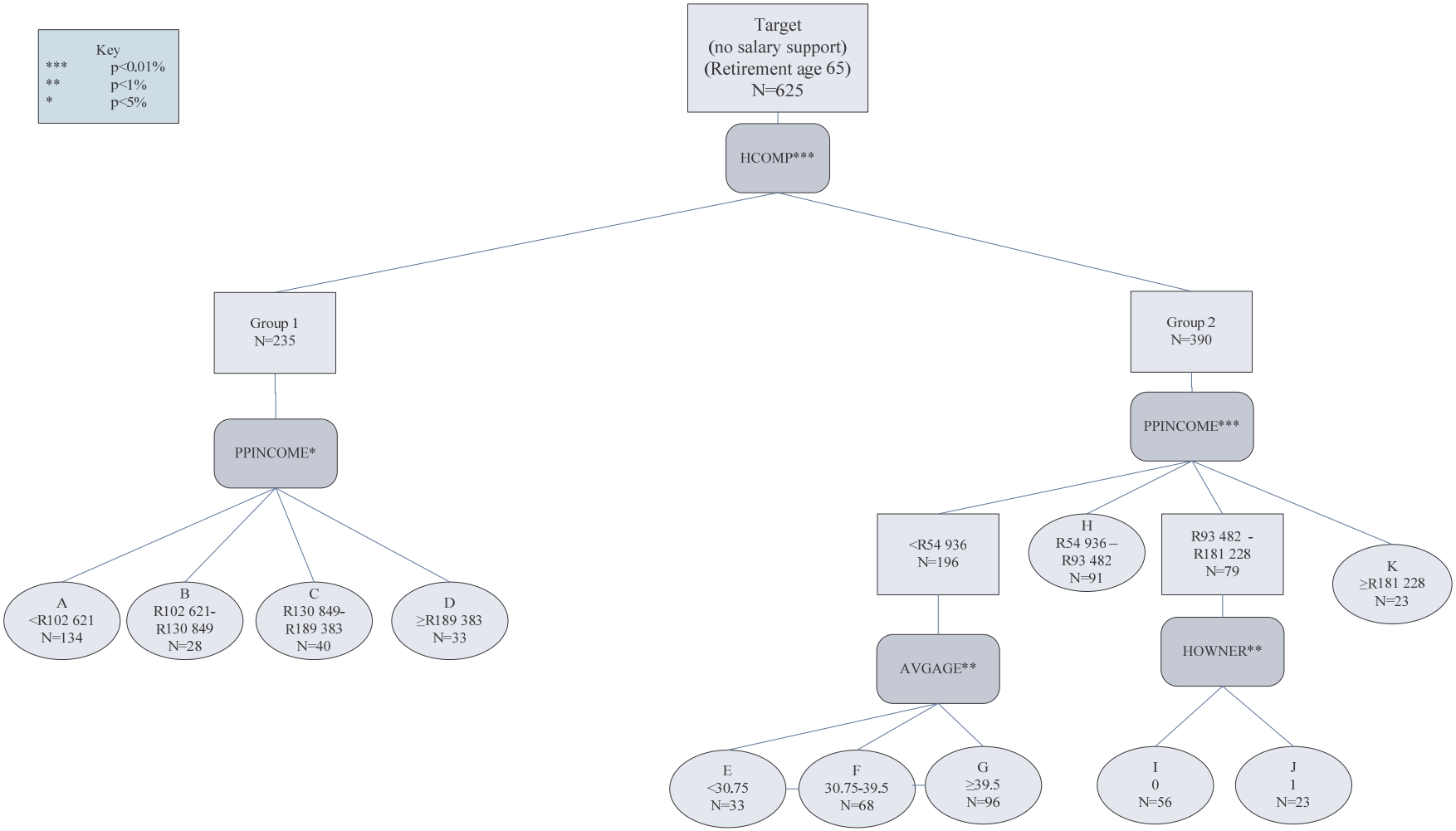


Figure 9.3 Dendrogram of targets for retirement age 65

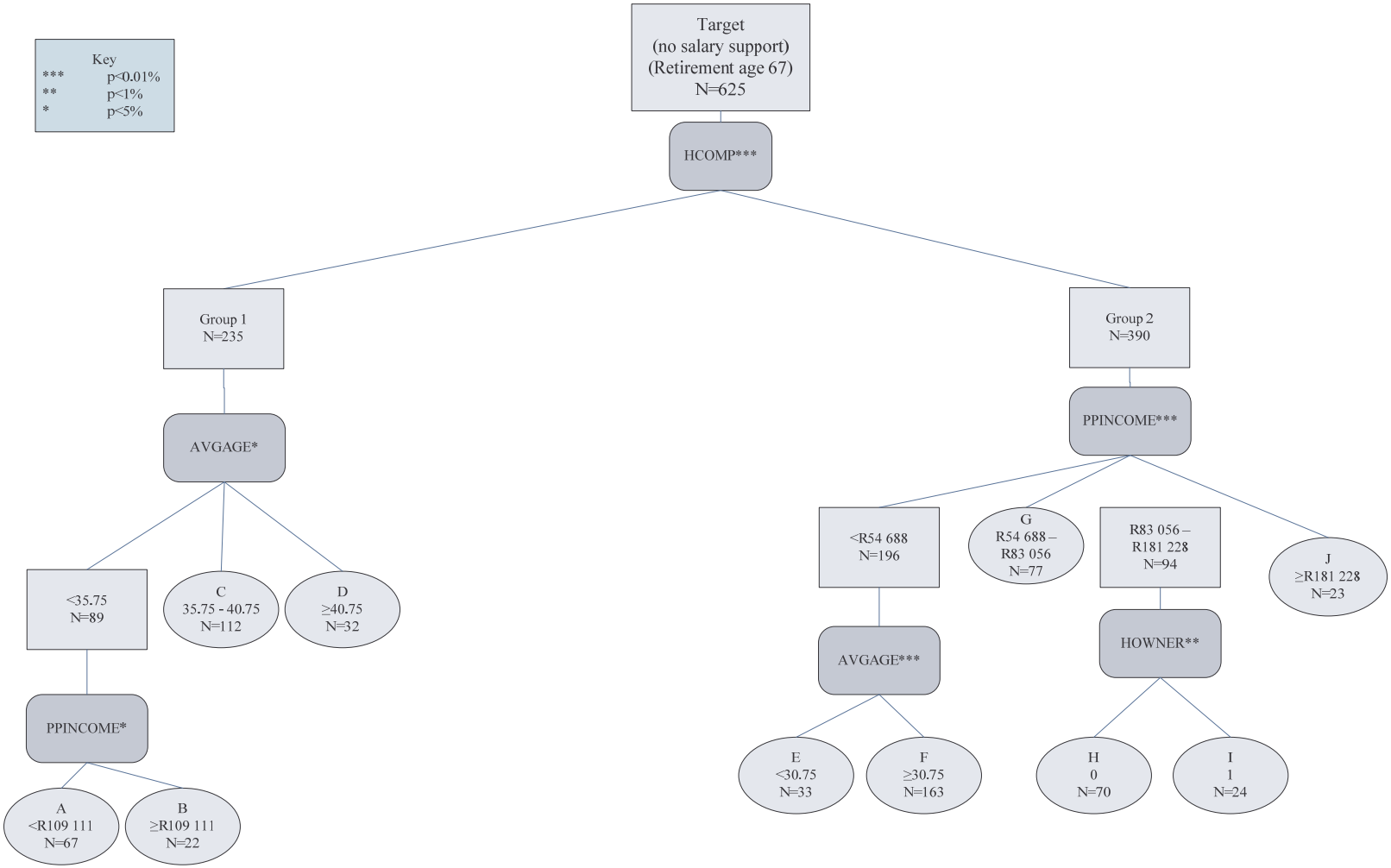


Figure 9.4 Dendrogram of targets for retirement age 67

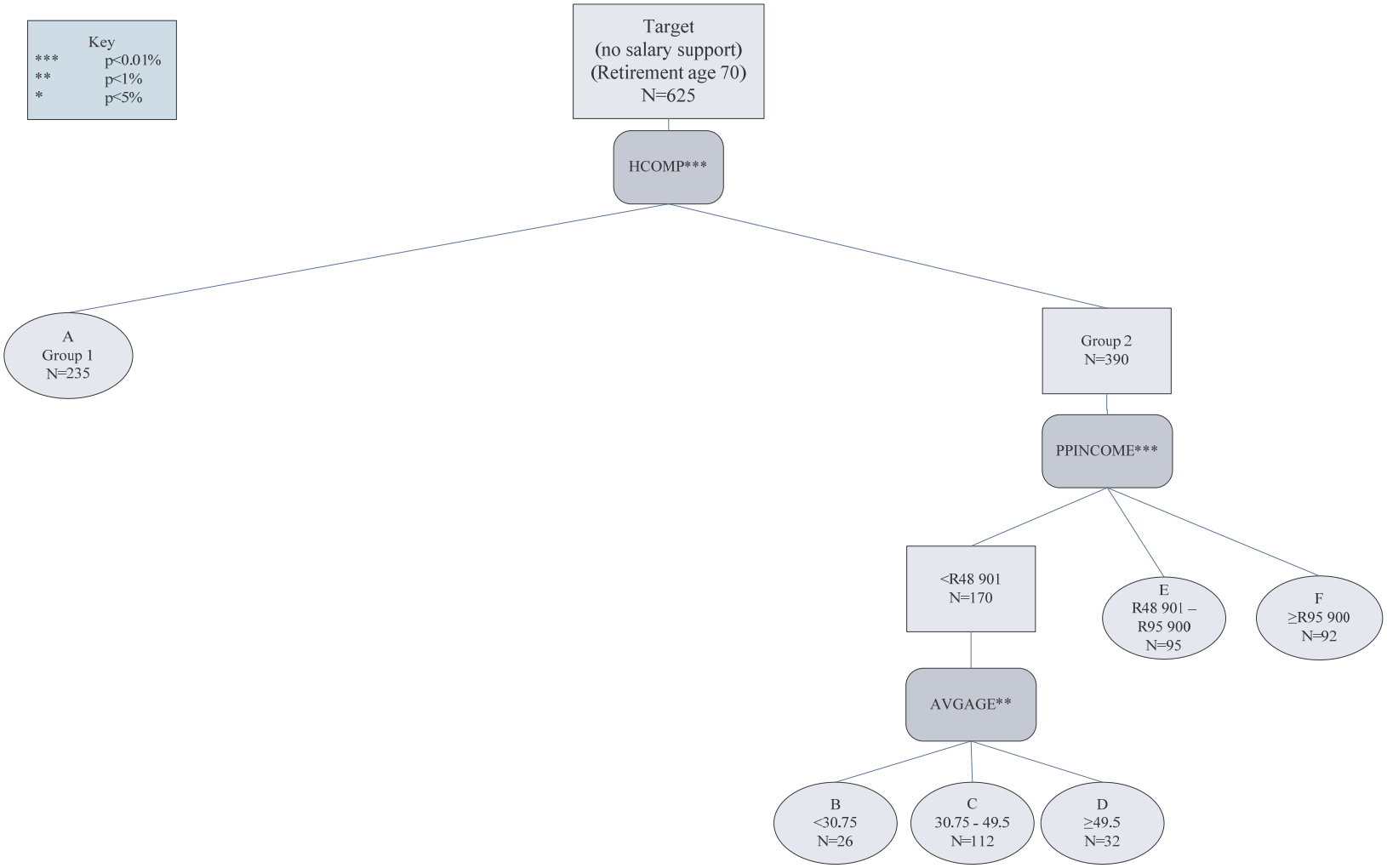


Figure 9.5 Dendrogram of targets for retirement age 70

9.2.2 Regression analysis

9.2.2.1 Group 1 households

For all retirement ages, the target was found to be a linear function of average age and income p.p.p.a., with the target also being influenced by the sex of the head of the household and whether the household was rural or urban. In other words, the model had the form:

$$Target = \hat{\alpha} + \hat{\beta}_1 FEMALE1 + \hat{\beta}_2 RURAL + \hat{\beta}_3 AVGAGE + \hat{\beta}_4 PPINCOME \quad (9.1)$$

Where:

Target is the estimated retirement adequacy target;

$\hat{\alpha}$ is the estimated intercept; and

$\hat{\beta}$ is the estimated slope coefficient for the associated independent variable.

The estimated regression parameters are given in Table 9.1.

Table 9.1 Regression parameters for Group 1 households

	Retirement age									
	60		**63**		**65**		**67**		**70**	
Intercept	13.33	***	12.09	***	11.52	***	10.90	***	10.00	***
FEMALE1	1.15	**	1.13	**	1.20	**	1.11	**	0.86	**
RURAL	-1.30	**	-1.28	**	-1.20	**	-1.15	**	-1.12	**
AVGAGE	0.07	**	0.07	***	0.08	***	0.07	***	0.06	***
PPINCOME	-5.36×10^{-6}	*	-4.25×10^{-6}	*	-4.72×10^{-6}	**	-4.48×10^{-6}	**	-4.32×10^{-6}	**
R^2	0.1224		0.1337		0.1556		0.1529		0.1442	
Model F	7.67	***	8.88	***	10.60	***	10.38	***	9.69	***

* Significant at the 5% level
** Significant at the 1% level
*** Significant at the 0.01% level

9.2.2.2 Group 2 households

In order to obtain normally distributed error terms, the data were segmented into households earning less than R50 000 p.p.p.a. and those earning R50 000 p.p.p.a. or more. A model with normal error terms could not be obtained for the poorer group, although a model was obtained for the wealthier subset and is set out in equation (9.2).

$$Target = \hat{\alpha} + \hat{\beta}_1 HOWNER + \hat{\beta}_2 RSR + \hat{\beta}_3 AGEYOUNG + \hat{\beta}_4 PPINCOME \quad (9.2)$$

Where:

Target is the estimated retirement adequacy target;

$\hat{\alpha}$ is the estimated intercept; and

$\hat{\beta}$ is the estimated slope coefficient for an associated independent variable.

Table 9.3 gives the estimated regression parameters. The age of the youngest household member was significant for retirement ages of 65 and older but not for younger retirement ages.

Table 9.2 Regression parameters for Group 2 households earning R50 000 p.p.p.a. or more

	Retirement age									
	60		**63**		**65**		**67**		**70**	
Intercept	13.78	***	12.63	***	11.29	***	10.64	***	9.66	***
HOWNER	0.78	*	0.75	*	0.70	*	0.66	*	0.63	*
RSR	5.42	**	4.92	**	4.46	**	4.16	**	3.66	*
AGEYOUNG	-		-		0.03	*	0.03	*	0.02	*
PPINCOME	-9.23×10^{-6}	***	-8.55×10^{-6}	***	-8.76×10^{-6}	***	-8.33×10^{-6}	***	-8.43×10^{-6}	***
R^2	0.1134		0.1144		0.1443		0.1442		0.1590	
Model F	8.82	***	8.96	***	8.73	***	8.72	***	9.78	***

* Significant at the 5% level
** Significant at the 1% level
*** Significant at the 0.01% level

9.2.3 Interquartile ranges

The spread of the retirement adequacy targets calculated by the target estimation model was explored using interquartile ranges. The range between the 25th and 75th percentiles for the three household groups identified by the CHAID analysis is given in Table 9.3.

Table 9.3. Interquartile ranges for best estimate targets without salary support

	Retirement age				
	60	**63**	**65**	**67**	**70**
Group 1	13.9-17.0	12.9-15.9	12.6-15.5	11.9-14.7	10.7-13.3
N	226	236			
Group 2 earning less than R50 000 p.p.p.a.	13.4-14.6	12.3-13.4	12.3-13.1	11.6-12.4	10.6-11.3
N	172	177			
Group 2 earning R50 000 p.p.p.a. or more	12.2-14.2	11.1-13.0	10.8-12.7	10.2-12	9.1-10.8
N	214	215			

The segmentation suggested by the CHAID analysis was not intuitive. In order to make the results of this research more understandable to individuals, who might wish to use them for financial planning purposes, the upper-quartile values for the retirement adequacy targets

calculated by the target estimation model were found for each household composition. These values are set out in Table 9.4.

Table 9.4 Seventy-fifth percentile of the best estimate retirement adequacy targets

	Retirement age				
	60	**63**	**65**	**67**	**70**
Single females	18.2	16.9	16.6	15.7	14.3
Single males	14.3	13.2	12.9	12.2	11.1
Male-female and female-male (no salary support)	16.5	15.4	15.1	14.3	12.8
Male-male and female-female (no salary support)	15.8	14.6	14.1	13.2	12.1
Male-female and female-male (salary support)	15.1	14.0	13.7	12.9	11.7
Male-male and female-female (salary support)	14.0	12.8	12.4	11.7	10.5

9.3 The effect of salary support on the targets on a best estimate basis

Salary support was defined as the wages or salary earned by the working person in a semi-retired household. The impact of salary support on the retirement adequacy targets was estimated by subtracting the estimated retirement adequacy target for a household allowing for salary support from the estimated retirement adequacy target not allowing for salary support.

9.3.1 Categorical data analysis

There were only 100 two-person households in the sample where the individuals fell into different age categories and hence salary support would be relevant. Due to the small sample size, the CHAID analysis only revealed that the percentage of income earned by the older person was significant at the 0.01% level.

9.3.2 Regression analysis

After eliminating outliers, the model described in equation (9.3) was found to be consistent for various retirement ages:

$$SS = \hat{\alpha} + \hat{\beta}_1 AGEGAP + \hat{\beta}_2 PPINCOME + \hat{\beta}_3 FEMALE1 + \hat{\beta}_4 YRSED1 + \hat{\beta}_5 INCPOLD \qquad (9.3)$$

Where:

SS is the estimated effect of salary support on the retirement adequacy targets;

$\hat{\alpha}$ is the estimated intercept; and

$\hat{\beta}$ is the estimated slope coefficient for the associated independent variable.

The regression parameters are given in Table 9.5.

Table 9.5 Regression parameters for the effect of salary support on the targets on a best estimate basis

	Retirement age				
	60	**63**	**65**	**67**	**70**
Intercept	3.70 ***	3.59 ***	3.53 ***	3.22 ***	3.47 ***
GAP	0.34 ***	0.32 ***	0.32 ***	0.28 ***	0.28 ***
PPINCOME	5.06×10^{-7} *	6.32×10^{-7} **	6.60×10^{-7} **	5.69×10^{-7} **	4.75×10^{-7} *
FEMALE1	0.10 *	0.11 *	0.12 *	0.13 **	0.12 *
YRSED1	0.02 **	0.02 *	0.02 *	0.02 *	0.02 **
INCPOLD	-5.69 ***	-5.45 ***	-5.37 ***	-4.86 ***	-5.07 ***
R^2	0.9866	0.9822	0.9793	0.9786	0.9765
Model F	1176.22 ***	905.19 ***	665.65 ***	750.45 ***	682.01 ***

* Significant at the 5% level
** Significant at the 1% level
*** Significant at the 0.01% level

9.3.3 Interquartile ranges

The range of the effect of salary support on the retirement adequacy targets from the 25th to the 75th percentile is given in Table 9.6.

Table 9.6 Interquartile ranges for the effect of salary support on the targets

	Retirement age				
	60	**63**	**65**	**67**	**70**
Salary Support	2.2-3.5	2.1-3.3	2.1-3.2	1.9-2.8	2.0-3.0
N	98	100			

9.4 Sensitivity of the results to the interest rate

The impact of a change in the interest rate on the targets and the effect of salary support can be observed by consideration of the interquartile ranges. The interquartile ranges for the targets are given in Table 9.7.

Table 9.7 Interquartile ranges of targets for various interest rate assumptions

Household composition	Basis	Retirement age				
		60	63	65	67	70
Group 1	Pessimistic	15.5-19.2	14.4-17.7	14.0-17.3	13.1-16.3	11.7-14.5
	Best estimate	13.9-17.0	12.9-15.9	12.6-15.5	11.9-14.7	10.7-13.3
	Optimistic	12.5-15.3	11.7-14.4	11.4-14.1	10.8-13.4	9.9-12.2
	N	226	236			
Group 2 earning less than R50 000 p.p.p.a.	Pessimistic	14.8-16.2	13.6-14.8	13.5-14.4	12.6-13.6	11.4-12.3
	Best estimate	13.4-14.6	12.3-13.4	12.3-13.1	11.6-12.4	10.6-11.3
	Optimistic	12.1-13.3	11.3-12.3	11.3-12	10.7-11.4	9.8-10.5
	N	172	177			
Group 2 earning more than R50 000 p.p.p.a.	Pessimistic	13.5-15.8	12.3-14.3	12.0-14.0	11.2-13.1	9.9-11.7
	Best estimate	12.2-14.2	11.1-13	10.8-12.7	10.2-12	9.1-10.8
	Optimistic	11-12.9	10.2-11.9	9.9-11.7	9.4-11	8.4-10.1
	N	214	215			

The interquartile ranges for the impact of salary support on the retirement adequacy targets at various retirement ages and on the three interest rate bases are given in Table 9.8.

Table 9.8 Interquartile ranges of the effects of salary support for various interest rate assumptions

	Retirement age				
	60	63	65	67	70
Pessimistic	2.2-3.6	2.2-3.5	2.2-3.4	1.9-3.0	2.1-3.2
Best estimate	2.2-3.5	2.1-3.3	2.1-3.2	1.9-2.8	2.0-3.0
Optimistic	2.1-3.3	2.1-3.1	2.1-3.1	1.8-2.8	2.0-2.9
N	98	100			

9.5 Repeated measures ANOVA and *post-hoc* tests for retirement age effects

As outlined in Section 3.6.4, repeated measures ANOVA tests were performed at a household level to test whether increasing the retirement age impacted on the target. Retirement age was found to be significant at the 0.01% level as shown in Table 9.9.

Table 9.9 Test for retirement age fixed effect

	Group 1		Group 2 earning less than R50 000 p.p.p.a.		Group 2 earning more than R50 000 p.p.p.a.	
Effect	**F Value**	**Degrees of freedom**	**F Value**	**Degrees of freedom**	**F Value**	**Degrees of freedom**
Retirement Age	5 143.00 ***	4 , 926	5 215.41 ***	4,695	4 952.80 ***	4 , 851

* Significant at the 5% level
** Significant at the 1% level
*** Significant at the 0.01% level

The pairwise comparisons of means using a Bonferroni adjustment showed that as retirement age increased, the target decreased as indicated in Table 9.10.

Table 9.10 Change in target least square mean for a change in retirement age

	Group 1	Group 2 earning less than R50 000 p.p.p.a.	Group 2 earning more than R50 000 p.p.p.a.
60 to 63	-1.2***	-1.1***	-1.1***
60 to 65	-1.5***	-1.4***	-1.4***
60 to 67	-2.3***	-2.1***	-2.1***
60 to 70	-3.6***	-3.2***	-3.3***
63 to 65	-0.3***	-0.2***	-0.3***
63 to 67	-1.1***	-1.0***	-1.0***
63 to 70	-2.5***	-2.0***	-2.2***
65 to 67	-0.8***	-0.7***	-0.7***
65 to 70	-2.1***	-1.8***	-1.9***
67 to 70	-1.3***	-1.1***	-1.2***

* Significant at the 5% level
** Significant at the 1% level
*** Significant at the 0.01% level

9.6 Repeated measures ANOVA and *post-hoc* tests for retirement savings rate and retirement age effects

Using the simulated targets for hypothetical retirement savings rates and retirement ages, it was possible to assess the impact of varying both retirement age and savings rate using a repeated measures ANOVA test. Both these factors and their interaction were found to be significant at the 0.01% level as shown in Table 9.11.

Table 9.11 Tests for fixed effects of hypothetical retirement savings rate and retirement age

	Group 1		Group 2 earning less than R50 000 p.p.p.a.		Group 2 earning more than R50 000 p.p.p.a.	
Effect	**F Value**	**Degrees of freedom**	**F Value**	**Degrees of freedom**	**F Value**	**Degrees of freedom**
Retirement age	19 660.0***	4 , 4 406	16 756.5***	4,3 305	18 375.5***	4 , 4 043
Retirement savings rate	14 213.3***	3 , 4 406	12 725.8***	3,3 305	11 070.0***	3 , 4 043
Retirement age* Retirement savings rate	30.92***	12 , 4 406	20.92***	12,3 305	28.92***	12 , 4 043

* Significant at the 5% level
** Significant at the 1% level
*** Significant at the 0.01% level

The differences in least squares means indicated that as retirement age and savings rates increase, the target may decrease. The results are given in Appendix J.

10 DISCUSSION

10.1 Definitions of adequacy and expression of the adequacy targets

10.1.1 Definition of adequacy

An adequate income was defined as an amount sufficient to smooth consumption at retirement or to provide for a minimally adequate level of consumption if higher. As outlined in Chapter 8, the use of the compound definition of adequacy provided useful insight into which households would benefit from saving for retirement as opposed to relying fully on the SOAG. Although some relatively young households earning relatively little were projected to benefit from saving for retirement, most households earning under R24 424.50 p.p.p.a. would have a higher living standard if they relied on the SOAG as opposed to saving for retirement. The minimum income level in March 2006 terms at which saving for retirement was beneficial was R24 424.50 p.p.p.a. Even without allowing for inflationary adjustments, this was more than twice as high as the R12 000 p.p.p.a. minimum suggested by the Department of Social Development (2007b). National Treasury (2007) did not suggest a lower income limit for mandatory savings but suggested that wage subsidies should be provided for people with annual earnings of less than R15 000. The variation in these lower limits suggests that further research is required to establish which low income households should save for retirement.

The definition of adequacy was also useful for estimating targets for households that may otherwise consume below the minimally adequate level during the early years of retirement and for whom consumption-smoothing approaches would under-estimate the retirement adequacy target.

10.1.2 Expression of retirement adequacy targets

The wealth-earnings ratio was preferred to the replacement ratio for expressing retirement adequacy targets for three reasons.

Firstly, replacement ratio retirement adequacy targets are very sensitive to the value of the annuity factor used in the divisor which is in turn dependent on the annuity increase assumptions. Anecdotal evidence suggested that pensioners do not find annuities that match

their needs over time. The Old Mutual Retirement Monitor (Old Mutual, 2010c) suggested that 40% of the 200 pensioners surveyed experienced a reduction in living standards during retirement.

Secondly, the sensitivity of the replacement ratios to the annuity factor creates a number of presentational problems which are difficult to explain to individuals. For example, the same replacement ratio target would be more expensive for a woman to obtain than a man, which may create confusion for individuals trying to assess their retirement readiness against the retirement adequacy target.

Thirdly, wealth-earnings ratios are consistent with DC retirement fund benefit statements. It is easier for individuals to gauge the adequacy of their savings against wealth-earnings targets, particularly if they have more than one retirement savings vehicle. This is because wealth-earnings do not require individuals to have access to annuity rates and understand the features of the annuities to which the rates apply. The targets themselves are also easy to interpret as a multiple of salary.

Current earnings at retirement were used in the denominator not only due to theoretical soundness but also because it avoided the difficulty of calculating lifetime earnings in a country with high periodic unemployment.

In summary, wealth-earnings ratios are theoretically sound and while still sensitive to investment return and mortality assumptions, they avoid the difficulty in ascertaining appropriate annuity assumptions and conveying these assumptions.

10.2 Changes in consumption and savings at retirement

10.2.1 Methodology

The CHAID analysis was more sophisticated than the matched-pairs methodology used by Palmer (1989; 1992; 1994; 2008) that matched households only by income and household composition. The CHAID analysis suggested that income (including income in kind), medical scheme membership, home ownership status, dwelling value and education of household head were also significant. The resultant matching was more complex than was

suggested by any of the literature. In contrast to Cook & Settersten (1995) and Banks, Blundell & Tanner (1998), no significant age effect on consumption was detected.

10.2.2 Healthcare expenditure

Households where at least one person was a medical scheme member did not experience a significant increase in healthcare expenditure as age increased or work-status changed. For households without medical scheme insurance and with male household heads, retirement was associated with an increase in healthcare expenditure which was significant for some households. It is possible that this was not a true work-status effect: some retirements may have been due to ill-health which would be associated with higher healthcare costs around the time of retirement. When combined with the fact that the retired households were on average older than the working households, this may have caused the CHAID to detect a work-status effect instead of an age effect. Although self-reported health-status can be subject to bias (Case & Deaton, 2005), having access to this information and including it in the analysis may have been beneficial, and would have been consistent with Hurd & Rohwedder (2005).

Detection of sex of the head of the household as a significant determinant of healthcare expenditure was considered an unusual finding. This may have been a result of confounding as sex of the household head is linked to the sex of the household members and sex is strongly associated with healthcare expenditure (Paulin, 2000) and the rate of increase of healthcare expenditure in old age (Petertil, 2005).

The increase in healthcare expenditure appeared to be funded from retirement savings that are no longer required in retirement. For incentivised households that experienced an increase in healthcare expenditure on retirement, the increase in annual healthcare consumption was equal to approximately 59.2% of the annual retirement savings, which indicated that it is feasible for the increase in healthcare consumption on retirement to have no impact on other consumption.

10.2.3 Non-healthcare consumption, including gifting

Non-healthcare consumption was unaffected by age and work-status in general, but was influenced by income and dwelling value. This suggested that any observed drop in consumption at or in retirement was a result of financial necessity.

Consideration of gifting patterns, a type of non-healthcare consumption, revealed that for most households neither age nor work-status influenced the gifting level. Where work-status was significant, it was found that gifting decreased on retirement. This was contrary to the findings of Dexter (1984) and Palmer (1992). The households in the model development sample that had a significant reduction in gifting at retirement earned between approximately R5 500 and R56 000 p.p.p.a., and it was hypothesised that during their working lives these households support other family members, as per Maitra & Ray (2003), and that these transfers would cease in retirement. This was supported by the model development sample data that suggested that for households in this income bracket, on average, each person in working and retired households supported 2.5 and 0.1 people, respectively. The wealthiest 4.7% of households in the model development sample displayed an increase in gifting on retirement; however, this was not found to be statistically significant.

In summary, non-healthcare consumption was not found to change with age or work-status in contrast to the view that certain work-related expenditures need not be replaced in retirement. The results of this research show that non-healthcare consumption does not decrease on retirement if income does not change and all other demographic characteristics are taken into account.

10.2.4 Non-retirement savings

It was interesting to note that there was no age or work-status effect on non-retirement savings. This was significant as it suggested that if income levels were high enough, pensioners would continue to save. These savings could be precautionary or bequest-related.

The retirement adequacy targets derived in this research did not include provision for precautionary savings. The targets could be approximately adjusted for precautionary savings by multiplying by one plus the ratio of non-retirement savings to consumption. As presented in Sections 4.8.7 and 4.8.8, the total estimated consumption rate and non-retirement savings rates are 69.2% and 10.4% respectively; this suggested that targets would be adjusted upwards by approximately 15.0% on average. However, this means that individuals would require approximately 15.0% more income, which may increase the marginal tax rate. Hence, this adjustment may under-estimate the required target.

10.2.5 Tax

Antler & Kahane (1987) stressed the importance of considering the differences in taxation for working and retired households. However, in South Africa reduced tax rates are a function of age and not of work-status, and the earliest benefit is seen only at age 65. Hence, the expected tax rate over the future lifetime of individuals retiring before age 65 may be lower than their current tax rate if income is held constant. However, there would be not necessarily be a sharp drop in tax liability at retirement. It is possible for individuals retiring at age 65 to have a sudden drop in their marginal tax rate. However, the size of the effect would be influenced by the exact age at retirement and the timing of their birthday relative to the tax year end date. If income were to drop, the marginal tax rate would decrease immediately. However, the analysis provided in Sections 10.2.2 and 10.2.3 indicates that there is no reason to believe that a reduced income in retirement would be adequate. Hence, there is no reason to assume there will be a decrease in taxation at retirement.

10.2.6 Summary

Apart from retirement savings, there is no reason to assume that a household that retires would have gross income needs any lower than an identical household that continues working.

10.3 Estimation of targets

An adjusted TSE model was used to estimate the targets. This model can be reparameterised easily and can be adjusted for changes to the tax and social security regimes. The retirement adequacy targets estimated in this research may be subject to criticism based on the data quality and sample size and as well as the sample definition and sensitivity to assumptions, which are discussed in turn as follows.

10.3.1 Data quality and sample size

The retirement adequacy targets were calculated for the target estimation sample, which was a small sub-sample from IES 2005/2006. Thirty percent of working households in the model development sample were used to arrive at the estimates. The size of the sample was a reflection of the controls employed to ensure, firstly, the integrity of the data and, secondly,

that the households used were appropriate in terms of restrictions discussed in the literature, as delineated in Sections 2.5.8 and 2.6.2. It is important to note that the data used in the analysis was thoroughly checked for reasonability and the sample size, although small, produced statistically significant results. A larger sample could have been used, however, this would have compromised the data integrity and hence the results of the research.

10.3.2 Sample definition

Completely removing children from the sample avoided complicated adjustments for childcare costs, typically assumed to reduce in retirement (Engen, Gale & Uccello, 1999). However, it introduced the implicit assumption that, once children leave home, consumption patterns return to the levels they were before the birth of children. Stoller & Stoller (2003) suggested that consumption levels may be higher for empty-nesters due to gifting behaviour. The target estimation sample may have included both childless households and households with grown children who had left home. If Stoller & Stoller (2003) are correct, the resultant targets would be sensitive to the mix of these households in both the model development sample and the target estimation samples. There is no logical reason to associate the cessation of childcare costs with retirement. In certain households, childcare costs may cease well before retirement, while in others they continue for years into retirement.

10.3.3 Sensitivity to assumptions

The estimated targets were found to be extremely sensitive to changes in the interest rate assumption, particularly at early retirement ages. A two percent adjustment to the interest rate resulted in non-overlapping interquartile ranges for retirement ages 60 and 63 across all household types. Group 2 households earning less than R50 000 p.p.p.a. were found to have targets that were extremely sensitive to this assumption. This was somewhat surprising given the lower life expectancy of males which would shorten the duration of the payments relative to Group 1 households. From a retirement planning perspective, short-term changes in interest rates may cause fluctuations in annuity rates and wealth which may, in turn, influence the individual's ability to secure an adequate income in retirement. Ensuring that pre-retirement and post-retirement investment strategies are matched would reduce this effect.

10.4 Effect of retirement age and retirement savings rate on the target

10.4.1 Retirement age

The repeated measures ANOVA confirmed what was suggested by the regression parameters: as retirement age increases, the targets decrease. The smallest reduction was observed for increasing the retirement age from 63 to 65. For all household types, the reductions were an increasing function of the deferment period.

This was consistent with the findings of Mitchell & Moore (1998) for single males but the opposite of what Mitchell & Moore (1998) found for other household types. However, it should be noted that Mitchell & Moore (1998) used replacement ratios and not wealth-earnings ratios. The model output in this research indicated that consumption rose as retirement age increased but the corresponding annuity factor required to calculate the replacement ratio decreased. Consequently, the replacement ratio equivalents of the targets were found to be fully consistent with Mitchell & Moore (1998).

For Group 2 households earning over R50 000 p.p.p.a. and Group 1 households, the reductions were also an increasing function of the retirement age, as shown in Table 10.1.

Table 10.1 Reduction in the best estimate target for deferred retirement

		Years retirement deferred					
Household type	**Retirement age**	**2**	**3**	**4**	**5**	**7**	**10**
Group 1	60		-1.2		-1.5	-2.3	-3.6
	63	-0.3		-1.1		-2.5	
	65	-0.8			-2.1		
	67		-1.3				
Group 2 earning more than R50 000 p.p.p.a.	60		-1.1		-1.4	-2.1	-3.3
	63	-0.3		-1.0		-2.2	
	65	-0.7			-1.9		
	67		-1.2				

For Group 2 households earning less than R50 000 p.p.p.a., the relationship between initial retirement age and the reduction in the target was not as clearly defined.

The salary support provided during semi-retirement reduced the targets for two reasons. Firstly, semi-retirement deferred retirement where the younger person earned enough to support the household, or at least substantially reduced the pension income needs in the first few years of retirement. Secondly, the model incorporated the assumption that spending was constant in real terms, as opposed to rising with salary inflation, once the household entered the semi-retirement phase. Hence, semi-retirement, like retirement, had the effect of reducing the consumption trajectory relative to what it would have been had the household remained working. The median reduction in target for various retirement ages is given in Table 10.2. Given the small number of households with age gaps of ten years or more, the reductions in the retirement adequacy targets due to large age gaps should be interpreted with caution.

Table 10.2 Median reduction in the best estimate target due to salary support

	Age gap							
	5		**10**		**15**		**20**	
Older person's retirement age	**Reduction in target**	**N**	**Reduction in target**	**N**	**Reduction in target**	**N**	**Reduction in target**	**N**
60	-2.6	72	-4.0	14	-5.0	8	-5.8	4
63	-2.5	74	-3.9		-4.8		-5.4	
65	-2.5		-3.8		-4.7		-5.4	
67	-2.2		-3.4		-4.1		-4.8	
70	-2.4		-3.6		-4.3		-4.7	

Hence, deferring retirement and allowing for salary support may significantly reduce adequacy targets expressed as wealth-earnings targets.

10.4.2 Retirement savings rate

The repeated measures ANOVA on the hypothetical savings rate indicated that the model was calculating targets correctly, and that retirement adequacy targets decreased as the retirement savings rate increased as per Mitchell & Moore (1998).

However, when regression models were used to estimate targets from actual household savings rates, the results strongly contradicted the results of the tests using hypothetical savings rates. For Group 1 households, retirement savings rates were not found to be significant at all, while for Group 2 households earning more than R50 000 p.p.p.a., a 10.0%

additive increase in the retirement savings rate was found to increase the target by 0.4 to 0.5 times annual salary. Due to non-normality of error terms, it was not possible to ascertain the impact of the retirement savings rate for poorer Group 2 households.

Under the Mitchell & Moore (1998) model, increasing retirement savings would make adequacy targets easier to obtain by lowering the target itself as well as increasing the rate of wealth accumulation. The results of the regression analysis in this research showed that increasing retirement savings may not reduce the target.

This unusual finding may in fact be a result of a combination of the factors outlined below.

10.4.2.1 Reporting errors

Savings and debt data in the IES were known to be poorly captured as discussed in Section 4.2.2.6.

10.4.2.2 Confounding and spurious selection

The retirement savings rate was not found to be strongly correlated with any of the other regression parameters. However, there may have been other factors that were not included in the model but which may have had an impact on the target and be strongly correlated with the retirement savings rate. For example, relative to an informally employed person, a formally employed person may have greater access to retirement savings vehicles and greater ability to contribute to these vehicles given the stability of their income. If the formally employed person also has a higher consumption rate, then the retirement savings rate and the targets will be positively correlated, even though the difference is a result of employment type.

10.4.2.3 Model error

Reality may be more complex than the basic economic model suggested by Mitchell & Moore (1998), even allowing for the interaction between retirement savings and non-retirement savings suggested by Aron & Meullbauer (2000). The poor IES 2005/2006 debt data meant that debt financing and the interaction between debt and savings could not be appropriately modelled. It is noteworthy that Mitchell & Moore (1998) used hypothetical savings rates in their model and not actual savings rates as in this research. It is possible that

real households react to increases in retirement savings rates in ways other than reducing consumption.

10.4.2.4 Summary

Although a repeated measures ANOVA test indicated that higher savings rates are associated with lower targets using hypothetical savings rates, retirement adequacy targets modelled from real household savings data does not support this relationship. It is possible that the interaction between savings and consumption is much more complex than a simple substitution.

10.5 Factors that influence the targets

The impact of retirement age and retirement savings rates on the targets is discussed in Section 10.4. It is difficult to comment on how various factors influence targets for Group 2 households earning under R50 000 p.p.p.a. as an examination of simple correlations may have given spurious results. In addition, there were only 35 same-sex couples and seven female-male households in the target estimation sample and these samples were too small to arrive at any firm conclusions. The factors influencing targets for the other household groups are discussed further in this section.

10.5.1 Factors that influence the targets without salary support

The CHAID analysis indicated a difference in the distribution of retirement adequacy targets for different types of households that was supported by different interquartile target ranges. The different regression independent variables confirmed that different household types had retirement adequacy targets that were influenced by different factors. The results suggested that targets for the following household groups were different:

- Male-female households in rural areas;
- Male-female households in urban areas;
- Single female and female-male households in rural areas;
- Single female and female-male households in urban areas;
- Single male and same-sex households earning less than R50 000 p.p.p.a.;
- Single male and same-sex households earning more than R50 000 p.p.p.a that rent; and

– Single male and same-sex households earning more than R50 000 p.p.p.a that own their homes outright or with a mortgage.

10.5.1.1 Income

A negative relationship was observed between income and the retirement adequacy targets for Group 1 households and wealthier Group 2 households. This effect, discussed in Section 2.8.1, is well-documented in the literature. It was interesting to note that the targets for the wealthier Group 2 households were much more sensitive to income than the targets for Group 1 households. This may be due to the fact that the Group 1 households were wealthier with average incomes of R120 231.62 p.p.p.a. relative to the average for wealthier Group 2 households which was R111 445.95 p.p.p.a. This concurred with findings from Palmer (1994; 2008) and Hatcher (1997) that sensitivity to income decreases as income increases.

Hence, single male and same-sex households earning over R50 000 p.p.p.a. and single female, male-female, female-male households at all income levels were found to have targets that decreased with income.

10.5.1.2 Age

The fact that the targets increase with average age in Group 1 households, and with the age of the youngest person in wealthier Group 2 households for retirement ages over 65, was somewhat surprising given that with longevity improvements one would expect targets to increase with longer projection periods and not shorter ones. However, this may be a hidden mortgage effect as the probability of repaying a mortgage before retirement would decrease with increasing age. Older ages were also positively correlated with having a mortgage and with the value of the dwelling, which directly impacts the balance outstanding. There were only 90 mortgage holders in the sample of 625, and hence this hypothesis could not be tested.

10.5.1.3 Home ownership

For wealthier Group 2 households, the targets increased if a person owned or mortgaged their home as opposed to renting it.

This unusual result could be the result of the interaction between mortgage holding and home ownership, in that all mortgage holders are home owners and mortgage holders may have unpaid housing debt at retirement.

A second possible explanation is that owners tended to have higher dwelling values as a multiple of annual salary than renters, and this may have influenced other consumption behaviour such as paying higher maintenance costs, rates and taxes. The dwelling value to annual salary ratio for wealthy Group 2 households was 0.8 for renters and 1.4 for owners, which supported this hypothesis.

Another explanation is that home ownership is a proxy variable for a number of other variables that were not measured.

In summary, single male and same-sex households earning more than R50 000 p.p.p.a. and who rented had lower targets than those who owned their homes outright or with a mortgage.

10.5.1.4 Female head of household

Having a female head of household increased the target for Group 1 households. It should be noted that there were only 7 female-male households in the Group 1 sample, and hence this result may reflect that the cost of providing an annuity for a single female life is greater than that for a male-female or female-male couple, due to the fact that females have lighter mortality than males.

Sex of the head of the household is not typically considered in target adequacy research and is typically taken to be male. However, according to the weighted IES 2005/2006 data, 38.9% of households are female-headed. Hence, the dynamics around the sex of the household head may require further investigation using a larger sample.

Although it is difficult to draw conclusions about female-female households due to their small sample size, the findings suggested that female-headed households may have higher targets than male-headed households.

10.5.1.5 Living in a rural area

For Group 1 households, living in a rural area reduced the target substantially. This may be a result of the fact that consumption rates for Group 1 households were 75.0% in rural areas and 78.8% in urban areas. However, this difference was not statistically significant at the 5% level.

10.5.2 Factors that influence the effect of salary support on the targets

Separating the dates of retirement for two-person households where there was a discernable age gap resulted in the retirement adequacy target being reduced, because the rate of increase of consumption during the semi-retirement phase was suppressed and retirement was deferred. Mathematically, the salary support factor is equal to the annuity factor for the household multiplied by the percentage of the household income earned by the younger person.

10.5.2.1 Age gap

The larger the age gap, the greater the reduction in the target due to salary support. This was because full household retirement was deferred for longer, and the household consumption increased with inflation as opposed to salary inflation during the longer semi-retirement period.

10.5.2.2 Income

There was a weak positive relationship between income p.p.p.a. and the effect of salary support. It so happened that the demographic mix of wealthier households was such that they had a higher annuity factor even though the percentage of income earned by the younger person was slightly lower. Hence the targets allowing for salary support were lower at higher incomes, due both to the value of the salary support being higher at higher incomes and the target without salary support decreasing with income, as discussed in Section 10.5.1.1.

10.5.2.3 Percentage of income earned by the older person

The greater the income share to the older person, the lower the percentage of household spending needs that would be met by the younger partner during semi-retirement.

10.5.2.4 Years of education of the household head

There was a weak positive association between the years of education and the effect of salary support.

This implied that the target allowing for salary support would decrease with increasing levels of education. This was contrary to the findings of Yuh (1998) and Hatcher (1997), as presented in Section 2.8.7. The education level of the household head was found to be weakly negatively correlated with the age gap and the percentage of income earned by the older person. As discussed in Sections 10.5.2.2 and 10.5.2.3, this was expected to result in lower salary support estimates for higher education levels and not the positive relationship that was found.

However, male-headed households had half a year less education on average than female-headed households, where the latter averaged 13.3 years. The years of education of the household head may therefore be reinforcing the effect of the gender of the head of the household, discussed below.

10.5.2.5 Female head of household

Female-headed households tended to have slightly less of the household income being earned by the head of the household (56.5% as opposed to 60.0%) but also tended to have a much larger average age gap of 9.2 years relative to 6.6 years. Both of these factors result in a larger salary support effect.

10.6 The level of the targets suggested by South African data

10.6.1 Relative to published targets

A direct comparison with Mitchell & Moore (1998) and Palmer (1994; 2008) was not possible due to the use of different currencies which made it impossible to match households by income level.

10.6.1.1 Group 1 households

The regression analysis indicated that there was no difference between the predicted targets for a female living alone and a two-person household with a female household head and a

male partner. This research found that male-female households had adequacy ratios between 0.9 and 1.2 times annual salary lower than equivalent female only and female-male households.

Given that an annuity for a female was more expensive than that for a male-female or female-male household, converting the wealth-earnings targets to replacement ratios would give replacement ratio targets that are lower for single females than for female-male households and that are, in turn, lower than the targets for male-female households. This corresponded with the pattern found in Mitchell & Moore (1998) and shown in Table 2.3.

The lowest replacement ratio target to fall within the interquartile range of the estimated retirement adequacy targets was 85%, which is the upper limit of recommended replacement ratios according to Engen, Gale & Uccello (1999), and towards the upper end of the range suggested by Greninger *et al* (2000).

10.6.1.2 Group 2 households

For Group 2 households earning less than R50 000 p.p.p.a., a replacement ratio of 85% fell within the interquartile range. However, for households earning more than this, none of the targets suggested in the literature was sufficiently high to fall within the interquartile range.

10.6.2 Relative to other household compositions

There was very little overlap of the interquartile ranges for Group 2 households earning more than R50 000 p.p.p.a. and Group 1 households, suggesting that the targets for Group 1 households may be higher than those of wealthy Group 2 households. This was consistent with the relationships in Mitchell & Moore (1998) and Palmer (1994; 2008).

10.6.3 Relative to targets used by South African retirement funds

The 2010 Old Mutual Retirement Funds Survey (Old Mutual, 2010b) indicated that most retirement funds used a replacement ratio target of between 70% and 79%. The results of this research suggested that these targets may be inadequate. A gross replacement ratio target of 79% was inadequate for at least 82.0% of single females and at least 88.7% of single males. Allowing for salary support, the target would be inadequate for at least 50.4% of male-female and female-male households and 40.0% of male-male and female-female households. The

cumulative distribution function of the retirement adequacy targets on a replacement ratio scale, shown in Figure 10.1, implies that a gross replacement ratio target of 100% would be adequate for most households. The fact that a 100% replacement ratio at age 65 is suitable for the majority of households is not surprising, given that no tax advantage was modelled for older ages and consumption was not found to decrease on retirement.

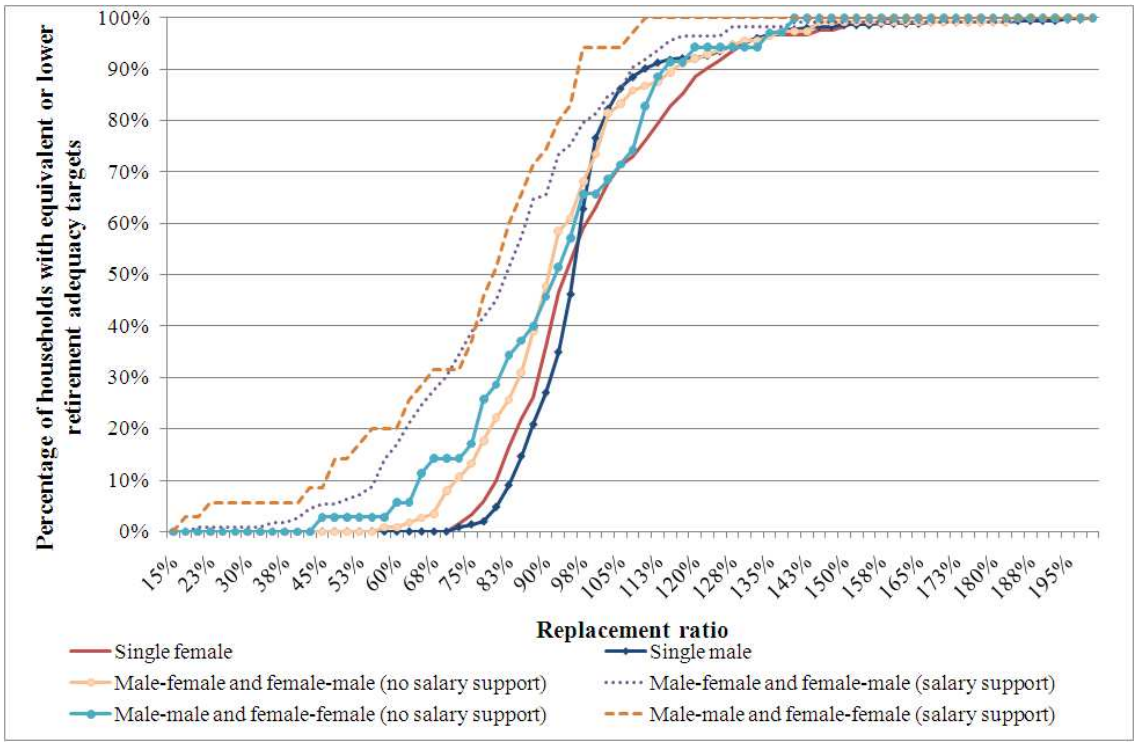


Figure 10.1 Retirement age 65 retirement adequacy target cumulative distribution function on a replacement ratio scale

10.6.4 Relative to what is obtainable through saving

Table 10.3 indicates the percentage of salary required to be saved annually to retirement age in order to obtain a target wealth-earnings ratio, using a net real rate of return of 5.0% p.a. and given different ages at which the household starts to save. The required savings rates would have been higher if the more conservative assumption of 5.0% p.a. gross of all fees, suggested by Rusconi (2005), had been used.

Wealth-earnings ratios that lay outside the interquartile ranges on all three interest rate bases are deliberately left blank.

Table 10.3 Savings rates required to meet a given wealth-earnings ratio target

Wealth-earnings ratio	Retirement age									
	60		63		65		67		70	
	Start age		Start age		Start age		Start age		Start age	
	22	30	22	30	22	30	22	30	22	30
8									4.2%	6.5%
9					6.1%	9.7%	5.5%	8.6%	4.7%	7.3%
10			7.6%	12.2%	6.8%	10.8%	6.1%	9.6%	5.2%	8.1%
11	10.0%	16.2%	8.4%	13.4%	7.5%	11.9%	6.7%	10.6%	5.7%	8.9%
12	10.9%	17.6%	9.2%	14.6%	8.2%	13.0%	7.3%	11.5%	6.2%	9.7%
13	11.8%	19.1%	9.9%	15.9%	8.9%	14.1%	7.9%	12.5%	6.8%	10.5%
14	12.7%	20.6%	10.7%	17.1%	9.6%	15.1%	8.6%	13.4%	7.3%	11.3%
15	13.6%	22.0%	11.5%	18.3%	10.2%	16.2%	9.2%	14.4%	7.8%	12.1%
16	14.5%	23.5%	12.2%	19.5%	10.9%	17.3%	9.8%	15.4%		
17	15.4%	25.0%	13.0%	20.7%	11.6%	18.4%				
18	16.3%	26.4%	13.7%	21.9%						
19	17.2%	27.9%								

Group 1 households had an average retirement savings rate of 9.5% of income p.p.p.a. Group 2 households earning below and above R50 000 p.p.p.a. had average retirement savings rates of 10.2% and 10.1% of income p.p.p.a., respectively.

If savings are made consistently from age 22, on a best-estimate and optimistic basis, a contribution rate of 10.9% of income p.p.p.a. should be sufficient to provide an adequate retirement benefit for most households from age 65 upwards. Even using a pessimistic post-retirement investment return assumption, a 10% savings rate is sufficient to secure a comfortably adequate retirement income from the ages of 67 or 70 for about 75% of target estimation sample.

However, consistent saving from age 22 ignores the possibility of unemployment and the leakage of retirement savings which may accompany it. The analysis of the savings rates required from age 30 indicates that many households will not be able to enjoy a comfortable retirement should they retire before age 67. A comfortable retirement at age 67 may not be feasible for single women, couples of the same age, and some poorer single males and same-sex couples, unless post-retirement interest rates are very favourable. However, couples

where there is an age gap of five years or more may be able to achieve their targets at age 67 on a best-estimate basis.

Given current savings patterns, the results suggest that retirement before age 67 is not feasible. However, there are a number of stakeholders in the retirement decision, including the state, the retirement fund, the employer and the employee. The Act defines 'normal retirement age' as the age at which members of retirement funds become entitled to retire but allows any withdrawal after age 55 to be taxed as a retirement benefit. If the employer's retirement fund rules were worded to make members ineligible as fund members after the normal retirement age and the conditions of employment necessitate active membership of the retirement fund, there would be no contractual protection for employees to remain employed after normal retirement age. Such provisions may make it difficult for fund members to reach the retirement adequacy targets, especially for normal retirement ages of 65 or less.

10.6.5 Heuristics

The regression models had poor R^2 values which meant that there was considerable variation in the targets that could not be explained by the regression variables. This meant that the regression models were unlikely to provide statistically sound heuristics for different household compositions.

The interquartile ranges can be used as suggestive guidelines.

It should be noted that the results of this research strongly contradicted the "conventional wisdom" that suggests that lower incomes are sufficient in retirement due to a reduction in work-related expenditure and lower taxation in retirement.

However, it is important to note that the target estimates are not only sensitive to model parameters but to the assumptions relating to annuitisation at retirement. Should the household choose to make a higher cash withdrawal at retirement instead of annuitising, more longevity risk would be retained by the household which may result in the required wealth-earnings ratio being higher or lower than the recommended targets.

A further consideration is the fact that by their nature, best estimate assumptions will result in targets being over-estimated for certain individuals and under-estimated for others, even within the targets suggested for the demographic groups.

When interpreting the level of the targets it is also important to consider the sensitivity of the targets to various demographic factors as discussed in Section 10.5. The characteristics of the target estimation sample, as set out in Section 4.8, should be considered before applying the retirement adequacy targets to any particular population.

11 FINDINGS, IMPLICATIONS AND SUMMARY

This chapter delineates the main findings of this research in Section 11.1 before outlining the implications for various stakeholders. The limitations of the study are acknowledged in Section 11.3 and areas for future research are set out in Section 11.4. A summary of the research is set out in Section 11.5.

11.1 Conclusions and findings

The conclusions from the literature and findings described in this research can be summarised as follows:

- It is meaningful to define adequacy as sufficient to smooth pre- and post-retirement consumption subject to a minimum income level;
- Wealth-earnings ratios can be used to express retirement adequacy targets;
- Non-healthcare consumption does not decrease at retirement;
- Healthcare expenditure may increase at retirement;
- Households earning under R24 424.50 p.p.p.a. may not benefit from making retirement provision;
- The effect of retirement savings on the retirement adequacy target is unclear;
- The retirement adequacy target decreases with retirement age;
- Salary support can lower the adequacy target by more than extending the retirement age;
- It is difficult to comment on retirement adequacy targets for certain groups, such as single males, male-male and female-female households earning less than R50 000 p.p.p.a;
- Different targets apply based on household characteristics, particularly household composition, income, home ownership and location;
- Retirement adequacy targets may decrease with income;
- Single females and female-male households may have higher targets than male-female households; and
- Home ownership can increase targets.

11.2 Implications

The research has practical implications for policy makers, retirement fund trustees, financial planners and individuals saving for retirement.

11.2.1 A change in vocabulary may improve the usefulness of retirement adequacy targets for individuals

Replacement ratios are widely-used but they obscure information about expenditure patterns in retirement: a 75% replacement ratio securing a constant income in real terms is quite different from a 75% replacement ratio that secures a constant income that does not increase with inflation. In addition, the calculation of replacement ratios requires the use of an appropriate annuity factor which would require actuarial calculations and an actuarial basis. Hence, it is impractical for an individual to assess his or her own retirement wealth expressed as a replacement ratio unless supplied with an appropriate annuity factor whereas a wealth-earnings ratio simply requires an individual to sum the value of his or her non-housing assets and divide by his or her total salary.

11.2.2 Retirement adequacy targets may be higher than previously suggested which may require remedial action

If retirement funds use replacement ratio retirement adequacy targets of between 75% and 79%, approximately equivalent to wealth-earnings ratios of between 8.4 and 13.8, the findings of this research suggest this may be insufficient for between 40% and 90% of fund members depending on the household compositions. It was noted that the estimated wealth-earnings targets were not sufficiently high to provide for post-retirement savings. In order to meet these higher adequacy targets, funds could:

- Increase retirement ages, as discussed in Section 10.4.1;
- Encourage semi-retirement in two-person households where there is an age gap, as discussed in Section 10.5.2;
- Increase retirement savings rates, although this may not reduce the targets themselves as discussed in Section 10.4.2; and
- Increase expected investment return net of all expenses.

The final point relates to pre-retirement wealth accumulation as opposed to retirement adequacy targets and hence was not discussed in detail in this research although the retirement adequacy targets should be considered in setting investment strategies as discussed

in Section 1.1. An investigation into the relative merits of these arrangements is beyond the scope of this research.

As shown in Section 6.4, non-healthcare consumption was not seen to drop at retirement where income was held constant. Some households were found to have increased healthcare costs around the time of retirement. For these households, about half of the household budget that was being directed to retirement savings would be redirected to healthcare. Tax advantages are age-related and not work-status related. So, given an average retirement savings rate of roughly 10% of income, households would need between 90% and 95% of their pre-retirement income the month after they retire. The fact that retired households have larger healthcare budget shares and healthcare inflation typically outstrips CPI inflation means that this percentage grows in real terms during retirement.

Given the initial replacement ratio adequacy targets of 40% (Department of Social Development, 2007a) and 75% (National Treasury, 2004), policymakers involved in the reform of retirement funds may need to increase their expectations of what is sufficient. This research indicates that households cannot expect to maintain the same lifestyle with a much lower income in retirement. Hence, individuals may need to adjust their expectations of what is needed in retirement.

11.2.3 It is unlikely there is a single target that is appropriate for all households

The retirement adequacy targets were found to be complex functions of a number of factors. Although quartile analysis provided insight into what target may be appropriate for a group of people who are, say, members of the same retirement fund or the target population for a state retirement savings scheme, changes in the mix of household characteristics could influence the target for the group.

A multiple linear regression was not possible for all household types and where regression models were found, the adjusted-R^2 statistics were low which indicated that the models did not explain sufficient variability in the observed retirement adequacy targets. An alternative approach was to consider the 75th percentile of the retirement adequacy targets. Depending on the household composition, targets were in the region of 14.0 to 18.0 times annual salary for

retirement age 60 and reduced to between 12.5 and 16.5 and between 10.5 and 14.5 times annual salary for retirement ages 65 and 70 respectively.

11.2.4 Later retirement ages may improve the feasibility of meeting the targets

Given the information in Table 10.3 and reported savings levels for the target estimation sample, a comfortable retirement at age 65 would require a favourable combination of full employment and net real investment returns of 5.0% p.a. or more. The research suggested that retiring at 67 or 70 may allow for more households to experience a comfortably adequate retirement.

11.2.5 The retirement adequacy targets should be updated regularly

The basis for the target estimation model can accommodate a variety of assumptions and it could be modified to allow for tax changes. Palmer (1989; 1992; 1994; 2008) has demonstrated the value of using the same model to recalculate retirement adequacy targets as new household data becomes available and as tax systems change.

11.2.6 It could be difficult to apply the target estimation model to retirement funds

In theory, the target estimation model could be applied at a retirement fund level. However, only the very largest funds would have sufficient households containing only one or two adults to allow for a meaningful analysis. Alternatively, adult equivalence scales could be used. However, Atkinson (1992) highlighted that there is considerable variation in these scales for households with children and hence the model results may be very sensitive to this parameter. Ignoring the considerable difficulty that the choice of equivalence scale would pose, attempting to obtain reliable consumption and savings data would be extremely difficult and possibly subject to considerable non-response. Section 4.2.1 sets out some of the issues that would need to be considered.

11.3 Limitations

11.3.1 Sample size

As discussed in Section 10.3.1, the target estimation sample was clearly defined but small, which may raise queries as to the applicability of the results. The characteristics of the target

estimation sample, detailed in Section 4.8, should be considered before the estimated retirement adequacy targets are applied.

11.3.2 Non-saving households

The statistical models for retirement adequacy targets were based only on households that were identified as incentivised to save and that indicated that they were saving for retirement. The literature and some of the statistical models derived in this research indicated that the retirement adequacy target was influenced by retirement savings rates. This implied that the removal of non-saving households may have improved the reliability of the estimates for members of retirement funds who are saving for retirement. However, the results may not be applicable to the general population given the high percentage of households that should be saving for retirement and do not.

11.3.3 Healthcare data concerns

Healthcare expenditure data in IES 2005/2006 was collected only over one month. Given that healthcare expenditure is volatile and healthcare costs were seen to increase sharply for some groups, healthcare data averaged over a longer period may have improved the quality of the estimates. However, due to the fact that healthcare budget shares were low and capped, this was unlikely to have had a significant impact on the results.

11.4 Areas for further research

The following research questions were raised and were outside the scope of this research.

11.4.1 How would changes to the taxation regime affect retirement adequacy targets?

An additional income tax rebate applying from age 70 was introduced in the 2011/2012 tax year which would lower the tax burden for retired individuals going forward. Further research is required to update the target estimates for this additional rebate as well as other changes to the taxation of personal income.

11.4.2 Who should be saving for retirement?

The change in consumption at and in retirement was derived from the model development sample, while the targets were calculated for the target estimation sample where the latter is a

small subset of the former. This was necessary for this research as the targets were calculated only for incentivised actual savers and an initial model run using the model development sample was required in order to identify those households that would benefit from retirement saving. As income was the chief determinant of incentivisation and the CHAID analysis controlled for income, the fact that the income profiles of the two samples were different should not have had a material impact on the results. The approach adopted was necessary but not ideal and separate research is required on which households should save for retirement. Then, the change in consumption at and during retirement should be estimated for the households and the model run on the same subset.

11.4.3 Does longitudinal data suggest a change in expenditure at retirement?

Palmer (1992; 1994; 2008), who used a simple matched-pairs methodology on cohort data, found that the estimated change in consumption at retirement has not been consistent over time. Although cross-sectional data allows for income to be controlled which eliminates changes in consumption due to changes in income level, Jianakoplos, Menchik & Irvine (1989) warned that cross-sectional data could over- or understate the estimated change in consumption.

A study of a longitudinal data set containing the consumption, income and savings patterns of households as they near and enter retirement would add considerably to the understanding of income and consumption dynamics of households around the time of retirement.

11.4.4 How do real households respond to increases in retirement savings rates?

A basic economic model suggested by Mitchell & Moore (1998) suggested that retirement adequacy targets and retirement savings are perfectly negatively correlated (Mitchell & Moore, 1998). A household spending model allowing for complex interactions between retirement savings and non-retirement savings was suggested by Aron & Meullbauer (2000). However, the findings of this research suggest that reality may be even more complex.

11.4.5 What are the retirement adequacy targets for non-saver households?

Only households that actually saved for retirement were considered, even though there were a considerable number of households that needed to save for retirement in order to smooth

consumption but did not. It is recommended that further research be done on the needs of this segment and how coverage of the current system can be extended to include them.

11.4.6 What pensioner mortality assumptions are appropriate for households incentivised to save for retirement?

The longevity assumption was important in the calculation of the retirement adequacy targets. The households included in target estimation sample may have had a different income profile to those used to create SAIML98/SAIFL98. However, using an adjusted alternative scale would have required careful consideration as to how to adjust the scale appropriately. Further research is required on appropriate bases for South African pensioners, both those with annuities from insurers and those without.

11.4.7 What do stochastic target estimation models suggest about retirement adequacy targets?

As discussed in Sections 5.3 and 5.9, Milevsky & Robinson (2000) have used stochastic investment return and mortality assumptions to assess retirement wealth adequacy. Given the sensitivity of the retirement adequacy targets to the post-retirement investment return assumption, highlighted in Section 10.3.3, and the uncertainty around the appropriate mortality assumptions, extension of the deterministic model to a stochastic model may provide some useful insights into the distribution of retirement adequacy targets under different scenarios. In addition, stochastic mortality assumptions would allow for the assumptions around annuitisation at retirement to be relaxed.

11.4.8 How does health-status impact on retirement adequacy targets?

As discussed in Section 2.6.2, tests for changes in consumption at and in retirement should control for health-status. The literature also identified some evidence that health-status may influence the level of retirement adequacy targets, set out in Section 2.8.8. Hence, it would be of interest to investigate the changes in consumption at and in retirement and to estimate the retirement adequacy targets controlling for health-status. This is particularly pertinent in South Africa as, under the Act, people with disabilities may treat all medical expenses as tax-deductible at any age, while this concession applies only after age 65 for people not living with disabilities, as set out in Section 5.5.2.6.

11.4.9 What is the impact of home ownership and mortgage holding on retirement adequacy targets?

The mortgage data from IES 2005/2006 was of very poor quality. In addition, a number of simplifying assumptions and adjustments had to be made in order to obtain reasonable estimates of the mortgage at retirement. Some of these, such as the assumption that the mortgage is never extended, may be unnecessarily restrictive. The influence of home ownership and mortgage tenure on adequacy targets should be researched further using a better data set.

11.4.10 Will South Africans accumulate enough wealth to retire comfortably?

This research did not address the question of the preparedness of South African households for retirement, but rather estimated targets against which retirement wealth accumulation could be measured. It is suggested that this be researched if suitable data on household wealth is found.

11.4.11 How do children affect household spending pre- and post-retirement?

This research focussed only on one- and two-adult households in each life stage. This is obviously not realistic.

Although the traditional nuclear family model would suggest that many working households have children and then adults live alone during retirement, South African data suggest otherwise. According to the 2001 Census, 71% of South Africans aged 65 or older lived in households of three or more (Statistics South Africa, 2005). Hence it is possible that children may live in retired households. It is also unclear how having children in the house before retirement affects consumption long after they have moved out.

The dynamics around inter- and intra-household budget allocations in the presence of children require further investigation.

11.4.12 How can retirement adequacy targets for the self-employed be calculated?

As discussed in Sections 2.5.7.1 and 4.4.1, households deriving income from self-employment and farming were excluded from this and similar studies due to their

consumption data being considered particularly unreliable. An investigation into the retirement adequacy targets for this segment of the population would be useful.

11.5 Summary

Despite the importance of retirement adequacy targets to stakeholders ranging from the policymakers debating retirement reform to individuals planning for their retirement, there had been little research on retirement adequacy targets in a South African context.

This research aimed to address six research questions:

i) How can adequacy be defined and how can adequacy targets be expressed?

ii) How can the consumption-smoothing and minimally adequate elements of adequacy targets be estimated?

iii) How does consumption change at retirement?

iv) How do savings rates and retirement ages influence the target levels?

v) What demographic factors influence the level of the targets?

vi) What do South African data suggest retirement adequacy targets should be?

A comprehensive literature review led to the adoption of a definition of adequacy that was the greater of an income level sufficient to smooth consumption at retirement and a level of income required to meet a minimum living standard.

The retirement adequacy targets were estimated using a carefully parameterised deterministic TSE cashflow model.

Targets were expressed as wealth-earnings ratios rather than replacement ratios, using current earnings at retirement as the divisor. The wealth-earnings ratio has a number of favourable attributes including the easy interpretation of the results in terms of multiples of salary and the fact that individuals can gauge their wealth-accumulation relative to the targets without requiring access to an annuity basis.

One- and two-adult household samples from the IES 2005/2006 data set were used after removing households with poor or missing data and households where consumption and expenditure estimates were expected to be unreliable.

The research suggested that consumption did not decline on retirement and for certain households, healthcare consumption may have increased sharply. However, it should be noted that healthcare expenditure formed a relatively small part of household budget share and the fact that healthcare expenditure data in IES 2005/2006 was collected over a period of only one month meant the healthcare expenditure effect should be interpreted with caution.

Targets were found to decrease as retirement age increased. However, there was no clear relationship between retirement savings rates and retirement adequacy targets.

Targets were estimated for households earning over R24 424.50 p.p.p.a. and saving for retirement. This minimum income level was chosen as the model results showed that households earning below this limit were likely to lose SOAG benefits by saving for retirement. There was a high proportion of non-saving households in the model development sample, all of which were excluded as the aim of the research was to estimate targets for households that should be saving for retirement and, in fact, are.

The targets when salary support was eliminated were a complex function of seven different demographic factors, not all of which applied to all household types. For single male, male-male and female-female households earning under R50 000 p.p.p.a., non-normal error terms made it impossible to identify factors that impacted the targets by regression. It should be noted that for single male, male-male and female-female households earning over R50 000 p.p.p.a, the regression model detected the retirement savings rate was a significant determinant of the retirement adequacy target. The signs of the regression coefficients are summarised in Table 11.1.

Table 11.1 Sign of regression coefficients for modelling retirement adequacy targets

	Single female, male-female and female-male households	**Single male, male-male and female-female households earning over R50 000 p.p.p.a**
Income p.p.p.a.	-	-
Female head of household	+	Not statistically significant
Living in a rural area	-	Not statistically significant
Average age	+	Not statistically significant
Home ownership	Not statistically significant	+
Age youngest	Not statistically significant	+

The effect of salary support on the retirement adequacy targets was a function of five different factors, namely the age gap, income p.p.p.a., sex of household head, number of years of education of the household head and the percentage of household income earned by the older person in the household.

The derived retirement adequacy targets were found to be higher than, or in the highest ranges of, the targets suggested in the literature.

Table 11.2 indicates the best estimate targets that were projected to be sufficient for 75% of the households according to different household types.

Table 11.2 Seventy-fifth percentile of the best estimate retirement adequacy targets

	Retirement age				
	60	**63**	**65**	**67**	**70**
Single females	18.2	16.9	16.6	15.7	14.3
Single males	14.3	13.2	12.9	12.2	11.1
Male-female and female-male (no salary support)	16.5	15.4	15.1	14.3	12.8
Male-male and female-female (no salary support)	15.8	14.6	14.1	13.2	12.1
Male-female and female-male (salary support)	15.1	14.0	13.7	12.9	11.7
Male-male and female-female (salary support)	14.0	12.8	12.4	11.7	10.5

On a best estimate basis, the upper quartiles of the retirement adequacy targets ranged from between 14.0 and 18.0 times annual salary at age 60 to between 10.5 and 14.5 for a retirement age of 70. The targets were sensitive to the interest rate assumption.

The targets for retirement ages 67 and 70 were obtainable for most households given current savings rates, provided disciplined savings took place from age 22. The targets for retirement age 70 were obtainable for households given current savings rates, even if saving only commenced at age 30.

Replicating this research on a larger data sample and updating the tax assumptions used may improve the applicability of the results.

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APPENDIX A: ANNUITY BASIS

Table A.1 Annuity basis items

Item	Parameter
Annuity terms	Benefits payable annually in arrears
Increase	Annuity value is constant in real terms
Joint life terms	On death of the first spouse, consumption is halved and then increased by the economies of scale factor
Economies of scale factor	9.25%
Base mortality	SAIFL98 & SAIML98. Mortality of spouses is assumed to be independent.
Mortality improvements	Reduction of 1 year of age for every 20 years projected from 1998
Expenses	2% commission (excluding VAT) payable on purchase of annuity. Administration fees are 2.04% including VAT
Insurer's profit margin	0.5% p.a.
Net real rate of return	4.0%
Current age	40
Retirement age	65

APPENDIX B: CHAID ILLUSTRATIVE EXAMPLE

Consider a household where Y is the dependent variable, α is a continuous independent variable, β is a binary independent variable that can take on values 0 and 1 and γ is a categorical independent variable with four categories named 1, 2, 3 and 4, respectively.

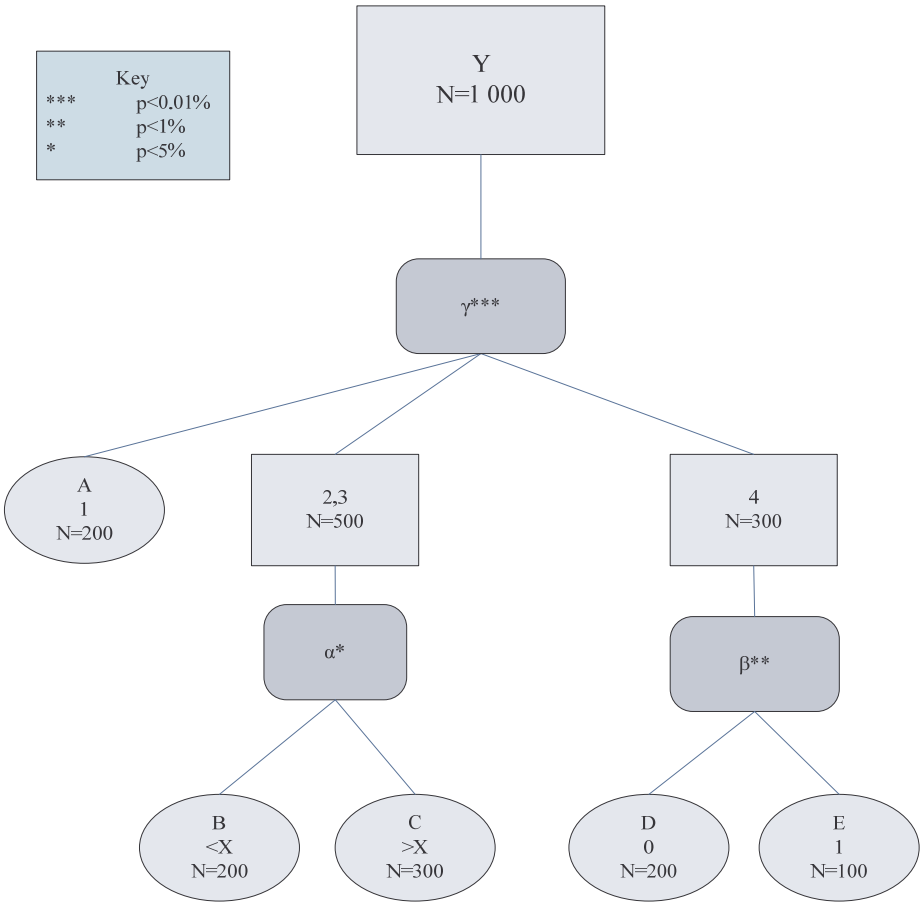

Figure B.1 Illustrative CHAID dendrogram

The following implications can be made from Figure B.1 and the application of Kass (1980). The households can be divided into five distinct leaves, each of which was statistically significantly different from the other at a 5% significance level. Each leaf is defined by the split variables used to arrive at the leaf. For example, leaf B can be described as households where γ=2 or 3 and α<X. The split variables can be considered predictive. For example, for households where γ=4, α is not a statistically significant predictor of Y. In addition, the dendrogram suggests that it is not necessary to separate households where γ=2 from those

where γ=3. Finally, although non-terminating nodes can be compared, this comparison should be interpreted with caution as any apparent differences in observed values might be explained by subsequent split variables. For example, if all households where γ=4 were compared with all households where γ=1, the comparison might be spurious in that households where β=0 and γ=4 were found to be significantly different from households where β=1 and γ=4. Hence, any difference in the observed value of Y between households where γ=1 and γ=4 may be fully explained by β.

APPENDIX C: TECHNICAL INFORMATION FOR TESTS ON AGE AND WORK-STATUS EFFECTS ON HEALTHCARE EXPENDITURE

Table C.1 Healthcare expenditure definition

COICOP	Item
6111400	Pharmacy service fees in private institutions
6111100	Medicine purchased with prescription in private institutions
6111101	Medicine purchased with prescription in public institutions
6111200	Medicine purchased without prescription in private institutions
6111201	Medicine purchased without prescription in public institutions
6111300	Pharmacy dispensing fees in private institutions
6111301	Pharmacy dispensing fees in public institutions
6211121	Other medical services in public institutions
6232001	Service of medical auxiliaries (freelance nurse, midwives, freelance optometrist, physiotherapist, speech therapist etc) in public institutions
6111401	Pharmacy service fees in public institutions
6311101	Hospital service fees (eg wards, beds and theatre fees) in public institutions
6311100	Hospital service fees (eg wards, beds and theatre fees) in private institutions
6233000	Non-hospital service (ambulance service other than hospital) in public institutions
6232000	Service of medical auxiliaries (freelance nurse, midwives, freelance optometrist, physiotherapist, speech therapist etc) in private institutions
6231102	Medical analysis laboratories and X-ray service in public institutions
6231101	Medical analysis laboratories and X-ray service in private institutions
6221001	Dental service (service of dentists include oral-hygienists) in public institutions
6221000	Dental service (service of dentists include oral-hygienists) in private institutions
6211201	Consultations of traditional healers in public institutions
6131000	Therapeutic appliances and equipment (like spectacles and hearing aids) in private institutions
6233001	Non-hospital service (ambulance service other than hospital) in private institutions
6211200	Consultations of traditional healers in private institutions/work places
6121001	Other medical products (bandages, syringes, knee supports etc) in public institutions
6121100	Condoms, strings and other contraceptives, (excluding tablets and injections)
6121000	Other medical products (bandages, syringes, knee supports etc) in private institutions
6131001	Therapeutic appliances and equipment (like spectacles and hearing aids) in public institutions
6211100	Medical services in private institutions
6211101	Medical services in public institutions
6211110	Flat rate in respect of services and medicine obtained at hospital/clinic in private institutions
6211120	Other medical services in private institutions
6211111	Flat rate in respect of services and medicine obtained at hospital/clinic in public institutions
12531120	Medical aid contribution (Contribution by employer in private institutions)

12531121	Medical aid contribution (Contribution by employer in public institutions)
12531110	Medical aid contribution (Paid by household member in private institution)
12531111	Medical aid contribution (Paid by household member in public institution)
12531020	Medical insurance

Table C.2 Healthcare expenditure categorisation

Category name	**Category range**	**Count**
Almost nil	[0.0-0.1%)	643
Low	[0.1%-0.5%)	522
Low-moderate	[0.5%-2.0%)	571
Moderate	[2.0%-5.0%)	522
High	[5.0%-15.0%)	349
Catastrophic	[15.0%-92.6%]	114

APPENDIX D: TECHNICAL INFORMATION FOR TESTS ON AGE AND WORK-STATUS EFFECTS ON GIFTING

Table D.1 Gifting definition

COICOP	Item
99111102	In kind maintenance of/remittance to family members and dependants living elsewhere (including alimony/palimony paid to ex-wife/ex-husband, children)
99111112	In cash maintenance of/remittance to family members and dependants living elsewhere (including alimony/palimony paid to ex-wife/ex-husband, children)
99111202	Gifts to persons who are not members of this household (excluding cash gifts) in kind
99111212	Gifts to persons who are not members of this household (excluding cash gifts)

Table D.2 Gifting rate categorisation

Category name	Category range	Count
Non-gifter	0.0%	836
Small gifter	(0.0%-2.5%)	491
Moderate gifter	[2.5%-10.0%)	431
Moderate-high gifter	[10.0%-23.0%)	447
High gifter	[23.0%-45.0%)	402
Big gifter	[45.0%-98.5%)	114

APPENDIX E: TECHNICAL INFORMATION FOR TESTS ON AGE AND WORK-STATUS EFFECTS ON NON-HEALTHCARE CONSUMPTION

Table E.1 Non-healthcare consumption categorisation

Category name	Category range	Count
Very low	[0.0%-45.0%)	516
Low	[40.0%-60.0%)	478
Moderate	[55.0%-75.0%)	473
High	[65.0%-90.0%)	427
Very high	[90.0%-110.0%)	402
Reliant	[110.0%-681.0%)	425

Table E.2 Mean non-healthcare consumption rates by leaf

Leaf	Households	Mean non-healthcare consumption rate
A	264	98.0%
B	247	71.8%
C	127	62.0%
D	593	78.5%
E	346	86.6%
F	101	103.8%
G	78	69.0%
H	82	70.4%
I	79	62.2%
J	22	49.2%
K	36	70.6%
L	52	65.8%
M	22	74.1%
N	28	72.0%
O	70	71.5%
P	36	88.8%
Q	196	52.6%
R	85	63.5%
S	21	78.2%
T	27	77.6%
U	209	50.3%

APPENDIX F: TECHNICAL INFORMATION FOR TESTS ON AGE AND WORK-STATUS EFFECTS ON NON-RETIREMENT SAVING

Non-retirement savings were defined as regular savings less withdrawals from savings which was then subsequently adjusted for the difference between the total mortgage payment and owner's imputed rental, in the case of homeowners.

The COICOP codes for regular savings and withdrawals from savings are given below.

Table F.1 Non-retirement savings definition

COICOP	Item
52710000	Deposits into savings
52660000	Other investments
52650000	Offshore
52640000	Investment plans
52620000	Unlisted company - shares
52610000	Listed company - shares
52410000	Repayment on loans and overdrafts
52630000	Unit trusts
52310000	Life and endowment policies
52252000	Levy on timeshare
52110000	Improvements, additions and alterations (including build-in furniture, solar energy systems, swimming pools and garden layouts)
52122000	Services for improvements, additions and alterations(carpenters, electricians etc)
52500000	Contributions to a stokvel
52140000	Building materials not included in Q813 (a) or (c) (eg for building purposes)
52150000	Labour and material for improvements, additions and alterations
52210000	Cost of other dwelling
52220000	Capital payments (including deposit)
52230000	Monthly capital payments
52240000	Other payments such as transfer duty and transfer costs and registration of mortgage bond
52320000	Life insurance covering mortgage debt
52251000	Purchase of timeshare
52130000	Security structures (including fences, electronic gates)
52720000	Withdrawals from savings

Table F.2 Non-retirement savings categorisation

Category name	Category range	Count
Dissavers and non-savers	[-787.9%-2.5%)	1 786
Small savers	[2.5%-7.0%)	331
Moderate savers	[7.0%-25.0%)	450
Good savers	[25.0%-121.0%)	154

Table F.3 Non-retirement savings by leaf

Leaf	Number households	Mean savings rate
A	877	0.5%
B	557	3.0%
C	329	6.4%
D	431	8.1%
E	64	10.2%
F	421	10.5%
G	42	24.5%

APPENDIX G: MODEL BASIS SUMMARY

Table G.1 Basis

Description	Value
Salary inflation	2.00%
Healthcare inflation	2.50%
Healthcare CPI budget share	6.90%
Non-healthcare inflation	-0.19%
Pessimistic discount rate	3.00%
Best estimate discount rate	4.00%
Optimistic discount rate	5.00%
Minimum income p.p.p.a.	R22 224
Economies of scale adjustment	9.25%
Real increase in the primary rebate	2.00%
Real increase in secondary rebate	1.50%
Insurer's profit loading	0.50%
Administration fee	2.04%
Commission	2.28%

APPENDIX H: PROMOTIONAL SALARY SCALE

Table H.1 Promotional salary scale

Age	Adjusted PEN promotional salary scale	Age	Adjusted PEN promotional salary scale
16	1.0000	44	4.6298
17	1.1888	45	4.6534
18	1.3761	46	4.6770
19	1.5588	47	4.7061
20	1.7399	48	4.7298
21	1.9160	49	4.7521
22	2.0912	50	4.7758
23	2.2601	51	4.8051
24	2.4267	52	4.8288
25	2.5877	53	4.8526
26	2.7428	54	4.8821
27	2.8952	55	4.9059
28	3.0503	56	4.9281
29	3.1980	57	4.9579
30	3.3496	58	4.9816
31	3.4876	59	5.0115
32	3.6291	60	5.0353
33	3.7673	61	5.0590
34	3.8982	62	5.0891
35	4.0206	63	5.1128
36	4.1389	64	5.1430
37	4.2493	65	*5.1430*
38	4.3453	66	*5.1430*
39	4.4277	67	*5.1430*
40	4.4936	68	*5.1430*
41	4.5437	69	*5.1430*
42	4.5839	70	*5.1430*
43	4.6075		

Note: Figures in regular typeface are taken directly from the PEN tables. Figures in italics are extrapolated.

APPENDIX I: SOAG-IMPLIED MINIMUM INCOME SUPPORT

The means-test for the SOAG determines the size of the benefit that the individual will receive and is given by equation (I.1)

$$D = k_1 A - k_2 B \qquad \text{(I.1)}$$

Where D is the annual social grant, A is the maximum annual social grant, B is the annual income earned and k_1 and k_2 are constants. Income is averaged for married couples irrespective of matrimonial property regime. This formula was introduced in the 2008 Regulations and is simpler than the formula used previously, described in Government Notice 591 (1994). Setting D to the minimum grant payable and solving for B gives the income level at which the minimum level of support is provided. Adding R1 gives the minimally adequate income level. The maximum and minimum SOAG values and the gazetted values of k_1 and k_2 are given in Table I.1.

Table I.1 SOAG data

Effective date	A (nominal)	Minimum grant (nominal)	k_1	k_2	Real income support per person (March 2006 rands)
01-Jul-96	430	50	1.3	1	857
01-Jul-97	470	50	1.3	1	867
01-Jul-98	490	50	1.3	1	851
01-Oct-98	500	50	1.3	1	841
01-Jul-99	520	50	1.3	1	866
01-Jul-00	540	50	1.3	1	850
01-Jul-01	570	50	1.3	1	856
01-Apr-02	620	50	1.3	1	878
01-Oct-02	640	50	1.3	1	854
01-Apr-03	700	50	1.3	1	919
01-Apr-04	740	50	1.3	1	972
01-Apr-05	780	50	1.3	1	992
01-Apr-06	820	50	1.3	1	1 013
01-Apr-07	870	50	1.3	1	1 008
01-Apr-08	940	50	1.3	1	982
22-Aug-08	940	100	1.3	0.5	1 786
01-Oct-08	960	100	1.3	0.5	1 824
01-Apr-09	1 010	100	1.3	0.5	1 874
01-Apr-10	1 080	100	1.3	0.5	1 923

(the Increase Notices; the SOAG Regulations)

Appendix J: Differences in least square means for target estimates

Table J.1 Group 1 households

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA	60		63		1.0859	0.01244	<.0001
RA	60		65		1.3777	0.01244	<.0001
RA	60		67		2.1128	0.01244	<.0001
RA	60		70		3.3074	0.01244	<.0001
RA	63		65		0.2919	0.01227	<.0001
RA	63		67		1.027	0.01227	<.0001
RA	63		70		2.2215	0.01227	<.0001
RA	65		67		0.7351	0.01227	<.0001
RA	65		70		1.9296	0.01227	<.0001
RA	67		70		1.1946	0.01227	<.0001
RSR		0		0.125	1.4898	0.01102	<.0001
RSR		0		0.15	1.7911	0.01102	<.0001
RSR		0		0.175	2.0936	0.01102	<.0001
RSR		0.125		0.15	0.3013	0.01102	<.0001
RSR		0.125		0.175	0.6038	0.01102	<.0001
RSR		0.15		0.175	0.3025	0.01102	<.0001
RA*RSR	60	0	60	0.125	1.683	0.02507	<.0001
RA*RSR	60	0	60	0.15	2.0239	0.02507	<.0001
RA*RSR	60	0	60	0.175	2.3664	0.02507	<.0001
RA*RSR	60	0	63	0	1.2069	0.02482	<.0001
RA*RSR	60	0	63	0.125	2.757	0.02482	<.0001
RA*RSR	60	0	63	0.15	3.0695	0.02482	<.0001
RA*RSR	60	0	63	0.175	3.3833	0.02482	<.0001
RA*RSR	60	0	65	0	1.5229	0.02482	<.0001
RA*RSR	60	0	65	0.125	3.0455	0.02482	<.0001
RA*RSR	60	0	65	0.15	3.3535	0.02482	<.0001
RA*RSR	60	0	65	0.175	3.6624	0.02482	<.0001
RA*RSR	60	0	67	0	2.3402	0.02482	<.0001
RA*RSR	60	0	67	0.125	3.7717	0.02482	<.0001
RA*RSR	60	0	67	0.15	4.061	0.02482	<.0001
RA*RSR	60	0	67	0.175	4.3516	0.02482	<.0001
RA*RSR	60	0	70	0	3.6873	0.02482	<.0001
RA*RSR	60	0	70	0.125	4.9491	0.02482	<.0001
RA*RSR	60	0	70	0.15	5.2049	0.02482	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	60	0	70	0.175	5.4614	0.02482	<.0001
RA*RSR	60	0.125	60	0.15	0.3409	0.02507	<.0001
RA*RSR	60	0.125	60	0.175	0.6834	0.02507	<.0001
RA*RSR	60	0.125	63	0	-0.4761	0.02482	<.0001
RA*RSR	60	0.125	63	0.125	1.074	0.02482	<.0001
RA*RSR	60	0.125	63	0.15	1.3865	0.02482	<.0001
RA*RSR	60	0.125	63	0.175	1.7003	0.02482	<.0001
RA*RSR	60	0.125	65	0	-0.1601	0.02482	<.0001
RA*RSR	60	0.125	65	0.125	1.3625	0.02482	<.0001
RA*RSR	60	0.125	65	0.15	1.6705	0.02482	<.0001
RA*RSR	60	0.125	65	0.175	1.9794	0.02482	<.0001
RA*RSR	60	0.125	67	0	0.6572	0.02482	<.0001
RA*RSR	60	0.125	67	0.125	2.0887	0.02482	<.0001
RA*RSR	60	0.125	67	0.15	2.378	0.02482	<.0001
RA*RSR	60	0.125	67	0.175	2.6686	0.02482	<.0001
RA*RSR	60	0.125	70	0	2.0043	0.02482	<.0001
RA*RSR	60	0.125	70	0.125	3.2661	0.02482	<.0001
RA*RSR	60	0.125	70	0.15	3.5219	0.02482	<.0001
RA*RSR	60	0.125	70	0.175	3.7784	0.02482	<.0001
RA*RSR	60	0.15	60	0.175	0.3425	0.02507	<.0001
RA*RSR	60	0.15	63	0	-0.817	0.02482	<.0001
RA*RSR	60	0.15	63	0.125	0.7331	0.02482	<.0001
RA*RSR	60	0.15	63	0.15	1.0456	0.02482	<.0001
RA*RSR	60	0.15	63	0.175	1.3594	0.02482	<.0001
RA*RSR	60	0.15	65	0	-0.501	0.02482	<.0001
RA*RSR	60	0.15	65	0.125	1.0216	0.02482	<.0001
RA*RSR	60	0.15	65	0.15	1.3296	0.02482	<.0001
RA*RSR	60	0.15	65	0.175	1.6385	0.02482	<.0001
RA*RSR	60	0.15	67	0	0.3163	0.02482	<.0001
RA*RSR	60	0.15	67	0.125	1.7478	0.02482	<.0001
RA*RSR	60	0.15	67	0.15	2.0371	0.02482	<.0001
RA*RSR	60	0.15	67	0.175	2.3277	0.02482	<.0001
RA*RSR	60	0.15	70	0	1.6634	0.02482	<.0001
RA*RSR	60	0.15	70	0.125	2.9252	0.02482	<.0001
RA*RSR	60	0.15	70	0.15	3.181	0.02482	<.0001
RA*RSR	60	0.15	70	0.175	3.4375	0.02482	<.0001
RA*RSR	60	0.175	63	0	-1.1595	0.02482	<.0001
RA*RSR	60	0.175	63	0.125	0.3906	0.02482	<.0001
RA*RSR	60	0.175	63	0.15	0.7031	0.02482	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	60	0.175	63	0.175	1.0169	0.02482	<.0001
RA*RSR	60	0.175	65	0	-0.8435	0.02482	<.0001
RA*RSR	60	0.175	65	0.125	0.6791	0.02482	<.0001
RA*RSR	60	0.175	65	0.15	0.9871	0.02482	<.0001
RA*RSR	60	0.175	65	0.175	1.296	0.02482	<.0001
RA*RSR	60	0.175	67	0	-0.02624	0.02482	1
RA*RSR	60	0.175	67	0.125	1.4053	0.02482	<.0001
RA*RSR	60	0.175	67	0.15	1.6946	0.02482	<.0001
RA*RSR	60	0.175	67	0.175	1.9852	0.02482	<.0001
RA*RSR	60	0.175	70	0	1.3209	0.02482	<.0001
RA*RSR	60	0.175	70	0.125	2.5827	0.02482	<.0001
RA*RSR	60	0.175	70	0.15	2.8385	0.02482	<.0001
RA*RSR	60	0.175	70	0.175	3.095	0.02482	<.0001
RA*RSR	63	0	63	0.125	1.5501	0.02453	<.0001
RA*RSR	63	0	63	0.15	1.8626	0.02453	<.0001
RA*RSR	63	0	63	0.175	2.1764	0.02453	<.0001
RA*RSR	63	0	65	0	0.316	0.02453	<.0001
RA*RSR	63	0	65	0.125	1.8386	0.02453	<.0001
RA*RSR	63	0	65	0.15	2.1466	0.02453	<.0001
RA*RSR	63	0	65	0.175	2.4555	0.02453	<.0001
RA*RSR	63	0	67	0	1.1333	0.02453	<.0001
RA*RSR	63	0	67	0.125	2.5648	0.02453	<.0001
RA*RSR	63	0	67	0.15	2.8541	0.02453	<.0001
RA*RSR	63	0	67	0.175	3.1447	0.02453	<.0001
RA*RSR	63	0	70	0	2.4804	0.02453	<.0001
RA*RSR	63	0	70	0.125	3.7422	0.02453	<.0001
RA*RSR	63	0	70	0.15	3.998	0.02453	<.0001
RA*RSR	63	0	70	0.175	4.2545	0.02453	<.0001
RA*RSR	63	0.125	63	0.15	0.3126	0.02453	<.0001
RA*RSR	63	0.125	63	0.175	0.6264	0.02453	<.0001
RA*RSR	63	0.125	65	0	-1.2341	0.02453	<.0001
RA*RSR	63	0.125	65	0.125	0.2886	0.02453	<.0001
RA*RSR	63	0.125	65	0.15	0.5965	0.02453	<.0001
RA*RSR	63	0.125	65	0.175	0.9055	0.02453	<.0001
RA*RSR	63	0.125	67	0	-0.4168	0.02453	<.0001
RA*RSR	63	0.125	67	0.125	1.0148	0.02453	<.0001
RA*RSR	63	0.125	67	0.15	1.3041	0.02453	<.0001
RA*RSR	63	0.125	67	0.175	1.5947	0.02453	<.0001
RA*RSR	63	0.125	70	0	0.9304	0.02453	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	63	0.125	70	0.125	2.1922	0.02453	<.0001
RA*RSR	63	0.125	70	0.15	2.4479	0.02453	<.0001
RA*RSR	63	0.125	70	0.175	2.7045	0.02453	<.0001
RA*RSR	63	0.15	63	0.175	0.3138	0.02453	<.0001
RA*RSR	63	0.15	65	0	-1.5467	0.02453	<.0001
RA*RSR	63	0.15	65	0.125	-0.02401	0.02453	1
RA*RSR	63	0.15	65	0.15	0.2839	0.02453	<.0001
RA*RSR	63	0.15	65	0.175	0.5929	0.02453	<.0001
RA*RSR	63	0.15	67	0	-0.7294	0.02453	<.0001
RA*RSR	63	0.15	67	0.125	0.7022	0.02453	<.0001
RA*RSR	63	0.15	67	0.15	0.9915	0.02453	<.0001
RA*RSR	63	0.15	67	0.175	1.2821	0.02453	<.0001
RA*RSR	63	0.15	70	0	0.6178	0.02453	<.0001
RA*RSR	63	0.15	70	0.125	1.8796	0.02453	<.0001
RA*RSR	63	0.15	70	0.15	2.1353	0.02453	<.0001
RA*RSR	63	0.15	70	0.175	2.3919	0.02453	<.0001
RA*RSR	63	0.175	65	0	-1.8605	0.02453	<.0001
RA*RSR	63	0.175	65	0.125	-0.3378	0.02453	<.0001
RA*RSR	63	0.175	65	0.15	-0.02986	0.02453	1
RA*RSR	63	0.175	65	0.175	0.2791	0.02453	<.0001
RA*RSR	63	0.175	67	0	-1.0432	0.02453	<.0001
RA*RSR	63	0.175	67	0.125	0.3884	0.02453	<.0001
RA*RSR	63	0.175	67	0.15	0.6777	0.02453	<.0001
RA*RSR	63	0.175	67	0.175	0.9683	0.02453	<.0001
RA*RSR	63	0.175	70	0	0.304	0.02453	<.0001
RA*RSR	63	0.175	70	0.125	1.5658	0.02453	<.0001
RA*RSR	63	0.175	70	0.15	1.8216	0.02453	<.0001
RA*RSR	63	0.175	70	0.175	2.0781	0.02453	<.0001
RA*RSR	65	0	65	0.125	1.5227	0.02453	<.0001
RA*RSR	65	0	65	0.15	1.8306	0.02453	<.0001
RA*RSR	65	0	65	0.175	2.1396	0.02453	<.0001
RA*RSR	65	0	67	0	0.8173	0.02453	<.0001
RA*RSR	65	0	67	0.125	2.2489	0.02453	<.0001
RA*RSR	65	0	67	0.15	2.5382	0.02453	<.0001
RA*RSR	65	0	67	0.175	2.8288	0.02453	<.0001
RA*RSR	65	0	70	0	2.1645	0.02453	<.0001
RA*RSR	65	0	70	0.125	3.4263	0.02453	<.0001
RA*RSR	65	0	70	0.15	3.682	0.02453	<.0001
RA*RSR	65	0	70	0.175	3.9386	0.02453	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	65	0.125	65	0.15	0.3079	0.02453	<.0001
RA*RSR	65	0.125	65	0.175	0.6169	0.02453	<.0001
RA*RSR	65	0.125	67	0	-0.7054	0.02453	<.0001
RA*RSR	65	0.125	67	0.125	0.7262	0.02453	<.0001
RA*RSR	65	0.125	67	0.15	1.0155	0.02453	<.0001
RA*RSR	65	0.125	67	0.175	1.3061	0.02453	<.0001
RA*RSR	65	0.125	70	0	0.6418	0.02453	<.0001
RA*RSR	65	0.125	70	0.125	1.9036	0.02453	<.0001
RA*RSR	65	0.125	70	0.15	2.1594	0.02453	<.0001
RA*RSR	65	0.125	70	0.175	2.4159	0.02453	<.0001
RA*RSR	65	0.15	65	0.175	0.309	0.02453	<.0001
RA*RSR	65	0.15	67	0	-1.0133	0.02453	<.0001
RA*RSR	65	0.15	67	0.125	0.4183	0.02453	<.0001
RA*RSR	65	0.15	67	0.15	0.7076	0.02453	<.0001
RA*RSR	65	0.15	67	0.175	0.9982	0.02453	<.0001
RA*RSR	65	0.15	70	0	0.3339	0.02453	<.0001
RA*RSR	65	0.15	70	0.125	1.5957	0.02453	<.0001
RA*RSR	65	0.15	70	0.15	1.8514	0.02453	<.0001
RA*RSR	65	0.15	70	0.175	2.108	0.02453	<.0001
RA*RSR	65	0.175	67	0	-1.3223	0.02453	<.0001
RA*RSR	65	0.175	67	0.125	0.1093	0.02453	0.0016
RA*RSR	65	0.175	67	0.15	0.3986	0.02453	<.0001
RA*RSR	65	0.175	67	0.175	0.6892	0.02453	<.0001
RA*RSR	65	0.175	70	0	0.02489	0.02453	1
RA*RSR	65	0.175	70	0.125	1.2867	0.02453	<.0001
RA*RSR	65	0.175	70	0.15	1.5425	0.02453	<.0001
RA*RSR	65	0.175	70	0.175	1.799	0.02453	<.0001
RA*RSR	67	0	67	0.125	1.4315	0.02453	<.0001
RA*RSR	67	0	67	0.15	1.7209	0.02453	<.0001
RA*RSR	67	0	67	0.175	2.0115	0.02453	<.0001
RA*RSR	67	0	70	0	1.3472	0.02453	<.0001
RA*RSR	67	0	70	0.125	2.609	0.02453	<.0001
RA*RSR	67	0	70	0.15	2.8647	0.02453	<.0001
RA*RSR	67	0	70	0.175	3.1213	0.02453	<.0001
RA*RSR	67	0.125	67	0.15	0.2893	0.02453	<.0001
RA*RSR	67	0.125	67	0.175	0.5799	0.02453	<.0001
RA*RSR	67	0.125	70	0	-0.08439	0.02453	0.1116
RA*RSR	67	0.125	70	0.125	1.1774	0.02453	<.0001
RA*RSR	67	0.125	70	0.15	1.4332	0.02453	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	67	0.125	70	0.175	1.6897	0.02453	<.0001
RA*RSR	67	0.15	67	0.175	0.2906	0.02453	<.0001
RA*RSR	67	0.15	70	0	-0.3737	0.02453	<.0001
RA*RSR	67	0.15	70	0.125	0.8881	0.02453	<.0001
RA*RSR	67	0.15	70	0.15	1.1438	0.02453	<.0001
RA*RSR	67	0.15	70	0.175	1.4004	0.02453	<.0001
RA*RSR	67	0.175	70	0	-0.6643	0.02453	<.0001
RA*RSR	67	0.175	70	0.125	0.5975	0.02453	<.0001
RA*RSR	67	0.175	70	0.15	0.8532	0.02453	<.0001
RA*RSR	67	0.175	70	0.175	1.1098	0.02453	<.0001
RA*RSR	70	0	70	0.125	1.2618	0.02453	<.0001
RA*RSR	70	0	70	0.15	1.5176	0.02453	<.0001
RA*RSR	70	0	70	0.175	1.7741	0.02453	<.0001
RA*RSR	70	0.125	70	0.15	0.2557	0.02453	<.0001
RA*RSR	70	0.125	70	0.175	0.5123	0.02453	<.0001
RA*RSR	70	0.15	70	0.175	0.2566	0.02453	<.0001

Table J.2 Group 2 households earning less than R50 000 p.p.p.a.

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA	60		63		1.1586	0.01235	<.0001
RA	60		65		1.4056	0.01235	<.0001
RA	60		67		2.0667	0.01235	<.0001
RA	60		70		3.0547	0.01235	<.0001
RA	63		65		0.247	0.01224	<.0001
RA	63		67		0.9082	0.01224	<.0001
RA	63		70		1.8961	0.01224	<.0001
RA	65		67		0.6611	0.01224	<.0001
RA	65		70		1.6491	0.01224	<.0001
RA	67		70		0.9879	0.01224	<.0001
RSR		0		0.125	1.4026	0.01098	<.0001
RSR		0		0.15	1.6878	0.01098	<.0001
RSR		0		0.175	1.9751	0.01098	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RSR		0.125		0.15	0.2853	0.01098	<.0001
RSR		0.125		0.175	0.5725	0.01098	<.0001
RSR		0.15		0.175	0.2872	0.01098	<.0001
RA*RSR	60	0	60	0.125	1.5693	0.02484	<.0001
RA*RSR	60	0	60	0.15	1.8872	0.02484	<.0001
RA*RSR	60	0	60	0.175	2.2062	0.02484	<.0001
RA*RSR	60	0	63	0	1.2829	0.02467	<.0001
RA*RSR	60	0	63	0.125	2.7145	0.02467	<.0001
RA*RSR	60	0	63	0.15	3.0044	0.02467	<.0001
RA*RSR	60	0	63	0.175	3.2952	0.02467	<.0001
RA*RSR	60	0	65	0	1.5194	0.02467	<.0001
RA*RSR	60	0	65	0.125	2.9592	0.02467	<.0001
RA*RSR	60	0	65	0.15	3.2544	0.02467	<.0001
RA*RSR	60	0	65	0.175	3.5521	0.02467	<.0001
RA*RSR	60	0	67	0	2.2619	0.02467	<.0001
RA*RSR	60	0	67	0.125	3.6129	0.02467	<.0001
RA*RSR	60	0	67	0.15	3.8882	0.02467	<.0001
RA*RSR	60	0	67	0.175	4.1667	0.02467	<.0001
RA*RSR	60	0	70	0	3.368	0.02467	<.0001
RA*RSR	60	0	70	0.125	4.589	0.02467	<.0001
RA*RSR	60	0	70	0.15	4.8371	0.02467	<.0001
RA*RSR	60	0	70	0.175	5.0873	0.02467	<.0001
RA*RSR	60	0.125	60	0.15	0.3179	0.02484	<.0001
RA*RSR	60	0.125	60	0.175	0.6368	0.02484	<.0001
RA*RSR	60	0.125	63	0	-0.2864	0.02467	<.0001
RA*RSR	60	0.125	63	0.125	1.1452	0.02467	<.0001
RA*RSR	60	0.125	63	0.15	1.4351	0.02467	<.0001
RA*RSR	60	0.125	63	0.175	1.7259	0.02467	<.0001
RA*RSR	60	0.125	65	0	-0.04997	0.02467	1
RA*RSR	60	0.125	65	0.125	1.3898	0.02467	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	60	0.125	65	0.15	1.6851	0.02467	<.0001
RA*RSR	60	0.125	65	0.175	1.9828	0.02467	<.0001
RA*RSR	60	0.125	67	0	0.6925	0.02467	<.0001
RA*RSR	60	0.125	67	0.125	2.0436	0.02467	<.0001
RA*RSR	60	0.125	67	0.15	2.3188	0.02467	<.0001
RA*RSR	60	0.125	67	0.175	2.5973	0.02467	<.0001
RA*RSR	60	0.125	70	0	1.7986	0.02467	<.0001
RA*RSR	60	0.125	70	0.125	3.0196	0.02467	<.0001
RA*RSR	60	0.125	70	0.15	3.2677	0.02467	<.0001
RA*RSR	60	0.125	70	0.175	3.518	0.02467	<.0001
RA*RSR	60	0.15	60	0.175	0.3189	0.02484	<.0001
RA*RSR	60	0.15	63	0	-0.6043	0.02467	<.0001
RA*RSR	60	0.15	63	0.125	0.8273	0.02467	<.0001
RA*RSR	60	0.15	63	0.15	1.1172	0.02467	<.0001
RA*RSR	60	0.15	63	0.175	1.408	0.02467	<.0001
RA*RSR	60	0.15	65	0	-0.3679	0.02467	<.0001
RA*RSR	60	0.15	65	0.125	1.0719	0.02467	<.0001
RA*RSR	60	0.15	65	0.15	1.3672	0.02467	<.0001
RA*RSR	60	0.15	65	0.175	1.6649	0.02467	<.0001
RA*RSR	60	0.15	67	0	0.3746	0.02467	<.0001
RA*RSR	60	0.15	67	0.125	1.7257	0.02467	<.0001
RA*RSR	60	0.15	67	0.15	2.0009	0.02467	<.0001
RA*RSR	60	0.15	67	0.175	2.2794	0.02467	<.0001
RA*RSR	60	0.15	70	0	1.4807	0.02467	<.0001
RA*RSR	60	0.15	70	0.125	2.7017	0.02467	<.0001
RA*RSR	60	0.15	70	0.15	2.9498	0.02467	<.0001
RA*RSR	60	0.15	70	0.175	3.2001	0.02467	<.0001
RA*RSR	60	0.175	63	0	-0.9233	0.02467	<.0001
RA*RSR	60	0.175	63	0.125	0.5083	0.02467	<.0001
RA*RSR	60	0.175	63	0.15	0.7982	0.02467	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	60	0.175	63	0.175	1.089	0.02467	<.0001
RA*RSR	60	0.175	65	0	-0.6868	0.02467	<.0001
RA*RSR	60	0.175	65	0.125	0.753	0.02467	<.0001
RA*RSR	60	0.175	65	0.15	1.0483	0.02467	<.0001
RA*RSR	60	0.175	65	0.175	1.346	0.02467	<.0001
RA*RSR	60	0.175	67	0	0.05569	0.02467	1
RA*RSR	60	0.175	67	0.125	1.4067	0.02467	<.0001
RA*RSR	60	0.175	67	0.15	1.682	0.02467	<.0001
RA*RSR	60	0.175	67	0.175	1.9605	0.02467	<.0001
RA*RSR	60	0.175	70	0	1.1618	0.02467	<.0001
RA*RSR	60	0.175	70	0.125	2.3828	0.02467	<.0001
RA*RSR	60	0.175	70	0.15	2.6309	0.02467	<.0001
RA*RSR	60	0.175	70	0.175	2.8812	0.02467	<.0001
RA*RSR	63	0	63	0.125	1.4316	0.02448	<.0001
RA*RSR	63	0	63	0.15	1.7215	0.02448	<.0001
RA*RSR	63	0	63	0.175	2.0123	0.02448	<.0001
RA*RSR	63	0	65	0	0.2365	0.02448	<.0001
RA*RSR	63	0	65	0.125	1.6763	0.02448	<.0001
RA*RSR	63	0	65	0.15	1.9715	0.02448	<.0001
RA*RSR	63	0	65	0.175	2.2692	0.02448	<.0001
RA*RSR	63	0	67	0	0.979	0.02448	<.0001
RA*RSR	63	0	67	0.125	2.33	0.02448	<.0001
RA*RSR	63	0	67	0.15	2.6053	0.02448	<.0001
RA*RSR	63	0	67	0.175	2.8838	0.02448	<.0001
RA*RSR	63	0	70	0	2.0851	0.02448	<.0001
RA*RSR	63	0	70	0.125	3.3061	0.02448	<.0001
RA*RSR	63	0	70	0.15	3.5542	0.02448	<.0001
RA*RSR	63	0	70	0.175	3.8044	0.02448	<.0001
RA*RSR	63	0.125	63	0.15	0.2899	0.02448	<.0001
RA*RSR	63	0.125	63	0.175	0.5807	0.02448	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	63	0.125	65	0	-1.1951	0.02448	<.0001
RA*RSR	63	0.125	65	0.125	0.2447	0.02448	<.0001
RA*RSR	63	0.125	65	0.15	0.5399	0.02448	<.0001
RA*RSR	63	0.125	65	0.175	0.8376	0.02448	<.0001
RA*RSR	63	0.125	67	0	-0.4526	0.02448	<.0001
RA*RSR	63	0.125	67	0.125	0.8984	0.02448	<.0001
RA*RSR	63	0.125	67	0.15	1.1737	0.02448	<.0001
RA*RSR	63	0.125	67	0.175	1.4522	0.02448	<.0001
RA*RSR	63	0.125	70	0	0.6535	0.02448	<.0001
RA*RSR	63	0.125	70	0.125	1.8745	0.02448	<.0001
RA*RSR	63	0.125	70	0.15	2.1226	0.02448	<.0001
RA*RSR	63	0.125	70	0.175	2.3728	0.02448	<.0001
RA*RSR	63	0.15	63	0.175	0.2908	0.02448	<.0001
RA*RSR	63	0.15	65	0	-1.485	0.02448	<.0001
RA*RSR	63	0.15	65	0.125	-0.04523	0.02448	1
RA*RSR	63	0.15	65	0.15	0.25	0.02448	<.0001
RA*RSR	63	0.15	65	0.175	0.5478	0.02448	<.0001
RA*RSR	63	0.15	67	0	-0.7425	0.02448	<.0001
RA*RSR	63	0.15	67	0.125	0.6085	0.02448	<.0001
RA*RSR	63	0.15	67	0.15	0.8838	0.02448	<.0001
RA*RSR	63	0.15	67	0.175	1.1623	0.02448	<.0001
RA*RSR	63	0.15	70	0	0.3636	0.02448	<.0001
RA*RSR	63	0.15	70	0.125	1.5846	0.02448	<.0001
RA*RSR	63	0.15	70	0.15	1.8327	0.02448	<.0001
RA*RSR	63	0.15	70	0.175	2.083	0.02448	<.0001
RA*RSR	63	0.175	65	0	-1.7758	0.02448	<.0001
RA*RSR	63	0.175	65	0.125	-0.336	0.02448	<.0001
RA*RSR	63	0.175	65	0.15	-0.04076	0.02448	1
RA*RSR	63	0.175	65	0.175	0.257	0.02448	<.0001
RA*RSR	63	0.175	67	0	-1.0333	0.02448	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	63	0.175	67	0.125	0.3177	0.02448	<.0001
RA*RSR	63	0.175	67	0.15	0.593	0.02448	<.0001
RA*RSR	63	0.175	67	0.175	0.8715	0.02448	<.0001
RA*RSR	63	0.175	70	0	0.07277	0.02448	0.566
RA*RSR	63	0.175	70	0.125	1.2938	0.02448	<.0001
RA*RSR	63	0.175	70	0.15	1.5419	0.02448	<.0001
RA*RSR	63	0.175	70	0.175	1.7922	0.02448	<.0001
RA*RSR	65	0	65	0.125	1.4398	0.02448	<.0001
RA*RSR	65	0	65	0.15	1.7351	0.02448	<.0001
RA*RSR	65	0	65	0.175	2.0328	0.02448	<.0001
RA*RSR	65	0	67	0	0.7425	0.02448	<.0001
RA*RSR	65	0	67	0.125	2.0935	0.02448	<.0001
RA*RSR	65	0	67	0.15	2.3688	0.02448	<.0001
RA*RSR	65	0	67	0.175	2.6473	0.02448	<.0001
RA*RSR	65	0	70	0	1.8486	0.02448	<.0001
RA*RSR	65	0	70	0.125	3.0696	0.02448	<.0001
RA*RSR	65	0	70	0.15	3.3177	0.02448	<.0001
RA*RSR	65	0	70	0.175	3.568	0.02448	<.0001
RA*RSR	65	0.125	65	0.15	0.2953	0.02448	<.0001
RA*RSR	65	0.125	65	0.175	0.593	0.02448	<.0001
RA*RSR	65	0.125	67	0	-0.6973	0.02448	<.0001
RA*RSR	65	0.125	67	0.125	0.6537	0.02448	<.0001
RA*RSR	65	0.125	67	0.15	0.929	0.02448	<.0001
RA*RSR	65	0.125	67	0.175	1.2075	0.02448	<.0001
RA*RSR	65	0.125	70	0	0.4088	0.02448	<.0001
RA*RSR	65	0.125	70	0.125	1.6298	0.02448	<.0001
RA*RSR	65	0.125	70	0.15	1.8779	0.02448	<.0001
RA*RSR	65	0.125	70	0.175	2.1282	0.02448	<.0001
RA*RSR	65	0.15	65	0.175	0.2977	0.02448	<.0001
RA*RSR	65	0.15	67	0	-0.9926	0.02448	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	65	0.15	67	0.125	0.3585	0.02448	<.0001
RA*RSR	65	0.15	67	0.15	0.6337	0.02448	<.0001
RA*RSR	65	0.15	67	0.175	0.9122	0.02448	<.0001
RA*RSR	65	0.15	70	0	0.1135	0.02448	0.0007
RA*RSR	65	0.15	70	0.125	1.3345	0.02448	<.0001
RA*RSR	65	0.15	70	0.15	1.5826	0.02448	<.0001
RA*RSR	65	0.15	70	0.175	1.8329	0.02448	<.0001
RA*RSR	65	0.175	67	0	-1.2903	0.02448	<.0001
RA*RSR	65	0.175	67	0.125	0.06075	0.02448	1
RA*RSR	65	0.175	67	0.15	0.336	0.02448	<.0001
RA*RSR	65	0.175	67	0.175	0.6145	0.02448	<.0001
RA*RSR	65	0.175	70	0	-0.1842	0.02448	<.0001
RA*RSR	65	0.175	70	0.125	1.0368	0.02448	<.0001
RA*RSR	65	0.175	70	0.15	1.2849	0.02448	<.0001
RA*RSR	65	0.175	70	0.175	1.5352	0.02448	<.0001
RA*RSR	67	0	67	0.125	1.351	0.02448	<.0001
RA*RSR	67	0	67	0.15	1.6263	0.02448	<.0001
RA*RSR	67	0	67	0.175	1.9048	0.02448	<.0001
RA*RSR	67	0	70	0	1.1061	0.02448	<.0001
RA*RSR	67	0	70	0.125	2.3271	0.02448	<.0001
RA*RSR	67	0	70	0.15	2.5752	0.02448	<.0001
RA*RSR	67	0	70	0.175	2.8255	0.02448	<.0001
RA*RSR	67	0.125	67	0.15	0.2753	0.02448	<.0001
RA*RSR	67	0.125	67	0.175	0.5538	0.02448	<.0001
RA*RSR	67	0.125	70	0	-0.2449	0.02448	<.0001
RA*RSR	67	0.125	70	0.125	0.9761	0.02448	<.0001
RA*RSR	67	0.125	70	0.15	1.2242	0.02448	<.0001
RA*RSR	67	0.125	70	0.175	1.4745	0.02448	<.0001
RA*RSR	67	0.15	67	0.175	0.2785	0.02448	<.0001
RA*RSR	67	0.15	70	0	-0.5202	0.02448	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	67	0.15	70	0.125	0.7008	0.02448	<.0001
RA*RSR	67	0.15	70	0.15	0.9489	0.02448	<.0001
RA*RSR	67	0.15	70	0.175	1.1992	0.02448	<.0001
RA*RSR	67	0.175	70	0	-0.7987	0.02448	<.0001
RA*RSR	67	0.175	70	0.125	0.4223	0.02448	<.0001
RA*RSR	67	0.175	70	0.15	0.6704	0.02448	<.0001
RA*RSR	67	0.175	70	0.175	0.9207	0.02448	<.0001
RA*RSR	70	0	70	0.125	1.221	0.02448	<.0001
RA*RSR	70	0	70	0.15	1.4691	0.02448	<.0001
RA*RSR	70	0	70	0.175	1.7194	0.02448	<.0001
RA*RSR	70	0.125	70	0.15	0.2481	0.02448	<.0001
RA*RSR	70	0.125	70	0.175	0.4984	0.02448	<.0001
RA*RSR	70	0.15	70	0.175	0.2503	0.02448	<.0001

Table J.3 Group 2 households earning R50 000 p.p.p.a. or more

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA	60		63		1.0683	0.01175	<.0001
RA	60		65		1.3127	0.01175	<.0001
RA	60		67		1.9712	0.01175	<.0001
RA	60		70		3.0423	0.01175	<.0001
RA	63		65		0.2444	0.01173	<.0001
RA	63		67		0.903	0.01173	<.0001
RA	63		70		1.974	0.01173	<.0001
RA	65		67		0.6586	0.01173	<.0001
RA	65		70		1.7296	0.01173	<.0001
RA	67		70		1.0711	0.01173	<.0001
RSR		0		0.125	1.2532	0.0105	<.0001
RSR		0		0.15	1.5059	0.0105	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RSR		0		0.175	1.7595	0.0105	<.0001
RSR		0.125		0.15	0.2527	0.0105	<.0001
RSR		0.125		0.175	0.5063	0.0105	<.0001
RSR		0.15		0.175	0.2536	0.0105	<.0001
RA*RSR	60	0	60	0.125	1.4402	0.02352	<.0001
RA*RSR	60	0	60	0.15	1.7304	0.02352	<.0001
RA*RSR	60	0	60	0.175	2.0215	0.02352	<.0001
RA*RSR	60	0	63	0	1.1855	0.02349	<.0001
RA*RSR	60	0	63	0.125	2.4956	0.02349	<.0001
RA*RSR	60	0	63	0.15	2.7596	0.02349	<.0001
RA*RSR	60	0	63	0.175	3.0244	0.02349	<.0001
RA*RSR	60	0	65	0	1.4651	0.02349	<.0001
RA*RSR	60	0	65	0.125	2.7354	0.02349	<.0001
RA*RSR	60	0	65	0.15	2.9922	0.02349	<.0001
RA*RSR	60	0	65	0.175	3.2501	0.02349	<.0001
RA*RSR	60	0	67	0	2.195	0.02349	<.0001
RA*RSR	60	0	67	0.125	3.3864	0.02349	<.0001
RA*RSR	60	0	67	0.15	3.6271	0.02349	<.0001
RA*RSR	60	0	67	0.175	3.8686	0.02349	<.0001
RA*RSR	60	0	70	0	3.3907	0.02349	<.0001
RA*RSR	60	0	70	0.125	4.4447	0.02349	<.0001
RA*RSR	60	0	70	0.15	4.6566	0.02349	<.0001
RA*RSR	60	0	70	0.175	4.8692	0.02349	<.0001
RA*RSR	60	0.125	60	0.15	0.2901	0.02352	<.0001
RA*RSR	60	0.125	60	0.175	0.5813	0.02352	<.0001
RA*RSR	60	0.125	63	0	-0.2548	0.02349	<.0001
RA*RSR	60	0.125	63	0.125	1.0554	0.02349	<.0001
RA*RSR	60	0.125	63	0.15	1.3194	0.02349	<.0001
RA*RSR	60	0.125	63	0.175	1.5842	0.02349	<.0001
RA*RSR	60	0.125	65	0	0.02483	0.02349	1

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	60	0.125	65	0.125	1.2952	0.02349	<.0001
RA*RSR	60	0.125	65	0.15	1.552	0.02349	<.0001
RA*RSR	60	0.125	65	0.175	1.8098	0.02349	<.0001
RA*RSR	60	0.125	67	0	0.7547	0.02349	<.0001
RA*RSR	60	0.125	67	0.125	1.9461	0.02349	<.0001
RA*RSR	60	0.125	67	0.15	2.1868	0.02349	<.0001
RA*RSR	60	0.125	67	0.175	2.4284	0.02349	<.0001
RA*RSR	60	0.125	70	0	1.9505	0.02349	<.0001
RA*RSR	60	0.125	70	0.125	3.0044	0.02349	<.0001
RA*RSR	60	0.125	70	0.15	3.2164	0.02349	<.0001
RA*RSR	60	0.125	70	0.175	3.429	0.02349	<.0001
RA*RSR	60	0.15	60	0.175	0.2911	0.02352	<.0001
RA*RSR	60	0.15	63	0	-0.5449	0.02349	<.0001
RA*RSR	60	0.15	63	0.125	0.7652	0.02349	<.0001
RA*RSR	60	0.15	63	0.15	1.0292	0.02349	<.0001
RA*RSR	60	0.15	63	0.175	1.2941	0.02349	<.0001
RA*RSR	60	0.15	65	0	-0.2653	0.02349	<.0001
RA*RSR	60	0.15	65	0.125	1.005	0.02349	<.0001
RA*RSR	60	0.15	65	0.15	1.2619	0.02349	<.0001
RA*RSR	60	0.15	65	0.175	1.5197	0.02349	<.0001
RA*RSR	60	0.15	67	0	0.4646	0.02349	<.0001
RA*RSR	60	0.15	67	0.125	1.656	0.02349	<.0001
RA*RSR	60	0.15	67	0.15	1.8967	0.02349	<.0001
RA*RSR	60	0.15	67	0.175	2.1383	0.02349	<.0001
RA*RSR	60	0.15	70	0	1.6604	0.02349	<.0001
RA*RSR	60	0.15	70	0.125	2.7143	0.02349	<.0001
RA*RSR	60	0.15	70	0.15	2.9262	0.02349	<.0001
RA*RSR	60	0.15	70	0.175	3.1388	0.02349	<.0001
RA*RSR	60	0.175	63	0	-0.836	0.02349	<.0001
RA*RSR	60	0.175	63	0.125	0.4741	0.02349	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	60	0.175	63	0.15	0.7381	0.02349	<.0001
RA*RSR	60	0.175	63	0.175	1.0029	0.02349	<.0001
RA*RSR	60	0.175	65	0	-0.5564	0.02349	<.0001
RA*RSR	60	0.175	65	0.125	0.7139	0.02349	<.0001
RA*RSR	60	0.175	65	0.15	0.9707	0.02349	<.0001
RA*RSR	60	0.175	65	0.175	1.2286	0.02349	<.0001
RA*RSR	60	0.175	67	0	0.1735	0.02349	<.0001
RA*RSR	60	0.175	67	0.125	1.3649	0.02349	<.0001
RA*RSR	60	0.175	67	0.15	1.6056	0.02349	<.0001
RA*RSR	60	0.175	67	0.175	1.8472	0.02349	<.0001
RA*RSR	60	0.175	70	0	1.3692	0.02349	<.0001
RA*RSR	60	0.175	70	0.125	2.4232	0.02349	<.0001
RA*RSR	60	0.175	70	0.15	2.6351	0.02349	<.0001
RA*RSR	60	0.175	70	0.175	2.8477	0.02349	<.0001
RA*RSR	63	0	63	0.125	1.3101	0.02346	<.0001
RA*RSR	63	0	63	0.15	1.5741	0.02346	<.0001
RA*RSR	63	0	63	0.175	1.839	0.02346	<.0001
RA*RSR	63	0	65	0	0.2796	0.02346	<.0001
RA*RSR	63	0	65	0.125	1.5499	0.02346	<.0001
RA*RSR	63	0	65	0.15	1.8068	0.02346	<.0001
RA*RSR	63	0	65	0.175	2.0646	0.02346	<.0001
RA*RSR	63	0	67	0	1.0095	0.02346	<.0001
RA*RSR	63	0	67	0.125	2.2009	0.02346	<.0001
RA*RSR	63	0	67	0.15	2.4416	0.02346	<.0001
RA*RSR	63	0	67	0.175	2.6832	0.02346	<.0001
RA*RSR	63	0	70	0	2.2053	0.02346	<.0001
RA*RSR	63	0	70	0.125	3.2592	0.02346	<.0001
RA*RSR	63	0	70	0.15	3.4711	0.02346	<.0001
RA*RSR	63	0	70	0.175	3.6837	0.02346	<.0001
RA*RSR	63	0.125	63	0.15	0.264	0.02346	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	63	0.125	63	0.175	0.5288	0.02346	<.0001
RA*RSR	63	0.125	65	0	-1.0306	0.02346	<.0001
RA*RSR	63	0.125	65	0.125	0.2398	0.02346	<.0001
RA*RSR	63	0.125	65	0.15	0.4966	0.02346	<.0001
RA*RSR	63	0.125	65	0.175	0.7544	0.02346	<.0001
RA*RSR	63	0.125	67	0	-0.3007	0.02346	<.0001
RA*RSR	63	0.125	67	0.125	0.8907	0.02346	<.0001
RA*RSR	63	0.125	67	0.15	1.1314	0.02346	<.0001
RA*RSR	63	0.125	67	0.175	1.373	0.02346	<.0001
RA*RSR	63	0.125	70	0	0.8951	0.02346	<.0001
RA*RSR	63	0.125	70	0.125	1.9491	0.02346	<.0001
RA*RSR	63	0.125	70	0.15	2.161	0.02346	<.0001
RA*RSR	63	0.125	70	0.175	2.3736	0.02346	<.0001
RA*RSR	63	0.15	63	0.175	0.2648	0.02346	<.0001
RA*RSR	63	0.15	65	0	-1.2945	0.02346	<.0001
RA*RSR	63	0.15	65	0.125	-0.02419	0.02346	1
RA*RSR	63	0.15	65	0.15	0.2326	0.02346	<.0001
RA*RSR	63	0.15	65	0.175	0.4905	0.02346	<.0001
RA*RSR	63	0.15	67	0	-0.5646	0.02346	<.0001
RA*RSR	63	0.15	67	0.125	0.6268	0.02346	<.0001
RA*RSR	63	0.15	67	0.15	0.8675	0.02346	<.0001
RA*RSR	63	0.15	67	0.175	1.1091	0.02346	<.0001
RA*RSR	63	0.15	70	0	0.6312	0.02346	<.0001
RA*RSR	63	0.15	70	0.125	1.6851	0.02346	<.0001
RA*RSR	63	0.15	70	0.15	1.897	0.02346	<.0001
RA*RSR	63	0.15	70	0.175	2.1096	0.02346	<.0001
RA*RSR	63	0.175	65	0	-1.5594	0.02346	<.0001
RA*RSR	63	0.175	65	0.125	-0.289	0.02346	<.0001
RA*RSR	63	0.175	65	0.15	-0.0322	0.02346	1
RA*RSR	63	0.175	65	0.175	0.2256	0.02346	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	63	0.175	67	0	-0.8295	0.02346	<.0001
RA*RSR	63	0.175	67	0.125	0.3619	0.02346	<.0001
RA*RSR	63	0.175	67	0.15	0.6026	0.02346	<.0001
RA*RSR	63	0.175	67	0.175	0.8442	0.02346	<.0001
RA*RSR	63	0.175	70	0	0.3663	0.02346	<.0001
RA*RSR	63	0.175	70	0.125	1.4202	0.02346	<.0001
RA*RSR	63	0.175	70	0.15	1.6322	0.02346	<.0001
RA*RSR	63	0.175	70	0.175	1.8448	0.02346	<.0001
RA*RSR	65	0	65	0.125	1.2703	0.02346	<.0001
RA*RSR	65	0	65	0.15	1.5272	0.02346	<.0001
RA*RSR	65	0	65	0.175	1.785	0.02346	<.0001
RA*RSR	65	0	67	0	0.7299	0.02346	<.0001
RA*RSR	65	0	67	0.125	1.9213	0.02346	<.0001
RA*RSR	65	0	67	0.15	2.162	0.02346	<.0001
RA*RSR	65	0	67	0.175	2.4036	0.02346	<.0001
RA*RSR	65	0	70	0	1.9257	0.02346	<.0001
RA*RSR	65	0	70	0.125	2.9796	0.02346	<.0001
RA*RSR	65	0	70	0.15	3.1915	0.02346	<.0001
RA*RSR	65	0	70	0.175	3.4042	0.02346	<.0001
RA*RSR	65	0.125	65	0.15	0.2568	0.02346	<.0001
RA*RSR	65	0.125	65	0.175	0.5147	0.02346	<.0001
RA*RSR	65	0.125	67	0	-0.5404	0.02346	<.0001
RA*RSR	65	0.125	67	0.125	0.651	0.02346	<.0001
RA*RSR	65	0.125	67	0.15	0.8917	0.02346	<.0001
RA*RSR	65	0.125	67	0.175	1.1333	0.02346	<.0001
RA*RSR	65	0.125	70	0	0.6553	0.02346	<.0001
RA*RSR	65	0.125	70	0.125	1.7093	0.02346	<.0001
RA*RSR	65	0.125	70	0.15	1.9212	0.02346	<.0001
RA*RSR	65	0.125	70	0.175	2.1338	0.02346	<.0001
RA*RSR	65	0.15	65	0.175	0.2578	0.02346	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	65	0.15	67	0	-0.7973	0.02346	<.0001
RA*RSR	65	0.15	67	0.125	0.3941	0.02346	<.0001
RA*RSR	65	0.15	67	0.15	0.6348	0.02346	<.0001
RA*RSR	65	0.15	67	0.175	0.8764	0.02346	<.0001
RA*RSR	65	0.15	70	0	0.3985	0.02346	<.0001
RA*RSR	65	0.15	70	0.125	1.4524	0.02346	<.0001
RA*RSR	65	0.15	70	0.15	1.6644	0.02346	<.0001
RA*RSR	65	0.15	70	0.175	1.877	0.02346	<.0001
RA*RSR	65	0.175	67	0	-1.0551	0.02346	<.0001
RA*RSR	65	0.175	67	0.125	0.1363	0.02346	<.0001
RA*RSR	65	0.175	67	0.15	0.377	0.02346	<.0001
RA*RSR	65	0.175	67	0.175	0.6186	0.02346	<.0001
RA*RSR	65	0.175	70	0	0.1407	0.02346	<.0001
RA*RSR	65	0.175	70	0.125	1.1946	0.02346	<.0001
RA*RSR	65	0.175	70	0.15	1.4065	0.02346	<.0001
RA*RSR	65	0.175	70	0.175	1.6192	0.02346	<.0001
RA*RSR	67	0	67	0.125	1.1914	0.02346	<.0001
RA*RSR	67	0	67	0.15	1.4321	0.02346	<.0001
RA*RSR	67	0	67	0.175	1.6737	0.02346	<.0001
RA*RSR	67	0	70	0	1.1958	0.02346	<.0001
RA*RSR	67	0	70	0.125	2.2497	0.02346	<.0001
RA*RSR	67	0	70	0.15	2.4616	0.02346	<.0001
RA*RSR	67	0	70	0.175	2.6743	0.02346	<.0001
RA*RSR	67	0.125	67	0.15	0.2407	0.02346	<.0001
RA*RSR	67	0.125	67	0.175	0.4823	0.02346	<.0001
RA*RSR	67	0.125	70	0	0.004383	0.02346	1
RA*RSR	67	0.125	70	0.125	1.0583	0.02346	<.0001
RA*RSR	67	0.125	70	0.15	1.2702	0.02346	<.0001
RA*RSR	67	0.125	70	0.175	1.4829	0.02346	<.0001
RA*RSR	67	0.15	67	0.175	0.2416	0.02346	<.0001

Effect	Retirement Age (RA)	Retirement Savings Rate (RSR)	RA	RSR	Estimate	Standard error	Bonferroni adjusted p
RA*RSR	67	0.15	70	0	-0.2363	0.02346	<.0001
RA*RSR	67	0.15	70	0.125	0.8176	0.02346	<.0001
RA*RSR	67	0.15	70	0.15	1.0295	0.02346	<.0001
RA*RSR	67	0.15	70	0.175	1.2422	0.02346	<.0001
RA*RSR	67	0.175	70	0	-0.4779	0.02346	<.0001
RA*RSR	67	0.175	70	0.125	0.576	0.02346	<.0001
RA*RSR	67	0.175	70	0.15	0.7879	0.02346	<.0001
RA*RSR	67	0.175	70	0.175	1.0006	0.02346	<.0001
RA*RSR	70	0	70	0.125	1.0539	0.02346	<.0001
RA*RSR	70	0	70	0.15	1.2659	0.02346	<.0001
RA*RSR	70	0	70	0.175	1.4785	0.02346	<.0001
RA*RSR	70	0.125	70	0.15	0.2119	0.02346	<.0001
RA*RSR	70	0.125	70	0.175	0.4245	0.02346	<.0001
RA*RSR	70	0.15	70	0.175	0.2126	0.02346	<.0001