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 and the Bush administration established a bipartisan presidential commission to advise on detailed aspects of such a plan.

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 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 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 this approach is a guarantee that the individual would not lose any of the value of each year's PRA savings and might be guaranteed to earn at least some minimum positive 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 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 184 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 98 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.

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]

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. I will assume therefore that the investment based plans are all structured through Personal Retirement Accounts. In all of these plans, individuals 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 PRA investment-based plans involve various forms and mixtures of the following four approaches:

(1)   Restrictions on the investment assets;

(2)   A mixed system that combines pay-as-you-go benefits and investment based annuities;

(3)   Government guarantees;

(4)   Market based guarantees.

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[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.

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

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.

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 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.

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[2]. That paper analyzed the potential experience of an

individual who contracts 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 annuity 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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[2]"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 a 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.

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 investment at age 66 will be at least equal to the amount that the individual contributed during 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.[3]

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 the average historic real return of 7 percent, 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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[3]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, 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 to 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.

An Annual Contract Guaranteed Real 1% PRA Plan

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.

Simulating the Distribution of PRA Investment Outcomes

We simulate the distribution of the accumulated pension assets at age 67 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.[4]

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.[5]. The TIPS are assumed

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

[5]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

to deliver a sure real return of 2 percent.[6]

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.

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. 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 benefits, etc..

The first row of Table 1 shows the relative benefit distribution corresponding to a mixed

and the corresponding parameters in levels.

[6]The actual return on TIPS currently (July 2004) varies between 1.1 percent at 5 years and 2.25 percent at 25 years. Our analysis does not vary the TIP return by maturity.

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 more than five times the benchmark.[7] There is only a one percent chance that the combined benefit would be less than 75 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 TIPS are selected to guarantee a No Lose accumulation (zero real return) to age 66. The accumulated funds are then used to buy a variable annuity invested in a combination of equities and TIPS selected to give a minimum zero real return.

Note first that the median ratio of the combined benefits to the benchmark pure pay-as-you-go benefits is 2.49. 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 249 percent of the basic benchmark pay-

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[7]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.

as-you-go benefit. Note next that the 5th percentile in the distribution of the combined benefits

corresponds to 108 percent of the benchmark benefits. There is thus only one chance in 20 that

the combined benefits will be less than 108 percent of the benchmark benefits. At the extreme one

percent level, the combined benefits would be 95 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 95 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 four times the benchmark benefit, a level corresponding to

150 percent of the peak pre-retirement income. Similarly, there is one chance in 10 (i.e., the 90th

percentile) that the combined income would be more than nine times the benchmark benefit,

equivalent to more than three times 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 1st percentile 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 more than

nine times the benchmark benefit to about six times the benchmark. The combined median income

falls from 249 percent of the benchmark to 184 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 two percent below the benchmark level, not very different from the five percent with the r>0

guarantee.

Individuals with different degrees of risk aversion will have different preferences among

these three options. One way to represent these preferences is by the expected utility of the three

different options using a constant relative risk aversion utility function.[8] We find that the No Lose

option with a zero guaranteed return is preferred to the less risky 1 percent guaranteed return

plan with every risk aversion value between 1 and 4, 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 4. 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. We

could, and will, explore later the impact of even higher risk aversion parameters. Alternatively,

the CRRA framework may not reflect the kind of extreme risk aversion that would make someone

give up much of the upside potential to reduce the risk in the extreme lower tail of the

distribution.

Finally, a calculation comparing the expected utility of these three 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 4 the investment based plans are preferred to the pure

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[8]We do this calculation for individuals at ages 67, 77, 87 and 97 and then combine these
with weights reflecting the survival probabilities to these ages.

pay as you go plan.

Lower Cost Mixed Plans

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 from 12.4 percent to18.6 percent.[9] 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 cost in the combination of the PAYGO tax and the PRA contribution.

Of course, the investment based approach involves some risk and it is the purpose of this

section to see what that risk is when the combined cost is reduced by 20 percent. Thus, the 18.6

percent would be reduced to 14.9 percent. Instead of a PAYGO increase of 6.2 percent of

payroll – from 12.4 percent to 18.6 percent – the increase would be only 2.5 percent of payroll.

We analyze that here in terms of the current 12.4 percent financing of benchmark benefits by

looking at the effect of a 20 percent reduction from the current 12.4 percent cost, i.e., cutting the

PAYGO tax in the mixed system from 6.2 percent to 4.96 percent and similarly cutting the PRA

contribution from 6.2 percent to 4.96 percent. As in the earlier part of the paper, we are looking

at a fully phased in system since risks are greatest at that point.

Table 2 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

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

substantially higher than the benchmark distribution: 4.30 times the benchmark.

At the 10th percentile, the new low cost strategy with no guarantee produces a combined benefit equal to 110 percent of the benchmark. But at the 1st percentile, the combined benefits in the low cost plan are only 60 percent of the benchmark, a level that some would consider an uncomfortably high level of risk. Moreover, when we look at the potential experience of the 87 year olds (not shown in the table), the increase in variance that occurs with age implies that the combined benefit at the 1st percentile would be only 50 percent of the benchmark.

The second row of Table 2 shows how much the risk can be reduced by introducing guaranteed annual rates of return. A No Lose annual guarantee of a real return greater than zero raises the combined benefit at the 1st percentile from 60 percent of the benchmark to 76 percent of the benchmark. For the 87 year olds, the increase is from 50 percent of the benchmark to 74 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 10th percentile the combined benefit declines from 110 percent of the benchmark to 95 percent. At the median, the drop is from 4.3 times the benchmark to less than half that, 1.99 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 2 shows that an annual guarantee of r>1 raises the 1st percentile only from 0.76 with r>0 to 0.78. Even for the 87 year olds, the increase at the 1st percentile is only from 0.74 to 0.78. Higher points on the distribution show the kinds of benefit decreases associated with these small risk reductions (for the 77 year olds). At the

10th percentile, the benefits are reduced from 95 percent of benchmark to 90 percent and at the 50th percentile the reduction is from 1.99 times benchmark to 1.47 times benchmark.

To compare the expected CRRA utility values of these 80 percent plans, I have again calculated the expected utilities at four ages (67, 77, 87 and 97) and combined these using the survival probabilities. These expected utility calculations are done with a constant relative risk aversion function, with risk aversion values from 1.0 to 4.0.

All three of the mixed investment-based plans produce distributions of combined benefits with the low cost PAYGO and PRA contributions that have higher expected utility than the pure pay-as-you-go plan financed at full cost, i.e., with a 12.4 percent PAYGO tax instead of the combined 9.92 percent of the mixed investment based plans.

Given the distributions shown in rows 2 and 3 it is not surprising that the zero annual guarantee plans have higher expected utility than the one percent guarantee. Much more surprising is the fact that the no guarantee plans have higher expected utility than the plans with a no lose zero guarantee. This may of course say more about the properties of the CRRA utility function than about the actual choices that individuals would make. Faced with the distributions in rows 2 and 3 some people might choose the greater protection of row 2 even though it means foregoing the potential for the very large upside gains in the right hand tail of the distribution with no TIPS.

Tailoring the Guarantees to Individual Preferences

It is however possible to extend the range of different guarantees in a way that could make a guarantee plan preferable to the no guarantee distribution. This can be done by using combinations of puts and calls in which the cost of the put is financed by selling a call.

To see why this might be a preferred option, consider row 2 of Table 2. 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 eight 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 1 percent and to finance the cost of this put by selling a call option that gives its buyer all of the annual returns above some level . Note that a put-call strategy that caps the upside rate of return in order to purchase a put that guarantees at least a 1 percent real return would have a different distribution of combined pension incomes than a 1 percent guarantee achieved with TIPS (since that does not put a cap on the maximum possible rate of return.)

Yet a different 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 one percent real return.

Directions for Future Work

Future work in this project will examine a variety of strategies for reducing the risk of investment-based plans. These will include a variety of put-call strategies, different mixes of pay-as-you-go and PRA accounts, the substitution of corporate stock for some of the equities in the PRA accounts, and the lifetime contract annuities in which the individual buys an annuity each

year instead of accumulating funds and buying the annuity at age 67. We will also consider

feedback rules in which the individual changes the asset mix or investment strategy in response to

the relative performance of the PRA accounts at different ages.

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Table 1
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	0.75	1.05	1.37	2.85	5.37	10.72	33.71
No Lose (r > 0)	0.95	1.08	1.19	1.70	2.49	4.07	9.76
No Lose (r > 1%)	0.98	1.06	1.13	1.40	2.75	6.06	2.32

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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

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	0.60	0.84	1.10	2.28	4.30	8.57	26.97
No Lose (r > 0)	0.76	0.86	0.95	1.36	1.99	3.26	7.81
No Lose (r > 1%)	0.78	0.85	0.90	1.12	1.47	2.20	4.85

Combined Pension Income at age 77 based on PAYGO equal to 0.4 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.