Lifetime Annuities for US: Evaluating the Efficacy of Policy Interventions in Life Annuity Markets

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1. Introduction

As the baby boom generation nears retirement age, the question of the adequacy of retirement income is growing more important. In addition to demographic trends, concerns over the future of Social Security and the downward trend in traditional defined benefit pensions have brought more attention to the importance of private saving for funding retirement income. The adequacy of retirement income depends not only on how much wealth a household accumulates, but also on decisions on how to allocate and spend this wealth after retirement. Uncertainty about the length of life is crucial in decision making about allocating and spending down wealth. Annuities provide an important form of insurance in dealing with this uncertainty and help guarantee that retirees will not outlive their resources. Unfortunately, economic research has indicated that individuals appear to underutilize private annuities.

Much of the recent public policy attention regarding the adequacy of retirement savings has focused on programs, often tax-based incentives, to encourage savings. These policies have typically not dictated that retirees use this savings to purchase annuities. New proposals, however, have introduced targeted incentives to increase annuitization (see, for example, the Lifetime Pension Annuity for You Act of 2005 that is described in more detail below). Our goal is to provide an economic analysis of the prognosis for success from these initiatives.

Our analysis suggests that the initiatives proposed to date are indeed likely to substantially increase private annuitization, with our baseline estimates indicating an increase in annuitization on the order of $50,000 on average for retired couples. Our results also indicate that this increase will occur at relatively modest cost to the government in terms of forgone tax revenues, with estimates of the steady-state revenue costs of less than 10-15 cents per dollar of

additional annuitization over the entire life of each retired cohort. However, while existing proposals are likely to substantially increase annuitization for retirees with income tax liability and sufficient assets to annuitize , lower income retirees with no income tax liability may benefit from another type of proposal such as a refundable tax credit. Such a tax credit would encourage annuitization among those households more at risk of outliving their retirement resources. It is important to emphasize that, though our estimates rely on well developed analytical techniques, they are nevertheless subject to considerable uncertainty, and should therefore be interpreted cautiously.

The paper proceeds as follows. The second section provides background on private annuity markets and summarizes economic research on annuitization decisions and the "annuity puzzle" regarding the underutilization of annuities. The third section describes recent proposals and discusses issues of policy design for increasing annuitizaton. In the fourth section, we present a framework for assessing the magnitude of the effects on the incentive to annuitize. The fifth section incorporates this pricing information into a model of annuity decisions to assess the possible magnitudes of the effects of these incentives on household decisions. A sixth section broadly considers other possible approaches to increasing annuitization. The final section offers some brief concluding remarks.

2. A Brief Review of Private Annuity Markets in the United States

2.1 Institutional Features of the Annuity Market

Before turning to our analysis of annuity markets and the uses of public policy in increasing the annuitization of wealth, a brief review of institutional features of the annuity market in the United States will help set the context for our discussion. Annuities are insurance

contracts that provide insurance against outliving one's financial assets by allowing a lump sum of wealth to be converted into a stream of future payments that typically continues as long as someone is living. Annuities that pay benefits as long as someone is alive are "life annuities." Insurance companies also provide annuities with a fixed duration called "period certain" annuities; period certain annuities do not provide insurance against outliving one's assets so they are less useful in the context of retirement planning.

It is also possible to purchase annuities that combine the insurance aspect of a life annuity with a minimum number of years of benefit payments through a "life annuity with a guaranteed benefit." For example, a retiree could purchase a life annuity that would pay a minimum of ten years of benefits; his heirs would then receive the guaranteed benefits in the event that he dies within ten years of the start of benefits. Another common annuitization choice is for couples to purchase "joint and survivor annuities" in which the life contingency is based on two lives instead on one. In these annuities, couples choose at the start of the contract whether the surviving annuitant will receive the same benefit as the couple (i.e., a 100% or "full" survivor benefit) or a fraction of the couple's benefit (e.g., a 2/3 survivor benefit with payments that decrease by 1/3 after one annuitant passes away).

In purchasing an annuity, investors can buy an immediate annuity with benefits starting immediately after the purchase or put money into a deferred annuity. Deferred annuities have two phases: an accumulation phase and a liquidation phase. In the accumulation phase, the insurance company invests the money and the investor's account is credited with the investment returns. For the liquidation phase, the investor may choose a lump sum withdrawal or annuitize using one of the annuity options described above. An important aspect of deferred annuities is that investing in them does not commit the investor to a life annuity. This annuitization decision

does not occur until later in life. If the owner of a deferred annuity dies while the annuity is still in its accumulation phase, the value of the contract goes to a designated beneficiary.

Another choice facing the purchaser of an annuity is the type of investments that will determine the future value of the contract. In the accumulation phase, the underlying investments can either be fixed investments, similar to bonds, or equity investments in the case of variable annuities. The same possibilities exist for the liquidation phase. Typically, investors choose fixed annuities at this stage so that the future payments remain constant. For variable annuities, the future payments depend on the investment performance of a portfolio of assets; the annuitant receives a payment based on a number of units (determined by the amount annuitized and the expected mortality at the time of annuitization) times the value of the underlying index. At the time of annuitization, annuitants can also choose payment streams that will increase over time instead of providing a level future payment stream. Policies with such options include "graded" annuities in which the rate of increase is predetermined and "inflation-protected" annuities where the future payments are tied to increases in the price level.

The final important institutional detail of annuity markets for our analysis is their tax treatment. A major distinction in the taxation of annuity contracts is between "qualified" and "non-qualified" purchases. In this instance, "qualified" refers to an annuity which is purchased within a tax-advantaged savings vehicle, such as a 401(k) or Individual Retirement Account (IRA). These accounts allow investors to save with pre-tax dollars (either in the form of a tax deduction for contributions as in IRAs or the exclusion of contributions from taxation as is done for 401(k) accounts). The returns to the investments in these accounts are not taxed until

withdrawal. For such annuities, the entire payment from the annuity is considered taxable under the logic that all withdrawals from such accounts are fully taxable.[1]

Non-qualified annuities refer to annuity contracts purchased with after-tax dollars. Non-qualified annuities can be either deferred or immediate annuities. The amount of money contributed to the annuity establishes the taxpayer's basis (or principal) in the annuity. During the accumulation phase of a non-qualified deferred annuity, the investment returns on the contribution to the annuity are not taxed. Instead, the taxation on the "inside buildup" in the annuity is tax-deferred. For both deferred and immediate annuities, a portion of the benefit stream from the annuity is the return of basis to the taxpayer and is not subject to income taxation.[2] The portion of a non-qualified annuity payment that is deemed income depends on a formula for apportioning the payment between return of basis and income. This apportionment depends on the annuitant's life expectancy when the assets are annuitized and the type of payments that will be received from the annuity (e.g., fixed versus variable payments). The income from the annuity faces ordinary income tax rates even when the assets that generate the return for the insurance company yield capital gains or dividends that would have face marginal tax rates below the annuitant's tax rate on ordinary income had the annuitant invested in these assets directly.

[1] For Roth-styled IRAs (also known as after-tax IRAs), the entire annuity payment is exempt from tax. The key difference between a Roth IRA and a traditional IRA is that taxpayers contribute after-tax dollars to the Roth IRA and face no further taxation but contribute pre-tax dollars to a traditional IRA and are taxed on the entire future withdrawals. If a taxpayer faces a constant marginal tax rate over time, then both types of retirement accounts provide the same after-tax rate of return for accumulating wealth.

[2] Since the inside buildup of a deferred annuity is tax deferred, the basis component of a deferred annuity is smaller than the basis component of an immediate annuity. Hence, for an equal amount of annuitized wealth, a deferred annuity generates more taxable income than an immediate annuity generates.

2.2 Previous Research on Annuitization Decisions

Economists have appreciated the usefulness of annuities in financing consumption in retirement since the theoretical analysis of Yaari (1965). Yaari considered individuals without bequest motives and with access to actuarially fair life annuities. He established that these individuals would not only find annuities useful, but would in fact find it optimal to *fully* annuitize, that is, to spend all of their wealth on purchasing a life-annuity. Davidoff, Brown, and Diamond (2005) have recently extended these results, showing that optimizing individuals should make extensive use of life-annuity markets under an extremely broad set of circumstances.

In practice, however, few retired households make use of life annuities, and there is consensus among economists that existing private annuity markets are quite thin. Despite this consensus, clear documentation of the paucity of private annuity purchases is surprisingly difficult to come by. Recent evidence on market thinness comes from two primary sources. The Health and Retirement Survey (HRS) has been the primary source for evidence on the life-annuity purchases and holdings of retired households.[3] Complementary evidence from the other side of the market comes from the life insurance industry. Unfortunately, neither data source provides an ideal measure of the levels of annuitization in the United States.

The HRS is a survey fielded by the Institute for Social Research at the University of Michigan. It tracks the 1931-1941 birth cohort in the U.S. The first wave of the survey took place in 1992, and follow-up surveys have been conducted every two years. Since the HRS asks detailed financial, health, and retirement questions and since its panel nature allows researchers to follow individuals over time to study the ultimate use of their retirement assets, it would

[3] Brown (2001) also briefly discusses the September 1994 Current Population Survey, which included a supplement providing information about pension coverage. The data here are quite limited, however.

appear to be the ideal data set for understanding the extent of annuitization among the elderly. Some research has fruitfully employed it to this end. As of the 5th wave (2000), Poterba et al. (2003) report extremely low levels of (privately) annuitized wealth. For example, the mean percentage of wealth held in the form of a private annuity among males between ages 63 to 67 is about 5% of total wealth, while the median male in this age range had *no* annuitized wealth. Johnson et al. (2004) use panel features of waves 1-5 of the HRS and find that, among individuals with defined contribution (DC) retirement plans who left their job after age 65, only 10% actually converted their DC accumulations into annuities.

While suggestive, these low levels of reported annuitization within the HRS do not imply low levels of ultimate annuitization *per se*. First, the fact that so few individuals with DC retirement plan balances chose to annuitize those assets through that plan upon leaving their job may simply reflect that annuitizing withdrawals is not an option for many plans. Indeed, Brown and Warshawsky (2000) report that approximately 75% of DC plan participants do *not* have this option. This suggests that approximately 40% of individuals with the annuitization option took it up at the time of job separation (i.e., 10% of the 25% with the option).[4] Second, those who do not annuitize through the DC plan may nevertheless plan to annuitize their assets. Johnson et al. (2004) report that 60% of the over-65 DC plan-holders who left their job either left their DC wealth within the plan or rolled it over into an IRA. These individuals may simply intend to annuitize the wealth at a later date.[5] Third, the apparent lack of annuitization of households in

[4] Brown (2001) reports that nearly 50% of the 950 households in the 1992 wave of the HRS with at least $5000 in defined contribution wealth and with the option of converting that wealth to a life annuity at the time of retirement reported an *intention* to use that wealth to purchase a life annuity. These stated intentions thus appear to match up reasonably well with the annuitization behavior reported in Johnson et al. (2004).

[5] Rollovers to IRA accounts may also reflect the intention to immediately (or quickly) annuitize assets through providers outside of the DC plan. Such roll-overs for the purposes of immediate annuitization may be desirable, even for individuals with access to life-annuities through their DC pension plan, since annuities provided through employer provided plans must be priced on a gender-neutral basis (following the Norris v. Arizona (1983) Supreme Court decision) while gender-specific annuity pricing is permitted in the private market.

the HRS may simply reflect the relative youth of that population. Indeed, Dushi and Webb (2004) argue that optimizing households would indeed wish to delay annuitization beyond the oldest ages observed in the first five waves of the HRS. As further waves become available and are analyzed, researchers will be better able to understand the extent to which households will, in fact, annuitize.

Annuity sales data from the life insurance industry would seem to provide a second useful angle for measuring the size of annuity markets. Such data are available (see, for example, Çebi (2006) and NAVA (2005)), but employing them for studying patterns of life-annuitization is not straightforward. Sales data include purchases of both deferred and immediate annuities. This means that they jointly include annuity purchases taking place during the accumulation phase and during the liquidation phase of retirement planning. As mentioned in Section 2.1, an individual with wealth in a deferred annuity contract may or may not choose to use that wealth to purchase a life annuity, and sales data do not indicate the ultimate disposition of the wealth. It therefore provides little guidance on the levels of life-annuitization activity.

Sales of immediate annuities, which are typically used in the distribution phase to provide income for retirees, are quite small – on the order of $10 billion per year, or about 5% of deferred sales (Çebi, 2006). Furthermore, this $10 billion per year includes both the sale of life-annuities and the sale of period-certain annuities, so even this small quantity overstates the size of the market for immediate life annuities.

Finally, Brown (2000) reports data from American Council of Life Insurance indicating that less than 4% of individuals receiving income from Social Security additionally received income from a private annuity. Again, this *overstates* the fraction of individuals receiving life-annuity income, since this 4% includes both life annuities and period-certain annuities.

The thinness of annuity markets is an international phenomenon. James and Vittas (2004) describe the paucity of the private markets in Canada, Australia, Israel, and Singapore, for example. Indeed, the only well-documented examples of thick annuity markets are in Chile and the United Kingdom, both of which have a pension system which includes mandatory annuitization of certain forms of retirement savings. Outside of these "compulsory" markets, the "voluntary" annuity markets are quite thin in these countries as well. Finkelstein and Poterba (2004) present data on all of the policies sold by a major annuity provider over a 17 year period in the United Kingdom. Fewer than 220 "voluntary" polices were sold per year over that time span, compared with over 10 times that number of annuities sold in the "compulsory" market.

The tension between the in-theory desirability of annuitization and the small size of private annuity markets in practice has been dubbed the "annuity puzzle." This puzzle has been the focus of a substantial literature in economics. The small size of private annuity markets suggests that life-annuities may be less desirable as Yaari's theoretical analysis indicated. The literature has identified a number of potential explanations for this puzzle.

First, Yaari's "full annuitization" result is based on the assumption that actuarially fair annuities are available. If annuities are costly – in the sense of being less than actuarially fair – they are clearly less desirable. The literature has developed and employed the concept of the "money's worth" of an annuity policy to an individual as a measure of its degree of actuarial unfairness. The concept is most easily illustrated in the context of a single premium immediate annuity, where an individual pays a lump sum price for an annuity in exchange for a periodic (e.g., monthly or quarterly) stream of payments that continue so long as the individual remains alive. There is some chance the individual will live for a long time, in which case she will receive many payments and the total value of those payments will be high. There is also some

chance that she will die young, in which case she will receive few payments and the total value of the payments will be low. Finally, there is some chance of an intermediate outcome. Taking an average of the values across these different outcomes gives the *expected value* of the payment stream provided by the annuity policy. The money's worth is the ratio of this expected value to the price originally paid for the policy. Thus, the money's worth of an actuarially fair annuity is 1, while the money's worth of an "unfair" annuity is less than 1. We discuss money's worth calculations in greater in Section 4.

The difference between 1 and the money's worth of a given annuity can be interpreted as the implied load on that annuity. Economists have distinguished between two types of loads. The "administrative" load captures the cost for insurance companies to administer the contract and earn a normal rate of profit. The "adverse selection" load captures the fact that the average person who buys an annuity may not be the same as the average person in the population. There are at least two reasons for this. First, individuals who are in better health will expect long lives and will therefore find annuities more attractive than those who are in worse health. Second, wealthy individuals are both more likely to annuitize and will tend to make larger annuity purchases than less wealthy individuals, and it is well documented that wealthier individuals tend to live longer than less wealthy individuals (Attanasio and Hoynes, 1995). For both reasons, the population of annuity-buyers will tend to have lower mortality (higher longevity) than the average person. To cover costs and earn normal profits, insurance companies therefore need to make annuity policies more expensive than they would be if the average person in the population bought them. This higher price is the "adverse selection" component of the load.

Mitchell et al. (1999) report that for the average individual in the population, life annuities offered in 1999 had loads of about 15 to 20 cents, attributing about one-half of this to

adverse selection. The question then arises: are these loads large enough to resolve the "annuity puzzle?" In other words, would individuals facing annuities with a money's worth of only 0.80 to 0.85 still find annuitization desirable? Answering this question requires estimating the desirability of annuitization. For this purpose, economists have employed two closely related concepts, called the "wealth equivalent" (WEQ) and the "annuity equivalent wealth" (AEW). We focus attention on the latter.

Broadly speaking, AEW is a money-based measure of the value to an individual of access to annuity markets (though there is considerable variation across contexts in the specific definition of AEW). We discuss the formalities of AEW calculations in our context in Section 5 and in a technical appendix, but the basic idea is simple to illustrate. To compute the AEW of access to a particular annuity market for a particular individual, one considers how well off she is (or would be) with access to that market. One then asks: by what factor would her wealth have to be increased in order for her to be willing to forgo access to that product or market? This factor is her AEW. Saying that an individual has an AEW of 1.25 thus says that she is indifferent between two scenarios: having her current wealth and access to the specified annuity market, and having 25% more wealth but lacking access to that market.

Typically, studies have focused on actuarially fair annuity markets in computing AEWs. Then an AEW of 1.25 indicates that access to actuarially fair annuities is "like" having 25% more wealth. An individual with an AEW of 1.25 would be willing to pay a load of approximately 25% to purchase an annuity. Such an individual would be willing to purchase annuities with money's worths was significantly greater than 0.75. Mitchell et al. (1999) compute the AEWs of access to actuarially fair annuities for individuals with "standard"

preferences and population average mortality to be on the order of 1.5,[6] suggesting that many individuals would be willing to pay a substantial load to access actuarially fair annuity markets. Given their money's worth estimates of 0.8-0.85, they conclude that loading alone cannot explain the thinness of the annuity market: average individuals with reasonable preferences should still find it optimal to annuitize even with the empirically observed loads.

Given that loads alone cannot resolve the annuity puzzle, the literature has explored several other possible solutions. First, Mitchell et al. (1999) and others have noted that the existence of pre-annuitized wealth – for example, Social Security income streams – can substantially reduce the value of annuitization (as captured by the AEW). However, they conclude that individuals with half of their wealth in pre-annuitized form would still find additional annuitization desirable.

Second, Brown and Poterba (2000) have explored the possibility that married couples find annuitization less desirable than do single individuals. Intuitively, married couples face less longevity risk than single individuals because they can pool risk within the household and therefore value the longevity insurance provided by life-annuities less highly. As Brown and Poterba discuss, this can go some way towards explaining the annuity puzzle, but there should still be a substantial fraction of couples – in addition to the many single individuals – who still wish to annuitize.

Third, most AEW calculations operate on the assumption that the individual gets no utility from leaving positive wealth to heirs upon their death. Friedman and Warshawsky (1990) and others have made the point that bequest motives can reduce the demand for annuitization. Freidman and Warshawsky argue that "reasonable" levels of bequest motives can explain the

[6] Mitchell et al. actually employ the closely related WEQ (wealth equivalent) notion; we infer the AEWs from their calculations.

annuity puzzle. Presumably, however, many individuals – e.g. many childless ones – do not have bequest motives, so this is at best a partial explanation. Furthermore, while bequests may indeed motivate many individuals, the hard empirical evidence is decidedly mixed as to exactly how or whether these motives are relevant, in practice, for the decision to annuitize assets. Brown (2001), examining the 1992 wave of the HRS, does not find a significant relationship between the stated desire to leave bequests and the stated intention to annuitize DC plan assets upon retirement, for example. Similarly, Johnson et al. (2004) examine the 2000 wave of the HRS and note that childless adults – who presumably have lower average bequest motives than their peers with children – are no more likely to annuitize assets from DC balances.

The preceding discussion serves to highlight the consensus in the economics literature that the annuity puzzle is indeed still a puzzle: each of the potential solutions described above can go some way towards explaining it, but they cannot completely resolve it.[7] This view is well articulated in Dushi and Webb (2004). They use the 2000 wave of the HRS to compute the levels of pre-annuitized wealth for the entire distribution of households. They find that the median household in fact has substantially more than 50% of their non-housing wealth pre-annuitized (the typical assumption made in earlier analysis). They argue that this is sufficient to resolve the "puzzle" for the median married household. However, it leaves open the question of why wealthier households or non-married households do not appear to annuitize.

Dushi and Webb (2004) additionally make a substantial methodological improvement on the AEW literature. Earlier work had computed the AEW to be the value of annuitizing all of one's wealth at a particular age (typically 65). Dushi and Webb consider instead the value individuals attribute to the ability to purchase *any* amount of annuities at *any* time or times in the

[7] Recent work, notably Turra and Mitchell (2004) and Sinclair and Smetters (2004), has explored the possibility that other risks – in particular the risk of liquidity needs for medical expenditures – can make annuitization less desirable. Whether this sort of consideration is sufficient to resolve the puzzle is still an open question.

future. This more realistic modeling approach highlights two effects which they argue can reduce the size of annuity markets. First, individuals who do annuitize will only annuitize *part* of their wealth, potentially reducing the volume of the market. Second, individuals may want to delay annuitization significantly – with married couples wishing to delay annuitization until their mid 70s or later under standard preference, loading, and mortality assumptions. This may help to explain the low levels of annuitization currently observed in the HRS, while leaving open the possibility of additional annuitization as the HRS population ages.

Brown (2001) shows that, in spite of its inability to completely resolve the annuity puzzle, the AEW framework is nevertheless a useful framework for analyzing annuitization decisions. He computes an AEW for a sub-sample of the 1992 wave of the HRS and shows that AEW is associated with individuals' stated intentions to annuitize. His estimates indicate that a 1% increase in AEW leads to nearly a 1% increase in the intention to annuitize. In light of this supportive evidence, our study continues to employ the AEW framework. We explore the likely effectiveness and costs of various policies designed to encourage annuitization upon retirement. To do so, we employ HRS data and develop a nationally representative population of retired individuals, and we collect a set of prices for annuity products. We then apply the money's worth and (a version of) the AEW concepts to this data, both with and without the various policy proposals in place. In doing so, we follow Brown and Poterba (2000) in explicitly considering the joint-consumption decisions of married couples. We also follow Dushi and Webb in allowing individuals to choose not just whether but also how *much* of their retirement wealth to annuitize.[8]

[8] For reasons we discuss below, we do not consider the fully-flexible decision of when to annuitize.

3. The Analytics of Subsidizing Annuitization

The public policy challenge for ensuring retirement income adequacy needs to address both the level of household saving and how households use assets to finance consumption in retirement. Over the past few decades, government policies, such as the expansion of Individual Retirement Accounts (IRAs) and 401(k) plans, have provided incentives for retirement savings but have not emphasized the importance of using some portion of retirement assets for the purchase of a life annuity. Recent policy proposals, such as the Lifetime Pension Annuity for You Act of 2005 (H.R. 2951 introduced by Representative Earl Pomeroy on June 16, 2005), S 381 and H.R. 819 Retirement Security for Life Act of 2005 introduced by Senators Smith and Conrad and Representative Nancy Johnson on February 15, 2005, and H.R. 1960 and H.R. 1961, Pension Preservation and Savings Expansion Act of 2005 introduced by Representatives Portman and Cardin on April 28, 2005 attempt to remedy this concern. The proposals are broadly similar, and the income exclusions in the Pomeroy bill falls in the mid-range of the other bills, so we focus our analysis on this particular bill, which we henceforth refer to as the "Lifetime PAY proposal." After briefly outlining this proposal, we will discuss general policy design issues for encouraging annuitization.

3.1 The Lifetime Pension Annuity for You Act

The Lifetime Pension Annuity for You Act (Lifetime PAY) would create tax incentives for annuitizing retirement wealth.[9] Under this proposal, taxpayers can exclude a portion of income from a life annuity from their taxable income each year. The portion of the income from an annuity that can be excluded from taxable income is 25 percent for a qualified annuity and 50 percent for a non-qualified annuity. The amount of annuity income that can be excluded from

[9] For a full description of the proposal, see the text of H.R. 2951, 109th Congress.

taxable income is capped at $5,000 per year ($10,000 per year for joint returns). For future years, this cap is indexed for inflation. The preferential tax treatment applies to the payments received as lifetime income payments so that it does not extend to any guaranteed benefits paid to the annuitant's heirs. The proposal limits the preferential treatment to annuities that have a significant life annuity component in that to receive the benefit the annuity must not have a guaranteed benefit period exceeding the maximum of 10 years or the life expectancy of the annuitant. The proposal does not apply to annuity payments received in the context of an employer-provided defined benefit pension.

3.2 Rationales for Policy Intervention

Before turning to issues of policy design, it is helpful to consider the rationales underlying public policies geared towards increasing annuitization. One rationale for such policies is that insurance markets are imperfect and government intervention can improve market outcomes. For example, a subsidy could counteract market imperfections created by the adverse selection problem discussed in Section 2. A second rationale for government intervention is that individuals tend to annuitize too little private wealth since they will not bear the cost of outliving their resources alone. Instead, if an elderly person spends all of his or her wealth, he or she may qualify for government assistance so that the rest of society bears part of the cost of the individual's good fortune to live a long life.[10] By encouraging annuitization, the government may reduce its costs associated with social assistance for people who outlive their assets.

A third rationale for these policies is that many people have a natural tendency to underestimate their need for insurance. Public policy can have two beneficial effects in this

[10] The possibility that the social safety net can reduce incentives for saving and other socially-beneficial behaviors has been explored in many contexts. For the specific example of precautionary saving, see Hubbard, Skinner, and Zeldes (1995).

regard. First, by lowering the price of annuities, people might become more likely to purchase them. Second, the government policy may play an informational role in signaling to people that private annuities are a useful financial product. While our estimates below will focus solely on the first of these effects (basically the price elasticity of annuity purchases), the informational role of public policy may have an important, though hard to quantify, effect.

In the case of non-qualified annuities, there is a fourth rationale for subsidizing the purchase on annuities based on the relative tax treatment of alternative investments. Suppose someone is choosing between investing assets in an immediate annuity or in a portfolio that would generate capital gains and dividends. The taxable income portion of the annuity would be taxed as ordinary income while the capital gains and dividends generated by the alternative portfolio would face lower tax rates under current tax law. The preferential tax rates on capital gains and dividends might discourage annuitization.[11]

A natural question to ask is what are the desirable features of policies aimed at increasing annuitization? In designing policies to increase annuitization, three issues are critical. First, government policy should create an incentive for individuals and couples to demand more annuitization. Second, the policy should be directed towards groups within the overall population whose lack of annuitization creates the most vulnerability to risks of outliving their resources. Third, a well-designed policy would be cost effective in terms of its budgetary consequences for the government.

[11] This rationale would not apply for annuities purchased through qualified retirement accounts since under the alternative – phased withdrawals from the account – all withdrawals are considered ordinary income.

3.3 Incentives in Policy Design

One explanation for the annuity puzzle is that people do not annuitize their wealth due to the high price of private annuities (i.e., the combination of the administrative and adverse selection loads) relative to other investment vehicles. To counteract the negative effects of these insurance loads in the private annuity market, the government could subsidize the purchase of private annuities. One form of government subsidy for annuitization is a reduction in the taxes that would otherwise be due on annuity income. Such a tax-based approach could take the form of exemptions of part of annuity income from taxable income (as in Lifetime PAY) or through a tax credit based on the amount of annuity income received.[12]

A subsidy should increase the demand for annuities, which could mitigate the adverse selection problem in the market. If the shift in demand was sufficiently large, then an indirect effect of the subsidy would be that the private market annuity prices fall as the pool of annuitants has mortality risk closer to the mortality risk of the overall population. This rationale for the subsidy suggests targeting people who do not buy annuities due to personal characteristics such as a low life expectancy or low risk aversion. Unfortunately, the government is no better at measuring these characteristics than are private insurers so this sort of targeting is infeasible. In the absence of this information, it seems natural to conclude that subsidies for annuitization

[12] Another form of subsidy would be to provide a matching grant at the time of annuitization; for example, for every $100,000 annuitized, the government could give the annuitant an additional $5,000. While such a policy could be constructed to have the same present value effect on the annuitization decision as the tax-based approaches, it has several design flaws that make it politically infeasible. First, the administrative costs of a standalone program would be high. Second, the timing of government receipts (or outlays) differs across subsidy types with the wealth-based approach leading to earlier outlays than the income-based subsidy. Thus, while the different programs would not change the present value of overall government receipts and outlays, a matching grant would increase measured government budget deficits. Third, even if the present value of the benefit was constructed to be the same, this form of subsidy – whereby the government would effectively write checks on behalf of the already-wealthy – is likely to be politically infeasible. A matching grant system does have one appealing feature. It would focus the incentive exclusively on post-enactment annuitization without providing a subsidy for pre-enactment annuitization decisions (unless the policy was expressly made retroactive looking back over many years). In contrast, for the income-based approach to subsidize only post-enactment decisions, the law would need to make cumbersome distinctions between income from pre-enactment and post-enactment annuities. Of course, without such distinctions, the income-based approach provides windfall gains to people with pre-enactment annuities.

should, in addition to being politically feasible, have features designed to appeal to retirees with relatively small amounts of assets as well as to those with large amounts of assets.[13]

To achieve a uniform price effect across households through tax policy, one theoretically sound approach would be to allow for a tax credit based on the income received from an annuity. The tax credit would give the same dollar benefit per dollar of annuity income to all households, regardless of their marginal tax rate. In designing tax credits, the decision of whether the credit is refundable is an important issue. If the credit is not refundable, then it provides uniform benefits among households with a tax liability before applying the credit. Refundability extends the uniform benefits to taxpayers whose tax liability is less than the credit amount (including households with a zero tax liability). Refundability is especially important for tax credits for annuity income because many elderly households have low or zero tax liabilities[14] However, while a refundable tax credit would have this potentially desirable feature of providing the same price incentive for all households, regardless of their tax liability and marginal tax rate, tax credits are often less politically salient than tax policies that adjust taxable income directly. Therefore, policy options such as the Lifetime PAY proposal, which provides an exemption for a portion of income from annuities from taxable income, are likely to be needed as one policy tool to stimulate increased use of annuities.

This rationale for the subsidy also provides a framework for thinking about the appropriate size of the subsidy. As discussed above, Mitchell, et al. (1999) report that the difference in mortality between the observed annuitant pool and the general population accounts for private annuities being roughly 7-10 percent more expensive than if their prices were based

[13] In contrast, if the driving motivation for changing the tax treatment of annuities is to level the playing field with alternative investments that generate dividends and capital gains, then a reduction in marginal tax rates would be a more sensible policy than a refundable tax credit.

[14] The Tax Policy Center reports that, as of the tax year 2000, 50% of the elderly class faced a marginal tax rate of 0, while 36.3% faced only 15% marginal tax rates (Tax Facts, Tax Policy Center).

on the mortality of the general population. A subsidy at a rate equal to this mark up (or, this portion of the insurance load) would roughly offset the effects of adverse selection in market prices. Alternatively, if one wanted consumers to face actuarially fair annuity prices (where actuarially fair is defined relative to the overall population), then the subsidy for annuitization would need to offset both the adverse selection load and the administrative load.

Combating adverse selection as a goal of the policy also raises the issue of the timing of the subsidy. A common assumption about person-specific information regarding longevity is that the asymmetric information problem grows more severe as people age. For example, a 70-year-old person has a better idea of whether he or she will outlive most of his or her cohort than does a 50-year-old. If this assumption is true, insurance companies face a more severe adverse selection problem when older people face decisions about annuitization than when people must commit to annuitization at young ages. In Section 4, we report evidence consistent with this pattern when we examine how insurance loads vary with age. A policy that induces people to annuitize at younger ages would have the benefit of reducing the loads faced by annuitants. A subsidy based on the age of the annuitant, with people who commit to annuities at younger ages receiving a larger subsidy, could accomplish the goal of encouraging earlier annuitization.[15]

While tying the size of the subsidy to age or to a pre-commitment to annuitize are two ways to reduce adverse selection, it is worth noting that subsidies that are tied to the receipt of income from an annuity also favor annuitization earlier in life. For example, the Lifetime PAY proposal provides a partial tax exemption for annuity income up to a limited amount per year. By annuitizing at an earlier date, an individual increases the number of years that he or she will

[15] Shifting the timing of the annuitization decision does not necessarily imply that people start drawing on annuities earlier in life. In Section 6, we consider policies that subsidize the purchase of forward contracts on annuities so that a relatively young people commit savings to annuity contracts that will start paying out as an annuity when they reach a specific age (say age 65) without the potential for a lump sum withdrawal.

receive the tax break. One way of thinking about this proposal is that it increases the after-tax rate of return on annuitized wealth and, by annuitizing earlier in life, an investor can increase the time horizon over which the higher after-tax rate of return is earned.[16] This incentive to annuitize at an earlier age is especially important for households that would receive more annuity income than the upper threshold at which the policy has a marginal effect since by annuitizing earlier in life – and therefore receiving lower periodic payments over a longer period of time – these households would increase the amount of wealth affected by the subsidy.

Holding the amount of wealth accumulated by a household as given, a subsidy for annuitization creates an incentive to substitute annuitized wealth for unannuitized wealth. One could think of this incentive as a price effect that comes from annuitized wealth providing relatively more consumption than unannuitized wealth after the subsidy. However, there is also an income (or wealth) effect of lowering the price of annuitization that could partially offset the price effect. The subsidy reduces the amount of wealth that an investor must annuitize in order to receive a given stream of annuity payments.

To fix ideas about how a subsidy can have these two different effects, consider the following simple subsidy. The government offers a 5 percent match for every dollar that someone commits to a life annuity at the time the annuity is purchased (as opposed to subsidizing the income from the annuity). The price effect is that a dollar's worth of annuity now only costs roughly 95 cents. For someone who is not purchasing a private annuity, this price change unambiguously induces them to be more likely to purchase an annuity. However, for someone who is already annuitizing some wealth, the income effect clouds the issue. For example, someone who would annuitize $100,000 of wealth without the subsidy could increase his or her stream of annuity benefits even if he annuitizes less than $100,000 of his or her wealth;

[16] This only applies to annuitization with non-qualified funds.

by committing $98,000 of private resources to the annuity, the total annuity purchase would be $102,900 ($98,000*1.05) since the government would be providing $4,900 in subsidy.

This distinction between the price effect and the income effect of a subsidy for annuitization becomes particularly important for proposals that impose caps on the amount of annuitized income (or wealth) that are eligible for the preferential treatment. For example, continuing from the example above, suppose that the 5 percent matching subsidy for annuitized wealth only applies to the first $100,000 of annuitized wealth. The price effect would only be relevant over the range of annuitization decisions between $0 and $100,000. For a household that plans to annuitize more that $100,000 even without the subsidy, this policy provides a pure income effect equal to the maximum subsidy of $5,000. A household that plans on annuitizing $200,000 without the subsidy could receive the same future annuity benefits by annuitizing $195,000 of their wealth plus the $5,000 of subsidy from the government. Of course, they would have some propensity to annuitize a portion of the $5,000 of wealth created by the subsidy but one would expect this propensity to be less than one so that the household would commit less of its pre-subsidy wealth to the annuity.[17]

While it is natural to think that the most important decision affected by policies aimed at increasing annuitization is the choice of the form in which households hold wealth (i.e., annuities versus other assets), subsidizing the purchase of annuities may also have incentive effects of household saving decisions. There are two separate channels through which a subsidy for annuitization can affect household savings. First, for some households, the subsidy would

[17] If the subsidy comes in the form of matching the wealth that goes into the annuity, then private insurers would observe an increase in annuity purchases from this household since the insurance company would not distinguish between the household's contribution and the government's match. However, if the subsidy takes the form of matching the income produced by the annuity (or decreasing the taxation of annuity income so that the after-tax annuity stream increases), then households facing a pure wealth effect from the subsidy would have an incentive to reduce their purchases of the annuity and insurance companies would observe a reduction in annuity sales (or amounts of wealth annuitized from deferred annuities) since the government's subsidy will flow to the household in the form of reduced annual income taxes (or as an annual subsidy if the program is done outside of the tax system).

increase the after-tax return to saving. Second, the nature of the insurance provided by an annuity may affect households' demand for precautionary savings. On the precautionary savings channel, consider a household that would not voluntarily annuitize any of its wealth in the absence of the subsidy because it finds insurance loads too high to merit the insurance provided by the annuity. As an alternative to using annuity markets, such a household might engage in precautionary savings in hopes of building up a sufficient buffer stock of wealth to avoid outliving its assets. If the subsidy improves the payoff to annuitizing by enough that the household decides to annuitize a substantial fraction of its wealth, then this precautionary motive for retirement savings will decrease and actual savings might decrease.

In contrast to the possible effects on precautionary savings, the increase in the after-tax rate of return to saving leads to a more traditional analysis of the household saving decision. For a household considering financing its retirement by saving in standard bond or equity markets and annuitizing that savings, subsidizing annuitization increases the after-tax rate of return on savings because any given amount of savings will allow the household to purchase an annuity with larger after-tax payments. Similarly, for someone considering saving through a qualified retirement account or a deferred annuity, subsidizing the purchase of annuities increases the after-tax return on their savings by lowering the effective tax rate on the withdrawals from the account.

The effects of this change in the after-tax return to saving are complicated. While it is natural to believe that the increased rate of return will lead people to save since the price of future consumption has fallen, two factors mitigate this conclusion. First, the income effect of the change in the rate of return makes it cheaper to reach any target level of retirement consumption so people may choose to increase consumption both early and late in life. The

empirical evidence on this issue is controversial but a consensus seems to have emerged that these plans (IRAs and 401ks for example) have had a positive effect on private saving.

Second, the limited nature of the preferential treatment of annuitization raises the issue that for some households it would not change the return to saving at the margin; instead, the policy could create a pure windfall that would increase future wealth. A household that would have sufficient wealth to generate annuity income in excess of the amount that receives preferential treatment should respond to the policy by saving less via the wealth effect. The effects of subsidizing annuitization on savings decisions are similar for individuals considering saving through both qualified accounts and non-qualified accounts. However, it is worth noting that subsidizing annuitization may differentially encourage saving for retirement *via* qualified accounts relative to saving *via* non-qualified accounts, and will generally encourage the purchase of deferred annuities relative to saving in other non-qualified accounts. Funds in a qualified account prior to annuitization earn returns that will eventually be taxed, but not until they are withdrawn. When annuitization is subsidized, the taxation that these earnings will eventually face is lower, raising the effective return on qualified funds between the time they are saved and the time they are annuitized.[18] Purchasing a deferred annuity with non-qualified funds is similarly encouraged by subsidies for annuitization since returns on the inside buildup are tax deferred.

3.4 Targeting and Distributional Concerns

There are several rationales for targeting policies aimed at increasing annuitization at specific portions of the population. In particular, one might want to limit the benefits of the

[18] The Lifetime PAY proposes treating annuities purchased with qualified and non-qualified funds differently. Hence, comparing the extent to which this policy encourages savings in qualified *versus* non-qualified accounts is not completely straightforward.

proposals that flow to wealthy households. Since one policy goal is to encourage people to take actions to avoid outliving their assets, the policies should be directed at people for whom this issue is a concern. Very wealthy households would not fall into this category. For someone with the potential to leave a large bequest, the intended bequest may provide a substantial buffer of assets that can be drawn upon for the expenses associated with living longer than expected. Furthermore, some well-off households already annuitize enough wealth that further annuitization might not achieve much additional security. The possibility that there is a point beyond which further annuitization is not necessary suggests capping the amount of benefit that any household can receive from the new law. As with other public policies, general distributional concerns are an important element of policy design.

Given the argument for targeting the policies at specific groups and limiting the amount of subsidy that is available to each household, the question becomes: what is the best way to achieve these goals? A simple and effective way of targeting who receives benefits is the approach taken by most of the current tax-based proposals, including the Lifetime PAY act. These proposals impose a limit (based on family structure) of the amount of income generated by an annuity that is eligible for exemption from income taxation, for example, the $5,000 limit of exempted annuity income in the Lifetime PAY proposal. For an exemption rate of 25% (as for annuities purchased with qualified retirement assets), this limit creates an effective threshold for the size of the annuity that is affected by the policy at $20,000. That is, if someone receives $20,000 in annuity payments from an annuity purchased with qualified assets, he or she can exclude $5,000 of this income from taxable income so that only $15,000 is taxable. Effectively, the proposal reduces the marginal tax rate on annuity income by 25% (e.g., a marginal tax rate of 20% would become a marginal tax rate of 15%) for a taxpayer that is below the effective

threshold. Based on current annuity prices (see below), a 66-year old single male would reach the effective threshold by annuitizing approximately $250,000 through a qualified account.[19] Annuitants with larger annuities would benefit from the policy but the benefit would be capped in overall dollar terms. The weakness of this form of targeting the benefits of the proposal is that households that would purchase annuities larger than the effective threshold without the new legislation would not have any additional incentive to purchase annuities; for these households, the policy would have a revenue cost to the government without encouraging annuitization.

An alternative mechanism for targeting specific households would be to condition the benefits of the proposal on household characteristics. For example, the incentive to annuitize wealth could be phased out based on overall household income. Unfortunately, these sorts of phase out provisions in the tax code typically create hidden increases in marginal tax rates that would effectively discourage other activities, such as work and saving. Furthermore, for older households, taxable income is a highly imperfect measure of well-being since many of these households have retired and are living off of accumulated assets. While measures of wealth might be better measures of the potential well-being of the elderly, the income tax system is not designed to measure wealth. Given these concerns, using phase outs would be an especially poor way to target incentives to increase annuitization.

Increasing the use of annuities by U.S. retirees will depend on shaping proposals that can gain acceptance by both Congress and the Administration as well as on having provisions that will stimulate people to annuitize. The choice between exempting annuity income from taxation and providing a tax credit for annuity income is related to the issue of who benefits from the

[19] For non-qualified annuities, calculating the effective threshold is much more complicated because a portion of the annuity payment is return of basis; this portion varies with age and the type of annuity. This difference would tend to increase the effective threshold level relative to qualified annuities. Offsetting this is the feature of the Lifetime PAY proposal which sets the rate at which income from non-qualified annuities can be excluded from income at 50% (instead of 25%).

policy. For example, an exemption-based policy will encourage more affluent households who pay income taxes and the dollar value of the benefit increases with the household's marginal tax rate. On the other hand, encouraging households with fewer assets and little or no taxable income will require a different approach, such as a refundable tax credit.[20]

To fix ideas about the potential distributional consequences of providing incentives for annuitization, we consider the wealth distribution of households near the normal retirement age. Table 3.1 replicates a table, based on the Health and Retirement Survey (HRS), from Dushi and Webb (2004). This table consolidates several waves of the HRS to focus on couples for which the head of household is age 65. It provides the wealth distribution by decile for this sample of couples broken down by type of wealth (excluding the top one percent of the wealth distribution). To place some context on the ability of the wealth represented in the table to finance consumption, at current annuity prices, a couple could annuitize $100,000 in exchange for a nominal annual benefit of roughly $8,100 (or $5,750 if the annuity is inflation protected).[21]

Several important patterns emerge from Table 3.1. First, wealth at retirement age is unevenly distributed. The average wealth of the 9th decile is 3.5 times larger than the average wealth of the 2nd decile. In part, this variance highlights the differences across households in how prepared they are for financing retirement. Second, Social Security wealth plays an

[20] The refundability of the credit affects access to the credit by households with low or zero tax liability. For households with positive tax liabilities (exceeding the value of the credit), refundability is of no consequence since the credit merely offsets an existing tax liability. Politically, one might worry about refundability allowing tax benefits to accrue to affluent households that have arranged their financial affairs such that they have zero tax liability. The exemption from taxable income approach would not allow these affluent households without taxable income to benefit from the tax incentives for annuitization. Alternatively, this concern provides a rationale for targeting the refundable tax credit to less affluent households – provided that "affluence" is measured by something other than taxable income.

[21] The data in the Table 3.1 are in 2000 dollars. Adjusting for inflation would increase the values by roughly 20 percent.

important role in the balance sheets of households near retirement age.[22] Even for the 5th decile, Social Security wealth is almost half (47 percent) of total wealth. Third, defined benefit (DB) pensions account for a substantial fraction of the wealth of this cohort but DB pension wealth is quite unevenly distributed. From the standpoint of ensuring that households are annuitized, DB pension wealth is attractive since the payments are a form of an annuity.[23] It is important to note that trends in pension coverage imply that future cohorts will have less DB pension wealth than the current cohort.

Fourth, the combination of Social Security and DB pension wealth implies that many households hold a considerable fraction of their wealth in annuitized forms. The fraction of wealth held in annuitized forms decreases steadily from the bottom decile to the top decile, mainly reflecting the declining importance of Social Security wealth relative to total wealth. The high fractions of wealth that is held in annuitized forms does not necessarily imply that these households are in good shape for retirement since many of the households with a high degree of annuitization have relatively low total wealth.

Fifth, the amount of wealth in qualified accounts (IRA and DC pensions) is relatively modest for this cohort. However, the data are somewhat dated (based on 1992-2000) so these balances understate the importance of this wealth for current and future cohorts of retirees.

In terms of targeting proposals to increase annuitization, the data in the table suggest that the bottom three deciles of the wealth distribution do not have substantial amounts of wealth that can be annuitized. Compounding this effect is that much of these groups' wealth outside of Social Security and DB pensions is held as housing equity. While reverse mortgages offer some

[22] Social Security wealth is calculated based on taking the discounted value of projected future benefits assuming no changes in the benefit formula (a reasonable assumption for the cohort at retirement age).
[23] While DB pensions are attractive in that they provide retirees annuitized payments, they face a host of other issues (including issues of solvency) that are relevant for policy discussions.

possibilities to tap into these assets and create annuity streams, the reverse mortgage market is almost non-existent. Given the common hesitancy for people to move out of their houses, these groups really have limited assets available to annuitize. Of course, the table presents averages for the deciles which masks the heterogeneity within the deciles so one would expect that many households in these groups do have portfolios that would allow them to take advantage of the policy to some extent (if the policy was structured so that it reached households with a zero marginal tax bracket).

Examining the wealthier deciles suggests that the capped policies would still provide marginal incentives for many households. That is, given the level of households' non-annuitized wealth, it appears that relatively few households are in the position that they were planning on annuitizing more than the effective thresholds implied by the caps in the policy proposals. For example, the average non-annuitized wealth in the 8th wealth decile is roughly $400,000 which would benefit at the margin from the Lifetime PAY proposal even if all of this wealth was annuitized through a qualified account.

3.5 Cost Effective Policy Design

The effectiveness of the policy proposals depends on the size of the incentives introduced by the policies and how responsive household annuity decisions are to these incentives. The cost to the government in terms of budget consequences depends on several design features of the policy. The most obvious of these are the rate of subsidy or size of the tax exemption and the level at which these benefits are capped. These policies would provide preferential tax treatment for annuities that would have been purchased in the absence of the policies so that the revenue consequences depend on both the level of annuitization without the policy and the change in

annuitization due to the policy. For households that would annuitize more than the effective thresholds implied by the policies, there would be a revenue cost without an associated benefit of increased incentives to annuitize.

Another issue for the budget consequences of these policies is the treatment of annuity decisions that occurred before enactment of the new legislation. This issue is the classic issue of how to create transition rules when tax policy changes. If the preferential treatment applies to annuity income without distinguishing pre-enactment and post-enactment annuities, then the legislation will create windfall gains for the owners of pre-enactment annuities. These windfall gains are a transition issue since over time the owners of the pre-enactment annuities will die and the entire population will have faced the new rules when deciding on how much to annuitize. Alternative (albeit cumbersome) transition rules could limit the government budget consequences of these windfall gains. It is worth noting that subsidies based on wealth annuitized that are paid at the time of annuitization would typically not face these transition rules since it is natural to think of such rules as applying to post-enactment transactions without retroactively applying to pre-enactment transactions.

4 The Money's Worth of Currently Available Annuities

4.1 Money's Worth: Descriptions and Formalities

The money's worth (MW) of an annuity is a measure of how fairly that annuity is priced for a given individual. Specifically, it is the ratio of the expected value of the income stream provided by that annuity to the premium paid for it. To illustrate MW calculations in a simple setting, consider a world with zero inflation, no taxes, and an annual interest rate of 5%. A 65 year old retiree is considering purchasing an annuity with $100,000 of her retirement wealth.

With that $100,000 premium, she can purchase an annuity that pays her $7000 each year, starting exactly 1 year from today. Whether this is a good deal or not depends on her expected lifespan. If she knows that she will die within the next year—say because she has recently been diagnosed with an incurable and fatal illness—it clearly is not. She will pay $100,000 for the product, and in return she will receive nothing; her MW would be 0.

If, on the other hand, she somehow knew that she was going live for exactly 35 1/2 more years, she would anticipate receiving 35 payments and the product would appear to be a better deal. In present value terms, she would expect to receive a total value of:

(4.1) $$EV = \frac{\$7000}{(1+.05)} + \frac{\$7000}{(1+.05)^2} + \cdots + \frac{\$7000}{(1+.05)^{35}} = \sum_{s=1}^{35} \frac{\$7000}{(1+.05)^s} = \$114618.36.$$

(Note that computing the present values requires discounting the nth payment by a factor $d_n = (1+.05)^n$.) The MW of this annuity for her would consequently be approximately 1.15 (i.e., $114618.36/$100000), and the product would be an excellent deal for her.

More realistically, our hypothetical retiree is uncertain about her future lifespan. Suppose she knows that she has some small probability—say 3%—of dying before she receives her first payment. She therefore knows that she has a 97% probability of living to receive her first payment. Similarly, suppose she knows that she has a 94% of living to receive her second payment, a 91% chance receiving her third payment, and so forth, so that she has a 4% chance of receiving her 32nd payment, a 1% chance of receiving the 33rd payment, and she has no possibility of living to receive any payments beyond this. She has an expected value of

(4.2) $$EV = 0.97 \cdot \frac{\$7000}{(1+.05)} + 0.94 \cdot \frac{\$7000}{(1+.05)^2} + \cdots + .04 \cdot \frac{\$7000}{(1+.05)^{32}} + .01 \cdot \frac{\$7000}{(1+.05)^{32}} = \$69148.94$$

from the annuity purchase, so the MW of this annuity for her is approximately 0.69.

Below, we compute MW's for an entire class of annuity products. As in the examples above, the products we consider are paid for with a single premium, exactly 1 year prior to the due date of the first annuity payment, and each annuity we consider makes annual payments thereafter. The general formula for the money's worth of an individual (single life) annuity can be written as:

$$\textbf{(4.3)} \quad MW = \frac{1}{Y} \cdot \left(\sum_{n=1}^{\infty} S_n \cdot \tfrac{P_n}{d_n} \right) = \frac{1}{Y} \left(S_1 \cdot \tfrac{P_1}{d_1} + S_2 \cdot \tfrac{P_2}{d_2} + \cdots + S_n \cdot \tfrac{P_n}{d_n} + \cdots \right).$$

In (4.3), Y is the premium paid for the annuity product, and the term in parentheses is the expected value of the annuity. S_n gives the probability that the nth payment will be made – i.e., the probability that the annuitant will survive for at least n years. P_n gives the after-tax size of the annuity payment received by the annuitant if she is alive n years after purchase, in current dollars – i.e., adjusted for inflation.[24] Finally, $d_n = (1+r_1)\cdot(1+r_2)\cdots(1+r_n)$ is the discount rate used for computing present values of money received in period n, where r_n is the real after tax interest rate in year n.

We also compute the MWs of joint and survivor annuities. We will focus on symmetric joint and survivor annuities, where the ratio between the payments if only one annuitant is alive and the payment if both annuitants are still alive is given by f=2/3. The MW of these annuities is given by:

$$\textbf{(4.4)} \quad MW = \frac{1}{Y} \cdot \left(\sum_{n=1}^{\infty} S_n^B \cdot \tfrac{P_n}{d_n} + \sum_{n=1}^{\infty} S_n^O \cdot \tfrac{f P_n}{d_n} \right),$$

[24] In a world with inflation but no taxes, for example, an annuity paying a (nominal) $7000 per year every year would therefore have a declining series of payments. We abstract from uncertain inflation here and henceforth. Mitchell et al. (1999) considered uncertain inflation, and showed that it is not particularly important for the sorts of calculations we do.

where S_n^B and S_n^O are, respectively, the probabilities that both annuitants will be alive to receive the nth payment and that exactly one of the annuitants will be alive to receive the nth payment.

4.2 Money's Worth: Data Sources

To use expressions (4.3) and (4.4) in computing the money's worth of life annuities, we need several pieces of data. We consider these data requirements and our sources for them in turn.

4.2.1 Survival Probabilities

We compute MWs for individuals of various ages with population-average mortality rates. We use the U.S. Social Security Administration's Actuarial Study 120 (Bell and Miller, 2005) for these mortality rates. It contains cohort mortalities (and mortality projections) for the every 10th annual cohort from 1900 to 2100. We focus on the 1920, 1930, 1940, and 1950 cohorts. We use these tables to compute the cumulative survival probabilities $S_n^{M,19xx}$ for males and $S_n^{F,19xx}$ for females for each of these cohorts. $S_3^{M,1920}$ gives the probability that a male born in 1920 who lives to his 86th birthday 2006 will be alive at that same date in 2009 (i.e., 2006+3), and so forth. For example, to compute the MW of a single life annuity product purchased by a male from the 1930 cohort purchased on his 76th birthday, with annual payments starting on his 77th birthday, for example, we use $S_n^{M,1930}$ for S_n in (4.3).

To compute the survival probabilities S_n^B and S_n^O we need for joint and survivor annuities in (4.4), we make the plausible assumption that the mortality probabilities of the two annuitants are independent.[25] For convenience, we focus on the couples consisting of a male and a female, each born on the same day of the same year (1920, '30, '40, or '50). For couples from

[25] This assumption rules out the possibility of a "broken heart" effect, whereby the surviving spouse's mortality probability increases upon the death of her partner.

the 19xx cohort, we thus take $S_n^B = S_n^{M,19xx} \cdot S_n^{F,19xx}$

and $S_n^O = \left(S_n^{M,19xx}\right) \cdot \left(1 - S_n^{F,19xx}\right) + \left(1 - S_n^{M,19xx}\right) \cdot \left(S_n^{F,19xx}\right)$.

4.2.2 Annuity Prices, Products, and Premiums

We use annuity price quotes from Vanguard.[26] They have an online interface that gives instant price quotes for a variety of annuity products. Quotes are based on the following pieces of information supplied by the potential annuitant.

- *Gender and birthday* (for both annuitants in the case of joint and survivor policies). We used as a birthday the day at which we requested the quote, July 23rd, 2006. We obtained quotes for both genders separately and for joint and 2/3 survivor annuities with a male primary annuitant and a female joint annuitant.[27]
- *The size of the premium*. Vanguard requires that this exceed $20,000, but pricing is linear above this amount – e.g., doubling the premium doubles the payment stream. Given this, we obtained quotes for $100,000 policies and used the linearity of pricing for computing the MWs of larger policies.
- *The type of payment* – whether the annuity is nominal, inflation indexed, graded, or variable. We obtained quotes only for nominal and inflation indexed annuities.
- *The number and frequency of payments*. We obtained quotes on life annuities without guarantee periods and providing annual payments.

[26] https://flagship2.vanguard.com/VGApp/hnw/content/AccountServ/Retirement/ATSAnnuitiesOVContent.jsp

[27] Vanguard's joint and survivor annuities with 2/3 survivor benefit are asymmetric with respect to the primary and secondary annuitant, paying the full amount if the primary annuitant is alive and reducing the payment only in the event that the primary annuitant dies and the secondary annuitant continues to live. These seem to be unnatural retirement products. Our quote is instead for a synthetic symmetric joint and 2/3 survivor annuity we create by taking a weighted average of prices from Vanguard for single life annuities for each gender and for joint and full survivor annuities.

- *When the payments will begin*. We obtained quotes under the assumption that they would start one year from the date of purchase.
- *The state of residence and whether the assets are qualified or nonqualified*. We obtained quotes based on the state of New York. The quotes for New York were the same for qualified and nonqualified annuities (as was true for almost all states) and were the same as quotes for almost all other states (California was a notable exception for which Vanguard offered slightly different quotes).

The price quotes we obtained give the nominal size of the first payment in the income stream.

Table 4.1: Initial payment, per $100,000 premium.

Age:	56	66	76	86
Gender	**Nominal Annuities**			
Male	$7347.00	$9003.48	$12350.52	$19358.40
Female	$6937.80	$8272.56	$11154.60	$18091.08
Joint and 2/3 Survivor	$6885.97	$8160.92	$10796.41	$16705.24
	Inflation Protected Annuities			
Male	$4881.48	$6556.32	$9836.88	$16695.24
Female	$4487.64	$5881.56	$8742.48	$15504.48
Joint and 2/3 Survivor	$4436.40	$5775.33	$8412.08	$14223.16

Source: Vanguard.com, 2006. See text for details.

Vanguard's annuity prices are reasonably representative of average market prices. Most prices we report differ from a 16-company average prices reported by www.immediateannuities.com by less than 0.5%, with Vanguard generally offering slightly better pricing

4.2.3 Interest Rates, Inflation Rates, and Taxes

To compute the discount factors d_n and to convert the nominal income streams provided by the annuities described above into real payments, we need both interest rates and inflation

rates. We infer nominal interest rates and inflation rates from the term structure of nominal and inflation protected treasury bonds, as of July 31st, 2006.[28]

As described above, the discount factors d_n in (4.3) and (4.4) are based on the *after tax* real interest rate. We therefore present results for marginal tax rates of 0%, 15%, and 25%. We use this same set of marginal tax rates to compute the after tax payments P_n received by annuitants. For qualified annuities, the entire annuity payment P_n (or $\frac{2}{3}P_n$ in the case of joint and survivor annuities with a single surviving member) is subject to tax, so the after-tax payment is given by the fraction $(1-mtr)$ of the pre-tax payment, where *mtr* is the marginal tax rate.

The tax treatment of non-qualified annuities is more complicated, since some of the annuity income is excluded from gross income for the purposes of taxation. We assume that individuals purchase non-qualified annuities using a lump sum of cash *Y* and we take this cash to be the "basis" for the annuity purchase. (This means that we ignore inside buildup considerations.) As described in Section 2, the tax code recognizes some portion of the annuity payments as the return of this basis, and excludes it from taxation. For example, a 65 year old male purchasing a nominal life annuity with non-qualified assets would be able to exclude nearly 60% of the payment from his annuity for approximately 15 years. In general, the tax code treats the amount *Y*/*L* of each annuity payment as "return of basis" for each of the first *L* years, where *L* is a life expectancy taken from IRS Publication 939. We use the *L* from this publication in our calculations of the after tax payment stream P_n for purchases with non-qualified assets.[29]

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[28] J. Huston McCulloch makes this data publicly available at http://www.econ.ohio-state.edu/jhm/ts/ts.html#comp. We thank him for providing this public service.

[29] For joint and survivor annuities with a low fraction *f* of survivor benefits and particularly for inflation protected annuities, it can be the case that *Y/L* actually exceeds the total annuity payment in some payment periods. The tax code allows this extra basis to be rolled over to future years. This can substantially complicate our calculations (and

An additional feature of the tax code makes computing the MW different for qualified and non-qualified annuities. Suppose that a retiree is considering spending $100,000 on an annuity policy. For non-qualified funds, the alternative to spending that money on an annuity would be to have $100,000 in cash. Consequently, we compute MWs using Y =$100,000 in (4.3) or (4.4). In contrast, the alternative to using qualified funds to purchase an annuity would be to have $100,000 in a qualified account. To spend that money, the individual would have to withdraw it from that account, subjecting it to taxation. Consequently, we use $Y = \$(1 - mtr) \cdot 100{,}000$ to compute MW.

4.3 Baseline MW results

Table 4.2 presents our basic results on the MW of the annuities policies offered by Vanguard as summarized in Table 4.1. It reports MW's for each of the age and gender groups from Table 4.1 for each of the different tax rates, and for both qualified and non-qualified sources of funds.

The MW's in Table 4.2 indicate substantial loads on annuity prices – on the order of 5-10 cents on the dollar for 56 year olds, increasing to 30-35 cents on the dollar for 86 year olds for nominal annuities. These loads are relatively consistent across households of a given age, with males facing slightly higher loads. The age 66 loads are modestly lower than the loads reported by Mitchell et al. (1999), and our results indicate a somewhat steeper increase in loading with

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the annuitant's tax returns) so we ignore this feature. Instead, we make the calculation under the assumption that individuals receive tax "rebates" on the extra basis. This may modestly overstate the value of the annuity. We verified that this approximation is reasonable by comparing our results to results under the assumption that the extra basis is simply forfeited – a more significant *under*estimate of the value of the annuity. The two MW estimates only differed by more than 1% for high tax rates and at old ages, and the largest difference – inflation protected joint and survivor annuities for 86 year old couples – was only about 2.5%.

age. This sharp increase in loads with age is consistent across products, genders, and tax rates. This pattern is strongly suggestive of an increase in adverse selection loads with age.

MWs for inflation protected annuities are uniformly lower than MWs for nominal annuities, implying loads of about 6-10 more percentage points. This compares well with previous estimates of load differentials in international annuity markets (James and Vittas, 2004).

Moving to higher tax rates appears to increase the value of annuitization of non-qualified wealth for inflation protected annuities, but very modestly or not at all for nominal annuities. There is a clear pattern of increases in MW with marginal tax rates within qualified accounts. This is an artifact of our use of $Y = \$(1 - mtr) \cdot 100{,}000$ in the denominator of (4.3) and (4.4). As described above, the thought experiment involved in this computation is the comparison of the value of the annuity purchased with qualified money and the value of that money *if it were withdrawn from the qualified account as a lump sum*; this withdrawal subjects the money to taxation all at once. In contrast, if the money is instead annuitized it is effectively withdrawn slowly, deferring much of the tax payment. Replacing the denominator by the present value of the after-tax income stream generated by a phased withdrawal of the money would mute this pattern substantially.

4.4 Evaluating Policy Proposals via MWs

Our approach to using the MW framework to evaluate the potential for policy interventions to enhance annuitization in the U.S. is simple: we will evaluate the impact of two policy proposals on the money's worth of annuities for the different types of households in Table 4.2. We will model these policies as having an effect on the MW of annuities *only* insofar as

they change the size of the after-tax payments P_n implied by the annuities in Table 4.1 and the tax treatment of annuity income. We will return below to discussing potential secondary effects.

4.4.1 Policy 1: The Lifetime PAY bill

We discussed the Lifetime PAY bill in Section 2. If enacted, this bill would provide a tax exemption on 50% or 25% of annuity income depending on whether the funds used for the purchase are qualified or non-qualified. In either case, the total amount exempted each year could not exceed $5000 per person.

For households with a positive marginal tax rate, this policy reduces the effective tax rate on annuity income, raising the after tax real income stream P_n provided an annuity and hence the money's worth of the annuities. We computed precisely how enactment of the Lifetime PAY policy would change the after-tax income stream each product-household pair in Table 4.2. We then used this to calculate the change in the MWs of these annuity products for these households. Table 4.3 summarizes our calculations for annuities purchased with an initial $100,000 premium.

Since the Lifetime PAY bill provides a tax exemption, it provides larger benefits for individuals in higher tax brackets, as Table 4.3 illustrates. The table also highlights the fact that the Lifetime PAY bill is not directly helpful for encouraging annuitization among households facing a zero marginal tax rate. For non-qualified funds, Table 4.3 indicates that the Lifetime PAY bill has similar effects on the MW of both nominal and inflation protected annuities and across types of households within a given tax bracket, though men appear to receive a slightly smaller percentage benefit. The table also illustrates that the bill differentially improves the value of annuitization of non-qualified assets at younger ages relative to at older ages, and it may therefore encourage earlier annuitization.

As Table 4.3 indicates, the effect of the bill on the MWs of qualified policies depends on the tax rate, but not on the household age or the type of annuity purchased. This independence is easily understood. Consider the 15% tax bracket, for example. Prior to the enactment of the bill, income provided by any annuity is taxed at 15%. The annuitant actually receives 85% of each payment, after taxes. With the policy in place, 25% of the income is tax-excludable, so the annuitant effectively faces an 11.25% tax rate on those payments and receives 88.75% of each payment, after taxes. Hence, each of the annuitant's after tax payments is 4.41% higher (i.e., 100% x (88.75-85)/85).

The age and annuity-type independence of the Lifetime PAY bill on qualified annuity purchases illustrated in Table 4.3 only applies for small enough annuity policies. Sufficiently large annuity policies will provide enough income to exhaust the income exemption limits in the policy. The Lifetime PAY policy will thus yield smaller increases in MWs for larger annuities. This effect is illustrated in Table 4.4, which shows the percentage increase in the MW of nominal, non-qualified annuities under the bill for larger annuity purchases. Although large enough policies benefit less from the bill, in percentage terms, than smaller policies, we see from the table that the bill can still provide substantial benefits even for annuity purchases as large as $1 million.

As discussed in Section 3, the limit on the tax exemption has an additional feature that tends to encourage annuitization at younger ages, a feature that applies to both qualified and non-qualified annuities: purchasing annuities at young ages provides a longer, lower income stream, as compared with purchasing annuities at older ages. For large-premium policies, this means that a higher fraction of early-age annuity purchases will be eligible for the tax exemption. This

effect can also be discerned in Table 4.4: at age 56, the percentage increase in MW is much less sensitive to the size of the initial premium than at age 86.

In summary, the Lifetime PAY bill has features which make it desirable as a policy for encouraging annuitization among the elderly. First, our MW calculations indicate that it can improve the value of annuitization by several percent, substantially decreasing the implied loads. Second, our analysis suggests that it tends to differentially encourage annuitization at younger ages. This may help to alleviate adverse selection issues in annuity markets.

4.4.2 Policy 2: An Annuity-Subsidy Policy

Encouraging lower net worth households to purchase an annuity may require a direct subsidy to the income provided by annuities. Under the policy proposal we consider here, the government provides a 5% refundable tax credit on income from qualified annuities and a 10% subsidy on income from non-qualified annuities, up to a maximum subsidy of $1000 per year.[30] We choose these parameters so that the policy is approximately comparable to the Lifetime PAY proposal.

For an individual facing a 20% marginal tax rate, the two policies (Lifetime PAY and the refundable tax credit) coincide.[31] For households facing higher marginal tax rates, the Lifetime PAY bill is more generous, and for households facing lower marginal tax rates, the subsidy policy is more generous. This relative generosity of the two policy interventions is illustrated by comparing Tables 4.4 and Table 4.5. The latter presents our estimates of the consequences of the refundable tax credit on the MW of various non-qualified annuities for various households, at the

[30] We envision this subsidy being implemented as a refundable tax credit, so it can equivalently be viewed as a tax break for annuity purchases.
[31] For example, a 25% tax exclusion reduces the effective tax rate on the first $20,000 of qualified annuity income from 20% to 15%, reducing taxes by exactly the same as a 5% tax credit.

$100,000 premium level, and we see that this latter policy is more generous at both the 0% and 15% marginal tax rates. Table 4.5 thus confirms that the refundable tax credit policy is differentially more effective at encouraging annuitization in lower tax brackets, relative to the Lifetime PAY bill.

We do not report the effects of the subsidy policy on purchases of annuities with qualified funds, since this effect is reasonably obvious: a 5% subsidy on these annuities would increase their money's worth by 5% (at least for annuities below the limit).[32] Nor do we report the effects of this subsidy policy as the size of the initial premium varies. The analysis and results are essentially identical to their analogs under the Lifetime PAY act.

4.4.3 Policy choices

One possibility to consider is to allow annuitizing individuals to elect their *choice* of two policy options discussed above: either a tax-benefit as in the Lifetime PAY bill or a refundable tax credit as per the subsidy bill we analyze. This choice option would benefit low marginal tax households relative to the Lifetime PAY bill, and would benefit high marginal tax households relative to the subsidy bill.[33]

Offering this sort of choice would thus have the advantage, relative to a single policy, of increasing some households' benefits from the policy. For example, taking the Lifetime PAY proposal as the starting point, adding a refundable tax credit would provide an additional benefit – and hence additional incentives to annuitize – to low-income households only. These

[32] This is not strictly true except for zero marginal tax rates. For positive marginal tax rates, a 5% subsidy actually has a greater than 5% effect on the MW. To see why, consider an annuity which is (pre-tax) actuarially fair. Then, for an individual in the 15% tax bracket, the MW is given by the ratio of 0.85 – the after tax present value of annuitizing $1 – to 0.85 – the after tax value of $1 withdrawn from a qualified account. With the 5% subsidy, the MW is now given by 0.90/0.85 > 5%.

[33] This sort of choice has some precedent in the current tax code in the area of work-related child care expenses. Some families can choose between taking the Child Care Tax Credit and using a Dependent Care Assistance Plan that allows it to fund child care with pre-tax dollars (i.e., the value of these accounts depends on the family's marginal tax rate).

households tend to be at greater risk of exhausting retirement resources, and providing this additional benefit seems like a natural extension of the Lifetime PAY proposal.

Another benefit of this two-track approach is that refundable tax credits are often associated with programs that are targeted at lower-income households (e.g., the recent refundable savers' credit and the Earned Income Credit). Thus, the two-track approach would allow the refundable tax credit to focus on lower income households and the exemption approach to encourage annuitization of higher-income families. A proposal that exclusively focused on a refundable tax credit for lower-income families that annuitize would be an especially poor policy choice in this area given the thinness of immediate annuity markets. This market thinness is not just an issue of low-income households not buying annuities. The annuity puzzle persists even for relatively high-income households. As discussed above, a major reason to promote annuitization is to help develop the annuity market and reduce adverse selection problems. Thus, a broad-based approach that reaches many households is necessary. Given that tax policy traditionally relies on adjusting taxable income (as opposed to providing refundable tax credits) to encourage particular behaviors, a two-track approach seems like an attractive option as a politically feasible way to encourage annuitization.

4.4.4 Secondary policy effects

We have focused in this section on the "direct" effect of these policy interventions on the MW of existing annuity policies. We have assumed, in particular, that there are no effects of the policy intervention on the price of annuity purchases (so Table 4.1 still applies). There are at least two reasons these prices might change. First, if there is market power in the annuity industry or if there is an upward-sloping market supply curve for annuities, then the benefits of these policy interventions would be partially offset by rising prices of annuities.

However, we believe that a more important effect tends to work in the opposite direction, leading to better annuity prices. As discussed in Section 2, as much as half of the loading in annuity markets appears to be due to adverse selection. These large adverse selection loads are attributable in large part to the thinness of existing markets. Policy interventions like the Lifetime PAY bill and a refundable tax credit for lower net worth retirees are likely to thicken the market, and thereby to reduce this portion of the load. Feedback effects could make this benefit substantial: market thickening due to lower prices would further encourage annuitization, further thickening markets, and so forth.[34]

5. Annuity Equivalent Wealth Analysis

The results of the preceding section indicate that the Lifetime PAY bill and the proposed subsidy policy would have significant effects on the monetary value of annuitization to retirees. This suggests that the policies can be effective in encouraging annuitization. This section explores the extent to which they will be effective in doing so. We employ a version of the AEW wealth framework described in Section 2. This framework makes assumptions on the preferences of households, and it assumes that their consumption, savings, and annuitization decisions are rationally driven by these preferences. We will ask: how much would a proposed policy intervention change the amount that these households would optimally annuitize?

This discussion in Section 2 suggests that we must be cautious in interpreting AEW estimates. Indeed, the "annuity puzzle" documented in that section is precisely the observation that this optimizing framework produces larger estimates of annuitization than we actually observe in the data. Since we employ similar techniques, we too find the "annuity puzzle:" our

[34] We might dub this feedback a "life-spiral," since it is the opposite of the adverse selection "death spirals" discussed in the literature on other insurance markets (Cutler and Reber, 1998).

predictions of annuitization patterns in the absence of any policy interventions are significantly higher than currently observed annuitization patterns. The usefulness of our estimates lies in the hope that, though the AEW framework produces over-estimates of annuitization levels, it is nevertheless a reasonable guide to *changes* in annuitization levels. Brown's (2001) results at least suggest that this is a reasonable hope. Even if one is unwilling to trust estimates of changes in annuitization levels, Brown's research indicates that one can have greater confidence that estimates of changes in the AEW levels can be a useful guide for estimating changes in annuitization propensities.

5.1: Formalities of our AEW model

We now describe our basic analytical framework. We relegate the most technical details to an appendix. Consider a household consisting of a man and a woman who are both one day shy of their 65th birthday and have just retired. They have some wealth W_0, and they own a life-annuity $\mathbf{A_0}$ which will provide a known stream of real after-tax annual payments for the rest of their lives. We will use A_{65}^B, A_{66}^B, A_{67}^B, and so forth, to denote the payments made if both are still alive at the end of their 65th, 66th, 67th years, and so forth. Similarly, A_{65}^O, A_{66}^O, A_{67}^O, etc., will denote the payments if only one is still alive.

This couple is trying to plan their retirement – in particular, they are trying to plan how they should consume their wealth and their annuity income over the years of their retirement. For simplicity, we assume that households do all of their consumption at the end of the year (and that they have already consumed at age 64). There are many consumption plans that the household could follow. They could, for example, plan to consume their entire wealth plus their age 65 annuity payment at the end of their 65th year, and plan to live on their annuity stream

thereafter. Or they could plan to consume very little in their 60s, saving all of their wealth and some of their annuity stream while planning to have very high consumption in their 70s and 80s (if they live that long). Central to our AEW analysis will be to determine that couple's *optimal* consumption plan and, in particular, how well off they will be under that plan. This naturally requires making assumptions about the preferences – the utility function – of that couple. We describe the technical assumptions we make in greater detail in the appendix. (They are in line with the standards assumptions made in the literature.) Of particular importance to this qualitative description of our calculations is our assumption that the couple has *no* bequest motive.

Our algorithm for computing the optimum consumption pattern follows a "dynamic programming" approach, which proceeds as follows. We first assume that households know that they will not live beyond age 100.[35] Absent a bequest motive, this means that we know how the household will behave if either or both of its members is lucky enough to live to age 100: the remaining member or members will simply consume all of their remaining wealth (including their age 100 annuity payment). This allows us to compute the well-being (utility) of the household at age 100 for any given wealth level and for any given set of surviving members. We will use $V_{100}^{B}(W)$ to denote the utility of the household at age if both members survive to 100 with wealth W. $V_{100}^{M}(W)$ and $V_{100}^{F}(W)$ will denote the analogous terms if only the man or woman survives, respectively.

Now consider the household at age 99. If both household members remain alive at age 99, they have a number of options. They can consume all of their wealth. This consumption give them high utility at age 99, but leaves them with very little wealth at age 100—in fact, just

[35] We pick 100 in keeping with Brown (2001) and others. The exact choice of "oldest age" is not particularly important for our results.

their age 100 annuity payment A_{100}^{B} or A_{100}^{O} —if both or one of them lives to their 100th birthday. Alternatively, they can consume very little at age 99, consequently getting little age 99 consumption utility, but leaving any survivors with substantially more wealth to consume at age 100, and hence expectations of greater utility later in life. Our preference assumptions allow us to determine the *optimal* amount of age 99 consumption: this is the consumption that optimally balances the utility of age 99 consumption and the expected "continuation" utility from (possible) age 100 consumption. We use $V_{99}^{B}(W)$ to denote the total utility expected for the couple from age 99 on—including both age 99 consumption utility and possible age 100 continuation utility—when they make this optimal age 99 consumption choice. Similarly, we use $V_{99}^{M}(W)$ and $V_{99}^{F}(W)$ to denote the "age 99 and on" utility function if only the man or only the woman survives to age 99.

We next iterate this process backwards, computing $V_{98}^{B}(W)$, $V_{98}^{M}(W)$, and $V_{98}^{F}(W)$. The number $V_{98}^{B}(W)$ gives their expected continuation utility from age 98 on *if* they make their optimal consumption choice at age 98 (and similarly for $V_{98}^{M}(W)$ and $V_{98}^{F}(W)$.) Continuing this iterative process back to the time of the age 65 annuity payment (i.e., the age of the 65th year) yields $V_{65}^{B}(W)$, $V_{65}^{M}(W)$, and $V_{65}^{F}(W)$, the expected lifetime utilities from that day forward for households of different compositions and with wealth *W*.

Now let us return to the household at the moment of retirement – one day before their 65th birthday and one year before their anticipated age 65 annuity payment (when the functions $V_{65}^{B}(W)$, $V_{65}^{M}(W)$, and $V_{65}^{F}(W)$ apply). They have wealth W_0 and anticipate an annuity stream $\mathbf{A_0}$. How well off is this household? Since we assume that they have already consumed at age 64, their utility comes from their anticipated consumption at ages 65 and on—i.e., they

will begin to get utility in one year. There are four possibilities: first, both the man and woman could survive the year, in which case the couple's expected utility for the rest of their life from age 65 on will be $V_{65}^{B}\left((1+r_{65})W_0 + A_{65}^{B}\right)$. (In writing this, we use the facts that the household earns interest on their wealth W_0 over the course of the year and that they receive their age 65 annuity payment at the end of the year, before their age 65 consumption decision.)

Second, the woman could die while the man survives, in which case the household's continuation utility from age 65 on will be $V_{65}^{M}\left((1+r_{65})W_0 + A_{65}^{O}\right)$. Third, the man could die while the woman survives giving continuation utility $V_{65}^{F}\left((1+r_{65})W_0 + A_{65}^{O}\right)$. Finally, both the man and the woman could die, in which case we take the continuation utility to be zero.[36] Taking a weighted average of these four continuation utilities, with weights proportional to the probabilities of the four events occurring, gives the total lifetime utility $V\left(W_0, \mathbf{A_0}\right)$ of the couple.

The preceding algorithm yields the lifetime utility $V\left(W_0, \mathbf{A_0}\right)$ for a given initial level of wealth and for a given annuity. For a couple without access to private annuity markets, the $\mathbf{A_0}$ is the annuity income stream provided by the combination of Social Security (SS) and defined benefit (DB) pensions. For a couple with access to annuity markets, the issue is more complicated: if they start with wealth W_0 and a pre-existing annuity $\mathbf{A_0}$, they can choose to use some of that wealth to purchase additional annuities, giving them a lower wealth W_0' and a different, larger annuity stream $\mathbf{A}_0'$. Different amounts of annuity purchases will give them different $(W_0', \mathbf{A}_0')$ combinations, and hence different lifetime utilities $V\left(W_0', \mathbf{A}_0'\right)$.

[36] This is a completely innocuous assumption for our purposes, since we take death probabilities to be given and immutable. It would give entirely equivalent results to assume that death yields extremely large negative utilities.

For computational ease, we assume that annuity markets offer a single type of annuity product. We then assume that households with access to annuity markets optimally choose the amount of their initial wealth W_0 that they wish to annuitize – i.e., they choose the amount that maximizes $V(W_0', \mathbf{A}_0')$.[37] Let V^* denote the lifetime utility the couple achieves when it chooses the optimal amount of annuitization, and we can define (our version of) AEW. V^* gives the lifetime expected utility of households with access to annuity markets. The AEW measures how much the household's wealth would have to be increased by to compensate them for removing their access to the annuity market. Mathematically, it solves:

(5.1) $V(AEW \cdot W_0, \mathbf{A_0}) = V^*$.

Note that our model invokes the assumption that all annuitization takes place upon retirement at age 65. Qualitatively similar analysis would apply if we allowed individuals the opportunity to annuitize at any age – or at many different times over the course of their lifetime. We take a view that the model is necessarily stylized in any event, and concentrating the annuitization decision at a single age provides a reasonable approximation to the slightly more flexible model which allows delay of annuitization. Furthermore, Table 4.2 shows sharply increasing loads with time, suggesting that the assumption that annuitization will take place at retirement or shortly thereafter, and never again.[38]

[37] As described in more detail in the appendix, we distinguish between qualified and non-qualified wealth, and we assume that individuals use a stacking rule: they annuitize all of their qualified wealth before annuitizing any of their non-qualified wealth. Qualitatively, this seems like a reasonable rule of thumb, since qualified wealth is presumably wealth that households have pre-designated for funding retirement. However, we have simply *imposed* this rather than solving the substantially more difficult dynamic programming problem which would allow individuals to optimally choose which type of wealth to annuitize.

[38] Dushi and Webb (2004) use a similar model to ours and explicitly allow for this more flexible sort of annuitization. They argue that many households would optimally delay their annuitization decision substantially.

5.2: Using AEWs to Evaluate Policy Interventions – Intuition and Calibration

Although the preceding analysis was geared towards estimating the value of access to annuity markets for various households, computing V^* requires computing the *amount* of annuitization undertaken by optimizing households. Subject to the caveats above, we can use this to evaluate the efficacy of policy interventions in encouraging annuitization.

We start with a collection of 40 households, calibrated to capture the distribution of U.S. households consisting of a husband and wife around age 65. We take an inflation protected joint and 2/3 survivor policy offered by Vanguard, and we assume that this is the unique annuitization option available to these households. Then, for each our 40 households, we compute the AEW and the optimal amount of annuitization they would undertake using the algorithm described in Section 5.1 above.

To evaluate a proposed policy intervention, we determine how that policy intervention will affect the after-tax real payout streams from privately purchased annuities of different sizes. We then find the new AEW and the new optimal amount of annuitization each household will undertake when faced with these modified payout streams from privately purchased annuities. Finally, we compare the new AEW and optimal annuitization amounts with the old values to determine the policy's effects.

These computations require substantial data input. We already discussed much of this input – e.g., the term structure of interest and inflation rates – in Section 4. We take mortality rates from the SSA Publication 120 (Bell and Miller, 2005) used in Section 4, but we consider households born in 1941 (i.e., who are turning 65 in 2006). The publication only contains

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Their analysis relies on loads which are constant across different ages of annuitization, in contrast to the sharply increasing loads for real-world annuities. Whether loads which increase this rapidly are sufficient to induce optimizing households to annuitize at 65 is an open question.

mortality rates for the 1940 and 1950 cohort, so we linearly interpolate mortality rates to arrive at 1941 mortality rate estimates. The remaining inputs consist of preference parameters (for the preferences described in greater detail in the appendix), tax rates, the size and structure of pre-existing annuities, and annuity prices. We consider these in turn.

Preference parameters: We make the standard assumptions used in the literature (e.g., Brown (2001) or Mitchell et al. (1999)), with a relative risk aversion parameter of 1.5, a "joint consumption factor" of 0.6245 (which captures inter-household consumption complementarities), and a subjective discount rate of 3% per year for future utility.

Tax rates: We compute approximate tax rates using the National Bureau of Economics Research's TAXSIM calculator for each of the 40 households we describe in greater detail in Section 5.2 below. Each of our 40 households has some DB wealth, some DC wealth, some Social Security wealth, and "other" wealth. We assume each couple files jointly, has no children, wages, dividends, or special deductions. We take other property income to be 5% of "other" wealth. We assume that taxable pension income is given by 7.5% of pension plus IRA wealth, and that gross Social Security income is given by 7.5% of Social Security wealth. We restrict attention to Federal taxes only by using New Hampshire as the state of residence.

Pre-existing annuities: We treat both Social Security and DB pensions as pre-existing real annuities with 2/3 joint and survivor benefits. The 2/3 survivor benefit is the ratio of the Social Security benefits for a surviving spouse to the Social Security benefits for a couple with one worker with a substantially larger earnings history than the other (e.g., a one earner household).

Annuity prices and types: We use joint and 2/3 survivor annuities, and we separately consider inflation protected and nominal payments. We treat males and females symmetrically, so that the same 2/3 survivor benefits are due to either survivor, and the private annuities have the same

symmetric structure as our social security and DB payments. We priced the policies on July 12, 2006 for a couple born on July 13, 1941, with annual payments commencing on July 13, 2007, and found that each $100,000 premium would buy a real (respectively, nominal) joint and survivor income stream with initial payment $5757.76 ($8108.73).[39]

5.2.1 Constructing the household distribution

In constructing a distribution of households, our goal is to consider the wealth distribution of a cohort at the beginning of retirement. We start with the distribution reported by Dushi and Webb (2004) that is summarized in Table 3.1.[40] One approach would be to take an average couple from each decile as representative of the decile. However, this approach would ignore some important variation in characteristics that would affect annuitization decisions within each decile. Specifically, annuitization decisions will depend on the amount of pre-annuitized wealth and, potentially, the amount of wealth in qualified retirement accounts. To capture this heterogeneity within deciles, we construct four representative households for each decile. Each representative of the decile has the same amount of total wealth (equal to the average total wealth for the decile) but a different composition of wealth. To maintain the same amount of total wealth, we adjust non-retirement financial assets. We weight these four couples so that they are representative of the decile.

[39] As discussed above, the joint and 2/3 survivor annuities offered and directly quoted by Vanguard distinguish between the primary and secondary annuitant, and only reduce payments to the 2/3 level if the *primary* annuitant dies. Couples who want symmetric joint and 2/3 survivor annuities, however, can readily achieve them by combining Vanguard's policy offerings. A couple who buys three annuities—an individual annuity paying $10,000 per year for each of the two household members, and a joint and *full* survivor annuity paying $10,000 per year—will replicate the purchase of a joint and 2/3 survivor annuity paying $30,000 per year. We use this to construct and price a "synthetic" symmetric joint and 2/3 survivor annuity.

[40] Dushi and Webb imputed DB and SS wealth from incomes reported in the HRS using a fixed rate of interest and inflation. In our (still preliminary) calculations, we treated total reported DB and SS wealth as the present value of the *after tax* income stream they provide, discounted by the after tax real interest rate for each household. This allows us to treat the income stream provided by DB and SS wealth as untaxed in our AEW routine. We suspect that this is a relatively unimportant distinction for our purposes, but we are still in the process of confirming this suspicion.

One representative from each decile does not have a defined benefit pension so it is defined as having zero DB pension wealth. However, we allocate 80 percent of the decile's overall IRA and DC pension wealth to these couples. The weight for this household is the fraction of households in the decile that do not report having a DB pension. We account for heterogeneity in DB pension wealth by assuming the following distribution of DB wealth across the three representative households with DB pensions. We begin by calculating the average DB wealth for the decile conditional on having a DB pension. We assign one representative couple this average DB wealth; the weight for this household is 50% of the total weight for DB households. The third representative has a DB pension with a below average wealth (specifically, 50% of the average value) and the fourth representative has DB pension that is above average (specifically, 150% of the average value); the weight for each of these is 25% of the total DB household weight. In addition, we allocate each of the couples with a DB pension a proportional share of the 20 percent of the decile's total IRA and DC pension wealth.[41]

5.3: Results

Tables 5.1 and 5.2 summarize our central findings for the effects of the Lifetime PAY bill and a refundable tax credit proposal (RTC), respectively, using inflation-protected annuities. In both tables, we present results averaged across the four classes of household within each decile of the population described in Section 5.2.1. For simplicity, our calculations assume the RTC policy is in place for all retirees, regardless of their net wealth. The last two rows present overall or average effects for the entire population and for the subset of the population below the 10th decile in wealth, respectively. We single out this sub-sample because we believe that bequest

[41] In a few cases in the bottom decile, this algorithm leads to negative financial assets. In these cases, we constrain financial assets to be zero and adjust the DB pension balance accordingly, assigning the residual DB wealth to the households who would otherwise be assigned no DB wealth. This "fix" is of quantitatively minor importance.

motives are most likely to play a role among the wealthiest households, and the AEW framework may therefore be less well suited to analyzing the top decile. Column 4 of both tables reports our estimates of the optimal fraction of wealth voluntarily annuitized in the absence of any policy intervention, while Column 5 contains our estimates of the optimal fractions voluntarily annuitized in the presence of the respective policy interventions. The next to last row of Column 4 of these tables indicates our estimates that 15.89% of total retirement wealth (6.50% within the first 9 deciles) would be optimally pre-annutized, higher than observed annuitization levels in the HRS (Poterba et al., 2003). This is in line with the "annuity puzzle" described above.[42]

Our estimates of changes in the percent of wealth annuitized are reported in Column 6 of the tables. Table 5.1 suggests that the Lifetime PAY bill will increase overall annuitization by 5.67% (6.58% within the first 9 deciles), an increase of approximately $51,000 of annuitized wealth per household, with the largest percentage increases occurring in the 7th and 8th deciles of the wealth distribution. Table 5.2 indicates our estimates that the subsidy bill will increase overall annuitization by 6.17% (7.52% below the 10th decile), or about $55,000 per household, with the greatest percentage increases occurring in the same deciles.[43]

These results rely on the behavioral assumptions of the dynamic programming exercise. The "annuity puzzle" discussed in Section 2 makes it clear that these assumptions lead to overestimates of annuitization levels. For this reason, we regard our estimates of annuitization levels as unreliable. We instead focus primarily on our estimates of the changes in annuitization levels, with the hope that our reliance on predicted changes in annuitization mitigates concern

[42] Again, the relative youth of the retirees in the HRS may mask larger levels of ultimate annuitization. However, we find much starker "annuity puzzle" results for (unreported) computations using nominal annuities instead of inflation protected ones – with "predicted" annuitization levels of 37.73% and 27.23% of retirement wealth for the entire population and for deciles 1-9, respectively.

[43] We obtain similar estimates of the change in annuitization when we use nominal instead of inflation protected annuities. The Lifetime PAY bill is estimated to increase overall annuitization by 4.94% (6.76% for the first 9 deciles), or about $44,000 per household, while the subsidy policy is estimated to increase overall annuitization by 7.14% (9.85% for the first 9 deciles), or about $64,000 per household.

over the difficulties of squaring the dynamic programming results with behavior. Our relative confidence in using the dynamic programming approach to estimate changes in, as opposed to levels of, annuitization behavior builds on Brown (2001). As discussed in Section 2, Brown shows that estimates of AEWs from dynamic programming problems are indeed predictive of variations in annuitization decisions.

Columns 7 and 8 of Tables 5.1 and 5.2 provide our estimates of the AEW with and without the policy proposals in place. Since the proposals effectively reduce the load on annuities, they increase the value of having access to these markets, which is represented by a higher AEW. For example, the Lifetime PAY proposal increases the AEW for the eighth decile (i.e., a composite of the four different representative households that we create for the eighth decile) from 1.019 to 1.047. This difference suggests that the policy proposal reduces the load in the annuity market in a way that is the equivalent to increasing these households' wealth by 2.6 percent.

Table 5.1 again confirms what we saw in Section 4: the Lifetime PAY bill is unlikely to have substantial effects in encouraging annuitization among retired households with little wealth. We can see this by looking at Column 6, which shows that the first four deciles are predicted not to change their annuitization patterns at all, or by looking at Columns 7 and 8, which indicate that their AEW's are unchanged by the policy intervention. These results simply reflect that our estimated marginal tax rates for the households in the first four deciles are zero In contrast, refundable tax credit proposal appears to be better targeted towards increasing annuitization among the lower deciles of the population, although Table 5.2 indicates that even this policy may have no effect for the poorest retired families, who have the highest fractions of their wealth pre-annuitized.

The wealth and pre-annuitization patterns in the populations we constructed from HRS data are reasonable representations of the year 2000 age 65 cohort. There has been a well documented trend towards the decreasing importance of DB wealth and the increasing importance of DC and IRA wealth. To explore the consequences of this trend, we generated a fictional population which is based on the year 2000 age 65 cohort but has more DC wealth. Specifically, we created this population by converting 50% of the DB wealth of each of the 40 households in our baseline population to DC wealth. Table 5.3 reports our results on the effectiveness of the Lifetime PAY bill for this population. The estimates in Column 6 indicate that the policy would increase annuitization by 6.10% of retirement wealth, or an average of about $55,000 per household. This is modestly larger than, but reasonably comparable to the estimates for our baseline population in Table 5.1. The estimates in Table 5.3 differ substantially from Table 5.1 in that they indicate substantially higher baseline (pre-policy) levels of voluntary annuitization – about 27% on average. This reflects the increased importance of voluntary annuitization for households with less pre-annuitized wealth. Estimates for the subsidy bill show a similar pattern, so we do not present a separate table. We estimate this policy would increase annuitization by about 7.95% on average, or about $71,000 per household.

We view our estimates of changes in annuitization levels as best-guess baseline estimates, but it is important to note that there is still considerable uncertainty regarding these estimates. To highlight this uncertainty, consider an alternative estimation procedure which uses Brown's (2001) results more directly. He estimates that a 1% increase in the AEW is associated with a 1% increase in the ex-ante probability of annuitizing. If we make the heroic assumption that ex-ante probabilities of annuitizing are perfectly indicative of subsequent behavior and that households who do annuitize choose to annuitize fully, then we can combine this elasticity

estimate with our estimated changes in AEWs for our representative households to estimate the effects of the proposed policy changes. This procedure yields estimates of annuitization increases of $8,600 and $4,900 per household for the Lifetime PAY and subsidy policies, respectively, significantly lower than our baseline estimates. While these alternative estimates highlight the uncertainty in our baseline estimates, we place considerably less confidence in them relative to our baseline estimates: not only do they rely on several heroic assumptions, but it is not even clear that we can directly link Brown's results to our AEW estimates at all, as there are significant differences in how we operationalize the AEW computations.[44]

5.3 Revenue Costs

Out results suggest that both the Lifetime PAY bill and the RTC proposal would be effective in encouraging annuitization. It is important to address the question of how costly these policies would be. Before we proceed to the technical details how we estimate these revenue costs, it is worth briefly discussing the broad types of costs these policies induce. Fixing attention on a given cohort – say the cohort just turning 65 – there are two distinct types of costs associated with implementing these policies. First, these policies have *windfall* costs from the lower tax rates – and hence lower revenues – on households from this cohort that would have annuitized some of their wealth even without the policy change. Second, these policies may have revenue consequences on the additional annuitization that some households undertake. Absent the policy change, interest income on the money used for this additional annuitization would be subject to taxation without the policy (as would spending if this wealth is in qualified

[44] For example, Brown's AEW computes the value to a household of having access to an actuarially fair annuity market and annuitizing its wealth fully. Our AEW values represent the value to a household of choosing its optimal amount of annuitization in an annuity market with insurance loads that are representative of those faced in current markets.

accounts). This tax revenue may differ from the tax revenue collected in the presence of the policy when the wealth is instead annuitized.

Taken together, these two types of cost for a given cohort can be viewed as the "steady-state" revenue costs associated with the policy implementation. There may be additional revenue costs associated with the *transition* to the new policy regime. In particular, older cohorts who have already made their annuitization decisions may still benefit from the policy change; this is another windfall cost. We first present a range of estimates of the steady-state revenue cost per dollar of additional annuitization for the two policies. We will then briefly consider the transition costs.

5.3.1 Steady-State Revenue Cost Estimates

Our estimates of the steady-state revenue costs are designed to complement the estimates of increased annuitization based on Column 6 of Tables 5.1, 5.2, and 5.3, and they come with similar caveats to those estimates. We compute these estimates as follows

- For each household, we start with a "baseline" percentage of wealth voluntarily annuitized in the absence of the policy. For our upper-bound cost estimates, we will take this baseline to be our voluntary annuitization estimates from the third column of Tables 5.1, 5.2, and 5.3. In light of the "annuity puzzle" this is likely an overstatement of the amount voluntarily annuitized, so we also take a lower-bound baseline of *no* annuitization. By assuming no pre-existing annuitization through private annuity markets, the policy will have a windfall cost of zero since there is no annuitization without the policy; this lower-bound obviously understates the government's cost. To each baseline annuitization level, we then add the estimates of the percentage increase in

annuitization from Column 6 of the associated table.[45] This gives us an overall percentage annuitized for each decile in the presence of the policy.

- Next, we compute the after-tax real income stream provided by this overall annuitization level both with and without the Lifetime PAY bill in effect.
- Finally, we take these after-tax income streams and compute the difference in the present discounted value of these two streams. This is our estimate of the revenue cost of the passage of the bill for this household.[46]

This procedure implicitly assumes that, absent any policy intervention, each household's decision to annuitize is approximately revenue neutral, in present value terms, from the Federal government's point of view. This seems like a reasonable assumption, though it may not be exactly correct in practice. Under this assumption, the revenue costs associated with the additional annuitization induced by the policy change and the revenue costs associated with the windfall gains from already-annuitized assets are treated symmetrically.

Table 5.4 summarizes our revenue cost per dollar of additional annuitization estimates associated with the estimated annuitization levels from Tables 5.1 and 5.2. These estimates suggest that the policies are likely to be quite cost-effective in the steady-state, with the Lifetime PAY bill estimated to cost between about $2100 and $6400 per household, or between about 4 and 12 cents per dollar of additional annuitization, and with the RTC proposal being modestly less costly, between about $2000 and $5500 per household, or 3.5 and 10 cents per dollar of additional annuitization. We also did similar calculations using nominal annuities as the available product instead of inflation protected annuities. This raised the lower bound estimates modestly, but approximately doubled the upper bound estimates to about 24 and 18 cents per the

[45] We actually do these estimates separately for each of the 40 households in the underlying population and then average across households.
[46] For this present value calculation, we use the *pre*-tax real-interest rate.

dollar for the Lifetime PAY and RTC proposal, respectively. These higher upper bounds reflect our calculation that, absent any policy intervention, households would voluntarily annuitize a larger fraction of their wealth when offered nominal annuities instead of the inflation protected ones – i.e., the "annuity puzzle" looks larger for nominal annuities.[47]

These calculations of costs are based on several assumptions which may bias them downwards. First, they assume that the estimates of increases in annuitization from Tables 5.1 and 5.2 are correct; our uncertainties about these estimates apply here as well. Second, the households used in the estimates in Tables 5.1 and 5.2 have a large portion of their wealth in the form of defined benefit accounts. Future cohorts will have less of their wealth in defined benefit plans, and therefore would presumably tend to voluntarily annuitize a larger fraction of more of even absent any policy interventions. This will tend to increase the windfall revenue costs associated with the policy interventions. To get a feel for how large this cost increase will be, we use the same thought experiment as we did in Table 5.3: we create a simulated population by shifting half of each household's DB wealth into DC wealth and use the same methodology to compute the revenue costs per dollar of additional annuitization using this modified population. Table 5.4 also reports these results. It indicates that this would indeed increase the costs associated with the policy, but the costs would still remain relatively modest, with upper bounds of about $8600 and $7900 per household or about 16 cents and 11 cents per dollar of additional annuitization for the Lifetime PAY policy and subsidy policies, respectively.

[47] This reflects the fact that our model households find the nominal policies more desirable than the inflation-protected annuities. This preference arises for three reasons. First and foremost, the inflation protected annuities we consider have higher implicit loads than the nominal ones we consider (*viz,* Table 4.2). Second, positive loads on annuities can increase the relative appeal of front loaded annuities (such as the nominal annuities we consider) even if the loads were the same across products. Intuitively, increasing loads induce households to reduce their annuitization levels; one way they can accomplish this is by shifting their annuitization towards front-loaded products that effectively have less "built-in" annuitization. Finally, the low real interest rate term structure implies that many of our households face after-tax real interest rates below their 3% rate of time preference. This would make front-loaded annuities more desirable even without *any* loading.

5.3.2 Transition Costs

We use the following procedure to obtain a "back of the envelope" estimate of the transition costs associated with a policy change. We maintain the assumption that all households annuitize at age 65, and never again. This means that at the time the policy change is undertaken, the cohorts aged 66, 67, and so on, at the time, receive benefits from the policy change without changing their annuitization behavior. To measure the magnitude of these benefits, we make the (simplistic) assumption that each of these cohorts is an "aged" version of the age-65 cohort summarized in Table 3.1. We further assume that each household had annuitized at age 65 according to third column of Table 5.1. We then "age" each cohort using their mortality tables, and we compute the expected present value of their tax benefit from the new treatment of annuity income from the time of passage forward.

Table 5.5 summarizes our results. It reports the increase in the present discounted value of the existing annuity stream of every 5th cohort (older than 65) pursuant to each of the two policy changes.[48] The results are reported in per living households at age 65 in that cohort. Table 5.5 indicates that the cost per pre-annuitized cohort decreases rapidly with the age of that cohort. This is for two reasons. First, older cohorts have fewer surviving members at the time of the passage of the bill. Second, older cohorts have higher mortality rates; hence, the present value of the existing annuity stream is lower.

The final row of Table 5.5 reports the equally weighted sum of the costs across all cohorts. It indicates a (back-of-the-envelope) estimated total transition revenue cost of approximately $55,000 and $44,000 per household in a single cohort for the Lifetime PAY bill and RTC proposal, respectively. This is on the order of the total increase in annuitization of the

[48] It is important to note that these revenue costs are in present value terms over the entire life of the households, not annual revenue costs.

age 65 cohort, making it seem large. However, since this calculation is done on a per household in a single cohort basis, it effectively collapses the entire cost of the transition onto a single cohort. To get a more realistic feel for the transition cost, we make the (simplistic) assumption that each future cohort will be identical to this first cohort and that the policy will remain in place forever. We then compute the cost per dollar of increased annuitization over the entire future (in expected present value terms). This effectively spreads the cost of the transition over all future cohorts to be affected by the policy change. Using an interest rate of 3%, we compute the present value of the total future increase in annuitization to be $1.75m (i.e., $51,000×1.03/.03) and $1.89m and per age-65 household for the Lifetime PAY and RTC proposals, respectively. This implies a transition cost of about 3.1 cents or 2.3 cents per dollar increase in annuitization for the two respective proposals. This suggests that, in present value terms, the transition costs are relatively modest as compared with increase in annuitization achieved and also as compared with the steady-state costs.

6. Broader Policies for Encouraging Annuitization

Our analysis has focused on tax policies aimed at improving the incentives that households face to annuitize some wealth for retirement. While our analysis based on forward-looking decision making suggests that these price incentives should increase annuitization, the existence of the annuity puzzle suggests that many factors beyond simply tax proposals for annuities affect households' decisions. For example, financial education could also play an important role. In this section, we briefly outline some other possible government strategies for increasing annuitization. We begin by discussing ways that the government could improve

education about annuities and access to annuity markets. We then discuss some issues in how the government might encourage the creation of new annuity products.

One strategy would focus on financial education for retirement planning. While the government would not want to enter the business of offering detailed financial advice, it could provide some general information about retirement options, including the need for savings and the advantages of annuitization. Since 1999, the Social Security Administration (SSA) has sent annual statements to American workers that explain their potential Social Security benefits. In conjunction with explaining benefit options for Social Security, the SSA must explain fairly complicated concepts about annuitization in informing workers about their options for taking Social Security benefits; for example, the SSA explains the trade-offs between starting benefits at the early retirement age and delaying the start of benefits until a later age (with a higher monthly benefit). The government could extend this sort of information to include discussions of the advantages and disadvantages of annuity markets.

This information campaign could help combat the public's lack of understanding of annuity products that is discussed in a task force report of the American Council of Life Insurers (ACLI, 1999). This report suggests that many individuals only have a vague understanding of annuity products and often view the purchase on an annuity as a gamble with the odds stacked in favor of the insurance company. As Brown and Warshawsky (2000) point out, if potential annuitants view annuities as a gamble that increases risk as opposed to an insurance product that reduces risk, it is unlikely that they will behave as described by rational economic models of annuitization decisions. If consumers believe that annuities are an unfair gamble sold by insurance companies, then they might not trust any information from private insurers since they view the insurance company as a casino that is trying to entice them to gamble. Thus, an

increase in government-provided information might allay consumers' fears of information coming from a party with a vested interest in selling an unfair product. Of course, the government information would need to be balanced and provide a clear explanation of both the advantages (e.g., longevity insurance) and disadvantages (e.g., insurance loads) of annuities.

While all individuals have access to many private insurance firms that sell annuities, retirement savings is decoupled from the annuity market for many people. This separation stems from the fact that retirement assets are often held in tax-advantaged accounts that do not directly offer annuitization as a withdrawal option. Thus, annuitizing these assets requires a two-step process of withdrawing the funds from the retirement account and rolling them over into an annuity product. Brown and Warshawsky (2000) report that, in 1997, only 27 percent of 401(k) plan participants had the option of purchasing a life annuity without this two-step process. There are several possible ways to strengthen the link between retirement saving and annuitization; we will discuss these options below. As evidence that such changes might increase annuitization, Brown and Warshawsky discuss the rather sparse evidence on take-up decisions of annuity options from DC pension plans. One interesting piece of evidence is that Ameriks (1999) finds that annuitization rates are quite high for TIAA-CREF participants – the main source of defined contribution pensions in the education and research sectors. Traditionally, TIAA-CREF has designed rules to encourage annuitization and has provided substantial financial education to couple retirement savings with annuitization.

One small step for strengthening the link between retirement savings and annuity markets is that the rules for 401(k) (and similar tax code provisions for other employer-provided defined contribution retirement accounts) could require that life annuities be included as a withdrawal option. This requirement would eliminate forcing retirees to take two steps to annuitize these

assets. It would reduce the administrative costs of annuitization and help to promote annuitization by signaling that the government believes that annuitization is sufficiently important for retirement savings that these plans must offer such an option. The disadvantage of such a proposal is that is would slightly increase the cost of administering a 401(k) since employers would need to include a life insurance company as one of the investment options in the plan since annuities are sold by life insurance companies. It is unclear whether employer decisions about offering plans would be sensitive to this type of requirement.

This proposal focuses mainly on convenience, reducing transaction costs, and improving information. The link between saving and annuitizing through these plans could be made even more explicit in many ways. Following on the behavioral economics findings that the "default" option matters for savings choices through retirement savings plans, one could also design these plans such that the default option is that the savings is annuitized at a specific age in the future. Changing the default option would not legally bind anyone to annuitize wealth but would require employees to take an action to avoid annuitization rather than take action to annuitize.

A more stringent version of linking saving with annuitization would be to redesign 401(k) plans such that they have two tiers of saving. One tier would work as contributions and withdrawals work under current rules. The other tier would commit the savings to be used as a life annuity. To induce people to use the second tier and give up the flexibility advantage of the first tier, the government could offer larger tax incentives for the second tier of savings relative to the first tier of savings.[49]

[49] Rather than offer the carrot of additional tax incentives to invest with a pre-committed annuity, the government could also mandate that some fraction of 401(k) savings be invested in the second tier. The problem with such mandates is that they could have the unintended consequence of decreasing the total amount of savings undertaken through the plans. Such a reduction in the level of savings could have a detrimental effect on the adequacy of retirement income.

A second broad area for government involvement in increasing annuitization is to facilitate the creation of new retirement planning contracts that would facilitate annuitization. One example of how government policy has already facilitated improvements in the annuity market is the role government-issued inflation-protected bonds have played in helping to foster the development of inflation-protected annuity products. In creating a market for these bonds, the government has made it easier for insurance companies to offer inflation-protected annuities. Loads on these products are still relatively high, which may reflect their relatively recent introduction; the market for these products will hopefully improve over time.[50] A well-developed market for private inflation-protected annuities would address one of the major concerns which arise as the economy moves from relying on DB pension plans to DC pension plans for financing retirement, namely the relative advantage that the former have in often providing an inflation-protected stream of benefits.

In spite of the obvious benefits in terms of the flexibility that DC pensions allow individuals to exercise in determining their future retirement resources, they have several unattractive features *vis a vis* the DB pensions they are replacing. Beyond the benefits of inflation protection, there are at least two advantages of DB pensions. First, DB plans are purchased by large groups of workers who have effectively pre-committed to purchasing annuity streams at an early age. Because of this, they do not suffer as badly from the adverse selection problems that plague individual annuitization decisions. Second, DB plans pool the risk of dying at an early age (before retirement) and living long after retirement. Under a DB pension, the pension fund can relatively inexpensively provide a given level of retirement benefits to workers who live to retirement because it does not have to provide any benefits to those workers who die

[50] The higher loads likely also in part reflect the larger adverse selection loads in these markets, so the higher loads for these products are likely to be somewhat persistent, however.

before retirement age (and therefore never receive any pension benefits). In contrast, under a DC pension, the employee owns the assets once they are vested so that his or her heirs inherit the account balance if she dies before retirement.[51]

Just as the government has helped to facilitate the development of markets for inflation protected annuities, it may be able to play a role in facilitating the design of DC pensions that can retain these two other benefits of DB pension plans. Specifically, one can imagine a system in which individuals purchase a "personal pension" with their retirement contributions instead of simply accumulating assets that they could later annuitize. These products would pay the worker a stream of benefits upon retirement, but if the worker died prior to retirement the assets would flow to the pension provider (and, implicitly, to the pool of potential annuitants) rather than to his heirs. This reversion of assets would allow the pension provider (probably a life insurance company) to pay higher rates of return than those paid by financial assets.

Insurance companies would face several challenges in creating these types of personal pensions. If the contracts pre-specified future annuity payments, then one challenge is that they would substantially extend the time horizon insurance companies face in setting annuity prices. Insurance companies commonly face a pool of annuitants who annuitize near or after retirement age so that the relevant term structure of interest rates (and inflation) and mortality risk for the insurance company is limited to roughly 30 years (and most annuitants have a life expectancy well less than 30 years). However, if insurance companies needed to price these pre-commitment annuity contracts, the pricing decisions might need to forecast interest rates and mortality over substantially longer horizons (say 60 or 70 years). As an alternative, the insurance company could promise to annuitize in the future without specifying the terms at

[51] Under DB plans, a surviving spouse may receive some survivor pension benefits but there is still substantial pooling across people who die before retirement and those who die after retirement.

which the annuities would be available. But this would pose even greater problems: if an individual has pre-committed to annuitize with a *given* firm at unspecified future terms, the firm may have a strategic incentive to specify the terms to its own advantage. Hence, it exposes the worker to hold-up problems. If, on the other hand, an individual is free to annuitize with *any* firm, this may undermine the ability of firms to pool pre-retirement mortality risk.

There is a mechanism for addressing these concerns, but it requires the development of and education about a new annuity product, a "pre-retirement" annuity. Like a deferred annuity, a pre-retirement annuity would have an accumulation stage and a liquidation stage. However, unlike deferred annuities, these products would pool mortality risk before retirement age and would require that the investment be withdrawn as a life annuity. To avoid the complications to life insurance companies of pricing products for extremely long horizons and at the same time mitigate the potential hold-up problems associated with contracts that would not fully specify the terms of annuitization, retirees would be allowed to change insurance companies before annuitization.

To illustrate this product, consider a worker at age 35 who is saving through a 401(k) for his anticipated retirement at age 65. Instead of investing his contribution in a standard bond or equity market, he would purchase a 30-year "pre-retirement" annuity product from an insurance company. This product could be linked to the same bond or equity markets, in the sense that the firm would invest the assets in these markets and provide benefits linked to the return on these investments, but it would have a key difference: returns would be contingent on the worker living to the 30-year maturity of the product. In other words, the worker would only receive benefits if he lived to his expected retirement age. This life-contingency would allow the insurance company to provide higher returns to those individuals who reached retirement, just as

in a DB pension plan. Upon retirement, the individual could shop for annuity prices. Insurance companies could offer prices that recognize the timing of the individuals' contributions to the account and the restriction that the funds must be annuitized so that the pricing would not necessarily reflect the adverse selection problems that plague current annuity pricing.

The government could potentially play a role in facilitating the development of this product. We envision the following two-pronged approach: the first prong would encourage the purchase of these products by explicitly countenancing their usefulness and providing tax advantages for purchasing them. This tax advantage could take the form of increased 401(k) limits for individuals purchasing these products, or of additional tax benefits for 401(k) contributions made in this form. This first prong would replicate one of the major advantages of DB pension plans: the pooling of pre-retirement mortality risk. The second prong would link this tax advantage to a pre-commitment to annuitize the assets upon retirement. The individual would have the option of annuitizing with any firm upon retirement, not just the firm from which he purchased his pre-retirement annuity, thus circumventing the hold-up problem. This second prong would replicate a second major advantage of DB pension plans: the reduced adverse selection problems associated with earlier pre-commitment to annuitize assets.

Of course, this loose proposal is only one of many possible approaches to aiding the development of better DC-based pension plans. More generally, the government could serve as a third-party information provider on some of the key pieces of information that make it difficult for insurance companies to provide long term contracts. For example, the government could provide an index based on future mortality, interest rate, and inflation projections that would allow firms to sell personal pension products whose payout at retirement would depend (only) on this index. Then firms could write longer term products with individuals pre-committed to

annuitize assets with them by linking the terms of future payouts to this third-party index, thereby circumventing hold-up problems. Alternatively, the government might be able to facilitate the development of these markets by offering reinsurance for insurance companies that take certain types of long-term risks.

7. Concluding Remarks

Annuitization decisions of retirees promise to be a growing public policy concern as the baby boom generation retires, life expectancy continues to grow, and the retirement planning landscape continues to shift from traditional pension plans to retirement plans based on personal accounts. The combination of the demographic trends and the change in pension institutions is headed for a confrontation with what economists refer to as the annuity puzzle: households seem reluctant to annuitize their assets voluntarily through private insurance markets and these markets are much thinner than economic theory predicts they ought to be. While there are many potential causes for the annuity puzzle, public policy can play a role in combating the potential underutilization of these markets.

In this paper, we explored the efficacy of tax-based proposals to increase the voluntary annuitization of retirement wealth in the United States. We focus on two types of interventions. First, based on recent proposals such as the Lifetime Pension Annuity for You Act of 2005, we examine the effects of proposals that allow taxpayers to exclude a portion of their annuity income from their taxable income. Second, we study a proposal that would provide refundable tax credits for income from life annuities. The main difference between these proposals is that the value of the exemption proposal depends on a household's marginal tax rate (and, hence, the level of its taxable income). Our results suggest that both approaches have merit and that both

may be needed in order to achieve politically attractive solutions to encourage greater use of annuities, especially immediate annuities.

Our analysis implies that the proposals could substantially reduce the insurance loads that contribute to why households may be reluctant to annuitize. Furthermore, our analysis based on how the proposals would change desired annuitization patterns suggest that these price changes could have a substantial effect on the amount of voluntary annuitization in the economy. Our benchmark estimates suggest that 65-year old couples would respond to the policies by increasing the amount of wealth that they annuitize by an average of roughly $50,000. The revenue consequences of these proposals are a concern but, mainly due to the low level of initial annuitization, these proposals appear to have fairly modest revenue costs for the government. We estimate the present value of the steady-state revenue costs to be on the order of 10-15 cents per additional dollar of annuitized wealth.

One concern over these estimates is that the literature has not provided precise empirical estimates of how annuitization responds to price incentives like these proposals. This lack of precision suggests that our estimates be interpreted with caution. Our benchmark results suggest a substantial response to these price incentives that some people may view with some skepticism. However, there are several reasons to expect that our methodology omits some important features of the policy that could lead to even larger responses than we predict. First, as annuity markets thicken, one would expect that the private market pricing would improve, especially if adverse selection problems become less severe in these markets. Second, our estimates do not include any "informational responses" to the policy by which a government policy to encourage a behavior plays the role of increasing public awareness of the wisdom of the behavior.

Incorporating these effects into more refined estimates of the proposals would be a useful area for further research.

Bibliography

American Council of Life Insurers (ACLI), "Positioning and Promoting Annuities in a New Retirement Environment," Task Force on Annuity Messages, 1999.

Ameriks, John. "The Retirement Patterns and Annuitization Decisions of a Cohort of TIAA-CREF Participants," TIAA-CREF Institute *Research Dialogues*. Issue 60, August 1999.

Attanasio, Orazio and Hilary Hoynes, 2000, Differential Mortality and Wealth Accumulation, *Journal of Human Resources* 35 Issue 1, 1-29.

Bell, Felicitie and Michael Miller, 2005 Life Tables for the United States Social Security Area 1900-2100, *Actuarial Study No. 120 Social Security Administration, Office of the Chief Actuary.*

Brown, Jeffrey R. and James M. Poterba, 2000, Joint Life Annuities and Annuity Demand by Married Couples, *Journal of Risk and Insurance* 67 Issue 4, 527-53.

Brown Jeffrey R. and Mark Warshawsky, 2000, Longevity Insured Retirement Distributions from Pension Plans: Market and Regulatory Issues. In *Public Policies and Private Pensions,* W. Gale, J. Shoven, M. Warshawsky eds., Brookings Institution: Washington, D.C.

Brown, Jeffrey 2000, How Should We Insure Longevity Risk in Pensions and Social Security?, *Boston College Center For Retirement Security Issues in Brief*

Brown,Jeffrey 2001, Private Pensions, Mortality Risk, and the Decision to Annuitize, *Journal of Public Economics* 82 Issue 1, 29-62.

Çebi, Pinar, 2006, Can Annuities Enhance Retirement Lifestyles?, *American Council for Capital Formation Special Report.*

Cutler, David M. and Sarah J. Reber, 1998, Paying for Health Insurance: The Trade-Off between Competition and Adverse Selection, *Quarterly Journal of Economics* 113 Issue 2, 433-66.

Davidoff, Thomas, Jeffrey Brown, and Peter Diamond, 2005, Annuities and Individual Welfare, *American Economic Review* 95 Issue 5, 1573-90.

Dushi, Irene and Anthony Webb, 2004, Household Annuitization Decisions: Simulations and Empirical Analyses, *Journal of Pension Economics and Finance* 3 Issue 2.

Feenberg, Daniel and Elisabeth Coutts, 1993, An Introduction to the TAXSIM Model, *Journal of Policy Analysis and Management 12 No. 1, 189-94.*

Finkelstein, Amy and James Poterba, 2004, Adverse Selection in Insurance Markets: Policyholder Evidence from the U.K. Annuity Market, *Journal of Political Economy* 112 Issue 1 Part 1, 183-208.

Friedman, Benjamin and Mark Warshawsky, 1990, The Cost of Annuities: Implications for Saving Behavior and Bequests, *Quarterly Journal of Economics* 105 Issue 1, 135-54.

Hubbard, R. Glenn, Jonathan Skinner, and Stephen P. Zeldes, 1995, Precautionary Saving and Social Insurance, *Journal of Political Economy* 103 issue 2, 360-99.

James and Vittas, *Annuity Markets in Comparative Perspective: Do Consumers Get Their Money's Worth?*, World Bank 2004.

Johnson, Richard, Leonard Burman and Deborah Kobes 2004, *Annuitized Wealth at Older Ages: Evidence from the Health and Retirement Study*, Urban Institute.

Mitchell et al., 1999, New Evidence on the Money's worth of Individual Annuities, *American Economic Review* 89 Issue 5, 1299-1318.

McCulloch, J. Huston, 2006, The U.S. Real Term Structure of Interest Rates with Implicit Inflation Premium, http://www.econ.ohio-state.edu/jhm/ts/ts.html#comp.

NAVA, 2005, *2005 Annuity Fact Book*, National Association for Variable Annuities.

Poterba, James, Joshua Rauh, Steven Venti and David Wise, 2003, Utility Evaluation of Risk in Retirement Saving Accounts**,** NBER Working 9892.

Sinclair, Sven and Kent Smetters, 2004, *Heath Shocks and the Demand for Annuities*, Technical Paper Series, Congressional Budget Office.

Tax Policy Center, Tax Facts, Returns by Marginal Tax Rate 2000, http://taxpolicycenter.org/TaxFacts/TFDB/TFTemplate.cfm?Docid=214.

Turra, Cassio and Olivia Mitchell, 2004 *The Impact of Health Status and Out-of-Pocket Medical Expenditures on Annuity Valuation*, University of Michigan Retirement Research Paper, WP 2004-086

Vanguard Lifetime Income Program, Get an Instant Quote, https://flagship4.vanguard.com/VGApp/hnw/content/AccountServ/Retirement/ATSAnnui tiesOVContent.jsp

Yaari, Menahem, 1965, Uncertain Lifetime, Life Insurance, and the Theory of the Consumer, *The Review of Economic Studies*, 32, 137-150.

Appendix – Formalities of the AEW Calculations:

This appendix offers a brief and technical summary of the AEW computation procedure described loosely in Section 5. We break our discussion into three sections. The first describes the preferences of a household and uses them to derive its indirect utility function $V(W_0, \mathbf{A})$ over initial wealth and annuity payment streams. The second section describes how we use this function to derive the AEW of access to a given annuity product. The final section describes how we actually compute the function $V(W_0, \mathbf{A})$.

Throughout this appendix, we assume that all values are *real* values (i.e., in current dollars) unless we specifically note otherwise.

<u>(i) Preferences</u>:

Our AEW procedure involves maximizing the utility of a household with preferences:

$$\text{(A.1)} \quad U(\mathbf{C}) = \sum_{\substack{65 \le \tau^m \le 101, \\ 65 \le \tau^f \le 101}} P(\tau^m, \tau^f) \sum_{t=65}^{100} \delta^{64-t} \left(u_t \left(c_t(\tau^m, \tau^f); \tau^m, \tau^f \right) \right),$$

where τ^m and τ^f are the death age of the male and the female, respectively; $P(\tau^m, \tau^f)$ gives the probability that the male and female will die at ages τ^m and τ^f, respectively; where $\delta = 1.03$ reflects our assumption that households discount the future by 3% per year; and where

$$\text{(A.2)} \quad u_t\left(c; \tau^m, \tau^f\right) = \begin{cases} 2\dfrac{\left(\left(\frac{1+\nu}{2}\right)c\right)^{1-\gamma}}{1-\gamma} & \textit{if } t < \min\{\tau^m, \tau^f\} \\ \dfrac{c^{1-\gamma}}{1-\gamma} & \textit{if } \min\{\tau^m, \tau^f\} \le t < \max\{\tau^m, \tau^f\} \\ 0 & \textit{otherwise} \end{cases}.$$

In (A.2), $\gamma = 1.5$ is the coefficient of relative risk aversion, and $\nu = .625$ measures consumption complementarities if both the husband and wife are living.

The household maximizes its utility over feasible consumption plans of the form:

$$\text{(A.3)} \quad \mathbf{C} = \left\{ (c_{65}(\tau^m, \tau^f), \cdots, c_{100}(\tau^m, \tau^f) \right\}_{65 \le \tau^m \le 101, 65 \le \tau^f \le 101},$$

where the term $c_t(\tau^m, \tau^f)$ gives the amount of assets the household plans to consume at age *t*, if the male and female die at τ^m and τ^f, respectively. To capture the fact that the households do not know death ages in advance, we need to impose a feasibility constraint:

$$\text{(A.4)}\quad c_t(\tau^m,\tau^f) = c_t(\tau'^m,\tau'^f) \;\; if \;\; \left\{\begin{array}{ll} t \le \min\{\tau^m,\tau^f,\tau'^m,\tau'^f\} & or \\ \tau^m = \tau'^m \le t < \min\{\tau^f,\tau'^f\} & or \\ \tau^f = \tau'^f \le t < \min\{\tau^m,\tau'^m\} & \end{array}\right\}.$$

Resource constraints also restrict feasible consumptions. Fixing an initial wealth level W_0 and an annuity stream $\mathbf{A} = \{(A^B_{65},\cdots,A^B_{100}),(A^O_{65},\cdots,A^O_{100})\}$, with the time t annuity payment given by

$$\text{(A.5)}\quad A_t(\tau^m,\tau^f) = \begin{cases} A^B_t \;\; if \;\; t < \min\{\tau^m,\tau^f\} \\ A^O_t \;\; if \;\; \min\{\tau^m,\tau^f\} \le t < \max\{\tau^m,\tau^f\} \\ 0 \quad otherwise \end{cases},$$

we impose:

$$\text{(A.6)}\quad c_t\left(\tau^m,\tau^f\right) \le W_t\left(\tau^m,\tau^f\right),$$

where $W_t\left(\tau^m,\tau^f\right)$ is defined recursively by $W_{64}\left(\tau^m,\tau^f\right) = W_0$ and, for $65 \le t \le 100$, by:

$$\text{(A.7)}\quad W_t\left(\tau^m,\tau^f\right) = \begin{cases} A_t\left(\tau^m,\tau^f\right) + (1+r_t)\left(W_{t-1}\left(\tau^m,\tau^f\right) - c_{t-1}\left(\tau^m,\tau^f\right)\right) if \;\; t < \max\{\tau^m,\tau^f\} \\ 0 \quad otherwise \end{cases},$$

where r_t is the real (annual) after-tax interest rate faced by the household between ages (t – 1) and t. Expression (A.6) reflects our assumption that households cannot borrow against (or sell) their future annuity income. (A.7) reflects our (purely technical) assumption that all wealth is lost once both members of the household have died.

For a given initial wealth an annuity stream, then, the feasible set $\Gamma(W_0,\mathbf{A})$ of consumption profiles is the set of set of consumption profiles $\mathbf{C}$ satisfying (A.4) and (A.6) for all $65 \le t \le 100$ and for all $65 \le \tau^m \le 101$ and $65 \le \tau^f \le 101$.

Finally, we can formally define the lifetime expected utility of a household as a function of an initial wealth and an initial annuity stream:

$$\text{(A.8)}\quad V(W_0,\mathbf{A}) = \max_{\mathbf{C}\in\Gamma(W_0,\mathbf{A})} U(\mathbf{C}).$$

(ii) <u>Computing AEWs</u>

We assume that there is a single annuity product available for purchase. It is linearly priced: for each $1 premium, it provides a stream of pre-tax life-contingent payments $a_t(\tau^m,\tau^f)$. We

separately consider two types of annuity, nominal and inflation protected annuities. Nominal annuities pay:

$$\text{(A.9)} \qquad a_t(\tau^m,\tau^f) = \begin{cases} a/\pi_t & \text{if } t < \min\{\tau^m,\tau^f\} \\ \frac{2}{3}a/\pi_t & \text{if } \min\{\tau^m,\tau^f\} \le t < \max\{\tau^m,\tau^f\} \\ 0 & \text{otherwise} \end{cases},$$

where π_t is the ratio of the price levels at age *t* and age 64. Inflation protected annuities pay:

$$\text{(A.10)} \qquad a_t(\tau^m,\tau^f) = \begin{cases} a & \text{if } t < \min\{\tau^m,\tau^f\} \\ \frac{2}{3}a & \text{if } \min\{\tau^m,\tau^f\} \le t < \max\{\tau^m,\tau^f\} \\ 0 & \text{otherwise} \end{cases}$$

(A.9) and (A.10) are both joint and 2/3 survivor annuities. Based on Vanguard's pricing, as described in the text, we take *a* = \$8108.73in (A.9) and *a* = \$5757.76 in (A.10).

Now consider a household with marginal tax rate κ, an average tax rate $\bar{\kappa}$, an amount W^Q of qualified wealth and an amount $W_0 - W^Q$ of non-qualified wealth (with no inside buildup). We use this to compute the real after-tax annuity income function $A_t^*(B,\tau^m,\tau^f)$. $A_t^*(B,\tau^m,\tau^f)$ gives the size of the annuity payment at year *t* for each possible pair of death times for the couple as a function of the amount *B* the household spends on an annuity. As described in the text, we assume a "stacking rule:" individuals first annuitize their qualified wealth. We separately treat three cases: the baseline case with no policy intervention, the Lifetime Pay policy intervention and the subsidy policy intervention (*viz* Section 4.4.2). Following IRS guidelines, we take the *de jure* life expectancy of a couple to be 22 years, and define the *real exclusion* amount via:

$$\text{(A.11)} \quad E_t(B) = \begin{cases} (B - W^Q)/(22\cdot\pi_t) & \text{if } B > W^Q \text{ and } t \le 22 \\ 0 & \text{otherwise} \end{cases},$$

where we have used the stacking rule and the zero exclusion for qualified annuities.
Case 1: Baseline tax treatment:

$$\text{(A.12)} \quad A_t^*(B,\tau^m,\tau^f) = E_t(B) + (1-\kappa)(Ba_t(\tau^m,\tau^f) - E_t(B)).$$

Equation (A.12) reflects our simplifying "refund of extra basis" assumption discussed in the text (*viz* Section 4.2.3).

Case 2: Lifetime PAY tax treatment:

The Lifetime PAY bill would exempt some annuity income from taxation. Were there no limits, the exemption would be given by :

$$\text{(A.13)}\quad \overline{X}_t(B,\tau^m,\tau^f) = \begin{cases} 0.25Ba_t(\tau^m,\tau^f) & \text{if } B < W^Q \\ 0.25Ba_t(\tau^m,\tau^f) + 0.5((B-W^Q)a_t(\tau^m,\tau^f) - E_t(B)) & \text{otherwise} \end{cases}.$$

Equation (A.13) reflects the 25% and 50% exemption for qualified and non-qualified annuity income in the Lifetime PAY bill and our "stacking rule" assumption.

Writing the total exemption, including the $5000 per living annuitant limit in the bill, we have:

$$\text{(A.14)}\quad X_t(B,\tau^m,\tau^f) = \begin{cases} \min\{\overline{X}_t(B,\tau^m,\tau^f),10{,}000\} & \text{if } t < \min\{\tau^m,\tau^f\} \\ \min\{\overline{X}_t(B,\tau^m,\tau^f),5{,}000\} & \text{if } \max\{\tau^m,\tau^f\} \le t < \min\{\tau^m,\tau^f\} \\ 0 & \text{otherwise} \end{cases}.$$

Finally, the after-tax annuity income function is given by:

$$\text{(A.15)}\quad A_t^{*,LP}(B,\tau^m,\tau^f) = E_t(B) + (1-\kappa)(Ba_t(\tau^m,\tau^f) - E_t) + \kappa X_t(B,\tau^m,\tau^f).$$

Case 3: Subsidy policy intervention:

Ignoring limits, the subsidy intervention we consider provides a refundable tax credit equal to :

$$\text{(A.16)}\quad \overline{R}_t(B,\tau^m,\tau^f) = \begin{cases} 0.05Ba_t(\tau^m,\tau^f) & \text{if } B < W^Q \\ 0.05Ba_t(\tau^m,\tau^f) + 0.1((B-W^Q)a_t(\tau^m,\tau^f) - E_t(B)) & \text{otherwise} \end{cases}.$$

Equation (A.16) reflects the 5% and 10% credit on qualified and non-qualified annuity income and our "stacking rule" assumption. Including the $1000 per live annuitant maximum tax credit, the refundable tax credit is given by:

$$\text{(A.17)}\quad R_t(B,\tau^m,\tau^f) = \begin{cases} \min\{\overline{R}_t(B,\tau^m,\tau^f),2{,}000\} & \text{if } t < \min\{\tau^m,\tau^f\} \\ \min\{\overline{R}_t(B,\tau^m,\tau^f),1{,}000\} & \text{if } \max\{\tau^m,\tau^f\} \le t < \min\{\tau^m,\tau^f\} \\ 0 & \text{otherwise} \end{cases}.$$

Finally, the after-tax annuity income function is given by:

$$\text{(A.18)}\quad A_t^{*,S}(B,\tau^m,\tau^f) = E_t(B) + (1-\kappa)(Ba_t(\tau^m,\tau^f) - E_t) + R_t(B,\tau^m,\tau^f).$$

Using $\mathbf{A}^*(B)$ (respectively, $\mathbf{A}^{*,\mathbf{LP}}(B)$ and $\mathbf{A}^{*,S}(B)$) to denote the entire stream (i.e., the stream for any death date pair) of after tax annuity payments received in exchange for a premium of B under the baseline case (respectively, under the Lifetime PAY bill and the subsidy policy) we can now describe the household's optimal annuitization decision. Let $K(B) = B$ if $B > W^Q$, and

$K(B) = B + \bar{\kappa}(W^Q - B)$ otherwise (to reflects our assumption that any qualified income which is not annuitized is withdrawn immediately and taxed at the household's average tax rate). Then, under the baseline policy, the household's optimal fraction voluntarily annuitized, α_{vol}^* solves:

$$\text{(A.19)} \quad \alpha_{vol}^* = \frac{1}{W_0}\left\{\arg\max_{0 \le B \le W_0} V(W_0 - K(B), \mathbf{A}^*(B) + \mathbf{A_0})\right\},$$

with obvious analogs for the optimal fractions annuitized, $\alpha_{vol}^{*,LP}$ and $\alpha_{vol}^{*,S}$ in the other two cases. Similarly, we can define the lifetime utility V^* for a household with access to a given annuity market in the baseline case (and analogously for the others):

$$\text{(A.20)} \quad V^* = \max_{0 \le B \le W_0} V(W_0 - K(B), \mathbf{A}^*(B) + \mathbf{A_0}).$$

Finally, we implicitly define the AEW of access to a given type of annuity policy via:

$$\text{(A.21)} \quad AEW = \min\left\{x \middle| V(xW_0, \mathbf{A}_0) \ge V^*\right\}.$$

(iii) <u>Computing (A.8)</u>

As the first section of this appendix suggests, evaluating the function $V(W_0, \mathbf{A})$ is a non-trivial task. We use standard dynamic program techniques for this. Following Brown (2001) and others, we write the problem in recursive form (i.e., via a Bellman equation). In particular, we define the functions $V_{100}^B(W)$, $V_{100}^M(W)$, and $V_{100}^F(W)$ via:

$$\text{(A.22)} \quad \begin{aligned} V_{100}^B(W) &= 2\frac{\left(W\left(\frac{1+\nu}{2}\right)\right)^{1-\gamma}}{1-\gamma} \\ V_{100}^M(W) &= V_{100}^F(W) = \frac{W^{1-\gamma}}{1-\gamma} \end{aligned}, \quad \text{and}$$

and then recursively define the value functions for $65 \le t \le 100$ via the Bellman equations:

$$\text{(A.23)} \quad \left\{\begin{aligned} V_t^B(W) &= \max_{0 \le c \le W}\left\{2\frac{\left(c\left(\frac{1+\nu}{2}\right)\right)^{1-\gamma}}{1-\gamma} + \delta^{-1}\begin{pmatrix} (1-q_{t+1}^m)(1-q_{t+1}^f)V_{t+1}^B((1+r_{t+1})(W-c)+A_{t+1}^B) \\ +q_{t+1}^f(1-q_{t+1}^m)V_{t+1}^M((1+r_{t+1})(W-c)+A_{t+1}^O) \\ +q_{t+1}^m(1-q_{t+1}^f)V_{t+1}^F((1+r_{t+1})(W-c)+A_{t+1}^O) \end{pmatrix}\right\} \\ V_t^M(W) &= \max_{0 \le c \le W}\left\{\frac{c^{1-\gamma}}{1-\gamma} + \delta^{-1}(1-q_{t+1}^m)V_{t+1}^M((1+r_{t+1})(W-c)+A_{t+1}^O)\right\} \\ V_t^M(W) &= \max_{0 \le c \le W}\left\{\frac{c^{1-\gamma}}{1-\gamma} + \delta^{-1}(1-q_{t+1}^f)V_{t+1}^F((1+r_{t+1})(W-c)+A_{t+1}^O)\right\} \end{aligned}\right\},$$

where q_t^m (respectively, q_t^f) gives the male (female) mortality rate at age t (i.e., the conditional probability that a male (female) who lives until the last day of his $(t-1)^{\text{st}}$ birthday will die before she reaches his t^{th} birthday).

Finally:

$$\text{(A.24)}\quad V(W_0,\mathbf{A}) = \delta^{-1}\begin{pmatrix} (1-q_{t+1}^m)(1-q_{t+1}^f)V_{65}^B((1+r_{65})W_0 + A_{65}^B \\ \quad + q_{65}^f(1-q_{t+1}^m)V_{65}^M((1+r_{65})W_0 + A_{65}^O \\ \quad + q_{65}^m(1-q_{t+1}^f)V_{65}^F((1+r_{65})W_0 + A_{65}^O \end{pmatrix}.$$

To evaluate (A.24), we discretize the wealth space and approximate the functions $V_t^B(W)$, $V_t^M(W)$, and $V_t^F(W)$ recursively, starting for $t = 100$ by evaluating (A.22), and then numerically optimizing (A.23) via a grid search. This gives us an approximation of (A.24). For a better approximation, we use a finer discretization (in practice, grids with 750 points appear to be sufficient for our purposes).

Finally, we solve (A.20) and (A.21) using a search routine that relies on there being a unique local maximum to that problem; this speeds computation time up significantly relative to a grid search routine.

Table 3.1: Composition of Health and Retirement Study Households' Balance Sheets at Age 65 - Couples

Total Wealth Deciles*	1	2	3	4	5	6	7	8	9	10
Non-Retirement Wealth (in 2000 $)	**28,711**	**60,076**	**86,690**	**120,875**	**127,976**	**166,928**	**201,657**	**235,777**	**316,387**	**976,239**
Financial Assets	-243	7,708	7,297	14,290	11,821	13,118	23,413	25,108	50,399	204,085
Business Assets	973	2,458	7,297	14,290	11,821	13,118	23,413	25,108	50,399	204,085
Primary Residence Net of Mortgage	25,983	46,386	63,678	77,399	87,335	115,327	109,670	142,139	157,521	244,241
Net Other Property	1,998	3,524	8,418	14,896	16,999	25,365	45,161	43,422	58,068	323,828
Retirement Wealth (in 2000 $)	**155,181**	**251,928**	**318,283**	**366,261**	**430,027**	**484,342**	**545,404**	**600,499**	**774,237**	**1,051,688**
Social Security	142,111	209,310	227,351	251,752	260,138	272,463	261,455	270,474	296,868	301,920
Defined Benefit Pensions	10,203	28,943	75,548	77,523	129,641	160,455	187,735	205,334	303,128	394,919
Defined Contribution Pensions	1,050	5,971	6,410	14,895	12,419	10,595	21,742	21,685	43,847	122,548
IRAs	1,817	7,704	8,974	22,091	27,829	40,829	74,472	103,006	130,394	232,301
Total Wealth (in 2000 $)	**183,892**	**312,004**	**404,973**	**487,136**	**558,003**	**651,270**	**747,061**	**836,276**	**1,090,624**	**2,027,927**
Annuitized Wealth as % of Total Wealth	**80%**	**76%**	**73%**	**67%**	**67%**	**63%**	**56%**	**50%**	**49%**	**32%**
Total Number of Observations	180	158	158	144	140	139	128	126	131	114
with Defined Benefit	44	78	118	96	120	117	103	101	107	74
without Defined Benefit	136	80	40	48	20	22	25	25	24	40

Source: Dushi and Webb (2004)

Notes: Data from Health and Retirement Study, waves 2 to 5. Sample: married couples who turned 65 in any of the waves 2 to 5. Sample size – 1431 observations, from which 13 observations falling in the 100th wealth percentile were dropped resulting in a sample of 1418. We excluded the 100th percentile from the 10th decile and the wealth upper cut-off point is $4,332,141. The present values of Social Security and employer Defined Benefit pensions were calculated using a real rate of interest of 3% and an inflation rate of 2.5%. Annuitized wealth equals the sum of SS and DB pensions. Figures are in 2000 dollars and weighted using household weights. Variation between deciles in number of observations is due to weighting.

* 1 is lowest decile of income, 10 is highest decile of income.

Table 4.2: ***Benchmark Money's Worth* Ratios by Gender, Age and Marginal Tax Rates with No Policy Intervention***

Panel A: Non-Qualified, Nominal									
Marginal Tax Rate	**0%**			**15%**			**25%**		
Age	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**
56	0.92	0.93	0.94	0.93	0.94	0.95	0.93	0.95	0.95
66	0.86	0.88	0.88	0.87	0.88	0.89	0.87	0.89	0.89
76	0.78	0.82	0.81	0.79	0.82	0.82	0.79	0.82	0.82
86	0.65	0.73	0.70	0.64	0.72	0.70	0.64	0.71	0.70
Panel B: Non-Qualified, Inflation Protected									
Marginal Tax Rate	**0%**			**15%**			**25%**		
Age	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**
56	0.81	0.82	0.82	0.84	0.85	0.86	0.86	0.87	0.88
66	0.77	0.78	0.79	0.79	0.81	0.81	0.80	0.82	0.82
76	0.71	0.75	0.74	0.72	0.76	0.75	0.73	0.76	0.76
86	0.60	0.68	0.65	0.60	0.68	0.65	0.60	0.67	0.65
Panel C: Qualified, Nominal									
Marginal Tax Rate	**0%**			**15%**			**25%**		
Age	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**
56	0.92	0.93	0.94	0.99	1.01	1.02	1.05	1.07	1.08
66	0.86	0.88	0.88	0.91	0.94	0.94	0.95	0.98	0.99
76	0.78	0.82	0.81	0.81	0.86	0.85	0.84	0.89	0.88
86	0.65	0.73	0.70	0.66	0.76	0.73	0.67	0.77	0.74
Panel D: Qualified, Inflation Protected									
Marginal Tax Rate	**0%**			**15%**			**25%**		
Age	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**
56	0.81	0.82	0.82	0.89	0.91	0.91	0.95	0.98	0.98
66	0.77	0.78	0.79	0.82	0.85	0.85	0.86	0.89	0.90
76	0.71	0.75	0.74	0.74	0.79	0.77	0.76	0.81	0.80
86	0.60	0.68	0.65	0.61	0.70	0.67	0.62	0.71	0.68

Source: Author's calculations, as described in text. The calculations assume a premium of $100,000. "Couples" refers to a joint-and-survivor annuity for a couple with the same age and a symmetric 2/3 survivor benefit.

** The money's worth of an annuity is the ratio of expected value of the income stream provided by that annuity to the premium paid for it.*

Table 4.3*: Percent Change in Money's Worth* Ratios Under Lifetime PAY Bill ($100K Premium)*

Panel A: Non-Qualified, Nominal									
Marginal Tax Rate	**0%**			**15%**			**25%**		
Age	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**
56	0	0	0	3.49	3.80	3.90	6.20	6.76	6.87
66	0	0	0	2.67	3.07	3.03	4.71	5.41	5.22
76	0	0	0	1.86	2.53	2.17	3.25	4.44	3.75
86	0	0	0	1.00	2.12	1.74	1.73	3.68	2.99
Panel B: Non-Qualified, Inflation Protected									
Marginal Tax Rate	**0%**			**15%**			**25%**		
Age	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**
56	0	0	0	2.93	3.28	3.38	5.29	5.92	6.03
66	0	0	0	2.12	2.51	2.48	3.80	4.48	4.37
76	0	0	0	1.51	2.00	1.73	2.67	3.53	3.00
86	0	0	0	0.78	1.60	1.48	1.35	2.76	2.55
Panel C: Qualified, Nominal and Inflation Protected									
Marginal Tax Rate	**0%**			**15%**			**25%**		
Age	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**
56	0	0	0	4.41	4.41	4.41	8.33	8.33	8.33
66	0	0	0	4.41	4.41	4.41	8.33	8.33	8.33
76	0	0	0	4.41	4.41	4.41	8.33	8.33	8.33
86	0	0	0	4.41	4.41	4.41	8.33	8.33	8.33

Source: Author's calculations, as described in text. The calculations assume a premium of $100,000. "Couples" refers to a joint-and-survivor annuity for a couple with the same age and a symmetric 2/3 survivor benefit. The entries are the percentage change in the money's worth based on the benchmarks described in Table 4.2.

** The money's worth of an annuity is the ratio of expected value of the income stream provided by that annuity to the premium paid for it.*

Table 4.4: ***Percentage Increase in Money's Worth* Under Lifetime PAY Proposal, by Size of Policy***

Marginal Tax Rate 15%												
	Males				Females				Couples			
Age	**100K**	**250K**	**500K**	**1,000K**	**100K**	**250K**	**500K**	**1,000K**	**100K**	**250K**	**500K**	**1,000K**
56	3.49	3.49	2.86	1.51	3.80	3.80	3.16	1.65	3.90	3.90	3.90	2.93
66	2.67	2.42	1.98	1.11	3.07	2.98	2.41	1.25	3.03	3.03	2.95	2.08
76	1.86	1.26	1.00	0.74	2.53	2.11	1.68	0.84	2.17	2.14	1.96	1.17
86	1.00	0.57	0.43	0.36	2.12	1.79	0.97	0.48	1.74	1.50	1.11	0.55
Marginal Tax Rate 25%												
	Males				Females				Couples			
Age	**100K**	**250K**	**500K**	**1,000K**	**100K**	**250K**	**500K**	**1,000K**	**100K**	**250K**	**500K**	**1,000K**
56	6.20	6.20	5.06	2.67	6.20	6.76	5.61	2.94	6.87	6.87	6.87	5.19
66	4.71	4.25	3.45	1.94	4.71	5.25	4.23	2.19	5.22	5.28	5.13	3.61
76	3.25	2.19	1.72	1.26	3.25	3.66	2.91	1.46	3.75	3.69	3.36	2.01
86	1.73	0.98	0.73	0.61	1.73	3.09	1.66	0.83	2.99	2.56	1.89	0.94

Source: Author's calculations, as described in text. "Couples" refers to a joint-and-survivor annuity for a couple with the same age and a symmetric 2/3 survivor benefit. The entries are the percentage change in the money's worth based on the benchmarks described in Table 4.2, adjusted for the size of the initial policy premium.

** The money's worth of an annuity is the ratio of expected value of the income stream provided by that annuity to the premium paid for it.*

Table 4.5: ***Percent Change in Money's Worth* Ratios Under Refundable Tax Credit Proposal ($100K Premium)***

Panel A: Non-Qualified, Nominal									
Marginal Tax Rate	**0%**			**15%**			**25%**		
Age	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**
56	4.25	4.64	4.81	4.65	5.07	5.20	4.96	5.40	5.49
66	3.28	3.77	3.80	3.56	4.09	4.04	3.77	4.33	4.22
76	2.30	3.15	2.76	2.48	3.38	2.90	2.60	3.55	3.00
86	1.27	2.68	2.23	1.33	2.83	2.32	1.38	2.94	2.39
Panel B: Non-Qualified, Inflation Protected									
Marginal Tax Rate	**0%**			**15%**			**25%**		
Age	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**	**Male**	**Female**	**Couples**
56	3.48	3.92	4.11	3.90	4.37	4.51	4.23	4.73	4.82
66	2.55	3.03	3.07	2.82	3.34	3.31	3.03	3.59	3.49
76	1.86	2.45	2.19	2.01	2.67	2.31	2.13	2.83	2.40
86	0.98	2.01	1.90	1.03	2.13	1.97	1.07	2.21	2.03

Source: Author's calculations, as described in text. The calculations assume a premium of $100,000. "Couples" refers to a joint-and-survivor annuity for a couple with the same age and a symmetric 2/3 survivor benefit. The entries are the percentage change in the money's worth based on the benchmarks described in Table 4.2.

** The money's worth of an annuity is the ratio of expected value of the income stream provided by that annuity to the premium paid for it.*

Table 5.1: ***Estimated Change in Annuity Equivalent Wealth (AEW)* and Annuitized Wealth Induced by Lifetime PAY Bill for Inflation-Protected Annuities***

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
Decile	Average Wealth ($)	%of Wealth Pre-Annuitized	% of Wealth Voluntarily Annuitized w/out policy	% of Wealth Voluntarily Annuitized with policy	Change in % of Wealth Annuitized Due to Policy	AEW Without Policy	AEW With Policy
1	208,648.98	81.83	0.00	0.00	0.00	1.0000	1.0000
2	354,008.43	76.36	0.00	0.00	0.00	1.0000	1.0000
3	470,566.48	73.04	0.66	0.66	0.00	1.0001	1.0001
4	557,638.95	67.00	2.10	2.10	0.00	1.0004	1.0004
5	662,614.72	66.74	0.11	1.88	1.78	1.0007	1.0014
6	780,707.92	62.92	1.19	6.47	5.28	1.0028	1.0062
7	912,382.62	55.86	6.04	16.82	10.77	1.0101	1.0239
8	1,088,085.41	49.62	10.73	26.21	15.48	1.0185	1.0469
9	1,389,605.96	48.99	15.91	23.30	7.39	1.0341	1.0515
10	2,541,823.94	31.11	39.63	43.03	3.39	1.0544	1.0823
Overall	896,608.34	51.45	15.89	21.57	5.67	1.0243	1.0401
Deciles 1-9	713,806.61	59.50	6.50	13.08	6.58	1.0124	1.0234

Source: Authors' calculations, as described in text.

** Annuity Equivalent Wealth is a money-based measure of the value to an individual of access to annuity markets*

Table 5.2: ***Estimated Change in Annuity Equivalent Wealth (AEW)* and Annuitized Wealth Induced by Refundable Tax Credit Proposal for Inflation-Protected Annuities***

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
Decile	Average Wealth ($)	%of Wealth Pre-Annuitized	% of Wealth Voluntarily Annuitized w/out policy	% of Wealth Voluntarily Annuitized with policy	Change in % of Wealth Annuitized Due to Policy	AEW Without Policy	AEW With Policy
1	208,648.98	81.83	0.00	0.00	0.00	1.0000	1.0000
2	354,008.43	76.36	0.00	3.23	3.23	1.0000	1.0009
3	470,566.48	73.04	0.66	4.43	3.77	1.0001	1.0029
4	557,638.95	67.00	2.10	7.50	5.40	1.0004	1.0056
5	662,614.72	66.74	0.11	5.94	5.83	1.0007	1.0036
6	780,707.92	62.92	1.19	7.65	6.45	1.0028	1.0079
7	912,382.62	55.86	6.04	16.14	10.10	1.0101	1.0198
8	1,088,085.41	49.62	10.73	22.76	12.03	1.0185	1.0364
9	1,389,605.96	48.99	15.91	23.94	8.03	1.0341	1.0521
10	2,541,823.94	31.11	39.63	42.40	2.77	1.0544	1.0745
Overall	896,608.34	51.45	15.89	22.07	6.17	1.0243	1.0371
Deciles 1-9	713,806.61	59.50	6.50	14.02	7.52	1.0124	1.0223

Source: Authors' calculations as described in text.

* *Annuity Equivalent Wealth is a money-based measure of the value to an individual of access to annuity markets*

Table 5.3: ***Estimated Change in Annuity Equivalent Wealth (AEW)* and Annuitized Wealth Induced by Lifetime PAY Bill For Inflation-Protected Annuities and For Households with Extra DC Wealth***

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
Decile	Average Wealth ($)	%of Wealth Pre-Annuitized	% of Wealth Voluntarily Annuitized w/out policy	% of Wealth Voluntarily Annuitized with policy	Change in % of Wealth Annuitized Due to Policy	AEW Without Policy	AEW With Policy
1	208,648.98	81.83	0.00	0.00	0.00	1.0000	1.0000
2	354,008.43	71.73	0.00	0.00	0.00	1.0000	1.0000
3	470,566.48	63.93	0.66	0.66	0.00	1.0001	1.0001
4	557,638.95	59.11	2.14	2.14	0.00	1.0004	1.0004
5	662,614.72	55.64	1.58	3.36	1.78	1.0018	1.0025
6	780,707.92	51.26	1.19	11.38	10.18	1.0069	1.0113
7	912,382.62	44.19	9.62	28.92	19.30	1.0191	1.0401
8	1,088,085.41	38.91	15.43	34.47	19.04	1.0275	1.0668
9	1,389,605.96	36.62	28.03	34.22	6.19	1.0651	1.0931
10	2,541,823.94	22.29	49.58	49.03	-0.55	1.0771	1.1072
Overall	896,608.34	41.56	21.64	27.74	6.10	1.0380	1.0582
Deciles 1-9	713,806.61	49.18	10.58	19.31	8.73	1.0225	1.0388

Source: Authors' calculations as described in text. "Extra DC wealth" considers the thought experiment of converting ½ of each household's DB pension wealth to DC pension wealth.

** Annuity Equivalent Wealth is a money-based measure of the value to an individual of access to annuity markets*

Table 5.4: ***Estimated Steady-State Revenue Costs of Policy Interventions***

	Baseline Defined Contribution Wealth Levels				Extra Defined Contribution Wealth			
	Lifetime PAY		RTC* Policy		Lifetime PAY		RTC* Policy	
	Per household	Per $ of annuitization	Per household	Per $ of annuitization	Per household	Per $ of annuitization	Per household	Per $ of annuitization
Lower Bound	$2,106.28	0.0414	$1,987.25	0.0359	$2,324.85	0.0425	$2,810.28	0.0394
Upper Bound	$6,427.43	0.1264	$5,461.92	0.0987	$8,583.81	0.1570	$7,921.94	0.1112
Midpoint	$4,266.86	0.0839	$3,724.59	0.0673	$5,454.33	0.0975	$5,366.11	0.0753

Source: Authors' calculations, as described in text. The left panel reports estimates of the revenue cost of introducing the Lifetime PAY and subsidy bills on the each cohort as they reach age 65 and annuitize. These are computed by comparing the difference in the present discounted value of a fixed annuity stream with and without the policies. The lower-bound estimates assume zero annuitization prior to the policy implementation, while the upper-bound estimates assume baseline annuitization levels as in the third column of Tables 5.1 and 5.2. Both estimates assume that the respective policy change induces the change in annuitization indicated in the 6th column of Table 5.1 or 5.2. The right panel reports analogous estimates for the fictional population with 50% of each household's DB wealth converted into DC wealth.

** RTC stands for Refundable Tax Credit*

Table 5.5: ***Estimated Transition Revenue Cost, by Cohort Age***

Cohort Age at Time of Passage	Lifetime PAY Policy Transition Cost Per Household	Refundable Tax Credit Policy Transition Cost Per Household
66	4,462.449	3,570.781
71	3,448.473	2,768.426
76	2,426.075	1,956.648
81	1,480.442	1,203.398
86	737.7019	609.5508
91	245.3019	203.9665
96	44.0959	36.6825
Total (Across All Cohorts)	54,923.16	44,310.02

Source: Author's calculations, as described in text. This table reports increases in the expected present value of the pre-existing annuity streams of each cohort due to the introduction of each of the two types of policy intervention. It assumes that each cohort's wealth distribution at age 65 was given by Table 3.1, and it assumes that each cohort aged in a cohort-specific way according to the Social Security Administration's mortality tables (Bell and Miller, 2005). The pre-existing annuity stream used for these calculations is given by Column 3 in Tables 5.1 and 5.2. The total is an equally weighted sum across all cohorts (not the just 7 listed), and thus implicitly assumes that each age-65 cohort is the same size.