Projecting Future U.S. Pension Benefits

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Abstract

The PSG models are used to project future pension benefits and social security benefits for the 1990 birth cohort. The projection shows wide variation in future pension benefits, both across macroeconomic scenarios for the whole cohort and across different individual life histories in the same macroeconomic scenario. Viewing this variation as risk to a cohort individual at birth, the risk-adjusted pension benefit is substantially smaller than the risk-adjusted social security benefit, even though the average (non-risk-adjusted) pension benefit is roughly the same as the average social security benefit. This is true because the individual will receive stable social security benefits in almost all life histories, while the real value of the pension benefit received will vary widely across life histories depending on the details of the individual's realized job history and the nature of the macroeconomic environment within which that job history plays out. As a result, a 1990 cohort individual would have a larger risk-adjusted pension plus social security benefit if some of the tax subsidy currently provided to pension benefits was reduced and the resulting tax revenue was used to finance scheduled social security benefits, rather than leaving the pension tax subsidy in place and receiving the lower social security benefits that are payable given current trust-fund revenue sources.

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1 Introduction

The nature of employer-sponsored pensions has changed substantially over the past several decades in the U.S. The shift in employer offerings from traditional defined-benefit plans to defined-contribution plans and new hybrid plans has left employees with pension benefits that are less sensitive to career job changes, but more sensitive to asset return fluctuations. The magnitude of the shift in pension offerings implies that information about the pension benefits of current retirees provides little information about the pension benefits future retirees are likely to accumulate over their work careers. In addition to this uncertainty about future pension benefits, there are questions about the level of future social security benefits given the long-run imbalance between trust-fund tax income and benefit cost.

This paper projects future pension and social security benefits for a large sample of a birth cohort whose members are just now beginning their work careers. The benefit projection is based on realistic work careers that include job changes, jobs that do not offer pensions, disability, and annual fluctuations in asset returns and inflation. The underlying demographic and economic projection uses intermediate-cost assumptions from the social security Trustees Report (2007) and produces population, aggregate earnings, payroll taxes, and social security benefits that closely match those in the Trustees Report. The assumptions about employer pension offerings and employee pension behavior are consistent with the most reliable data available from government and private sources, and are the same as used in official government analysis of pension regulations. As a result, the paper provides, for the first time, a projection of both pension and social security benefits for a large representative sample of individuals that is based on a recognized set of assumptions and that explicitly simulates the effect on benefits of uncertain future inflation and asset returns.

The paper is organized as follows. Section 2 describes projection methods: the microsimulation model used to produce the benefit projection, the assumption details, and the validity of the model. Section 3 describes how pension benefits are measured and presents projection results: estimates of the variation in benefits across macroeconomic scenarios for the whole birth cohort and across individuals in the birth cohort, and estimates of the risk-adjusted benefit at birth. Section 4 compares these projection results with others presented in recent papers by other authors. Section 5 concludes.

2 Projection Methods

This section describes the PSG models used to produce the projection, the baseline assumptions used by the PSG models in this work, and the validity tests that have been performed on the PSG models.

2.1 Model Structure

The pension and social security benefit projection presented in this paper is produced by the PSG models, three stochastic microsimulation models — SSASIM, PENSIM, GEMINI — that work together seamlessly to provide an easy-to-use, well-documented, fast-running, extensively-validated, publicly-available capability for U.S. pension and social security analysis. The PSG models have been used for years by the Department of Labor, Social Security Administration (SSA), Government Accountability Office (GAO), and various private non-profit organizations to analyze the effects of pension regulations and social security reforms. Comprehensive documentation of the PSG models and examples of their use are available at the PSG web site ⟨http://www.polsim.com⟩.

SSASIM simulates the stochastic macroeconomic scenarios and produces social security trust-fund solvency estimates (Holmer, SSASIM Guide 2008). PENSIM simulates life histories and employer-sponsored pension benefits for a large cohort sample (Holmer, Janney and Cohen, PENSIM Overview 2008, Holmer and Janney, Pension Characteristics 2003). GEMINI simulates social security benefits for each individual in the cohort sample (Holmer, GEMINI Guide 2008). The interactions between the three models are described in "Getting Started with the PSG Models" (Holmer 2008).

2.2 Baseline Assumptions

While the PSG models can use any set of demographic and economic assumptions, the projection presented in this paper uses intermediate-cost assumptions from the social security Trustees Report (2007). Using standard assumptions that are well understood, if not always agreed with, and using these same assumptions to project both pension and social security benefits, provides the projection with a transparency missing from most other pension projections.

In addition to the basic demographic and economic assumptions, the projection uses baseline PENSIM assumptions about employer pension offerings and employee pension behavior. These baseline assumptions include a pension characteristics imputation model that is estimated with National Compensation Survey establishment-level pension plan data that can be analyzed only at the Bureau of Labor Statistics (Holmer and Janney, Pension Characteristics 2003). The pension offering assumptions used in this projection include widespread adoption of automatic enrollment in private defined contribution plans in the next few years, but otherwise project offerings to be unchanged in the future. The baseline PENSIM assumptions also include a range of behavioral models that simulate employee behavior with regards to plan participation, contributions, investments, rollovers, and annuitization. In each case, the baseline behavioral parameters have be specified so that PENSIM simulates aggregate results observed in government and private survey data (Holmer, Janney and Cohen, PENSIM Overview 2008, section 2.2).

Inflation and Treasury bond yields are assumed to fluctuate from year to year around mean values according to a vector autoregressive model estimated with annual data from 1954–2005 (Holmer, SSASIM Guide 2008, section 1.2.5). Annual deviations from the mean equity return are assumed to have a log-normal distribution without any mean reversion, with a standard deviation of 20.2 percent, which equals the historical volatility over the 1926–2005 period. The geometric means of the inflation rate and real Treasury bond yield are 2.8 percent and 2.9 percent, respectively, which are the same as in the Trustees Report (2007). The geometric mean of the real (nominal) equity return is assumed to be 4.9 (7.84) percent, which is somewhat less than the historical average over past decades, but the same as assumed by the Department of Labor in its official, peer-reviewed, and OMB-approved regulatory impact analysis of default investment rules for defined-contribution pension plans (the PSG web site ⟨http://www.polsim.com/well-known-users.html⟩ provides links to the final rule in the October 24, 2007, *Federal Register*, and to details of the regulatory impact analysis).

These inflation rate and asset return stochastic processes are used to generate 500 scenarios, each one of which begins in 2004 and extends more than one hundred years into the future. In each scenario, a 0.1 percent sample of the 1990 birth cohort is simulated from birth to death. The all-scenario sample contains 1,850,624 cohort individuals who are native born in 1990, never emigrate, and live long enough to reach retirement. This count does not include the simulated spouses who can be younger or older than the individuals in the cohort sample.

2.3 Validation Tests

The validity of output generated by the PSG models has been tested over the years in several ways. The overall conclusion from these tests, some of which compare simulated results to real survey data and others of which compare simulated results to simulated results from other models, is that the PSG models produce realistic samples of individual life histories and realistic aggregate results. The validation tests fall into five categories.

First, a variety of demographic and economic statistics calculated from samples of individual life histories simulated by PENSIM have been compared with the same statistic tabulated from real survey data (Holmer, Janney and Cohen, PENSIM Overview 2008, chapter 8).

Second, future-year aggregate demographic and economic statistics calculated from PENSIM life histories closely match the projected statistics in the social security Trustees Reports.

Third, various employer-sponsored pension statistics from the PSG models have been compared to statistics tabulated from real survey data (Holmer, Janney and Cohen, PENSIM Overview 2008, chapter 10). These statistics include defined-contribution plan participation rates, individual and family defined-contribution account balances, and defined-benefit plan benefit receipt in retirement.

Fourth, estimates of the solvency effects of nearly two dozen social security reform provisions produced by the PSG models have been compared with estimates produced by the SSA Office of the Chief Actuary (OCACT). These comparisons, which have been performed by SSA staff, show that in almost all cases, the two estimates are the same or very close. And in the few cases where there are meaningful differences, investigations raise as many questions about the OCACT estimates as about the PSG estimates.

And fifth, PSG model estimates of the effects of numerous multiple-provision social security reform proposals on individual benefits and trust-fund solvency have been compared with OCACT estimates. These comparisons, which have been performed by SSA and GAO staff over the years, have been favorable to the PSG models. For example, in the case of the Commission to Strengthen Social Security reform proposals, the stylized individual benefit estimates differed by less than one percent.

3 Projection Results

This section presents the pension and social security benefit projection results for the 1990 birth cohort in three subsections. The first subsection describes how benefits are measured. The second subsection shows how benefits vary across scenarios, individuals, and lifetime earnings groups. And the third subsection estimates the cohort's risk-adjusted benefit at birth by interpreting the simulated cohort individuals as the probability distribution of life histories facing an individual at birth and applying standard expected utility methods.

3.1 Measurement of Pension Benefits

The projection focuses on a subset of the 1990 birth cohort that includes only individuals who are native born, never emigrate, and live until they retire (or become disabled). This subset contains 1,850,624 individuals or about 3700 individuals in each of the 500 scenarios. The pension and social security benefits received by an individual in each retirement year are always expressed in 2007 dollars.

A simple form of benefit sharing is assumed. The pension (or social security) benefit received by a married individual is calculated as the sum of one-half of the individual's benefit and one-half of the benefit of the individual's spouse in that year. The benefit received by a single individual is simply that individual's benefit.

An individual's pension benefit is the sum of traditional defined-benefit plan payments and payments from annuities purchased with the retirement-age balance in defined-contribution and hybrid (cash-balance) plans and in the individual's personal investment account that accumulates balances rolled over from plans offered by prior employers. The traditional defined-benefit plan payments may or may not be inflation indexed depending on the characteristics of the plan; the annuities purchased with balances are never inflation indexed. Single individuals always elect single-life options, and married individuals always elect joint-and-survivor options, for all traditional defined-benefit payments and for all purchased annuities. The projection assumes that purchased annuities are priced with a loading that insures the solvency of the annuity provider.

An individual's social security benefit is the the Old-Age, Survivors, and Disability Insurance benefit (OASDI) for that individual, which does not include spousal benefits but does include child benefits if they are being paid based on that individual's earnings record.

In summary, each individual in the sample has a spouse-shared pension benefit and social security benefit, expressed in 2007 dollars, for each year of retirement, which begins when the individual experiences disability or retires. The sample of 1,850,624 cohort individuals experiences 44,322,100 retirement years, implying an average of nearly 24 retirement years. Each individual's average benefit is computed as the unweighted mean of the individual's annual real benefits. Each average benefit statistic for a group of individuals is computed as a weighted mean where each individual's average benefit is weighted by the individual's number of retirement years. This means that individuals with long (short) retirements get a larger (smaller) weight in a group average. Computing average benefits for groups using retirement-year weights produces averages that are not substantially different from unweighted averages.

3.2 Variation in Pension Benefits

The presentation of results on the variation in projected pension benefits across scenarios and individuals is organized into five parts.

Whole-Cohort-Average Benefit across Scenarios

The first part shows the variation across the 500 scenarios in the all-sample average pension benefit and social security benefit. As described above, the real benefit in each retirement year is averaged to produce a benefit for an individual, and each one of these individual benefits is used to produce a retirement-years weighted average for the whole scenario sample. The mean of these 500 whole-cohort benefits, and the benefit at the 5th, 25th, 50th, 75th, and 95th percentile are plotted in 2007 dollars in the left graph of Figure 1.

In the right graph of Figure 1, the benefits are translated into replacement rates using a pre-retirement earnings concept derived from the present value of lifetime earnings. Throughout this paper, an individual's pre-retirement earnings level is the earnings at age 65, expressed in 2007 dollars, for a hypothetical person with the same present value of lifetime earnings who has constant relative earnings in each year from age 21 through 65 (that is, the same proportion of economy-wide average earnings). Annual earnings are

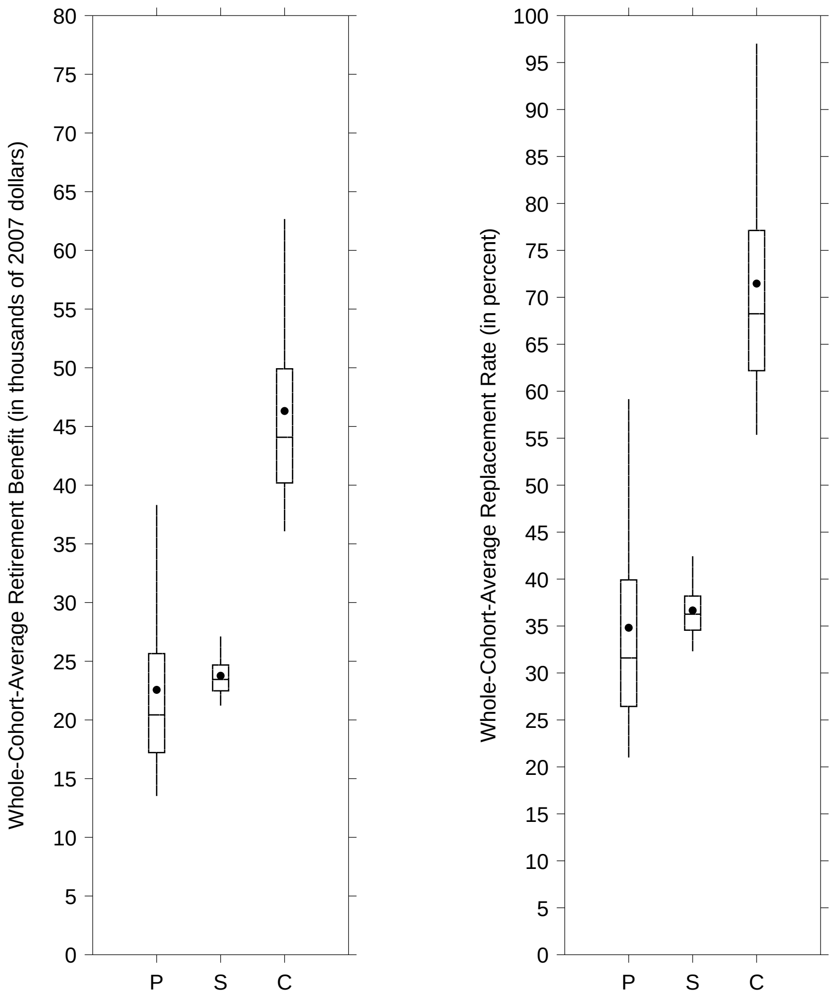

Figure 1: ***Whole-Cohort-Average Dollar Benefit and Replacement Rate Variation across Macroeconomic Scenarios***. *Modified box-and-whisker plots show percentile distribution of whole-cohort-average dollar benefits and whole-cohort-average replacement rates across scenarios for pensions (P), for social security (S), and for pensions and social security combined (C). The box marks the 25th, 50th, and 75th percentile values; the dot marks the mean value; the ends of the whiskers mark the 5th and 95th percentile values.*

calculated using the same spouse-sharing rules as used to calculate benefits. This concept of pre-retirement earnings is a direct generalization of the common final year of earnings, but accommodates earnings histories that have irregular patterns and/or zero earnings just before retirement.

A number of things are apparent from Figure 1. First, the 1990 cohort as a whole faces considerable uncertainty in the level of pension benefits it can expect. The pension replacement rate, which averages about 35 percent across all the scenarios, ranges from about 21 percent in the 5th-percentile scenario to about 59 percent in the 95th-percentile scenario. Given the assumptions used in this projection, all of this variation is caused by differences across scenarios in inflation rates and in bond and equity returns.

In contrast, the scenario variation in social security benefits around the average replacement rate of almost 37 percent is smaller. That there is any variation in social security benefits across the scenarios may be a surprise unless it is remembered that social security policy indexes only for inflation and not for deflation. The scenarios used in this projection are like those used by the Congressional Budget Office in their CBOLT stochastic projections (CBO 2005, Figure 11 on page 21), in that they include a few years in each scenario that have negative inflation rates, during which real social security benefits rise.

The level of pension benefits averaged over the whole birth cohort and over all scenarios is almost as high as the level of social security benefits that are scheduled to be paid. This pension projection assumes unchanged employer offering (apart from the widespread adoption of automatic enrollment in private-sector plans). While no change in offerings over the coming decades seems like an unlikely outcome, it is difficult to know how pension offerings are likely to evolve in coming decades. Likewise, this social security benefit projection might not play out if the program's long-run financial imbalance is solved by reducing benefit levels. Given current tax policy, payable benefits for this cohort are estimated to be about thirty percent below the scheduled benefits shown in Figure 1. Results from sensitivity tests on these pension offering and scheduled benefit assumptions are presented in the next subsection on risk-adjusted benefit estimates.

Earnings-Group-Average Benefit across Scenarios

The average dollar benefit in each scenario for lifetime earnings tertiles are shown in Figure 2. Three equal-sized groups of individuals are defined in

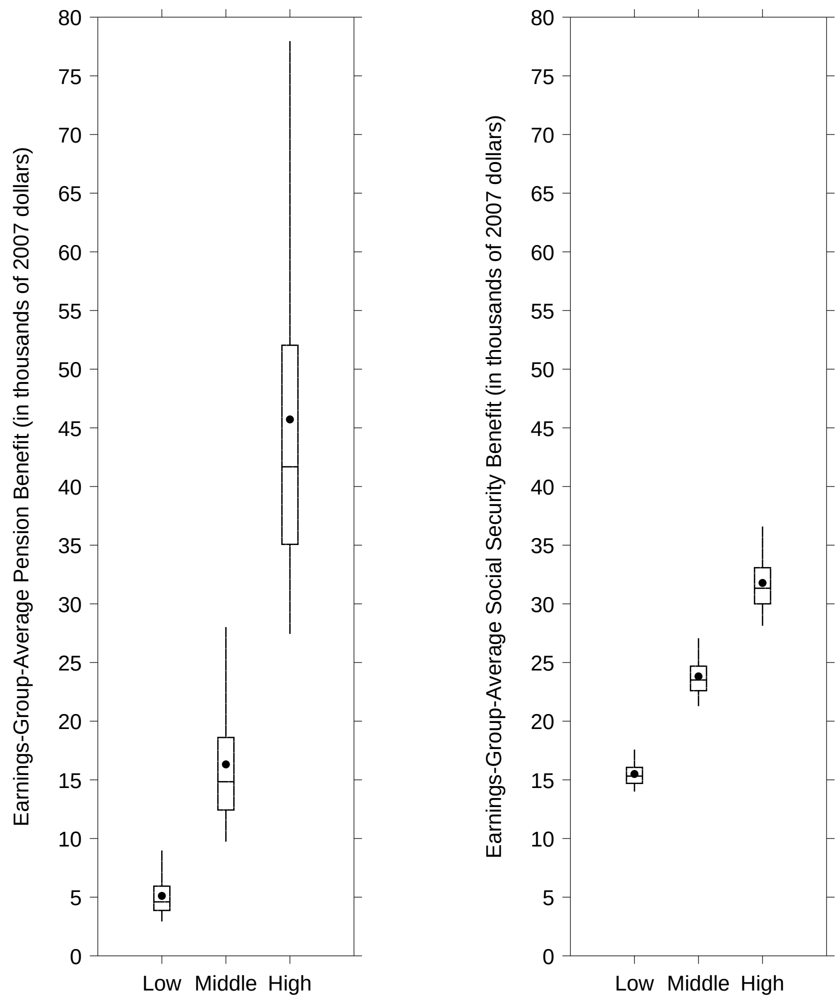

Figure 2: ***Earnings-Group-Average Pension and Social Security Dollar Benefit Variation across Macroeconomic Scenarios***. *Modified box-and-whisker plots show percentile distribution of average benefits across scenarios for three equal-sized groups of cohort individuals defined by the present value of spouse-shared lifetime earnings. The box marks the 25th, 50th, and 75th percentile values; the dot marks the mean value; the ends of the whiskers mark the 5th and 95th percentile values.* ***Combined pension and social security benefit means: Low 20.6, Middle 40.1, High 77.5 thousands of 2007 dollars***.

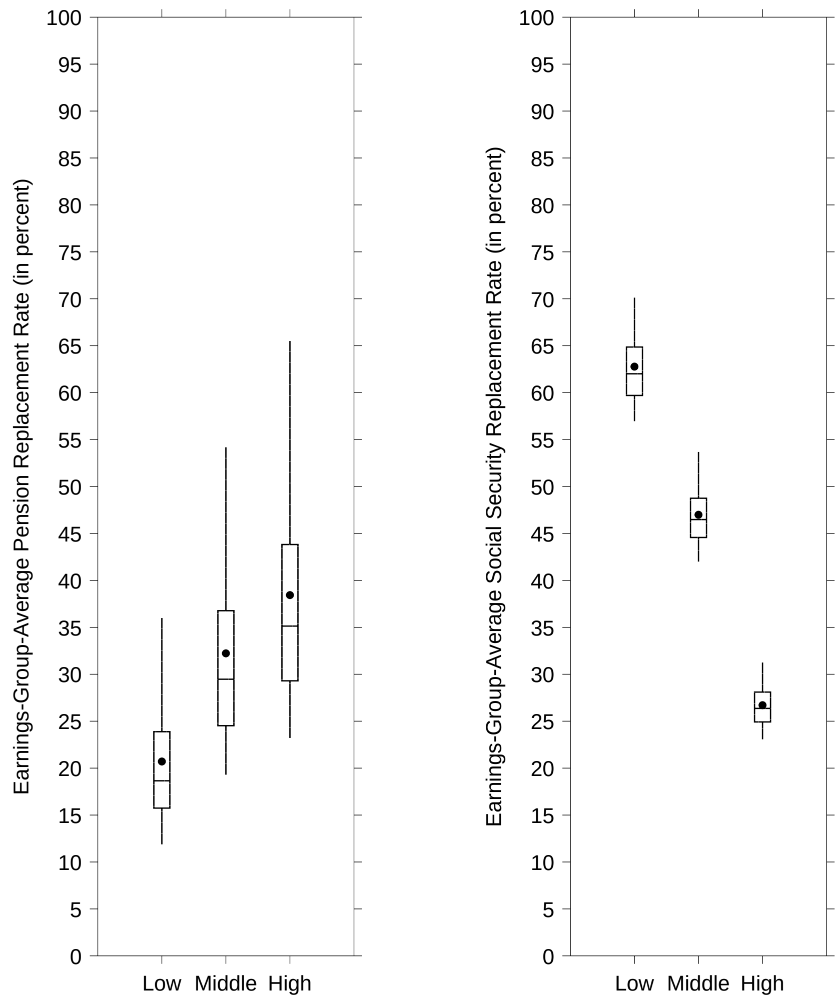

Figure 3: ***Earnings-Group-Average Pension and Social Security Replacement Rate Variation across Macroeconomic Scenarios****.* *Modified box-and-whisker plots show percentile distribution of average replacement rates across scenarios for three equal-sized groups of cohort individuals defined by the present value of spouse-shared lifetime earnings. The box marks the 25th, 50th, and 75th percentile values; the dot marks the mean value; the ends of the whiskers mark the 5th and 95th percentile values.* ***Combined pension and social security replacement rate means: Low 83, Middle 79, High 65 percent****.*

each scenario using the present value of spouse-shared lifetime earnings.

The dollar benefit distributions in Figure 2 show that pension benefits vary more across the earnings groups than do social security benefits. This is not surprising given the progressive benefit formula used to compute social security benefits. They also show that, on average for both the low and middle earnings groups, scheduled as well as payable social security benefits are larger than projected pension benefits. Pension benefits are noticeably larger than social security benefits only for the high earnings group.

Earnings-Group-Average Replacement Rate across Scenarios

The average replacement rates in each scenario for the three lifetime earnings groups are shown in Figure 3.

The right graph in Figure 3 provides a vivid picture how the progressive social security benefit formula produces a relatively high (low) replacement rate for the low (high) earnings group. The left graph in Figure 3 shows that the large dollar difference in pension benefits between the earnings groups is caused largely by differences in lifetime earnings, but that pension replacement rates do rise significantly with lifetime income.

Aggregate Benefit Shares by Lifetime Earnings Groups

Another way to look at benefit variation is to calculate the share of aggregate benefits that goes to the three earnings groups. There is little variation in aggregate benefit shares across the scenarios, so Table 1 shows the all-scenario mean share for each earnings group. The top earnings group is projected to get 69 percent of pension benefits versus 7 percent for the low earnings group. The shares of social security benefits are much less unequal.

Incidence of Zero Benefits during Retirement

A major cause of the relatively low pension replacement rate and aggregate share for the low earnings group is the high incidence of individuals who receive no pension benefits in retirement. Table 2 shows that the percent of individuals who are projected to get zero pension benefits, which varies little across scenarios, ranges from 25 percent for the low earnings group to 4 percent for the high earnings group. The 25 percent incidence of zero pension benefits means that one in four individuals with low lifetime family earnings lives throughout retirement in a family that receives no pension benefits.

Table 1: ***Percentage Share of Aggregate Benefits by Earnings Group***. *Share of benefits is averaged across all scenarios for three equal-sized groups of cohort individuals defined by the present value of spouse-shared lifetime earnings. Variation in share across scenarios is relatively small.*

Benefit	Earnings Group		
Type	Low	Middle	High
Pension benefits	7	24	69
Social security benefits	22	33	45
Pension plus social security benefits	15	29	56

Table 2: ***Percent of Individuals with Zero Pension Benefits in Last Year of Retirement***. *Percent with zero pension benefits is averaged across all scenarios for three equal-sized groups of cohort individuals defined by the present value of spouse-shared lifetime earnings. Variation in percent across scenarios is relatively small. Note that the baseline assumptions regarding pension balance annuitization implies that virtually all individuals with zero benefits in the last year of retirement receive no benefits throughout retirement.*

Individuals at	Earnings Group		
All Earnings Levels	Low	Middle	High
13	25	10	4

3.3 Risk-Adjusted Pension Benefit at Birth

The prior subsection interprets the simulated cohort life histories as different individuals and conducts conventional distributional analysis to measure how benefits vary across individuals looking back from the end of the cohort's life span. Such distributional analysis adopts an *ex post* perspective. But the sample of simulated life histories can also be interpreted as representing the probability distribution of different lives that could be experienced by a cohort member at birth. Such an *ex ante* perspective uses this simulated probability distribution, and an assumed level of risk aversion for the newborn cohort member, to compute a risk-adjusted (or certainty-equivalent) benefit at birth using expected utility methods.

This alternative perspective has been adopted in several social security studies whose analysis framework derives from *Dynamic Fiscal Policy* (Auerbach and Kotlikoff 1987), including Nishiyama and Smetters (2007) and Nishiyama and Smetters (2008) among others.

This subsection uses the sample of projected life histories to compute, for a member of the 1990 birth cohort at birth, three risk-adjusted benefits: a risk-adjusted pension benefit, a risk-adjusted social security benefit, and a risk-adjusted combined (pension plus social security) benefit. A constant relative risk aversion (or power) utility function is used in these expected utility computations.

The expected utility computation method recognizes only benefit variation across macroeconomic scenarios and benefit variation across lifetime earnings tertiles in each scenario. Because the certainty-equivalent benefit is computed using just 1500 equally-probable average benefit amounts (one for each tertile in each of 500 scenarios), the risk adjustment is partial in that it ignores interpersonal benefit variation within each lifetime earnings tertile.

The risk-adjusted benefit is computed using three different parameter values for the degree of constant relative risk aversion: 0, 2, and 4. Using a value of zero implies no risk aversion, and hence, the risk-adjusted benefit is equal to the average benefit. A value of two corresponds to the assumed level of risk aversion in Nishiyama and Smetters (2007) and Nishiyama and Smetters (2008). A value of four corresponds to the assumed baseline level of risk aversion in Auerbach and Kotlikoff (1987) and the top of the range of assumed values in Poterba, Rauh, Venti and Wise (2007). But there is empirical evidence from the Health and Retirement Study — based on questions that were posed in the first surveys (Barsky, Juster, Kimball and

Shapiro 1997) and improved in subsequent surveys — that risk aversion levels are higher than four, with the median being 6.3, the mean 8.2, and with the interquartile range running from 3.9 to 10.3 (Kimball, Sahm and Shapiro 2008, Table 4). So, in the following discussion a parameter value of two is characterized as a 'low' level and four as a 'moderate' level of constant relative risk aversion.

Baseline Results

The top panel of Table 3 shows the risk-adjusted benefit for pensions, for social security (OASDI), and for pensions and social security combined, under the baseline assumptions (which include scheduled social security benefits). The risk-adjusted benefits assuming no risk aversion are exactly the same as the mean dollar benefits shown in the left graph of Figure 1. As the assumed degree of risk aversion rises from zero to four, the risk-adjusted pension benefit falls substantially (by 73 percent from 22.4 to 6.0 thousand 2007 dollars), while the risk-adjusted social security benefit falls modestly (by 16 percent from 23.7 to 19.8 thousand 2007 dollars). This is not surprising given the much greater uncertainty in pension benefits revealed in the figures and tables in the previous subsection.

The bottom three panels of Table 3 show results from three alternative benefit projections that change government policy toward pensions and social security and assume no individual behavioral responses to the policy changes. The second panel contains estimates of the risk-adjusted benefit using social security benefits that are payable given current trust-fund revenue projections. For lives beginning in 1990, average payable benefits are about 71 percent of scheduled benefits. While the risk-adjusted pension benefit is unchanged, the risk-adjusted social security benefit declines by about 5.6 thousand 2007 dollars (from 19.8 to 14.2) when assuming a moderate level of risk aversion.

The third panel in Table 3 contains estimates of the risk-adjusted benefit in a reform in which a sixteen percent excise tax is levied on all employer-sponsored pension distributions beginning in 2011 and the proceeds of this tax are deposited in the social security trust funds. The sixteen percent rate is derived from a non-stochastic, single-scenario run that assumes equity investments in pension accounts earn returns equal to those on Treasury bonds. This extra revenue is enough to eliminate the 75-year actuarial deficit in the social security trust funds, and therefore, allow the payment of sched-

Table 3: ***Risk-Adjusted (or Certainty-Equivalent) Benefit at Birth***. *Pension and OASDI (social security) benefits are expressed in thousands of 2007 dollars. Expected utility calculations recognize interpersonal variation in benefits across lifetime earnings tertiles within each scenario sample and sample variation in benefits across macroeconomic scenarios, but ignore yearly variation in benefits across retirement years within each life history and interpersonal variation in benefits within lifetime earnings tertiles. A standard power utility function is used in the calculations. See text for details on the pension distribution excise tax, whose revenues are assumed to be deposited in the OASDI trust funds, and details on scheduled and payable OASDI benefits. The risk-adjusted benefit estimates in the bottom three panels are computed assuming no behavioral responses to the policy changes.*

Constant Relative Risk	Retirement Benefit Type		
Aversion Parameter	Pension	OASDI	Pension+OASDI
No pension excise tax and scheduled OASDI benefits			
Estimated OASDI actuarial balance: –1.95% of taxable earnings			
0 (no risk aversion)	22.4	23.7	46.1
2	9.7	21.6	34.0
4	6.0	19.8	27.5
No pension excise tax and payable OASDI benefits			
Estimated OASDI actuarial balance: –0.08% of taxable earnings			
0 (no risk aversion)	22.4	16.8	39.2
2	9.7	15.4	27.5
4	6.0	14.2	21.7
16.0% pension excise tax and scheduled OASDI benefits			
Estimated OASDI actuarial balance: +0.04% of taxable earnings			
0 (no risk aversion)	18.8	23.7	42.5
2	8.1	21.6	32.2
4	5.0	19.8	26.4
30.7% pension excise tax and scheduled OASDI benefits			
Estimated OASDI actuarial balance: +1.87% of taxable earnings			
0 (no risk aversion)	15.5	23.7	39.2
2	6.7	21.6	30.5
4	4.1	19.8	25.4

uled benefits (which is why the risk-adjusted social security benefit is exactly the same in the third panel as in the top panel). Under this policy regime, the average pension benefit declines by sixteen percent (by definition of the excise tax reform) and the risk-adjusted pension benefit declines by about 1.0 thousand 2007 dollars (from 6.0 to 5.0) when assuming a moderate level of risk aversion. As a result, the risk-adjusted combined benefit is substantially higher when a pension excise tax is used to provide the extra revenue required to fund scheduled social security benefits (third panel) than when the funding gap is eliminated with social security benefit reductions (second panel). This is true under both moderate and low levels of risk aversion: in comparison to the risk-adjusted combined benefits under the policy regime of no pension excise tax and payable social security benefits, the risk-adjusted combined benefit is about 22 (17) percent higher when a pension excise tax is used to fund scheduled social security benefits, assuming a moderate (low) degree of risk aversion.

To underscore the source of this finding, the bottom panel in Table 3 contains risk-adjusted benefit estimates for a policy regime that has about a thirty percent excise tax on pension distributions, which generates so much extra revenue that there is a 75-year actuarial surplus roughly the same size as the current actuarial deficit. In this policy regime, the pension excise tax rate has been set at a level that makes the average combined benefit (39.2 thousand 2007 dollars) equal to that in the second panel where there is no pension excise tax, and hence, only payable social security benefits are received. Even with this high an excise tax rate, the risk-adjusted combined benefit is higher than in the no-excise-tax-with-payable-benefits policy regime by 17 (11) percent under a moderate (low) degree of risk aversion.

The notion that future generations would be better off if they somehow transfer resources from the current employer-sponsored pension system to the current social security system is likely to be a surprising finding for many readers. What is the intuition behind this finding? Does the government have any reason (other than revenue needs) to levy an excise tax on pension distributions? What is causing this finding: the macroeconomic risk faced by all the earnings tertiles or the risk at birth of not knowing lifetime earnings? Each question is answered in turn.

Intuitively, the pension and social security systems can be viewed as two assets, each one of which generates risky returns (or retirement benefits). The average return of the two assets is roughly the same, but the variability in return around the mean is much larger for the pension asset than for the social security asset (as shown in Figure 1 and Figure 2). When faced with the choice of cutting back holdings of one of these assets, an individual at birth would choose to cut back on the pension asset and maintain the holdings of the social security asset (rather than the other way around) because this choice produces a much larger risk-adjusted portfolio return (or combined benefit).

An excise tax on pension distributions can be rationalized as removing part of the distortionary tax subsidy granted to employer-sponsored pensions contributions and investment income under current tax law.

The exclusion from income taxation of pension contributions and earnings in employer-sponsored pension plans during fiscal year 2009 is projected to produce $195 billion in present value tax revenue losses (Office of Management and Budget 2008, pp. 298 and 301, pensions include both "401(k) plans" and "employer plans"). The combined annual tax expenditure in these two categories is $265 billion (Office of Management and Budget 2008, p. 298). The magnitude of tax expenditures on employer-sponsored pensions is large relative to even the largest government expenditure programs. For example, the social security (OASDI) payroll tax revenue projected for calendar year 2009, which will exceed benefit expenditures, is $729 billion (Trustees Report 2007, p. 38).

So, depending on which estimate is used, tax expenditures on employer-sponsored pensions account for a quarter or a third of social security expenditures. This is a relatively large tax expenditure on a system that generates relatively small risk-adjusted benefits.

An excise tax on pension distributions whose revenues are earmarked for social security is just one of many ways to reduce or eliminate this expensive and distortionary subsidy of employer-sponsored pensions. The general point is that future generations would find it preferable to somehow transfer resources spent subsidizing the pension system to the trust funds in order to attenuate future social security benefit reductions.

And finally, which of the two types of risk included in this analysis is primarily responsible for the finding? This question is answered by computing risk-adjusted benefits separately for each lifetime earnings tertile. This is equivalent to assuming that there is no uncertainty about lifetime earnings at birth and that only asset returns and inflation are uncertain at birth. Under this alternative assumption about what is known at birth, the qualitative finding (that the risk-adjusted combined benefit is higher when resources are moved from subsidizing pensions to funding social security) is the same, even for the high earnings tertile who have the largest pension benefits and experience the lowest social security replacement rates. See the Appendix for three versions of Table 3, one for each lifetime earnings tertile.

Sensitivity Tests

How robust are the Table 3 estimates of the risk-adjusted pension benefit to changes in projection assumptions? The baseline estimates indicate that, assuming a moderate level of risk aversion, the risk-adjusted pension benefit (with no excise tax) is 6.0 thousand 2007 dollars compared to 19.8 (14.2) for the scheduled (payable) social security benefit, even thought the average (or unadjusted for risk) pension benefit is almost as large as the average scheduled social security benefit (and a third larger than the average payable benefit).

If the assumed default contribution rate under automatic enrollment is raised from three to four percent, the risk-adjusted pension benefit rises less than one percent and still rounds to 6.0 thousand 2007 dollars.

If private-sector employer pension offerings are assumed to shift so that many more defined-contribution plans are offered (either alone or along with defined-benefit plans) in place of defined-benefit-only offerings, the risk-adjusted pension benefit rises slightly more than two percent to 6.1 thousand 2007 dollars.

If all pension balances are used to purchase inflation-indexed annuities (rather than annuities without any inflation indexing), the risk-adjusted pension benefit rises almost three percent to 6.1 thousand 2007 dollars.

And finally, consider raising the assumed mean equity return so that the geometric mean of the nominal equity rate of return is 10.2 percent. The 10.2 is the historical mean over the 1926–2005 period (10.4) adjusted down by 0.2 percentage points to account for historical inflation (3.0) being higher than projected inflation (2.8), according to Ibbotson (2006, page 31). This sensitivity test increases the the geometric mean of the nominal equity rate of return by 2.36 percentage points from the 7.84 percent baseline assumption. In this case, the risk-adjusted pension benefit rises about twenty percent to 7.2 thousand 2007 dollars.

This final sensitivity test produces the largest rise in the risk-adjusted pension benefit caused by a change in assumption. But this rise from 6.0 to 7.2 still leaves the risk-adjusted pension benefit far below the risk-adjusted scheduled and payable social security benefits of 19.8 and 14.2 thousand 2007 dollars, respectively. As a result, these sensitivity tests leave unchanged the conclusion that future generations would prefer a cut in pension benefits large enough to fund scheduled social security benefits over a reduction in social security benefits to the level payable with current tax revenues.

4 Comparison to Other Pension Projections

This section compares this pension projection with others presented in recent papers by other authors. These comparisons are complicated by differences in assumptions made by other papers, by differences in the scope of pensions included in other papers, and by differences in pension outcome statistics presented in other papers. Nevertheless, it is useful to conduct such comparisons in order to check for the possibility that the findings reported above are an artifact of a model that cannot produce pension projections similar to those produced by other projection models.

The comparison begins with the only all-pension projection available in the literature, and then proceeds to comparisons with two projections that focus on defined-contribution plans. These comparisons show that the pension projections produced by the PSG models are roughly comparable to these three other projections.

4.1 Other All-Pension Projections

The only other U.S. pension projection that includes both defined-benefit and defined-contribution plans in both the private and public sectors is produced using the Social Security Administration's MINT5 model (Butrica, Iams, Smith and Toder 2009).

This MINT5 projection includes estimates of mean social security benefits, mean defined-benefit pension benefit, and mean annuity income from defined-contribution retirement accounts, all at age 67 and all expressed in thousands of 2007 dollars, for "first boomers" born in 1946–50 and for "last boomers" born in 1961–65. For some unexplained reason, these means are calculated by "exclud[ing] individuals with family wealth in the top 5 percent of the distribution" (Butrica, Iams, Smith and Toder 2009, Table 3). The estimated means from Table 3 are as follows:

MINT5 estimates	Birth Cohorts	
	1946–50	1961–65
Social security	12.7	13.1
Defined-benefit pension	5.1	3.0
Defined-contribution pension	6.2	7.7

Estimates from PSG model projections for these two cohorts that use a similar method to calculate the mean benefit are as follows:

PSG estimates	Birth Cohort	
	1948	1963
Social security	12.1	13.5
Defined-benefit pension	3.7	4.0
Defined-contribution pension	4.6	7.0

These PSG means are computed by excluding the five percent with the largest family incomes at age 67 (rather than by excluding those with the largest family wealth as done in the MINT5 analysis). And the PSG projections assume all pension balances are converted to inflation-indexed annuities at retirement.

Given the residual differences in projection assumptions and mean benefit calculation, the differences in mean pension benefits are not very large. The PSG projection does not assume as large a reduction in defined-benefit plan offerings as does the MINT5 projection (for example, plan freezes are not simulated as in the MINT5 projection), and this shows in the results when comparing the two birth cohorts. The PSG projection shows a somewhat larger rise in defined-contribution benefits, although the basic magnitude of these benefits, relative to other pension benefits, and to social security benefits, is roughly the same. Although not shown here, the MINT5 and PSG estimates of the fraction of people who receive these three types of benefits are roughly the same.

4.2 Other 401(k)-Pension Projections

Projections of future defined-contribution pension benefits have been made by Poterba, Venti and Wise (2008) and by Holden and VanDerhei (2002). These papers produce benefit estimates using models that focus on defined-contribution pension plans.

Poterba-Venti-Wise Projection

Poterba, Venti and Wise (henceforth PVW) estimate 401(k) assets at age 65 for cohorts attaining age 65 up until 2040 (that is, up to the 1975 birth cohort), and conclude that cohorts that attain age 65 in future decades will have accumulated much greater retirement savings (in real dollars) than the retirement savings of current retirees (Poterba, Venti and Wise 2008). But given the substantial shift in recent pension offerings, there should be little doubt that retirement-age defined-contribution pension balances will be on the rise in the future as defined-benefit pension benefits stagnate or even decline. And, of course, some of this growth in defined-contribution pension balances simply represents a shift from non-tax-advantaged savings to tax-advantaged savings, rather than an increase in total individual savings. Despite all this, it is still useful to compare the PVW projection results with those generated by a comparable PSG projection.

PVW present estimates of pension balances at age 65 in 2000 dollars. In order to convert these estimates into a form that is comparable to annual benefit estimates, the balance at age 65 is divided by the price of inflation-indexed annuity at age 65 (estimated using the PSG models with gender-specific loading factors that ensure the solvency of the annuity provider) and then multiplied by an historical inflation factor to convert from 2000 dollars to 2007 dollars. The mean balance from the "historical [mean equity return] less 300 basis points" projection (Poterba, Venti and Wise 2008, Figure 3-1) and the mean converted benefit, both expressed in thousands of dollars for three different birth cohorts, are as follows:

PVW estimates	Birth Year (Year Attains 65)		
	1955 (2020)	1970 (2035)	1975 (2040)
Balance (in 2000 dollars)	112	180	269
Benefit (in 2007 dollars)	10.35	16.23	24.05

A roughly comparable PSG projection must assume that the mean equity return is two percent points above the baseline assumption described above in order to account for the use in the PVW projection of an arithmetic nominal (rather than a geometric real) historical mean, and to account for the fact that the PVW projection assumes no fees are levied on the investments held in defined-contribution and rollover accounts (rather than assuming typical fees as done in the PSG projection). Estimates from PSG model projections that use comparable return assumptions for these three cohorts are as follows:

PSG estimates	Birth Year (Year Attains 65)		
	1955 (2020)	1970 (2035)	1975 (2040)
Benefit (in 2007 dollars)	10.79	17.02	18.26
Ratio of PSG to PVW Benefit	1.04	1.05	0.76

These annual defined-contribution benefits are expressed in thousands of 2007 dollars.

Comparing defined-contribution benefit estimates from these two projections shows that the estimates are quite close for the cohorts born in 1955 and 1970 (with the PSG estimate being four or five percent higher than the PVW estimate). But the PVW estimate for the 1975 cohort, which attains age 65 in 2040, is much higher than the PSG estimate. The cause of this large difference is the PVW assumption that members of this cohort will be offered defined-contribution plans far more often during their careers than will individuals born just five years earlier (Poterba, Venti and Wise 2008, Figure 2-3). Not only does this assumption introduce a major discontinuity into the PVW projection, but it seems to imply that the overall pension offering rate will be higher for this 1975 birth cohort than it has been historically. While it does seem plausible to assume that the historical shift from defined-benefit to defined-contribution plans will continue to some extent in the future, there is nothing in the historical record to suggest that more employers will start offering pension plans in the next several decades. Given the relative close agreement between PVW and PSG estimates for the other two cohorts, it seems likely that if a PSG projection assumed higher pension offering rates, it could produce estimates for the 1975 cohort similar to those in the PVW projection.

Holden-VanDerhei Projection

Holden and VanDerhei (henceforth HV) estimate replacement rates generated by private-sector 401(k) defined-contribution pension plan accumulations (Holden and VanDerhei 2002). HV use a "final five-year average salary" denominator in the replacement rate, which is computed for individuals turning 65 between 2035 and 2039 (that is, the 1970–74 birth cohorts). When assumptions include historical equity returns and "not-always 401(k) coverage" over job careers, the projection produces a median replacement rate that rises from 21 percent in the lowest age-65 income quartile, to 26 percent in the highest age-65 income quartile (Holden and VanDerhei 2002, Figure 1).

By comparison, in the baseline pension projection presented above, the 1975 cohort-wide mean defined-contribution replacement rate is about 25 percent. When considering defined-contribution pension benefits, one would expect the mean to be noticeably higher than the median. This might suggest that PSG benefits are actually less than HV benefits, except for one countervailing factor. The HV benefits are private sector only, while the PSG benefits are for all individuals in the birth cohort no matter what kinds of jobs they held in their career. Because the incidence and generosity of defined-contribution pension plans is less in the public sector, there is reason to think that this difference in the sample used to compute benefits lowers the level of benefits in the PSG sample. Given these incompatibilities in the projection samples plus differences in replacement rate denominators, there is little reason to believe that the defined-contribution benefit estimates from the two projections are significantly different.

5 Conclusions

Projections of future pension benefits and social security benefits for the 1990 birth cohort are produced using the PSG models, which have been extensively validated in past years and have been shown in this paper to produce projected benefits that are in line with other recent pension projection efforts. The PSG projections summarized in this paper show wide variation in pension benefits, both between macroeconomic scenarios for the whole cohort and between different individual life histories in the same macroeconomic scenario.

When viewing this variation as risk to a cohort individual at birth, it is customary to compute a risk-adjusted benefit using expected utility theory and an assumed degree of risk aversion. The risk-adjusted pension benefit for a 1990 cohort individual is substantially smaller than the risk-adjusted social security benefit, even though the average (non-risk-adjusted) pension benefit is roughly the same as the average social security benefit. This is true because the individual will receive stable social security benefits in almost all life histories, while the real value of the pension benefit received will vary widely across life histories depending on the details of the individual's realized job history and the nature of the macroeconomic environment within which that job history plays out. And this is true even though the risk adjustment is partial because interpersonal variation in benefits within each lifetime earnings tertile is ignored.

One implication of this finding is that a 1990 cohort individual would have a larger risk-adjusted pension plus social security benefit if the tax subsidy currently provided to pension benefits was reduced and the resulting tax revenue was used to finance scheduled social security benefits, rather than leaving the pension tax subsidy in place and receiving the lower social security benefits that are payable given current trust-fund revenue sources.

Appendix

Table 4: ***Risk-Adjusted (or Certainty-Equivalent) Benefit at Birth for Low Lifetime Earnings Tertile***. *Same at Table 3 except that being in the low earnings tertile is certain at birth, leaving macroeconomic uncertainty as the only risk at birth.*

Constant Relative Risk	Retirement Benefit Type		
Aversion Parameter	Pension	OASDI	Pension+OASDI
No pension excise tax and scheduled OASDI benefits			
Estimated OASDI actuarial balance: –1.95% of taxable earnings			
0 (no risk aversion)	5.1	15.5	20.6
2	4.6	15.4	20.3
4	4.2	15.3	20.1
No pension excise tax and payable OASDI benefits			
Estimated OASDI actuarial balance: –0.08% of taxable earnings			
0 (no risk aversion)	5.1	11.1	16.3
2	4.6	11.1	15.9
4	4.2	11.0	15.7
16.0% pension excise tax and scheduled OASDI benefits			
Estimated OASDI actuarial balance: +0.04% of taxable earnings			
0 (no risk aversion)	4.3	15.5	19.8
2	3.8	15.4	19.6
4	3.5	15.3	19.3
30.7% pension excise tax and scheduled OASDI benefits			
Estimated OASDI actuarial balance: +1.87% of taxable earnings			
0 (no risk aversion)	3.5	15.5	19.0
2	3.2	15.4	18.8
4	2.9	15.3	18.7

Table 5: ***Risk-Adjusted (or Certainty-Equivalent) Benefit at Birth for Middle Lifetime Earnings Tertile***. *Same at Table 3 except that being in the middle earnings tertile is certain at birth, leaving macroeconomic uncertainty as the only risk at birth.*

Constant Relative Risk	Retirement Benefit Type		
Aversion Parameter	Pension	OASDI	Pension+OASDI
No pension excise tax and scheduled OASDI benefits			
Estimated OASDI actuarial balance: –1.95% of taxable earnings			
0 (no risk aversion)	16.3	23.8	40.1
2	14.8	23.7	39.2
4	13.7	23.5	38.4
No pension excise tax and payable OASDI benefits			
Estimated OASDI actuarial balance: –0.08% of taxable earnings			
0 (no risk aversion)	16.3	16.9	33.2
2	14.8	16.8	32.2
4	13.7	16.7	31.4
16.0% pension excise tax and scheduled OASDI benefits			
Estimated OASDI actuarial balance: +0.04% of taxable earnings			
0 (no risk aversion)	13.7	23.8	37.5
2	12.4	23.7	36.7
4	11.5	23.5	36.1
30.7% pension excise tax and scheduled OASDI benefits			
Estimated OASDI actuarial balance: +1.87% of taxable earnings			
0 (no risk aversion)	11.3	23.8	35.1
2	10.3	23.7	34.5
4	9.5	23.5	34.0

Table 6: ***Risk-Adjusted (or Certainty-Equivalent) Benefit at Birth for High Lifetime Earnings Tertile***. *Same at Table 3 except that being in the high earnings tertile is certain at birth, leaving macroeconomic uncertainty as the only risk at birth.*

Constant Relative Risk	Retirement Benefit Type		
Aversion Parameter	Pension	OASDI	Pension+OASDI
No pension excise tax and scheduled OASDI benefits			
Estimated OASDI actuarial balance: –1.95% of taxable earnings			
0 (no risk aversion)	45.7	31.8	77.5
2	41.5	31.6	74.4
4	38.5	31.4	72.0
No pension excise tax and payable OASDI benefits			
Estimated OASDI actuarial balance: –0.08% of taxable earnings			
0 (no risk aversion)	45.7	22.4	68.1
2	41.5	22.3	64.8
4	38.5	22.1	62.4
16.0% pension excise tax and scheduled OASDI benefits			
Estimated OASDI actuarial balance: +0.04% of taxable earnings			
0 (no risk aversion)	38.4	31.8	70.2
2	34.8	31.6	67.6
4	32.3	31.4	65.7
30.7% pension excise tax and scheduled OASDI benefits			
Estimated OASDI actuarial balance: +1.87% of taxable earnings			
0 (no risk aversion)	31.7	31.8	63.5
2	28.8	31.6	61.5
4	26.7	31.4	59.9

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