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One size fits all? Drawdown structures in Australia and The Netherlands

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Abstract

Australia and the Netherlands both combine an unfunded non-contributory flat rate pension with prefunded earnings related retirement schemes. Notwithstanding this similarity of structure, however, the two systems are very different. The Netherlands mandates annuitized drawdown structures. In Australia, no prescription, or even guidance, is offered. In both cases, products that better meet the needs of increasingly heterogeneous retirement cohorts are under consideration. We analyze the impact of various popular product choices in the Netherlands and in Australia on the welfare of individuals allowing for different income levels. The study assumes the market return and mortality are stochastic and includes the impact of mean-testing, which reduces the value of the first pillar flat rate. Products offering longevity insurance are the most preferred in the absence of bequest, whereas more flexible portfolios with phased withdrawals score higher when individuals have a bequest motive. The state pension replaces the need to purchase indexed annuities for low income individuals whereas it does not crowd out the demand for longevity insurance for median and high income quantiles. We conclude that the income category, bequests, state pension and risk aversion have to be allowed for in any sound welfare assessment of retirement income portfolios since these affect the ranking of portfolios more sharply than mortality differentials, loadings or timing of the purchase.

J.E.L. classification: H55, H75, J32
Keywords: Utility, CEC, Income, Retirement Income, Means-test

1 Introduction

The Dutch and the Australian retirement systems are widely regarded as amongst the best in the world and highly ranked in the Melbourne Mercer Global Pension Index (MMGPI) (2016). Australia and the Netherlands both combine an unfunded non-contributory flat rate pension with prefunded earnings related retirement schemes. Notwithstanding this similarity of structure, however, the two systems are very different (García-Huitrón and Ponds, 2015). The Netherlands mandates annuitized drawdown structures (Brown and Nijman, 2012). In Australia, no

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prescription, or even guidance, is offered (Bateman et al., 2001). Jointly studying these two countries allows us to assess the welfare implications of prescription compared to flexibility, defined contribution (DC) arrangements versus classical defined-benefit (DB) paradigms as well as the impact of means-testing the first pillar state pension compared to offering a flat-rate poverty alleviation pension to all participants (Bateman et al., 2016).

A natural way to analyse the comparability of retirement income products is to perform a welfare analysis. The literature in this area commonly studies the welfare implications of introducing an innovating income product compared to the classical lifetime annuity payout. For instance Stevens (2009); De Waegenaere et al. (2010); Horneff et al. (2010) and Post (2012) study the portfolio choice between a classical and a deferred annuity, that is, a life annuity purchased at a later moment during retirement. They find that deferred annuities can improve welfare of risk-averse individuals substantially because they insure against increases in annuity prices and provide a smooth income if individuals live longer than expected. Similarly, Doyle et al. (2004); Milevsky and Kyrychenko (2008) and Horneff et al. (2010) compare variable with classical annuities and find that individuals should not fully annuitize their wealth, even with bequest motives, and rather enhance their welfare by holding an equity portfolio and matching their consumption with withdrawals.

More recently, product innovations such as group self-annuitization (GSA) and phased withdrawals have been considered in Hanewald et al. (2013). They show that a GSA can outperform inflation-linked annuities when there are loadings and that portfolios with phased withdrawals improve individuals' welfare when they have a bequest motive. More recently Boon et al. (2017) show that individuals marginally prefer the GSA scheme over a fairly priced annuity.

In the Netherlands, choice flexibility has not been a part of the pension discussion until very recently (Dellaert and Ponds, 2014). Besides varying the timing of the payout phase, few innovations have been made in the construction of the payments. In particular, flexible payouts such as the 'high-low' and 'low-high' arrangements have been introduced. The first arrangement allows the individual to have a higher payout during the first five years followed by a lower payout during the remainder of their retirement. Dellaert and Ponds (2014) argue that individuals do not actively choose this payout construction, whereas Willemsen (2015) argues that there is an active choice for it when it is combined with early retirement since the higher initial payout compensates the lower state pension during the first five years. From a welfare viewpoint, van Ewijk et al. (2017) show that a 'high-low' payout arrangement improves welfare at a similar rate to taking up 10% of the pension wealth as a lump sum. Despite the limited choice and prescription in The Netherlands, both Australians and Dutch have choices to make and preferences are expected to be influenced by their heterogeneous attitude towards risk, income category and mortality (Bateman et al., 2001).

In order to assess the very different drawdown structures in Australia and the Netherlands, we perform a simulation based utility study allowing for individual exposures to equity and mortality risk (Brown, 2001). We study the most common choices in Australia, that is phased withdrawal, nominal and indexed annuities and combinations of them (Iskhakov et al., 2015). For the Netherlands, we allow individuals to choose an indexed annuity, 'high-low' or 'low-high' arrangement. To compare the products and retirement portfolios we use the often used Certainty Equivalent Consumption (CEC) as a measure of attractiveness. The CEC is the fixed consumption that corresponds to the utility level of a retirement portfolio, modified to allow for bequest. The CEC with bequest, compared to the CEC without bequest, measures the additional lifetime income that an individual is willing to receive to give up the life insurance (bequest) component of her portfolio.

We extend the literature on financial planning at retirement in at least four ways. We consider income heterogeneity using payments based on wages for three income categories for the

Netherlands and Australia. We also assess the impact of mortality heterogeneity by quantifying the impact of mortality differentials on welfare. We include a realistic and dynamic means-test of the state pension into our analysis and show its impact on retirement payouts. Finally, we investigate the importance of an individual's characteristics, such as risk attitude and desire to bequeath, as well as the role of product loadings on a life annuity in the ranking of retirement portfolios.

The optimal retirement income product portfolio is shown to be most affected by the bequest motive, means-testing of the first pillar pension and the level of income. Interestingly, mortality differentials, product loadings and timing are less significant factors. In the absence of a bequest, products providing longevity protection are the most welfare enhancing and rank highest in Australia and The Netherlands. A highly prescribed setting, such as the Dutch case, that offers limited choice at retirement may be the most cost-effective in enhancing individual welfare. However, once a bequest motive is included, products that provide more flexibility and liquidity rank higher especially for the lowest income quantile. In the presence of a bequest motive, portfolios with partial annuitization are preferred, especially for individuals from the highest income quantile who live on average longer than the population. Pricing assumptions that include loadings make annuities less attractive but not enough to score lower than a phased withdrawal product in the absence of a bequest. Risk attitude affects the ranking of portfolios, especially for the lowest income quantile. The state pension crowds-out indexed annuities for low income individuals but does not crowd out the demand for longevity insurance for median and high income quantiles. For our assumptions, mortality differentials do not affect the rankings substantially.

The remainder of the paper is structured as follows. Section 2 describes the modeling of the financial market, mortality risk and utility framework and describes the financial products which will be considered in our analysis. Section 3 provides details on the calibration of the equity, mortality and wages. Section 4 compares the retirement income portfolios for Australia and The Netherlands in the presence and absence of a means-tested state pension. Section 5 studies the sensitivity of our results to risk attitude, bequest motive, loadings on the annuities, mortality differentials and timing of the purchase. Finally, Section 6 concludes.

2 Model description

In order to compare and assess different retirement plan strategies we consider an individual choosing a portfolio of retirement income products. The shift from benefit-driven pensions to DC increases the uncertainty of the benefits paid to participants during retirement, mainly due to investment and longevity risk. The classical life-cycle literature indicates that a high exposure to equity is beneficial to gain from the stock market and achieve better retirement prospects. A downside of this is that retirement can vary sharply if the markets perform poorly. Similarly, uncertain lifespan needs to be incorporated in their financial planning. A participant failing to purchase longevity insurance may outlive their savings if they live longer than expected. To include these risks, we assume that participants contribute to a pension scheme and earn a stochastic market return. On and during retirement, they can purchase products providing equity exposure. Retirees have an uncertain lifespan driven by a stochastic mortality model that is suitable for modelling higher ages. The welfare for individuals of the retirement portfolios for Australia and the Netherlands assumes Constant Relative Risk aversion preferences for consumption and bequests. We incorporate the first pillar state pension to assess the interaction between the government subsidy and the products available in the private market.

2.1 Financial market

Contributions to a pension fund are assumed invested in a financial market with two assets: a money market account paying a risk-free constant return r^f and a risky equity index earning a risk premium. The risky equity index S_t at time t is modeled with a geometric Brownian motion as follows:

$$dS_t = \mu^s \cdot S_t \cdot dt + \sigma^s \cdot S_t \cdot dZ_t, \tag{2.1}$$

where

μ^s is the drift term and is equal to $r^f + \lambda^s \cdot \sigma^s$ where $\lambda^s \sigma^s$ is the risk premium parameter and σ^s is the stock price volatility.

The initial value of the fund is given by S_0. The annual return for the period $t-1$ to t on the account balances invested in equity during the individual's working career and retirement can be determined as follows:

$$i_t = \frac{S_t - S_{t-1}}{S_{t-1}}. \tag{2.2}$$

2.2 Life table

We incorporate stochastic mortality so that an individual has an uncertain lifespan upon retirement that incorporates both individual and aggregate or systematic mortality risk. The survival probabilities are assumed to follow a Cairns, Blake and Dowd (CBD) model (Cairns et al., 2006, 2009) which is fitted to the Australian and Dutch historical mortality experience from Human Mortality Database (2014, 2015). The CBD model is considered suitable for modelling higher ages and has a relatively simple structure and few parameters. The CBD model smooths mortality rates by age using a logit of the one year mortality probabilities, as shown below:

$$logit\,(q_x(y)) = \log\left(\frac{q_x(y)}{1 - q_x(y)}\right) = \kappa_y^{(1)} + (x - \overline{x})\kappa_y^{(2)}, \tag{2.3}$$

where

$q_x(y)$ is the probability that an individual aged x at time y will die between y and $y+1$ before attaining age $x+1$,

$\kappa_y^{(1)}$ and $\kappa_y^{(2)}$ represent period-related effects, and

$\overline{x}$ is the average age in the population considered.

The one-year death and survival probability are linked through the following expression $p_x(y) = 1 - q_x(y)$. The probability that an individual survives to age t in year $y + t - s$ conditional on being alive at age s in year y can be expressed as follows:

$${}_{t-s}p_s(y) = \prod_{j=0}^{t-s-1} (1 - q_{s+j}(y+j)) = \prod_{j=0}^{t-s-1} p_{s+j}(y+j). \tag{2.4}$$

Mortality is heterogeneous and depends on sex, education, income and marital status among others factors (Kaplan et al., 1996; Deaton and Paxson, 2001; Brown and McDaid, 2003). Insurers and retirement income providers have long been interested in what is known as 'basis risk', namely the fact that the life tables of the population differ from those of their insured portfolios (Millossovich et al., 2014; Villegas and Haberman, 2014). In particular, recent research shows that differences in life expectancy can be up to 10 years between socio-economic groups of the general population and pensioners and annuitants in pension schemes in the United Kingdom (Madrigal et al., 2011; Office for National Statistics, 2014). We price the annuities with the life table from the general population but we assume that mortality differs across income categories. In particular, following Madrigal et al. (2011), we assume that the individuals from the highest and lowest income categories have a lower or higher mortality than the average population respectively. Mathematically, this is expressed as follows:

$$p_x^{ic}(y) = \eta^{ic} \cdot p_x(y), \tag{2.5}$$

$$\eta^{ic} = \frac{\mathring{e}^{ic}_{x:\overline{n}|}}{\mathring{e}_{x:\overline{n}|}}, \tag{2.6}$$

where

η^{ic} is a constant which alters the life table for each income category. It is obtained as the ratio of the life expectancy of the income category ic, $\mathring{e}^{ic}_{x:\overline{n}|}$, over the life expectancy of the total population $\mathring{e}_{x:\overline{n}|}$. A value of η^{ic} higher or lower than one indicates that the income category ic has a higher or lower average survival respectively. This multiplicative approach implies that the relative difference in survival is equal across all ages. However, empirical evidence suggests that the difference in mortality between socio-economic categories narrows at older-ages (Madrigal et al., 2011).

2.3 Welfare

Discounted expected utility at time of purchase, which does not necessarily coincide with retirement, is used to assess welfare of retirement income product portfolios. The only source of income for the retiree is the retirement income purchased from retirement savings complemented by a first pillar flat-rate pension.

Constant Relative Risk Aversion (CRRA) preferences in consumption and bequest is as in Equation (2.7):

$$V(k_{s,y}) = \mathrm{E}_s\left[\sum_{t=s}^{\omega-s} \beta^{t-s}\left({}_{t-s}p_s(y)u(c_{t,y+t-s}) + {}_{t-1-s}p_s(y)q_{t-1}(y+t-1-s)b(k_{t,y+t-s})\right)\right], \tag{2.7}$$

where

$k_{s,y}$ represents the wealth at age s and age y,

β is the subjective discount factor,

ω is the last surviving age,

${}_{t-s}p_s(y)$ is the probability that an individual survives to age t in year $y+t-s$ conditional on being alive at age s in year y as in Equation (2.4) and $q_{t-1}(y+t-1-s)$ is the probability of death before attaining age t at time $y+t-s$ conditional on being alive at age $t-1$ at time

$t+t-s-1$. Alternatively, we can state that it is the probability of someone aged $t-1$ at time $y+t-s-1$ dying in the period $y+t-s-1$ and $y+t-s$.

Furthermore, $u(c_{t,y+t-s})$ represents the utility function for consumption and $b(k_{t,y+t-s})$ corresponds to the utility from bequest given as follows for CRRA preferences:

$$u(c_{t,y+t-s}) = \frac{(c_{t,y+t-s})^{1-\gamma}}{1-\gamma}, \tag{2.8}$$

$$b(k_{t,y+t-s}) = \alpha \frac{(k_{t,y+t-s})^{1-\gamma}}{1-\gamma}, \tag{2.9}$$

where γ is the risk aversion coefficient and α is the strength of the bequest motive. The risk aversion coefficient describes the willingness to substitute consumption across different states of the world. A coefficient of α equal to 0 indicates the absence of a bequest motive. In this case the individual gains utility solely from consumption.

2.4 Retirement financial products

2.4.1 Australia

Participants in the pension scheme contribute the statutory contribution rate of $\pi = 9.5\%$ to their superannuation fund[1] and earn equity return as in Equation 2.2. Wealth is determined on an annual basis using:

$$k_{x_r,y} = \sum_{x=x_0}^{x_r-1} \pi \cdot w_{x,y-x_r+x} \prod_{j=x+1}^{x_r} (1 + i_{y-x_r+x}) \tag{2.10}$$

where

π indicates the fixed contribution rate to the superannuation scheme,

x_0 is the age at the start of their working career,

x_r is the fixed retirement age,

$w_{x,y-x_r+x}$ is the annual wage earned by an individual aged x in year $y-x_r+x$,

i_j is the one-year stochastic equity return as in Equation (2.2).

Upon retirement, individuals can decide to purchase a retirement income product (or a portfolio of products) to finance their spending at retirement or to defer the purchase of the portfolio. During any deferral period their superannuation wealth remains in the pension fund and earns a stochastic investment return. If the purchase of the retirement portfolio is deferred, the individual is assumed to draw down their wealth to finance a modest lifestyle (ASFA, 2016).

The individuals choose between three different products which are commonly offered to Australian retirees. The first is a nominal life annuity, the second an indexed life annuity and the third a phased withdrawal arrangement. The first two products offer longevity insurance at the expense of flexibility and bequest while the latter offers flexibility in the drawdown pattern and the possibility to bequest at the expense of not providing longevity insurance. Phased withdrawals, also known as Account-based pensions in Australia, are currently by far the most

[1]Even though this percentage was lower in the past we assume 9,5% throughout the career.

popular retirement income product for Australians (Bateman and Piggott, 2011; Iskhakov et al., 2015).

The individual has the possibility to create a portfolio of products in order to obtain both longevity insurance and flexibility. We denote by θ_1, θ_2 and $\theta_3 = 1 - \theta_1 - \theta_2$ the proportion of the pension wealth used to purchase a nominal annuity, indexed annuity and phased withdrawal product respectively.

At the time of purchase the individual aged s in year y is offered an annuity based on their wealth and the fair annuity factor as follows:

$$a_{s,y,\lambda} = (1+l)\,\mathrm{E}_s\left[\sum_{x=s}^{\omega} {}_{x-s}p_s(y)\left(\frac{1+\lambda}{1+r}\right)^{x-s}\right], \tag{2.11}$$

where

l is the loading rate which increases the value of the annuity factor, decreasing the regular annuity paid. It can be considered a proportional premium attached to the contract for the insurer to finance expenses, transaction costs and unhedgeable risks (Mitchell et al., 1999). A value of $l = 0\%$ corresponds to a fairly priced annuity,

${}_{x-s}p_s(y)$ is the survival probability in Equation (2.4),

λ is the indexation rate during retirement. Note that $\lambda = 0$ for a nominal fixed annuity, and

r is the discounting rate used in the annuity calculation.

The consumption associated with a nominal annuity, $C^{A}_{x,y+x-s}$, and indexed annuity, $C^{iA}_{x,y+x-s}$, when $x > s$ for a product purchased when aged s in year y is given as follows:

$$C^{A}_{x,y+x-s} = \theta_1 \frac{k_{s,y}}{a_{s,t,0}}, \tag{2.12}$$

$$C^{iA}_{x,y+x-s} = \theta_2 \frac{k_{s,y}}{a_{s,t,\lambda}}\,(1+\lambda)^{x-s}, \tag{2.13}$$

where

$k_{s,y}$ is the superannuation wealth when the product is purchased and is given by Equation (2.10),

$a_{s,y,0}$ and $a_{s,y,\lambda}$ is the annuity factor for the nominal and indexed payment respectively and are calculated in Equation (2.11).

The phased withdrawal product allows the policyholder to regularly withdraw a specified amount from their superannuation fund until it is depleted. The withdrawal rates may depend on the age and statutory regulations on minimum withdrawals. The consumption associated to the phased withdrawal, $C^{PW}_{x,y+x-s}$, is as follows:

$$C^{PW}_{x,y+x-s} = \psi_x \cdot k^{PW}_{x,y+x-s} = \psi_x\,(1-\psi_{x-1})\,k^{PW}_{x-1}(1+i_{x,y+x-s}) \tag{2.14}$$

$$= \psi_x \cdot \theta_3 \cdot k_{s,y} \prod_{j=s}^{x-1} (1-\psi_j)\,(1+i_{y+j+1-s}), \tag{2.15}$$

where

ψ_x is the age-dependent withdrawal rate,

$k^{PW}_{x,y+x-s}$ is the remaining account balance available at age $x-s$ after the purchase in year y.

2.4.2 The Netherlands

The Netherlands has no mandated minimum pension contribution and legislation only stipulates the maximum pension rights that an individual can accrue annually. Despite the recent waves of reforms towards more flexibility (Bovenberg and Nijman, 2012), most individuals in the Netherlands are in defined benefit plans that provide around 75% of their average lifetime salary with 40 years of employment (Bateman et al., 2016). In practice, most individuals contribute a fixed rate of 17% of their wages to the retirement scheme, independent of their income level, age or sex (Bateman et al., 2016). Since the benefits paid during retirement are earnings-based and not contribution-based, we do not consider the impact of contributions. Most pension funds in the Netherlands have a threshold in the accumulation phase, usually set at the level of the state pension, on top of which individuals accrue pension rights. Therefore, individuals earning less than the annual state pension do not accrue second pillar benefits and rely solely on the state pension.

At retirement when aged s in year y, individuals receive a lifetime payment based on the pensionable salary $PS_{s,y}$ which is calculated as the average earnings above the threshold for the last 40 years. Past contributions are indexed to year y value with the Consumer Price Index. The array of products is reduced to three indexation-linked lifetime income since Dutch legislation makes full annuitization compulsory (Bateman et al., 2016). Individuals can choose between a 'high-low', 'low-high' and a classical inflation indexed payment. The 'high-low' arrangement provides 100% of their retirement entitlement in the 'high' stage from ages 65 to 70 and 75% during the 'low' stage from 70 years onwards[2]. The third product consists of an indexed annuity. The indexation rate paid during retirement, denoted as λ is based on the inflation set by the Centraal Bureau voor de Statistiek (2017). Mathematically, the retirement payout $x-s$ after retiring in year y can be expressed as follows:

$$C^{hl}_{x,y+x-s} = \begin{cases} P^{h,hl}_{x,y+x-s} = P^{h,hl}_{s,y}\,(1+\lambda)^{x-s} & \text{if } x \in [s, s+5]; \\ 75\% \cdot P^{h,hl}_{s+6,y+6} & \text{if } x = s+6; \\ 75\% \cdot P^{h,hl}_{s+6,y+6}\,(1+\lambda)^{x-s-6} & \text{if } x \in [s+6, \omega]. \end{cases} \tag{2.16}$$

$$C^{lh}_{x,y+x-s} = \begin{cases} P^{l,lh}_{x,y+x-s} = 75\% \cdot P^{h,lh}_{s,y}\,(1+\lambda)^{x-s} & \text{if } x \in [s, s+5]; \\ P^{h,lh}_{s+6,y+6} & \text{if } x = s+6; \\ P^{h,lh}_{s+6,y+6}\,(1+\lambda)^{x-s-6} & \text{if } x \in [s+6, \omega]. \end{cases} \tag{2.17}$$

$$C^{iDB}_{x,y+x-s} = 75\% \cdot PS_{s,y}\,(1+\lambda)^{x-s}\,, \tag{2.18}$$

where

$P^{h,hl}_{s,y}$ is the first pension paid in the high low environment, during the 'high' stage from age s to age $s+5$. Since the system is still defined benefit, we have to first transform the pensionable salary entitlement $PS_{s,y}$ to wealth by multiplying the entitlement by an annuity factor. Then this wealth is divided by another annuity factor to account for the variation in the retirement income pattern as follows:

[2]7 Artikel 63, lid 1.a Pensioenwet.

$$P^{h,hl}_{s,y} = \frac{PS_{s,y} \cdot a_{s,y,\lambda}}{\sum_{x=s}^{s+5} {}_{x-s}p_s(y) \left(\frac{1+\lambda}{1+r}\right)^{x-s} + 75\% \sum_{x=s+5+1}^{\omega} {}_{x-s}p_s(y) \left(\frac{1+\lambda}{1+r}\right)^{x-s}}, \tag{2.19}$$

$P^{l,lh}_{s,y}$ is the first pension paid in the low high arrangement and corresponds to 75% of the high pension paid after 5 years which is calculated in a similar manner as in Equation (2.19):

$$P^{h,lh}_{s,y} = \frac{PS_{s,y} \cdot a_{s,y,\lambda}}{75\% \sum_{x=s}^{s+5} {}_{x-s}p_s(y) \left(\frac{1+\lambda}{1+r}\right)^{x-s} + \sum_{x=s+5+1}^{\omega} {}_{x-s}p_s(y) \left(\frac{1+\lambda}{1+r}\right)^{x-s}}. \tag{2.20}$$

2.5 State Pension

Australia and The Netherlands state pensions pay a flat-rate income throughout retirement to all residents regardless of their wages during their career. There are some differences between the two countries. In The Netherlands the payment is applicable to all individuals regardless of income or asset status and only depends on the number of years that they have lived in the country. Retirees receive a full payment if they live in the Netherlands for at least 50 years. The gross amounts as from 1 January 2017 are 13,840.20€ for a single and 19,070.16€ for a couple per year (Social Security Bank (SVB), 2017). We consider in our analysis an individual who has lived in the Netherlands for the past 50 years, so they receive the full benefit.

On the other hand, Australia has a more complex system (Chomik and Piggott, 2014). All Australian residents who have lived in Australia for at least 10 years have the right to receive the full payment. The state pension paid to an individual, if any, is determined by an income and assets means test. The more assets an individual owns and the higher the income she has during retirement, the lower the government state pension received. The maximum monthly gross rates paid from 1 January 2017 are \$21,015.80 for singles and \$31,683.60 for a couple (Department of Human Services, 2017a).

The state pension at age x and year $y+x-s$ denoted as $SP_{x,y+x-s}$ paid is the minimum of the state pension after applying the asset test, $SP^{AT}_{x,y+x-s}$, and the state pension after applying the income test, $SP^{IT}_{x,y+x-s}$:

$$SP_{x,y+x-s} = \min\left(SP^{AT}_{x,y+x-s}, SP^{IT}_{x,y+x-s}\right) \tag{2.21}$$

The state pension after applying the asset test, $SP^{AT}_{x,y+x-s}$ is calculated as follows:

$$SP^{AT}_{x,y+x-s} = \max\left(0, SP_{x,y+x-s} - \max\left(0, k^{AT}_{x,y+x-s} - A_{x,y+x-s}\right) \cdot tr^{AT}\right) \tag{2.22}$$

where

$SP_{x,y+x-s}$ is the state pension at the time of calculation,

$k^{AT}_{x,y+x-s}$ is the wealth of the individual at age x in year $y+x-s$ for asset test purposes. The wealth for asset test purposes differs from the liquid account balance $k^{PW}_{x,y+x-s}$ since it also accounts for the underlying value of the annuities even though they do not include a bequest:

$$k^{AT}_{x,y+x-s} = \max\left(0, \theta_1 \cdot k_{s,y} - \sum_{j=s}^{x} C^{A}_{j,y+j-s}\right) + \max\left(0, \theta_2 \cdot k_{s,y} - \sum_{j=s}^{x} C^{iA}_{j,y+j-s}\right) + \max\left(0, k^{PW}_{x,y+x-s}\right), \tag{2.23}$$

$A_{x,y+x-s}$ is the asset threshold under which the individual receives a full state pension payment after applying the asset test. As of 1 January 2017 it is set equal to \$250,000 for single homeowners and \$375,000 for a couple who owns the home they live in (Department of Human Services, 2017b).

Finally, tr^{AT} is the fixed taper rate for the pension assets test. According to the Department of Human Services (2017b) the state pension is reduced every fortnight by \$3 per \$1,000 over the asset threshold $A_{x,y+x-s}$. This corresponds to an annualized taper rate of 0.078.

The state pension after applying the income test, $SP^{IT}_{x,y+x-s}$ is calculated as follows:

$$SP^{IT}_{x,y+x-s} = \max\left(0, SP_{x,y+x-s} - \max\left(0, C^{IT}_{x,y+x-s} - I_{x,y+x-s}\right) \cdot tr^{IT}\right), \tag{2.24}$$

where

$C^{IT}_{x,y+x-s}$ is the income of the individual for income test purposes. The income consists of the sum of retirement income payments as well as the 'deemed' return on assets. Department of Human Services (2017a) does not account for the real observed return on assets but assumes a certain rate of return, which corresponds to the 'deeming rate'. The income $C^{IT}_{x,y+x-s}$ is given as follows:

$$\begin{aligned} C^{IT}_{x,y+x-s} = & \min\left(\theta_1 \cdot k_{s,y} + \theta_2 \cdot k_{s,y} - \sum_{j=s}^{x} C^{A}_{j} - \sum_{j=s}^{x} C^{iA}_{j} + k^{PW}_{x,y+x-s}, D_{x,y+x-s}\right) \cdot 1,75\% \\ & + \max\left(\theta_1 \cdot k_{s,y} + \theta_2 \cdot k_{s,y} - \sum_{j=s}^{x} C^{A}_{j} - \sum_{j=s}^{x} C^{iA}_{j} + k^{PW}_{x,y+x-s} - D_{x,y+x-s}, 0\right) \cdot 3,25\% \\ & + C^{A}_{x,y+x-s} + C^{iA}_{x,y+x-s} + C^{PW}_{x,y+x-s}, \end{aligned} \tag{2.25}$$

where $D_{x,y+x-s}$ is the asset threshold for deeming purposes. The income test assumes that any capital under the threshold earns 1.75% per annum, and any capital above the threshold earns 3.25% per annum. For a single this threshold is set to \$49,200 while for a couple it is set to \$81,600 (Department of Human Services, 2017c),

$I_{x,y+x-s}$ is the income threshold which is set as \$164 per fortnight or equivalent to \$4,338 on a yearly basis, and

tr^{IT} is the taper rate for the income asset test. According to Department of Human Services (2017c) the state pension is reduced by 50 cents every fortnight for each dollar of income over 164\$. This yields to an annualized taper rate of 0.5.

We assume that the state pension and the various thresholds increase during retirement at the inflation rate as follows $SP_{x,y+x-s} = SP_{s,y}\left(1+\lambda\right)^{x-s}$.

3 Model calibration

This section presents the model calibration and parameters used in our portfolio comparison. We consider the case of an individual who enters employment at $x_0 = 18$ and retires at $x_r = 65$. At retirement, individuals then select from the Australian or Dutch portfolio of retirement income products so we have a consistent comparison. They are exposed to mortality during retirement until they either pass away or attain the age of $\omega = 110$. The financial market, welfare function and earnings profiles assumptions for our study as well as the calibration of the life tables for Australia and The Netherlands are detailed here.

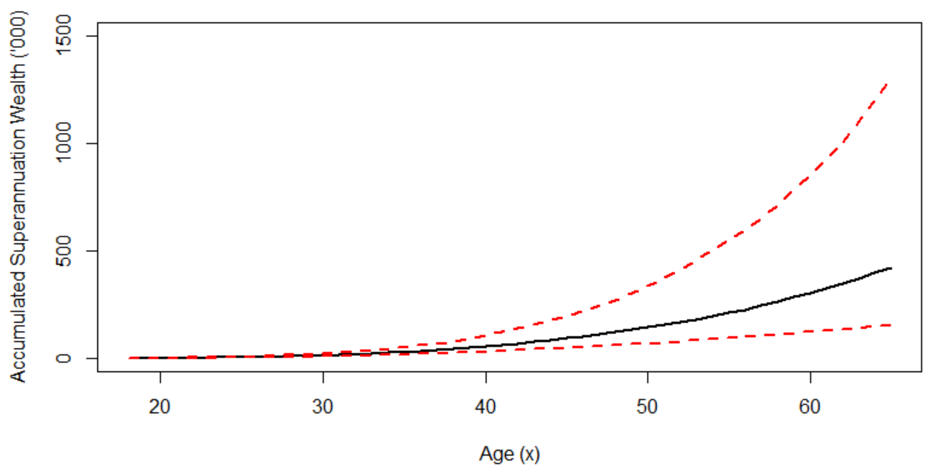
3.1 Equity risk

Pension funds and retirement income providers take on equity risk in the accumulation and decumulation phase with account balances invested into a fund with equity exposure (Bovenberg and Nijman, 2012). From an individual's perspective, equity risk exposure depends on whether the accumulation is in defined contribution or defined benefit funds.

Dutch retirees are not exposed to equity return risk during the accumulation period because their benefits are earnings-based. Similarly during retirement there is mo equity risk exposure since they receive a life time retirement income stream[3].

Australians, on the other hand, are exposed to equity risk during accumulation as the benefits are based on the accumulated contributions and investment returns. They also take on financial risk during retirement if they purchase a phased withdrawal product with investment exposure to equities.

Figure 1: Accumulated superannuation capital: median (black line) and 5% and 95% quantiles (red lines).



The drift term μ^s is equal to $r^f + \lambda^s \cdot \sigma^s$ where $\lambda^s = 0.155$, $\sigma^s = 0.158$, $r^f = 4\%$ and dZ_t is a

[3]DB pensions are commonly indexed to the Consumer Price Index or wages. In practice, indexation in the Dutch system depends on the solvency of the pension fund, that is, indexation is "*granted if the asset value of the fund is sufficient to cover all future obligations* as stated in De Jong (2008). Kortleve (2013) and Bovenberg et al. (2016) indicate that this solvency-dependent indexation was introduced after the global financial crisis to correct for an increasing exposure of pension funds to market and demographic risks. A stochastic or solvency-linked indexation would add another layer of uncertainty, decreasing the attractiveness of inflation-linked products.

Standard Brownian Motion (Gomes and Michaelides, 2005). Figure 1 depicts the accumulated superannuation wealth for an individual starting to contribute at 18 in 1964 and retiring at 65. The black line depicts the median accumulated wealth whereas the two red lines, corresponding to the 5% and 95% quantiles, indicate their variability. We abstract from the tax arrangements in Australia, despite them having an effect in the accumulated balance at retirement[4].

3.2 Mortality risk

We estimate the Cairns-Blake-Dowd (CBD) model presented in Section 2.2 using the Australian and Dutch data from the Human Mortality Database (2014, 2015). The calibration procedure is done in R using the following packages: demography (Hyndman et al., 2017) and StMoMo (Villegas et al., 2016). First we use the 'demography' package to extract the death counts $D_{x,y}$ for the age x at time y and the population's exposure to risk $E_{x,y}$. In our study we use the data on the total population and do not differentiate by gender. The Cairns et al. (2006) model is known to fit well old-age mortality and calibrate only between the age of 55 to $\omega = 110$.

We fit the data for the period from 1970 to 2011. In the estimation procedure we put zero weight to cohorts with less than 3 observations. Figure 2 shows the parameter estimates for the CBD model for Australia and The Netherlands. The top and lower panel plots the parameter estimates for Australia and The Netherlands respectively. We observe that the logarithm of the mortality rate in Equation 2.4 decreases with the time-period component $\kappa_y^{(1)}$ and increases the second period component $\kappa_y^{(2)}$ for ages higher than the average for the age interval studied, $x > \overline{x}$, and decreases for ages lower than $\overline{x}$.

We forecast the future mortality rate following Cairns et al. (2006) by assuming that the period indexes $\kappa_y^{(i)}$, $i = 1, 2$ evolve under a multivariate random walk with drift as follows:

$$\begin{pmatrix} \kappa_y^{(1)} \\ \kappa_y^{(2)} \end{pmatrix} = \begin{pmatrix} \delta_1 \\ \delta_2 \end{pmatrix} + \begin{pmatrix} \kappa_{y-1}^{(1)} \\ \kappa_{y-1}^{(2)} + \end{pmatrix} + \zeta_y^{\kappa} \tag{3.1}$$

$$\zeta_y^{\kappa} \sim N(0, \Sigma) \tag{3.2}$$

where $\delta = (\delta_1, \delta_2)'$ is a vector of drift parameters, ζ_y^{κ} is a multivariate white noise with a variance-covariance matrix of Σ. The forecasting is completed as well using the StMoMo R package (Villegas et al., 2016). Figure 3 shows the forecasted survival probability for Australia (black-line) and Australia (red-line) for a cohort retiring at 65. We observe that the survival probability of Dutch, black line, is lower than the survival probability of Australians, red line, for all ages considered.

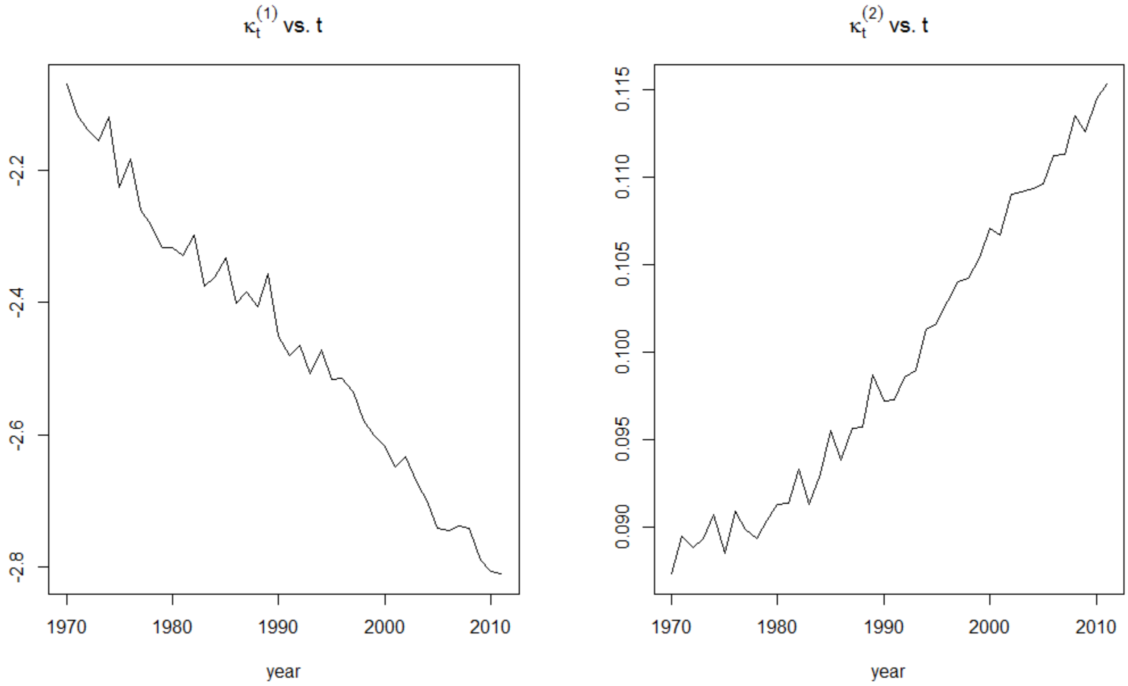
Despite the difference in the curve, both life tables yield similar life expectancy values: Australians have a life expectancy at 65 of 21.8 years whereas the Dutch have a life expectancy of 20.20 at retirement. The higher forecasted life expectancy for Australians aligns with life expectancy values based on observed historical data (OECD, 2017b).

Following Madrigal et al. (2011), we assume that mortality differs across income quantiles and assess whether this assumption affects of retirement income portfolios. The factor η^{ic} affecting the average survival probability in Equation (2.5) is equal to 0.9271 for the lower

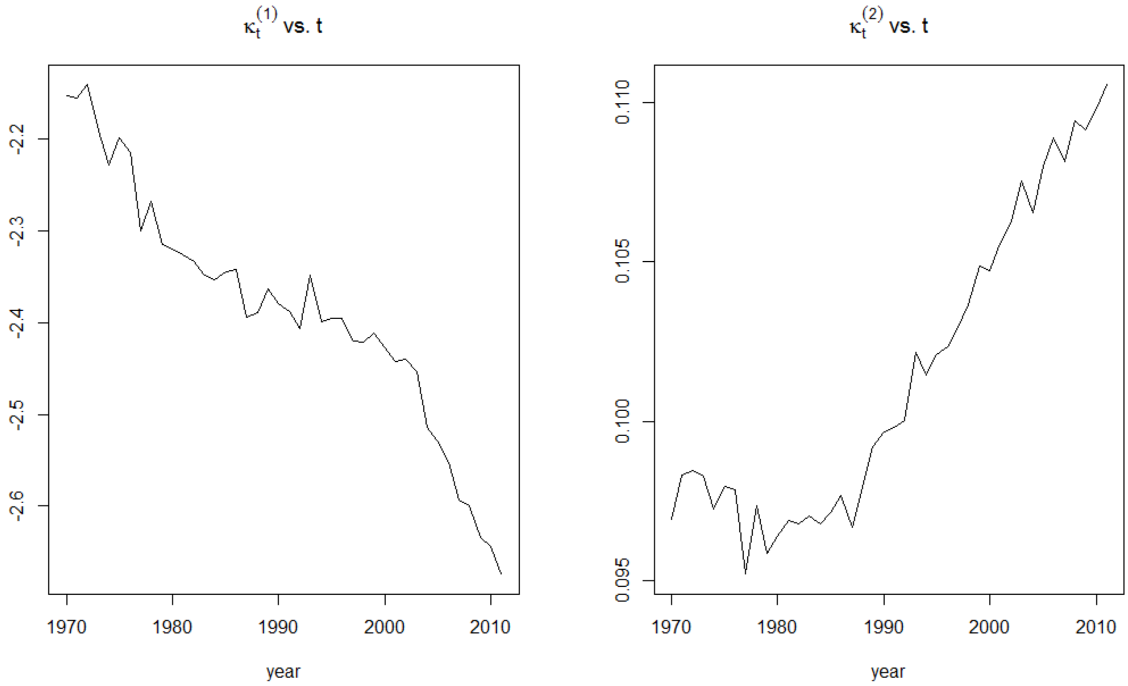
[4] Australia has a 'TTE' approach to taxation, that is, contributions and their return are taxed during the accumulation phase and the retirement income product at retirement is exempted (Kudrna and Bateman, 2014). In the Netherlands, tax exempt pension savings are in terms of accrued pension rights rather than contributions. Rights accrued on top of a certain threshold are therefore taxed. During retirement, the pension is subject to income tax (Bateman et al., 2016).

Figure 2: Cairns et al. (2006) Parameter Estimates.

Australia



The Netherlands

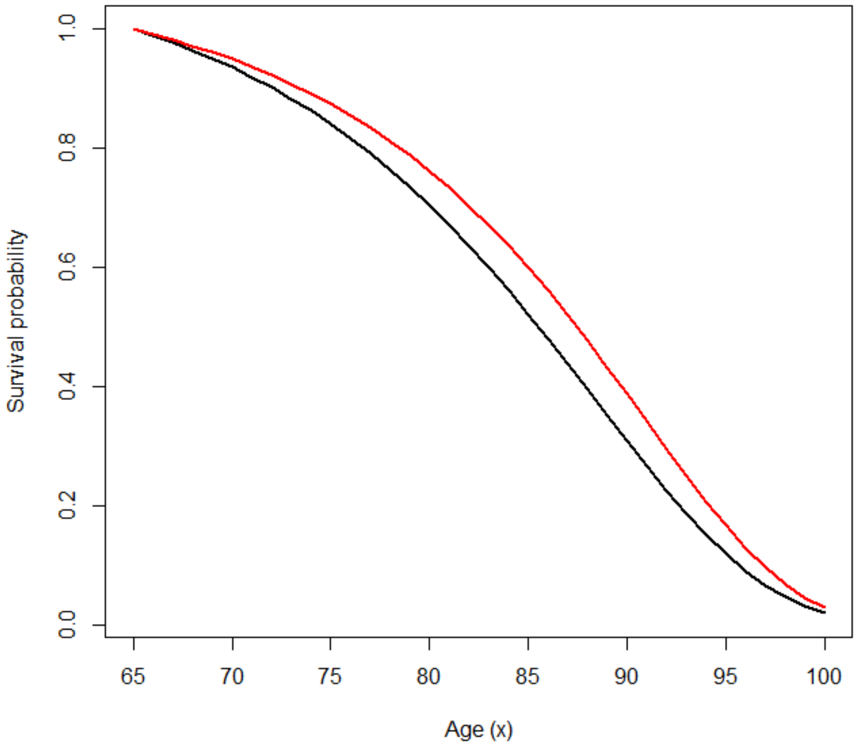


Notes: the top panel plots the parameter estimates for Australia while the lower panel shows the parameter estimates for The Netherlands. $\kappa_y^{(1)}$ shows the period-related effect and $\kappa_y^{(2)}$ is the period-dependent factor interacting with the difference between the age considered and the average age, that is $(x - \overline{x})$. Here the subscript t indicates the year which we denoted y.

income quantile $ic = 10^{th}$ and 1.13 for the higher income quantile $ic = 90^{th}$[5]. That is, the

[5]These values are obtained as the ratio between the life expectancy for the salary band £48.5K for

Figure 3: Survival probability for ages 65 to 110 for The Netherlands (black line) and Australia (red line) contingent on being alive at age 65.



Notes: the red color corresponds to Australia and the black color corresponds to The Netherlands. The probability shown is based on the average of 10000 Monte Carlo simulations.

individuals from the highest income quantile are expected to live 13% longer than expected and the individuals in the lower income quantile are expected to live 7% less long than expected. We assume the same mortality differentials in The Netherlands and Australia since no country-specific data is available and both countries have a similar Human Development Index (United Nations Development Programme, 2016)[6]. However, the higher inequality in Australia could lead to increasing mortality differentials between individuals from different income categories[7].

3.3 Wage profiles

We calculate the superannuation wealth for Australia and the defined benefit for the Netherlands for three income categories, namely the 10^{th} quantile, median and 90^{th} quantile. The Australian Bureau of Statistics publishes the employee gross earnings every year from 1993 to 1995 and every two years for the period between 1996 and 2016. However, most datasets prior to 2014 do not provide information on the income quantiles per age category. Therefore, the dataset from

the highest quantile or <£15K for the lowest income quantile over the life expectancy for the salary band £22,5K-£30.5K corresponding to the middle income range. We assume that the individuals belong to the same geo-demographic group C-middle and that their only difference is the earned wage.

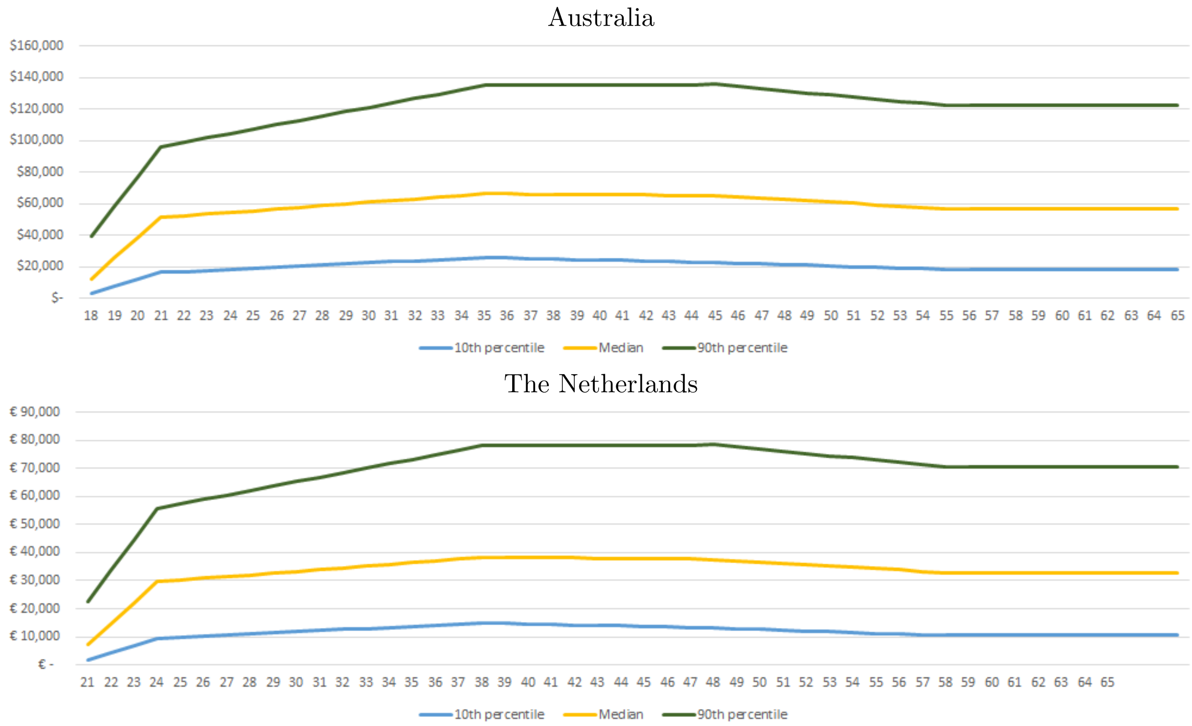
[6] Australia has a Human Development Index of 0.939 while The Netherlands has an index of 0.924 (United Nations Development Programme, 2016).

[7] The Gini coefficient, commonly used to measure inequality, indicates that Australia is more unequal than the Netherlands since their Gini value of 0.337 lies above the Dutch's Gini coefficient of 0.283 (OECD, 2017a).

Australian Bureau of Statistics (2016a) is used as input. To ensure comparability between the pension schemes considered, we use the Purchasing Power Parity (PPP)[8], to convert Australian gross wages in Figure 4 to Euros. By doing this, we reduce the disparities caused by inequality and country-specific wage profiles. The dataset on yearly earnings presents the wages per age categories that span age periods of 10 years. Given this shortcoming, we first calculate the age-specific wages by linear interpolation as follows:

$$\hat{w}_{x,2016} = w_{x_1,2016} + (x - x_1)\,\frac{w_{x_2,2016} - w_{x_1,2016}}{x_2 - x_1}, \tag{3.3}$$

Figure 4: Yearly gross earnings for the the 10th, median and 90th income quantile per age.



Source: own illustration using data from Australian Bureau of Statistics (2016a) and OECD (2015).

Figure 4 shows the interpolated yearly earnings as in Equation 3.3 for the three income categories as of 2014 for the ages between 18 to 65. Superannuation savings at retirement requires an individual's wages since entry to the pension scheme as in Equation (2.10). Due to the unavailability of reliable data before 2014 for income quantiles, we obtain past wages by adjusting the values as of 2014 using historical CPI (Australian Bureau of Statistics (2016b) for Australia and Centraal Bureau Statistiek (2017) for the Netherlands) as follows:

$$\hat{w}_{x,2016-65+x} = w_{x,2016} \cdot \frac{CPI_{2016-65+x}}{CPI_{2016}}, x \in [x_0, \omega] \tag{3.4}$$

For instance, the wage at age 50 in year $t = 2016 - 65 + 50$ will be equal to $\hat{w}_{50,2010} = w_{50,2016}\frac{CPI_{2010}}{CPI_{2016}}$.

[8]The Purchasing Power Parity rates allows us to "... *equalize the purchasing power of different currencies by eliminating the differences in price levels between countries.*" (OECD, 2015). The PPP value corresponds to 0.58 in our case, that is, 1 Australian dollar is PPP equivalent to 0.58 Euros.

3.4 Parametrization of the retirement income portfolio and welfare function

For Australia, the state pension, means-test thresholds presented in Section 2.5 and indexed annuity in Equation (2.13) are assumed to increase at the rate of 2.5% as indicated by the Reserve Bank of Australia (2017)[9]. For the Dutch case we assume a target inflation rate of 2% since this is the inflation rate related to price stability according to the European Central Bank (Centraal Bureau Statistiek, 2017)[10].

For the phased withdrawal product, we assume that individuals follow the minimum withdrawal percentages required by the Australian Taxation Office (2017). This aligns with the behavioral economics literature which suggests that defaults influence savings and investment behavior in pension plans (Beshears et al., 2009, 2011). Table 1 shows the age-dependent minimum withdrawal ψ_x as a percentage of the remaining superannuation balance.

Table 1: Minimum withdrawal percentages ψ_x as a percentage of the remaining balance.

Age (x)	Minimum ψ_x
55-64	4%
65-74	5%
75-79	6%
80-84	7%
85-89	9%
90-94	11%
95+	14%

Source: Australian Taxation Office (2017).

We assume a subjective discount factor of 2%, that is a $\beta = 0.98$ in line with recent welfare studies (Feldstein and Ranguelova, 2001; Post, 2012; Hanewald et al., 2013; Boon et al., 2017). Three levels of risk aversion coefficients are considered which represent low risk aversion, $\gamma = 2$, moderate risk aversion $\gamma = 5$ and high risk aversion, $\gamma = 8$. Finally, the bequest coefficient α is set equal to 0.15, indicating a low bequest motive (0 indicates no bequest motive and 1 indicates full bequest motive).

4 Portfolio comparison

The different portfolios considered, shown in Table 2, are compared by means of the 'Certainty Equivalent Consumption' (CEC) both in the presence and absence of a bequest. We use portfolios based on diversification heuristics as often observed in the empirical literature (Benartzi and Thaler, 2007; Bateman et al., 2017)[11]. The *CEC* corresponds to the yearly constant lifetime consumption that yields the same utility as a portfolio of retirement income. Mathematically, it can be determined as follows:

[9] The value of 2.5% lies between the 2 and 3% that the Governor and the Treasurer of the Reserve Bank of Australia consider an appropriate target for monetary policy in Australia.

[10] The inflation rate as of February 2017 is equal to 1.7% which increased substantially compared to the values close to zero experienced between 2014 and 2016.

[11] We do not compute the optimal proportions in each retirement product since we aim to show reults for representative portfolios, and in any event optimal portfolios reflect model specifications rather than actual portfolios.

Table 2: Retirement income portfolios for Australia and The Netherlands.

	Australia				The Netherlands		
	Nominal Annuity	Indexed Annuity	Phased Withdrawal		Indexed Annuity	High/Low	Low/High
1	100%	0%	0%	1	100%	0%	0%
2	0%	100%	0%	2	0%	100%	0%
3	0%	0%	100%	3	0%	0%	100%
4	50%	50%	0%				
5	50%	0%	50%				
6	0%	50%	50%				
7	33%	33%	33%				

Notes: Note that we do not consider product mixes for the Netherlands since all three products are income-based only.

$$\overline{U} = \mathrm{E}\left[\sum_{t=s}^{\omega-s} \beta^{t-s}{}_{t-s}p_s(y)\frac{CEC^{1-\gamma}}{1-\gamma} + \beta^{t-s}{}_{t-1-s}p_s(y)q_{t-1}(y+t-1-s)\alpha\frac{(k_{t,y+t-s})^{1-\gamma}}{1-\gamma}\right], \tag{4.1}$$

where $\overline{U}$ is the utility in (2.7) of a retirement portfolio. Note that the wealth $k_{t,y+t-s}$ depends directly on the implied CEC as follows:

$$k_{t,y+t-s} = k_{s,y}\prod_{j=s+1}^{t}(1+i_{y+j+1-s}) + \sum_{k=s}^{t-1}(P_{k,y+k-s} - CEC)\prod_{j=s+1}^{t}(1+i_{y+j+1-s}), \tag{4.2}$$

where $P_{k,y+k-s}$ represents the pension payments made throughout retirement which are dependent on the retirement portfolio.

The interpretation of the CEC differs in the presence or absence of a bequest motive. In the presence of a bequest, the CEC_{beq} is the yearly fixed amount that makes the individual indifferent between the combination of the consumption contingent to survival associated to the retirement portfolio and the life insurance on the remaining wealth contingent of death and a fixed consumption stream throughout retirement. In other words, the difference between the CEC_{beq} and the CEC is the willingness to give up the life insurance (bequest) component linked to a certain retirement income portfolio.

The subsequent subsections studies the preferences of three stylized individuals from the three income categories. We account for the mortality differentials which indicate that individuals from the highest and lowest income quantile live on average 13% longer and 7% less long respectively than the average individual in the population.

We study the preferences for individuals in two institutional settings. First individuals are in an Australian setting as a proxy for a flexible retirement income arrangement with a wide array of products. The state pension is means-tested and the pension wealth is based on contributions from the total yearly earnings without considering any threshold. Then we present the Dutch setting with a pension which is not means-tested and with pensions based on wages on top of the state pension threshold. To ensure the comparability of our results, we compare retirement income portfolios and institutional arrangements found in Australia and The Netherlands for stylized Australian individuals, that is, the life table, wages, inflation and state pension correspond to the Australian case. By doing this we assess the effect of introducing a prescribed Dutch setting in a more flexible Australian background. The sensitivity to bequest, risk aversion, pricing and timing of the annuity is further developed in Section 5.

4.1 Retirement income flexibility

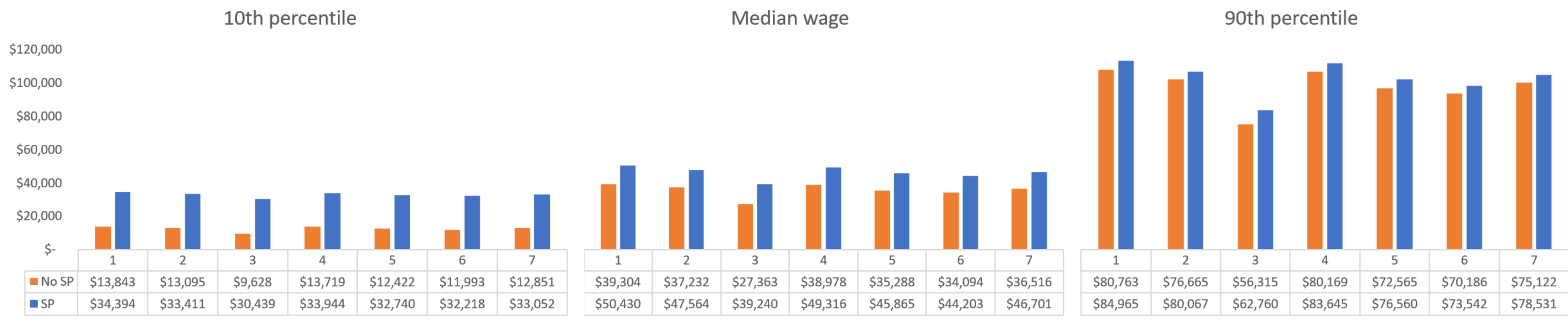
Figure 5 shows the Certainty Equivalent Consumption (CEC) for representative Australians for three income categories and compares the CEC in the presence and absence of a means-tested pension. We observe that the state pension, even means-tested, increases the CEC for the three income categories. However, the relative increase is lower for higher incomes, aligning with the purpose of the state pension in Australia: providing a higher protection to lower income categories since their private resources are more limited. In particular, the lowest income quantile more than doubles their income in the presence of the state pension while for the highest quantile it increases the CEC between \$3,000 and \$6,000 on a yearly basis.

To assess the effect of the means-test, bequest, and income category on the ranking of retirement portfolios, we rank the portfolios from 1 to 7, where 1 indicates the most preferred portfolio and 7 the least preferred portfolio (Table 3). The first row of Table 3 indicates that, in the absence of a bequest, the nominal annuity is the most welfare enhancing product while the pure phased withdrawal product is the least welfare enhancing. The higher the share of phased withdrawal, the lower the ranking of the portfolio. Australians, without bequest motives, currently taking up lump-sums or phased withdrawals on a much higher rate than they do take up annuities (Iskhakov et al., 2015; APRA, 2015) would be losing a CEC equivalent to \$4,215 for the lowest income quantile and \$24,448 for the highest income quantile on a yearly.

Individuals with a bequest motive see their preferences vary quite sharply. Figure 6 shows two things, first, the CEC of portfolios solely offering longevity protection do not see their CEC increase since they do not offer liquidity even when the individual has a bequest motive. Second, portfolios with a phased withdrawal component (portfolio 3, 5, 6 and 7) see their CEC substantially increase. The difference between the CEC with and without a bequest can be interpreted as the additional income that should be paid to an individual to give up their liquidity or bequest motive. For instance, an individual with a median wage purchasing a full phased withdrawal product would need a yearly additional income of \$21,018 to give up the life insurance component.

These preferences are further clarified in Table 3. We observe that portfolios with longevity protection go from the top 3 (portfolios 1, 3 and 4) without a bequest motive to the bottom 3 in the presence of a bequest. It is noteworthy that partial annuitization is welfare enhancing, even in the presence of the means-tested state pension. Indeed, portfolios which combine annuities and phased withdrawal (portfolio 5, 6 and 7) score higher than the portfolio invested fully in the phased withdrawal product (portfolio 3). In all scenarios individuals would prefer a nominal annuity compared to an indexed annuity. The indexed annuity provides a lower initial pension but a higher pension for the retirees living longer than average. The nominal annuity is therefore more welfare enhancing for those that live shorter than average.

Figure 5: Flexibility: Certainty Equivalent Consumption with (blue) and without a means-tested pension (orange) for the three income categories, risk aversion coefficient of 5 and without bequest motive.



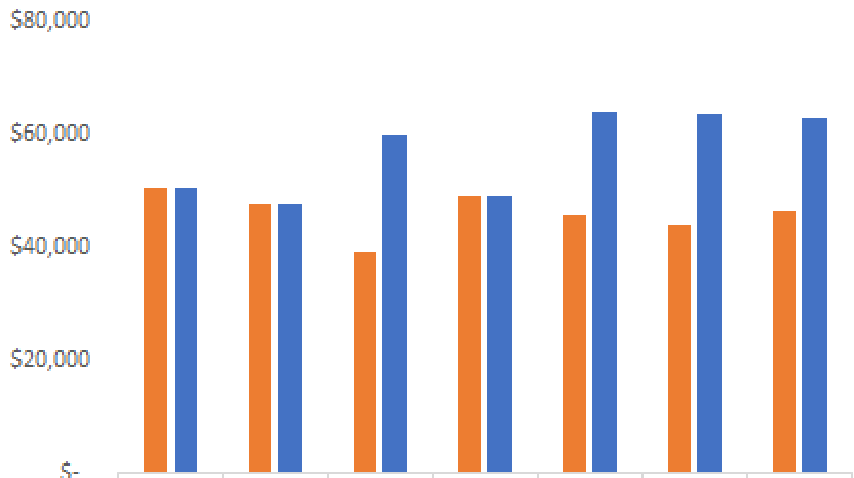
Notes: Note that the Australian state pension is means-tested as explained in Subsection 2.5 and that superannuation wealth is contribution-based.

Table 3: Flexibility: Ranking of the retirement income portfolios for different income categories, bequest motive and means-test.

Income	Bequest	Inclusion of State Pension	Portfolios 1	2	3	4	5	6	7
All wages	No	No, Yes	1	3	7	2	5	6	4
Q10	Yes	No	5	7	4	6	2	3	1
Q10	Yes	Yes	5	7	4	6	1	2	3
Q50	Yes	No, Yes	5	7	3	6	1	2	4
Q90	Yes	No, Yes	5	7	4	6	2	3	1

Notes: The ranking is shown from 1 to 7 where 1 indicates the most preferred and 7 the least preferred for Australia.

Figure 6: Flexibility: Certainty Equivalent Consumption with (blue) and without a bequest (orange) for the mean income category, risk aversion coefficient of 5 and means-tested state pension.



	1	2	3	4	5	6	7
No Bequest	$50,430	$47,564	$39,240	$49,316	$45,865	$44,203	$46,701
Bequest	$50,430	$47,564	$60,258	$49,316	$64,117	$63,850	$62,904

Notes: Note that the portfolios based solely on longevity protection products are not affected by the inclusion of a bequest motive since they do not offer liquidity.

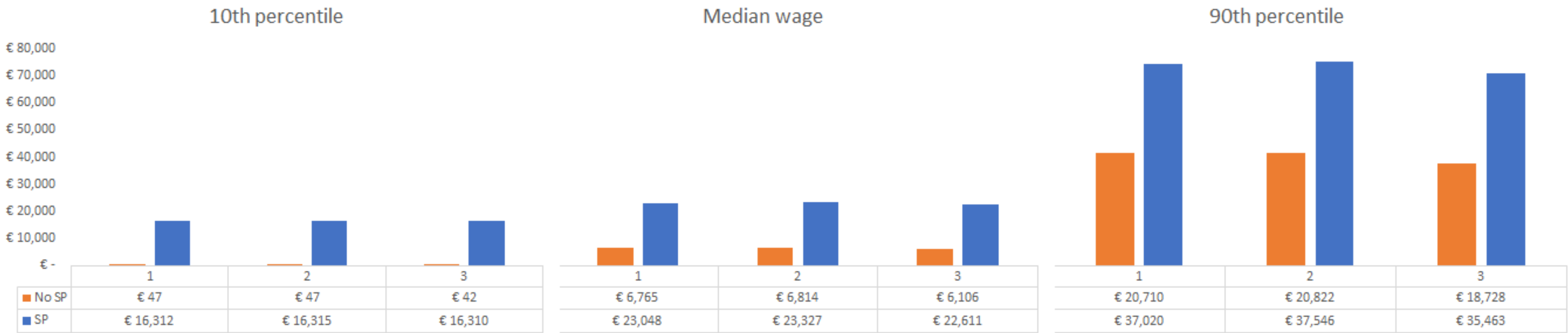
We observe that the state pension affects the ranking for the lowest income category. Namely, the preferred option in the absence of state pension accounts for 33% nominal and 33% indexed longevity protection and 33% phased withdrawal while in the presence of state pension the preferred portfolio consists of 50% nominal annuity and 50% phased withdrawal. For this income category the state pension, which is indexed, replaces the need for an indexed annuity in the private market. The inclusion of the bequest motive mimics the observed purchase of phased withdrawal products in Australia more closely for the risk aversion coefficient considered. However, recent experimental studies show that an (intended) bequest motive is the least preferred motive to hold liquid wealth during retirement, whereas self-gratification or precautionary health expenditures score higher (Alonso-García et al., 2017).

4.2 Retirement income prescription

Figure 7 shows the Certainty Equivalent Consumption (CEC) for representative individuals in a Dutch setting for the three income categories. The highly prescribed Dutch pension system mandates annuitization and the choice of products is in practice reduced to an indexed annuity, a ‘high-low’ and ‘low-high’ annuity as described in Subsection 2.4.2. The second pillar accrues a pension rights on top of a threshold, commonly set at the level of the state pension. The state pensionis paid to everyone who fulfills the residency requirements.

In this context, the welfare analysis abstracts from bequest since partial annuitization is not considered. Figure 7 shows that the effect of the state pension is nominally equal for all income categories. On a relative scale, the lowest income category draws their retirement income almost solely from the state pension while for the highest quantile it accounts for less than half of its regular retirement income. The effect for the lowest income category is the highest due to the reduced accrued rights on top of the state pension threshold.

Figure 7: Prescription: Certainty Equivalent Consumption with (blue) and without a state pension (orange) for the three income categories, risk aversion coefficient of 5 and without bequest motive.



Notes: The state pension in The Netherlands is paid to everyone and the second pillar accrues rights on top of the state pension franchise.

Table 4: Prescription: Ranking of the retirement income portfolios for different income categories and state pension considerations.

Income	Bequest	State Pension	Label 1	Label 2	Label 3
All categories	No	No, Yes	2	1	3

Notes: The ranking is shown from 1 to 3 where 1 indicates the most preferred and 3 is the least preferred for the Netherlands. Note that there are no values when bequest is accounted for in the case of The Netherlands since the products on scope do not have flexibility or liquidity options.

The first row of Table 4 indicates that the 'high-low' construction is the most welfare enhancing product while the least is the 'low-high' construction. Note, however, that innovations such as the 'high-low' or 'low-high' constructions marginally increase welfare, especially for the lowest income categories. Comparing the *CEC* between the lowest and median quantile indicates that the gains in welfare for the median wage are not proportional to their lifetime earnings. Indeed, the lowest income category earns a lifetime income which is about 40% of the median income. However, upon retirement the *CEC* for the lowest income is about $\frac{3}{4}$ of the *CEC* for the median earners. This confirms that the state pension is very efficacious at poverty alleviation for individuals with low lifetime wages.

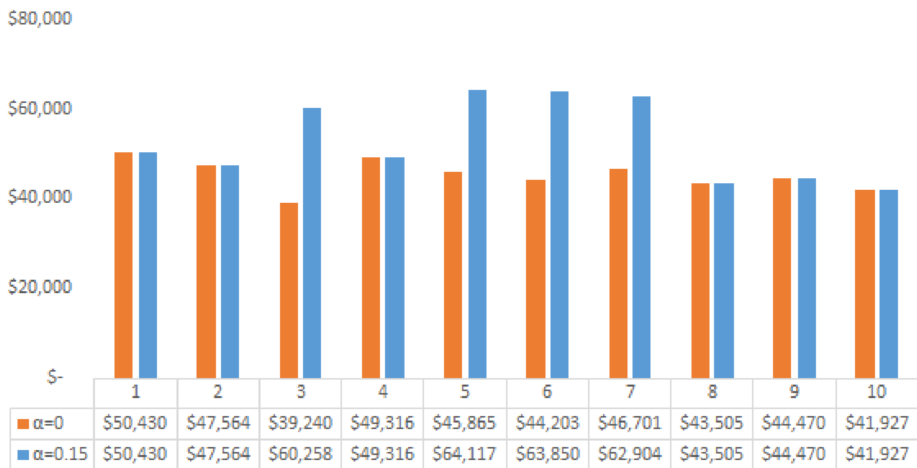
4.3 Flexibility versus prescription: a standardized comparison

Table 5: Flexibility versus prescription: Ranking of the retirement income portfolios for different income categories and bequest considerations.

		Australian							Dutch		
Income category	Bequest	1	2	3	4	5	6	7	8	9	10
Q10	No	1	3	7	2	5	6	4	9	8	10
Q50	No	1	3	10	2	5	7	4	8	6	9
Q90	No	1	3	10	2	5	8	4	7	6	9
Q10	Yes	5	7	3	6	1	2	4	9	8	10
Q50	Yes	5	7	4	6	1	2	3	9	8	10
Q90	Yes	5	7	4	6	2	3	1	9	8	10

Notes: The ranking is shown from 1 to 10 where 1 indicates the most preferred and 10 the least preferred.

Figure 8: Flexibility versus prescription: Certainty Equivalent Consumption with (blue) and without a bequest (orange) for the median wage, risk aversion coefficient of 5 and with state pension.



Notes: Note that the Australian state pension is means-tested as explained in Subsection 2.5 and that the second pillar accrues rights on the full wage. On the other hand, in The Netherlands the state pension is paid to everyone and the second pillar accrues rights on top of the state pension threshold.

We investigate the welfare implications of choosing between the flexible and the prescribed setting for a stylized Australian individual with median yearly earnings. We assume that she has the choice between a means-tested state pension combined with an array of portfolios offering longevity protection and flexibility (flexible Australian setting) and a state pension which is not means-tested and accrues rights on top of a threshold (prescribed Dutch setting). By doing this we can assess the effect of the two institutional settings on the same individual. The choice of portfolios is then increased from 7 to 10 different, where portfolio 8, 9 and 10 correspond to the Dutch portfolios 1, 2 and 3 from Table 2 respectively.

Table 5 presents the ranking of the retirement income portfolios for different income categories and bequest considerations. In presence of bequest, the additional choice offered to the individual does not affect the ranking of portfolios. Indeed, the 'high-low', indexed annuity and 'low-high' arrangement score as 8, 9 and 10 respectively, where 10 indicates the least preferred portfolio. However, in the absence of a bequest the 'high-low' product scores as the top 6 product for the median and high income quantile, just after portfolio 5 with 50% in a nominal annuity and 50% on phased withdrawal. However, the ranking for lowest income quantile is not affected and it is still best-off with the array of products offered in the flexible Australian setting.

The keen observer observes in Figure 8 that portfolio 5 and 6 have a comparable CEC to the 'high-low' arrangement for an individual with median earnings. This aligns with the results from van Ewijk et al. (2017). They found that the welfare of a 'high-low' pension is equivalent to taking an initial 10% lump-sum. Here we observe that a 'high-low' pension lies between a portfolio with 50% nominal annuity and 50% phased withdrawal, and a portfolio with a third in a nominal annuity, indexed annuity and phased withdrawal product.

Note as well that the portfolio 2, paying an indexed annuity, has a higher CEC than portfolio 8, which pays an indexed annuity as well. In the first one, the annuity is based on the accumulated wealth and an annuity factor whereas the latter is based on a defined benefit formula which accrues pension rights on top of the state pension threshold. Interestingly, a means-tested pension combined with an actuarially fair indexed annuity ranks higher than the defined benefit formula based on an average career and a 75% replacement rate.

The results in Table 5 confirm that a highly prescribed institutional setting, such as the Dutch one mandating longevity protection by law, is welfare enhancing when the bequest motive is not considered. Indeed, products offering longevity protection score higher than those including equity exposure and flexibility in both the flexible and prescribed setting.

5 Sensitivity analysis

5.1 Sensitivity to individual characteristics: risk attitude and bequest motive

We analyze the effect of the risk aversion γ and bequest α coefficient in the CEC for three income categories. First we analyze the effect of the risk aversion coefficient. Figure 9 shows a mixed effect of an increasing γ. It decreases the CEC for portfolios with longevity protection (portfolio 1, 2 and 4) and increases it for the portfolio 3 invested solely in a phased withdrawal product. Due to this opposite effect the portfolios combining longevity protection and flexibility do not have a monotonic relationship with the risk aversion coefficient. For instance, portfolio 7 with a third invested in each product has a lower CEC for the highest risk aversion coefficient considered compared to the lowest risk aversion coefficient.

From a welfare viewpoint this contradictory relationship can be explained as follows: we are willing to receive less, or alternatively pay a higher price, for a retirement product guaranteeing an income stream during retirement the more risk averse we are. On the other hand, the phased withdrawal product enhances welfare in the presence of a bequest but is objectively a riskier product since it does not offer a lifelong payment and has equity exposure. In this context, the

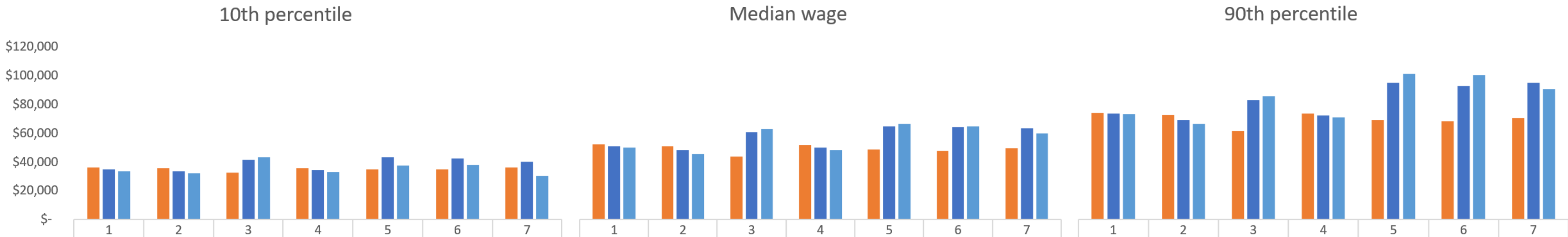
Table 6: Sensitivity to the risk aversion and bequest coefficient: Ranking of retirement income portfolios in Australia with state pension for different income categories, risk aversion and bequest coefficients.

		Portfolios for $\alpha = 0.15$								Portfolios for $\gamma = 5$						
Income	γ	1	2	3	4	5	6	7	α	1	2	3	4	5	6	7
Q10	2	2	4	7	3	5	6	1	0	1	3	7	2	5	6	4
Q50	2	1	3	7	2	5	6	4	0	1	3	7	2	5	6	4
Q90	2	1	3	7	2	5	6	4	0	1	3	7	2	5	6	4
Q10	5	5	7	3	6	1	2	4	0.5	5	7	2	6	1	3	4
Q50	5	5	7	4	6	1	2	3	0.5	5	7	4	6	2	1	3
Q90	5	5	7	4	6	2	3	1	0.5	5	7	4	6	2	1	3
Q10	8	4	6	1	5	3	2	7	1	5	7	1	6	2	3	4
Q50	8	5	7	3	6	1	2	4	1	5	7	3	6	2	1	4
Q90	8	5	7	4	6	1	2	3	1	5	7	4	6	2	1	3

*Notes:*The ranking is shown from 1 to 7 where 1 indicates the most preferred and 7 the least preferred for Australia. The first half of the table presents the ranking of retirement income portfolios for Australia when the bequest coefficient is set equal to $\alpha = 0.15$ for varying risk aversion coefficients. The second half of the table fixes a risk aversion coefficient of $\gamma = 5$ and analyzes the effect an increasing bequest coefficient α for different income categories.

Figure 9: Sensitivity to the risk aversion and bequest coefficient: CEC for Australia with state pension. The upper panel assumes a bequest motive of $\alpha = 0.15$ for the risk aversion coefficient 2 (orange), 5 (blue) and 8 (light blue). The lower panel assumes a risk aversion coefficient of 5 for the bequest motive coefficients $\alpha = 0$ (orange), $\alpha = 0.5$ (blue) and $\alpha = 1$ (light blue).

Risk aversion coefficient



10th percentile	1	2	3	4	5	6	7
γ=2	$35,765	$35,419	$32,337	$35,613	$34,637	$34,428	$35,860
γ=5	$34,394	$33,411	$41,357	$33,944	$42,792	$42,083	$40,045
γ=8	$33,312	$31,923	$43,159	$32,664	$37,057	$37,550	$30,004

Median wage	1	2	3	4	5	6	7
γ=2	$51,613	$50,603	$43,319	$51,242	$48,068	$47,380	$49,070
γ=5	$50,430	$47,564	$60,258	$49,316	$64,117	$63,850	$62,904
γ=8	$49,416	$45,258	$62,467	$47,741	$65,947	$64,128	$59,264

90th percentile	1	2	3	4	5	6	7
γ=2	$85,534	$84,327	$71,008	$85,453	$79,879	$78,814	$81,692
γ=5	$84,965	$80,067	$96,018	$83,645	$110,101	$107,516	$110,125
γ=8	$84,474	$76,997	$99,309	$82,167	$117,194	$116,062	$104,661

Bequest coefficient

10th percentile	1	2	3	4	5	6	7
α=0	$34,394	$33,411	$30,439	$33,944	$32,740	$32,218	$33,052
α=0.5	$34,394	$33,411	$44,772	$33,944	$44,865	$44,674	$39,500
α=1	$34,394	$33,411	$47,075	$33,944	$46,136	$46,057	$39,382

Median wage	1	2	3	4	5	6	7
α=0	$50,430	$47,564	$39,240	$49,316	$45,865	$44,203	$46,701
α=0.5	$50,430	$47,564	$66,181	$49,316	$71,680	$71,886	$68,228
α=1	$50,430	$47,564	$70,879	$49,316	$76,228	$76,690	$70,232

90th percentile	1	2	3	4	5	6	7
α=0	$84,965	$80,067	$62,760	$83,645	$76,560	$73,542	$78,531
α=0.5	$84,965	$80,067	$106,739	$83,645	$122,956	$123,417	$119,737
α=1	$84,965	$80,067	$115,587	$83,645	$133,425	$133,880	$124,255

individual needs a higher equivalent yearly payment the more risk averse she is in order to offset the increased risk exposure.

The first half of Table 6 shows the ranking of retirement income portfolios for varying risk aversion coefficients. The ranking of the lowest income category is the most sensitive to λ. The individual in this category is assumed to live less long than expected. Therefore, they should be less well off with an annuity since these are assumed fairly priced with the average life table. However, we observe in Table 6 that a risk seeking individual ($\gamma = 2$) prefers 2/3 in longevity protection and 1/3 in phased withdrawals and is less well-off with the full phased withdrawal, while the most risk averse ($\gamma = 8$) has the opposite preference, namely she is best off with the phased withdrawal product and the least with the 2/3 in longevity protection. The highest the risk seeking behavior, that is, the lower the risk aversion coefficient, the most positive attitude the individual has towards longevity risk. They assume that they live longer than expected and gain more from the markets than the average. Therefore, they would rather have a higher exposure to longevity insurance since they may have the belief that they outperform their peers in terms of life expectancy. Similarly, the more risk averse the lower the individual's belief to gain from longevity and would therefore prefer the full flexibility of the phased withdrawal to complement their state pension.

The other two income categories have similar preferences as in Table 6. They increase their exposure to phased withdrawals with risk aversion. The increasing risk aversion increases the relative weight of later cash flows, which are higher due to two reasons. First, since the individuals live either the same as the life table (median income) or longer (high income), the probability-weighted cash-flow increases. Second, the reduced phased withdrawal capital at later ages will increase the means-tested age pension.

The relationship between the income portfolio preferences and bequest is more straightforward. Recall that the difference between the CEC with bequest and without can be interpreted as the individual's subjective price to give up the flexibility and possibility to a bequest. Therefore, it is clear that for the portfolios with a positive phased withdrawal exposure this price increases with α representing the desire for a bequest. In particular, for the individual earning the median income and choosing the portfolio 3, the value to give up a desire to bequeath of $\alpha = 1$, which corresponds to drawing the same relative utility from life insurance than to survival contingent income, amounts to \$31,639, almost 100% of the CEC without bequest.

In regards to the ranking of portfolios, we observe in the second half of Table 6 that the higher the bequest motive, for the same risk aversion coefficient, the higher the percentage invested in phased withdrawals. The contrast is more stark for the lowest income quantile which goes from being best off with a nominal annuity in the absence of a bequest to a portfolio fully invested in phased withdrawal for the highest bequest motive. For the other two income categories the same trend holds. However, the individuals in these categories would be best off with a maximum of 50% invested in phased withdrawal (portfolio 6). It follows from the higher life expectancy in average that they should still have exposure to annuities since they are priced to their advantage, that is, the annuity is priced based on the average life table while the highest income will live 13% longer than that in average.

5.2 Sensitivity to the pricing of the annuity: mortality differentials, loadings and timing

The analysis performed in this section is for the median income category and a risk aversion coefficient of $\gamma = 5$. The graphics in Figure 10 depict the effect of the mortality differentials and loadings in the presence of a state pension (means-tested for the case of Australia) and without bequest, that is, $\alpha = 0$. While the ranking of the portfolios will vary for different bequest and state pension assumptions, the overall trend remains the same for all mortality differentials.

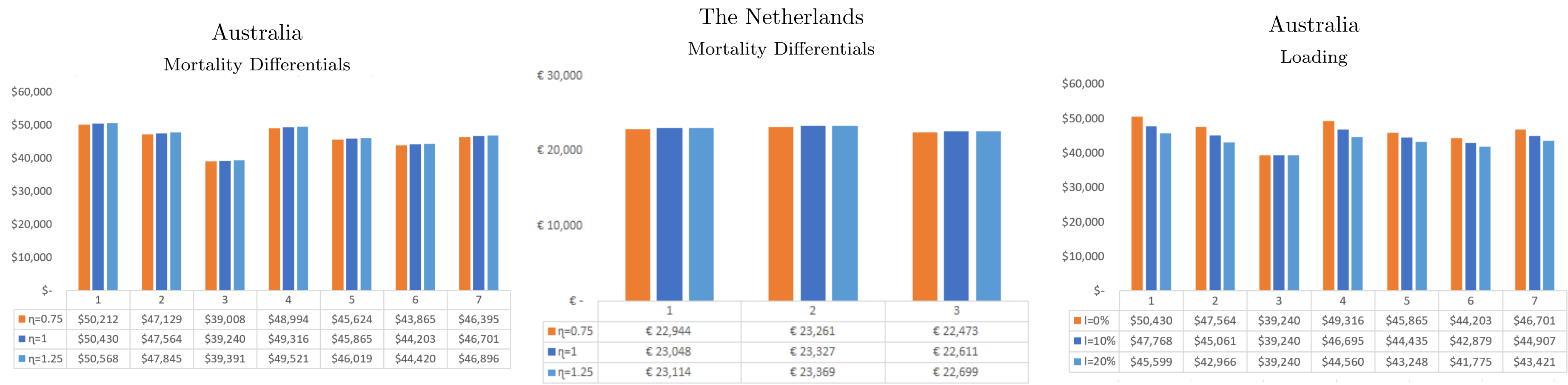
The first two graphics in Figure 10 show the effect of mortality differentials in the CEC. We observe that the CEC increases with the mortality differentials η, that is, the lower value of the CEC is found when individuals live on average 25% less than the average individual in the economy and the highest value is found when individuals live on average 25% longer than the average individual. However, the difference between the CEC are small both in Australia and The Netherlands. This is because the individual is expected to live longer than what has been allowed for in the life table used in the pricing of the annuity. This corresponds to a higher welfare since they receive payments for a longer period than expected.

The last graphic in Figure 10 shows the effect of loadings in the welfare of individuals for the case of Australia[12]. Fixed nominal and indexed annuities are commonly affected by loadings which increase the value of the annuity factor used to transform the pension wealth into a regular payment stream. These loadings are used to finance non-hedgeable risks such as idiosyncratic and systematic longevity risk. We observe that the loadings do not affect the phased withdrawal product by their pricing construction. Therefore, the effect of adding loadings to the annuities will be lower for portfolios combining phased withdrawal and annuities. For annuity-only portfolios we observe that the CEC decreases with the loadings. In fact, considering a loading of $l = 20\%$ decreases the CEC of the first two portfolios by \$5,000 nominally on a yearly basis.

Since the effect of the mortality differential is equivalent for all products, we observe that the mortality differentials do not affect the ranking of portfolios. In fact, the ranking is more sensitive to the presence or absence of bequests, state pension or loadings as in Table 7. In fact, when the individual does not have a bequest motive, $\alpha = 0$, the most and least preferred portfolio remains the same for all mortality differentials and loadings. Despite the presence of loadings the individual is best off with a nominal annuity and worst off with a pure phased withdrawal product. However, the indexed annuity becomes less favorable for increasing loadings. For instance, a loading of 20% drives the indexed annuity from the 3^{rd} to the 5^{th} place and puts portfolio 7 with a 1/3 in phased withdrawal to the third place. There are two reasons why the indexed annuity is less popular that the nominal annuity. First, the utility structure favours the cash-flows received earlier during retirement which increases the utility of a nominal annuity. Secondly, a loading of the same relative size will have a higher effect in the indexed annuity factor since the factor is already higher than the nominal.

[12]We do not consider the effect of loadings in The Netherlands since we assume that Defined Benefit pensions are paid out.

Figure 10: Sensitivity to the pricing assumptions: CEC for Australia and The Netherlands in the absence of a bequest for the median income category.



Notes: The first two graphs show the evolution of the portfolios in Australia and The Netherlands when accounting for mortality differentials. The third graph shows the evolution of the *CEC* for Australians in the median income category for different loadings on the annuities.

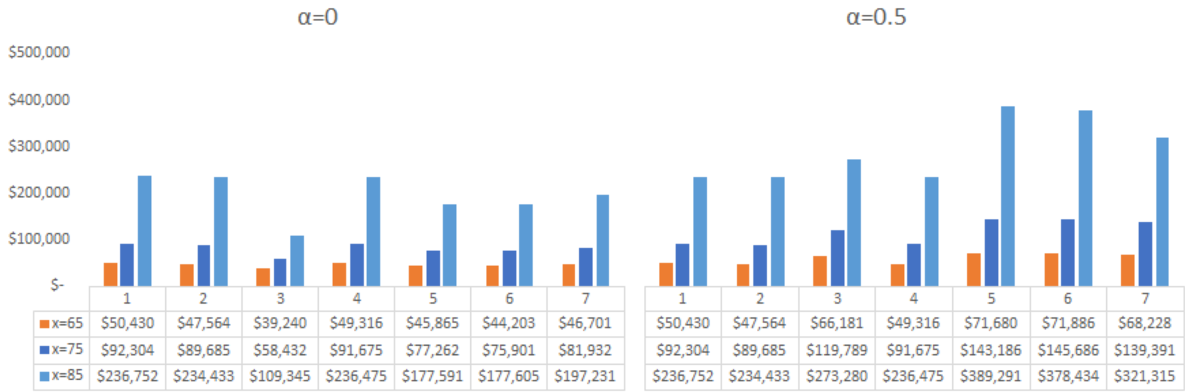
Table 7: Sensitivity to the pricing assumptions: Ranking of retirement income portfolios for different state pension, bequest and loading combination for the median income category.

			AU							NL		
State Pension	Bequest (α)	Loading (l)	1	2	3	4	5	6	7	1	2	3
No, Yes	No	0%	1	3	7	2	5	6	4	2	1	3
No, Yes	No	20%	1	5	7	2	4	6	3			
No	Yes	0%	5	7	4	6	2	3	1			
Yes	Yes	0%	5	7	4	6	1	2	3			
No	Yes	20%	5	7	4	6	2	3	1			
Yes	Yes	20%	5	7	3	6	1	4	2			

Notes: The ranking is shown from 1 to 7 where 1 indicates the most preferred and 7 the least preferred for Australia and 3 is the least preferred for the Netherlands. The ranking presented assumes a bequest coefficient of $\alpha = 0.15$ for the analysis in the presence of a bequest. Furthermore, it makes usage of the median income category. The impact of the mortality differentials and loadings is very similar for the other two income quantiles.

Accounting for a bequest, Table 7, turns the ranking upside down as in the previous analysis: portfolios with exposure to phased withdrawals will score among the top 3 (portfolio 5, 6 and 7), while the three portfolios on annuities (portfolio 1, 2 and 4) will go to the bottom 3. However, the best product for the individual in scope will vary depending on the loading and whether we have state pension or not. The most preferred without state pension is portfolio 7 with 33% nominal annuity, 33% indexed annuity and 33% in phased withdrawal. Including a state pension shifts the preference to portfolio 5 with 50% nominal and 50% phased withdrawal. In this case the the desire to be protected from inflation is covered by the state pension and drives the private indexed annuity out of the market. Finally, we observe that for the highest loading the preference for portfolios with indexed annuities decrease to favour portfolios with phased withdrawal.

Figure 11: Certainty Equivalent Consumption for Australia for different purchase ages and a risk aversion coefficient of 5.



In order to estimate the effect of delaying the purchase of the product portfolio, we assume that if the purchase is after the retirement age of 65 the individuals receive the means-tested state pension and that they draw their wealth down to consume $24,108, which according to ASFA (2016) is the amount corresponding to a modest lifestyle of a single individual owning the house they live in. Figure 11 shows that the CEC increases with the age of purchase. This follows from the definition of Equation (4.1). The higher the age, the shorter the remaining lifetime and therefore the higher the annuities will be. The effect is larger whenever the individual has a bequest motive since the portfolio has to compensate for the lower expected lifetime and the desire to leave a bequest which will have a higher relative value at higher ages since death is more probable. Overall, the ranking of portfolios is not substantially affected by the timing of the purchase.

6 Conclusion

This paper has assessed portfolios of retirement income products for the Australian and Dutch retirement systems allowing for income levels and a range of factors that are expected to impact the comparison. First, we have assessed the impact of means-testing the first pillar pension on the welfare of representative Australians from three income categories. The state pension meets its purpose by increasing the welfare of lower socio-economic categories. Furthermore, we observe that for all income categories the state pension reduces the demand for indexed annuities since it is an inflation linked payment. Dutch households are best off purchasing a 'high-low' pension arrangement which provides a higher pension during the first five years of retirement. We show that a flat state pension with 'high-low' pension is comparable in terms of CEC to a portfolio evenly split between nominal annuity and phased withdrawal on top of a means-tested indexed pension. The 'high-low' arrangement provides a similar welfare as investing a share of their income in a flexible phased withdrawal product.

Mortality differentials impact the CEC and ranking of products, especially in the presence of a bequest. Surprisingly, the effect of these differentials on the ranking of retirement income portfolios is limited. The choices at retirement are mostly affected by the bequest motive and the presence of loadings in the pricing of annuities. In the absence of a bequest, products which offer longevity protection are preferred in all scenarios in line with the seminal work of Yaari (1965). On the other hand, individuals with a bequest motive prefer portfolios with exposure to liquidity and flexibility by increasing the proportion to phased withdrawals. However, for some risk and bequest preferences we observe that the highest income quantile would be better off with a portfolio combining phased withdrawals and annuities, even in the presence of a means-tested pension. This is due to the low state pension received after means-testing and the fact that they are assumed to live longer on average than what is implied by the pricing life table, benefiting more from a fairly priced annuity. Finally, loadings affect the portfolios by reducing the exposure to indexed annuities. However, this decrease is not sufficient to favour products without loadings, such as phased withdrawal products, in the absence of a bequest motive.

From a policy perspective we conclude that the Dutch institutional setting would be the most cost-effective in providing welfare and simplifying the portfolio choice. Individuals would be better off with products offering longevity protection in the absence of a bequest. However, once that bequest is accounted for the Australian setting provides alternatives that increase the welfare of individuals. A choice limited to longevity protection products could lead to a CEC loss of \$20,000 yearly for individuals with a bequest motive.

Our approach assumes that individuals consume the full payout associated with their retirement income products. Wu et al. (2015) analyze eight years of Centrelink data[13] and show that consumption stays low on average, even among the wealthier individuals who receive a full or partial state pension payment. In particular they show that poorer retirees appear to consume even less than the first pillar state pension payment. Similarly, Van Ooijen et al. (2015) find that elderly Dutch on average keep large amounts of assets even at a very old age, leaving large bequests. Taking into account the optimal consumption during retirement is an area for future research.

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[13]Centrelink is the Australian government agency which delivers a range of social security government payments.

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