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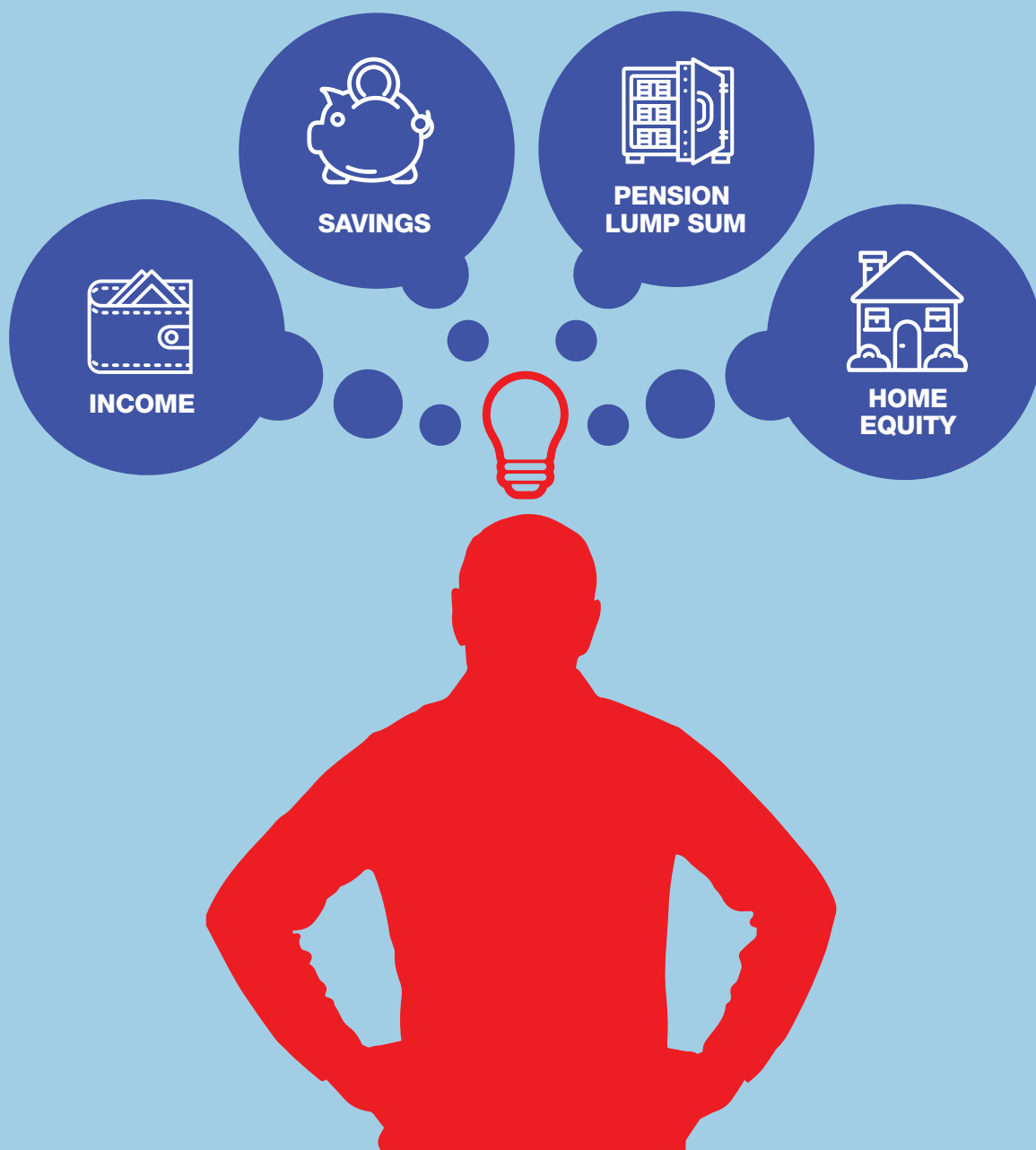
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# Flexible and affordable methods of paying for long term care insurance

Les Mayhew, Ben Rickayzen and David Smith

lesmayhew@googlemail.com

Cass Business School, Faculty of Actuarial Science and Insurance, City University London | **January 2017**



The International Longevity Centre – UK (ILC-UK) is a futures organisation focussed on some of the biggest challenges facing Government and society in the context of demographic change.

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ILC–UK  
11 Tufton Street  
London  
SW1P 3QB

Tel: +44 (0) 20 7340 0440

[www.ilcuk.org.uk](http://www.ilcuk.org.uk)

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## Note on the authors

**Professor Les Mayhew** is based at Cass Business School in the Faculty of Actuarial Science and Insurance. He is a long term associate of ILC-UK and has produced many research papers on topics ranging from inequalities in adult lifespan, to longevity, pensions, paying for social care and housing wealth. He is an Honorary Fellow of the Institute and Faculty of Actuaries and a member of the Royal Economic Society. He is a former senior civil servant and member of the Office for National Statistics expert panel that advises on population projections. His research interests include health, pensions, and health and social care, for which he has received various research grants and is twice a winner of the Cass research prize'.

**Professor Ben Rickayzen** is a Professor of Actuarial Science and has been Head of the Faculty of Actuarial Science and Insurance at Cass Business School since January 2008. His research interests include health and social care, with a particular emphasis on long-term care for the elderly. He has received ESRC, EPSRC and Institute and Faculty of Actuaries' grants to support his work. He began his career at the actuarial consultancy, Bacon & Woodrow (now part of Aon), and qualified as a Fellow of the Institute of Actuaries in 1990.

**David Smith** is a Senior Lecturer in Actuarial Science in the Faculty of Actuarial Science and Insurance, Cass Business School, where he is Course Director of the BSc (Hons) Actuarial Science degree. He has carried out a great deal of research with Professor Les Mayhew in developing new methods of projecting populations as well as investigating new ways that the increasing costs of pensions and long-term care in the UK could be funded. He completed the Institute of Actuaries' examinations in 2002.

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# Foreword

In 1911, the average life expectancy for a man was 51.5 years. In 2011 it was 79, and between the period 2012-2014, men in England and Wales who reached the age of 65 could expect to live for a further 19 years. There have also been significant increases in the number of the 'oldest old' in the UK. In 1971, there were just 126,701 people aged over 90. By 2012 this had risen to 513,449; by 2027, this number is predicted to rise to over 1 million.

The dramatic increases in average life expectancies witnessed throughout the 20<sup>th</sup>, and early 21<sup>st</sup> centuries are one of our society's greatest achievements, and should rightly be celebrated. However, whilst we are living longer, we are also spending a greater proportion of our lives in ill health.

As of 2014, men are likely to spend nearly a fifth, and women more than a fifth, of their lives in ill health, requiring specialist care or additional assistance to engage in activities of daily living. At the same time, approximately 1.86 million people in England alone, or 1 in 10 of those over the age of 50, had unmet care needs.

Spending such a large proportion of one's life in need of specialist care is difficult to comprehend, not least because any resulting anxiety could be exacerbated by the lack of long-term care insurance products currently available.

This report will surely be welcomed by insurance providers and public policy experts as we all consider how best to engage and serve a rapidly ageing population with diverse asset/wealth holdings. Through exploring flexible approaches to funding long-term care insurance which account for the many ways in which individuals might fund long-term care, we might yet be able to provide long-term care funding solutions which preserve quality of life both now and in the future.

## **Baroness Sally Greengross OBE**

Chief Executive, International Longevity Centre – UK

Co-President, International Longevity Centre Global Alliance

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# Executive Summary

With the dramatic increase expected in the number of older people requiring care, and the tightening of public funding, individuals will be increasingly expected to contribute to and plan for their own care in later life. However, history shows us that people are very reluctant to save for their care to the extent that there are no longer any providers of pre-funded long-term care insurance products in the UK to help address this problem. In this paper, we consider a product which is a disability-linked annuity that provides benefit payments towards the cost of both domiciliary and residential nursing care. We investigate different ways in which individuals can purchase this product with the goal of minimising the impact on their living standards, hence making the purchase of the product more palatable. As well as the traditional methods of purchasing insurance out of income and savings, this product can also be purchased by making use of assets such as residential property. This flexibility would allow individuals to have control over the timing of their payments to fit around their lifestyle. Some people will be more attracted to particular payment methods than others and a framework is presented which segments people according to individual circumstances. A model is developed showing how the annuity works and how premiums are calculated.

**Key words: Population ageing – long-term care – disability linked annuities – payment methods – market segmentation**

# Flexible and affordable methods of paying for long-term care insurance

## 1. Introduction

With the dramatic increase expected in the number of older people requiring care, and the tightening of public funding, individuals will be increasingly expected to contribute to and plan for their own care in later life (Colombo et al 2011; Wittenberg et al 2008; Pickard et al 2007; Karlsson et al, 2006). In England and Wales, for example, the population aged 75+ will increase from 4.65m to 10.4m between now and 2050, opening up the potential for massive increases in care provision whether State or privately funded (Appleby, 2013).

How to pay for long-term care is, and has been, a hot topic in the insurance world and in government circles (Mayhew 2017; Kings Fund 2014; Dilnot Commission 2011; Wanless 2006; HMSO 1999). Local authority social care budgets continue to be squeezed and the thresholds for receiving State support have been tightened. The result is that fewer people will receive State support than previously, and more people will be forced to pay for their own care (see SCIE 2015 for more information and definitions). However, history shows us that people are very reluctant to save for their care to the extent that there are no longer any providers of pre-funded long-term care insurance products in the UK to help address this problem (Mayhew et al 2010; Karlsson et al 2006; Poole 2006).

Theories abound about why this is the case but two of the most important are that the product is relatively expensive and, secondly, people have an 'optimism bias'. That is they do not believe it will affect them even though roughly a quarter will require long-term care at some point in their lives.<sup>1</sup> Another important reason is that many believe that the State will pay for their social care just as it provides health care free of charge at the point of use. In the UK, social care is means tested which means that to qualify for State financial support an individual's income must be less than the care tariff and that their assets must be worth less than £23,250.<sup>2</sup> The fact that many people do receive State funded care probably reinforces the belief that it is free so that there is no need 'to take action'.

The problem is that it is hard for an individual to know if they will qualify for State support in advance of needing it, and secondly if they do make a conscious decision to save, then State support will be withdrawn by £1 for every extra £1 of income. As a broad rule of thumb, if the value of the benefits plus income approximately equals the care costs that an individual will experience in the future then their assets should be fully protected; if it is less than future care costs then they will only be partially protected and the individual may eventually end up receiving State support anyway if they remain in care for long enough. This becomes more likely the greater the difference between the benefits received, the care costs experienced and the generosity of the means test itself at the time of need.

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<sup>1</sup> Unlocking the Potential, DEMOS, 2014: - [http://www.demos.co.uk/files/Unlocking\\_potential\\_-\\_web.pdf?1393180449](http://www.demos.co.uk/files/Unlocking_potential_-_web.pdf?1393180449)

<sup>2</sup> Income is defined as personal income plus imputed income from assets less a personal allowance of £24.40 per week (see Mayhew 2017 for further details).



However, this paper is not concerned with means testing as such but it flags up the fact that changes to means testing will be needed to make providing for long-term care more attractive to a greater number of people. While this is a necessary condition, in addition, suitable products in terms of both their cost and the benefits they provide must become available (see Mayhew 2017, which proposes changes to means testing arrangements).

The main objective of this paper is to investigate the different ways in which individuals can purchase a long-term care insurance product with the goal of minimising the impact on their living standards. As well as the traditional methods of purchasing insurance out of income and savings, we also consider how the product can be purchased through the use of assets such as residential property. This flexibility would allow individuals to have control over the timing of their payments to fit around their lifestyle and bequest motives (Mayhew et al 2016). To achieve this, we decided to focus on one particular type of insurance product, a disability-linked annuity, as we believe that this has significant advantages over the traditional indemnity product.

It is also useful, and may be essential, if there are financial inducements that apply to the policies on offer. Examples could include tax relief on the premiums or the benefits, disregards for means testing purposes or reductions in exposure to inheritance tax liability on death. We make this point because buying this kind of insurance is always going to be a 'hard sell' based on what we know about previous failed attempts to launch products of this kind in the UK. However, a full discussion of how inducements such as tax breaks could operate or how changes could be made to means testing to improve the marketability of the product is beyond the scope of this paper.

## **1.1 Benefits payable**

Rickayzen (2007) proposed a product which he called a "disability linked annuity". This is a standard whole life annuity but with the benefit received increasing if the person becomes disabled. He considered two levels of annuity enhancement which would depend on the severity of disability (i.e. "moderate" or "severe"). Therefore, the annuity increased to help meet the higher living costs due to care needs. A similar product, known as a "care annuity", has been considered in the US (Brown & Warshawsky 2013; Warshawsky 2012; Murtaugh et al 2001).

The product considered in this paper is a variation on the disability linked annuity in that no annuity payments are made while the policyholder is "healthy" (i.e. they are not in either a "moderate" or "severe" states of disability) - see Kenny (2017). Determinants of the policyholder's state of health could, for example, be linked to the failures of a set number of Activities of Daily Living (ADLs), such as being unable to dress or feed oneself. The "moderate" state could therefore equate to the policyholder requiring care at home, whereas the "severe" state could equate to the policyholder needing nursing or residential care. The benefit amounts will thus be designed to approximately cover the associated costs.

The reason we have chosen to design a product which pays no annuity benefits while the policyholder is in good health is that this minimises the cost of the product by only focusing on the care cost needs.

Having described the benefits which the product provides, we are now in a position to compare different payment methods which could be used to purchase the annuity.

## 1.2 Payment methods evaluated

A key aspect of the research is to investigate and compare four different methods of payment for this product. These are:

- a one-off upfront lump sum premium;
- a regular monthly or annual premium which ceases if and when the benefits are triggered;
- a payment after death or entering long-term residential care using the value of the home upon sale: either (a) based on a percentage of the housing equity; or (b) at an agreed monetary amount.

For long-term care insurance, cover needs to be purchased on an individual basis. This is because, if joint policies were sold, then if one of the couple triggers the benefits the other life would lose their cover. Therefore, a couple would each need their own individual policy.

An issue arises if a couple want to use equity release to purchase their policies as the premium is paid when the policyholder enters care or dies which is problematic in the case where the spouse still needs to live in the home. This not only causes delay, but increases uncertainty for the insurer as to when they will receive the premium. For these reasons, we assume in our model that only people living alone are able to use equity release.

To model the benefits specified above, we consider the following four possible care pathways a person could embark upon. They could:

- (1) die before becoming disabled – no benefit paid
- (2) die whilst moderately disabled
- (3) die whilst severely disabled (having been previously moderately disabled)
- (4) die whilst severely disabled (having not previously been moderately disabled)

The rest of this paper is structured as follows: Section 2 provides more detail about the policy context from a consumer perspective; Section 3 identifies potential customers and considers 'willingness to pay'; Section 4 describes the model and Section 5 the results. Section 6 draws the conclusions together and suggests the next steps.

## 2. Policy background

There is no universally agreed way to pay for social care. Usually it is a partnership between the individual and the state in different measure. Examples range from universal insurance systems, such as exists in Germany, to co-funding solutions based on a mix of state, local and personal contributions (e.g. those found in Japan and Sweden). In the UK, care is heavily means tested where both assets and income are taken into account so that only the poorest qualify for state assistance. Proposed changes to the means test should lead to it becoming more generous, although not by very much. However, these changes have been postponed to at least 2020 and this opens up a window of opportunity for the government and personal finance industry to work together in the meantime.

The problem is that long-term care insurance has never properly functioned in the UK for a range of reasons. As noted earlier, one is that people incorrectly assume that the State will take care of them and, secondly, they are unaware of the huge costs that can accrue which could result in them having to sell the family home. Because the probability of needing long-term care at any time in one's life is still relatively small, many people are willing to take the chance rather than reducing their current standard of living, especially given the modest incomes of most pensioners.

One thorny issue is that all but the wealthiest face the conundrum that if they save for long-term care then a similar amount will be taken away by a reduction in state support. The population is also conflicted in others ways. For many, their most important asset is their home but this is an illiquid asset until it is sold. Such an upheaval at a late stage in life can be very uncomfortable unless it is done soon enough and planned in an orderly way rather than as a 'distress sale' which can happen.

However, attitudes appear to be slowly changing. A recent survey<sup>3</sup> found that nearly 50% of adults see their home as a key part of their retirement planning whilst one in three want to give money to a child or grandchild and 61% see it as part of their inheritance planning. More surprisingly, 56% of respondents recognise that some wealth would be needed to pay for care and therefore this may indicate that there would be demand for a suitable long-term care product. This paper argues that greater flexibility over the method of paying for long-term care protection could enable people to inject more certainty into their retirement plans while also protecting their inheritance.

Many older people are asset rich but income poor. This means that they may need to cut their standard of living to pay for long-term care insurance or use some of their tax free pension lump sum which they would rather have spent on something more enjoyable such as a cruise or a new car. If instead, they are able to use the value in their home, they may be able to purchase long-term care insurance without having to sell their home.

As previously mentioned, the product we propose is annuity based where the benefits would be triggered upon a needs assessment. Ideally it would be tied to the new State system introduced under the Care Act (2014). However, the traditional method of basing it on the loss of ADLs could also be considered. Benefits cover spells in domiciliary, residential care or both and would seamlessly move from one care setting to another, subject to the benefits being triggered in the ways suggested.

Since care costs vary considerably according to the level of care required, the charges levied by individual care providers to indemnify against these potential costs will generate large amounts of uncertainty. This would translate into large, unmarketable premiums which is why our proposed product provides an annuity which is of specified monetary amounts. Therefore, although our product only provides a contribution towards the actual costs, we believe that the policyholders would prefer the cheaper premiums and the guaranteed benefits i.e. the insurance company does not specify the care to which the policyholder is entitled.

The advantages are that, when taking out the policy, the individual can choose the levels of annuity that they wish to receive if they subsequently require care, and they can choose how to apply the annuity payments to suit their care needs best. The product itself could be bought at any age but,

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<sup>3</sup> Taken from the Actuarial Post: <http://www.actuarialpost.co.uk/news/retirees-desire-to-leave-inheritance-weakening-3697.htm>

for various reasons, most people would not commit until around retirement age when retirement planning becomes a key issue.

As noted in the introduction, the wider question of how the claim payments are treated under the means test rules is not considered. Suffice it to say that we favour the idea that the government should provide some reward to people who have made a conscious decision to save for their care. These rewards could include tax relief on premium payments as exists for pensions, or some of the income benefits could be disregarded for means testing purposes.

We begin our analysis by reviewing the distribution of income and assets in the population aged 65+ and the constraints they face in confronting the question of how to pay for possible care needs in later life. These include competing objectives such as preserving current living standards, gifting opportunities and maintaining liquid assets to meet any unforeseen future events.

### **3. Identification of potential markets**

Age 65 is currently considered to be the boundary between working age and pension age in the UK, although the distinction is becoming increasingly blurred following the elimination of the default retirement age and changes in state pension age.

Figure 1 is a contour map showing the distribution of wealth in the age 65+ population based on assets and income using data from ELSA.<sup>4</sup> Contours represent concentrations of the age 65+ population with different levels of income and capital.

By age 65, most of the current population will have retired and will have paid off their mortgages. Their incomes will generally be lower than in pre-retirement but will also be more certain. However, their circumstances may change if they work beyond 65, if they receive a windfall (e.g. through inheritance) or if they still have an outstanding mortgage.

It can be seen that income is concentrated in the £7,000 to £15,000 range, with a modal value of approximately £11,000 per annum. This is made up from a combination of the State pension, any private pension entitlement, plus other sources including welfare benefits.

The distribution of asset values shows a completely different pattern to income; it is bimodal (i.e. it has two peaks) and ranges from nothing to very substantial amounts (assets above £250,000 are not shown).<sup>5</sup> Two particular asset concentrations are observed – one, very dense, near the x-axis centred on incomes of £11,000 per annum with assets of under £25,000, and another, centred on the same income level, with assets of £100,000. The reason for these two centres of asset concentration is that the second peak consists mainly of home owners and the first peak does not.

It should be noted that the values of asset holdings are in respect of individuals rather than couples and so the value of jointly owned assets is assumed to be divided equally between the couple.

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<sup>4</sup> English Longitudinal Study of Ageing: <http://www.elsa-project.ac.uk/> (accessed 12 Feb 2014)

<sup>5</sup> Note that net negative assets are also possible e.g. as a result of outstanding mortgage debt, although this is a relatively rare occurrence.

Figure 1 schematically divides the age 65+ population into four stylised groups. These are as follows:

- A: People with low to median incomes and relatively few savings. They do not have any property assets and could receive some means tested financial support such as help with housing costs or other benefits;
- B: People who do not own their own home but have a reasonable retirement income. They are able to set money aside each month but do not have large liquid savings;
- C: Home owners with median to high retirement incomes. They are the most likely to have sufficient liquid savings to draw upon if needed;
- D: Home owners with low to median retirement income. They may struggle with the cost of living (i.e. they are 'asset rich and income poor').

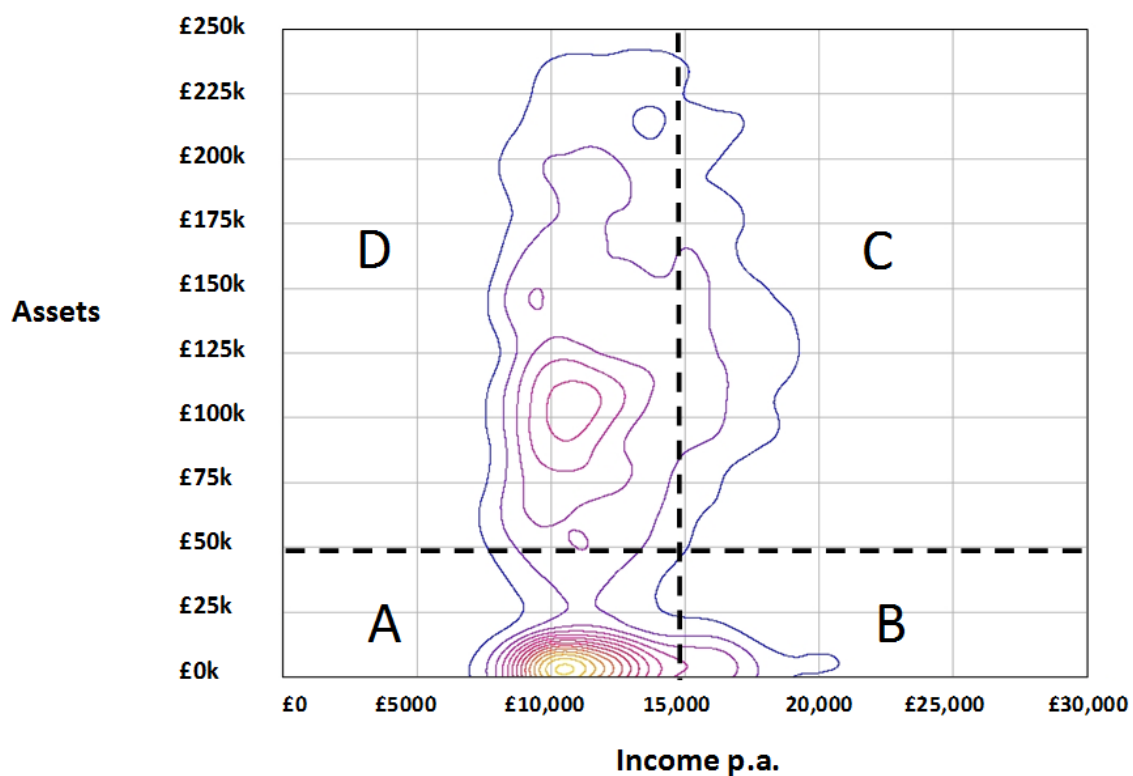


Figure 1: Wealth map of the age 65+ population with contours indicating concentrations of assets and income. For an explanation of the notation, see text.

Let us consider four retirement objectives that are important to people in retirement and how these might influence whether to purchase a long-term care policy. We further consider the most appropriate method to pay for the product.

These objectives, shown in the columns of Table 1, are to:

1. maintain a satisfactory standard of living, including paying household bills, having enough to eat and some money left over for leisure, holidays and family visits;
2. be able to gift money to close relatives such as children or grandchildren (e.g. to pay for education or a deposit on a home);
3. retain control over their finances to avoid becoming dependent on State financial aid, and ideally with no need to borrow;
4. reduce their exposure to inheritance tax so that as much of their estate remains and their legacy is protected.

For illustration we will assume that these objectives are common to all four groups but in different measure depending on their position on the income-asset spectrum. We will assume that members in each group are considering whether to protect themselves against the cost of long-term care and are analysing what their options are. Each individual is considering the same annuity based policy and is deciding whether to purchase cover and how best to pay for it. The options are:

- Do nothing - that is, decide not to purchase the product
- Purchase by a one-off upfront lump sum premium
- Purchase by regular monthly or annual premiums which cease if and when the product is triggered
- Purchase by a payment after death using the value of the home upon sale: either
  - (a) based on a percentage of the housing equity; or
  - (b) by means of a monetary loan secured against the house.

In both the latter cases, the debt would be settled on sale of the home or entry into care, depending on individual circumstances.

Group	Method of payment	No reduction in current standard of living	Gift opportunity	Less likely to fall back on the state if care needed	No or reduced exposure to IHT
A	Do nothing	✓	✓	✗	✓
B	Regular payments	✗	✗	✓	✓
C	Single premium	✗	✗	✓	✓
D	Housing equity	✓	✓	✓	✓

Table 1: Retirement objectives that condition responses as to whether to seek financial protection for care costs in later life. Key: ✓ more likely to apply; ✗ less likely to apply

We now consider each group's approach to paying for long-term care in response to their wealth and their retirement objectives:

**Group A:** People in Group A are those most likely to 'do nothing'. They are prepared to take the risk, hoping that they will never need long-term care before they die. They are on low to median incomes with assets less than £50,000. As they have low income and assets, they judge that the State will probably fund their care and may be aware that if they did save more then State support would be reduced. Since their assets are well below the threshold for inheritance tax purposes (currently £325,000) inheritance tax is not a consideration. If they do have savings, they would prefer to gift regularly in small amounts (e.g. to grandchildren) rather than risk having the savings affect the means test.

**Group B:** People in Group B have incomes that are higher than the median. Their savings are relatively modest and they are unlikely to own their own homes. Those people in Group B who have a high enough income will be able to pay a regular premium without unduly sacrificing their standard of living. On the other hand, a single premium payment could eat into their modest savings, reduce their gifting opportunities, and could also affect large purchases such as buying a new car or going on a cruise. Equity release is not an option in their case and nor is inheritance tax an issue.

**Group C:** People in Group C have similar incomes to those in Group B but are also more likely to own their own homes and have more savings. Of all the groups they have the greatest choice in terms of their preferred method of payment but they may decide that a single premium is best for them. This is because it secures their long-term care needs without taking the risk that adverse changes in their future personal circumstances could affect their ability to continue to pay regular premiums. However, there are some people with sufficient income and savings who may decide to take no action and so fall into the 'do nothing' camp because they believe they can self-fund if need be. The key point is that, by purchasing a policy by any of these methods, will protect the remaining estate from the risk of high care costs.

**Group D:** People in Group D are home owners on relatively low retirement incomes that range from low to median. Assuming they have few liquid savings they would not be able to afford either a single premium or to make regular payments without sacrificing their current standard of living. Therefore, the most logical way to purchase long-term care insurance is by utilising equity release. By ceding a proportion of their property, the rest is protected against the risk of depletion from the costs of long-term care, hence allowing it to be bequeathed. The equity that is released to pay for the policy will reduce the value of their estate. As a result, they would be less exposed to inheritance tax assuming the value of the estate is above the threshold. In these circumstances, and assuming inheritance tax is paid at 40%, the net cost to the estate is effectively only 60% of the premium. Purchasing an insurance policy will mean that the remaining assets would be protected for inheritance purposes.

To put a scale on the sizes of these groups, of the approximate 11.3m people aged 65+ in England, roughly 2.5m people fall into Group A, 0.9m in B, 3.6m in C and 4.3m in D.

### 3.1 Other factors affecting the choice of method of payment

As well as the points about assets and income described above, there are other factors that will affect the need for long-term insurance and the most suitable payment method. For the age 65+ population, one of the biggest determinants will be whether the individual has a spouse or not. If they do then the spouse will be a source of informal care which may reduce the need to purchase long-term care insurance. If the individual does want to purchase long-term insurance then having a spouse may prove problematic if equity release is going to be used. This is due to the additional risks to the insurance company that the spouse will remain in the house for a long time after the individual has entered a care home. Further complications would be the impact on income if the spouse dies. If the spouse's pension was the main source of income, and there is little or no survivor's pension attached, then this will lead to a dramatic fall in income. This is a particular concern if a regular premium is being used.

The other main additional factor to be considered is whether the individual has children. For individuals over age 65, we would assume that their children are independent adults and would therefore be another source of informal care which, again, will reduce the need for long-term care insurance. However, the risk with this arrangement will be that informal care may not be available when it is required due to changes in the circumstances of the adult children.

For the population under age 65, even more complications arise due to other financial conflicts such as raising young families, paying off mortgages and contributing to pension plans. This requires separate analysis to see whether there is any market in this age group. For the sake of brevity, we therefore focus the remainder of this paper on the product itself and the four groups defined above. We plan to publish further work on the suitability of different payment methods based on current and future life circumstances at a later date.

## 4. The annuity model

In this section, we develop the method for determining the premium for each of the payment methods described in Section 1.1. It draws on three previous publications by the authors which are Mayhew et al (2016), Mayhew and Smith (2014) and Rickayzen (2007).

To simplify the exposition, we base our results on single lives and assume that couples take out an individual policy for each life separately. In the case of equity release, we have not calculated the premium in respect of couples. This is because of the earlier mentioned complications in cases where the surviving partner remains in the home (see Section 1.1).

The product we are considering pays two levels of benefits based on the level of disability of the policyholder. We can generalise these annuity benefits as follows (noting that Z will be greater than Y):

- £Y per annum whilst person moderately disabled
- £Z per annum whilst person severely disabled
- [No payments made whilst person in good health]



The possible pathways of benefits are as follows. The person could die:

- (1) before becoming disabled – no benefit paid; or
- (2) whilst moderately disabled; or
- (3) whilst severely disabled (having been previously moderately disabled); or
- (4) whilst severely disabled (having not previously been moderately disabled).

We define the time spent in the various care states as follows:

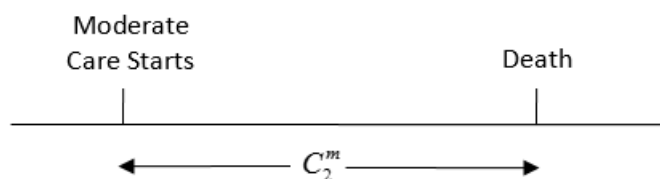
$C_2^m$  = length of time spent in moderate care under pathway 2

$C_3^m$  and  $C_3^s$  = length of time spent in moderate and severe care, respectively, under pathway 3

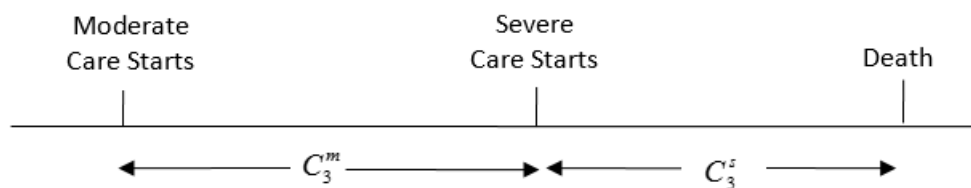
$C_4^s$  = length of time spent in severe care under pathway 4

Diagrammatically, pathways 2, 3 and 4 look as follows:

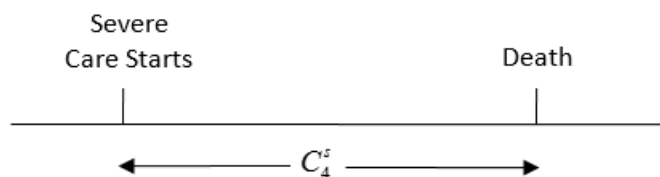
#### Pathway 2



#### Pathway 3



#### Pathway 4



The derivations of the premiums under the different payment methods are given in the appendix.

## 5. Illustrative examples of premium calculations

As discussed in Section 3, we believe that the optimal choice of paying for this long-term care product is based on balancing the many changing demands on people's assets and income rather than simply choosing the method which has the lowest present value of expected future premium payments. In fact, as seen in the calculations in the appendix, we are pricing this product on an "actuarial equivalence basis" so that each method is cost neutral if the pricing assumptions are borne out in practice. Of course, each individual will financially gain or lose depending on their own personal care journey. As far as the benefits are concerned, these are index linked and the term 'current value' refers to their value at today's prices.

However, to understand the financial feasibility of the various payment methods we need to calculate some examples of premium costs. For example, we need to know the size of the single premium to gauge whether the pension fund of an individual will be able to cover that cost without materially impacting negatively on their standard of living.

To calculate the premiums for the different payment methods, we use the following assumptions:

- Inflation = 2% per annum
- Investment return = 4% per annum
- House price inflation = 3.5% per annum
- Mortgage on home = 4.5% per annum
- Maximum age when premiums cease for capped version = 85
- Current value of benefit when cared for at home = £10,000 per annum
- Current value of benefit when in residential care = £25,000 per annum

Table 2 sets out the assumed percentages of people entering each of the four pathways and the assumed average lengths of time spent in each. Since there are no consistent data on which to draw, these assumptions are gleaned from various studies and discussions but they can be easily adjusted in the model which follows.

Care pathway	Percentage by pathway type	Time spent in care states (years)	
		Domiciliary	Residential
No care	70%	0	0
Domiciliary only	10%	4	0
Domiciliary and residential	10%	3	2
Residential only	10%	0	2

*Table 2: Parameters used for premium calculations*

### 5.1 Results

Table 3 shows the premium values for each method of payment based on the assumptions stated above. As can be seen, the premiums rise with age. In our pricing basis we assumed that, regardless of age at commencement of policy, 30% of people will need some form of care. However, the older policyholders will be expected to die sooner and hence will trigger their care benefits earlier. In addition, for policyholders paying by regular premiums, the older the policyholder,

the shorter the duration during which premiums will be paid. Both these factors will cause the calculated premiums to increase with age.

Age at commencement of policy	Regular premium (£ p.a.)	Capped premium (£ p.a.)	Single premium (£)	Equity Release <sup>6</sup>
50	508	525	9,298	10,923
55	597	625	10,109	11,621
60	713	760	10,958	12,335
65	869	952	11,831	13,052
70	1,087	1,249	12,706	13,753
75	1,400	1,773	13,546	14,409

*Table 3: Premium values for different payment options and ages*

The regular and capped premiums are calculated as annual payments with the capped premium, in this example, ceasing at age 85. As expected, the capped premium is always higher than the uncapped premium because, by definition, the average payment term for the capped premium will be lower than for the uncapped premium. It can be seen that the percentage difference between the two premiums increases with age (from 3.3% at age 50 to 26.6% at age 75). There are two main reasons for this, which can be demonstrated using an example.

Firstly, let us consider a 50 year old who dies at age 90. If they choose the capped version, they will pay premiums for 35 years whereas in the uncapped case they will pay for 40 years (i.e. a 14% increase in the premium term). By contrast, if this person purchased the contract at age 75 then the respective terms would be 10 and 15 years (i.e. a 50% increase in the premium term).

Secondly, using the same example, the extra payments for the 50 year old will be occurring 35 years after the date of purchase. The present value of these additional payments is therefore very small. In the case of the 75 year old, the additional payments are only 10 years away and the present value of these is therefore much more significant.

It should also be noted that the expected age at death of a 75 year old is higher than for a 50 year old. Therefore, the cap has the effect of removing the extra premiums from these additional years of life.

Turning our attention to the single premium column of Table 3, it can be seen that, at first glance, these amounts are significantly larger than the regular premiums at each age. However, as noted in Section 5, the premiums have been calculated on a cost neutral basis and hence they represent the expected present value of the regular premiums.

We can see that the single premium when expressed as a multiple of the regular premium decreases with age. For example, at age 50 the single premium is approximately 18 times the regular uncapped premium and this multiple falls to just under 10 for a 75 year old. This is due to the expected number of future regular premiums reducing as the policyholder's age at commencement increases.

<sup>6</sup> The number given in this column is used to calculate the percentage of the home that must be ceded in the equity release contract. For example, a 50 year old who owns a house worth £100,000 would need to cede 10.923% of the equity when purchasing the product.

The fourth column is the nominal amount that would be charged if the policyholder plans to use equity release in the form of ceding a percentage of the home. It therefore differs to the other columns as the amount is used purely to calculate the percentage of the property ceded. For example, Table 3 shows that a 65 year old needs to cede a current value of £13,052 to purchase the contract. Therefore, if they own a house worth £100,000 they would need to cede 13.052% of the equity when purchasing the product. If instead the house is worth £200,000 then they would need to cede 6.526% of the equity (i.e. half the previous percentage).

We can see that the amount that has been calculated in the equity release column is higher than the equivalent single premium. This stems from the fact that the values in the pricing basis assume that house price inflation will be below the rate of investment return. Since the insurance company will not be able to receive the premium until the policyholder moves into care or dies, the fact that the rate of increase in the house value is assumed to be below that of the investment return means that the initial nominal amount must be greater than the equivalent single premium. If instead we had assumed that house price inflation was greater than the expected rate of investment return then the nominal amount would be lower than the equivalent single premium.

An alternative approach to using the equity in the home to fund long-term care insurance would be to utilise a loan secured on the property. This loan would roll up at a specified rate of interest and would again be paid when the policyholder moves into a care home or dies. For pricing, if we assume that the loan would roll up at the same rate of interest as used in the pricing basis then the initial amount would be the same as the single premium. We therefore do not show these values in the table.

To reiterate, although the premiums are of differing amounts, they are all priced using the same mortality and morbidity assumptions and should therefore be considered cost neutral for comparison purposes. There is therefore no such thing as 'better value' among the different options at the time of purchase; instead, it is the impact that the cash flows would have on the person's living standards and/or bequest motives that will determine the most appropriate option.

The final option to consider is the "do nothing" option. Assuming that the long-term care product described in this paper is available, there are five main reasons why an individual might not purchase such cover:

- They feel that they cannot afford the premium without impacting unduly on their lifestyle or bequest motives
- They believe that their family will be able to cover most of the future care needs
- They believe that they have sufficient funds to cover the care costs
- They believe that they will never need care
- They have not considered the risk of needing long-term care in the future

## **5.2 The impact of care paths and payment method on future cash flows**

As discussed in Section 5.1, there are several payment options available to the policyholder which are all assumed to be cost neutral at the point of purchase. In pure financial terms, the realised present value of each payment method depends on the outcome of a number of different factors. Combining the various possible outcomes therefore creates an infinite number of scenarios which we could consider. However, for the sake of brevity, we will focus on a potential policyholder aged

65 and only analyse the factors in general rather than combining them. Broadly, the main three factors are as follows:

- Length of time before care is required or until death
- Duration of care
- Rate of house price inflation

### **5.2.1 Length of time before care is required or until death**

The length of time before care is required (or until death occurs) determines the duration for which regular premiums will be paid. We therefore have a relatively straightforward relationship between the length of duration and the optimum payment method (noting that equity release is more complicated and will be discussed separately).

If the duration is short then the optimum choice is the regular uncapped premium, followed by the capped premium and then the single premium. As the duration increases, the differences in the present value for the various methods narrows until the duration is close to the expected duration implied in the pricing basis. At this point the present value for each of the three payment methods will be approximately the same.

As the duration continues to increase, the order of the optimum choice of payment method reverses i.e. the order becomes single premium, capped premium and regular premium. At very long durations, the regular uncapped premium method becomes increasingly expensive when compared to the other two methods.

For equity release, it is the duration before going into a care home (or dying) which determines the cost in conjunction with house price inflation over this period.

### **5.2.2 Duration of care**

Assuming that insurance has been purchased, all the methods will produce the same value of benefits if care is required. If, however, insurance has not been purchased (i.e. the “do nothing” option) then the duration and level of care required is critical since the individual will have to pay for any care out of their income and savings. It should be noted that, for people on low income and assets, care is likely to be provided by the State and so the “do nothing” option is nearly always the most suitable.

Assuming that the individual does have sufficient assets to consider purchasing long-term care insurance at age 65, the impact that the duration of care has on the realised present value of the choice made is discussed below.

#### **5.2.2a Death occurs before care is required**

In this scenario, the “do nothing” option has the highest net present value (i.e. zero) as the cost of premiums has been saved and no benefits have been foregone.

### **5.2.2b Death occurs after a brief period of care**

Although some benefits have been foregone (i.e. the individual would have received some annuity payments from an insurance policy), “doing nothing” may still have been the best choice. It will depend on the benefits received (i.e. the level and duration of care) and also the duration of the policy before care was required (when comparing with the regular premium contracts).

### **5.2.2c Death occurs after a long period of care**

Having a long period of care will mean that the individual is almost certain to be worse off if they had not bought long-term care insurance compared to any of the purchase methods we have considered. In particular, an individual who had a sizeable estate before they entered care will have needed to fully self-fund their care costs and hence will have substantially depleted their assets.

In a worst case scenario they may have needed to downgrade their quality of care provision if they had exhausted their assets whilst still requiring care. Even if this point is not reached, their bequest motive will have been severely compromised.

It should be noted that the family could provide care; however, financially the family would still be worse off not buying insurance as the benefits would have been paid directly to the policyholder.

### **5.2.3 Rate of house price inflation**

From a purely financial point of view, whether the product should have been purchased using equity release or using cash is easy to determine. If house prices rose slower than was assumed in the pricing basis, then equity release would have been the better choice and vice versa.

However, in many circumstances where the pensioner is asset rich and income poor, the negative impact which paying a premium has on day to day living standards far outweighs any potential gains in terms of net present value from choosing a premium funding method compared to the equity release method. In other words, we should be focusing on the utility of deferring payment of the premium as the criterion used to determine the best choice rather than the financial net present values.

## 6. Conclusions

Past history has shown that the demand for long-term care insurance has been very low in the UK. This is due to the following factors:

- People's belief that the National Health Service (NHS) provides long-term care
- It is an unsavoury subject as people are unwilling to think of themselves as requiring long-term care
- The insurance premiums are perceived to be high
- People's belief that their family will be able to provide the care
- People's cynical view that insurance companies will not pay the benefits to which the policyholders are entitled

We believe that a combination of societal changes and the design of the payment methods and benefits of this product ameliorates the issues mentioned above as we now discuss.

### 6.1.1 People's belief that the NHS provides long-term care

Until quite recently, people in the UK have held the belief that their long-term care needs would be met by the NHS and have therefore seen no need to make provision for such care. As more and more people observe friends and family requiring long-term care, they become aware that it is not part of NHS provision and they witness the financial impact that the cost of care has on people's lives. Increasing media coverage of the issue has also brought it to people's attention. We therefore believe that there will be greater interest in purchasing long-term care insurance which protects against these financial risks.

### 6.1.2 An unsavoury subject

As people are happy to picture themselves enjoying a healthy active retirement, it is not difficult to encourage them to contribute towards their pension, even though the amount actually saved may be insufficient. However, people are unwilling to imagine themselves needing care at an older age. As buying insurance will crystallise the idea of them requiring care, they may either consciously or subconsciously avoid investigating potential products. Alternatively, they may simply dismiss the idea of ever reaching a point when they require care, particularly at a level which could not be provided informally.

### 6.1.3 The insurance premiums are perceived to be high

A problem with long-term care insurance is that the risk to the provider is far greater than the risk as perceived by the policyholder. Firstly, the latter's view on the probability of them needing care is substantially lower than it is in reality. Secondly, the policyholders do not take sufficient account of the uncertainty of changes in medical advances and care costs from the time when they take the policy out to when the benefits are triggered. By contrast, this uncertainty will be factored into the pricing of the premiums by the insurance company. Individuals, therefore, tend to be dissuaded from purchasing the policy as they see it as poor value for money.

#### **6.1.4 People's belief that their family will be able to provide the care**

There are two main reasons why people may overestimate the ability of family to provide for their future care needs. Firstly, as noted above, even when they think of themselves as needing care, people usually only imagine requiring a low level of care which could be provided by non-professionals. Secondly, people struggle to take into account the changes that will occur to their family between now and the time when they need care. For example, their spouse will be aging alongside them and may then be too frail to provide care or may even require care themselves. In addition, their adult children may have their own young families (with the associated demands on their time) or have moved away for work reasons by the time that care is needed.

#### **6.1.5 People's cynical view of insurance companies**

In the UK, there is a widespread belief that insurance companies will often use the small print, if possible, to avoid paying the full benefit to which policyholders believe they are entitled. In the case of traditional long-term care indemnity products this could take the form of refusing to make any payment (if the insurance company assesses the individual as being insufficiently incapacitated) or providing a level of care that is much lower than the policyholder's expectations.

### **6.2 The benefits of the product design**

We believe that the modified version of the disability-linked annuity which we are proposing in this paper, along with our suggested payment methods, deals with many of the above issues.

The growing awareness that the NHS will not provide care apart from to the least wealthy and only those that qualify for Continuing Care should mean a number of individuals will start looking for long-term care insurance products. However, as these people are not high net worth individuals with easy access to professional financial advice, they will be looking for a simple product with easily understandable benefits. We believe that our two-level disability-linked annuity benefit triggered by the failure of standard ADL's will be comprehensible to a significant proportion of the population.

While our product does not make the thought of needing long-term care any more pleasant, we believe that both the benefit structure of the product and the flexibility of the payment methods make the purchase of cover more attractive.

As people age, the risk of requiring long-term care comes into sharper focus. Firstly, the concept of them getting to very old age, with the associated risk of needing care, becomes very apparent. Secondly, they will see their friends and relatives needing care and the associated financial implications. Thirdly, they become aware that even if they only develop a mild level of incapacity then their home may no longer be suitable. This would lead to a requirement to move to a more suitable property, or directly to a residential care home.

With the proposed equity release method, even at this later stage in life (where income might be low and premiums high) cover can still be purchased by those with housing wealth. In effect, this will mean that they surrender a guaranteed component of their estate in order to protect the remainder.

For those just entering retirement, the product design of the benefits being annuity payments rather than fully indemnifying care costs should result in lower, more palatable premiums. This could either



be in the form of a single premium taken from the tax free lump sum at retirement or by use of regular premiums paid out of retirement income.

An additional attraction of the benefit structure is that the lower level of benefits that will be paid if the individual becomes moderately incapacitated may allow them to stay in their home for longer. As, in general, policyholders prefer to stay living in their home for as long as possible, this is another attractive feature of the product.

At the point of retirement, purchasing this product can be beneficial even if informal care is thought to be available. This is because, assuming care is needed, benefits are paid directly to the policyholder rather than to a formal care provider. If informal care is in place then the annuity payments can be used to provide income for the informal carers. Alternatively, if informal care can only be provided part of the time (or even not at all), the gap in care provision can be filled by purchasing formal care. The additional advantage of purchasing this policy is that if the policyholder enters a state of incapacity that requires professional care the policy will pay out the larger benefit needed to fund this provision.

The final problem which is addressed by this product is the cynical view held by some people that the insurance will refuse to pay the full benefits to which the policyholder believes they are entitled. As the claim triggers are based on well-established ADLs, which could be verified by independent assessors, and the level of payments themselves are specified, potential policyholders should feel reassured that the insurance benefits will be paid.

We therefore believe that the product design, both in terms of benefits and payment methods, overcomes many of the barriers that previously prevented people from purchasing long-term care insurance. However, the success of such a product will also require assistance from the government.

Firstly, the government needs to decide on a long term strategy regarding what should be covered by the State and what should be required by private provision. Ideally, this would be a cross-party agreement which would stand the tests of time. The uncertainty over the level of State provision is one factor which dissuades people from saving, in particular the way the means test operates in terms of asset and income thresholds i.e. people do not want to make private provision if this simply means they lose the equivalent State benefits (see Mayhew, 2017).

Secondly, the tax regime is also important. For example, if premiums were paid out of pre-tax income this would lower the net cost to the individual. Similarly, if the product is purchased through a single premium at retirement, then the cost of the premium could be met by increasing the tax free lump sum from the standard 25% of the pension fund. A more draconian method would be to restrict people's access to their tax free lump sum unless they purchase long-term care insurance.

Finally, unlike regular annuities, some of the benefit payments could be tax exempt and/or disregarded for means testing purposes (see Mayhew 2017 for examples of how this might work).

With this help from government, we believe that the product we have described could be popular with people having a range of individual financial circumstances and would therefore bring new money into the care system.

The main beneficiaries, apart from individuals and care providers, would be the insurance industry, wealth advisors who work with client end-users, policymakers and government.

This research is a natural follow-on from previously published papers in this area which tackle different requirements on the wealth spectrum. These include 'Personal Care Savings Bonds' (Mayhew and Smith 2014) , 'Paying for Care Costs in Later Life Using the Value in People's Homes' (Mayhew et al, 2016) and 'The Role of Private Finance in Paying for Long-term care' (Mayhew et al, 2010).

Our results showed, as expected, that premiums are lower if purchased at younger ages. While insurance companies may focus on this feature in order to promote immediate sales, it is more important to individuals to consider how cash-flows will affect their lifestyles, especially in retirement. In particular, although equity release might not be the most cost effective payment method, the fact that it preserves income and lifestyle means that it may generate the most utility to the individual.

A common approach used by independent financial advisers (IFAs) is to engage people at the point when they crystallise their pension savings and have not yet adjusted to their new level of income (Mayhew et al, 2014). In the UK, while the average pension pot is relatively small, which would restrict the ability to pay upfront premiums, many people have housing wealth which could be an alternative source of funds. These funds could be released by downsizing but the equity release route could be more suitable for many people. In summary, we believe that in the UK, people should start recognising that their housing wealth is part of both their retirement and long-term care planning (Engelhardt & Kumar 2011).

Another reason why retirement age is a good time to think about future care needs is that, if people defer purchase until they are in their 70s, they are likely to have fewer liquid assets and the premiums will be more expensive. However, as discussed, many may not focus on the need for long-term care until a later age e.g. when they witness friends and relatives requiring care. At this point, equity release might be the only way in which long-term care can be funded.

Finally, although hardly anyone considers the risk of requiring long-term care pre-retirement since the risk is so small, it is still possible e.g. upon the impact of a stroke or a serious accident. Those most likely to be affected financially are families with dependent children where the loss of the main income will almost certainly lead to financial hardship, even before the cost of care is taken into account. Even though our product can be purchased at young ages, this would be unlikely as the risk is small and these people are usually the most financially stretched. Those people requiring long-term care at such a young age will normally be provided for by the State, assuming they are eligible for disability benefits and compensation payments in the event of an accident.

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## APPENDIX: Premium calculations

### A1.1 Calculating the present value of the benefits

As mentioned in Sections 1.1 and 4, the product we are considering pays two levels of benefits based on the level of disability of the policyholder. We can generalise these annuity benefits as follows (noting that  $Z$  will be greater than  $Y$ ):

- £  $Y$  per annum whilst person moderately disabled
- £  $Z$  per annum whilst person severely disabled
- [No payments made whilst person in good health]

For convenience, we assume that everyone has the same age dependent mortality rates regardless of the care pathway. We further assume the following:

- The annuity is paid continuously
- The annuity increases in payment (continuously) at  $k\%$  per annum
- The discount rate is  $i\%$  per annum
- $p_f\%$  of policyholders go down care pathway  $f$  where  $f = 1, 2, 3$  or  $4$

We now consider the present value of the benefits in respect of an individual who has purchased the product at age  $a$ . This is calculated using the weighted present value of the four different pathways as follows:

$$PV_B = p_1 \times PV_1 + p_2 \times PV_2 + p_3 \times PV_3 + p_4 \times PV_4$$

Where  $PV_B$  = Present value of the benefits

$PV_f$  = Present value of the benefits for pathway  $f$  (where  $f = 2, 3$  or  $4$ )

$PV_1 = 0$  (since no benefit is paid for pathway 1)

Using standard actuarial notation we have:

$$PV_2 = \sum_{t=a+c_2^m}^{\omega} \frac{d_t}{1_a} \times \bar{s}_{\frac{j\%}{c_2^m}} \times V^{t+\frac{1}{2}-a} \times Y$$

$$PV_3 = \sum_{t=a+c_3^m+c_3^s}^{\omega} \frac{d_t}{1_a} \left( \bar{s}_{\frac{j\%}{c_3^m}} \times Y \times (1+i)^{c_3^s} + \bar{s}_{\frac{j\%}{c_3^s}} \times Z \right) \times V^{t+\frac{1}{2}-a}$$

$$PV_4 = \sum_{t=a+c_4^s}^{\omega} \frac{d_t}{1_a} \times \bar{s}_{\frac{j\%}{c_4^s}} \times Z \times V^{t+\frac{1}{2}-a}$$

where  $\frac{1}{1+j} = \frac{1+k}{1+i} \Rightarrow j = \frac{1-k}{1+i}$

$l_a$  is the number of people who are aged exactly  $a$

$\omega$  is the limiting age for the life table

$d_t$  is the number people dying between age  $t$  and  $t + 1$

$\bar{s}_{\overline{r}|}^{j\%}$  is the accumulated amount a person would get if they invested a continuously paid annuity of £1 per annum for a period of  $r$  years at a rate of interest of  $j\%$  per annum

We assume that, regardless of age at purchase, the same percentage of people will eventually need care before they die. However, we also make the assumption that to trigger care, the individual must survive a certain number of years i.e. the individual can only go down pathway 2 if they survive  $C_2^m$  years. For older ages this probability of survival becomes significant as it moves further away from 1.

The fact that, at older ages, a substantial proportion of people die each year causes a problem in ensuring that a fixed proportion of lives need care i.e. when a significant number of people die before they can trigger a care benefit then the overall percentage of people needing care will be lower than the fixed percentage mentioned above. To compensate for this, we gross-up the percentage of people needing care by the reciprocal of the probability of surviving the period until the first disability benefit can be triggered.

So if we are considering the second path

$$PV_2 = \sum_{t=a+C_2^m}^{\omega} \frac{d_t}{l_a} \times \bar{s}_{\overline{C_2^m}|}^{j\%} \times V^{t+\frac{1}{2}-a} \times Y$$

Then, to trigger a payment, the life has to survive for  $C_2^m$  years and hence the adjustment to be

made is  $\frac{1}{l_{a+C_2^m}}$ .

And hence

$$PV_2 = \sum_{t=a+C_2^m}^{\omega} \frac{d_t}{l_a} \times \bar{s}_{\overline{C_2^m}|}^{j\%} \times V^{t+\frac{1}{2}-a} \times Y \times \frac{1}{l_{a+C_2^m}} = \sum_{t=a+C_2^m}^{\omega} \frac{d_t}{l_{a+C_2^m}} \times \bar{s}_{\overline{C_2^m}|}^{j\%} \times V^{t+\frac{1}{2}-a} \times Y$$

$$PV_3 = \sum_{t=a+C_3^m+C_3^s}^{\omega} \frac{d_t}{l_{a+C_3^m+C_3^s}} \left( \bar{s}_{\overline{C_3^m}|}^{j\%} \times Y \times (1+i)^{C_3^s} + \bar{s}_{\overline{C_3^s}|}^{j\%} \times Z \right) \times V^{t+\frac{1}{2}-a}$$

$$PV_4 = \sum_{t=a+C_4^s}^{\omega} \frac{d_t}{l_{a+C_4^s}} \times \bar{s}_{\overline{C_4^s}|}^{j\%} \times Z \times V^{t+\frac{1}{2}-a}$$

## 1.2 Calculating the premiums

Having derived the present value of benefits, we now turn our attention to the calculation of the premiums for the three methods of payment: (a) single premium; (b) regular payments; (c) using housing equity.

### (a) Single Premium

As the single premium is paid at the commencement of the policy then, assuming that we are pricing using the actuarial equivalence principle, this equates to the present value of the benefits calculated above.

### (b) Regular Premium

As the regular premiums are paid annually in advance until moderate or severe care is required (or until death if no care is required) the present value of the premiums received will depend on the care paths taken by the policyholders.

We define  $PV_p$  to be the present value of the paid premiums, assuming that the premium is £1 per annum paid annually in advance.

$$PV_p = p_1 \times PV_1^p + p_2 \times PV_2^p + p_3 \times PV_3^p + p_4 \times PV_4^p$$

Where:

$PV_f^p$  = Present value of premiums received for policyholder who goes down care pathway  $f$

For policyholders who go down pathway 1 (i.e. they die without requiring care) premiums are paid until death hence:

$$PV_1^p = \sum_{t=a}^{\omega} \frac{1}{1+a} \times v^{t-a}$$

For pathways 2, 3 and 4, the premiums cease when the policyholder first triggers a care payment.

Defining  $a_{\overline{r}|}$  as the present value at time 0 of the annuity of £1 per annum paid annually at the end of each year for a period of  $r$  years, we obtain the following expressions:

$$PV_2^p = \sum_{t=a+c_2^m}^{\omega} P \times \frac{d_t}{1+a+c_2^m} \times \left( a_{\overline{t-a-c_2^m}|} + 1 \right)$$

$$PV_3^p = \sum_{t=a+c_3^m+c_3^s}^{\omega} P \times \frac{d_t}{1+a+c_3^m+c_3^s} \times \left( a_{\overline{t-a-c_3^m-c_3^s}|} + 1 \right)$$

$$PV_4^p = \sum_{t=a+c_4^s}^{\omega} P \times \frac{d_t}{1+a+c_4^s} \times \left( a_{\overline{t-a-c_4^s}|} + 1 \right)$$

Therefore, the annual premium will be calculated as  $\frac{PV_B}{PV_p}$ .

We should note that the above formulae can be modified so that the maximum term can be capped at a specified age.

### (c) Housing Equity

Let us consider an individual living in their home. We need to calculate the present value that £1 of current housing stock is worth when the house is sold; that is when the person either dies or enters a residential care home (i.e. triggers the higher claim benefit). To be able to determine this amount we need to consider how quickly the house value appreciates between the point of purchase and the point of sale, and we then discount this back to the point when the product is purchased. This will allow us to calculate the current value of the home which must be used to pay for future care. This value will then be used to calculate the percentage of the house ceded to the insurance company.

Let house price inflation be  $h\%$  per annum, and assume that death or moving into care occurs halfway through the year of age.

We define  $PV_p$  to be the present value of £1 of current housing capital realised on the sale of the home.

$$PV_p = p_1 \times PV_1^p + p_2 \times PV_2^p + p_3 \times PV_3^p + p_4 \times PV_4^p$$

Where:

$PV_f^p$  = Present value of £1 of current housing capital realised on the sale of the home for policyholder who goes down care pathway  $f$

$$PV_1^p = \sum_{t=a}^{\omega} \frac{d_t}{1_a} \times v^{t-a+\frac{1}{2}} \times (1+h)^{t-a+\frac{1}{2}}$$

$$PV_2^p = \sum_{t=a+c_2^m}^{\omega} \frac{d_t}{1_{a+c_2^m}} \times v^{t-a+\frac{1}{2}} \times (1+h)^{t-a+\frac{1}{2}}$$

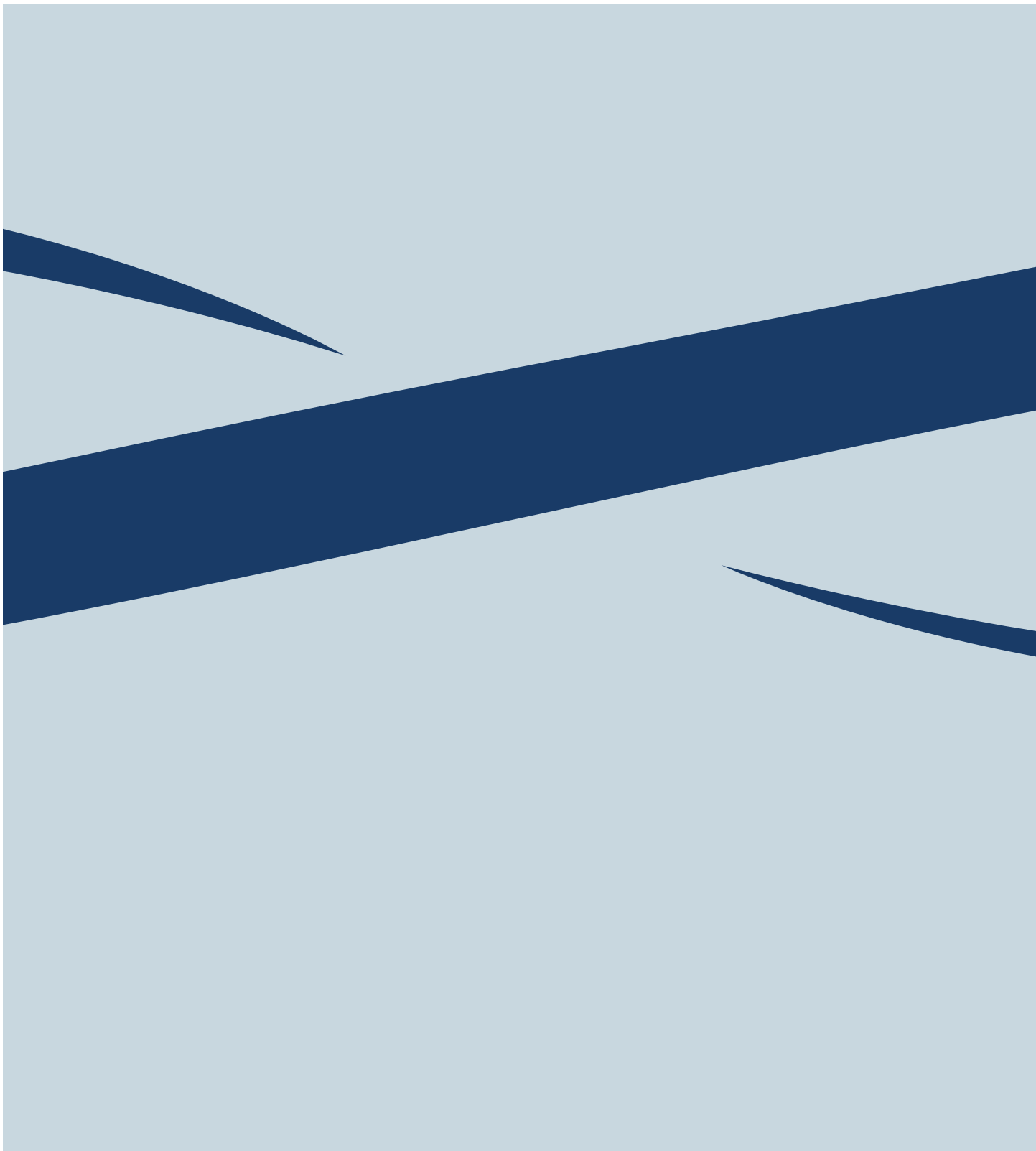
$$PV_3^p = \sum_{t=a+c_3^m+c_3^s}^{\omega} \frac{d_t}{1_{a+c_3^m+c_3^s}} \times v^{t-a-c_3^s+\frac{1}{2}} \times (1+h)^{t-a-c_3^s+\frac{1}{2}}$$

$$PV_4^p = \sum_{t=a+c_4^s}^{\omega} \frac{d_t}{1_{a+c_4^s}} \times v^{t-a-c_4^s+\frac{1}{2}} \times (1+h)^{t-a-c_4^s+\frac{1}{2}}$$

Therefore, the current housing capital to be ceded will be calculated as  $\frac{PV_B}{PV_p}$ . This value would then be converted into a percentage of the home to be ceded to the insurance company.

If instead the care is to be repaid by a loan of a fixed monetary amount - with a mortgage rate of  $m\%$  per annum then above equations are the same, but with  $h\%$  replaced by  $m\%$ .





**ILC-UK**

11 Tufton Street  
London  
SW1P 3QB  
Tel : +44 (0) 20 7340 0440

**[www.ilcuk.org.uk](http://www.ilcuk.org.uk)**

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