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Measuring Adequacy of Retirement Savings

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Abstract

This article introduces four metrics quantifying the adequacy of retirement savings taking into account all major sources of retirement income. The metrics are applied to a representative sample of the Australian population aged 40 and above. Employers in Australia currently make compulsory contributions of 9.25 per cent of wages and salaries to tax-advantaged defined-contribution employee retirement savings accounts. Our analysis reveals that compulsory retirement savings, even when supplemented by the means-tested government pension and private wealth accumulation, are not in general sufficient to fund a comfortable lifestyle during retirement. We further find that omitting one or more 'pillars' of saving will significantly bias estimates of retirement savings adequacy. Our analysis also points to several shortcomings of the widely-used income replacement ratio as an indicator of savings adequacy.

JEL classification: D14, D91, P46

Keywords: Retirement savings, financial literacy, life-cycle consumption and savings, household finance

I. Introduction

There seems to be widespread agreement that most people do not save enough for their retirement (Shlomo Benartzi, 2012, B. Douglas Bernheim, 1992, J. Beshears et al., 2009, James J. Choi et al., 2004, Alicia Munnell et al., 2006, Jonathan Skinner, 2007). While there is a multiplicity of normative models of life-cycle consumption and saving, many of these models are difficult to implement in practice, even for finance professionals (Annamaria Lusardi and Olivia S. Mitchell, 2007, Jonathan Skinner, 2007). This means that there is no agreement on how much saving is enough.

The most widely used measure to assess adequacy of retirement savings is the income replacement ratio (Jonathan Skinner, 2007), the ratio of post-retirement income (or consumption) to pre-retirement income (or consumption). As a rule of thumb, a replacement ratio of about 80 per cent is often considered adequate (Shlomo Benartzi, 2012). However, the income replacement ratio has some shortcomings. First, there are practical difficulties in implementing this measure for the purpose of retirement income planning. Pre-retirement income is not constant over the lifecycle, implying that the estimated adequate post-retirement income will be sensitive to the point in the lifecycle at which it is evaluated. In particular, post-retirement income needs of younger people will be systematically underestimated if current income is used to determine post-retirement income needs. Second, the income replacement ratio ignores the fact that the actual level of consumption implied varies with income level. For example, people with low pre-retirement income levels will often be able to achieve a high income replacement ratio, largely due to social security payments such as pensions and various other forms of post-retirement income support, but this is a much lower level of consumption than that of people in high income groups who often have a much lower income replacement ratio. And third, there is robust evidence that many people struggle with interpreting information such as the income replacement ratio and hence it may not be very effective in communicating savings adequacy (Valerie F. Reyna and Charles J. Brainerd, 2007).

Another severe shortcoming of existing assessments of retirement savings adequacy is the focus on retirement savings accounts, such as 401(k) accounts in the United States, sometimes additionally taking into account government pensions. Retirement income of the majority of individuals and households is, however, drawn from a wider set of sources that includes property (both the home and property investments) and financial assets other than retirement savings accounts. Thus, many existing assessments of savings adequacy likely paint an

imperfect picture of adequacy. Moreover, ignoring these other sources of retirement income likely also leads to misrepresentation of the total risk profile of retirement savings and income.

Partly as a consequence of the lack of agreement on what constitutes an adequate level of retirement savings, financial advice is often based on rules of thumb such as the widely-used 'ten per cent rule' prescribing that savings should equal ten per cent of after-tax income (Shlomo Benartzi, 2012). Such rules of thumb ignore the large heterogeneity in individual circumstances and in many cases will lead to savings outcomes that are either too high or too low.

At the same time, it has been widely documented that retirement savings vary significantly even among people with similar income levels (B. Douglas Bernheim et al., 2001). Savings behavior is affected by a large number of factors, including socio-economic, cognitive and other psychological factors (B. Douglas Bernheim and Antonio Rangel, 2005, B. Douglas Bernheim, Jonathan Skinner and Stephen Weinberg, 2001). A 'one-size-fits-all' approach, either to determining optimal savings behavior or to the development of means to improve savings, is therefore likely to be inappropriate.

The insufficiency of retirement savings is one of the more important economic, social and political challenges of our time, with significant consequences at both the individual and societal level. Greater prevalence of inadequate retirement savings translates to increased prevalence of inadequate living standards in retirement, and in particular more widespread poverty among the elderly. Moreover, lack of retirement savings leads to greater demands for various forms of government social assistance, increasing the likelihood of fiscal imbalances. Indeed, the ageing of populations and underfunding of retirement is argued by some to pose a major threat to global financial stability (International Monetary Fund, 2012).

For policy-makers committed to a system of wide-scale self-funded retirement, it is important to have a set of meaningful measures and to diagnose the extent and nature of any inadequacy of retirement savings. It is of course also important to develop effective means to implement savings targets, for example by communicating inadequacy to people with the aim for people to take action and by adjusting the institutional environment accordingly (Shlomo Benartzi, 2012).

In this article, we suggest four metrics quantifying the adequacy of retirement savings and estimate their likely values for a representative sample of the Australian population. Two of the metrics express adequacy in terms of consumption levels, the first measuring projected consumption levels during retirement and the second measuring the shortfall relative to a

target consumption level. The other two metrics express adequacy in terms of the number of years in retirement that an adequate consumption level can be maintained, the first measuring the projected age at which savings will run out and the second measuring the difference between this age and life expectancy. Importantly, our metrics reflect key personal circumstances as well as all 'pillars' of retirement savings (World Bank, 2008), that is, government pension and social security payments, compulsory and voluntary retirement savings, and other household assets. We believe that these metrics are a meaningful indicator of savings adequacy and that they can be effective in communicating savings adequacy to individuals to improve their retirement savings behavior and to alert policy makers to both the extent and nature of inadequate savings.

We then estimate the four metrics of savings adequacy for 5,001 households (singles and couples) aged 40 and above using data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey, a nationally representative household panel survey that collects data on a broad range of topics, but with a strong emphasis on household finances and employment. Importantly for this study, employers in Australia are effectively required to make compulsory superannuation contributions for employees earning at least $450 per month, which is almost always done through a personal defined-contribution retirement savings account. This 'Superannuation Guarantee' was introduced in 1992, initially specifying a minimum contribution rate of 3 per cent, which was gradually increased up to 9 per cent by 2002, where it remained until July 2013.[1] This means that working Australians automatically save at a rate close to the rule of thumb of 10 per cent that is often used by financial advisors elsewhere (Shlomo Benartzi, 2012). Hence, in addition to estimating retirement savings adequacy for a representative sample of a sizeable developed country, our data also allow us to evaluate the adequacy of this popular rule of thumb, since the youngest age groups in our dataset will have made compulsory contributions to retirement savings accounts for most of their working lives. In addition, our data enable us to evaluate the relative contributions of the four 'pillars' of retirement savings as well as heterogeneity in savings adequacy along various economic, social and demographic characteristics. In addition, we investigate the extent to which the four proposed adequacy metrics, as well as the

[1] Current legislation specifies that, starting in July 2013, the minimum contribution rate be gradually increased to 12 per cent by July 2019, with 9.25% applying at the time of writing. The current government may extend this timetable by two years to 2021. Superannuation Guarantee contribution requirements were initially restricted to employees aged 18 to 64, but the upper age limit has been gradually increased over time and, as of July 2013, there are no upper age restrictions.

income replacement ratio and several key financial indicators, convey similar amounts of information about adequacy.

We find that omitting one or more of the 'pillars' of retirement savings leads to significant underestimation of consumption levels during retirement, particularly among those with higher levels of disposable income and net worth. Moreover, we find that saving at the Superannuation Guarantee level (currently 9.25 per cent of wages and salaries) during a significant part of working life is not sufficient to achieve an adequate level of consumption during retirement for many in our sample. Indeed, reliance solely on saving at this rate—that is, assuming no government pension support—generates a median consumption level during retirement far below the relative poverty line.

Our analyses also suggest that the income replacement ratio has some limitations as an indicator of retirement savings adequacy. Most importantly, the income replacement ratio tends to be higher for low-income groups and lower for high-income groups, despite the latter group having higher consumption levels. This suggests that the income replacement ratio should be supplemented by other measures of savings adequacy to obtain a more comprehensive view of income or consumption during retirement, a point we will return to at the end of this article.

We also find that financial variables such as current household income, retirement savings account balance and net worth are not necessarily good proxies for adequacy of retirement savings, and more comprehensive metrics such as the ones we propose in this article should be considered.

The remainder of the article is structured as follows. In Section II we consider the question of how retirement savings targets, and potential shortfalls, might be defined. The algorithm for projecting retirement income is described in Section III. Section IV provides a brief overview of the HILDA Survey data, and explains how the particular subsample of respondents was chosen and how problematic issues such as distinguishing between individual and household circumstances were addressed. Section V presents results of our projections, which outline the extent of shortfalls in projected wealth from a required retirement savings target path for both singles and couples. Section V also examines the extent to which our four chosen metrics of retirement savings adequacy correlate with each other, and how well they correlate with other adequacy metrics and with key financial indicators. Section VI summarizes our findings and discusses shortcomings of our metrics as well as their suitability in public policy information campaigns.

II. Setting savings targets and defining adequacy

Assessment of adequacy of retirement savings requires both the determination of the *target* level of income or consumption in retirement, and the calculation of the *projected* income or consumption in retirement. In this section, we consider the former. The subsequent section describes how we estimate retirement income and consumption levels based on currently available information and how we define adequacy of retirement savings based on expected income and consumption levels.

There appear to be two main types of contenders for defining income or consumption targets. The first type defines target retirement wealth by reference to a desired "replacement ratio", most commonly expressed as a desired ratio of post-retirement income or consumption to pre-retirement income or consumption. The savings target is that level of wealth which will enable an income or consumption stream in retirement equal to some proportion of pre-retirement employment income or consumption.[2] Typically an average replacement ratio in the region of 70-80 per cent is assumed (with the ratio often decreasing as pre-retirement income increases), reflecting the fact that changed consumption needs, a shift from accumulation (savings) to decumulation mode, and different tax circumstances in retirement will reduce the income level needed to maintain a similar lifestyle level (A.H. Munnell et al., 2011).

Another measure of this kind is the "replacement wealth ratio". Here the target is the level of wealth at retirement required to fund a certain level of income during retirement, expressed as a multiple of pre-retirement income (A. Basu and M. Drew, 2010, P. Booth and Y. Yakoubov, 2000). A replacement wealth ratio of six to eight times pre-retirement income is typically considered adequate (A. Basu and M. Drew, 2010). Note that the replacement wealth ratio does not map one-to-one to the income replacement ratio and that the mapping between the two measures depends on the (real) rate of return on retirement savings.

The replacement ratio approach takes account of different income levels in the population and the likelihood of 'habit formation' in consumption and lifestyle preferences, such that wealthier individuals are assumed to have higher retirement consumption ambitions than the less wealthy (A.H. Munnell, F. Golub-Sass and A. Webb, 2011). On the other hand, it is difficult, particularly for younger people, to predict income and consumption levels long into

[2] Strictly speaking, the terminology should refer to a cash flow, because some part of the post retirement funds received and used for consumption is a running down of the capital amount available.

the future, which makes any replacement ratio approach difficult to implement in practice. Moreover, given the 'habit formation' rationale for the approach, presumably what is required is a measure of permanent income, or at least multi-year income. The approach also implicitly assumes that pre-retirement income is 'adequate', which is not universally true.

We adopt an alternative approach by developing metrics based on achieving a specified level of retirement consumption that are independent of pre-retirement income levels. This is both simpler and arguably provides for a more tangible estimate of target level of retirement wealth required for individuals unsure of their likely final pre-retirement income. The measure is also consistent with the notion that our interest is in whether individuals can achieve some minimum standard of living in retirement. It has strong parallels with studies of poverty, whereby the focus is on the number of people who do not have an income above a certain (poverty) threshold (see, for example, Organization of Economic Cooperation and Development, 2008).

A key issue is the specification of target retirement income levels. For the purposes of this article we use a benchmark widely used in Australia for retirement income provided by the Association of Superannuation Funds of Australia (ASFA) (2012). The target income levels are $38,339 for singles and $52,472 for couples.[3] These targets are significantly higher than the targets that would be adopted if looking at a poverty level threshold. The HILDA Survey data indicate that the ASFA target levels are in fact close to the actual mean incomes of retirees in 2010, which were $37,998 for singles (median $23,000) and $54,358 for couples (median $41,136). Moreover, they are similar to the median estimates of the level of retirement income deemed necessary by non-retired Australians above age 40 to fund a satisfactory lifestyle ($35,000 and $50,000 for singles and couples, respectively), according to the HILDA Survey.

We use current wealth and forecast accumulation from savings and returns on wealth to compute an expected retirement savings amount. Based on this figure, and taking into account the government pension, we compute four different metrics of the adequacy of retirement savings. The first metric is the 'consumption level', the level of consumption that can be sustained until age 90. This metric is independent of any target level or other benchmark. The second metric is the 'consumption shortfall', the difference between the *projected*

[3] More specifically, we use the so-called "comfortable" levels provided by ASFA in December 2012 and deflate them to 2010 dollars to align to the HILDA data timing. In this article, all dollar figures are expressed in Australian dollars at 2010 prices, unless stated otherwise.

consumption level and the *target* level of consumption. The third metric is the 'run-out age', the age at which private wealth is exhausted when consuming at the target level of consumption from the age of retirement. And the fourth metric is the 'age gap', the number of years between the time at which private wealth is exhausted, and hence consumption must be reduced to the level of the (full) government pension, and life expectancy. We now describe the computation of the expected level of private income available during retirement for individuals of various pre-retirement ages as well as the four metrics of adequacy of retirement savings.[4]

III. Estimating adequacy metrics

Individuals typically draw retirement income from at least three sources: government pension and social security payments (often referred to as 'Pillar 1'), compulsory retirement savings ('Pillar 2'), and voluntary retirement savings. We split the last category into tax-advantaged retirement savings such as voluntary contributions to retirement savings accounts ('Pillar 3'), and other retirement savings ('Pillar 4'). The latter include ordinary savings accounts, securities, life insurance policies, and property investments. While we include all of the four 'pillars' of retirement savings in our estimations, we exclude the value of the home from retirement savings, assuming that home ownership is maintained until death and that the home is bequeathed to descendants (Jonathan Skinner, 2007).

These four pillars of retirement savings largely correspond to the five pillars of the World Bank's "Five Pillar Framework" of retirement savings (World Bank, 2008). Our Pillar 1 is similar to the World Bank's non-contributory "zero pillar". There is no equivalent of the World Bank's mandatory "first pillar" in Australia and thus our framework does not contain any equivalent. Our Pillars 2 and 3 corresponds to the World Bank's mandatory "second pillar" and voluntary "third pillar" respectively while our Pillar 4 overlaps with the World Bank's voluntary "third pillar" as well as the non-financial "fourth pillar".[5] We do not

[4] Our calculations are based on an extension of an algorithm that was initially developed by Towers Watson for the Australian Securities and Investment Commission MoneySmart calculator. The calculator enables individuals to input personal financial details and obtain output on likely shortfalls in retirement consumption in the form discussed above. The calculator is publicly available at www.moneysmart.gov.au.

[5] As we cannot separate the value of past voluntary contributions from the past compulsory contributions included in the retirement savings account balance, our Pillars 2 and 3 should be viewed in combination. Our Pillar 2 includes actual past voluntary contributions while our Pillar 3 includes expected future voluntary contributions.

consider informal support (e.g. family support) and certain types of formal social programs (e.g. health care and housing), which are part of the World Bank's fourth pillar.

Core elements of the Australian retirement savings system

Several of the savings pillars, and thus the level of savings required before retirement to achieve a target level of retirement income, depend significantly on the institutional environment such as tax rates and the nature and level of social security payments. To put the estimation of the four adequacy metrics in this article in context and to facilitate interpretation of estimation results, we briefly describe the core elements of the Australian retirement saving system.

The first pillar is the Age Pension, a universal flat-rate but means-tested pension payable to retired people over the retirement age, which currently is 65 for men and has been increasing since 1996 for women, from 60 prior to 1996 up to 65 as of 1 January 2014. The pension commencement age is scheduled to increase in steps up to age 67 by 1 July 2023.[6] Since 2009, the Age Pension for singles has been set equal to 27.7 per cent of average weekly total earnings of male employees, while the Age Pension for couples is 150 per cent of the single rate.

The second pillar is based on compulsory retirement savings accounts, known as superannuation. Introduced in 1992, legislation initially specified a minimum contribution rate of 3 per cent, which was gradually increased up to 9 per cent by 2002, where it remained until July 2013. Current legislation specifies that, starting in July 2013, the minimum contribution rate be gradually increased to 12 per cent by July 2019 with 9.25% currently applying. This increase is reflected in our analyses. Superannuation Guarantee contribution requirements were initially restricted to employees aged 18 to 64, but the upper age limit has been gradually increased over time and, as of July 2013, there is no upper age restriction.

The third pillar is based on voluntary contributions to tax-favoured retirement savings accounts. These have a longer history than compulsory contributions, but are now less important than compulsory contributions. The fourth pillar comprises any other savings such as direct security holdings, property investments or life insurance policies.

[6] From 1 July 2017, the qualifying age will start increasing in line with the following: date of birth from 1/7/1952 to 31/12/1953 – age 65.5; date of birth from 1/1/1954 to 30/6/1955 – age 66; date of birth from 1/7/1955 to 31/12/1956 – age 66.5; for those with birth dates after 1/1/1957, eligibility is from 67.

We now turn to the projection of retirement savings.

Projecting retirement savings

For ease of exposition and the purposes of this article, we consolidate Pillars 2 to 4 of retirement savings together into one asset class with a common after-tax rate of return. We assume that during the accumulation phase, these assets, which we denote by K, evolve according to the following non-stochastic process of the generalised form:

$$K_{t+1} = K_t(1+r) + \left((sg+s)w_t(1-T) - c\right)\left(1+\frac{r}{2}\right), \quad (1)$$

with $w_{t+1} = (1+i)(1+f)w_t$, where t denotes the year, r denotes the return on assets, sg denotes the compulsory retirement savings rate, s denotes the voluntary savings rate, T denotes the tax rate on retirement savings contributions, c denotes administration and insurance costs, w denotes gross wages and salaries, i denotes price inflation, and f denotes real income (wage and salary) growth.[7]

During retirement, income is drawn from retirement savings, K, as well as any government pension or social security payments, denoted as p. The level of government pension and social security payments in any given year during retirement depends on the level of other income and wealth (so-called income test and assets test within the overall means-testing framework). This means that once the specified retirement age is reached, government pension eligibility has to be calculated in that and each subsequent year during retirement based on the level of other income and wealth and thus the variable p above will not be constant during retirement and will typically depend substantially on the current level of retirement savings K.

We also assume that the consumption pattern is maintained in real terms to ensure the purchasing power of the retirement income over time is not eroded, that is, retirement income is assumed to increase in line with nominal wage growth (i.e. $(1+i)(1+f)$).

Defining savings adequacy

We now define our four metrics of retirement savings adequacy. The first metric is the expected level of cash flow available post-retirement, given current circumstances such as the level of income and wealth. The expected level of cash flow available post-retirement,

[7] Annual steps are used, with additions to wealth (or subtractions in the retirement phase) assumed to occur mid-year, apart from Government co-contributions, which are applied at the end of the year.

denoted by $\hat{c}$, is the sum of cash flow available from retirement savings, $\hat{k}$, and the cash flow from government pension and social security payments, $\hat{p}$. Since pension payments are means-tested, $\hat{p}$ is a function of $\hat{k}$. If we define A as the present value today of an annuity with cash flow k starting at retirement, τ_r, ending after $\tau_e - \tau_r$ years, with τ_e denoting life expectancy or the age when retirement savings cease to provide any retirement income, and real interest rate r, then $\hat{k}$ is the value of k at which $A(k, \tau_r, \tau_e, r) = K_{\tau_r}$, that is, the annuity at which the present value of this annuity is equal to the value of retirement savings at the time of retirement. $\hat{p}$ is calculated according to local pension and social security rules.

Our second metric is the difference between expected cash flow post-retirement, $\hat{c} = \hat{k} + \hat{p}(\hat{k})$, as computed above, and the target level of cash flow (see Section II), which we denote by $\bar{c}$. We denote this metric by $\hat{s}$, and thus $\hat{s} = \hat{c} - \bar{c}$. We call this metric the *consumption shortfall.*

To compute our third and fourth metrics, we assume that retirees consume at the target level of consumption, $\bar{c}$, starting at retirement and will continue to do so until their retirement savings have been depleted. We call this time the *run-out age*, $\hat{\tau}_{ro}$—that is, $\hat{\tau}_{ro}$is the value of τ_{ro} at which $A(\hat{k}^*, \tau_r, \tau_{ro}, r) = K_{\tau_r}$. This metric indicates the age up until which the individual will be able to consume at the target level of consumption during retirement before running out of private retirement savings.

Our fourth metric, which we denote by $\hat{\gamma}$, is the difference between the run-out age $\hat{\tau}_{ro}$ and life expectancy τ_e that is $\hat{\gamma} = \hat{\tau}_{ro} - \tau_e$. We call this metric the *age gap*. It indicates how many years before life expectancy the individual is expected to deplete her private retirement savings if she consumes at the target level from retirement onwards or, in other words, how many years she will have to live without any private retirement savings, that is, solely on government pension payments.

The two sets of metrics, consumption level and consumption shortfall on the one hand, and run-out age and age gap on the other, make different assumptions about consumption in the post-retirement phase. The consumption level and consumption shortfall metrics calculate the level of consumption that can be achieved and the difference between this level and the target level of consumption respectively. These metrics can be expressed in today's dollars to ensure consistency between individuals retiring at different points in time and comparability against retirement income targets based on current costs of living.

The run-out age and age gap metrics assume that individuals immediately commence consuming at the target consumption level upon retirement (if accumulated wealth permits),

drawing down retirement savings and using whatever government pension income is available to them. They continue to do so until private retirement savings are exhausted and they are forced to revert to a lower level of consumption equal to the full government pension. Because this involves a different run-down of private retirement savings compared to the consumption metrics, and thus potentially has different implications for government pension receipts over the retirement phase, these two measures will not be perfectly correlated.

IV. Dataset

We now turn to estimating the adequacy metrics described in the previous section based on the individual circumstances of a large set of individuals and households. Our data come from the HILDA Survey, an Australian household panel study that commenced in 2001 with a nationally representative sample. The survey is conducted annually by face-to-face interview with every household member aged 15 years and over, supplemented by a self-completion questionnaire, also administered to all household members aged 15 years and over (Wooden and Watson, 2007; Summerfield et al., 2012). Annual re-interview rates (the proportion of respondents from one wave who are successfully interviewed the next) are high, rising from 87 per cent in Wave 2 to over 95.5 per cent from Wave 5 onwards.

The HILDA Survey is well-suited to the study of retirement savings adequacy, collecting comprehensive information on a wide range of relevant topics for a sample representative of the entire population. The topics covered include labor market and education activity, retirement intentions and behavior, income, expenditure, health and disability, subjective wellbeing, and personal relationships. Most importantly for this study, the HILDA Survey also collects detailed information on household assets and debts every four years. For each household, information was collected on 11 asset components and 7 debt components, which can be combined to calculate the value of retirement savings.

This article draws on the wealth data collected in 2010 (Wave 10), which contains information on 14,255 individuals over the age of 15 residing in 7,317 households.[8] However, we only report results for the 7,540 individuals aged 40 and above, residing in 5,001 households. These individuals are representative of 10.0 million people or 45.6 per cent of the

[8] The data used in this paper were extracted using the Add-On package PanelWhiz v4.0 (Oct 2012) for Stata. PanelWhiz was written by Dr. John P. Haisken-DeNew (john@panelwhiz.eu). The PanelWhiz generated DO file to retrieve the HILDA data used here and any Panelwhiz Plugins are available upon request. Any data or computational errors in this paper are our own. John P. Haisken-DeNew and Markus Hahn (2010) describe PanelWhiz in detail.

Australian population as of June 2010 (Australian Bureau of Statistics, 2013). While in principle it is possible to project retirement savings for individuals younger than 40 years of age, in practice these projections are likely to be much less reliable because of greater uncertainty about future earnings, household composition, home-ownership status, and wealth accumulation. The focus of our analysis will be on individuals between age 40 and 64 but we also report estimation results for individuals aged 65 and above as a comparison between the part of our sample below retirement age (65) and above retirement age. All estimates presented in the Results section (Section V) are computed using population weights to make them representative of the Australian population (Nicole Watson, 2012).

Our dataset allows us to address three important issues: (1) we can examine retirement savings in a setting in which all four pillars of retirement savings (government pension, compulsory and voluntary retirement savings, other savings) have been present for more than 20 years and investigate their relative contributions; (2) employees of the younger age groups in our sample will have generally received contributions of 9 per cent (or more) of their wages and salaries to a defined-contribution retirement savings account throughout a significant part of their working lives; that is, we examine a sample in which employees are saving at a rate close to the '10 per cent rule' that is often used as a rule of thumb by financial advisors in the United States (Shlomo Benartzi, 2012); and (3) the retirement savings system in Australia is in a more mature state than similar defined-contribution pension systems elsewhere in the world, and hence our data allow us to investigate issues now that other countries will be dealing with in the near future when their defined-contribution retirement savings grow. The US and UK in particular have started down the path of moving away from defined-benefit employer supported benefits towards defined-contribution systems, but this has generally happened later than in Australia. The issue of retirement adequacy and the appropriate level of savings is a more significant issue when the responsibility lies with the individual to save for and manage their own retirement income.

To project retirement savings as described in Section III, we calculate *net* assets of each household in 2010, our starting date, based on the data available in the HILDA Survey. More specifically, we combine a household's bank accounts, superannuation (retirement savings) accounts, securities (equity, fixed income securities), trust funds, life insurance policies, property investments, and businesses. We exclude the home of the household since we assume that it will be bequeathed or used to finance late-in-life specialist accommodation or aged-care expenses (see Section III). From total assets we subtract household debt. This gives us the current value (in 2010) of (net) retirement savings, K.

The HILDA Survey also collects each household-member's wage and salary income,w, from which contributions to retirement savings are made, and their age, marital status and home ownership status.

In the accumulation phase until the assumed retirement age (65), retirement savings are assumed to evolve according to Equation (1), with the following parameter specifications: asset returns r = 6.4 per cent p.a. net of investment tax and asset-based fees prior to retirement and 6.5 per cent p.a. net of asset-based fees after retirement (consistent with the investment objectives for the typical default investment strategy used by the majority of individuals in their superannuation accounts, as well as with the assumptions used by the Australian regulator in its publicly available calculator); price inflation i = 2.5 per cent p.a. (the mid-point of the Reserve Bank of Australia's target range); and real income (wage and salary) growth f = 1 per cent p.a. (assumptions used by the Australian regulator in its publicly available calculator).[9] Compulsory superannuation contributions (sg) are set at 9 per cent up to 2012 and then increased in-line with the legislated changes from 2013 onwards. Voluntary superannuation contribution rates (s) are based on levels observed in the HILDA Survey data for 2010, allowing for contributions tax (T) and administration/insurance costs (c) where applicable.

Sample summary statistics

Table 1 provides statistics on the socio-demographic characteristics of our sample. The 7,540 individuals in our sample, of whom 4,034 (53.5 per cent) are female, reside in 5,001 households. The median and mean ages of our sample members are 56.0 years and 57.8 years, respectively (standard deviation = 12.6). 5,230 (69.35 per cent) are married or live in a de-facto marriage and 599 (7.95 per cent) are lone parents. The mean number of children is 0.6. Of all sample members, 2,630 (34.95 per cent) did not complete high school, 676 (9.05 per cent) completed high school, 2,561 (24.05 per cent) obtained other post-secondary school qualification or a diploma, and 1,667 (22.15 per cent) have a university degree or higher qualifications. 4,489 (59.55 per cent) sample members live in a major city, 2,001 (26.55 per cent) live in inner regional Australia while 1,048 (13.95 per cent) live in remote areas. 3,277 (43.55 per cent) of our sample members are fully employed and 2,511 (33.35 per cent) are

[9] This is also relevant for calculating pension amounts given the linking of the full pension to 25% of average weekly earnings.

fully retired from the workforce. A breakdown of demographic characteristics by age group is provided in Table 1.

Table 2 provides sample summary statistics of income and wealth variables. Median gross household income is $77,000 ($97,601 for sample members aged 40-64, and $34,880 for sample members aged 65 and above).[10] Private sources account for 72.6 per cent of gross income received by sample members, although this share differs considerably be age group, declining from 84 to 88 per cent among those aged 40 to 59 to approximately 30 per cent among those aged 80 and over. The government pension is an important income source among those aged 65 and over. Among sample members aged 65-69, government pensions make up 39 per cent of income, rising up to two-thirds of income among sample members aged 80 and above. In other words, the government pension is by far the most significant source of retirement income.

Median household disposable income is $69,644 and declines in age from the 45-49 age group onwards. Reflecting the effects of adult children moving out of the parental home, median equalized household disposable income peaks later, reaching a high of $48,991 in the 55-59 age group age.[11]

Turning to household wealth, the median of total (gross) household assets in our sample is $731,000. Median total assets peak in the 55-59 age group at $975,950, and thereafter declines in age. The dominant asset class across all age groups in our sample is the home (47.9 per cent of total assets), followed by retirement savings accounts (*superannuation*, 19.9 per cent), and other financial assets (13.6 per cent). In older age groups, retirement savings accounts represent a much smaller share of total assets than in younger age groups, reflecting the fact that superannuation was only introduced in 1992 and thus older members of our sample did not contribute much to superannuation during their working lives. In addition, older members will have drawn on those accounts during retirement. In those age groups, other financial assets, mainly securities, are far more important.

[10] All dollar figures are in Australian dollars at 2010 prices. The mean AUD/USD exchange rate in 2010 was 1.09.

[11] Income is equivalised using the modified OECD scale, whereby household income is divided by the equivalence scale. The scale is equal to one plus 0.5 for each additional household member after the first aged 15 and over plus 0.3 for each child aged under 15. For details see **A. Hagenaars, K. de Vos, M. Zaidi.** 1994. "Poverty Statistics in the Late 1980s: Research Based on Micro-Data," Luxembourg: Office for Official Publications of the European Communities.

Median total household debt in the sample as a whole is $12,000, while median debt by age group declines from $134,000 in the 40-44 age group down to 0 in all age groups above 65.. In younger households, debt is dominated by mortgages whereas older households' debt is mainly comprised of other forms of debt. Median net worth is $604,164. A breakdown of the composition of income and wealth by age group is also provided in Table 2.

In Table 3 we provide statistics on the distributions of household disposable income and net worth for the entire sample as well as by age group to demonstrate the high degree of variability of income and wealth across the population. Looking at disposable income, the ratio of the 90^{th} percentile to the 10^{th} percentile is 7.0 when taking into account the entire sample. Across age groups, this ratio is largest in the age group 65 to 69 (7.0) and lowest in the age group 40 to 44 (4.0). Disparities are even greater for net worth. Here, the ratio of the 90^{th} percentile to the 10^{th} percentile is 51.0 for the entire sample, highest in the age group 75 to 79 (80.6) and lowest in the age group 55 to 59 (18.4).

In summary, there is a high degree of heterogeneity in income and wealth across our sample as well as in the composition of income and wealth. Thus, we expect there to be a correspondingly high degree of heterogeneity in adequacy of retirement savings.

TABLE 1—SAMPLE SUMMARY STATISTICS

	All	Age group									
		40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Number of persons in sample	7,540	1,174	1,242	1,144	945	876	695	519	420	331	194
Sex (number)											
Male	3,506	534	596	547	438	420	334	245	187	145	60
Female	4,034	640	646	597	507	456	361	274	233	186	134
Age (years)											
Mean	57.8	42.0	47.0	52.0	56.9	61.9	67.0	72.0	76.9	81.8	88.0
SD	12.6	1.4	1.4	1.4	1.4	1.4	1.5	1.4	1.4	1.4	2.8
Median	56.0	42.0	47.0	52.0	57.0	62.0	67.0	72.0	77.0	82.0	87.0
Household type (number)											
Couple	3,252	162	264	423	541	593	473	353	246	148	49
Couple with dependent children	1,978	726	646	388	144	45	16	6	3	2	2
Lone parent	599	141	135	117	61	51	23	18	18	14	21
Lone person	1,466	111	155	168	159	160	161	130	145	157	120
Other	245	34	42	48	40	27	22	12	8	10	2
Number of dependent children											
Mean	0.6	1.5	1.1	0.7	0.3	0.1	0.0	0.0	0.0	0.0	0.0
SD	1.0	1.2	1.2	1.0	0.7	0.4	0.3	0.1	0.1	0.0	0.0
Median	0.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Educational attainment (number)											
Did not complete high school	2,630	295	311	288	289	328	314	250	228	206	121
Completed high school	676	136	113	113	79	80	51	28	32	19	25
Other post-school qualification	1,803	286	366	297	249	186	149	107	80	56	27
Diploma	758	134	128	127	91	87	69	55	33	27	7
Degree or higher	1,667	322	324	318	237	194	111	77	47	23	14
Remoteness area (number)											
Major city	4,489	732	741	704	555	502	391	283	252	204	125
Inner regional	2,001	287	342	295	249	238	208	152	100	82	48
Outer regional and remote	1,048	154	158	145	141	136	96	84	68	45	21
Employment status (number)											
Employed	3,277	969	1,037	927	665	432	150	45	27	9	2
Not employed	4,263	205	205	217	280	444	545	474	393	322	192
Retirement status (number)											
Retired	2,511		35	111	179	359	507	456	374	311	179
Not retired	5,029	1,174	1,207	1,033	766	517	188	63	46	20	15

TABLE 2—SAMPLE STATISTICS ON INCOME AND WEALTH STRUCTURE

	All	Age group									
		40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Sample size	7,540	1,174	1,242	1,144	945	876	695	519	420	331	194
Retired sample size	2,511	0	35	111	179	359	507	456	374	311	179
Household income											
Median gross income ($)	77,000	105,250	107,000	101,754	96,000	66,136	45,300	36,777	32,358	27,750	24,246
Composition of gross income (%)											
Private income	72.6	83.8	87.0	88.2	85.7	73.8	58.0	44.9	33.4	30.6	31.8
Wages and salaries	54.9	75.9	77.1	79.0	68.0	49.4	24.2	13.2	9.8	5.8	7.9
Investment income	6.0	0.2	2.2	2.4	5.2	6.5	12.5	13.4	12.5	16.0	13.3
Private pensions	6.3	0.8	0.8	1.8	5.4	11.3	17.7	15.1	10.0	7.4	7.3
Other private income	5.4	6.9	6.9	5.1	7.0	6.6	3.6	3.2	1.2	1.4	3.3
Public transfers	26.9	16.1	12.9	11.7	14.4	26.1	41.1	53.7	63.8	67.8	66.7
Government pensions	21.8	5.4	6.1	6.9	10.3	21.1	38.6	51.5	62.1	66.6	66.6
Other public transfers	5.1	10.7	6.8	4.8	4.1	5.0	2.5	2.2	1.8	1.2	0.1
Median disposable income ($)	69,644	89,871	91,099	89,865	83,481	65,330	44,471	36,777	32,358	27,750	24,246
Median equivalised disposable income ($)	38,477	42,161	44,712	47,581	48,991	38,449	29,000	24,543	22,119	20,200	22,437
Household wealth											
Median total assets ($)	731,000	702,350	767,200	845,750	975,950	801,800	771,000	613,700	492,518	470,730	408,571
Composition of assets (%)											
Home	47.9	46.0	45.7	42.9	46.7	46.0	49.5	57.1	55.9	59.2	52.9
Investment property	8.4	9.7	10.4	10.9	9.8	7.8	6.7	5.9	3.4	2.9	2.8
Superannuation	19.9	23.8	22.6	25.5	24.1	22.1	16.5	10.4	7.2	3.4	5.9
Other financial assets	13.6	9.0	8.6	10.1	10.3	14.2	16.8	17.8	25.5	28.9	33.7
Other assets	10.1	11.6	12.7	10.6	9.2	9.9	10.5	8.7	8.0	5.5	4.7
Median total debt ($)	12,000	134,000	105,000	75,500	38,500	1,550	0	0	0	0	0
Composition of debt (%)											
Mortgages	47.6	56.8	55.2	47.0	44.6	38.6	34.9	28.6	34.2	27.8	6.3
Other debt	52.4	43.2	44.8	53.0	55.4	61.4	65.1	71.4	65.8	72.2	93.7
Median net worth ($)	604,164	493,000	568,000	644,200	869,577	748,900	747,500	596,000	487,365	464,200	408,571

TABLE 3—SAMPLE STATISTICS ON INCOME AND WEALTH DISTRIBUTIONS

	All	Age group									
		40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Sample size	7,540	1,174	1,242	1,144	945	876	695	519	420	331	194
Retired sample size	*2,511*		*35*	*111*	*179*	*359*	*507*	*456*	*374*	*311*	*179*
Household disposable income ($)											
10th percentile	22,080	38,287	36,543	33,350	29,300	24,261	18,200	17,420	17,680	15,300	13,000
25th percentile	37,410	58,150	59,083	58,488	53,784	38,000	27,120	25,400	25,140	18,350	19,240
Median	69,644	89,871	91,099	89,865	83,481	65,330	44,471	36,777	32,358	27,750	24,246
75th percentile	109,529	117,337	132,360	129,826	126,809	104,588	72,725	59,010	53,453	41,251	46,101
90th percentile	154,353	152,997	168,144	176,504	173,484	161,850	127,617	87,591	77,000	67,490	66,136
Mean	82,024	95,380	100,576	100,665	97,759	80,809	59,832	48,360	41,996	36,157	35,200
Standard deviation	65,073	59,631	62,857	65,815	72,855	69,458	57,564	52,445	30,512	29,059	26,656
Net worth ($)											
10th percentile	39,300	35,391	45,200	46,157	136,500	33,126	29,765	45,000	18,800	22,724	33,126
25th percentile	287,900	200,902	255,580	278,666	402,450	366,500	362,200	312,200	266,950	251,500	163,000
Median	604,164	493,000	568,000	644,200	869,577	748,900	747,500	596,000	487,365	464,200	408,571
75th percentile	1,109,700	873,770	1,015,000	1,172,250	1,365,143	1,467,000	1,396,000	1,075,500	874,536	708,000	847,000
90th percentile	2,005,000	1,508,000	1,673,477	2,016,000	2,516,500	2,465,000	2,309,500	2,169,200	1,514,500	1,246,174	1,200,000
Mean	930,282	730,050	809,621	927,750	1,173,711	1,175,878	1,132,446	950,363	768,706	588,149	595,726
Standard deviation	1,214,235	999,336	1,024,046	1,175,540	1,335,837	1,514,187	1,476,663	1,205,392	1,143,612	565,078	666,962

V. Results

We now combine the dataset in the previous section with our algorithm to calculate the adequacy metrics described in Section III. In all of our analyses, we produce four alternative projections of the consumption level in retirement, with each successive projection taking into account one additional source ('pillar') of retirement income. The first projection considers only compulsory retirement savings (compulsory superannuation). In the second projection we add voluntary superannuation contributions, while the third projection additionally takes into account the government pension (called the *Age Pension* in Australia). Finally, we add other (net) savings to the pool of assets in the fourth projection. The latter information in particular is typically not included in estimates of retirement savings due to unavailability of data. To compute net savings, we add bank account balances, cash investments, equity investments (net of investment loans), assets in trusts, life insurance contracts, property assets (excluding the home, net of mortgages on those properties), and business assets (net of business debt). The last projection, taking into account all pillars of retirement savings, provides our primary set of results, while differences between the outcomes of the alternative projections provide information on the relative contributions of the various pillars.

Consumption level and consumption shortfall

Consumption level

Figure 1 and Table 4 present summary statistics of our projections of consumption levels during retirement as well as consumption shortfalls. Table 4 shows estimation results separately for individuals below and above retirement age (65), and within those age groups separately for singles and couples.[12]

We first look at consumption levels (Panel A of Table 4). In the age group 40 to 64, the median consumption during retirement, only taking into account compulsory retirement savings as a source of retirement income, is $6,253 per annum for singles and $20,585 per annum for couples.[13] The consumption level for singles is less than one third of the relative poverty line in Australia (half of median equivalised disposable income in the population, and equal to $19,990 in 2010). Couples are slightly better placed, but even their median

[12] Age refers to an individual's age in 2010.

[13] All statistics reported in this section are population-weighted medians unless stated otherwise.

consumption levels are only about two-thirds of the relative poverty line. Taking into account voluntary contributions to retirement savings accounts (projection 2) does not change consumption levels materially, reflecting the fact that most people do not make significant voluntary contributions.

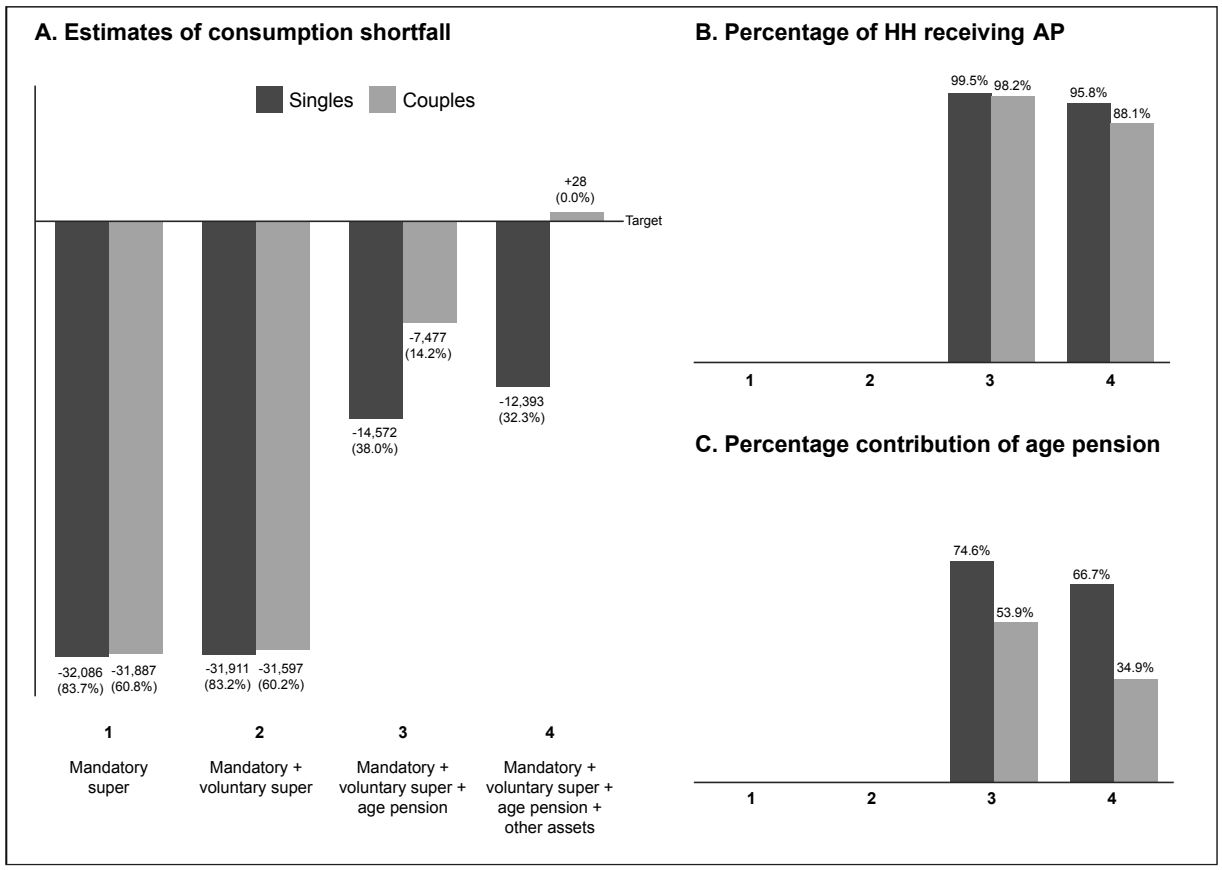

FIGURE 1. CONSUMPTION SHORTFALL—AGES 40 TO 64

Notes: (A) Estimates of the consumption shortfall by projection basis and marital status. The metric is computed as the difference between the level of consumption that can be sustained until age 90 and the target level of consumption. In figure below, the target level of consumption is the ASFA 'comfortable' level deflated to 2010 prices ($38,339 for singles and $52,472 for couples). (B) Percentage of households expected to receive the Age Pension during retirement by projection. (C) Estimated percentage contribution of the Age Pension to household consumption during retirement, by projection.

TABLE 4—SUMMARY STATISTICS OF CONSUMPTION LEVEL AND CONSUMPTION SHORTFALL METRICS ($)

	p10	p25	Median	p75	p90	Mean	Std dev
Panel A. Consumption level							
All people aged 40-64							
Singles							
Super only[1]	0	744	6,253	14,048	25,985	10,468	14,273
Super only[2]	0	744	6,428	14,539	27,470	10,829	14,739
Super[2] + Age Pension	17,301	18,743	23,767	30,553	38,693	26,695	11,557
Super[2] + Age Pension + Other assets	17,768	19,668	25,946	35,722	52,132	33,347	28,336
Couples							
Super only[1]	857	8,322	20,585	37,281	60,151	27,240	28,228
Super only[2]	857	8,452	20,875	38,277	61,953	27,875	28,703
Super[2] + Age Pension	28,051	34,352	44,995	56,138	71,809	48,397	22,706
Super[2] + Age Pension + Other assets	29,457	40,242	52,500	73,728	121,324	72,826	75,210
All people aged 65 and above							
Singles							
Super only[1]	0	0	0	0	6,976	2,441	10,183
Super only[2]	0	0	0	0	6,976	2,441	10,183
Super[2] + Age Pension	18,743	18,743	18,743	18,743	25,970	20,897	8,804
Super[2] + Age Pension + Other assets	18,744	19,344	24,329	35,231	59,153	37,518	48,154
Couples							
Super only[1]	0	0	0	10,595	35,858	11,919	29,202
Super only[2]	0	0	0	10,595	35,858	11,919	29,202
Super[2] + Age Pension	28,256	28,256	28,256	38,576	57,475	37,917	24,781
Super[2] + Age Pension + Other assets	28,376	30,054	39,451	62,374	116,804	64,208	76,056
Panel B. Consumption shortfall							
All people aged 40-64							
Singles							
Super only[1]	-38,339	-37,595	-32,086	-24,291	-12,354	-27,871	14,273
Super only[2]	-38,339	-37,595	-31,911	-23,800	-10,869	-27,510	14,739
Super[2] + Age Pension	-21,038	-19,596	-14,572	-7,786	354	-11,644	11,557
Super[2] + Age Pension + Other assets	-20,571	-18,671	-12,393	-2,617	13,793	-4,992	28,336
Couples							
Super only[1]	-51,615	-44,150	-31,887	-15,191	7,679	-25,232	28,228
Super only[2]	-51,615	-44,020	-31,597	-14,195	9,481	-24,597	28,703
Super[2] + Age Pension	-24,421	-18,120	-7,477	3,666	19,337	-4,075	22,706
Super[2] + Age Pension + Other assets	-23,015	-12,230	28	21,256	68,852	20,354	75,210
All people aged 65 and above							
Singles							
Super only[1]	-38,339	-38,339	-38,339	-38,339	-31,363	-35,898	10,183
Super only[2]	-38,339	-38,339	-38,339	-38,339	-31,363	-35,898	10,183
Super[2] + Age Pension	-19,596	-19,596	-19,596	-19,596	-12,369	-17,442	8,804
Super[2] + Age Pension + Other assets	-19,595	-18,995	-14,010	-3,108	20,814	-821	48,154
Couples							
Super only[1]	-52,472	-52,472	-52,472	-41,877	-16,614	-40,553	29,202
Super only[2]	-52,472	-52,472	-52,472	-41,877	-16,614	-40,553	29,202
Super[2] + Age Pension	-24,216	-24,216	-24,216	-13,896	5,003	-14,555	24,781
Super[2] + Age Pension + Other assets	-24,096	-22,418	-13,021	9,902	64,332	11,736	76,056

Notes: [1] Mandatory contributions only. [2] Mandatory + voluntary contributions. p10—10th percentile; p25—25th percentile; p75—75th percentile; p90—90th percentile; Std dev—Standard deviation.

Adding the government pension to the projection of consumption levels (projection 3) changes median consumption levels significantly, to $23,767 and $44,995 for singles and couples respectively, more than tripling the estimates for singles and more than doubling the estimates for couples compared to projection 2.

Adding other sources of retirement income increases the estimated median consumption level to $25,946 for singles and $52,500 for couples, representing respective increases of 9.2 per cent and 16.7 per cent relative to the projections without these other sources. The contribution of other sources increases with percentiles in the distribution. At the 90th percentile of consumption levels, for example, the difference between projections 3 and 4 is 34.7 per cent for singles and 68.9 per cent for couples. This analysis shows that omitting sources of retirement savings other than retirement savings accounts can lead to severe underestimation of consumption levels in retirement.

Looking at the individuals aged 65 and above, we find that the estimated median consumption level based on compulsory retirement savings alone is zero. This is unsurprising, since compulsory contributions were only introduced when these individuals were 45 or older. As a consequence, their lifetime compulsory contributions would be relatively low and, for many in this age group, have already been exhausted by 2010 (when they were well into their retirement). Their consumption is thus mainly funded by the government pension and other retirement savings. In this group, the omission of other retirement savings has even greater effects on the estimation of consumption levels. The difference between median consumption levels in projections 3 and 4 is 29.8 per cent for singles and 39.6 per cent for couples.

Consumption shortfall

Panel B of Table 4 presents our estimation results for the consumption shortfall metric. It expresses estimated consumption levels in retirement relative to a benchmark consumption level. As described in Section II, the benchmarks used in the present analysis are the ASFA 'comfortable levels', which are widely used in Australia as retirement income targets. These levels are very similar to current mean income levels of retirees in Australia as well as to the median level of retirement income deemed necessary by non-retired Australians for funding a satisfactory lifestyle.

In our first projection, which takes into account compulsory retirement savings only, the estimated median consumption shortfall in the age group 40-64 is $32,086 for singles and $31,887 for couples, or 83.7 per cent and 60.8 per cent, respectively. It is therefore clear that, for individuals in this age range, compulsory retirement savings are not yet nearly sufficient to fund a comfortable level of consumption during retirement. Couples are, however, better-placed than singles.

Adding the government pension substantially reduces the median consumption shortfall, to $14,572 for singles (38.0 per cent below target) and $7,477 for couples (14.2 per cent below target). Adding other retirement savings to the projections reduces the median shortfall further, to $12,393 for singles (32.3 per cent below target) and to just below zero (-$28) for couples. The shortfall for singles remains significant, however, even when taking all sources of income into account.

Consumption shortfalls are substantially higher for individuals aged 65 and above. As noted earlier, this population sub-group has almost no savings in compulsory retirement savings accounts (superannuation) and largely depends on the Age Pension for their income. The median consumption shortfall in projection 3 (retirement savings and government pension) is $19,596 (51.1 per cent of target) for singles and $24,216 (63.2 per cent) for couples. Adding other savings to the projections reduces the median shortfall to $14,010 (36.5 per cent) for singles and $13,021 (34.0 per cent) for couples. It is worth noting that, while the consumption shortfall is significantly larger for singles than for couples in the age group 40 to 64, this is not the case in the group aged 65 and older.

Table 5 presents statistics on consumption levels and shortfalls in projection 4 by age group, as well as a set of measures indicating the level of dependency of retirees on the government pension. For singles, the median consumption shortfall increases with age, peaking in the age group 65 to 69. In the case of couples, there is no clear trend among the younger age groups, while the consumption shortfall peaks in the age group 75 to 79.

Among those aged 40 to 64, the consumption shortfall is negative in 79.4 per cent of cases for singles and 49.8 per cent of cases for couples; 95.8 per cent of singles are projected to receive at least a partial government pension, which on average contributes 61.3 per cent of their income; in the case of couples, 88.8 per cent are projected to receive the government pension, which on average contributes 39.1 per cent to their income.

TABLE 5—RETIREMENT SAVINGS ADEQUACY AND DEPENDENCY ON GOVERNMENT PENSION IN RETIREMENT BY AGE GROUP

	40-64	>65	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Singles												
Median consumption level ($)	25,946	24,329	27,658	27,076	25,132	24,539	23,793	21,658	22,082	22,559	24,454	28,471
Median shortfall ($)	-12,393	-14,010	-10,681	-11,263	-13,207	-13,800	-14,546	-16,681	-16,257	-15,780	-13,885	-9,868
% with negative shortfall	79.4	77.9	79.3	74.8	77.3	80.1	87.7	80.5	83.7	83.3	80.0	65.5
% receiving Age Pension	95.8	96.9	95.4	96.1	95.1	96.6	96.5	97.9	98.9	96.2	99.4	92.9
% contribution of Age Pension	61.3	68.4	57.3	58.0	59.7	63.8	70.7	70.3	74.6	72.9	71.5	55.9
Couples												
Median consumption level ($)	52,500	39,451	52,998	53,752	53,879	52,499	47,368	43,634	37,065	34,952	35,966	56,381
Median shortfall ($)	28	-13,021	526	1,280	1,407	27	-5,104	-8,838	-15,407	-17,520	-16,506	3,909
% with negative shortfall	49.8	67.0	48.2	47.5	47.3	49.9	58.1	65.1	68.5	71.8	68.8	46.9
% receiving Age Pension	88.8	93.6	89.1	89.9	89.3	87.2	88.2	91.2	94.3	97.0	98.7	82.6
% contribution of Age Pension	39.1	60.5	35.7	36.6	38.0	40.1	47.1	56.5	61.9	67.4	64.1	44.5

Comparing individuals aged 40 to 64 with individuals aged 65 and above, for singles there is little difference in the consumption shortfall and in reliance on the government pension. However, there are marked differences in the case of couples: the median consumption shortfall is -$28 in the age group 40 to 64 and $13,021 in the age group 65 and older, while the mean contribution of the government pension to income is 39.5 per cent in the age group 40 to 64 compared to 60.5 per cent in the age group 65 and older. A likely explanation for this trend of decreasing reliance on the government pension is mandatory retirement savings. Those in the age group 65 and older only contributed to superannuation for a small part of their working lives, while those in the age group 40-64, and particularly the younger members of this age group, contributed to superannuation for a significant part of their working lives. Further analysis is required, however, to establish the causes of this difference across age groups in dependency on the government pension.

Run-out age and age gap

We now turn to the second set of adequacy metrics, run-out age and age gap, presented in Figure 2 and Table 6.

Run-out age

Panel A of Table 6 shows summary statistics for the run-out age metric. In the age group 40 to 64, the median run-out age is 69 years for singles in both projections 1 and 2 (compulsory and voluntary superannuation), while for couples it is 75 years in projection 1 and 76 years in projection 2. In projection 3 (including the government pension), the median run-out age does not change for singles in the age group 40 to 64, but increases to 82 years for couples in the same age group because eligibility for the government pension enables conservation of private savings. Finally, in projection 4, the median run-out age is 71 years for singles in the age group 40 to 64 and 92 years for couples. In most of our projections, the run-out age is substantially below life expectancy, a point we turn to now.

Age gap

The age gap metric compares run-out age to life expectancy, given a member's current age. Panel B of Table 6 presents summary statistics for the age gap metric. In projection 1 (compulsory retirement savings only), singles in the age group 40 to 64 are expected to run out of private retirement savings 20 years before life expectancy, compared to 13 years for couples.

The age gap does not narrow when adding voluntary superannuation contributions. Adding the government pension in projection 3 does not change the age gap for singles but reduces it from 13 years to 6 years in the case of couples. When adding other retirement savings in projection 4, the age gap decreases to 18 years for singles and to -4 years for couples.

Considering projection 4, which takes into account all 'pillars' of savings, in the age group 40 to 64, 77.2 per cent of singles and 45.6 per cent of couples are expected to run out of retirement savings before life expectancy, compared to 68.2 per cent of singles and 62.8 of couples in the age group 65 and older. This means that even when taking into account all sources of retirement income, the majority of the population is unable to fund a comfortable level of consumption for the entire expected period of retirement.

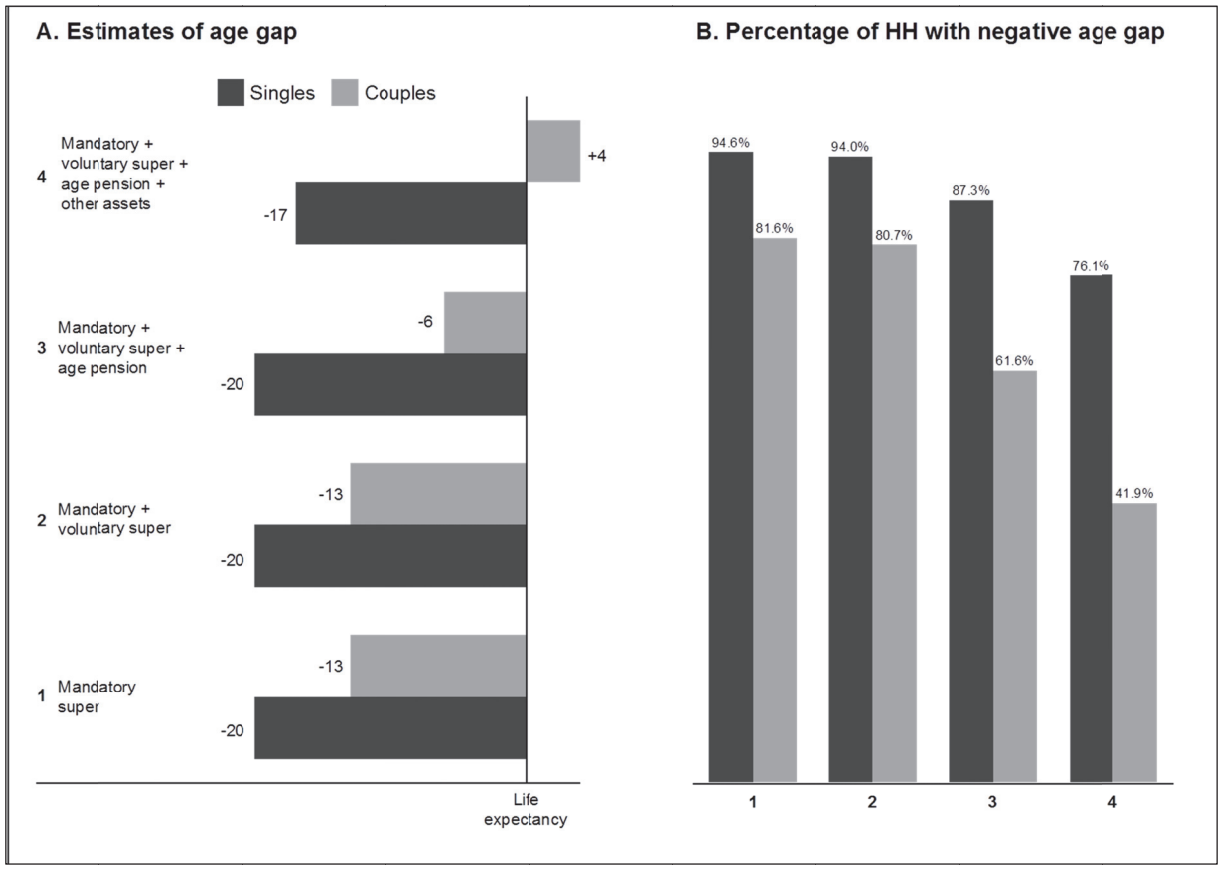

FIGURE 2. AGE GAP – AGES 40 TO 64

Notes: Age gap. (A) Age gap metric by projection basis and marital status. The metric assumes that individuals immediately commence consuming at the target rate upon retirement (if accumulated wealth permits), drawing down private wealth and using whatever Age Pension income is available to them. They continue to do so until private wealth is exhausted and they are forced to revert to a lower level of consumption equal to the full Age Pension amount. The age gap is the difference between the age at which that occurs and life expectancy. (B) Proportion of households expected to have a negative age gap for each projection basis.

TABLE 6—SUMMARY STATISTICS OF RUN-OUT AGE AND AGE GAP METRICS

	p10	p25	Median	p75	p90	Mean	Std dev
Panel A. Run-out age (years)							
All people aged 40-64							
Singles							
Super only[1]	66	66	69	73	81	72	8
Super only[2]	66	66	69	73	82	72	8
Super[2] + Age Pension	66	66	69	77	92	74	11
Super[2] + Age Pension + Other assets	66	67	71	87	106	78	15
Couples							
Super only[1]	67	70	75	83	97	78	11
Super only[2]	67	70	76	84	98	79	11
Super[2] + Age Pension	67	71	82	96	106	84	15
Super[2] + Age Pension + Other assets	69	77	92	107	114	92	16
All people aged 65 and above							
Singles							
Super only[1]	69	73	79	86	90	80	8
Super only[2]	69	73	79	86	90	80	8
Super[2] + Age Pension	69	73	80	86	90	80	8
Super[2] + Age Pension + Other assets	70	75	84	93	105	85	12
Couples							
Super only[1]	69	72	76	81	88	78	9
Super only[2]	69	72	76	81	88	78	9
Super[2] + Age Pension	70	73	77	83	97	80	11
Super[2] + Age Pension + Other assets	71	75	83	100	112	88	15
Panel B. Age gap (years)							
All people aged 40-64							
Singles							
Super only[1]	-24	-23	-20	-16	-7	-17	8
Super only[2]	-24	-23	-20	-15	-6	-17	9
Super[2] + Age Pension	-24	-23	-20	-12	5	-15	11
Super[2] + Age Pension + Other assets	-24	-22	-18	-2	17	-10	15
Couples							
Super only[1]	-22	-19	-13	-5	8	-10	11
Super only[2]	-22	-19	-13	-4	9	-10	12
Super[2] + Age Pension	-22	-17	-6	8	18	-4	15
Super[2] + Age Pension + Other assets	-20	-11	4	19	25	3	16
All people aged 65 and above							
Singles							
Super only[1]	-20	-16	-10	-7	-5	-11	6
Super only[2]	-20	-16	-10	-7	-5	-11	6
Super[2] + Age Pension	-19	-16	-10	-6	-4	-11	7
Super[2] + Age Pension + Other assets	-18	-14	-7	-1	13	-6	11
Couples							
Super only[1]	-19	-16	-12	-8	-3	-11	8
Super only[2]	-19	-16	-12	-8	-3	-11	8
Super[2] + Age Pension	-19	-16	-11	-7	8	-9	11
Super[2] + Age Pension + Other assets	-17	-13	-7	12	23	-1	15

Notes: [1] Mandatory contributions only. [2] Mandatory + voluntary contributions. p10—10th percentile; p25—25th percentile; p75—75th percentile; p90—90th percentile; Std dev—Standard deviation.

Replacement ratios

The most widely used measure of adequacy of retirement savings is the income replacement ratio. It computes the ratio of expected income during retirement to pre-retirement disposable income. In Table 7 we report estimates of the income replacement ratio for the population

aged 40 to 64 in 2010, calculated as the ratio of the projected retirement consumption level to actual disposable income in 2010. Taking into account only compulsory retirement savings (projection 1) leads to a median income replacement ratio of 12.8 per cent for singles and 32.9 per cent for couples. Adding voluntary superannuation contributions and the government pension (projection 3) leads to a median replacement ratio of 54.5 per cent for singles and 49.5 per cent for couples. Finally, in projection 4, taking into account all sources of retirement income, the median income replacement ratio is 63.0 per cent for singles and 59.1 per cent for couples. It is noteworthy that in projections 3 and 4, the income replacement ratio is higher for singles than for couples, yet the consumption shortfall is lower for couples than for singles. This points to the significance of the retirement income target that is being adopted when measuring adequacy, which we will discuss later in this section.

TABLE 7—SUMMARY STATISTICS OF REPLACEMENT RATIO METRIC

Income replacement ratio (%) ***Persons aged 40-64***	**p10**	**p25**	**Median**	**p75**	**p90**	**Mean**
Singles						
Super only[1]	0.0	2.0	12.8	25.4	44.4	31.5
Super only[2]	0.0	2.0	13.1	26.2	46.2	32.0
Super[2] + Age Pension	27.7	38.9	54.5	81.0	115.3	154.9
Super[2] + Age Pension + Other assets	30.7	43.9	63.0	94.6	138.0	188.0
Couples						
Super only[1]	1.0	9.7	20.0	32.9	51.8	27.7
Super only[2]	1.0	9.8	20.5	33.8	53.0	28.3
Super[2] + Age Pension	26.3	35.9	48.5	65.3	91.2	63.1
Super[2] + Age Pension + Other assets	31.9	43.2	59.1	87.2	129.7	90.3

Notes: [1] Mandatory contributions only. [2] Mandatory + voluntary contributions. p10—10th percentile; p25—25th percentile; p75—75th percentile; p90—90th percentile.

Heterogeneity of retirement savings adequacy

The sample summary statistics in Table 1, discussed in Section IV, show a large degree of heterogeneity in income and wealth across individuals, which we expect to be reflected in the measures of retirement savings adequacy. Table 8 contains medians of the different adequacy metrics by socio-demographic characteristics separately for age groups 40 to 64 and 65 and above. We will focus our discussion on the former age group.

Retirement savings adequacy is substantially worse for women than for men across all five metrics presented. Adequacy increases with income when considering consumption and age metrics but decreases when considering the income replacement ratio. That is, while consumption levels increase with income, the income replacement ratio decreases. This

relation is due to the fact that individuals with lower current income levels will be able to achieve a higher replacement ratio than individuals with higher current income levels. The main reason for this phenomenon is the government pension, which will replace a much larger part of current income for low-income individuals. Thus, many low-income people with a high projected income replacement ratio will nonetheless have low living standards in retirement, while many high-income people with a low projected income replacement ratio will nonetheless have relatively high living standards in retirement. This suggests that the income replacement ratio has some shortcomings as an indicator of retirement savings adequacy. The adequacy measure that is most appropriate depends on the goal of measuring adequacy. If the goal is to measure adequacy against a fixed (universal) living standard, then income replacement ratios are not appropriate. In such a case, it is more critical from a policy perspective to assess whether people are meeting certain *levels* of living standards. However, if the goal is to achieve a living standard that is closely related to the current standard of living, then the income replacement ratio may be a more appropriate indicator.

As Table 8 shows, retirement savings adequacy improves with net worth. It is slightly higher for couples with dependent children than for couples without children. This difference is likely driven by higher income and wealth in the former group. Adequacy is lower for lone parents than for lone persons. Adequacy increases with the number of children until two and then decreases, and is lowest for households with four or more children. Adequacy also increases with educational attainment and decreases with remoteness of residence. It is substantially lower for the non-employed than the employed, and significantly lower for individuals who have already retired than for those who have not yet retired.

TABLE 8—MEDIANS OF ADEQUACY METRICS BY DEMOGRAPHIC CHARACTERISTICS

Panel A. Persons aged 40-64	Consumption level ($)	Consumption shortfall ($)	Run-out age (years)	Age gap (years)	Income RR
Male	50,915	-21	92	5	0.61
Female	45,171	-5,509	85	-5	0.58
Income quartile					
1st quartile	28,562	-16,765	70	-18	0.96
2nd quartile	41,352	-7,809	82	-7	0.61
3rd quartile	52,777	981	93	4	0.53
4th quartile	70,038	17,566	106	17	0.44
Net worth quartile					
1st quartile	29,024	-16,516	71	-18	0.55
2nd quartile	40,552	-8,476	80	-9	0.55
3rd quartile	51,464	27	92	3	0.57
4th quartile	90,952	38,609	110	22	0.79
Household type					
Couple	50,541	-1,914	90	1	0.65
Couple with dependent children	54,648	2,176	95	3	0.56
Lone parent	24,092	-14,546	69	-21	0.44
Lone person	28,153	-10,267	74	-17	0.79
Other	42,433	-10,019	81	-10	0.30
Number of dependent children					
0	44,147	-5,513	84	-5	0.66
1	50,582	-1,148	90	-1	0.52
2	54,083	1,905	94	3	0.55
3	51,932	-540	91	-1	0.56
4 or more	45,628	-6,036	83	-8	0.50
Educational attainment					
Did not complete high school	40,359	-9,948	79	-12	0.62
Completed high school	46,968	-1,749	89	-1	0.61
Other post-school qualification	45,261	-6,204	84	-6	0.58
Diploma	53,220	1,875	94	4	0.58
Degree or higher	62,558	11,508	104	13	0.59
Remoteness area					
Major city	48,307	-2,077	89	-1	0.58
Inner regional	47,351	-3,921	87	-4	0.63
Outer regional	45,545	-5,412	85	-6	0.65
Remote	44,912	-4,020	89	-1	0.68
Employment status					
Not employed	32,858	-15,712	73	-17	0.74
Employed	51,415	188	93	2	0.57
Retirement status					
Not retired	49,554	-1,383	90	-1	0.58
Retired	32,775	-14,771	72	-16	0.86

Note: *Income RR*—Income replacement rate.

TABLE 8 CONTINUED—MEDIANS OF ADEQUACY METRICS BY DEMOGRAPHIC CHARACTERISTICS

Panel B. Persons aged 65+	Consumption level ($)	Consumption shortfall ($)	Run-out age (years)	Age gap (years)
Male	36,965	-12,144	84	-5
Female	31,780	-14,511	82	-8
Income quartile				
1st quartile	23,352	-17,903	81	-9
2nd quartile	29,677	-19,372	79	-10
3rd quartile	38,554	-10,372	84	-7
4th quartile	51,466	3,838	95	5
Net worth quartile				
1st quartile	28,258	-19,595	77	-12
2nd quartile	29,557	-18,472	78	-11
3rd quartile	37,655	-10,426	83	-7
4th quartile	79,872	28,087	108	19
Household type				
Couple	39,951	-12,520	83	-7
Couple with dependent children	44,558	-7,914	94	7
Lone parent	27,584	-10,755	89	-5
Lone person	23,352	-14,987	83	-8
Other	28,553	-23,919	77	-12
Educational attainment				
Did not complete high school	30,569	-16,348	81	-9
Completed high school	33,615	-14,489	86	-6
Other post-school qualification	37,679	-11,997	84	-7
Diploma	42,858	-6,701	85	-5
Degree or higher	59,063	8,978	99	10
Remoteness area				
Major city	35,451	-12,665	84	-7
Inner regional	32,568	-14,166	82	-8
Outer regional	33,560	-15,220	83	-7
Remote	50,292	-2,180	90	-1
Employment status				
Not employed	32,952	-14,700	83	-7
Employed	47,749	1,452	93	4
Retirement status				
Not retired	43,755	-5,560	87	-4
Retired	33,251	-14,515	83	-7

In Table 9, we examine heterogeneity of savings adequacy across socio-demographic groups from an alternative perspective. We distinguish individuals by degree of dependency of retirement income on the government pension: 100 per cent dependence; less than 100 per cent but at least 50 per cent dependence (50-100%); less than 50 per cent but greater than 0 per cent dependence (0-50%); and 0 per cent dependence. As before, we see a shift in dependency with age group. In the age group 40 to 64, most people fall into the 0-50% dependency category, while in the age group 65 and older, most people fall into the 50-100% dependency category.

Looking at the age group 40 to 64, the group that is exclusively dependent on the government pension (100 per cent dependency) is dominated by females (64.6 per cent),

while in the other dependency categories, the male/female ratio is around 1. Individuals with higher dependency on the government pension tend to be slightly older and have low current levels of income. Indeed, 79.7 per cent of individuals in this group are in the bottom quartile of current household disposable income, while in the group with no dependency on the government pension, only 6.5 per cent are located in this income quartile.

TABLE 9—DEPENDENCY ON GOVERNMENT PENSION IN RETIREMENT BY DEMOGRAPHIC CHARACTERISTICS

Panel A. Persons aged 40-64

	Proportion of income in retirement from Age Pension			
	100%	**50-100%**	**0-50%**	**0%**
Sample size	237	1,895	2,512	490
Per cent of age group	4.6	36.9	48.9	9.5
Projected retirement income ($, median)	30,200	61,667	104,429	129,755
Male	35.4	42.8	51.0	48.2
Female	64.6	57.2	49.0	51.8
Age (years)	54	52	50	52
Current income ($, median)	30,200	61,667	104,429	129,755
Current income quartile (%)				
1st quartile	79.7	41.9	10.7	6.5
2nd quartile	13.9	32.9	22.6	12.2
3rd quartile	3.0	18.1	32.6	23.5
4th quartile	3.4	7.1	34.1	57.8
Net worth ($, median)	10,335	346,973	897,000	2,956,800
Net worth quartile (%)				
1st quartile	81.9	46.2	8.5	0.4
2nd quartile	15.6	35.1	23.0	0.8
3rd quartile	2.5	17.2	36.8	6.1
4th quartile	0.0	1.6	31.8	92.7
Household type (%)				
Couple	27.4	37.8	38.5	39.6
Couple with dependent children	15.2	27.0	45.9	48.4
Lone parent	27.8	12.3	3.5	3.9
Lone person	27.8	20.3	10.5	7.8
Other	1.7	2.7	1.6	0.4
Number of dependent children (%)				
0	64.1	63.9	51.4	48.4
1	14.3	14.8	16.1	20.4
2	10.5	13.2	23.3	19.0
3	7.6	5.0	7.6	10.4
4 or more	3.4	3.1	1.6	1.8
Educational attainment (%)				
Did not complete high school	56.1	36.5	19.8	17.6
Completed high school	8.4	9.5	10.1	8.6
Other post-school qualification	22.4	31.0	24.4	14.5
Diploma	5.1	9.1	11.7	13.7
Degree or higher	8.0	13.8	34.0	45.7
Employment status (%)				
Not employed	91.1	31.0	13.8	18.0
Employed	8.9	69.0	86.2	82.0
Retirement status (%)				
Not retired	51.1	83.8	93.4	90.4
Retired	48.9	16.2	6.6	9.6

TABLE 9 CONTINUED—DEPENDENCY ON GOVERNMENT PENSION IN RETIREMENT BY DEMOGRAPHIC CHARACTERISTICS

Panel B. Persons aged 65+	**Proportion of income in retirement from Age Pension**			
	100%	**50-100%**	**0-50%**	**0%**
Sample size	85	1,306	561	118
Per cent of age group	4.1	63.1	27.1	5.7
Projected retirement income ($, median)	18,743	29,356	65,134	244,203
Male	40.0	43.0	50.8	50.0
Female	60.0	57.0	49.2	50.0
Age (years)	72	74	72	70
Current income ($, median)	24,410	29,267	50,841	73,739
Current income quartile (%)				
1st quartile	49.4	30.2	13.4	7.6
2nd quartile	21.2	31.0	15.2	5.9
3rd quartile	15.3	25.2	27.3	19.5
4th quartile	14.1	13.6	44.2	66.9
Net worth ($, median)	92,700	408,571	1,261,000	3,661,700
Net worth quartile (%)				
1st quartile	70.6	33.3	3.9	0.8
2nd quartile	21.2	34.8	7.8	0.8
3rd quartile	8.2	28.7	23.2	4.2
4th quartile	0.0	3.2	65.1	94.1
Household type (%)				
Couple	32.9	58.4	66.8	73.7
Couple with dependent children	0.0	0.2	0.9	1.7
Lone parent	10.6	3.1	4.3	2.5
Lone person	52.9	37.2	27.8	22.0
Other	3.5	1.0	0.2	0.0
Number of dependent children (%)				
0				
1				
2				
3				
4 or more				
Educational attainment (%)				
Did not complete high school	56.5	58.2	38.8	29.7
Completed high school	14.1	6.2	7.5	9.3
Other post-school qualification	16.5	20.2	20.0	16.1
Diploma	4.7	8.1	10.9	12.7
Degree or higher	8.2	7.3	22.7	32.2
Employment status (%)				
Not employed	92.9	92.7	83.2	70.3
Employed	7.1	7.3	16.8	29.7
Retirement status (%)				
Not retired	16.5	11.1	21.4	34.7
Retired	83.5	88.9	78.6	65.3

Looking at current net worth levels, median net worth in the group with highest dependency levels (100%) is $10,335, compared to $2,956,800 in the lowest dependency group (0%). The majority of people in the highest dependency group are lone parents and lone persons, whereas in the lower dependency groups the majority are couples. In the highest dependency group, the majority of people did not complete high school and only eight per cent have

university degrees, whereas in the lowest dependency group 45.7 per cent have university degrees and only 17.6 per cent did not complete high school. 91.1 per cent in the highest dependency group are unemployed and 48.9 per cent are retired, whereas in the lowest dependency group only 18 per cent are not employed and 9.6 per cent are retired.

Relationship between adequacy metrics and other financial indicators

In Table 10, we consider the relationship between the different adequacy metrics across the four projections as well as the relationship between these metrics and key financial figures, using Spearman rank correlations, with the aim to see to what extent key financial figures proxy for adequacy. All correlations reported are significant at the $p<0.001$ level.

We first look at correlations of the same adequacy metric across the four projections considered above. Table 10 shows that correlations of the consumption shortfall metrics across the first three projections are all above 0.9, indicating that the metric in those three projections conveys about the same amount information. However, the correlation between the consumption shortfall in the first three projections and the consumption shortfall in projection four is significantly lower. For example, it is 0.7256 between projection 3 and projection 4. This lower correlation indicates that the addition of other assets to the estimation of retirement saving adequacy adds a significant amount of information, as indicated by earlier analyses. The correlations in the age gap metric across the four projections exhibit a similar pattern and therefore lead to a similar conclusion.

To compare the ordering of individuals across the two metrics, we examined the correlation between the projection 4 consumption shortfall metric and the projection 4 age gap metric. This was found to equal 0.971, implying the two metrics provide very similar predictions, and suggesting that the choice between them for provision of information to individuals about retirement savings adequacy is likely to depend on behavioral considerations.[14]

[14] It is important to note, however, that the behavior assumed in the estimations of the age gap does not maximize Age Pension receipts.

TABLE 10—CORRELATIONS OF ADEQUACY METRICS WITH KEY FINANCIAL INDICATORS

Panel A. Correlations of consumption shortfall (CS) metrics and key financial indicators							
	CS 1	**CS 2**	**CS 3**	**CS 4**	**Income**	**Super**	**Net worth**
CS 1	1.0000						
CS 2	0.9986* (0.0000)	1.0000					
CS 3	0.9439* (0.0000)	0.9455* (0.0000)	1.0000				
CS 4	0.6642* (0.0000)	0.6653* (0.0000)	0.7256* (0.0000)	1.0000			
Income	0.5222* (0.0000)	0.5267* (0.0000)	0.6073* (0.0000)	0.5549* (0.0000)	1.0000		
Super	0.7674* (0.0000)	0.7687* (0.0000)	0.8419* (0.0000)	0.6622* (0.0000)	0.6351* (0.0000)	1.0000	
Net worth	0.3763* (0.0000)	0.3768* (0.0000)	0.4589* (0.0000)	0.7431* (0.0000)	0.4577* (0.0000)	0.6103* (0.0000)	1.0000
Panel B. Correlations of age gap (AP) metrics and key financial indicators							
	AP 1	**AP 2**	**AP 3**	**AP 4**	**Income**	**Super**	**Net worth**
AP 1	1.0000						
AP 2	0.9978* (0.0000)	1.0000					
AP 3	0.9594* (0.0000)	0.9644* (0.0000)	1.0000				
AP 4	0.7313* (0.0000)	0.7348* (0.0000)	0.7753* (0.0000)	1.0000			
Income	0.3852* (0.0000)	0.3936* (0.0000)	0.5141* (0.0000)	0.5323* (0.0000)	1.0000		
Super	0.5447* (0.0000)	0.5520* (0.0000)	0.6942* (0.0000)	0.6313* (0.0000)	0.6351* (0.0000)	1.0000	
Net worth	0.4313* (0.0000)	0.4330* (0.0000)	0.4901* (0.0000)	0.7522* (0.0000)	0.4576* (0.0000)	0.6108* (0.0000)	1.0000

Notes: p-values in parentheses. *Income*—Household disposable income; *Super*—Household superannuation balance; *Net worth*—Household net worth.

The consumption shortfall and age gap are also moderately correlated with household disposable income, superannuation balance, and net worth (Table 10). Table 11 reports results of regressions of the consumption shortfall in projection 4 on those key financial indicators as well as a set of socio-demographic characteristics. These results indicate that each of those indicators is correlated with consumption shortfall, even when controlling for socio-demographic characteristics. The best predictor is net worth (Table 11, models 5 and 6). When considering those three key financial variables together (Table 11, models 7 and 8), only the coefficients of disposable income and net worth are significant, even when controlling for socio-demographic factors. This suggests that the current superannuation

balance provides no information additional to that provided by the other two financial variables when predicting the consumption shortfall.

TABLE 11—REGRESSION RESULTS

Dependent variable: Projection 4 consumption shortfall								
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
HH disposable income	0.444***	0.433***					0.107***	0.096***
	(0.028)	(0.037)					(0.020)	(0.023)
HH super balance			0.099***	0.100***			-0.002	0.004
			(0.006)	(0.006)			(0.004)	(0.004)
HH net worth					0.047***	0.051***	0.045***	0.048***
					(0.002)	(0.002)	(0.002)	(0.002)
Age		54		-1,060***		-1,577***		-1,505***
		(142)		(185)		(115)		(94)
Female		-3,380**		-4,635***		-5,852***		-5,631***
		(1,716)		(1,644)		(1,060)		(916)
Married		-100.1		6,319***		-3,191***		-7,057***
		(1,731)		(1,449)		(936)		(1,236)
Homeowner		6,946***		5,756***		-17,488***		-18,408***
		(1,340)		(1,498)		(1,123)		(1,032)
Retired		1,145		-6,349***		-849		2,212*
		(2,941)		(1.907)		(1,364)		(1,339)
Unemployed		-8,715***		-12,003***		-4560***		-2,761**
		(2,071)		(1,602)		(1,456)		(1,349)
Constant	-24,607***	-29,915***	-5,965***	42,287***	-28,574***	68,366***	-36,136***	60,298***
	(2,407)	(6,997)	(1366)	(9,557)	(1,153)	(5,810)	(2,041)	(4,824)
Sample size	5,124	5,124	5,124	5,124	5,124	5,124	5,124	5,124
Log likelihood	-63,743	-61,013	-63,734	-60,603	-63,535	-60,932	-63,462	-60,524

Notes: Standard errors in parentheses. * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Finally, we report correlations between the four adequacy metrics (projection 4) and the income replacement ratio (Table 12, bottom row). The correlation between consumption level and income replacement ratio is 0.1404. Correlations with the income replacement ratio are slightly higher for the other three adequacy metrics, but none is higher than 0.22.

TABLE 12—PAIR-WISE CORRELATIONS OF ADEQUACY METRICS

	Consumption level	Consumption shortfall	Run-out age	Age gap	Replacement ratio
Consumption level	1.0000				
Consumption shortfall	0.9371* (0.0000)	1.0000			
Run-out age	0.9175* (0.0000)	0.9363* (0.0000)	1.0000		
Age gap	0.9227* (0.0000)	0.9358* (0.0000)	0.9947* (0.0000)	1.0000	
Replacement ratio	0.1404* (0.0000)	0.1787* (0.0000)	0.2207* (0.0000)	0.2093* (0.0000)	1.0000

Note: p-values in parentheses.

VI. Discussion and conclusion

In this paper we propose four metrics to measure the adequacy of retirement savings, two based on consumption levels during retirement and two based on the expected age of running out of retirement savings. We then estimate these metrics for a representative sample of the Australian population aged 40 and above using data from the HILDA Survey, producing alternative projections which successively build in each of the four pillars of the Australian retirement income system.

Our analysis shows that compulsory contributions to a retirement savings account (currently 9.25 per cent of wages and salaries) during the entire working life may not be sufficient to achieve an adequate level of consumption during retirement for a considerable proportion of the population. Indeed, based on our sample population, saving at this rate generates a median consumption level during retirement significantly below half of the median equalized income of the overall population, a commonly-used measure of relative poverty. This finding suggests a review of the '10-per cent rule', which is widely used by financial advisors (Shlomo Benartzi, 2012), is warranted.

We also find that omitting one or more of the 'pillars' of retirement savings leads to significant underestimation of consumption levels during retirement. One 'pillar' of retirement savings that is often not taken into account when projecting retirement income is savings vehicles other than dedicated retirement savings accounts (e.g. 401(k) accounts in the United States, and superannuation accounts in Australia). We show that omission of this voluntary savings pillar can lead to underestimation of consumption levels in retirement of 40 per cent or more, and that underestimation is particularly pronounced among people with high

expected levels of consumption. We conclude from this part of the analysis that assessment of the adequacy of retirement savings should take into account all sources of retirement income and not just dedicated retirement savings accounts and social security payments, as is often the case.

As our analyses make clear, the introduction of compulsory retirement savings seems to have reduced the relative contribution of the government pension to retirement income while increasing the contribution of (largely defined-contribution) retirement savings accounts. This means that the proportion of consumption from potentially risky assets, in particular retirement savings accounts, is increasing. This has implications for optimal portfolio allocation and suggests that portfolio allocation too needs to take into account all sources of retirement income, in particular government pensions, property and other assets, rather than focus in isolation on (a particular set of) retirement savings accounts such as 401(k) accounts in the United States or their equivalents elsewhere (Justin Wood, 2013). At the same, it also suggests that it is important to take into account risk when projecting adequacy of retirement savings, which is the subject of ongoing and planned future work by the authors.

We also report large heterogeneity in the adequacy of retirement savings across the population. This finding suggests that a 'one-size-fits-all' approach to retirement savings is likely to be inappropriate and that more personalized approaches should be pursued, taking into account individual circumstances.

A further key finding is the high correlations between our adequacy metrics on the one hand, and the low correlations between those metrics and the income replacement ratio on the other. Most importantly, the income replacement ratio tends to be higher for low-income groups and lower for high-income groups, while projected consumption levels in retirement are higher for the latter group than for the former. We conclude that the assessment of savings adequacy should at least be supplemented by the kind of metrics we propose.

We also find that financial variables such as current household income, superannuation balance and net worth are not necessarily good 'proxies' for measures of adequacy of retirement savings. In other words, the position of individuals in the distributions of current household income, superannuation balance and net worth are not necessarily good reflections of their positions in the distribution of retirement adequacy.

The projection of consumption levels during retirement of course depends on a large set of assumptions about individual, household and market factors, including wages, salaries and other income across the life cycle, real wage growth, employment status, marital status, home ownership status, retirement age as well as asset returns and their temporal patterns. We keep

all of the factors constant in the projections presented in this article to focus on the presentation of a new set of adequacy metrics and the assessment of the relative contributions of the four 'pillars' of retirement savings. An important direction of research in this area is the introduction into the model of uncertainty about the factors influencing adequacy, particularly stochastic asset returns and the impact of planned or involuntary retirement at different ages, and the investigation of the sensitivity of adequacy metrics to changes in the factors influencing retirement adequacy.

Finally, we also report significant gaps between the level of income individuals expect to need during retirement for a satisfactory lifestyle and their projected income in retirement. While the HILDA Survey data does not contain information about individuals' own assessments of the adequacy of their retirement savings, other studies report that a large fraction of the population acknowledge that they are not saving enough and would like to save more (G. D. Carroll et al., 2009). We believe that one means to help close the retirement savings gap is the provision of easily accessible tools, such as online retirement savings calculators or 'financial health checks', that help people assess the adequacy of their own retirement savings using metrics like the ones we present in this article.[15] Information provision of this sort is potentially one important addition to other measures to promote retirement savings, such as tax incentives, reducing pension eligibility (for example, by increasing the minimum age of eligibility), and the promotion of appropriate investment strategies. However, the efficacy of various mechanisms such as these is an unresolved empirical question, and warrants further investigation.

[15] For an example see the calculators at http://www.moneysmart.com.au, a website about personal finance maintained by the Australian Securities and Investment Commission, the Australian regulatory agency for consumer finance and financial markets.

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