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UNDERSTANDING THE ROLE OF VARIABLE AND INVESTMENT-LINKED DEFERRED PAYOUT ANNUITIES (VILDAS) IN HOUSEHOLD PORTFOLIOS OVER THE LIFE CYCLE

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EXECUTIVE SUMMARY

Payout annuities with immediate and life-contingent benefit streams have been shown to be useful in protecting the consumption needs of risk-averse households having uncertain lifetimes. In this project we examine the role of investment-linked deferred payout annuities (VILDAs); specifically we explore how variable investment-linked deferred annuities help households optimally manage their lifecycle consumption, saving, and portfolio allocation patterns, in view of the fact that they do not know how long they will live.

As with immediate payout annuities, VILDA providers promise retirees a lifelong periodic benefit stream in exchange for a non-refundable premium. While payments from immediate annuities start at the date of purchase, those from deferred life annuities only begin after a set number of years has passed (the deferring period), subject to the individual's survival. Due to discounting as well as the possibility that the annuitant dies before payouts start, the deferred payout annuity will be much less expensive than an immediate annuity with identical payouts. We examine these products both without and with systematic mortality risk. Insurers seeking to provide these products can manage systematic mortality risk by self-insuring or via risk transfer to purchasers of the annuity products.

Our results indicate that households having access to VILDAs have markedly higher lifetime consumption. For relief from systematic mortality risk, they would be willing to pay an additional load of between 1% to 4% of the actuarially fair premium, with higher values for younger and less wealthy households. Moreover, households can use the flexibility of VILDAs to invest significant portions of their annuity assets in equities. We also show that the self-insurance approach to managing systematic mortality risks leads to substantial annuity loadings that may exceed 30% for younger annuitants. In any case

most households are still better off with VILDAs, and many would prefer to participate in systematic mortality risk unless the insurer can hedge them at a significantly lower price. Our findings have implications for new payout products that may be attractive to households seeking to protect against retirement shortfalls.

INTRODUCTION

Most defined contribution pensions in the U.S. do not currently offer access to annuities for the decumulation or draw-down phase of the lifecycle.[1] Instead, innovation over the past decade has focused on the accumulation phase, as with the introduction of products to attract workers' saving including life cycle or target maturity date funds (c.f. Gomes, Kotlikoff and Viceira 2008). Yet attention is increasingly turning to the payout phase, to help retirees manage their portfolios in retirement. This project examines the role of investment-linked deferred payout annuities in a life cycle portfolio choice model. Our goal is to explore the relative appeal of deferred annuities in retirement accounts, and to highlight their low costs as well as their efficacy in providing longevity protection along with capital market exposure.

Previous research on dynamic portfolio choice over the lifecycle suggests that payout annuities with immediate and life-contingent benefit streams are very useful in protecting the consumption needs of risk-averse households having uncertain lifetimes.[2] Nevertheless, and notwithstanding the theoretical attractiveness of payout annuities, many consumers are reluctant to annuitize their wealth voluntarily.[3] Explanations for this gap between theoretically-optimal versus actual behavior include incomplete annuity markets, bequest motives, high costs charged by life annuity providers, and behavioral factors.[4] Yet some advocates of annuitization have proposed that annuities be used as a default option in tax-sheltered pension plans. For this reason deferred life annuities are now attracting attention from policymakers, regulators, and financial intermediaries.[5]

As with immediate payout annuities, providers of a deferred payout annuity promise to the retiree a lifelong periodic benefit stream in exchange for a non-refundable premium. While payments from immediate annuities start at the date of purchase, those from deferred life annuities only begin after a set number of years has passed (the deferring period), subject to the individual's survival. Due to discounting as well as the possibility that the annuitant dies before payouts start, the deferred payout annuity will be much less expensive than an immediate annuity with identical payouts. According to Milevsky (2005: 110), the low price of deferred annuities may help overcome psychological barriers to voluntary annuitization, as he argues that "engaging in irreversible financial transactions–that is annuitization– involving large lump sums will never be appealing to individuals regardless of (whether they grasp) the importance of longevity insurance."

While many previous studies (e.g. Horneff, Maurer, Rogalla 2010) have explored deferred annuities that pay flat or fixed lifetime benefits, our research turns to a different topic, namely *variable investment-linked deferred annuities*. Here we call these VILDAs, defined as products that provide both an *investment element,* in terms of a mutual fund-style subaccount, and an *insurance element,* by pooling longevity risks across the purchaser group. The idea is that benefits depend on the performance of the underlying asset portfolio (stocks, bonds, or some combination). Additionally, the benefit payout starts when the deferral period is over and then they continue for the life of the purchases.

This project asks how households might optimally value such life-contingent benefit streams over the lifecycle, using a model of optimizing behavior and a range of assumptions regarding uncertain longevity risk. To do this evaluation, we first focus on a world with unknown individual lifetimes, yet where mortality tables are non-stochastic. Next, we show how results change once we account for systematic risk to mortality patterns over time. Our goal is to show how household's

1 Benartzi, Previtero, and Thaler (2011) note that only about one-fifth of U.S. defined contribution plans offer annuities as a payout option.

2 Seminal research by Yaari 1965 has been added to by many authors; most recently see Davidoff, Brown, and Diamond (2005) and Horneff, Maurer, Mitchell and Stamos (2009, 2010).

3 In 2011 sales of fixed annuities stood at only $20 billion and of variable annuities $40 billion (LIMRA 2011), as compared to over $18 trillion in retirement assets (ICI 2011).

4 Schaus (2005) noted that fewer than one out of ten defined contribution participants opted for an annuity when it was available. Recent reviews of the literature include Horneff, Maurer, Mitchell and Dus (2007); Hu and Scott (2007); and Yagi and Nishigaki (1993).

5 For instance Gale, Iwry, John, and Walker (2008) propose automatic annuitization for 401(k) assets when US employees retiree; in Singapore, the government has recently mandated deferred annuitization (Fong, Mitchell, and Koh, 2011).

optimal consumption and portfolio allocations across stocks, bonds, and annuities change depending on how future mortality improvements are modeled.

Numerous past studies have sought to model the stochastic development of human mortality patterns over time.[6] In their foundational work, Lee and Carter (1992) provided a discrete-time one-factor model for the central death rate and employed it to describe the evolution of US mortality rates. This model did trace the (downward sloping) time trend in mortality. Subsequently it was extended, since a one-factor approach implies perfect correlation of mortality innovations over all ages, which contradicts empirical evidence. Analysts taking a multi-factor approach included Cairns, Blake, and Dowd (2006b) and Renshaw and Haberman (2003).

Insurers seeking to help protect against longevity risk must model how systematic mortality risk will evolve, as well as determine whether the insurer can manage its own exposure to this risk. Large and well-diversified providers can build up a natural hedge by establishing another line of business believed to offset general mortality improvements (such as life insurance; c.f. Gatzert and Wesker 2010).[7] Alternatively the insurer might seek to hedge this exposure using capital market instruments such as mortality swaps, making fixed payments in exchange for variable payments linked to the development of an underlying survival index. Currently, however, the market for mortality-linked products is still underdeveloped (Blake and Burrows, 2001; Cowley and Cummins 2005) so it is questionable whether an insurer with a substantial exposure to systematic mortality risk would be able to purchase an adequate amount of insurance against this sort of longevity risk.

The present paper focuses on two risk management approaches that are independent of firm size and capital market solutions: insurer self-insurance, and risk pool participation. Under the self-insurance strategy, providers will set the VILDA price so that they run little chance that benefits paid to annuitants will exceed provider reserves. Under the risk pool participation approach, the VILDA provider can refrain from taking systematic mortality risks into its books by only offering products which have annuitants participate in the development of general life-expectancy by adjusting benefit payments to unanticipated mortality shocks.[8]

In the remainder of our overview, we first describe the key characteristics of VILDAs and sketch the lifecycle implications of including VILDAs in the household portfolio assuming non-stochastic mortality tables. Next we introduce systematic longevity risk and trace its effect on optimal lifecycle behavior. A short section concludes.

VARIABLE INVESTMENT-LINKED DEFERRED PAYOUT ANNUITIES

The *immediate* investment-linked payout annuity is a financial contract between a retiree and a life insurance company, whereby in exchange for paying an initial (non-refundable) premium, the annuitant *immediately* begins to receive lifelong payments which, in expectation, are equal to the value of a pre-specified number of units on a specific asset portfolio, usually represented by mutual funds. Payments depend on the value of the annuity fund units (FUs), so they will be stochastic if the underlying assets are invested in risky assets. A buyer of a variable annuity can influence (within some bounds) how the assets are invested in various asset categories (e.g., equities, bonds, real estate) but he bears both the risks and rewards of this portfolio allocation.

By contrast in a variable investment-linked deferred annuity, the buyer pays a premium that generates lifelong payments beginning at a specified future age (or date) which marks the end of the deferral period. In our longer paper[9] on this subject, we detail how the initial income payment at the specified future age, as well as periodic payments after that, depend on the number of fund units held, the return on the underlying assets in which they are invested, and the insurance company's 'assumed interest rate' (AIR), and a loading factor. Also important of course is the mortality table used to price

6 For a detailed discussion of alternative approaches see Pitacco, Denuit, Haberman and Olivieri (2009), Cairns, Blake, Dowd (2006a), and Cairns, Blake, Dowd, Coughlan, Epstein, Khalaf-Allah (2010).

7 How good a hedge this is, in practice, is questioned by McCarthy and Mitchell (2010).

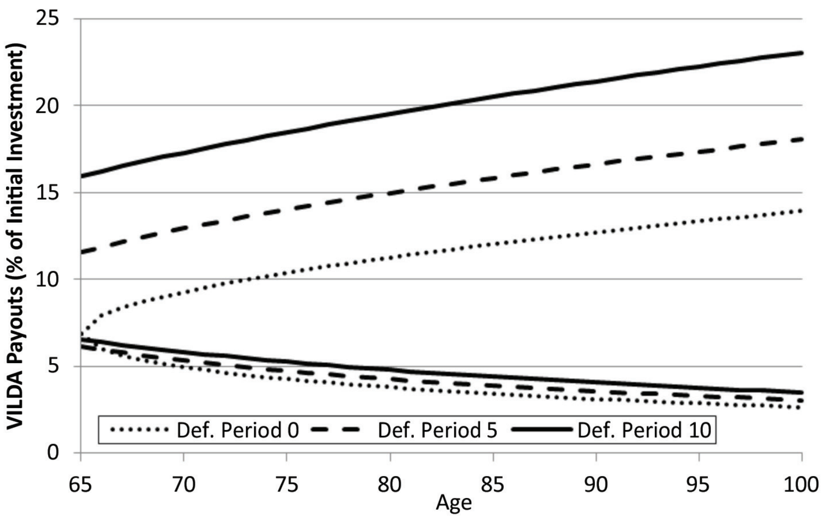
8 This is similar in spirit to the group self-annuitization model proposed by Piggott, Valdez, and Denzel (2005), and the product on offer by the Teachers Insurance and Annuity Association (TIAA) through its fellow life insurer, the College Retirement Equities Fund (CREF). Here benefit payments evolve according to the mortality experience of covered participants; see Weil and Fisher (1974) and Brown, Mitchell, Poterba, and Warshawsky (2001) for more information on the TIAA-CREF model.

9 See Kartashov, Maurer, Mitchell, Rogalla (2011).

the annuity. The classic immediate fixed annuity represents a special case of this general one, where the assets inside the annuity are entirely risk-free bonds, the AIR is set equal to the riskless interest rate, and the future age equals the age at purchase. By contrast, VILDA payouts depend on the asset allocation in the underlying fund as well as the deferral period.

Figure 1 illustrates the effects of deferral on the range of payouts for variable investment-linked annuity benefits, for alternative deferral periods. These are derived by simulating ten million payment paths for a deferred annuity having a constant 50/50 stock/bond allocation over time.[10] The figure illustrates the average as well as the lower bound defined by the 5th percentile or 5% quantile) and the upper bound (the 95% quantile). The 'payout possibility frontier' for an immediate variable annuity is represented by the dotted line from age 65, which starts by paying a benefit at age 65 amounting to 6.9% of the initial premium. Thereafter, the lower dotted line (5% quantile) slopes down with age, and if the retiree survives to age 80, his payout from the immediate variable annuity would only be 3.8%. This worsening risk over time results from the downside volatility of equity returns. On the positive side, the 95% quantile dotted line gradually rises to about 11.3% for a retiree still alive at age 80.

FIGURE 1
VILDA PAYOUT RANGES FOR ALTERNATIVE DEFERRAL PERIODS



Notes: Range of VILDA payouts (in % of initial VILDA investment) for deferral periods of 0, 5, and 10 years. Lower (upper) line represents 5% (95%) quantile. Payouts start at age 65. AIR = Exp. Fund Return = 4%. Non-stochastic mortality. Source: Kartashov et al. (2011).

We also note two important implications of deferring the start date for annuity payouts. First, the 5 - 95% spread for the first payment (assuming survival to age 65) is increasing in the deferral period. That is, the range for a five-year deferral period is 6.2 - 11.6%; for the 10 year deferral, it is 6.5 - 15.9%. Second, conditional on survival, both the up- and the downside payout profiles are enhanced; this result comes at the cost of having a larger chance of dying before the payments start.

INTEGRATING VILDAS INTO A LIFECYCLE MODEL

A. NO SYSTEMATIC MORTALITY RISK

In order to illustrate how the optimizing household might utilize VILDAs in a lifecycle model, we first assume no systematic risk of mortality tables changing over time. As is conventional in economic lifecycle models, we posit that the consumer optimally decides every year how much to consume, how much to spend on new annuities, and how to invest her liquid and annuitized wealth in equities and risk-free bonds, knowing that actual length of her lifetime is stochastic but assuming that the probability of mortality is given by a period mortality table.[11] Additionally we take some reasonable

10 As explained in our working paper, we set the risk-free rate at 2% per annum and gross equity returns are assumed to be log-normally distributed with a mean of 6% percent and a standard deviation of 20%. Annuity premiums are based on the 1996 U.S. female 2000 population table with the AIR set to 4%.

11 Initial mortality rates are taken from the 2007 U.S. female population mortality table as provided by the Human Mortality Database. We furthermore

parameter values from the literature for capital market risk, labor income volatility, risk aversion and time discount rates, and assume that as of age 67, the individual retires and ceases purchasing additional annuities.

Table 1, Column 1, reports means of simulated results for annuity purchase as well as annuity payments at various ages. On average, such households will begin purchasing VILDAs in their late 30s s (Panel A), and by age 40, they will have invested 27% of their initial labor income in VILDAs. Thereafter annuity purchases continue, rising to more than half of the initial labor income, and by age 67, the last period when we assume that VILDAs can be purchased, and these investments peak at just over first-year labor income. At age 67, VILDA payouts commence (Panel B); the initial amount paid on average amounts to 1.8 times the worker's first-labor income and thereafter benefit payments slowly increase rise to 2.2 times this level by age 90, conditional on survival.

TABLE 1
MEAN VILDA ANNUITY PURCHASES AND ANNUITY PAYMENTS BY AGE, FOR ALTERNATIVE MORTALITY TABLE ASSUMPTIONS

Age	Given Life Table (LT)	Stochastic LT, Participating	Stochastic LT, Non-participating
Panel A: Annuity Purchases			
30	0.00	0.00	0.00
40	0.27	0.10	0.00
50	0.50	0.55	0.89
60	0.51	0.54	1.07
67	1.06	1.20	1.39
Panel B: Annuity Payments			
67	1.84	1.73	1.60
80	2.07	1.96	1.82
90	2.19	2.08	1.93
100	2.33	2.20	2.03

Notes: Panel A: Purchases (as a multiple of first-year labor income) of VILDAs at each specified age. Panel B: Benefit paid (as a multiple of first-year labor income) by accumulated VILDAs at specified age. VILDAs pay an initial FU at age 67 with the amount decreasing thereafter according to the AIR (3%). Static mortality based on 2007 US female population table (assumed maximum age is 120). Stochastic mortality based on the Cairns et al. (2006) 2-factor model fitted to US mortality tables from 1933-2007 (assumed maximum age is 120). Source: Kartashov et al. (2011).

Table 2 summarizes optimal lifecycle asset allocation patterns within the VILDA annuity portion of the portfolio. Here Column 1 shows that households will, on average, invest most of their VILDA assets in stocks and only in their late 50s do they being shifting funds into bonds, with the bond share accounting for about 60% of their holdings on average. This is a typical result for lifecycle asset allocation studies that account for periodic labor income.

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assume that the mortality trend is constant over time, equal to the historical mean of improvements in U.S. female mortality between years 1933 and 2007. The assumed interest rate is 3%.

TABLE 2
MEAN VILDA BOND SHARE (%), FOR ALTERNATIVE MORTALITY TABLE ASSUMPTIONS

Age	Given Life Table (LT)	Stochastic LT, Participating	Stochastic LT, Non-participating
45	0.24	0.40	0.32
50	0.33	0.35	0.69
60	0.52	0.50	0.51
67	0.60	0.60	0.59
80	0.58	0.58	0.58
90	0.59	0.59	0.59
100	0.60	0.61	0.61

Notes: Allocation of funds held in VILDAs to risk-free bonds at specified age. Static mortality based on 2007 US female population table (assumed maximum age is 120). Non-participating VILDA pays one initial FU at age 67 and decreasing thereafter according to the AIR (3%). Participating VILDA–in expectation–pays one initial FU at age 67 and decreasing thereafter according to the AIR (3%). Actual benefits vary with unexpected systematic mortality shocks. Stochastic mortality based on the Cairns et al. (2006) 2-factor model fitted to US mortality tables from 1933-2007 (assumed maximum age is 120). Source: Kartashov et al. (2011).

Having access to VILDAs also benefits households in that it affords people the chance to consume much more than they would be able to otherwise, without this product. Table 3, Column 1, shows that being able to insure against unexpected individual longevity risk lets households maintain higher consumption levels by more than 16% for those in their 80's (conditional on survival).

TABLE 3
MEAN VILDA-RELATED CONSUMPTION INCREASES (%), FOR ALTERNATIVE MORTALITY TABLE ASSUMPTIONS

Age	Given Life Table (LT)	Stochastic LT, Participating	Stochastic LT, Non-participating
20	1.52	1.31	0.99
40	4.35	3.58	2.49
60	5.44	4.11	2.31
80	16.36	12.53	7.18
100	19.03	25.53	18.41

Notes: Excess consumption (in %) at specified age that household with access to VILDAs is able to afford compared to household in non-VILDA world. Static mortality based on 2007 US female population table (assumed maximum age is 120. Non-participating VILDA pays one initial FU at age 67 and decreasing thereafter according to the AIR (3%). Participating VILDA–in expectation–pays one initial FU at age 67 and decreasing thereafter according to the AIR (3%). Actual benefits vary with unexpected systematic mortality shocks. Stochastic mortality based on the Cairns et al. (2006) 2-factor model fitted to US mortality tables from 1933-2007 (assumed maximum age is 120). Source: Kartashov et al. (2011).

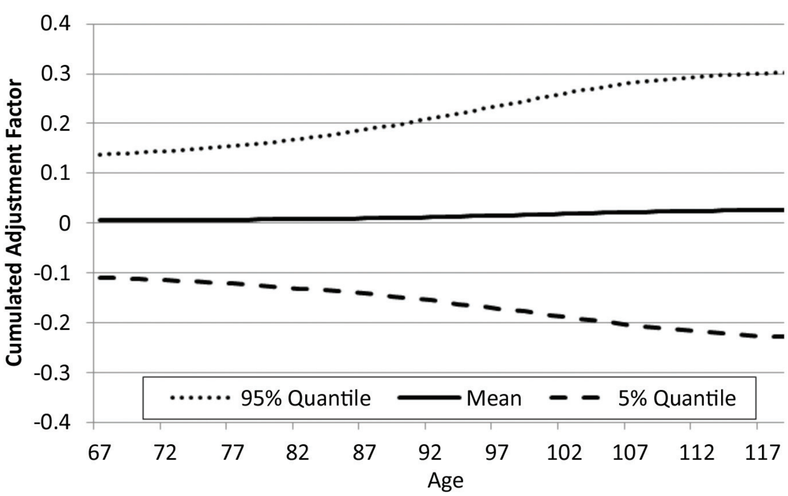
B. WITH SYSTEMATIC MORTALITY RISK

Our working paper (Kartashov et al., 2011) shows in detail how we model the process by which mortality rates for the population as a whole might evolve over time. As noted at the outset, insurers can handle this cohort-risk in at least two different ways. One approach is to *self-insure*, by which we mean that the provider will set the VILDA price (measured in FUs) to ensure a sufficiently high probability that the number of FUs paid to the annuitants does not exceed the number of FUs in the provider's reserves. In this setting, annuity prices depend on the state of the mortality process. These prices are not actuarially fair as they must include premiums for insuring against adverse mortality developments. The resulting price increases can be substantial, especially for younger annuitants. At age 20, for example, VILDA providers must charge loadings of around 32% to maintain a 99.99% confidence level (to be used in what follows). At the 99.5% confidence level, loadings must amount to over 20% for this age group. At later ages, the dispersion of possible future mortality outcomes decreases and so does the implied loading. Nevertheless at age 66, just before VILDA payments commence, the loadings required to meet the 99.99% (99.5%) confidence level still amount to around 14% (9%)

The second approach we examine is a *participation strategy*, where VILDA providers charge a fair price based on the actuarial principle of equivalence for new annuity purchases. In this scenario, unanticipated future mortality developments are passed on to annuitants by adjusting their stock of previously purchased claims to FU payments. In other words, if mortality patterns develop as anticipated, the adjustment factor is set to 1 and the number of FUs promised to the annuitant does not change. Any unexpected decrease (increase) in mortality will result in an adjustment factor below (above) 1 and, hence, decrease (increase) the promised number of FUs.

Figure 2 presents the mean as well as the 5% and 95% quantiles of the simulated adjustment factors for ages 20-120. Over virtually the entire deferral period, the 5:95% quantiles of the periodic adjustment factor span the range 0.98 – 1.02, which implies that claims to FU payments may increase or decrease by around 2% per period. Later, during the payout phase, this span widens to a maximum of 0.93 - 1.01 by age 105. Hence, while payments (measured in FUs) are projected to decrease by the factor of 0.971 per period, unexpected decreases in mortality might result in an additional periodic drop of 4%; in the case of mortality increases, payments might actually increase by 1%.

FIGURE 2
DISTRIBUTION OF VILDA CUMULATED ADJUSTMENT FACTORS



Notes: Cumulated Adjustment Factors representing the difference in benefit payments between participating VILDAs and otherwise equal non-participating VILDAs. Non-participating VILDA pays one initial FU at age 67 and decreasing thereafter according to the AIR (3%). Participating VILDA–in expectation–pays one initial FU at age 67 and decreasing thereafter according to the AIR (3%). Actual benefits vary with unexpected systematic mortality shocks. Stochastic mortality based on the Cairns et al. (2006) 2-factor model fitted to US mortality tables from 1933-2007 (assumed maximum age is 120). Source: Kartashov et al. (2011).

The resulting pattern of optimal variable annuity purchases and payouts for households at various ages is presented in columns 2 and 3 of Table 1. On average, the consumer with access to participating VILDAs begins to purchase these a bit later than with the known life table, but by age 50, her annuity purchases have risen to 55% of first-year's labor income and remain roughly constant over the following decade. At age 67, the end of the deferral period, the investor further boosts her VILDA investments to 1.2 times initial labor income. Average initial benefit payments are slightly lower than in Column 1. In the world with non-participating VILDAs, Column 3 shows that the purchase pattern is again deferred due to higher loads, even though at age 50 the consumer devotes almost 90% of first-year labor income to the product.[12]

Annuity payment patterns in Panel B of Table 1 show that being exposed to mortality risk is costly for participants. Nevertheless, the participating VILDAs (Column 2) pay benefits that exceed those of non-participating annuities at the mean (Column 3). Apparently, the lower price of participating VILDAs allows households to buy enough additional longevity insurance to more than compensate for the greater risk to which they are exposed.

Asset allocation patterns in Columns 2 and 3 of Table 2 indicate that neither the introduction of systematic mortality risks nor the specific VILDA design (participating vs. non-participating) has a major impact on the distribution of funds between asset classes. Again, average VILDA bond fractions increase only toward the end of the working life and remain stable during retirement, while the bond share dispersion narrows in retirement.

Consumption increases also flow to consumers over the life cycle. Already by age 20, households which purchase participating VILDAs are (on average) able to afford about 1.3 percent additional consumption compared to their counterparts in a VILDA-free world. This advantage increases to 4% by age 40 and to more than 4% by age 60. This can be attributed to the lesser need to build up liquid wealth to finance consumption at very high ages when being insured against unexpected individual longevity. Again, VILDAs in a world with stochastic mortality are particularly valuable for those who attain advanced ages. Average consumption of age-80 households with VILDA income exceeds that of similar-age households lacking VILDAs by over 12% and more than 25% for those attaining age 100. There are also consumption gains in the non-participating VILDA world, but the substantial loadings required by the insurer's need to self-insure against adverse systematic mortality developments drive up VILDA premiums substantially.

In our working paper we estimate the maximum premium that households would be willing to pay in order to be relieved of systematic mortality risks. This is equivalent to the loading charge for a non-participating VILDA (in excess of the actuarially fair price) that would equate the utility from buying a non-participating VILDA with the utility from a participating VILDA. We estimate that, at age 40, a household with wealth amounting to three times its first-year labor income would be willing to pay a premium of 1.2% above an actuarially fair (non-participating) VILDA premium, to insure against systematic longevity risk. At age 60, the premium is 3.6%. Workers with less wealth would be willing to pay even higher premiums: for instance if they hold wealth of only two times first-year earnings, they would be willing to pay a premium of 1.5% and at 60, an additional 3.8%. This suggests that VILDAs would be most readily targeted at younger and less wealthy households, inasmuch as they are most likely to benefit from the products.

CONCLUSIONS

Our objective was to examine the optimal role for variable investment-linked deferred annuities (VILDAs) in household portfolio and consumption choices over the lifecycle. Since their payments are deferred, VILDAs may be seen as a privately-financed complement to governmental social security schemes. Having investment choice within VILDAs gives households greater flexibility to achieve their individually-optimal asset mix, and, at the same time, allow annuity providers to transfer investment risks back to the purchaser pool. Of special interest is the performance of VILDAs under deterministic versus stochastic mortality processes, and we explore two approaches to managing systematic mortality risks which do not rely on financial markets or other hedging instruments. We show how annuity providers may elect to self-insure their position by demanding higher than actuarially fair premiums, or transfer systematic mortality risks to their buyers by adjusting payouts as actual mortality developments unfold.

12 Our working paper provides additional detail on the tails of the distribution.

Our results indicate that households benefit from gaining access to VILDAs as measured by markedly higher consumption over the whole lifecycle. Households would be willing to pay an additional load to be relieved of systematic mortality risk of between 1-4% of the actuarially fair premium, with the values being higher for younger and less wealthy households. Moreover, households can use the flexibility of VILDAs to invest significant portions of their annuity assets in equities. We also show that the self-insurance approach to managing systematic mortality risks leads to substantial annuity loadings that may exceed 30% for younger annuitants. Nevertheless, households are still better off with, than without, VILDAs. Provided an alternative, however, many households will prefer to participate in systematic mortality risk unless the insurer can hedge them at a significantly lower price. Depending on their age and wealth, consumers may be willing to pay a premium above the actuarially fair price of between 0.5 - 8%. When financial markets are thin and provide insurers with few hedging instruments in this price range, providers may seek to concentrate on their core competence–pooling idiosyncratic longevity risk–and transfer systematic mortality risk to annuitants.

The interested reader may find additional details on this work in our longer working paper on this topic (Maurer, Mitchell, Rogalla, and Kartashov 2012). The research reported herein was performed pursuant to a grant from the TIAA-CREF Research Institute. Additional research support was provided by the German Investment and Asset Management Association (BVI), the Pension Research Council at The Wharton School of the University of Pennsylvania, and the Metzler Exchange Professor program. Opinions and errors are solely those of the authors and not of the institutions with whom the authors are affiliated.

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