Reducing the Risk of Investment-Based Social Security Reform

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Many governments around the world – including Australia and Britain, Sweden and Mexico, China and Chile – have shifted from pure pay-as-you-go tax financed Social Security pensions to plans that rely in whole or in part on investments in stocks and bonds. There is now active discussion about the desirability of doing so in the United States. The Clinton administration came close to proposing such a plan. President Bush established a bipartisan presidential commission to advise on detailed aspects of such a plan and, after his reelection in 2004, reiterated his intention to introduce legislation to change Social Security in this way.

Any consideration of introducing an investment-based component into Social Security immediately raises the issue of the risk associated with uncertain asset returns. Some individuals would welcome the opportunity to achieve a higher return on their Social Security contributions even if that entails accepting additional market risk. Others would be reluctant to subject their retirement income to the uncertainty of investment returns. More generally, individuals differ in the extent to which they would accept additional risk in exchange for higher returns.

This paper presents a new market-based approach to reducing the risk of investment-

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based Social Security that could be tailored to individual risk preferences. With this new form of risk reduction, substituting an investment-based personal retirement account (PRA) for the traditional pure pay-as-you-go (PAYGO) plan could achieve both a significantly higher expected retirement income and a very high probability that the investment-based annuity would be at least as large as the pay-as-you-go benefit. A key feature of the approach developed here is a guarantee that the individual would not lose any of the real value of each year's PRA savings and might be guaranteed to earn at least some minimum real rate of return.

In one example of such a plan that is presented later in this paper, I examine the effect of replacing the current 12.4 percent pay-as-you-go tax with a mixed plan that has a 6.2 percent pay-as-you-go tax and 6.2 percent annual PRA savings. This new mixed plan, when fully phased in, would have the following desirable characteristics:

- The median value of the combined retirement income (i.e., the sum of the pay-as-you-go benefit and the PRA annuity) would be 147 percent of the traditional pay-as-you-go benefit.

- There would be a 95 percent probability that the combined retirement income (the pay-as-you-go benefit and the PRA annuity) exceeds the traditional pay-as-you-go benefit.

- There would be less than one chance in one hundred that the combined retirement income would be less than 96 percent of the traditional pay-as-you-go benefit.

- Each year's PRA saving would be guaranteed to earn at least a one percent real rate of return between the time that it is saved and its value at age 66 (and generally substantially more). I therefore refer to this as a "No Lose" plan.

- The variable annuity purchased at age 66 would have a similar "No Lose" feature, i.e., a guaranteed real rate of return of at least one percent.

Section 1 of the paper discusses alternative approaches to risk reduction in investment-based Social Security plans. The second section summarizes a private market approach to risk

reduction that I reported on in an earlier paper. The third section presents the idea of the "No Lose" plan, developed in the current paper, in which private markets provide a guarantee based on Treasury inflation protected bonds. . Simulation results for these alternative plans are then presented and discussed in sections 4 and 5 where the distribution of the combined pension income of the mixed plan (PAYGO plus PRA) is compared to the projected "benchmark" benefits of the current pure PAYGO plan. An alternative approach that permits tailoring the risk distribution to individual preferences by using the purchase and sale of equal value (i.e., self-financing) derivatives is analyzed in section 6. Section 7 shows the effect of lowering the combined PAYGO and PRA cost as a way of modeling the adjustment that would be needed to deal with the ageing of the population without the large rise in the payroll tax that would otherwise be required.

1. Alternative Approaches to Risk Reduction

The risk born by retirees in an investment-based plan can be thought of as the variability of the retirement income or as the probability that the retirement income will fall substantially short of the current-law pay-as-you-go benefits. In previous papers, Elena Ranguelova, Andrew Samwick and I assessed the magnitude of the risk in a pure investment-based plan and evaluated the effects of some of the ways of reducing that risk.[1]

[1]"The Transition to Investment-based Social Security when Portfolio Returns and Capital Profitability are Uncertain," Martin Feldstein, Elena Ranguelova and Andrew Samwick, in J. Campbell and Martin Feldstein (eds.), Risks Aspects of Investment Based Social Security Reform,(Chicago: University of Chicago Press, 2000). NBER Working Paper No. 7016; "Individual Risk in an Investment-Based Social Security System", (Martin Feldstein and Elena Ranguelova). American Economic Review , Vol. 91, No. 4, September 2001, pp 1116-25. NBER Working Paper No. 8074.

One way in which the investment risk to individual retirees could in principle be reduced would be for the government to accumulate the investment in a single national fund. The government could use the investment returns from this fund to finance defined benefits, making up any shortfall with tax revenue or government borrowing. Such a central fund involves problems of its own that lie beyond the scope of this paper.[2] I will assume therefore that the investment based plans are all structured through Personal Retirement Accounts. In all of these plans, individuals and/or their employers contribute to their PRAs during their working years and receive an annuity at retirement. The accumulated assets of individuals who die before reaching retirement age are assumed to be bequeathed according to the instructions of the deceased.

Strategies for reducing the risk of investment-based PRA plans involve various forms and mixtures of the following four approaches:

(1) Restrictions on the investment assets;

(2) A mixed system that combines PAYGO benefits and investment based annuities;

(3) Government guarantees;

(4) Market based guarantees.

I will comment now on each of these.

All actual and proposed investment-based plans restrict the assets in which the personal retirement accounts can be invested. These restrictions generally preclude investing in individual stocks by requiring that equity investments be limited to broadly diversified mutual

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[2]See my discussion of these problems in "Comment on P. Diamond, Administrative Costs and Equilibrium Charges with Individual Accounts," in John Shoven, ed., Administrative Aspects of Investment Based Social Security Reform(The University of Chicago Press, Chicago, 2000) pp. 162-169.

funds. Asset restrictions may also set maximum fractions of the portfolio or of new saving that can be invested in equities. The analysis in this paper considers the effect of using Treasury inflation protected bonds (TIPS) to introduce a risk-free real return as a component of the PRA investment.

While some countries have opted for a pure investment-based plan (e.g., Chile and Mexico) most countries have chosen a mixed system that combines pay-as-you-go benefits and investment based annuities. The three proposals analyzed by the President's Commission were of this form. The current analysis will focus on plans in which traditional pay-as-you-go benefits provide half of the benefits projected in current law with additional benefits provided by the PRA annuity.

In our earlier papers, Elena Ranguelova, Andrew Samwick and I analyzed a variety of government guarantees. A typical guarantee would stipulate that the government would supplement the income of retirees if the combined annual annuity payment fell below some level. To avoid the moral hazard problem of inducing individuals to take excessive risk, the government supplement would be based on the return on a "standard portfolio" like a 60:40 mix of the Standard and Poors 500 and the Lehman bond index. To make individuals cost-conscious about the annuity provider, the guarantee might take the form of allowing the individual to keep some fraction of the investment-based annuity (say 25%) and then supplementing the annuity if the remaining portion does not reach some level.

Our earlier analysis showed that providing a guarantee that individuals will receive at least as much as the benefits projected in current law (the "benchmark benefits") would impose relatively little risk on future taxpayers. Nevertheless, critics of such plans worry that

guarantees could be modified in the future to create expensive new entitlements. The current study therefore focuses on guarantees that could be provided by private financial markets.

2. A Private Market Solution: Accumulated Pension Collars

A specific proposal for a private market guarantee based on a system of puts and calls is presented in Feldstein and Ranguelova[3]. That paper analyzed the potential experience of an individual who contracts at age 21 to deposit a fraction of his or her earnings each year in a personal retirement account with the funds invested in a 60:40 portfolio of stocks and bonds. The accumulated funds are used at age 66 to finance a variable annuity invested in the same asset mix. This PRA investment is combined with a traditional pay-as-you go system that provides benefits equal to two-thirds of the projected "benchmark" benefits. The individual augments this combination with a put contract that provides that the sum of the PAYGO benefit and the annual PRA annuity would be at least as large as the benchmark benefit, i.e, that the PRA annuity would be at least equal to one-third of the benchmark benefit. The put contract would be part of the package provided by the seller of the PRA investment. To finance the cost of this put, the individual in effect sells a call that gives the buyer of the call any PRA annuity payments in excess of an amount that makes the value of the call equal to the value of the put. In short, the guarantee is based on purchasing a zero-cost "collar" , i.e., a combination of puts and calls of equal value.

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[3]"Accumulated Pension Collars: A Market Approach to Reducing The Risk of Investment-Based Social Security Reform," (Martin Feldstein and Elena Ranguelova). NBER Working Paper No. 7861, August 2000, in Tax Policy and the Economy 2000, (Cambridge, MA: MIT Press, 2001)

Although this collar approach to guaranteeing that the combination of the PRA annuity and the pay-as-you-go benefit would at least equal the benchmark benefit is conceptually interesting, it is not an operationally feasible strategy in practice because it requires individuals at the time that they enter the labor force to know the future path of their earnings. Only with this knowledge can they contract the amounts that they will save and calculate the size of the future pay-as-you-go benchmark benefit.

3. An Annual Contract "No Lose" PRA Plan

The current analysis therefore develops an alternative approach to a market based guarantee that could be implemented in practice. The key to this is that the guarantee is purchased each year based on that year's PRA savings. The basic contract would guarantee the individual a "No Lose" investment, i.e., that the real value of the PRA account at age 66 will be at least equal to the amount that the individual contributed during each year of his working life. More specifically, the amount saved in each year would be guaranteed to retain at least its real value by age 66. Such a guarantee could be provided by the firm that manages the PRA product (i.e., the mutual fund, bank, insurance company, etc..). The PRA legislation might require the PRA manager to offer such an option. Alternatively, the offer of such options might be voluntary. Similarly, individuals might be free to accept such an option only if they want or might be required to select such a guarantee on all or part of their PRA saving. We do not examine these issues but show the effect of such a guarantee on the possible levels of retirement income relative to the traditional pay-as-you-go benefit.

The simplest way to achieve such a No Lose PRA account would be to combine TIPS

(Treasury Inflation Protected Securities, which have a guaranteed real return) with equities. The fraction of the annual PRA saving that would have to be invested in TIPS to guarantee that the annual PRA saving would retain its real value by age 66 depends on the age of the saver and the rate of return on the TIPS of the relevant maturity. For example, if the saver is 21 years old and the real return on TIPS is 2 percent, a $1000 PRA saving would be divided between $410 in TIPS and the remaining $590 in equities. The 2 percent real return and the 45 year investment period imply that the $410 would accumulate to $1000 at the initial price level by age 66. Even if the equity portion became completely worthless, the PRA account would be worth the initial $1000 real dollars.[4]

At older working ages, there are fewer years for the TIPS to accumulate and therefore a larger fraction of the initial saving must be invested in TIPS. For example, a 40 year old would have to invest $598 out of each $1000 of new saving in TIPS to guarantee the $1000 value of the account at age 66 with the remaining $402 invested in equities.

In practice of course the value at age 66 of the annual PRA saving would be worth substantially more than the guaranteed amount because the equity portion of the account would add substantial value. Consider for example the 40 year old. The $598 in TIPS would be worth $1000 at age 66. If the $402 in equities earned a 7 percent real return (approximately the average historic real return over the past half century) , the $402 would grow to $2335, making the total value of that year's account $3335, more than three times the guaranteed amount.

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[4]The supply of TIPS created by the Treasury is already being supplemented by privately issued inflation protected bonds issued by several financial firms. (See Wall Street Journal, July 28, 2004, page D1) The no-risk character of those bonds could be enhanced by requiring that the issuers have appropriate guarantees backed by capital. An appropriate derivatives market in long-term inflation options could facilitate the expansion of this private market.

When the individual reaches age 66, all of the 45 annual PRA accounts would be combined to provide a single PRA retirement fund. The individual could then buy a conventional fixed rate annuity or a variable annuity. Alternatively, the No Lose approach could be continued in the annuity phase of the retirement plan. The annuity provider could offer a guarantee that the annual annuity payments would be at least as large as the individual's retirement fund could purchase with a zero real return. The annuity provider could achieve this guarantee with the appropriate mix of TIPS and equities. The expected return would of course again be much larger than the guaranteed minimum.

There is an alternative way of achieving a zero real return during both the accumulation phase and the annuity phase. The individual in each working year could purchase a real annuity with a guarantee that the return on the funds saved in that year would provide at least as large a real annuity starting at age 67 as would be available with a zero real rate of interest during both the accumulation and annuity phases. This "lifetime contract" has more funds invested in equities during the annuity phase than the "two stage" process that guarantees the accumulated value at age 66 and then uses that to buy the annuity with the zero real return guarantee.

This approach can be easily modified to increase the guarantee from a zero real return (No Lose) to a one percent real rate of return. For a 40 year old, $1000 saved in a PRA would grow at a 1 percent real rate of return to a real $1,295 at age 66. To guarantee at least this amount at age 66 by using TIPS with a 2 percent yield would require purchasing $774 of TIPS. The reduction in the equity investment from $402 (in the zero real guarantee case) to $226 with a one percent real guarantee shows the nature of the tradeoff between risk reduction and return reduction. If the $226 earned the historic average of 7 percent, it would grow to $1312 by age

66, making the total value of the account $2,607. This compares with an expected value of $3,335 with a zero real guarantee.

4. Simulating the Distribution of PRA Investment Outcomes

We simulate the distribution of the accumulated pension assets at age 66 in a fully phased-in plan on the basis of the means, variances and covariances of the returns on equities measured by the Standard and Poors 500 from 1946 to 2003 and on bonds by the Lehman corporate bond returns for 1973 to 2003. The mean log real returns are 6.9 percent for equities and 4.4 percent for corporate bonds. We subtract 40 basis points from the mean returns to reflect potential administrative costs.[5]

The distributions of pension incomes are based on 10,000 simulations for each plan that we study. Each simulation begins by drawing a mean rate of return for the proposed mix of stocks and corporate bonds during the individual's lifetime. This mean is drawn from a normal distribution with a mean equal to the estimated mean from the sample of observations and a standard deviation that equals the standard error of that mean. Conditional on this mean, we draw 80 annual rates of return corresponding to the potential returns at ages 21 through 100. These returns are assumed to be normally distributed and serially independent.[6] The TIPS are

[5]Actual variable annuity plans like TIAA-CREF have lower cost despite marketing expenses.

[6]See Feldstein and Ranguelova (American Economic Review, 2001) for a detailed description of the simulation approach and the relation between the parameters of the log returns and the corresponding parameters in levels.

assumed to deliver a sure real return of 2 percent.[7]

Each of the annual PRA accounts evolves in this way to age 66. At that point, we aggregate the individual accounts and purchase a variable annuity. The annuity is subject to a "No Lose" guarantee that the annual benefits are at least as large as would be achieved with a zero real return. Alternatively we calculate the "lifetime contract" annuities based on a guaranteed real annuity from each year's PRA saving which are then added together during the annuity phase.

5. Comparison of Alternative PRA Pensions Relative to the Pay-as-You-Go Benchmark

Our basic analysis compares the retirement annuities produced by different PRA plans with the level of benefits associated with the pay-as-you-go plan with a 12.4 percent payroll tax. For the sake of specificity, we consider an individual who earns $25,000 at age 21 and whose earnings then rise at 2 percent a year in real terms to $60,950 at age 66. We assume that the benefits at age 67 are then 40 percent of the earnings at age 66. Although a 40 percent replacement rate is standard for an individual with a median level of lifetime income, 40 percent is higher than such an individual would receive in retirement benefits at the $60,950 level of immediate pre-retirement income. The 40 percent replacement is intended as a rough approximation to the combined effects of pre-67 mortality, benefits for a retired spouse, survivor

[7]The actual return on TIPS currently (November 2004) varies between 0.8 percent at 5 years and 2.1 percent at 25 years. Our analysis does not vary the TIP return by maturity. This return has varied over time. Six months earlier it was 1.1 percent at 5 years and 2.25 percent at 25 years.

benefits, etc..[8]

The first row of Table 1 shows the relative benefit distribution corresponding to a mixed plan with a tax rate of 6.2 percent and a PRA saving rate of 6.2 percent. All of the PRA funds are invested in equities (the Standard and Poors 500) with no guarantee. The pay-as-you-go part of the plan, financed with a 6.2 percent tax rate, would provide benefits equal to half of the benchmark level. The data show that with no guarantee the mixed plan with a pure equity PRA investment produces a median combined benefit equal to 2.61 times the benchmark.[9] There is only a one percent chance that the combined benefit would be less than 74 percent of the benchmark. Some individuals with low risk aversion might prefer to have no guarantee, accepting the risk of a low combined benefit in order to have a chance to get a high combined benefit and secure in the knowledge that the pay-as-you-go benefit will provide 50 percent of the benchmark benefit.

Others however would be prepared to sacrifice some of the potential high return in order to reduce the risk of relatively low benefits. Row 2 of Table 1 shows the effect of the No Lose plan with a guarantee that the annual real return would be at least zero. The PRA funds are invested in a mix of equities (the Standard and Poors 500) and TIPS; there are no corporate bonds. The calculation is based on the two stage approach: the TIPS are selected to guarantee a No Lose accumulation (zero real return) to age 66 and the accumulated funds are then used to buy a variable annuity invested in a combination of equities and TIPS selected to give a

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[8]All of the calculations of relative benefits for this representative individual do not depend on the specific level of income.

[9]This is higher than the ratios reported in earlier studies with Ranguelova and Samwick because those studies used a PRA investment equal to 60 percent equities and 40 percent debt.

minimum zero ex ante real return.

Note first that the median ratio of the combined benefits to the benchmark pure pay-as-you-go benefits is 1.80. That is, there is an even chance that the combination of the reduced pay-as-you-go benefits and the PRA annuity will be at least 80 percent more than the basic benchmark pay-as-you-go benefit. Note next that the 5th percentile in the distribution of the combined benefits corresponds to 99 percent of the benchmark benefits. There is thus only one chance in 20 that the combined benefits will be less than 99 percent of the benchmark benefits. Even at the extreme one percent level, the combined benefits would be 90 percent of the benchmark level. In short, the no lose option offers a level of benefits that is likely to be substantially higher than the benchmark benefit in the pure pay-as-you-go system and that involves only a very small risk of receiving less than 90 percent of that benchmark benefit.

Note also that there is a significant chance with this no lose plan of receiving a great deal more than the benchmark benefit. The 70th percentile in the relative distribution corresponds to combined benefits equal to more than twice the benchmark benefit; a combined annuity equal to 266 percent of the benchmark benefit corresponds to about 100 percent of the individual's peak pre-retirement income. Similarly, there is one chance in 10 (i.e., the 90th percentile) that the combined income would be more than five times the benchmark benefit, equivalent to more than twice the peak pre-retirement income.

Selecting a guarantee of a one percent real return during both the accumulation and annuity phases instead of the zero percent reported in the second row of Table 1 does little to reduce the small risk at the first and fifth percentiles and lowers the combined benefits above that level. The implications of the one percent real return guarantee are shown in Row 3 of Table 1.

Comparing rows 2 and 3 shows that the combined income ratio at the 90th percentile declines from 5.7 times the benchmark benefit to about 3.6 times the benchmark. The combined median income falls from 180 percent of the benchmark to 147 percent of the benchmark benefit, still a substantial gain relative to the current law.

In exchange for these lower payouts at the middle and top of the distribution, the one percent real guarantee provides only slightly better protection against lower levels of combined retirement incomes. There is only a one percent risk that the combined benefit would be more than four percent below the benchmark level, not very different from the ten percent with the r>0 guarantee.

Rows four and five are based on lifetime return guarantees instead of the two-stage approach reported in rows two and three. The individual during each working year contributes to a PRA annuity plan that promises to pay a positive rate of return during both the accumulations and annuity phases. If an individual dies before retirement age the accumulated fund is paid as a bequest. This lifetime return guarantee approach keeps a larger share of funds invested in equities, thereby increasing both the risk and the expected return. Comparing the two r > 0 guarantees (rows 2 and 4) shows that the lifetime guarantee approach raises the median benefit from 1.8 times the benchmark to 2.14 times the benchmark. The 90th percentile rises from 5.73 times the benchmark to 8.62 times the benchmark but the first percentile declines from 90 percent of the benchmark to 82 percent.

None of the five distributions clearly dominates. A distribution with higher upside potential also has a greater probability of a low benefit. Individuals with different degrees of risk aversion will therefore have different preferences among these three options. One way to

represent these preferences is by the expected utility of the different options using a constant relative risk aversion utility function. We do expected utility calculations for individuals for CRRA values of 1 through 5 at ages 67, 77, 87 and 97 and then combine these with weights reflecting survival probabilities to these ages. The expected utility calculations therefore do not take into account the value of the bequests that might occur under these different plans.

We find that the No Lose option with a zero guaranteed return (row 2) is preferred to the less risky 1 percent guarantee for every CRRA value between 1 and 5, a not surprising result in light of the distribution of returns shown in Table 1. More surprising, however, is that the No Guarantee option (row 1) is preferred to the No Lose zero return option of row 2 for every CRRA value between 1 and 5. Since there is a substantial risk of a quite low combined benefit, this suggests that the upside gain potential outweighs this risk even for those with high risk aversion. With the lifetime contract approach (rows 4 and 5), the zero real return guarantee is again preferred to the one percent guarantee for all CRRA values, just as it is for the two stage approach. Comparing the two different ways of achieving the zero real return guarantee shows that the expected utility is higher with the lifetime guarantee for CRRA values up to 3.5, presumably because it permits more risk taking. Even with that greater risk taking implied by the lifetime contract approach, individuals continue to prefer the no guarantee option (row 1) to either of the lifetime contract options**.**

In the overall comparison of the No Guarantee and the four different guarantees shown in Table 1, the expected utility comparisons show that No Guarantee is preferred for all of the CRRA values up to 5.0. The lifetime contracts and the one percent negative return are dominated.

Finally, a calculation comparing the expected utility of these five plans to the expected utility of the pure pay-as-you-go benefit that pays 100 percent of the benchmark shows that for all of the risk aversion values between 1 and 5 the investment based plans are preferred to the pure pay as you go plan.

6. Tailoring the Guarantees to Individual Preferences with Zero Cost Collars

It is possible to extend the range of options in a way that could make a guarantee plan preferable to the no guarantee option. More specifically, using a combination of puts and calls in which the cost of the put is financed by selling a call, i.e., a zero cost collar, allows different ways of shaping the two tails of the distribution, depending on how the put and call are specified. In this way, the risk protection can be tailored to different groups of PRA participants.

To see why this might be a preferred option, consider row 2 of Table 1. These figures show that with the no lose real return guarantee the individual has a 10 percent chance of getting a retirement income equal to almost six times the benchmark benefit. Although such a large windfall would no doubt be welcome, a risk averse individual might be willing to forego some of that very high end possibility for a reduced risk of relatively low benefits and improved distribution of outcomes in the first 50 percent of the probability distribution.

One way to achieve that alternative distribution would be to buy a put option that guarantees a real return of at least zero and to finance the cost of this put by selling a call option that gives its buyer all of the value above some cumulative real rate of return. Such a put-call strategy that caps the upside rate of return in order to purchase a put that guarantees at least a zero real return would have a different distribution of combined pension incomes than a zero real

return guarantee achieved with TIPS (since that does not put a cap on the maximum possible rate of return.)

This strategy can be extended to consider zero cost collars that guarantee other minimum positive or negative real rates of return. On the basis of some preliminary analysis, the analysis here focuses on zero cost collars for minimum real returns of zero and minus one percent.

Table 2 compares the distributions shown in Table 1 for the no guarantee option (row one) and the zero real return option achieved with TIPS (row 2) to the distributions using puts to guarantee minimum returns of zero (row 3) and minus one (row 4) financed by selling calls on all of the returns above the level needed to finance those puts.

It is clear that a risk averse individual might well prefer a collar strategy with a minimum guarantee of minus one percent return to the TIPS zero return guarantee or to no guarantee at all. With this collar strategy there is only a one percent chance of receiving less than the benchmark benefit. The benefit is higher at each point in the distribution up to at least the 50^{th} percentile. At the 90^{th} percentile, the individual forsakes the one-in-ten chance of a benefit that is more than five times the benchmark (and therefore more than twice maximum preretirement income) but still can anticipate a benefit that is twice the benchmark.

This is borne out by the expected utility calculations. In a mixed system with a 6.2 percent PAYGO tax and a 6.2 percent PRA saving rate, an individual with CRRA less than or equal to four will prefer to invest their PRA in equities with no guaranteed return. But with a higher degree of risk aversion, the individual prefers to forego the potential high return for a minimum return of at least minus one percent.

There are of course other collars that might be preferred to this. For example one , one

possible strategy would sell a call that pays (say) 50 percent of the equity returns above some level and use the proceeds of that call option to buy a put that guarantees at least a minus percent real return.

7. Lower Cost Mixed Plans: Limiting the Tax Increase

A primary goal of Social Security reform is to avoid the large increase in the tax rate that will result from the aging of the population if no there is no program change. The Social Security actuaries estimate that the existing benefit rules would require raising the tax rate in the pay-as-you-go system by about 50 percent, from 12.4 percent to about 18.6 percent.[10] An advantage of the investment-based approach is that it is possible to finance the benefits implied by the existing benefit rules with a lower future cost.

A useful way to analyze the implication of the long-run demographically caused increase in the cost of producing the benefits in a pure PAYGO system is to consider the impact on benefits of cutting the PAYGO tax by one-third with a pure PAYGO system. A pure PAYGO system with a tax rate equal to two thirds of the current PAYGO 12.4 percent, i.e., an 8.3 percent combined tax rate, would show the one-third decline in benefits relative to the currently projected "benchmark"benefits that would be occur as a result of the demographic change. In contrast, a mixture of a PAYGO tax and a PRA contribution that totals 8.3 percent would show the extent to which it is possible to reduce the benefit shortfall with no increase in the total cost when the system is fully phased in.

Analysis of such a mixed plan with a 4.15 percent PAYGO tax and a 4.15 percent PRA

[10]The calculation is more complex because of disability benefits that are now financed as part of the 12.4 percent.

saving rate showed that the expected benefit would exceed the current benefit but that there would be a significant probability that benefits would be less than 75 percent of the benchmark benefit.

The current section therefore presents results for a plan that reduces costs by 20 percent instead of by the one-third needed to stabilize the implied tax rate. One way to interpret this would be as the net effect of reducing the payroll tax by one-third (from 12.4 percent to 8.3 percent, to stabilize the implied future tax rate) and dividing this between a PAYGO portion of 4.96 percent and a carve out to PRA accounts of 3.35 percent supplemented by individual PRA contributions of an additional 1.61 percent, bringing the total to 9.92 percent or 80 percent of the current 12.4 percent.[11] This would be equivalent to a future cost increase from 12.4 percent to 14.9 percent (instead of the 18.6 percent rate implied by the 50 percent cost rise that would occur with a pure PAYGO system) with 2.5 percent of payroll paid as an individual contribution on top of the tax.

Table 3 shows results similar to Table 1 except that the PAYGO and PRA costs have now both been reduced to 80 percent of what they were in Table 1. Consider first the results for the No Guarantee plan in line 1. The median level of the benefits in this probability distribution is still substantially higher than the benchmark distribution: 2.09 times the benchmark.

At the 10th percentile, the new low cost strategy with no guarantee produces a combined benefit equal to 86 percent of the benchmark. But at the 1st percentile, the combined benefits in the low cost plan are only 59 percent of the benchmark, a level that some would consider an

[11]The individual contribution could be induced on a voluntary basis by making the carve-out transfer to the PRA accouant conditional on the additional individual contribution. Making the individual contribution the "default option" would increase the participation rate.

uncomfortably high level of risk.

The second and third rows of Table 3 show how much the risk can be reduced by introducing guaranteed annual rates of return in a two stage plan. A No Lose annual guarantee of a real return greater than zero raises the combined benefit at the 1st percentile from 59 percent of the benchmark to 72 percent of the benchmark. The price of this risk reduction is a decline in the relative combined benefits starting at about the 10th percentile. Thus at the 30th percentile the combined benefit declines from 137 percent of the benchmark to 109 percent. At the median, the drop is from 2.1 times the benchmark to 1.44 times benchmark. The prospect for very high gains falls even more.

Giving up more of the upside benefits by requiring at least a one percent real return on each year's PRA savings improves the very low probability ratios only slightly and reduces the combined benefits at all higher percentiles. . Row 3 of Table 3 shows that an annual guarantee of r>1 raises the 1st percentile only from 0.72 with r>0 to 0.77. Higher points on the distribution show the kinds of benefit decreases associated with these small risk reductions.

Rows 4 and 5 of Table 3 repeat these calculations for the lifetime annuity plans. Since these involve a generally larger equity proportion in the PRA account they have higher risk than rows 2 and 3.

The last two rows of Table 3 use a collar to reduce risk by guaranteeing a minimum return of at least minus one percent on each year's savings and finance that put option by selling returns above a rate of return with an equal Black-Scholes value. This zero cost collar has the effect of limiting the maximum benefit to 1.65 times the benchmark but uses this limit to raise the low probability level to 98 percent of the benchmark at 10 percent and 79 percent at the one

percent level.

The implication of Table 3 is that a mixed system with a cost that is 20 percent lower than the cost required with a pure PAYGO plan, when combined with a zero cost collar that gives up the possibility of very high benefits in order to reduce the risk of low benefits, could provide benefits that are likely to be substantially higher than the current law benchmark and that have only a very small probability of being less than the current law benchmark. More specifically, using a zero cost collar that guarantees that the real return on each year's saving is not less than minus one percent implies a median benefit equal to 1.6 times the benchmark and that there is only once chance in 10 that the benefit would be less than 98 percent of the benchmark and only one chance in one hundred that it would be less than 79 percent of the benchmark.

The expected utility ranking of the alternatives in Table 3 imply that individuals with a CRRA value up to 4.0 would prefer to have no guarantee while those with higher risk aversion prefer the collar approach with a guarantee of minus one. Those with a higher risk aversion would prefer the collar approach with a guarantee of minus one percent.

The final calculations, presented in Table 4, show the implication of dealing with demographic change with a system that, when fully phased in, is purely investment-based with no pay-as-you-go component. More specifically, we assume that the accumulation is based on annual saving of 9.92 percent of payroll which is fully invested in equities except to the extent that a guarantee is provided by the use of TIPS or zero cost collars.[12] With no guarantee, this

[12]A method of transition from the existing PAYGO system to a pure investment based system in a way that does not require more than an additional 2 percent of payroll each year during the transition (equal to less than one percent of GDP) is presented in M. Feldstein and A.

pure investment based plan has a one percent probability of a benefit that is less than 38 percent of the benchmark and a five percent probability that the benefit is less than 68 percent of the benchmark. A TIPS based two-stage strategy that guarantees that each year's saving will have a positive real return substantially reduces this risk, raising the one percent level to 64 percent of the benchmark and the five percent level to 79 percent of the benchmark.

The risk can be reduced even more by the zero-cost collar that guarantees a real return of at least minus one percent on each year's saving by giving up any prospect of returns that would produce a benefit equal to more than 2.5 times the benchmark. With this collar, there is only a one percent risk of benefits that are less than 79 percent of the benchmark. The five percent risk level corresponds to 93 percent of the benchmark and the ten percent risk level is 116 percent of the benchmark.

An explicit expected utility calculation implies that with a CRRA value equal to 2.5 two or less, the individual would prefer the pure equity investment with no guarantee. With CRRA values between 3 and 4, the individual would choose the zero cost collar with the guaranteed real return of at least minus one percent. Finally, with CRRA values of 4.5 and 5, the preference would shift to the two-stage guarantee of a real return greater than zero based on investment in TIPS. The progression as risk aversion increases is thus from a more risky to a less risky approach.

For each CRRA value, the expected utility of the pure investment based plans with the 9.92 percent of payroll saving and with the utility maximizing guarantees exceeds the expected

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Samwick, "The Transition Path in Privatizing Social Security," in M. Feldstein, Privatizing Social Security (Chicago: University of Chicago Press, 1998).

value with mixed system with taxes and PRA contributions of 4.46 percent of payroll. Additional calculations would be needed to consider the path of transition before deciding whether the extra cost in the transition to a pure investment based system is justified by the higher level of long-run expected utility.

Two other expected utility calculations are worth mentioning. In the mixed plans with PAYGO taxes equal to PRA saving and with no guarantees, the expected utility of PRA investments that are 100 percent in equities exceeds the expected utility of PRA investments divided between equities and corporate debt in the ratio of 60 to 40. In contrast, in a pure investment based plan with no PAYGO component, the 100 percent equity investment is preferred only by individuals with low risk aversion (CRRA values up to 3.0) with the 60:40 stock bond portfolios preferred by individuals with higher CRRA values .

8. A Concluding Comment

This paper has described the risks implied by a mixed system of Social Security pension benefits with different combinations of pay-as-you-go taxes and personal retirement account (PRA) saving. The analysis showed how these risks can be reduced by using alternative guarantee strategies. The first such strategy uses a blend of equities and TIPS to guarantee at least a positive real rate or return on each year's PRA saving. The second is an explicit zero-cost collar that guarantees an annual rate of return by giving up all returns above a certain level. One variant of these guarantees uses a two stage procedure: a guaranteed return to age 66 and then a separate guarantee on the implicit return in the annuity phase. An alternative strategy provides a combined guarantee on the return during both the accumulation and the annuity phase.

Simulations are used to derive the probability distributions of retirement incomes relative to the "benchmark" benefits specified in current law. Calculations of expected utility show that these risk reduction techniques can raise expected utility relative to the plans with no guarantees. The ability to do so depends on the individual's risk aversion level. This underlines the idea that different individuals would rationally prefer different investment strategies and risk reduction options.

There are of course other ways that both types of guarantee could be modified that might produce higher expected utility. One line of research that should be considered is alternative designs of the puts and calls in the zero cost collars. Another approach would allow adjustments in the portfolio composition during the accumulation or annuity phase based on the performance of the investments to that point.

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Table 1
Guarantee Based on Combination with TIPS
Frequency Distribution of Combined Pension Income
Relative to Benchmark Pay-As-You-Go Benefits with Benchmark T = 12.4

(T = 6.2 S = 6.2)

	0.01	**0.05**	**0.10**	**0.30**	**0.50**	**0.70**	**0.90**
Real Rate of Return Guarantee							
None	0.74	0.93	1.08	1.71	2.61	4.38	10.28
Two Stage Guarantee							
No Lose ® > 0	0.90	0.99	1.06	1.36	1.80	2.66	5.73
No Lose ® > 1)	0.96	1.01	1.05	1.22	1.47	1.94	3.58
Lifetime Contract Guarantee							
No Lose (r > 0)	0.82	0.91	1.00	1.43	2.14	3.58	8.62
No Lose (r > 1)	0.90	0.95	1.01	1.27	1.69	2.57	5.63

Combined Pension Income at age 77 based on PAYGO equal to 0.5 benchmark benefit and PRA accounts invested in equities with TIPS to achieve the return guarantee. Benchmark based on pay-as-you-go with T = 12.4.

Table 2
Guarantee Based on Zero-cost Collar
Frequency Distribution of Combined Pension Income
Relative to Benchmark Pay-As-You-Go Benefits with Benchmark T = 12.4
(T = 6.2 S = 6.2)

Real Rate of Return Guarantee	**0.01**	**0.05**	**0.10**	**0.30**	**0.50**	**0.70**	**0.90**
None	0.74	0.93	1.08	1.71	2.61	4.38	10.28
Two-stage guarantee							
Using TIPS							
No Lose (r > 0)	0.90	0.99	1.06	1.36	1.80	2.66	5.73
Zero cost collar guarantee							
No Lose (r > 0)	0.94	1.01	1.13	1.56	1.81	1.85	1.86
r > minus one	0.99	1.08	1.23	1.73	2.00	2.06	2.06

Combined Pension Income at age 77 based on PAYGO equal to 0.5 benchmark benefit and PRA accounts invested in equities with TIPS or zero cost collar to achieve the return guarantee. Benchmark based on pay-as-you-go with T = 12.4.

Table 3
Low Cost Mixed Plans

Frequency Distribution of Combined Pension Income
Relative to Benchmark Pay-As-You-Go Benefits with Benchmark T = 12.4
(T = 4.96 S = 4.96)

Real Rate of Return Guarantee	**0.01**	**0.05**	**0.10**	**0.30**	**0.50**	**0.70**	**0.90**
None	0.59	0.74	0.86	1.37	2.09	3.50	8.22
Two Stage Guarantee							
No Lose ® > 0	0.72	0.79	0.85	1.09	1.44	2.13	4.58
No Lose ® > 1)	0.77	0.81	0.84	0.98	1.17	1.55	2.86
Lifetime Contract Guarantee							
No Lose (r > 0)	0.65	0.73	0.80	1.15	1.71	2.87	6.89
No Lose (r > 1)	0.72	0.76	0.81	1.02	1.35	2.06	4.50
Zero cost collar guarantee							
No Lose (r > 0)	0.75	0.81	0.90	1.25	1.45	1.48	1.49
r > minus one	0.79	0.86	0.98	1.39	1.60	1.65	1.65

Combined Pension Income at age 77 based on PAYGO benefits equal to 0.4 benchmark benefit and PRA accounts invested in equities with TIPS or zero cost collars to achieve the return guarantee. Benchmark based on pay-as-you-go with T = 12.4.

Table 4
Low Cost Pure Investment Plans

Frequency Distribution of Combined Pension Income
Relative to Benchmark Pay-As-You-Go Benefits with Benchmark T = 12.4
(T = 0 S = 9.92)

Real Rate of Return Guarantee	**0.01**	**0.05**	**0.10**	**0.30**	**0.50**	**0.70**	**0.90**
None	0.38	0.68	0.93	1.94	3.38	6.21	15.65
Two Stage Guarantee							
No Lose ® > 0	0.64	0.79	0.90	1.37	2.08	3.46	8.36
No Lose ® > 1)	0.74	0.81	0.88	1.16	1.55	2.31	4.92
Lifetime Contract Guarantee							
No Lose (r > 0)	0.50	0.65	0.80	1.50	2.62	4.93	12.99
No Lose (r > 1)	0.64	0.72	0.81	1.23	1.90	3.31	8.21
Zero cost collar guarantee							
No Lose (r > 0)	0.70	0.81	1.01	1.69	2.09	2.16	2.17
r > minus one	0.79	0.93	1.16	1.97	2.41	2.49	2.50

Combined Pension Income at age 77 based on no PAYGO benefits and PRA accounts invested in equities with TIPS or zero cost collars to achieve the return guarantee. Benchmark based on pay-as-you-go with T = 12.4.