"Toward Intergenerational and Intragenerational Equity in Social Security Reform: An Application of Stochastic Forecasting"

Wade Pfau
National Graduate Institute for Policy Studies
2-2 Wakamatsu-cho, Shinjuku-ku
Tokyo, Japan 162-8677

wpfau@grips.ac.jp

Abstract

In this paper, I combine traditional hypothetical worker analyses of Social Security with the techniques of stochastic forecasting. The hypothetical workers are born in different years, and they also vary in characteristics of lifetime employment earnings, family status, and ages of death. Rather than using the Social Security Administration's (SSA) deterministic forecasts for economic variables including inflation and wage growth, I develop a series of forecasts using Monte Carlo simulations in order to analyze more realistically the prospects of Social Security reform. Specifically, I compare an increase in the payroll tax, an increase in the normal retirement age, a switch from wage-indexing to price-indexing of benefits, and a reduction in the cost-of-living adjustment. Each reform is accompanied by a change in the payroll tax rate, such that each reform should approximately restore the 75 year actuarial balance of the Trust Fund. From the policy perspective, the normal retirement age increase and price indexing plans perform particularly poorly for most workers born in 1960 and later, as a straightforward tax increase or cost-of-living adjustment provide larger returns. Effort will be made to explain who the winners and losers would be with each reform proposal and also to quantify the differences in outcomes between my stochastic and the SSA's deterministic approach. Stochastic forecasts deserve stronger consideration because they add important details about the underlying probability distribution of the outcome measures.

JEL No.: C15, H55

1 Introduction

The looming retirement of the baby boom generation, coupled with declining mortality and fertility rates, will put Social Security in the United States under increasing strain in the decades ahead. Much debate presently centers on how best to remedy this situation. But in assessing the details of Social Security's future finances, policy makers are confounded by the uncertainties of forecasting a multitude of demographic, economic, and legislative trends. The current procedures used by the Social Security Administration (SSA) in their seventy-five year forecasts, which consist of developing three scenarios, are unable to provide the likelihood of experiencing various future outcomes. Consequently, these procedures do not allow policy makers to consider the risks involved with certain reforms, or to develop meaningful "money worth" measures to compare the prospects of various Social Security reforms for present and future workers. Fortunately, during the past decade a number of researchers began taking steps toward correcting some of these problems by creating stochastic models to deal better with these uncertainties.

With two goals in mind, I aim to combine traditional money worth analyses of Social Security with the techniques of stochastic modeling. First, the paper is motivated by the policy question of how to proceed with Social Security reform. To provide an answer, I examine how workers of different backgrounds and of different generations will be affected by various Social Security reform proposals. This will be accomplished for a variety of hypothetical workers by calculating two important money worth measures: the rate of return and the net lifetime transfer from Social

Security. The new dimension of my research is to calculate these returns using a modified version of the Social Security Trust Fund stochastic modeling framework developed by Lee et al. (2003) and others. The second goal is to determine the differences in outcomes between using a stochastic forecasting approach and the traditional deterministic forecasting approach of the SSA. This is an important methodological question which will provide insight on whether the SSA should seriously consider updating the forecasting methodology which it has used since its 1943 *Trustee's Report*.

Reforms I consider include increasing the payroll tax rate, increasing the retirement age, indexing earnings to the rate of inflation rather than the rate of wage growth, and decreasing the cost-of-living (COLA) adjustments applied to each year of benefit receipt. Because each of these reforms would affect the Trust Fund balance differently, to make them more comparable I associate an appropriate payroll tax change to achieve estimated actuarial balance over seventy-five years. Though many real world reform proposals would bundle together a number of these components in varying degrees, in this work I attempt to consider the unique effects of these individual components. By obtaining the stochastic rates of return and lifetime transfers for workers who vary by family types, income levels, birth year, and age of death, I will seek to explain the relative merits of each reform.

The rest of the paper is organized as follows. In Section 2, I review the relevant literature. Topics include the legislative and fiscal history of Social Security, problems with the Social Security Administration's forecasting procedures, details about the relevant stochastic modeling techniques, and an overview of the money worth and hypothetical workers literature. In Section 3, I describe the stochastic hypothetical workers model that will be used to analyze the reform proposals. This section includes a description of the hypothetical workers and their families, the assumptions and methods used to create the stochastic forecasts for the relevant economic variables, additional assumptions used to create the benefit and tax calculator programs, and a fuller description of the reform proposals under consideration. In Section 4, I present the results of the stochastic rates of return and lifetime transfers analysis. The section proceeds with two different types of comparisons. First, I will compare reforms on a by-age-of-death basis, which will demonstrate the important patterns in the relationship between reforms on the basis of family types and income levels. Then, in order to better grasp how increasing life spans will affect the comparison of reforms, tables will be presented which compare the outcomes of reforms after accounting for expected mortality rates. As I compare these reforms, I will also discuss how the results of the stochastic model compare to the results from conventional SSA forecasts. Section 5 concludes with a final assessment of the reform proposals and with some thoughts about a research program that should follow from the modeling efforts begun herein.

The policy findings of this paper should be of particular interest to policy makers. Two of the three reform proposals considered by the President's Commission to Strengthen Social Security (2001) includes a prominent role for the price indexing of benefits. While price indexing would not effect those retiring before 2009, and would have little effect on those retiring in the subsequent few years, the younger cohorts of workers would have much to lose. Though the Commission will not consider a payroll tax increase, almost anyone in the younger cohorts who survives to receive Social Security benefits for a more than a few years would see higher money worth measures from Social Security having paid higher taxes rather than experiencing the enormous benefit cuts associated with price indexing. The younger a person is, the worse price indexing will be, as young people will see their tax payments continue to grow at the rate of nominal wages, while their initial benefit levels would only grow at the rate of prices beginning in 2009. Among the other reform possibilities, not too much consideration is being given to further retirement age increases, and this is rightly so. As will be demonstrated in the paper, most workers would earn higher returns from the tax increase or COLA adjustment proposals than they would from the normal retirement age increase, as even one year's worth of lost benefits makes a significant difference in lifetime transfers and rates of return. Instead, this paper will show that from the perspective of maximizing the returns a worker can receive from Social Security, a straightforward tax increase or a COLA decrease are both stronger reform candidates for the cohorts considered than an additional normal retirement age increase or a switch to price indexing.

From the methodological perspective of comparing the stochastic and deterministic forecasts, the general conclusion is that policy makers will not obtain the "wrong" answers from deterministic forecasts, despite their shortcomings, but that stochastic forecasts do contribute important details about the reforms. By allowing more realistic forecasts of important economic variables, the variability of the results is generally much greater than with deterministic forecasts. The stochastic forecasting approach also shows that the median quantitative results will differ in meaningful ways from the SSA intermediate forecasts when real wage growth is allowed to fluctuate. The stochastic forecasts provide a probability distribution for future outcomes and help to shed light on the notion that the future direction of the economy plays an important role in determining which reform will best serve workers.

2 Background

2.1 History and the Future: Charting the Course of the Trust Fund

Social Security is a program that encompasses approximately 98% of jobs and that currently provides benefits to one in six Americans. Recipients of Social Security benefits include not just retirees, but also disabled workers, spouses and young children of deceased or disabled workers, and the spouses of retirees. However, this was not always the case. In fact, the original Social Security Act of 1935 created retirement benefits for only the retired worker, who became eligible at age 65. In 1939, Congress passed amendments to extend benefits to spouses and minor children of retired workers, as well as to the widows and minor children of deceased workers. Disability insurance arrived in 1954, and in subsequent years, the disability program expanded to include the families of disabled workers. In 1972, Congress passed legislation to create annual cost-of-living adjustments for benefit levels. Prior to that time, benefit increases were subject to the whims of Congress and happened only intermittently.

The 1975 Social Security Trustee's report estimated that the Old-Age, Survivors, and Disability Insurance (OASDI) Trust Funds (henceforth referred to as the "Trust Fund") would be depleted by 1979. The program generally desires to have its Trust Fund not projected to run out (given all of the expected future tax collections less benefit payments) for at least 75 years, so leaders viewed this as a serious problem. In 1977, Congress enacted amendments to deal with the impending financial problems. The amendments increased the payroll tax, increased the amount of income that was eligible for the payroll tax, and reduced benefits slightly. But because of the economic slowdown in the early 1980s, the Trust Fund again faced serious short-term funding problems. Alan Greenspan headed a commission to examine this problem in 1983. The Greenspan Commission called for, and Congress subsequently passed into law, an increase in the normal retirement age to gradually extend from 65 to 67, increases in Social Security tax rates, and the addition of new taxes for the benefits of the wealthiest individuals. The goal was not only to solve the immediate financial problems, but also to build up a surplus over the next few decades in anticipation of the inevitable Trust Fund drain resulting from the coming baby boomer retirement. Under the current law, the combined employee/employer tax rate for OASDI is 12.4%, and the normal retirement age is beginning its slow ascent toward 67 for those born in 1960 and later.

That Social Security is expected to again undergo funding shortages at some point in the future should come as no surprise. Social Security in the United States is meant to be pay-as-you-go, meaning that each generation of current workers pays for the benefits of the current retirees. Three trends, though, will make this an increasingly difficult task despite the present surpluses. First, the baby boom cohort is of unprecedented size and will begin retiring in less than ten years. Second, life spans are becoming longer, meaning that the retiring baby boomers will enjoy longer retirements. The 2003 *Trustee's Report* indicates that when Social Security benefit payments began in 1940, the cohort life expectancy for men and women who reached the age of 65 were 12.7 and 14.7 years, respectively. Men and women retiring in 2000 share a normal retirement age of 65, but their projected cohort life expectancies have increased to 16.5 and 19.5 years, respectively. The SSA expects such trends to continue in the future, as men and women born in 2000 and who live to reach 65 in 2065 can be expected to live for another 20.4 and 23.3 years, respectively. The third important trend is the decrease in fertility rates. During the height of the baby boom, women, on average, were having between 3.5 and 4 children each during their lifetimes. Now these numbers are closer to 2, and the 2003 *Trustee's Report* expects the long-run fertility rate in the United States to be just 1.95.

Combining these three trends means that there will be fewer workers available to support the retirees in 10 to 30 years. The SSA predicts that the ratio of people aged 65 and older to those aged between 20 and 64 will increase from 0.211 in 2000 to 0.348 in 2030. In other words, the ratio of the working age population to the retirees is expected to fall from about 5:1 to 3:1. As indicated, a legacy of the 1983 Greenspan Commission is that the Trust Fund accumulates more each year than it spends in order to build a buffer. However, in the 2003 *Trustee's Report*, the best guess for the future is that while the OASDI Trust Fund will continue to run surpluses until 2016, it is projected to run out of money by 2042 so that subsequent years will be met with drastic cuts in benefits, increases in taxes, or borrowing from the rest of the government's budget.

2.2 Flaws in the Social Security Administration's Approach

The actuaries of the SSA create 75 year forecasts for the future course of the Social Security Trust Fund, which are updated annually and published in the *Trustee's Report*. The accuracy of these forecasts is important, because it is clear that decisions made now will have long-term effects on the solvency of Social Security. Naturally, Trust Fund forecasts are subject to a great deal of uncertainty. For example, they depend on the future course of demographic variables, such as mortality, fertility, and immigration, and economic variables such as inflation, wage growth, returns on Treasury bonds, the unemployment rate, and labor force participation rates. To account for the inherent uncertainty about the future, the forecasts used by the Trustees are presented under three alternatives: the low-cost ("optimistic") Alternative-I, the intermediate-cost ("most likely") Alternative-II, and the high-cost ("pessimistic") Alternative-III. These scenarios present the expert opinion of the actuaries, but provide no consistent means for understanding the likelihood that any of the alternatives could occur. This point of view is summarized well by the Advisory Council on Social Security (1991):

> Further work is necessary to define the conceptual framework for the current low- and high-cost projections. Although theoretically they represent a collection of extreme values for each of the variables, how they should be interpreted is not obvious. For example, possible interpretations include: absolute bounds on what could possibly happen, confidence intervals, illustrative alternative projections, and sensitivity analyses.

Lee and Tuljapurkar (1998b) argue that the problems with these forecasts run even deeper. Such scenario-based forecasts assume that the future trajectories of variables are always either high or low, such that there will never by any baby booms or busts, for instance. Assumptions in these alternative scenarios are also combined in overly rigid ways. For instance, high mortality is always combined with high fertility in Alternative I, and low mortality with low fertility in Alternative III. Also, for instance, low inflation is always associated with low unemployment, and high inflation with high unemployment, and so on. Such a forecasting procedure does not provide the reader with any sense of the likelihood of these future scenarios, and also combine assumptions in ways that disregard economic theory. Related to this, the probabilities of falling in the high-low ranges will be different across each variable, such that when they are all put together to determine the Trust Fund's future course, the sense of probability will be completely lost.

2.3 Stochastic Modeling Techniques

And so, since the early 1990s, researchers attempting to heed the call of the Advisory Council have been interested in using more rigorous time series econometric techniques to create stochastic forecasts which include probability distributions for the future performance of Social Security. These stochastic models force their users to rigorously consider more than just point estimates, but also to consider the variability of and correlation among various future economic and demographic variables. Early innovators in this field include Ronald Lee and Shripad Tuljapurkar. Their work focuses on the aggregate population in order to chart the future course of the Trust Fund. In creating a stochastic model, they address important sources of economic and demographic uncertainty. The researchers' backgrounds are primarily in demography, and so they develop elaborate time series techniques to estimate mortality and fertility. Issues related to the population forecasts are discussed in Lee (1999), as well as Lee and Tuljapurkar (1994, 1998a). Regarding the economic variables, they mostly use the intermediate projections of the Social Security Administration. The variables that they do estimate stochastically are the real wage growth and the interest rate for the Trust Fund bond holdings. When considering stock market based reforms, they also project the index for the S&P 500 as a proxy for stock market performance (Lee and Tuljapurkar (1998b), Lee et al. (2003)). To estimate these variables, they rely on traditional time series techniques, in which the degree of variation in the innovation term provides the measure of future risks. Such models extrapolate history and expect the future to behave like the past.

Stochastic modeling techniques are slowly, but surely, beginning to influence the approach taken by US government policymakers. For instance, the Social Security Advisory Board (1999) included projections from the Lee group's work. Then, in 2001, the Congressional Budget Office released its own version of a stochastic model. Finally, the actuaries at the Social Security Administration created a stochastic model of the Trust Fund and published their results in the *Trustee's Report* of 2003. The Office of Policy at the Social Security Administration is also working hard to improve the stochastic modeling techniques for the SSA's Trust Fund projections (Burdick and Manchester (2003)). These models are far from perfect, and much work is needed to improve the assumptions about endogenous behavioral responses and macroeconomic feedback effects. At the same time, though, these stochastic modeling techniques have developed enough to be used in examining many new questions regarding Social Security's future.

2.4 Measuring the Impact of Reform on Hypothetical Workers

The concept of calculating a money worth measure for Social Security, which consists of combining the lifetime benefits and tax payments of an individual in some mechanical way, has been around since at least the 1960s. Most of the work to date, though, has been deterministic and has only been applied to the status quo or to basic reforms that increase taxes or cut benefits to keep an actuarial balance. I intend to use stochastic forecasting to broaden the usage and meaning of these money worth measures. The money worth measures considered here include the “rate of return” (ROR) and “lifetime transfer.” The rate of return expresses the interest rate a worker would need to earn on his or her Social Security tax payments in order to generate the same benefits as actually received from Social Security. It is defined according to the formula:

$$\sum_{x=20}^{119} \frac{p(x)\left[B(x)-T(x)\right]}{\left(1+r\right)^{x}} = 0,$$

where x represents age, $B(x)$ and $T(x)$ are the benefits received and taxes paid at each age, $p(x)$ is the probability of being alive at age x conditional on having survived to age 20, and r is the rate of return. An upper age of 119 is chosen because mortality data is available up to this age. Meanwhile, the lifetime transfer differs in that a value for r is chosen in advance with the purpose of calculating the above sum. This sum compares the discounted difference between total lifetime benefits and taxes, and it is positive when benefits exceed taxes, thus indicating that the worker got their “money worth” at some predefined discount rate. My lifetime transfers are calculated from the perspective of age 20, and are then converted into 2001 dollars for easier comparisons.

Leimer (1995) provides a discussion of how these measures can lead to different rankings of outcomes, depending on the lifetime streams of taxes and benefits. Essentially, the ROR does not reflect the size of tax contributions, such that an individual may experience a large ROR and a small lifetime transfer due to the relatively small amounts of tax payments and eligible benefits thereby produced. Thus the ROR measures the relative relationship between taxes and benefits, and the lifetime transfer measures the absolute difference, and both types of measures play an important role in considering the relative merits of reform proposals.

To study Social Security reform, these money worth measures will be calculated for a variety of hypothetical workers. Nichols et al. (2001) presents the most thorough and comprehensive representation of a ROR analysis for hypothetical workers (Leimer (1999) has more on previous incarnations). However, their approach considers only the present Social Security system and one reform that would gradually increase taxes to keep the Trust Fund in balance. It also uses the SSA's intermediate assumptions whenever forecasted data are needed. The paper creates workers who vary by year of birth, marital status, number of children, earnings level, and the pattern of lifetime earnings. Payments are made to workers and their families for death, disability, and retirement benefits. The results of Nichols et al. reflect the general types of results found in hypothetical worker studies. They find that Social Security is generally progressive, with lower wage workers earning higher rates of return than their wealthier counterparts. They also find that women fare better than men on account of their lower mortality rates, holding other factors constant. Married couples also do better than singles, as should be expected with their added spousal and child benefits. Specifically, for the present law case, rates of return vary for low income workers born between 1960 and the present, ranging from around 2.75-3.0% for single males to 3.0-3.25% for single females to about 5% for one-earner couples, and about 3.0-3.25% for two-earner couples. Meanwhile, when moving from the low earners to the maximum earners, the rates of return gradually drop. Single maximum earners can expect rates of return between 0 and 1%, and one-earner families can expect returns between 2.5 and 3.0%.

Leimer (1995) argues that actual workers differ by ages of labor force entry, labor force participation and unemployment patterns, lifetime earnings patterns, ages of retirement, and survival probabilities, all of which affect money worth measures but do not get properly considered in hypothetical workers analyses. In particular, a serious complaint about past ROR studies of hypothetical workers was that the earnings histories of workers were extremely unrealistic. The old pattern was to assign a worker to an earnings level that is some percentage of the economy-wide average earnings level, and then assume that this worker earned the same steady real wage for his/her entire working career. One ameliorative feature of the Nichols et al. study is its creation of a scaled earnings history to be compared to the traditional steady earnings history. Nichols uses data from the Continuous Work History Sample to construct a series of factors to more adequately explain age-specific earnings levels. These factors are then multiplied by the previously calculated steady earnings histories and by a factor to insure that the two earnings histories create the same initial benefit level. As such, Nichols creates a more realistic representation of earnings histories.

At the present, there have been a few initial forays into combining money worth analyses with stochastic modeling, though these studies are generally done at the aggregated cohort-wide level, without considering the differences between workers in a given cohort. For example, Anderson et al. (2001) use the results from their comprehensive stochastic model for the Trust Fund to calculate cohort-wide rates of return for several cohorts, born between the years 1941 and 1999. The ROR analysis is done for two policy reforms which they determine to imply a roughly 50% chance of solvency in 2075. These reforms include immediately increasing the OASI tax rate by 2%, or instead raising the normal retirement age in increments to age 69 by 2024. This study ignores disability insurance. Similarly, Caldwell et al. (1998) examine the future course of Social Security using microsimulation models and find that postwar cohorts' returns from the OASI program are becoming less and less and are approaching zero for cohorts born now. It is the differences between worker types that this paper addresses.

3 Description of the Hypothetical Workers Model

In this section I provide the details of the hypothetical workers model. First I describe the hypothetical workers to be used in the comparisons. Then I describe the procedures for creating the stochastic forecasts of the economy. Then I provide the details used in computing the taxes and benefits for the hypothetical workers and further describe how I transform the stochastic inputs into stochastic money worth measures for various hypothetical workers. Finally, I describe the reform proposals to be considered in this paper. This section provides an understanding for how I will calculate the lifetime Social Security benefits and taxes under a variety of family and income circumstances, which will allow me to develop the stochastic rates of return and lifetime transfer measures in the following section.

3.1 Descriptions of the Hypothetical Workers and Their Families

Hypothetical workers vary by birth year, gender, amount of lifetime earnings, marital status, and number of children. Birth cohorts I consider range in 10 year increments from 1960 to 2000. I assume that the date of any major life event is January 1st. These life events include being born, starting work, marrying, bearing children, retiring, and dying. For each birth cohort, I consider 16 different cases of hypothetical workers and their families. This breakdown includes four different family types for each of the four income levels. The family types include single males, single females, married couples in which the male is the only wage earner, and married couples in which each spouse earns wages.

Of course these family types are not a comprehensive reflection of all possible families. Rather they provide some representative examples to demonstrate general relationships. As such, I assume that married couples share their birth date, and that marriage occurs on the 22nd birthday. I do not consider divorce, so that a marriage is only dissolved by the death of a spouse.[1] Re-marriage is not possible. When two spouses work, they are assumed to earn the same income level. All married couples have two children (unless a parent dies before the child's birth date). The children are born on the 25^{th} and 27^{th} birthdays of the parents, respectively. I assume that the children stay in secondary school such that they will be entitled to any survivor benefits until the age of 19. I also assume that all children live to at least their 19^{th} birthdays. For the one-earner and two-earner families, I allow the male's age of death to vary, but set the age of death of the female spouse to her cohort's life expectancy at birth, which I calculate using the SSA's intermediate assumptions. Additionally, I do not account for disability insurance in this paper. Changes to this setup would obviously change the relationship of a given worker to Social Security, reflecting the rules regarding spousal benefits, divorcee benefits, and children's benefits. Nonetheless, the general relationships between the family types I have chosen provide important boundaries, e.g. a family with one child would have an expected rate of return from Social Security that would fall somewhere between the single worker's benefit and the two-children family benefit, and so forth.

For each of these four family types, I consider four different earnings patterns. The earnings of workers will vary by the proportion of the average wage index a worker earns. I assume that work begins on a worker's 20^{th} birthday, and that the worker retires precisely at their normal retirement age. Early or late retirement is allowed by the SSA, but monthly benefits are adjusted up or down in an actuarially fair fashion, so this assumption is relatively innocuous, except for workers who use

[1] Though many marriages end in divorce, this is not an important substantive detail for this model. If a marriage lasts for at least ten years, then an ex-spouse becomes eligible for benefits on the other's work record. Thus a worker could see multiple people earning a spousal benefit from their record, which could increase the rate of return, up to the family maximum of payable benefits from one worker's record.

private information about their own expected age of death to choose a retirement age. Earnings are either low, average, high, or at the maximum taxable level. The level of earnings is connected to the average wage index and simulations of its future course. Low earnings are calculated as 45% of the average wage index, average earnings parallel the AWI, high earnings are calculated as 160% of the AWI, and the maximum earnings multiply the AWI by a number close to 2.4 that allows maximum earnings to be a multiple of $100. Each worker receives a wage as described for each year they are alive between the ages of 20 and the normal retirement age. Workers who die before the retirement age do not receive employment earnings in subsequent years.

As in Nichols et al., I use a scaled earnings history to reflect better the age pattern of a typical worker's earnings. For this, I use the averages of the March 1992 to March 2000 Current Population Surveys to obtain income levels by age and gender. I then create a ratio of these incomes to the steady earnings level of the AWI, and then multiply this by a factor to ensure that the worker with steady and scaled earnings histories for the same income level lead to the same initial Social Security benefit. Maximum earnings remain at their steady levels though, so as to avoid the fact that some of the earnings at the maximum taxable level would be above the cap. This procedure assumes that the average age-specific income distribution by gender in 1992 to 2000 is suitable for all future and past years. To the extent that this assumption is accepted, the scaled earnings histories will provide a better reflection of true earnings history records than do the steady earnings. Finally, though it may be unrealistic to assume that a worker is employed consistently between the ages of 20 and the normal retirement age, Social Security benefit formulas consider only the top 35 years of earnings, which helps to lessen the impact of this assumption. Nonetheless, money worth measures will be understated with this assumption as the extra taxes paid do not translate into larger benefits.

3.2 Assumptions and Methods for Economic Variables

For the model, I treat four macroeconomic variables as stochastic.[2] Other variables such as labor force participation rates or fertility rates could also be treated as stochastic, but were instead fixed in the definitions of the hypothetical workers. The variables which I do treat as stochastic are those that will play a key role in the determination of taxes and benefits for the hypothetical workers. Inflation, specifically the Consumer Price Index for Urban and Clerical Workers (CPI-W), is used to create annual cost-of-living adjustments for benefits. The average wage index (AWI), a time series of average wage levels created by the Social Security Administration, has been used in a number of benefit computation formulas for those who first became eligible for benefits in 1979. These uses include indexing past wages in the formula to compute the average indexed monthly earnings, and increasing the bend points in the formula to compute the primary insurance amount, as well as adjusting upward the maximum taxable earnings. For proposals which include personal retirement accounts, an issue to be taken up in Chapter 2, I use the S&P 500 index to proxy for equity returns and Moody's Seasoned Aaa Corporate Bond Yield

[2] In earlier versions of the paper, I also treated mortality as stochastic. Because mortality rates are needed for ages between 20 and 119, it is difficult to forecast a stochastic model with the same long-run levels as the SSA assumptions for all age groups. Because I wish to compare the stochastic forecasts to the deterministic forecasts given the same long-run average levels, I therefore do not treat mortality as stochastic in this version of the paper.

index to proxy for bond returns. In the case of the AWI, annual calculations are the only numbers available. For inflation, the stock market, and the bond market, the annual data are produced using the changes between each January. Data cover the years between 1951 and 2000, and forecasts are made through 2119. Such long forecasts are needed because I assume that people can live to the age of 119 and the final birth cohort I consider is 2000.

A few papers serve as predecessors to this type of analysis. First, Foster (1994) produced an early stochastic evaluation of four important variables: inflation, unemployment, the real interest rate, and real average wage growth. What he found was that widely varying types of probabilities can be associated with the width between the *Trustees Report* alternative assumptions for the economic variables. Following Foster, Frees et al. (1997) forecasted these economic variables using a vector autoregression. Rosenberg and Young (1999) applied Bayesian estimation procedures to make univariate forecasts that allowed for level shifts and heterogeneous error components for the variables. As for those who create stochastic forecasts for the Trust Fund, Lee and Tuljapurkar (1998b) model the real interest rate for the Trust Fund and real wage growth as AR(1) processes with long-run constraints equal to the intermediate assumptions of the *Trustee's Report*. Meanwhile, the Congressional Budget Office's (2001) stochastic model included time series forecasts for nine economic and demographic variables. Lee et al. (2003) again apply long-run constraints and fit the real interest rate and real returns for the S&P 500 as a VAR(3), and they estimate real wage growth as an AR(1) process.

For my forecasts, I follow in the spirit of Frees et al. and Anderson et al. by using a vector autoregression. The vector autoregression uses the real values of the variables' growth rates (or return rate in the case of bonds); to obtain these I subtract the CPI-W series from the other variables. Then, from each of these variables I subtract a constant which serves as a long-run constraint on the average value of the forecasts. For CPI and AWI, these constraints coincide with the intermediate assumptions of the 2001 *Trustee's Report*. For equities and bonds, I use the mean of the historical series as the long-run constraint. These four series are then estimated as a VAR(2) process, and the fitted model parameters are seen in Table 1. The constant term is left out on account of using the long-run constraints. The error terms for each variable pass the lilliefors test of normality at the 0.05 level. I create 200 Monte Carlo simulations to serve as the forecast for these economic variables. Each simulation consists of a 120 year future path for each of the four variables.

3.3 Further Assumptions for Benefit and Tax Calculation Programs

In this section, I present the other important details that go into computing the tax and benefit records for my simulated workers. Tax collections are relatively straightforward. The lifetime earnings history of the hypothetical worker is multiplied by the existing or assumed payroll tax rate at each age. As is consistent with the literature, I assume that the worker bears the entire burden of the payroll tax. These lifetime earnings histories vary among workers based on cohort, earnings level, earnings type, and whether the worker dies prior to the normal retirement age. I assume that workers do not have other sufficiently large sources of income during retirement, such that potential income taxes on their benefits are not applicable. For workers with the highest incomes, this assumption is not realistic. So the actual returns to Social Security would be slightly lower for these higher income groups.

Benefit payments will be made for reasons relating to retirement and survivorship. I have constructed a series of programs that replicate the benefit computation formulas used by the SSA since 1979. Necessary ingredients in the benefit computation include finding the average indexed monthly earnings (AIME), converting this into the primary insurance amount (PIA), using the primary insurance amount to calculate the starting benefit for all relevant family members, checking to insure that the total benefit payments do not exceed the family maximum, and then increasing the annual benefits using the cost-of-living adjustment for all remaining years of the recipient's eligibility. As each hypothetical worker dies with the probabilities accompanying his age and cohort, payments will be made to his family members. As is common to the literature, these benefits will be considered part of the worker's own benefits for purposes of computing rates of return and lifetime transfers.

For retirement, a worker retires at the normal retirement age, and thus is entitled to 100% of the retired worker benefit. Family members of a retired worker are entitled to up to 50% of the worker's benefit, with a family limit of 150% to 180% of the worker's benefit level. Because of my assumptions about the birth dates of children, there will not be a case in which children will be eligible for a retired worker's benefit, thus leaving only the spouse. The spouse's benefit is 50% of the worker's benefit since I assume that the spouse waits until the normal retirement age to apply for benefits.

For survivorship, benefits to survivors are based on the deceased worker's income history. If a widow/widower waits until the normal retirement age, they are entitled to 100% of the deceased worker's benefit. A widow/widower with children under the age of 16 is entitled to 75% of the benefit level. Since I assume that children attend school, they are also entitled to 75% of the benefit level up to the age of 19. The family maximum is between 150% and 180% of the deceased worker's benefit level. This will affect families for the periods of time in which both children are under age 19, and when the family maximum applies, each family member's benefit is decreased by a proportional amount.

3.4 Reform Proposal Descriptions

This section outlines the characteristics of five different scenarios. Actual reforms considered in Congress often combine varying degrees of a number of the following scenarios as well as other minor changes to program rules. The purpose of this research is to consider the effects of various reform components most popular in reform discussions. The first scenario is merely the status quo baseline, which provides a standard for relative comparison with the other reform proposals. The next four scenarios each change one important aspect of the Social Security program in order to test the implications. These are an increase in the payroll tax, an increase in the normal retirement age, a switch to price-indexing of the benefits formula, and a decrease in the cost-of-living adjustment.

The goal of reforming Social Security is to help place the Trust Funds into 75 year actuarial balance. But as seen in Table 2, each of these reform proposals have differing effects on the actuarial balance, which make them not immediately comparable. The 2001 *Trustee's Report* estimates that the current Social Security system is not generating enough revenues to stay in balance past 2038, and that an immediate increase in the payroll tax of 1.86 percentage points would be needed for the Social Security system to maintain its solvency for the next 75 years.[3] Meanwhile, the reform to increase the normal retirement age from the presently legislated 67 to 70 for the cohorts I consider is expected to close 62% of the actuarial deficit, while changing to price indexing (instead of wage indexing) is expected to solve the funding problems and even lead to additional surpluses for the system after 75 years. Meanwhile, decreasing the cost-of-living adjustment by one percentage point annually would be expected to decrease the projected deficit by 73%.

In order to make the four reform proposals more comparable, I add an additional payroll tax change to the reform, such that the combined effect of the reform proposal and the payroll tax change should lead approximately to 75 year actuarial balance. Thus, the normal retirement age increase is accompanied by a 0.71 percentage point increase in the payroll tax rate, the price indexing proposal is accompanied by a decrease of 0.2 percentage points in the payroll tax rate, and the COLA adjustment is accompanied by a 0.51 percentage point increase in the payroll tax rate. These changes will allow for a fairer comparison between potential reforms.

Scenario I: Status Quo

The first scenario represents the status quo, in which the presently legislated course for Social Security remains in effect. Features of this baseline case include a

[3] The paper is written from the perspective of 2001. In 2003, the *Trustee's Report* changed the Trust Fund exhaustion date to 2042 and the needed tax increase to 1.92 percentage points.

gradual increasing of the normal retirement ages to 67, an OASDI payroll tax of 12.4%, the use of CPI-W to make annual cost-of-living adjustments, and the use of the average wage index for indexing benefits at the age of first eligibility.

Scenario II: Immediate Payroll Tax Increase

Scenario II changes only the future tax rates. The payroll tax rate will immediately adjust upward by 1.86 percentage points from its current level of 12.4%. The upward adjustment is chosen because it is the value that the 2001 *Trustee's Report* projects would keep the Trust Fund solvent over the 75 year horizon.

Scenario III: Adjust COLA to Better Reflect True Price Increases

Scenario III keeps growth in initial levels on almost the same path[4], but provides a way to slow the rate of growth in subsequent benefit levels resulting from the cost-of-living adjustment. The SSA uses the CPI-W to increase benefits each year so that the real benefit levels remain constant. However, a number of researchers argue that the CPI overstates the true level of rising prices. One possibility then, is to use a COLA of the CPI less one percentage point (but not less than zero). This is accompanied by a 0.51 percentage point payroll tax increase.

Scenario IV: Increased Retirement Ages

Scenario IV increases the normal retirement age as an alternative means to reforming Social Security. In the status quo, all five cohorts (since the oldest cohort is born in 1960) I consider will have a normal retirement age of 67. In this scenario, the presently-legislated upward adjustments in normal retirement ages are increased

[4] COLA adjustments begin with the wages earned at age 62 under the current benefit formulations, which could lead the initial benefits to be several percentage points smaller when taken at the normal retirement age.

further, such that for my cohorts the retirement age will be 70. This is accompanied by a 0.71 percentage point payroll tax increase.

Scenario V: Use Price Indexing Instead of Wage Indexing for Benefit Computations

Scenario V slows the rate of growth in future initial benefit levels. The modification to the status quo made in this scenario is that the CPI index will be used in place of the average wage index in the formula to compute average monthly indexed earnings (AIME). According to the President's Commission, this would be implemented starting in 2009 by multiplying the bendpoint factor ratios of the Primary Insurance Amount formula by the ratio of the price index to the wage index (approximately 0.99 on average) from two years prior. The literature does not make clear whether the multiplicative factor used to update the PIA bendpoints will be capped at one. I do not cap the formula, which will allow benefits to increase after years in which prices grew faster than wages, which could slightly bias results in favor of price indexing. Such a change would not decrease initial benefit payments from their present levels; rather it decreases the future rate of increases. With constant 1% real wage growth, the magnitude of this difference will be approximately 0.99 raised to the power of the number of years between the worker's retirement and 2009. This reform is accompanied by the 0.2 percentage point payroll tax decrease to make the reforms consistent. Note, however, that as real tax payments continue to grow over time while real benefits remain the same, such a reform is infinitely sustainable for the Trust Fund and the payroll tax could be decreased even further when looking beyond 75 years.

4 Results for the Stochastic Money Worth Analysis

In this section, I compare the money worth measures between reforms for workers who vary in terms of four important characteristics: age of death, income level, family type, and birth cohort. Section 4.1 compares the reforms using a visually based by-age-of-death framework. Section 4.2 compares the reforms with tables showing the expected values and standard errors of the stochastic money worth measures after integrating over the mortality rates. Such analysis allows for a consideration of the two substantive issues in this paper: from the policy perspective how do the reforms compare, and from the methodological perspective how different from the deterministic methods of the SSA are the results obtained with the stochastic forecasts.

4.1 Reform Comparisons with Age-of-Death Analysis

Reforms will be compared first using their relative performance on a by-age-of-death basis for the worker. Before proceeding with the comparisons, I will introduce the general patterns in the money worth measures conditional on age of death for single workers and families. A clear pattern emerges for single workers, as in the case of rates of return, workers who do not survive to the retirement age experience -100% rates of return. At retirement, rates of return quickly jump upward, as those who die after one year of benefit receipt have rates of return in the range of -20% to -15%. Depending on the economic conditions and the nature of the reform proposal, workers must generally live about five or six years into retirement to have good odds for a positive rate of return, though in some economic simulations workers living to 80 will still have negative rates of return. Obviously, the longer one lives, the higher will be the rate of return, though even those living to the age of 119 will not see their rates of return rise above 10%. A pattern also emerges with the lifetime transfers. As taxes are paid each year, the lifetime transfers continue to decrease until workers reach the age of retirement. Benefit receipt reverses the situation, though the net lifetime transfer may not become positive for these workers until after the age of 80. One-earner and two-earner families more easily experience positive money worth measures on account of the benefits payable to the spouse and children of a deceased worker. This means that a worker does not need to live to retirement to obtain positive money worth measures.

A word should also be said about how reforms affect the cohorts under consideration. Each cohort will experience the full effects of the normal retirement age increase and the COLA adjustment. However, the 1960 cohort, by circumstances of birth, would only pay the higher tax rate for the portion of their careers after the age of 43 or experience the price indexing for earnings after the age of 49. Meanwhile, these reforms begin in the 30s and 20s for the next two birth cohorts, and it is only the 1990 and 2000 birth cohorts who will experience the entire effects of price indexing and the tax increase. On a related note, this paper will have a bias that favors the perspective of younger workers, as members of the oldest cohort considered are only 42 years old at present. The older a worker is, the less they would have to lose with a price indexing or tax increase reform proposal. So it is perhaps for this reason that the price indexing proposal receives strong consideration in contemporary policy debates, at least from those philosophically opposed to further tax increases.

The analysis in this section refers to Figures 1 to 5, which compare the male age of death on the horizontal axis to the distribution of differences in money worth measures for two of the reforms on the vertical axis. Points appearing above the horizontal axis indicate a higher money worth measure from the first reform listed in the figure title and vice versa. In the first four figures, the tax increase and COLA adjustment are compared to each of the normal retirement age increase and price indexing proposals. Then, because the tax increase and COLA adjustment appear to be the most promising of the reforms, I also compare them to each other in Figure 5. Each of these figures includes three parts. In part (a), more extensive results are presented for low-income single males of the 2000 birth cohort, who will serve as a baseline for comparison. The top graph shows the ROR results, and the bottom graph shows the results for net lifetime transfers. These graphs include the 5%, 25%, 50%, 75%, and 95% quantiles of the stochastic forecasts for the entire set of outcomes for each age of death. The graphs also include the results of the SSA's deterministic scenarios.

Parts (b) and (c) of each figure provide comparisons for additional sets of workers in order to extend the analysis on the basis of cohort, income, and family type. Part (b) is presented in terms of rates of return and (c) in terms of lifetime transfers discounted at the two percent level. In order to keep the axes of the graphs consistent for visual observation, the rates of return always are graphed with a range of -3 to 3 percentage point differences, and the net lifetime transfers are plotted with ranges from -\$30,000 to \$30,000 differences in 2001 dollars. Each of (b) and (c) has three sections. The first section provides the birth cohort comparisons, comparing the

2000 birth cohort of single low-income males to the single low-income males of the 1960, 1970, 1980, and 1990 birth cohorts. The second section of the figure compares low income single males born in 2000 to single males born in 2000 who earn the average, high, and maximum incomes. The final section compares the low-income single males of the 2000 birth cohort to the low-income one-earner and two-earner families of the 2000 birth cohort. This allows more to be said about the relative winners between early and later cohorts, low-earners and high-earners, and singles and families.

Payroll Tax Increase & Normal Retirement Age Increase

Figures 1a to 1c compare the 1.86 percentage point payroll tax increase with raising the normal retirement age. For nondisabled workers who survive to retirement, the margin in favor of the tax increase is quite large (before age 67, both reforms lead to rates of return of -100%, so the difference between them is zero). In terms of rates of return, workers see higher returns from the tax increase starting at age 67, though the differences between the returns decreases over time as a relative balance between taxes and benefits develops. Perhaps surprisingly, though, the entire distribution of rates of return stays in favor of the tax increase at all subsequent ages of death. What this means is that workers will earn higher rates of return despite paying higher taxes during their entire working careers than they could receive with the lower taxes accompanied by the loss of three years of benefits. Likewise, for lifetime transfers it takes only one year of benefit receipt for the median differences from the reforms to be equaled out. This provides quite persuasive evidence that if the choices for reform are the tax increase and a raise in the normal retirement age, then non-disabled people are going to get higher lifetime transfers from Social Security with the tax increase, as the entire distribution of stochastic simulations moves in favor of the tax increase after one year of benefit receipt. Nevertheless, for ages before retirement, the NRA proposal will have the higher lifetime transfers on account of its smaller relative tax rate. Finally, after the age of 70 there is a slight trend for the quantiles to gravitate slowly toward the horizontal axis and this is a result of benefits under the NRA proposal generally being slightly higher for ages after 70 since the extra years of work provide higher wages to be used in the benefit computation formula.

The results of the deterministic SSA method are quite similar to the stochastic method in terms of rates of return, though the variance of the SSA method's three alternatives is negligible compared to the stochastic results. This must result from the stochastic simulations allowing for wider variations in the real wage growth, even though the growth is constrained on average to be one percentage point different as in the intermediate SSA assumptions. For the lifetime transfers, the SSA assumptions again lead to the same qualitative conclusions, though now there is a quantitative difference. The variation is much less and the intermediate SSA forecast shows a much larger transfer from the tax increase than the normal retirement age proposal.

Figures 1b and 1c extend the analysis to a wider variety of workers. In Figure 1b, we see for the cohort and income comparisons that there is a negligible difference in the median results between these two reforms. The patterns are the same as in Figure 1a. However, differences do appear when comparing family types in 1b. Whereas single workers see -100% rates of return for all ages before retirement for both proposals, families have the ability to collect survivor benefits when a worker dies young. Thus, after the ages of about 37 and 41, respectively, the two-earner and one-earner families see their rates of return favor the tax increase proposal. These workers thus see that their spouse would benefit by starting benefit collection at the age of 67 instead of 70 despite the higher taxes. Perhaps as an inadequacy of the ROR calculation, workers who die at even younger ages than 37 and 41 would have paid so little in taxes that the relative difference in such small tax collections overwhelms the difference in benefits, which in turn makes the normal retirement age appear as the stronger proposal at the younger ages.

Moving to Figure 1c, this discrepancy is gone, as one-earner and two-earner families will see higher median transfers with the tax increase at all ages. Other patterns also emerge for cohort and income groups when comparing lifetime transfers. The older cohorts would be required to pay higher taxes for a shorter period of time, and so the results more strongly favor the tax increase. Nonetheless, the same general pattern emerges as before; the NRA proposal is more promising for workers who die before retirement on account of its lower tax rates, while after one year of retirement the tax increase proposal provides the higher lifetime transfers. As for income groups, the role of lifetime transfers in comparing the absolute levels of taxes and benefits emerges to show that the higher income individuals pay larger amounts of taxes and so lean further to the side with the lower tax rate until retirement. Also interesting is that even though wealthier workers will be entitled to larger absolute benefits, this does not lead their overall lifetime transfers to be substantially larger as benefits are collected because of the progressive benefit formulas.

Cost-of-Living-Adjustment & Normal Retirement Age Increase

The next comparisons are between the cost-of-living-adjustment decrease and the raise in the normal retirement age, referring to Figures 2a to 2c. These results are not qualitatively different than in the last case. In Figure 2a, we see the rates of return distribution heavily favor the COLA adjustment starting at the age of 67. As more benefits begin to balance the taxes, the ROR distribution moves closer to the horizontal axis and some of the distribution crosses, though the median stochastic result continues to favor the COLA adjustment at all ages. For the SSA deterministic forecasts, again the variability between alternative assumptions is much smaller. The deterministic forecasts also move more quickly toward the NRA side such that after the age of 100 there is a slight favoring of the NRA proposal.

Meanwhile, for lifetime transfers the COLA adjustment sees better returns prior to age 67 because it has lower tax rates. The distribution then moves to more strongly favor the COLA adjustment once benefit payments begin at age 67. After the age of 70, though, the stochastic distribution slowly moves toward the NRA side, since the NRA benefits are increasingly larger than those available with the compounding effects of the COLA decrease, and the median result favors the NRA proposal after the age of 100. Interestingly, the SSA forecasts move more quickly to favor the COLA adjustment between the ages of 67 and 70 and then drop more rapidly such that the NRA sees a stronger performance for ages above the lower 90s. Again we are seeing the implications of constraining the economic variables to always maintain the same values rather than fluctuating in a more realistic manner.

From Figures 2b and 2c we can see that the 2000 low-income single males presented a pattern seen across cohort and income groups. For RORs, the results are almost indistinguishable, though the lifetime transfers do present differences. First, older cohorts have even more to gain from the COLA adjustment relative to the NRA increase. Also, wealthier individuals will see even higher returns with the COLA adjustment since the absolute levels of their benefits and taxes are higher. As for family types, both money worth measures present a median stochastic difference with a higher return from the COLA adjustment almost unanimously across the male age-of-death distribution, indicating that the compounding effects of the COLA adjustment are not great enough to overwhelm the loss of benefits to the spouse and potentially the worker from having to retire at a later age.

Payroll Tax Increase & Price Indexing

Figures 3a to 3c compare the payroll tax increase to the price indexing proposal. Figure 3a shows that for rates of return, the reform preference is dependent on the future course of the economy, though the payroll tax increase generally outperforms the price indexing proposal over 75% of the time, and the median difference at most ages beyond retirement is between 1 and 2 percentage points. It is remarkable that even for those who die after one year of benefit receipt, well over 75% of the individuals would find their rates of return to be higher with the tax increase. Regarding lifetime transfers, price indexing does better for ages of death before retirement because of the lower taxes, though the differences quickly move to favor the tax increase after a few years of benefit receipt. The SSA method shows the same qualitative result, though this method obscures the fact that in some economic scenarios it is possible that workers could be better off with price indexing despite its benefit cuts, since all three alternative scenarios lean toward the payroll tax increase. In fact, the SSA results make the tax increase appear even stronger than do the stochastic forecasts. In conclusion, the results from the 2000 birth cohort indicate that workers can generally expect higher returns from a payroll tax increase in lieu of price indexing, of course assuming that they live to the retirement age.

Moving to Figures 3b and 3c, the low-income single male born in 2000 is again compared to other worker groups. Compared to other cohorts, it is clear that the effects of price indexing are highly dependent on the birth cohort, with latter birth cohorts doing progressively worse under price indexing as their taxes grow at the rate of wages and their initial benefit grows only at the rate of prices. For this reason we see a consistent trend of median rates of return being increasingly higher with the tax increase for successive cohorts. Nonetheless, no similar pattern emerges for cohorts with the lifetime transfer results. As for income groups, the comparisons for rates of return are now quite similar, and this pattern firmly supports the use of the tax increase in the median case. With lifetime transfers, the wealthier workers pay more taxes and then receive larger benefits after retirement, which is seen in the steeper slopes of the median differences. From the perspective of family types, the median result for one-earner and two-earner families favors the tax increase because of the larger amounts of benefits these families will receive relative to their tax payments. For rates of return, the median difference is consistently about one percentage point in favor of the tax increase. Also, with lifetime transfers, the typical dip that single workers experience for the reform with lower taxes disappears, as families will see better results from the tax increase regardless of the male age of death. This evidence continues to be persuasive that a price indexing proposal would be quite ineffectual from the perspective of maximizing a worker's money worth measures for the cohorts under consideration.

Cost-of-Living-Adjustment & Price Indexing

Figures 4a to 4c consider two reforms which effect benefit levels: the price indexing proposal generally decreases the initial benefit level, but lets subsequent benefits grow at the rate of inflation, and the COLA adjustment leaves the initial benefit level relatively unchanged but gradually decreases the growth in future benefit levels. At ages past retirement, workers will be better off with the COLA adjustment between 75% and 95% of the time for both money worth measures. The differences for rates of return are pretty substantial, as at most ages the median difference is about two percentage points. At ages of death prior to the NRA, workers will have higher transfers with price indexing because of the lower taxes. Once the age of retirement is reached, price indexing starts off with much lower benefits, and it will take a long time for the decreases in the COLA to catch up in terms of lower benefit levels. Thus, the distribution at 67 begins to ascend to be more in favor of the COLA adjustment and does not reverse directions even at the age of 110. The trends with the SSA method are also quite similar, though much less variance accompanies the SSA techniques. The SSA forecasts also portray the COLA proposal even more favorably than do the stochastic forecasts.

Figures 4b and 4c provide additional intergenerational and intragenerational comparisons. From the perspective of cohorts, the gradual shift over time is for cohorts to do increasingly better with the COLA adjustment, as the compounding effects of price indexing make initial benefits increasingly smaller over time relative to the tax payments. In terms of differences across income levels, it is hard to conclude that there are any patterns in the differences between rates of return, though in general the effects on lifetime transfers are amplified, since the reform has larger effects on absolute levels of taxes and benefits as incomes grow. Additionally, one-earner and two-earner low income families generally see better returns with the COLA adjustment across the age of death distribution. In conclusion, if Congress seeks a way to limit future benefits, they will better serve the public by using the COLA adjustment proposal than by using price indexing, at least from the perspective of these cohorts.

Payroll Tax Increase & Cost-of-Living-Adjustment

For the final set of comparisons, the tax increase proposal is pitted against the COLA adjustment, as the results so far have indicated that these two reforms are generally more promising. Neither reform will be clearly preferable, as different workers are affected in different ways. Figure 5a provides the results for low-income single males from the 2000 birth cohort. From the perspective of rates of return, the longer a person lives, the most likely they will do better with the tax cut than with the COLA adjustment. However, until the age of about 80, over 75% of the distribution would be better off with the COLA adjustment, and it is not until closer to the age of 90 that the median rate of return favors the tax increase. This is to be expected, as the COLA adjustment does not begin to really manifest itself until people have received benefits for multiple years. Nonetheless, the differences in rates of return between these proposals are also generally quite small (mostly between -0.5 and 0.5 percentage points). The age-dependency factor also holds in the case of lifetime transfers. Workers who die before about the age of 75 will earn a higher lifetime transfer with the COLA adjustment, but as more years of lower COLAs compound themselves into lower benefits, the distribution of net transfers moves upward to favor the tax increase for workers dying at later ages, such that by the time people live to about 100, they will always have done better with the tax increase than with the COLA adjustment. The age of 85 is when the median difference crosses to the tax increase side. In both of these cases, the SSA forecasts provide qualitatively similar results, though the variation is much less and the forecasts tend to favor the tax increase slightly more than does the stochastic method.

Turning to Figures 5b and 5c, we can again see more detail on the role of cohorts, earnings, and family type in determining relative reform performance. For cohorts, again there is a trend for younger cohorts to be better off with the COLA adjustment over the tax increase. However, this is because the COLA adjustment affects all of the cohorts in the same way, whereas, as explained before, the tax increase is implemented at different points in the lives of different cohorts so as to have relatively less effect on the older workers compared to younger workers. This trend is observable with both of the money worth measures in the figures. When comparing these reforms by income level, the relative rates of return do not appear to be affected, but the same pattern emerges in lifetime transfers, in which wealthier workers pay larger amounts of taxes, which leads the COLA reform to be more preferable for workers of higher income dying before the retirement age. As for those dying after the normal retirement age, the median low-income worker begins to favor the tax increase at around age 85, while the maximum income worker does not favor the tax increase until closer to age 100. For family types, at ages of death before 45 the COLA adjustment produces higher rates of return. After this point, the differences between the returns are miniscule. The same qualitative results remain for lifetime transfers, as it is also still the case that people living to older ages will generally prefer the tax increase in lieu of seeing the compounding effects of their COLA adjustment continue for so many years.

The differences between these two reforms are typically much smaller than when comparing other sets of reforms. There is no clear-cut choice between these reforms that will help everyone. However, the COLA adjustment does provide an interesting way to redistribute wealth from people who live longer to people who do not and thus are already disadvantaged by Social Security. The next section will shed further light onto this situation by actually incorporating mortality rates into these results.

4.2 Expected Money Worth Measures Accounting for Mortality

In this section I reconsider these comparisons after accounting for actual life spans, which are obscured by the age-of-death analysis. Though we could see how reforms compared by age of death, it is also vital to know when people are expected to die for the results to be meaningful. These expectations are calculated by applying mortality probabilities to the money worth measures earned for each age of death. The calculation for the mortality probability shows the portion of people dying at a given age from the initial population at age 20:

$$\text{Prob}_a = mort_a \times \prod_{i=20}^{a-1} (1 - mort_i), \;\; a \in \{21,119\}$$

where *mort* refers to the gender-specific proportion of people dying at a given age conditional on having lived to the previous age. I use the intermediate assumptions of the SSA for the mortality forecasts rather than using stochastic forecasts of mortality. Because SSA forecasts are only made through 2075, I fit a growth trend to these forecasts in order to obtain results through 2119. This analysis refers to Tables 3 to 10 of the Appendix. Tables are presented for the low-income and high-income categories of each of the four different family types for each different cohort. For each cohort, the numbers in boldface are the rates of return and net lifetime transfers (and their standard errors in parentheses beneath) of the hypothetical worker for the reform proposal listed above. The second and third rows of each birth cohort show the median difference between the reform on the left and the reform above, and the standard errors are in parentheses. In other words, positive numbers indicate that the reform on the left provides higher money worth measures, and negative numbers favor the reform listed above.

Regarding the boldfaced numbers in these tables, we can see that the three trends typically found in previous hypothetical worker analyses continue to apply to the median performances of each reform from the stochastic simulations. First, the SSA program is progressive with respect to earnings. The parameters of the benefit computation formulas lead lower income individuals to receive higher rates of return on their payroll taxes than do workers with larger incomes. The second trend is that women earn higher rates of return than men, after controlling for income and labor force participation history (which are unrealistic controls). The higher returns earned by women are driven by their lower mortality rates and subsequently longer periods spent in retirement. Furthermore, married couples do better than singles, and in particular families with one wage earner do the best. This is no surprise, since as the family size grows, more people become eligible for benefits based on the worker's earning record, up to the family limit. Finally, because longevity and real wages are increasing for each cohort, there will be an important underlying force pushing younger cohorts to have higher returns than older cohorts. This force will be particularly poignant with the COLA adjustment and NRA increase, because these reforms affect each cohort equally. However, the tax increase and price indexing do not effect cohorts equally, as the 1990 birth cohort would be the first to feel the entire effects of the tax increase, and as the price indexing proposal would continue to adversely effect cohorts the later they retire. Also, the relationships between inflation and wages and how they enter the benefit computation formulas also work to prevent this upward trending pattern from always appearing in the results.

The interesting comparisons involve the differences between the proposals. For both types of money worth measures, it is always the case that the tax increase and the COLA adjustment lead to a higher median return than do either the NRA adjustment or price indexing. However, the variability of the results shows how differing economic situations can lead to the other proposal providing a better return in a fair number of cases. Specifically, Table 3 provides the results for low-income single males across cohorts. When comparing the tax increase and COLA adjustment, the trend is for the tax increase to produce slightly higher rates of return and the COLA adjustment to produce slightly higher lifetime transfers. The differences between the reforms are small, such that the discount factor applied to benefits in the lifetime transfers could be what gives the COLA an edge. When comparing each of these reforms to the NRA increase, the NRA increase provides lower returns and the standard errors of the differences are much less than the magnitude of the difference. For price indexing comparisons, it is interesting to note that the standard errors of the differences are generally larger than the magnitude of the differences, though the magnitude of the differences is still relatively large. Table 4 shows these comparisons for high-income single males, and though the returns these workers find in terms of levels are smaller than the before, the patterns between the differences are quite similar to the low-income single males. In terms of rates of return, the differences are almost identical, but in terms of the lifetime transfers the COLA reform is more strongly favored over the tax increase. The higher tax dollars that these workers pay lead them to have been better off with the reform proposal that creates more of a split between tax increases and benefit cuts.

Tables 5 and 6 provide the results from low-income and high-income single females, respectively. The way these results can differ from the single males is that the female mortality rates are applied, and females are projected to have longer life spans than males. The longer life spans will mean more years for the effects of the COLA adjustments to compound leading to more years of a higher relative benefit with the tax increase. For low-income single females this is represented with the tax increase generally leading to slightly larger returns, though the standard error in the returns usually exceeds their magnitude. For high-income single females, the tax increase still has the smallest of an edge with rates of return, but the higher absolute levels of taxes with the tax increase lead the COLA to provide slightly larger lifetime transfers when discounted at 2%.

Tables 7 and 8 show the results for both low-income and high-income one-earner couples. The eligibility for benefits available from a worker's earnings record allows the money worth measures for these groups to exceed those available to single workers. Now the tax increase generally provides higher median money worth measures than the other reforms as benefits play a larger relative role than taxes for one-earner couples. Finally, in Tables 9 and 10, both spouses earn an income and though these couples receive relatively lower returns from Social Security than their one-earner counterparts, the differences between reforms still follow the same patterns. Accounting for mortality will generally lead the tax increase to provide higher money worth measures than the COLA adjustment, a result which is important to consider in relation to the age of death analysis.

5 Summary and Conclusions

This paper has addressed two major questions plaguing the debate over Social Security. From the policy perspective, I have compared four different potential Social Security reforms to determine how different types of hypothetical workers would fair under each reform. From the methodological perspective, I have used stochastic forecasts of the most important economic variables to calculate taxes and benefits, because it is important to test whether the deterministic forecasting approach used by the Social Security Administration is missing important aspects when comparing differing types of reform proposals.

For the first question, the analysis of Section 4 indicates that of the reform proposals considered herein, the "best" reform depends on one's perspective regarding issues of intergenerational and intragenerational equity, as well as on the future course of the economy. Nevertheless, the results indicate that the tax increase or COLA adjustment will provide better solutions to Social Security's funding problems than could a normal retirement age increase or the price indexing proposal, at least for the cohorts used in this paper. The further one is from retiring, especially those who have just been born, the less appealing the price indexing proposal will seem, as real tax payments continue to grow while real benefits remain the same. Meanwhile, the proposal to increase the normal retirement age generally decreases rates of return and lifetime transfers across the board, relative to the other reform proposals. The results of this paper are important, because the President's Commission to Strengthen Social Security Reform refuses to consider any tax increases and has not paid much attention to COLA adjustments. This refusal to consider tax increases makes price indexing particularly attractive to those on the President's Commission, because its cuts in future benefit growth are so severe that this policy could be implemented with a small tax cut and still achieve actuarial balance.

For comparisons between the COLA adjustment and the tax increase, the basic story is that those who live the longest will be the losers with the COLA adjustment, while those who die by the age of 80 to 90 will be the winners with the COLA adjustment. The COLA adjustment keeps the initial benefit levels at nearly the same level as the status quo, instead leaving later benefit receipts to grow at a slower rate. This allows for the tax rates to be lower than otherwise possible, which in turn leads the money worth measures to be higher with the COLA decrease until later ages when the compounding effects of the smaller COLAs begin to manifest themselves more heavily. One *caveat* with the COLA adjustment is the need to ensure that extremely old people are still receiving large enough benefits to avoid poverty. If this became a problem, one could always think of a modification to this reform which would see the restoration of the original COLA formulation for people once they reach the age of 80, for instance, which would probably only require a very slight additional increase in the tax rate to maintain actuarial balance. Such issues are tested in Chapter 3.

The other important issue regards whether the use of stochastic models adds an important detail that is missing from the SSA's deterministic forecasting method. The figures have shown that the deterministic forecasts possessed the same qualitative behaviors to provide a decent first approximation, though frequently the actual values differed by a noticeable degree. Also, the variation provided by the optimistic and pessimistic assumptions of the SSA is dwarfed by the variation found in the stochastic simulations that allow the CPI and AWI to fluctuate each year. The lack of variability in the deterministic forecasts obscures the role that the course of the economy will play in determining which reform produces higher returns, as while the stochastic simulations frequently show mixed results, all three alternative SSA assumptions lead to agreement in the reform comparisons. The real test of the stochastic approach will be with personal retirement accounts though, when the variation in equity and bond markets over time could create much more significant effects for the stochastic forecasts.

Indeed, it must be recognized that this paper leaves much ground for additional research. First, the reform proposals gaining the most visibility as a result of the President's Commission to Strengthen Social Security (2001) all include some form of personal retirement accounts (PRAs). The stochastic model presented in this paper is perfectly adaptable to proposals with PRAs, though the details required for a proper presentation would make the present paper unbearably long. Chapter 2 creates suitable assumptions to implement PRAs that can be compared to the reforms in this paper. Other reform proposals also considered in modern America not receiving mention here include increasing the maximum taxable wage level, increasing the taxation of benefits (both of these would only effect the higher earners), including a portion of the government's general revenues in the Trust Fund, and investing part of the Trust Fund in equities. To the extent that these reforms are viable, the conclusions of this research should be tested more widely.

An additional aspect requiring consideration is the disability component of the Social Security program, as disabled workers and their families make up an important portion of Social Security beneficiaries, and the incorporation of disability benefits would increase the rates of return available from Social Security to all workers. I will take up this issue in subsequent research. I will also consider the implications of the inverse relationship existing between income levels and mortality, and whether the progressive nature of Social Security would be overturned after incorporating the notion that lower income individuals tend not to live as long as higher income individuals. This in turn could have important implications for the desirability of various reform proposals for different socioeconomic groups. Perhaps most importantly, if lower income workers die at younger ages, the COLA reform will be even more promising for them.

Finally, this first-generation stochastic model is a reduced form model. It does not incorporate any of the macroeconomic and behavioral feedbacks of a reform, and it also does not place Social Security into the wider framework of retirement income. Another step toward a comprehensive analysis would be to embed the hypothetical workers into a microsimulation model that would more adequately reflect realistic life histories as well as allow for endogenous feedbacks from various reforms in terms of savings, retirement decisions and the labor supply, overall government budgets, and so forth. Nonetheless, my model does take important steps forward in improving the ways that questions about Social Security reform can be discussed in light of the widespread uncertainty about the future, which does not incorporate arbitrary and pre-defined relationships among important underlying variables.

Bibliography

ADVISORY COUNCIL ON SOCIAL SECURITY (1991): The Social Security Technical Panel Report to the 1991 Advisory Council on Social Security. Washington, D.C.

ANDERSON, MICHAEL, HISASHI YAMAGATA, AND SHRIPAD TULJAPURKAR (2001): "Stochastic Rates of Return for Social Security Under Various Policy Scenarios," Working Paper UM00-03, Michigan Retirement Research Center, Ann Arbor.

BELL, FELICITIE C. (1997): "Social Security Area Population Projections: 1997," Actuarial Study, No. 112, Office of the Actuary, Social Security Administration.

BURDICK, CLARK, AND JOYCE MANCHESTER (2003): "Stochastic Models of the Social Security Trust Funds," Social Security Administration Office of Policy Research and Statistics Note No. 2003-01. Washington, D.C.

CALDWELL, STEVEN, MELISSA FAVREAULT, ALLA GANTMAN, JAGADEESH GOKHALE, THOMAS JOHNSON, AND LAURENCE J. KOTLIKOFF (1998): "Social Security's Treatment of Postwar Americans," NBER Working Paper Series, No. 6603. Cambridge, MA: National Bureau of Economic Research.

CITRO, CONSTANCE F., AND ERIC A. HANUSHEK, ed. (1997): Assessing Policies for Retirement Income: Needs for Data, Research, and Models. Washington, D.C.: National Academy Press.

CONGRESSIONAL BUDGET OFFICE (2001): Uncertainty in Social Security's Long-Term Finances: A Stochastic Analysis. Washington, D.C.

DIAMOND, PETER A. (1996): "Proposals to Restructure Social Security," The Journal of Economic Perspectives, 10:3, 67-88.

FELDSTEIN, MARTIN, AND ANDREW SAMWICK (2001): "Potential Paths of Social Security Reform," NBER Working Paper Series, No. 8592. Cambridge, MA: National Bureau of Economic Research.

FOSTER, RICHARD S. (1994): "A Stochastic Evaluation of the Short-Range Economic Assumptions in the 1994 OASDI Trustees Report," Actuarial Study, No. 109, Office of the Actuary, Social Security Administration.

FREES, EDWARD W., YUEH-CHUAN KUNG, MARJORIE A. ROSENBERG, VIRGINIA R. YOUNG, AND SIU-WAI LAI (1997): "Forecasting Social Security Actuarial Assumptions," North American Actuarial Journal, Volume 1 No. 4, 49-82.

GEANAKOPLOS, JOHN, OLIVIA S. MITCHELL, AND STEPHEN P. ZELDES (1998): "Social Security Money's Worth," NBER Working Paper Series, No. 6722. Cambridge, MA: National Bureau of Economic Research.

GRAMLICH, EDWARD M. (1996): "Different Approaches for Dealing with Social Security," The Journal of Economic Perspectives, 10:3, 55-66.

KOITZ, DAVID, GEOFFREY KOLLMANN, AND DAWN NUSCHLER (2001): "Social Security: What Happens to Future Benefit Levels Under Various Reform Options," CRS Report for Congress. Washington, D.C.: The Congressional Research Service.

LEE, RONALD D. (1999): "Probabilistic Approaches to Population Forecasting," Population and Development Review, supp to Vol 24, 156-190.

LEE, RONALD D., MICHAEL W. ANDERSON, AND SHRIPAD TULJAPURKAR (2003): "Stochastic Forecasts of the Social Security Trust Fund: Report for the Social Security Administration." Available at http://simsoc.demog.berkeley.edu/Reports/LAT_SSA_Mar2003.pdf.

LEE, RONALD, AND SHRIPAD TULJAPURKAR (1994): "Stochastic Population Forecasts for the United States: Beyond High, Medium, and Low," Journal of the American Statistical Association, 89:428, 1175-1189.

LEE, RONALD, AND SHRIPAD TULJAPURKAR (1998a): "Population Forecasting for Fiscal Planning: Issues and Innovations," mimeo.

LEE, RONALD, AND SHRIPAD TULJAPURKAR (1998b): "Stochastic Forecasts for Social Security," in Frontiers in the Economics of Aging, ed. by David Wise. University of Chicago Press, 393-428.

LEIMER, DEAN R. (1995): "A Guide to Social Security Money's Worth Issues," ORS Working Paper No. 67, Office of Research and Statistics, Social Security Administration.

LEIMER, DEAN R. (1999): "Lifetime Redistribution Under the Social Security Program: A Literature Synopsis," Social Security Bulletin, Vol. 62, No. 2, 1-9.

NICHOLS, ORLO R., MICHAEL D. CLINGMAN, AND MILTON P. GLANZ (2001): "Internal Real Rates of Return Under the OASDI Program for Hypothetical Workers," Actuarial Note, No. 144, Office of the Chief Actuary, Social Security Administration.

PRESIDENT'S COMMISSION TO STRENGTHEN SOCIAL SECURITY (2001): Strengthening Social Security and Creating Personal Wealth for All Americans. Washington, D.C.

ROSENBERG, MARJORIE A., AND VIRGINIA R. YOUNG (1999): “A Bayesian Approach to Understanding Time Series Data,” North American Actuarial Journal, Volume 3 No. 2, 130-143.

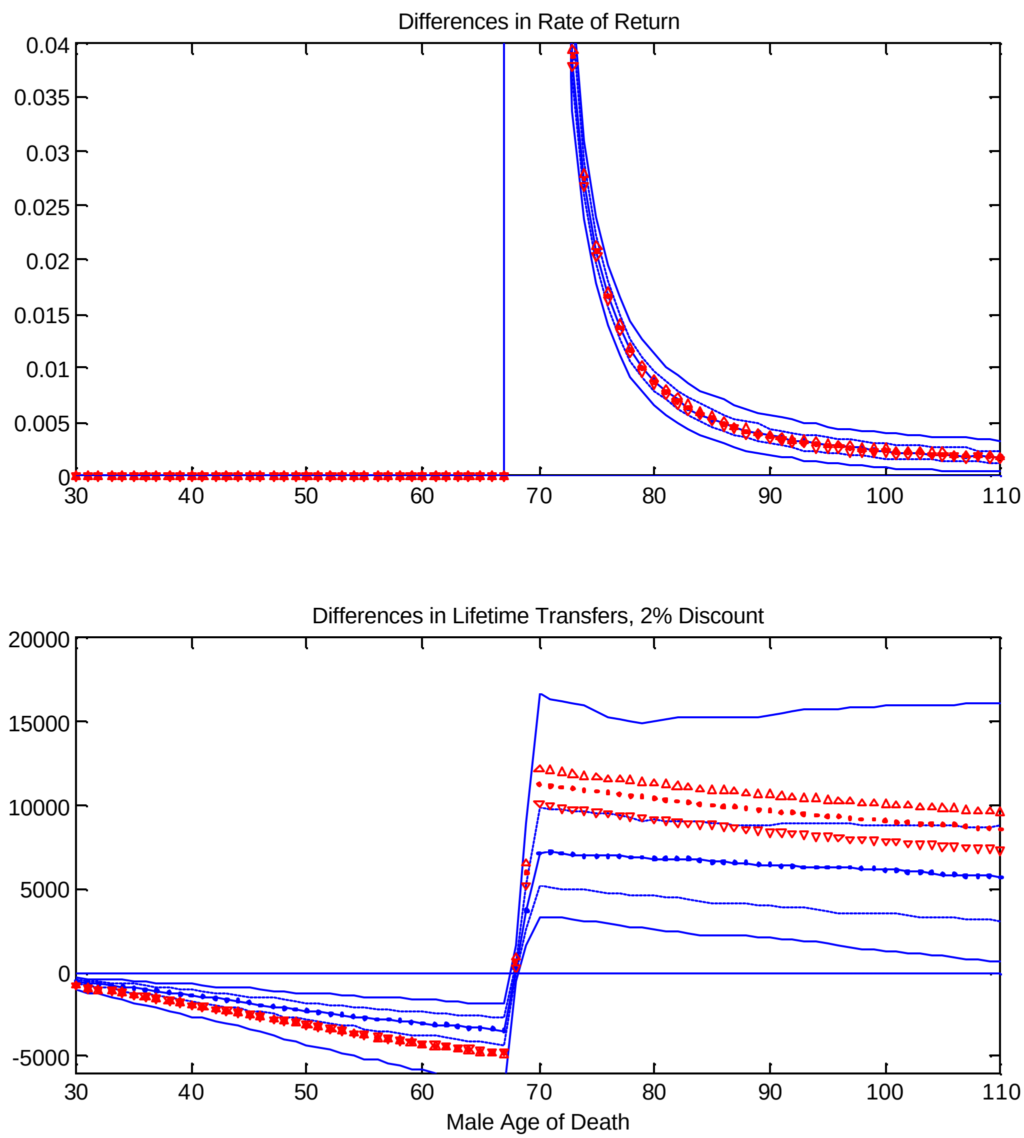
SOCIAL SECURITY ADMINISTRATION (2000): A Brief History of Social Security. Available from: http://www.ssa.gov/history/reports/briefhistory.html

SOCIAL SECURITY ADMINISTRATION BOARD OF TRUSTEES (2001, 2003): Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Disability Insurance (OASDI) Trust Funds. Washington, D.C.: Government Printing Office.

SOCIAL SECURITY ADVISORY BOARD (1999): The 1999 Technical Panel on Assumptions and Methods. Washington, D.C.

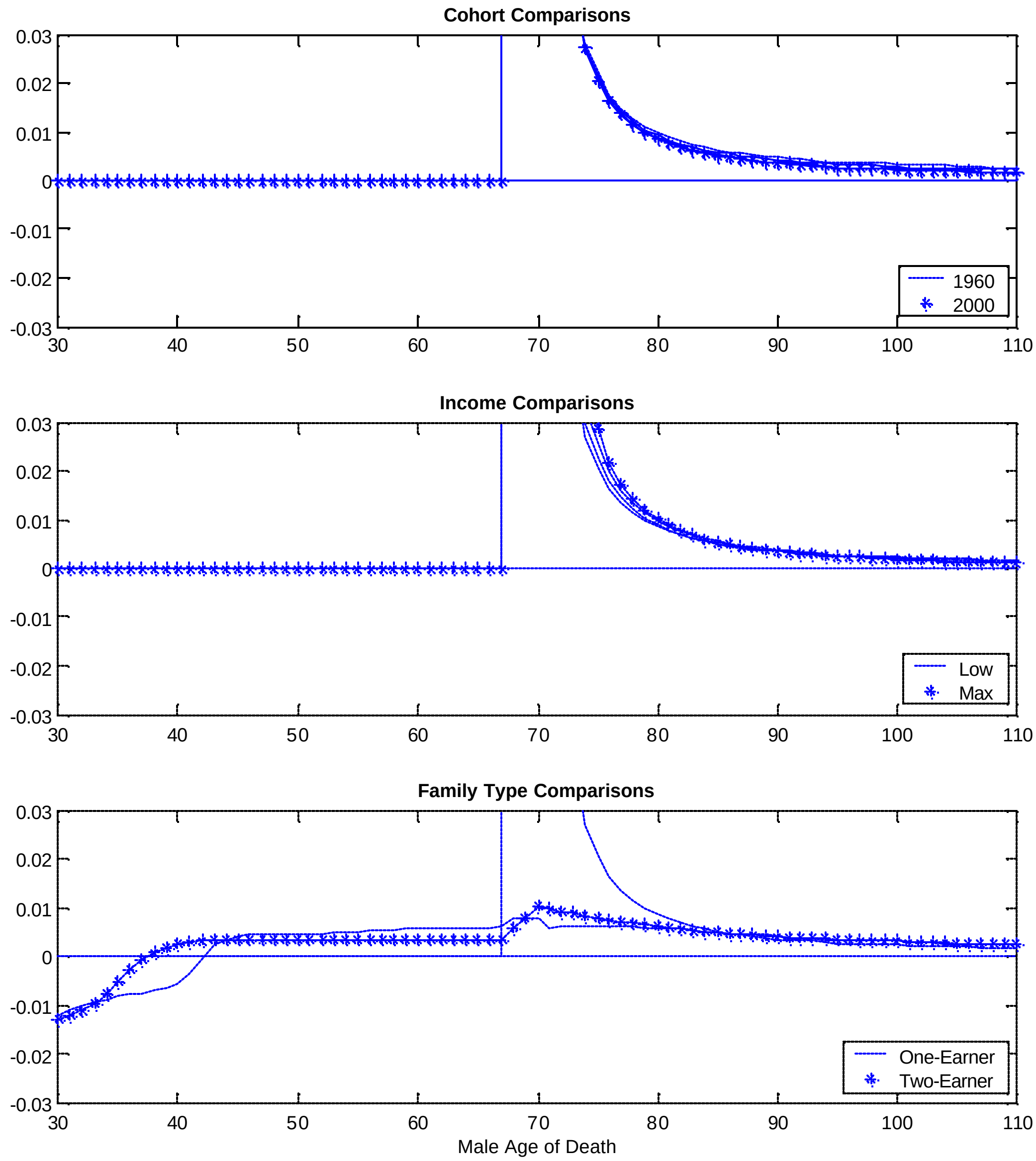
TODER, ERIC, MELISSA FAVREAULT, JOHN O’HARE, DIANE ROGERS, FRANK SAMMARTINO, KAREN SMITH, KENT SMETTERS, AND JOHN RUST (2000): Long Term Model Development for Social Security Policy Analysis. Washington, D.C.: The Urban Institute.

Figure 1a
Difference between Increasing the Payroll Tax by 1.86%
and Increasing the Normal Retirement Age
Low-Income Single Males of the 2000 Birth Cohort



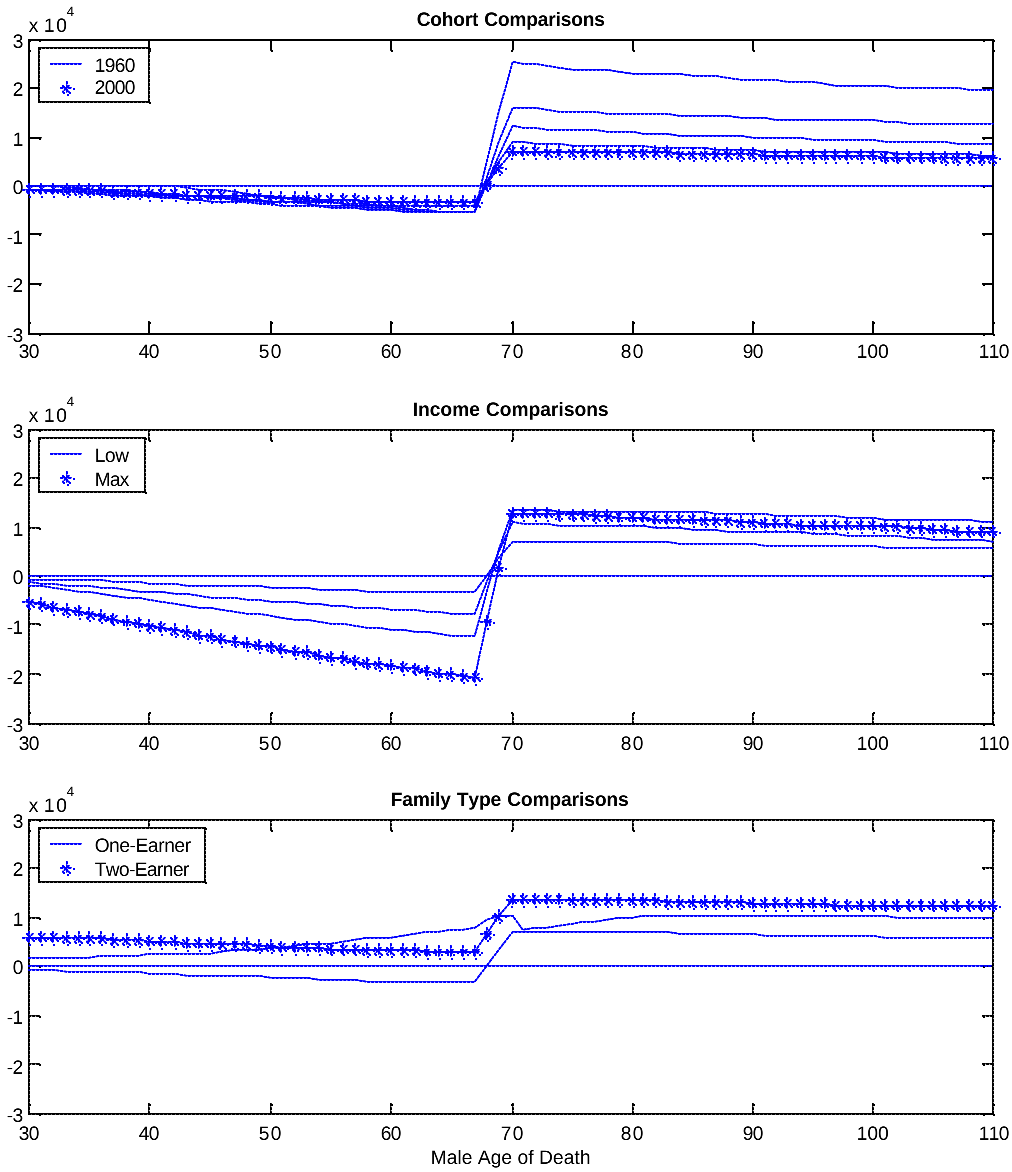
Rates of return are expressed in decimal form, i.e. 0.1 = 10% ROR. In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. The graphs present both the stochastic forecasts and the SSA deterministic forecasts. For the stochastic forecasts, the dotted line is the median quantile, the two dashed lines are the 25% and 75% quantiles, and the solid lines are the 5% and 95% quantiles. For the SSA forecasts, the dots represent the best case scenario, the upper triangles are optimistic case, and the lower triangles are the pessimistic case.

Figure 1b
Difference between Increasing the Payroll Tax by 1.86%
and Increasing the Normal Retirement Age
Rates of Return



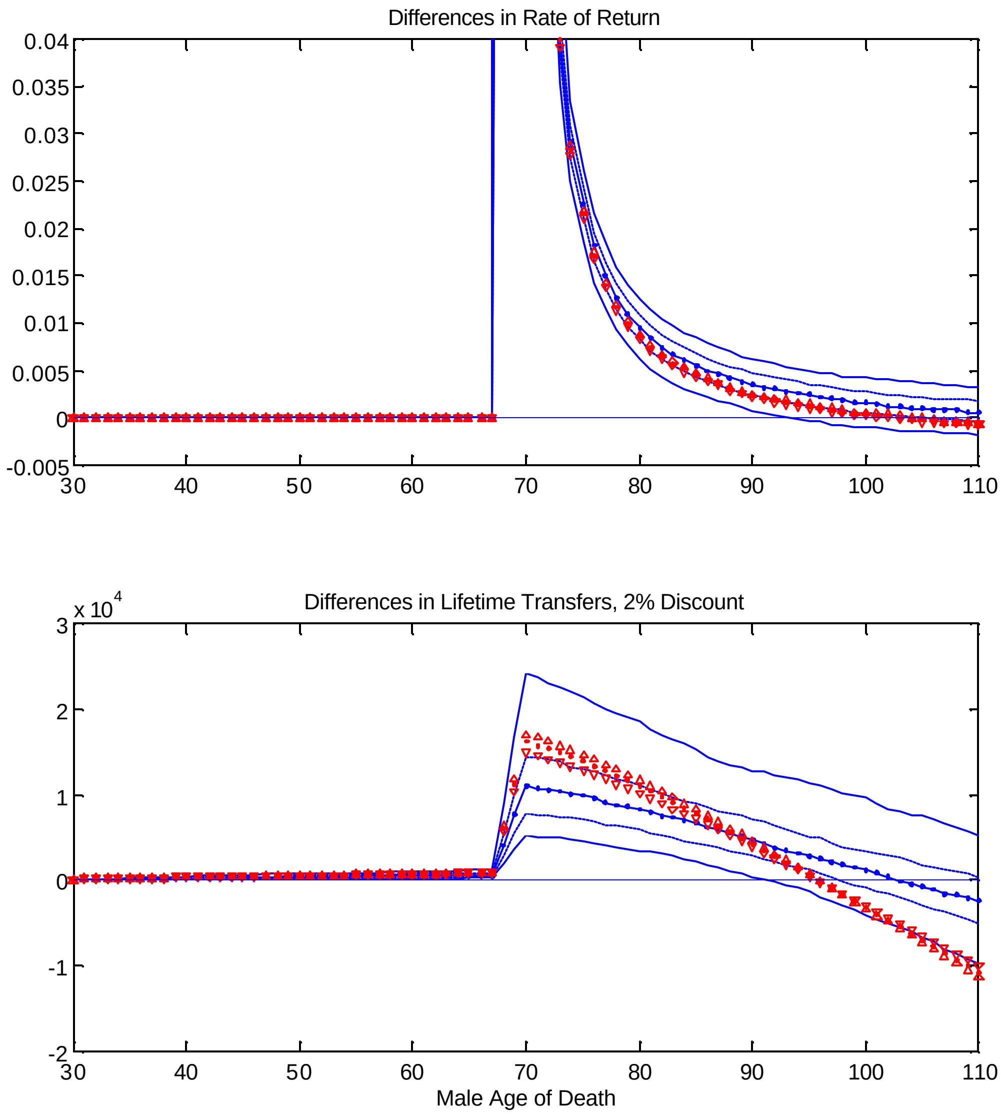
Rates of return are expressed in decimal form, i.e. 0.1 = 10% ROR. In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. Each line represents the median stochastic forecast for the given group.

Figure 1c
Difference between Increasing the Payroll Tax by 1.86%
and Increasing the Normal Retirement Age
Net Lifetime Transfers, 2% Discount



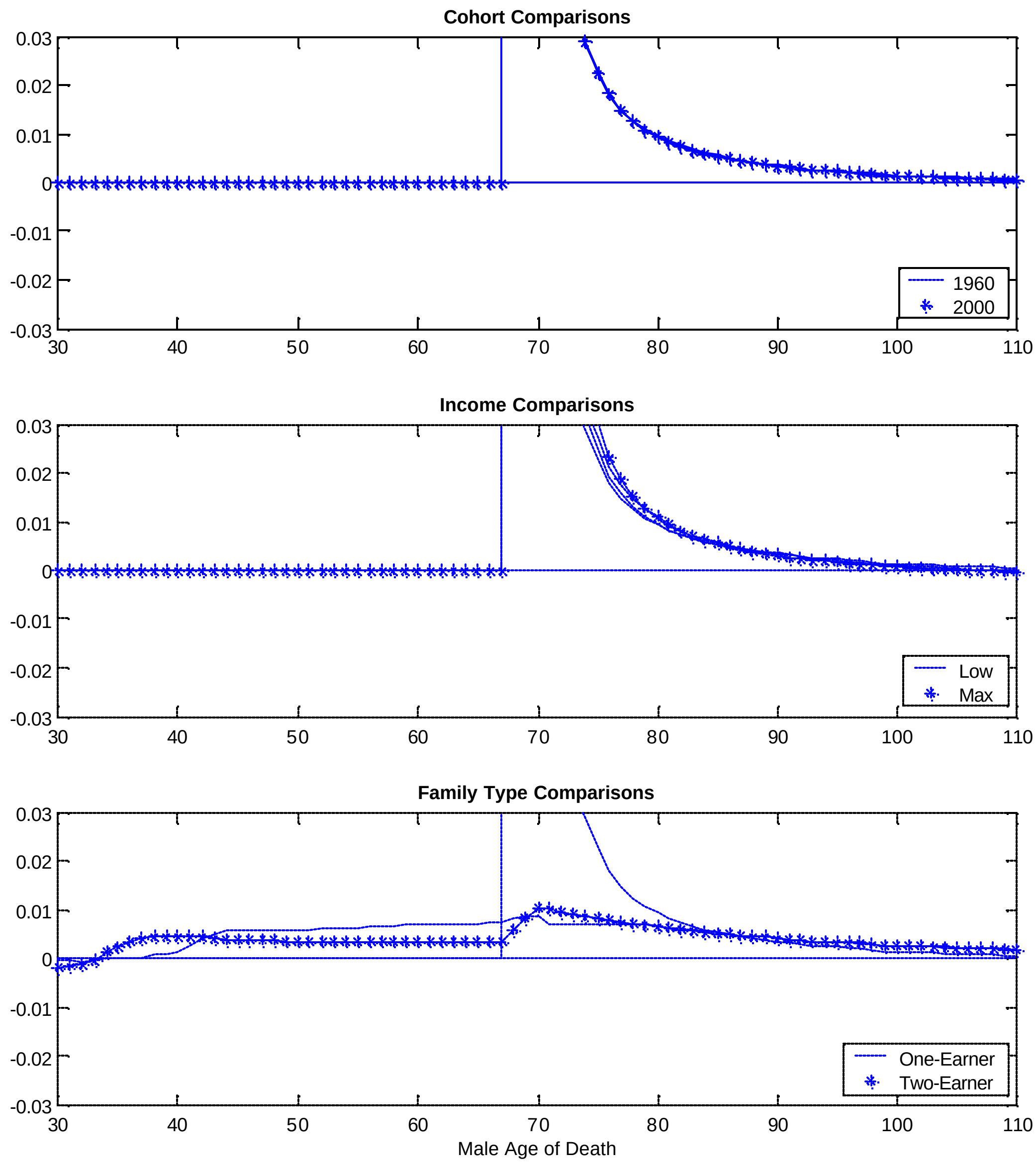
In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. Each line represents the median stochastic forecast for the given group.

Figure 2a
Difference between Adjusting the COLA Downward by up to 1% and Increasing the Normal Retirement Age
Low-Income Single Males of the 2000 Birth Cohort



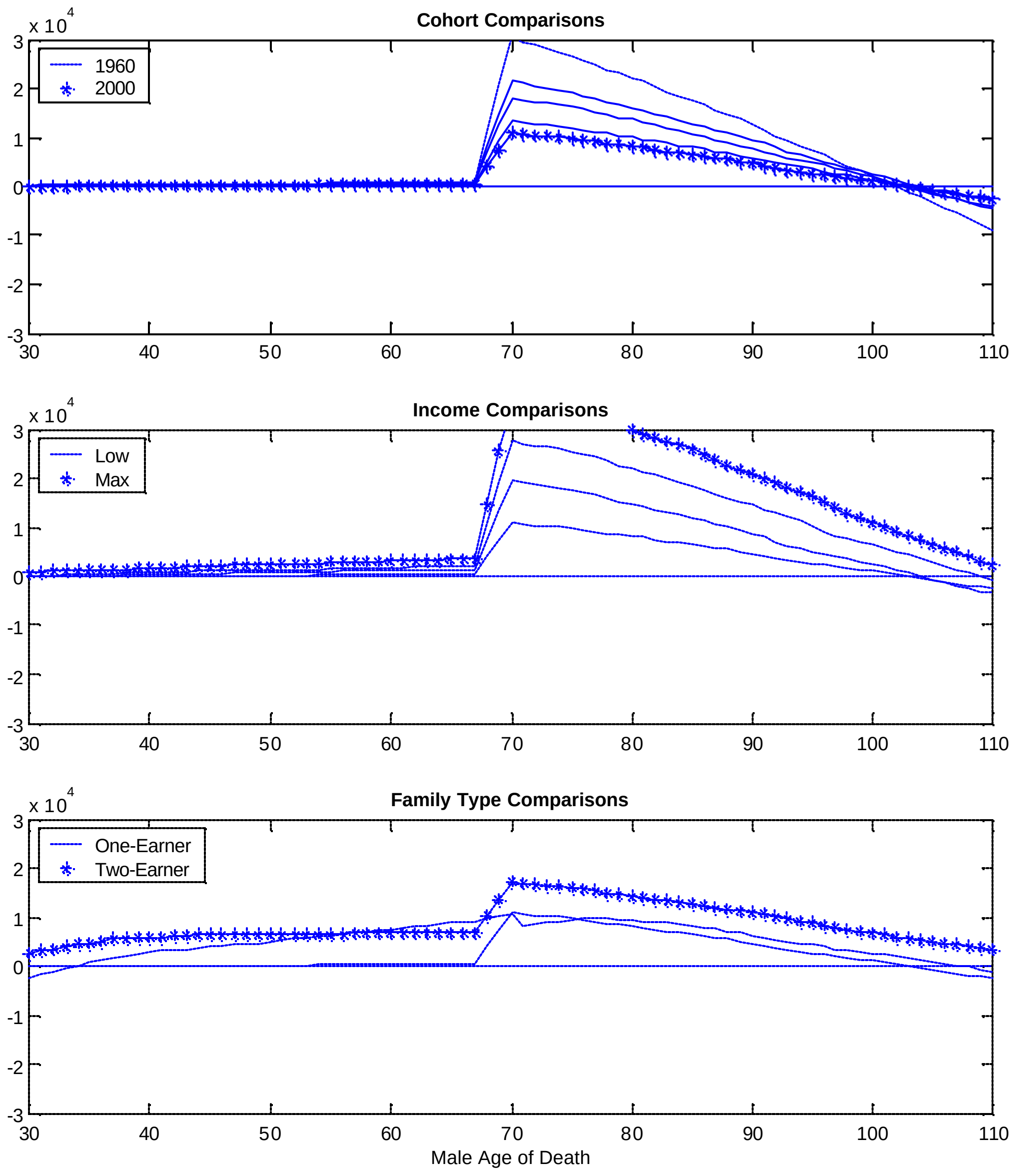
Rates of return are expressed in decimal form, i.e. 0.1 = 10% ROR. In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. The graphs present both the stochastic forecasts and the SSA deterministic forecasts. For the stochastic forecasts, the dotted line is the median quantile, the two dashed lines are the 25% and 75% quantiles, and the solid lines are the 5% and 95% quantiles. For the SSA forecasts, the dots represent the best case scenario, the upper triangles are optimistic case, and the lower triangles are the pessimistic case.

Figure 2b
Difference between Adjusting the COLA Downward by up to 1% and Increasing the Normal Retirement Age
Rates of Return



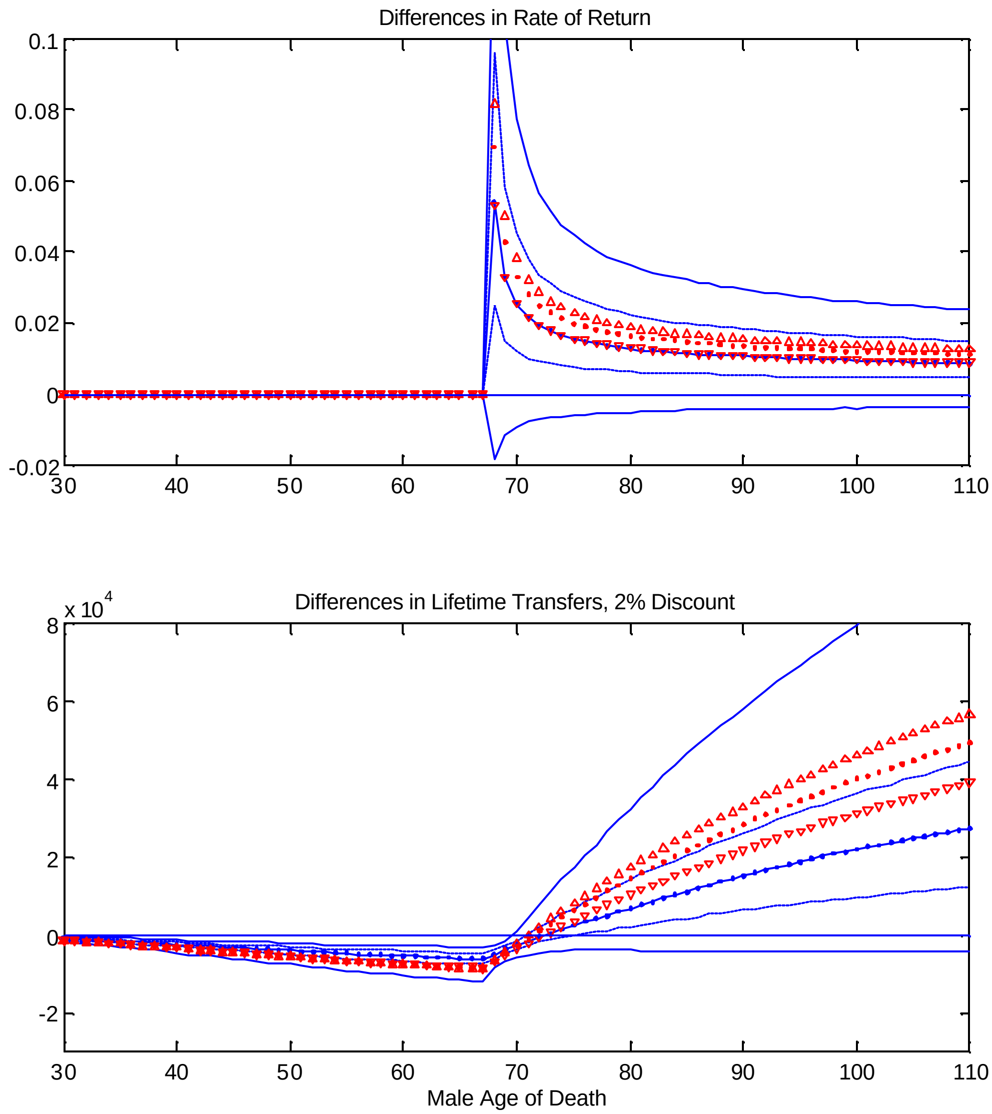
Rates of return are expressed in decimal form, i.e. 0.1 = 10% ROR. In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. Each line represents the median stochastic forecast for the given group.

Figure 2c
Difference between Adjusting the COLA Downward by up to 1% and Increasing the Normal Retirement Age
Net Lifetime Transfers, 2% Discount



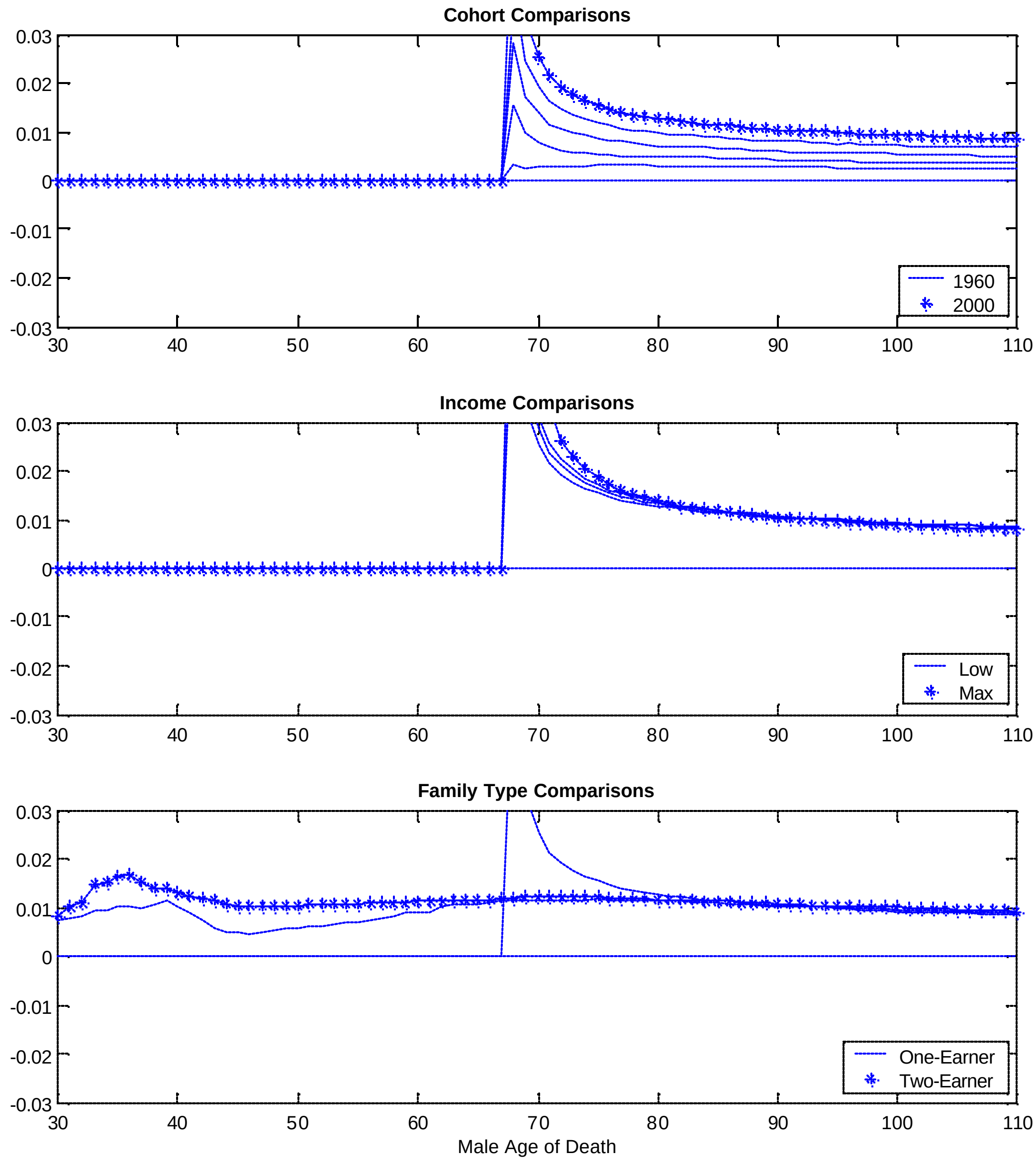
In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. Each line represents the median stochastic forecast for the given group.

Figure 3a
Difference between Increasing the Payroll Tax by 1.86%
and Computing Benefits with Price Indexing
Low-Income Single Males of the 2000 Birth Cohort



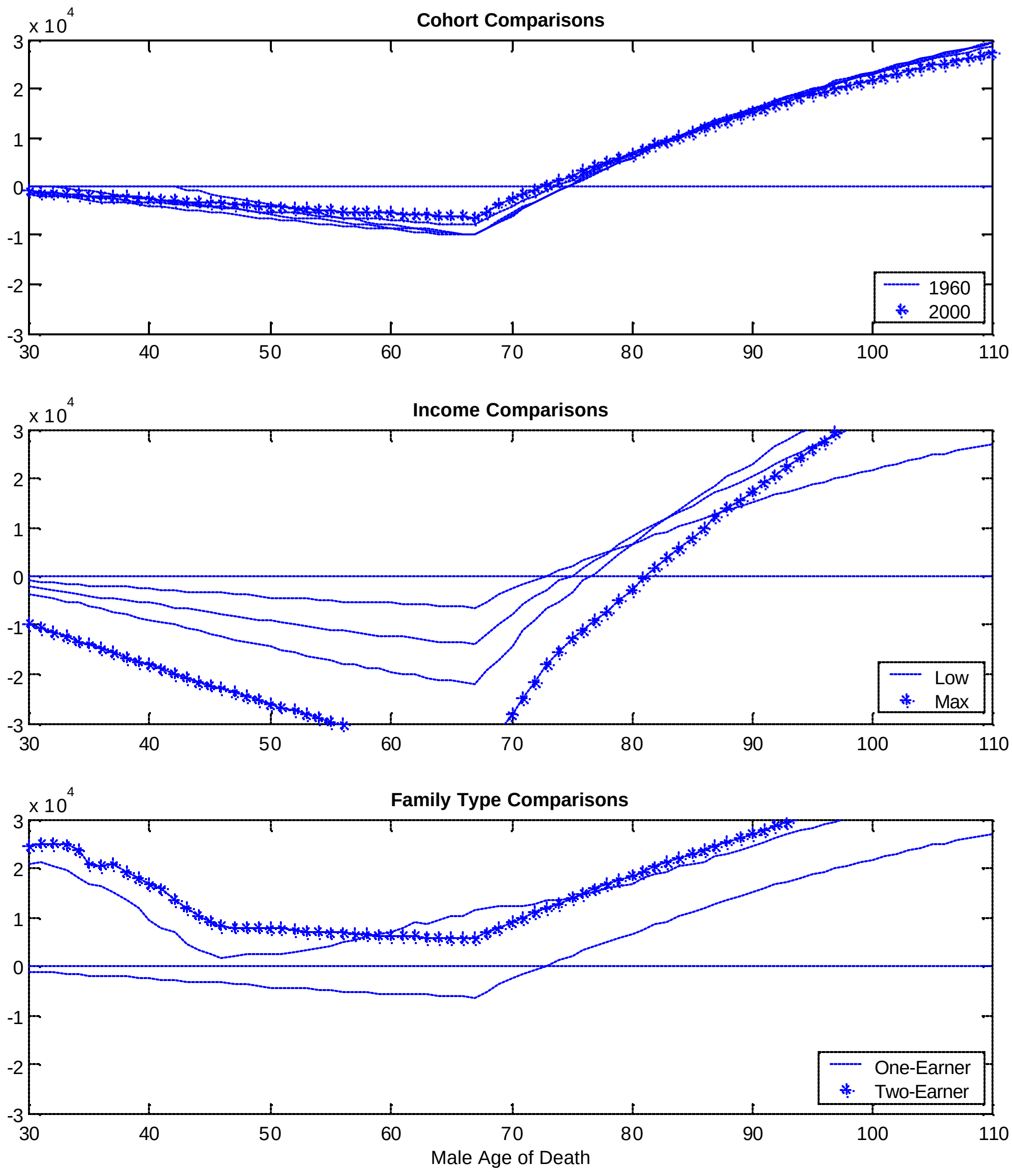
Rates of return are expressed in decimal form, i.e. 0.1 = 10% ROR. In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. The graphs present both the stochastic forecasts and the SSA deterministic forecasts. For the stochastic forecasts, the dotted line is the median quantile, the two dashed lines are the 25% and 75% quantiles, and the solid lines are the 5% and 95% quantiles. For the SSA forecasts, the dots represent the best case scenario, the upper triangles are optimistic case, and the lower triangles are the pessimistic case.

Figure 3b
Difference between Increasing the Payroll Tax by 1.86%
and Computing Benefits with Price Indexing
Rates of Return



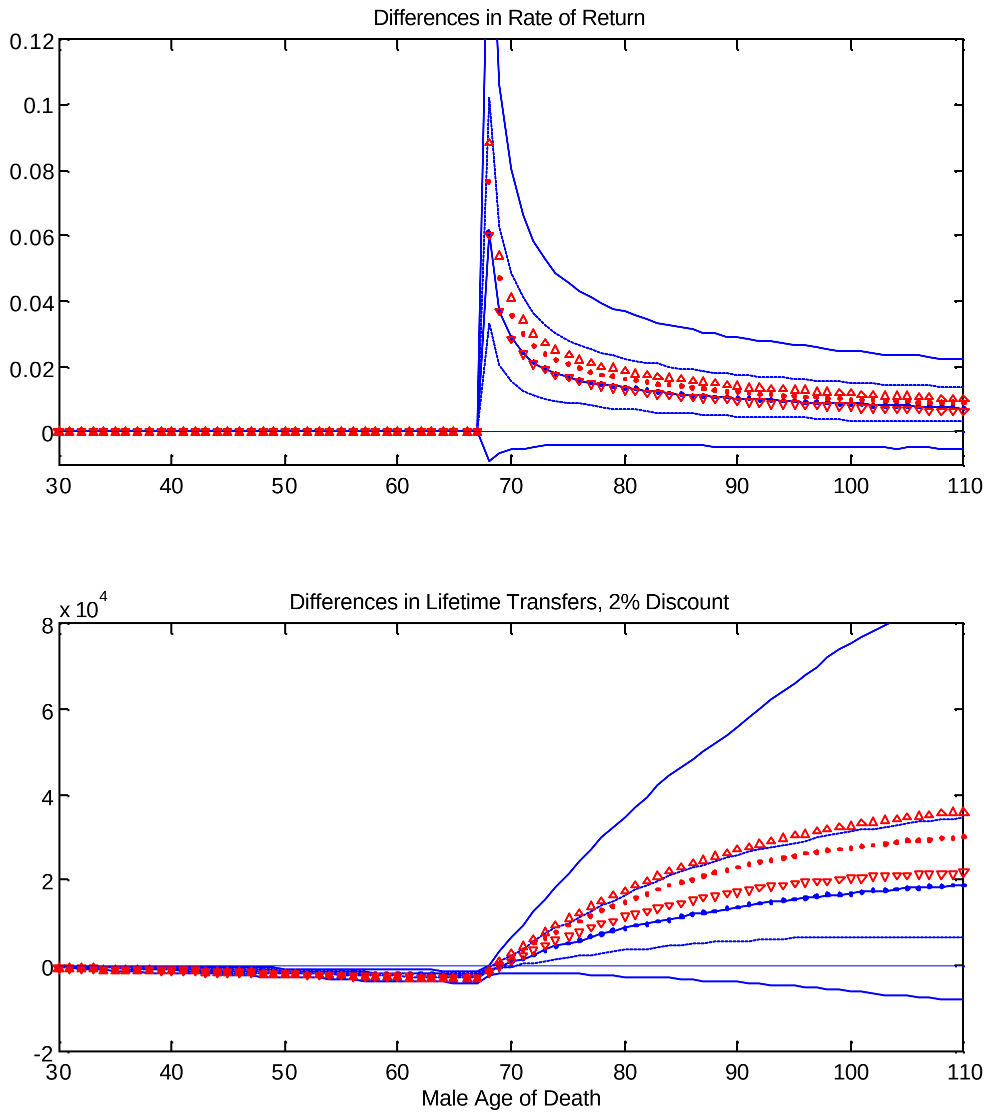
Rates of return are expressed in decimal form, i.e. 0.1 = 10% ROR. In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. Each line represents the median stochastic forecast for the given group.

Figure 3c
Difference between Increasing the Payroll Tax by 1.86%
and Computing Benefits with Price Indexing
Net Lifetime Transfers, 2% Discount



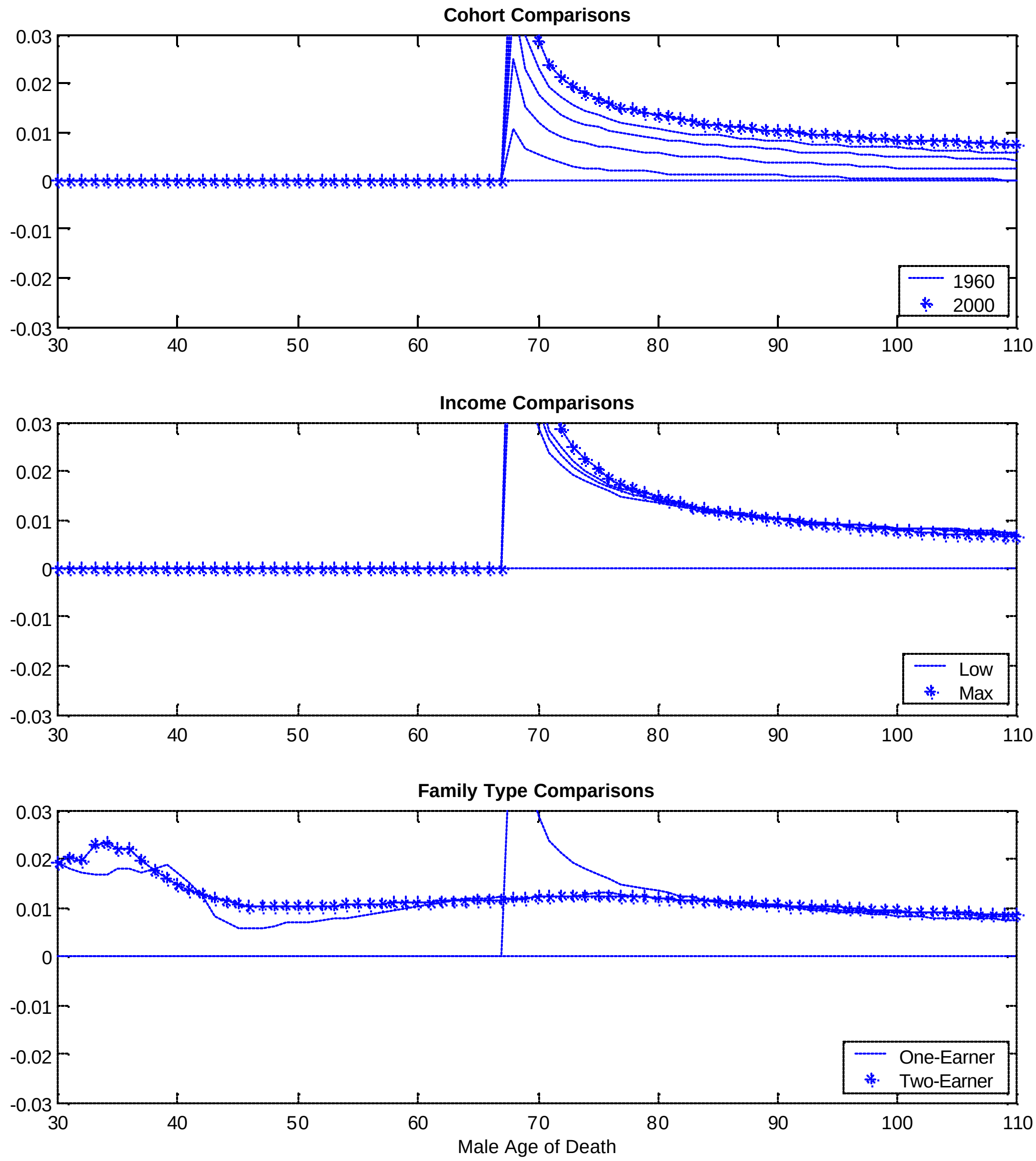
In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. Each line represents the median stochastic forecast for the given group.

Figure 4a
Difference between Adjusting the COLA Downward by up to 1% and Computing Benefits with Price Indexing
Low-Income Single Males of the 2000 Birth Cohort



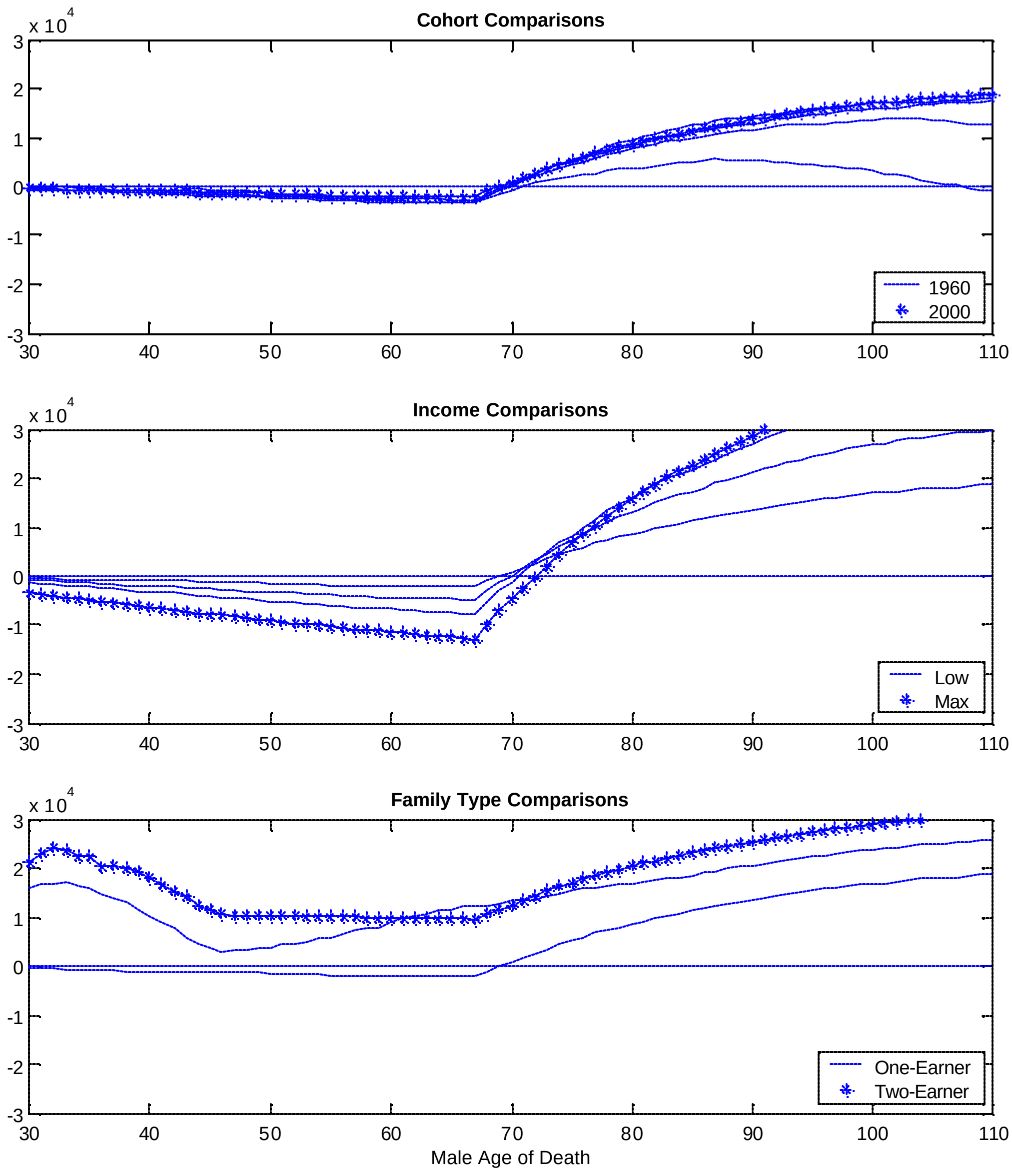
Rates of return are expressed in decimal form, i.e. 0.1 = 10% ROR. In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. The graphs present both the stochastic forecasts and the SSA deterministic forecasts. For the stochastic forecasts, the dotted line is the median quantile, the two dashed lines are the 25% and 75% quantiles, and the solid lines are the 5% and 95% quantiles. For the SSA forecasts, the dots represent the best case scenario, the upper triangles are optimistic case, and the lower triangles are the pessimistic case.

Figure 4b
Difference between Adjusting the COLA Downward by up to 1% and Computing Benefits with Price Indexing
Rates of Return



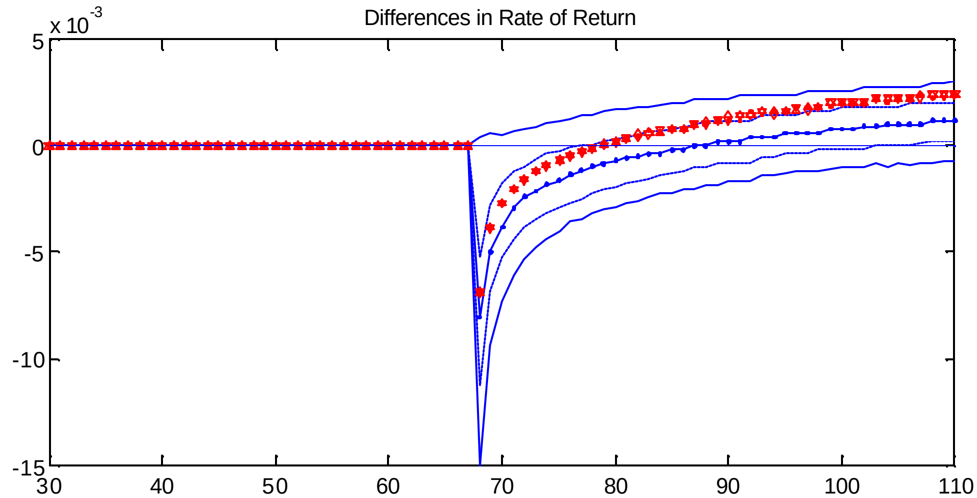
Rates of return are expressed in decimal form, i.e. 0.1 = 10% ROR. In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. Each line represents the median stochastic forecast for the given group.

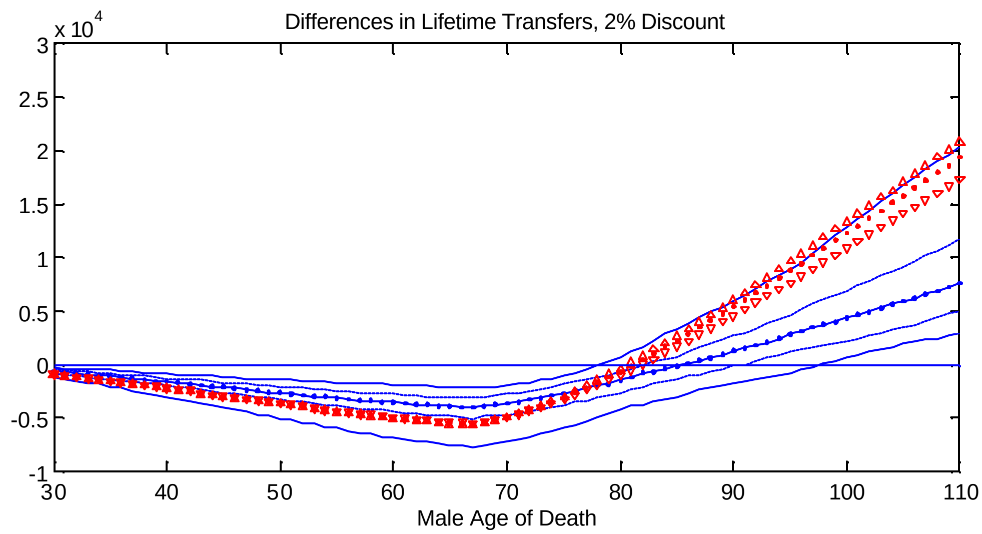
Figure 4c
Difference between Adjusting the COLA Downward by up to 1% and Computing Benefits with Price Indexing
Net Lifetime Transfers, 2% Discount



In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. Each line represents the median stochastic forecast for the given group.

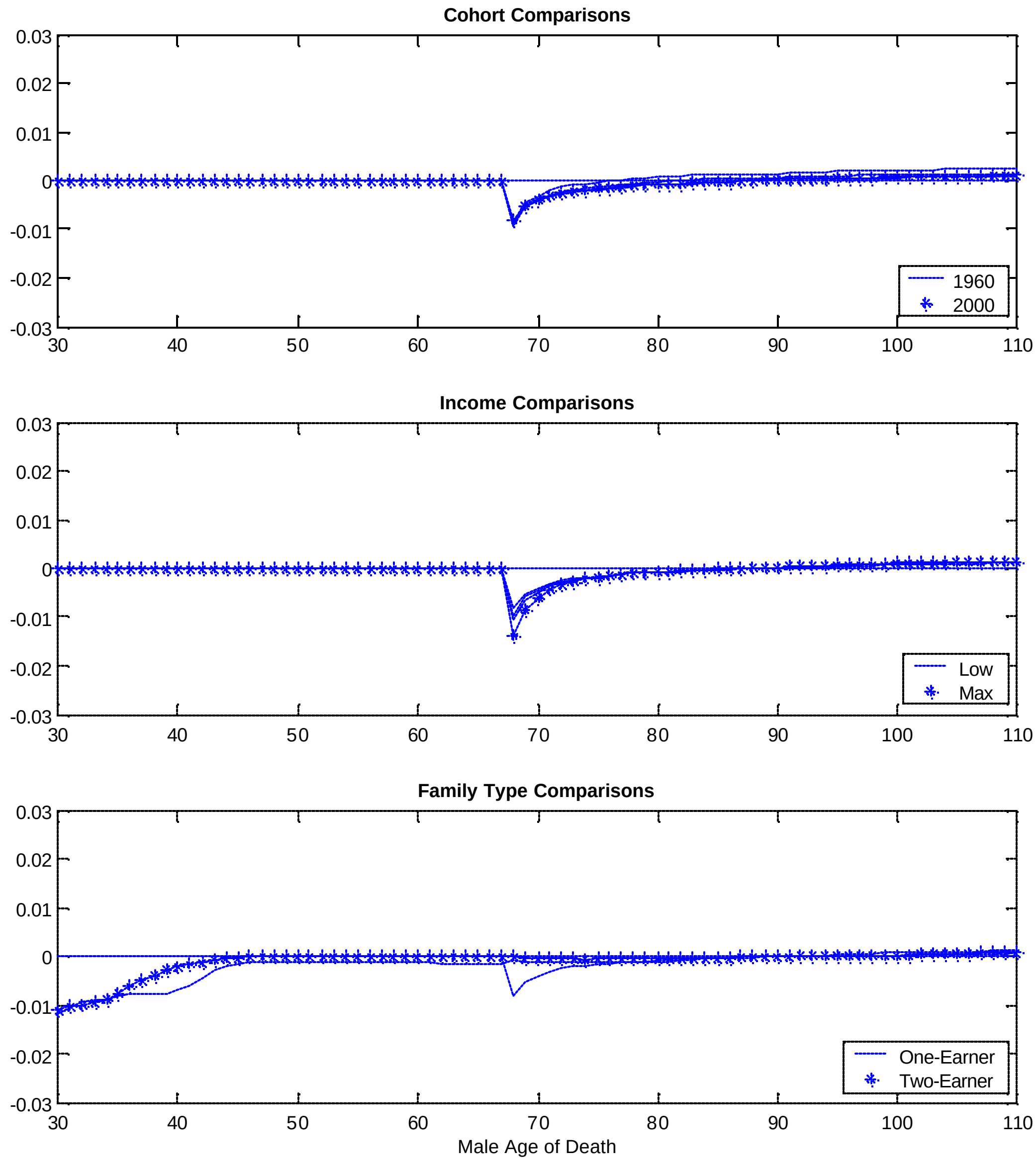
Figure 5a
Difference between Increasing the Payroll Tax by 1.86%
and Adjusting the COLA Downward by up to 1%
Low-Income Single Males of the 2000 Birth Cohort





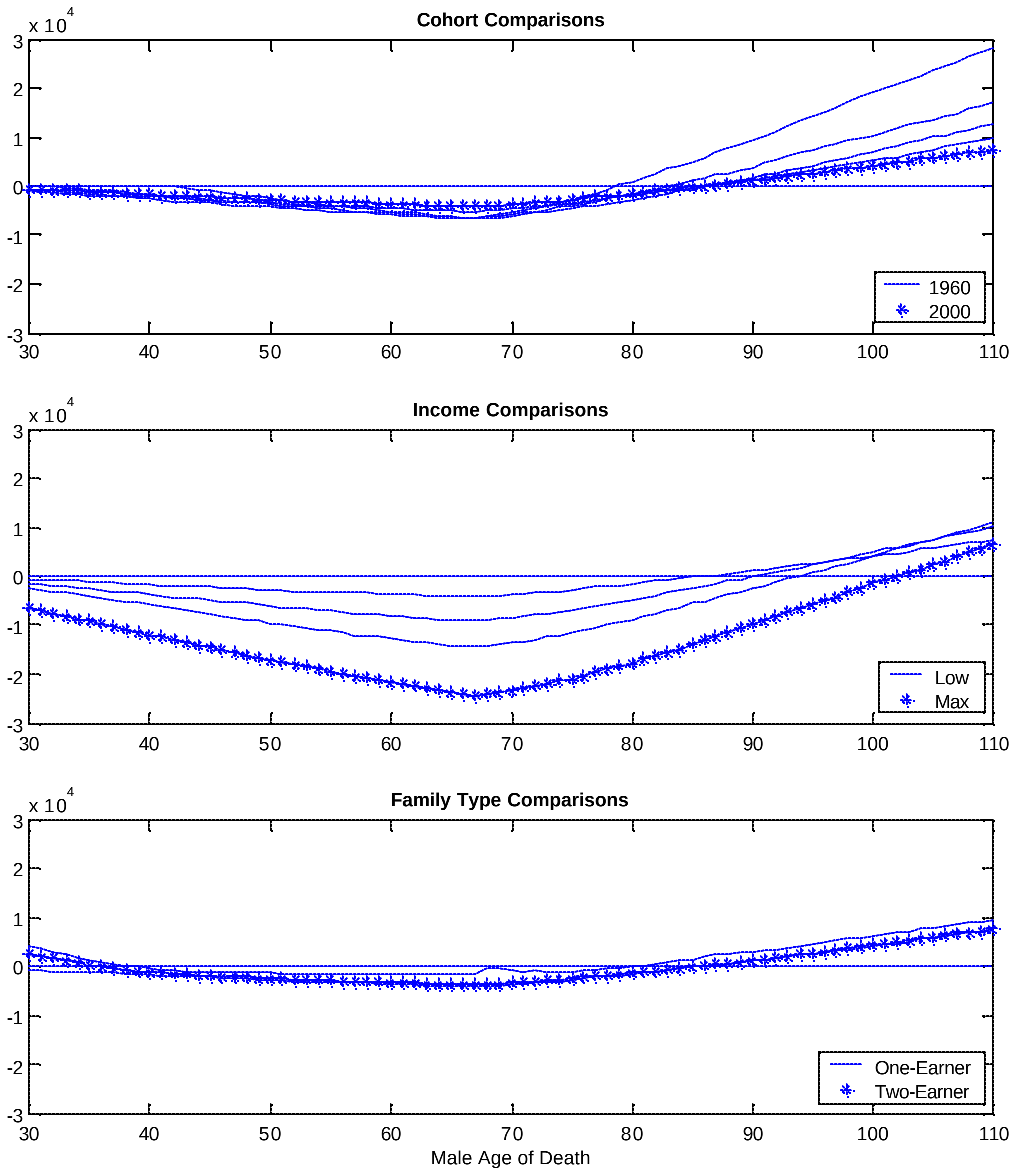
Rates of return are expressed in decimal form, i.e. 0.1 = 10% ROR. In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. The graphs present both the stochastic forecasts and the SSA deterministic forecasts. For the stochastic forecasts, the dotted line is the median quantile, the two dashed lines are the 25% and 75% quantiles, and the solid lines are the 5% and 95% quantiles. For the SSA forecasts, the dots represent the best case scenario, the upper triangles are optimistic case, and the lower triangles are the pessimistic case.

Figure 5b
Difference between Increasing the Payroll Tax by 1.86%
and Adjusting the COLA Downward by up to 1%
Rates of Return



Rates of return are expressed in decimal form, i.e. 0.1 = 10% ROR. In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. Each line represents the median stochastic forecast for the given group.

Figure 5c
Difference between Increasing the Payroll Tax by 1.86%
and Adjusting the COLA Downward by up to 1%
Net Lifetime Transfers, 2% Discount



In each graph, points above horizontal axis favor the first reform listed in the title, and vice versa. Each line represents the median stochastic forecast for the given group.

Table 1
Estimates for the VAR(2) Macroeconomic Variables

Dependent Variable	Long-run Constraint		Autoregressive Parameters							
			CPI-W		AWI		S&P 500		Bond Index	
			lag 1	lag 2	lag 1	lag 2	lag 1	lag 2	lag 1	lag 2
CPI-W	**3.30%**	Estimate	**1.10**	0.11	**0.59**	0.21	0.00	-0.02	-0.44	**0.55**
		Std Error	(0.27)	(0.29)	(0.14)	(0.14)	(0.02)	(0.02)	(0.30)	(0.26)
AWI	**1.00%**	Estimate	**-1.12**	0.50	-0.24	-0.17	-0.01	0.00	-0.43	0.18
		Std Error	(0.40)	(0.43)	(0.20)	(0.20)	(0.03)	(0.02)	(0.44)	(0.39)
S&P 500	**6.55%**	Estimate	-2.81	-0.57	**-2.89**	0.04	-0.14	-0.25	2.35	-1.84
		Std Error	(2.84)	(3.05)	(1.42)	(1.45)	(0.18)	(0.18)	(3.13)	(2.76)
Bond Index	**3.11%**	Estimate	-0.20	0.10	**-0.37**	**-0.30**	0.01	**0.02**	**0.81**	-0.15
		Std Error	(0.24)	(0.26)	(0.12)	(0.12)	(0.02)	(0.01)	(0.27)	(0.24)

Variance Covariance Parameters				
	CPI-W	AWI	S&P 500	Bond Index
CPI-W	2.19	-2.05	-13.34	-1.71
AWI	-2.05	4.55	21.31	1.63
S&P 500	-13.34	21.31	244.79	10.74
Bond Index	-1.71	1.63	10.74	1.78

Constraints represent the real long-run constraints applied to the data, except for CPI-W. The CPI-W and AWI constraints are those found in the 2001 *Trustees Report*. The S&P500 and Bond constraints are equal to the means of the historical data. Coefficients in boldface are significant with 90% confidence.

Table 2
Effects of Reform Proposals on the Actuarial Balance of the Social Security Trust Funds

Reform	Percent of 75-year deficit eliminated	Average 75-year reduction (as % of taxable payroll)
current system	0%	0.00%
payroll tax increase, 1.86%	100%	1.86%
decrease COLA	73%	1.35%
increase normal retirement age to 70	62%	1.34%
price indexing	100%	2.06%

Source: Koitz et al. (2001)

Table 3
Median Rates of Return and Lifetime Transfers (x $1,000) for Workers Low-Income Single Males, Comparisons Across Reforms

	Tax ?	COLA	NRA	Price Ind.	Tax ?	COLA	NRA	Price Ind.
Levels	**1.27%**	**1.17%**	**0.63%**	**1.03%**	**-$21**	**-$23**	**-$37**	**-$25**
	(0.44%)	**(0.50%)**	**(0.42%)**	**(0.35%)**	**($12)**	**($13)**	**($9)**	**($8)**
Tax Increase	---	0.13%	0.65%	0.28%	---	$2	$16	$5
	---	(0.13%)	(0.12%)	(0.46%)	---	($3)	($4)	($12)
COLA	-0.13%	---	0.54%	0.11%	-$2	---	$14	$2
	(0.13%)	---	(0.17%)	(0.47%)	($3)	---	($5)	($12)
Levels	**1.26%**	**1.20%**	**0.68%**	**0.79%**	**-$16**	**-$15**	**-$26**	**-$22**
	(0.48%)	**(0.53%)**	**(0.44%)**	**(0.44%)**	**($9)**	**($9)**	**($7)**	**($7)**
Tax Increase	---	0.05%	0.59%	0.43%	---	$0	$10	$5
	---	(0.12%)	(0.13%)	(0.64%)	---	($2)	($4)	($11)
COLA	-0.05%	---	0.54%	0.42%	$0	---	$10	$6
	(0.12%)	---	(0.18%)	(0.64%)	($2)	---	($4)	($11)
Levels	**1.27%**	**1.25%**	**0.76%**	**0.58%**	**-$14**	**-$13**	**-$21**	**-$21**
	(0.48%)	**(0.52%)**	**(0.43%)**	**(0.53%)**	**($8)**	**($8)**	**($6)**	**($8)**
Tax Increase	---	0.00%	0.51%	0.63%	---	-$2	$7	$6
	---	(0.12%)	(0.13%)	(0.79%)	---	($2)	($3)	($12)
COLA	0.00%	---	0.51%	0.68%	$2	---	$9	$8
	(0.12%)	---	(0.17%)	(0.79%)	($2)	---	($4)	($12)
Levels	**1.28%**	**1.28%**	**0.82%**	**0.40%**	**-$10**	**-$8**	**-$15**	**-$17**
	(0.48%)	**(0.52%)**	**(0.44%)**	**(0.67%)**	**($7)**	**($7)**	**($6)**	**($9)**
Tax Increase	---	0.01%	0.50%	0.85%	---	-$1	$5	$7
	---	(0.11%)	(0.12%)	(0.94%)	---	($1)	($3)	($12)
COLA	-0.01%	---	0.50%	0.86%	$1	---	$7	$7
	(0.11%)	---	(0.17%)	(0.93%)	($1)	---	($3)	($12)
Levels	**1.45%**	**1.40%**	**0.92%**	**0.18%**	**-$7**	**-$6**	**-$12**	**-$15**
	(0.46%)	**(0.51%)**	**(0.42%)**	**(0.80%)**	**($6)**	**($6)**	**($6)**	**($11)**
Tax Increase	---	0.01%	0.49%	1.09%	---	-$1	$5	$7
	---	(0.13%)	(0.12%)	(1.01%)	---	($1)	($3)	($12)
COLA	-0.01%	---	0.48%	1.06%	$1	---	$5	$8
	(0.13%)	---	(0.18%)	(1.01%)	($1)	---	($3)	($11)

For each cohort, the numbers in boldface are the rates of return and net lifetime transfers (and their standard errors in parentheses beneath) of the hypothetical worker under the reform proposal listed horizontally. The second and third rows of each birth cohort show the median difference between the reform on the left and the reform above, and the standard errors are in parentheses. In other words, positive numbers indicate that the reform on the left provides higher money's worth measures, and negative numbers favor the reform listed above.

Table 4
Median Rates of Return and Lifetime Transfers (x $1,000) for Workers High-Income Single Males, Comparisons Across Reforms

	Tax ?	COLA	NRA	Price Ind.	Tax ?	COLA	NRA	Price Ind.
Levels	**-0.34% (0.44%)**	**-0.45% (0.50%)**	**-0.98% (0.42%)**	**-0.57% (0.38%)**	**-$190 ($25)**	**-$186 ($27)**	**-$225 ($19)**	**-$187 ($22)**
Tax Increase	--- ---	0.13% (0.13%)	0.64% (0.12%)	0.25% (0.47%)	--- ---	-$3 ($6)	$36 ($10)	-$1 ($26)
COLA	-0.13% (0.13%)	--- ---	0.53% (0.17%)	0.09% (0.48%)	$3 ($6)	--- ---	$39 ($11)	$0 ($26)
Levels	**-0.32% (0.47%)**	**-0.40% (0.53%)**	**-0.92% (0.44%)**	**-0.78% (0.48%)**	**-$139 ($18)**	**-$131 ($19)**	**-$160 ($15)**	**-$140 ($22)**
Tax Increase	--- ---	0.06% (0.13%)	0.59% (0.13%)	0.43% (0.66%)	--- ---	-$9 ($4)	$20 ($8)	$0 ($24)
COLA	-0.06% (0.13%)	--- ---	0.54% (0.18%)	0.41% (0.66%)	$9 ($4)	--- ---	$29 ($9)	$9 ($24)
Levels	**-0.28% (0.46%)**	**-0.32% (0.51%)**	**-0.80% (0.42%)**	**-0.99% (0.58%)**	**-$120 ($17)**	**-$109 ($17)**	**-$134 ($16)**	**-$124 ($27)**
Tax Increase	--- ---	0.02% (0.13%)	0.52% (0.13%)	0.65% (0.81%)	--- ---	-$12 ($4)	$13 ($8)	$0 ($25)
COLA	-0.02% (0.13%)	--- ---	0.50% (0.17%)	0.68% (0.81%)	$12 ($4)	--- ---	$25 ($9)	$12 ($25)
Levels	**-0.24% (0.46%)**	**-0.27% (0.51%)**	**-0.73% (0.43%)**	**-1.18% (0.73%)**	**-$91 ($23)**	**-$80 ($22)**	**-$101 ($25)**	**-$96 ($34)**
Tax Increase	--- ---	0.03% (0.12%)	0.51% (0.13%)	0.87% (0.96%)	--- ---	-$8 ($3)	$9 ($7)	$4 ($25)
COLA	-0.03% (0.12%)	--- ---	0.49% (0.17%)	0.86% (0.96%)	$8 ($3)	--- ---	$18 ($8)	$13 ($25)
Levels	**-0.10% (0.45%)**	**-0.16% (0.50%)**	**-0.61% (0.41%)**	**-1.36% (0.86%)**	**-$70 ($30)**	**-$64 ($27)**	**-$79 ($33)**	**-$82 ($43)**
Tax Increase	--- ---	0.03% (0.14%)	0.50% (0.12%)	1.12% (1.03%)	--- ---	-$7 ($4)	$8 ($6)	$8 ($23)
COLA	-0.03% (0.14%)	--- ---	0.47% (0.17%)	1.07% (1.03%)	$7 ($4)	--- ---	$15 ($9)	$15 ($24)

For each cohort, the numbers in boldface are the rates of return and net lifetime transfers (and their standard errors in parentheses beneath) of the hypothetical worker under the reform proposal listed horizontally. The second and third rows of each birth cohort show the median difference between the reform on the left and the reform above, and the standard errors are in parentheses. In other words, positive numbers indicate that the reform on the left provides higher money's worth measures, and negative numbers favor the reform listed above.

Table 5
Median Rates of Return and Lifetime Transfers (x $1,000) for Workers
Low-Income Single Females, Comparisons Across Reforms

	Tax ?	COLA	NRA	Price Ind.	Tax ?	COLA	NRA	Price Ind.
Levels	**2.01% (0.44%)**	**1.87% (0.49%)**	**1.45% (0.41%)**	**1.75% (0.34%)**	**$0 ($17)**	**-$4 ($17)**	**-$18 ($13)**	**-$8 ($11)**
Tax Increase	--- ---	0.16% (0.12%)	0.55% (0.11%)	0.28% (0.44%)	--- ---	$5 ($4)	$18 ($5)	$9 ($16)
COLA	-0.16% (0.12%)	--- ---	0.41% (0.16%)	0.10% (0.45%)	-$5 ($4)	--- ---	$13 ($6)	$3 ($16)
Levels	**1.94% (0.47%)**	**1.85% (0.52%)**	**1.46% (0.44%)**	**1.48% (0.41%)**	**-$2 ($13)**	**-$3 ($13)**	**-$13 ($10)**	**-$11 ($9)**
Tax Increase	--- ---	0.08% (0.12%)	0.49% (0.12%)	0.42% (0.61%)	--- ---	$1 ($3)	$11 ($4)	$9 ($15)
COLA	-0.08% (0.12%)	--- ---	0.41% (0.17%)	0.38% (0.62%)	-$1 ($3)	--- ---	$10 ($4)	$8 ($14)
Levels	**1.91% (0.47%)**	**1.88% (0.52%)**	**1.51% (0.43%)**	**1.26% (0.49%)**	**-$2 ($11)**	**-$2 ($11)**	**-$10 ($8)**	**-$13 ($9)**
Tax Increase	--- ---	0.02% (0.12%)	0.42% (0.12%)	0.61% (0.75%)	--- ---	$0 ($3)	$8 ($4)	$10 ($16)
COLA	-0.02% (0.12%)	--- ---	0.39% (0.17%)	0.63% (0.76%)	$0 ($3)	--- ---	$8 ($4)	$10 ($15)
Levels	**1.91% (0.47%)**	**1.88% (0.51%)**	**1.55% (0.44%)**	**1.06% (0.63%)**	**-$1 ($10)**	**-$2 ($10)**	**-$7 ($8)**	**-$12 ($9)**
Tax Increase	--- ---	0.02% (0.11%)	0.40% (0.12%)	0.81% (0.89%)	--- ---	$0 ($2)	$6 ($4)	$10 ($16)
COLA	-0.02% (0.11%)	--- ---	0.38% (0.16%)	0.79% (0.89%)	$0 ($2)	--- ---	$6 ($3)	$9 ($15)
Levels	**2.06% (0.46%)**	**1.99% (0.50%)**	**1.62% (0.42%)**	**0.83% (0.75%)**	**$1 ($8)**	**$0 ($8)**	**-$4 ($6)**	**-$11 ($11)**
Tax Increase	--- ---	0.04% (0.13%)	0.40% (0.11%)	1.04% (0.96%)	--- ---	$0 ($2)	$5 ($3)	$10 ($15)
COLA	-0.04% (0.13%)	--- ---	0.36% (0.17%)	0.99% (0.96%)	$0 ($2)	--- ---	$5 ($4)	$10 ($14)

For each cohort, the numbers in boldface are the rates of return and net lifetime transfers (and their standard errors in parentheses beneath) of the hypothetical worker under the reform proposal listed horizontally. The second and third rows of each birth cohort show the median difference between the reform on the left and the reform above, and the standard errors are in parentheses. In other words, positive numbers indicate that the reform on the left provides higher money's worth measures, and negative numbers favor the reform listed above.

Table 6
Median Rates of Return and Lifetime Transfers (x $1,000) for Workers
High-Income Single Females, Comparisons Across Reforms

	Tax ?	COLA	NRA	Price Ind.	Tax ?	COLA	NRA	Price Ind.
Levels	**0.46%** **(0.43%)**	**0.32%** **(0.49%)**	**-0.07%** **(0.41%)**	**0.23%** **(0.36%)**	**-$149** **($34)**	**-$151** **($35)**	**-$190** **($26)**	**-$155** **($26)**
Tax Increase	--- ---	0.16% (0.13%)	0.53% (0.11%)	0.25% (0.45%)	--- ---	$3 ($8)	$40 ($12)	$6 ($35)
COLA	-0.16% (0.13%)	--- ---	0.38% (0.16%)	0.07% (0.46%)	-$3 ($8)	--- ---	$38 ($13)	$2 ($34)
Levels	**0.43%** **(0.46%)**	**0.33%** **(0.52%)**	**-0.05%** **(0.43%)**	**-0.01%** **(0.45%)**	**-$111** **($24)**	**-$108** **($25)**	**-$134** **($19)**	**-$120** **($25)**
Tax Increase	--- ---	0.08% (0.13%)	0.48% (0.12%)	0.41% (0.62%)	--- ---	-$5 ($6)	$23 ($9)	$7 ($31)
COLA	-0.08% (0.13%)	--- ---	0.40% (0.17%)	0.36% (0.63%)	$5 ($6)	--- ---	$28 ($10)	$13 ($31)
Levels	**0.44%** **(0.45%)**	**0.38%** **(0.50%)**	**0.04%** **(0.41%)**	**-0.24%** **(0.54%)**	**-$97** **($20)**	**-$90** **($20)**	**-$113** **($17)**	**-$109** **($29)**
Tax Increase	--- ---	0.04% (0.12%)	0.41% (0.12%)	0.61% (0.76%)	--- ---	-$9 ($5)	$15 ($9)	$9 ($32)
COLA	-0.04% (0.12%)	--- ---	0.36% (0.16%)	0.62% (0.77%)	$9 ($5)	--- ---	$24 ($9)	$17 ($32)
Levels	**0.44%** **(0.45%)**	**0.40%** **(0.50%)**	**0.07%** **(0.42%)**	**-0.44%** **(0.68%)**	**-$71** **($23)**	**-$64** **($22)**	**-$83** **($22)**	**-$86** **($35)**
Tax Increase	--- ---	0.05% (0.11%)	0.40% (0.12%)	0.82% (0.90%)	--- ---	-$6 ($4)	$11 ($8)	$12 ($32)
COLA	-0.05% (0.11%)	--- ---	0.36% (0.16%)	0.78% (0.90%)	$6 ($4)	--- ---	$17 ($8)	$17 ($32)
Levels	**0.57%** **(0.44%)**	**0.50%** **(0.49%)**	**0.16%** **(0.41%)**	**-0.62%** **(0.80%)**	**-$56** **($25)**	**-$51** **($24)**	**-$67** **($28)**	**-$74** **($42)**
Tax Increase	--- ---	0.06% (0.13%)	0.39% (0.11%)	1.05% (0.97%)	--- ---	-$4 ($4)	$10 ($7)	$14 ($30)
COLA	-0.06% (0.13%)	--- ---	0.34% (0.17%)	0.99% (0.97%)	$4 ($4)	--- ---	$14 ($9)	$19 ($30)

For each cohort, the numbers in boldface are the rates of return and net lifetime transfers (and their standard errors in parentheses beneath) of the hypothetical worker under the reform proposal listed horizontally. The second and third rows of each birth cohort show the median difference between the reform on the left and the reform above, and the standard errors are in parentheses. In other words, positive numbers indicate that the reform on the left provides higher money's worth measures, and negative numbers favor the reform listed above.

Table 7
Median Rates of Return and Lifetime Transfers (x $1,000) for Workers
Low-Income One-Earner Couples, Comparisons Across Reforms

	Tax ?	COLA	NRA	Price Ind.	Tax ?	COLA	NRA	Price Ind.
Levels	**4.74% (0.40%)**	**4.52% (0.45%)**	**4.36% (0.38%)**	**4.47% (0.29%)**	**$214 ($60)**	**$171 ($57)**	**$185 ($55)**	**$173 ($35)**
Tax Increase	--- ---	0.24% (0.11%)	0.36% (0.10%)	0.28% (0.37%)	--- ---	$42 ($13)	$30 ($13)	$45 ($50)
COLA	-0.24% (0.11%)	--- ---	0.14% (0.15%)	0.04% (0.38%)	-$42 ($13)	--- ---	-$12 ($16)	-$1 ($45)
Levels	**4.57% (0.44%)**	**4.43% (0.48%)**	**4.26% (0.41%)**	**4.16% (0.33%)**	**$143 ($47)**	**$116 ($44)**	**$123 ($42)**	**$99 ($24)**
Tax Increase	--- ---	0.14% (0.11%)	0.32% (0.11%)	0.40% (0.51%)	--- ---	$26 ($10)	$20 ($10)	$45 ($45)
COLA	-0.14% (0.11%)	--- ---	0.16% (0.15%)	0.27% (0.52%)	-$26 ($10)	--- ---	-$6 ($11)	$18 ($40)
Levels	**4.48% (0.45%)**	**4.42% (0.49%)**	**4.26% (0.41%)**	**3.96% (0.38%)**	**$117 ($45)**	**$98 ($41)**	**$104 ($40)**	**$71 ($19)**
Tax Increase	--- ---	0.08% (0.10%)	0.24% (0.10%)	0.52% (0.63%)	--- ---	$21 ($9)	$14 ($9)	$44 ($47)
COLA	-0.08% (0.10%)	--- ---	0.16% (0.15%)	0.46% (0.64%)	-$21 ($9)	--- ---	-$6 ($9)	$26 ($42)
Levels	**4.44% (0.46%)**	**4.34% (0.49%)**	**4.24% (0.42%)**	**3.70% (0.49%)**	**$87 ($46)**	**$70 ($40)**	**$76 ($40)**	**$45 ($17)**
Tax Increase	--- ---	0.08% (0.10%)	0.24% (0.10%)	0.70% (0.75%)	--- ---	$16 ($8)	$11 ($8)	$43 ($48)
COLA	-0.08% (0.10%)	--- ---	0.16% (0.14%)	0.61% (0.75%)	-$16 ($8)	--- ---	-$4 ($7)	$25 ($41)
Levels	**4.52% (0.44%)**	**4.42% (0.48%)**	**4.26% (0.41%)**	**3.49% (0.60%)**	**$72 ($44)**	**$57 ($38)**	**$63 ($38)**	**$29 ($17)**
Tax Increase	--- ---	0.10% (0.11%)	0.24% (0.10%)	0.88% (0.80%)	--- ---	$12 ($8)	$10 ($7)	$41 ($45)
COLA	-0.10% (0.11%)	--- ---	0.14% (0.15%)	0.79% (0.81%)	-$12 ($8)	--- ---	-$4 ($6)	$27 ($39)

For each cohort, the numbers in boldface are the rates of return and net lifetime transfers (and their standard errors in parentheses beneath) of the hypothetical worker under the reform proposal listed horizontally. The second and third rows of each birth cohort show the median difference between the reform on the left and the reform above, and the standard errors are in parentheses. In other words, positive numbers indicate that the reform on the left provides higher money's worth measures, and negative numbers favor the reform listed above.

Table 8
Median Rates of Return and Lifetime Transfers (x $1,000) for Workers High-Income One-Earner Couples, Comparisons Across Reforms

	Tax ?	COLA	NRA	Price Ind.	Tax ?	COLA	NRA	Price Ind.
Levels	**3.44%** **(0.39%)**	**3.22%** **(0.44%)**	**3.16%** **(0.37%)**	**3.22%** **(0.30%)**	**$307** **($126)**	**$226** **($121)**	**$240** **($113)**	**$230** **($77)**
Tax Increase	--- ---	0.24% (0.11%)	0.31% (0.09%)	0.25% (0.36%)	--- ---	$83 ($27)	$69 ($27)	$83 ($108)
COLA	-0.24% (0.11%)	--- ---	0.08% (0.14%)	-0.01% (0.38%)	-$83 ($27)	--- ---	-$13 ($32)	-$6 ($97)
Levels	**3.31%** **(0.42%)**	**3.16%** **(0.47%)**	**3.04%** **(0.39%)**	**2.93%** **(0.34%)**	**$201** **($96)**	**$149** **($89)**	**$153** **($84)**	**$116** **($54)**
Tax Increase	--- ---	0.16% (0.11%)	0.26% (0.10%)	0.37% (0.50%)	--- ---	$49 ($21)	$45 ($21)	$83 ($97)
COLA	-0.16% (0.11%)	--- ---	0.10% (0.15%)	0.22% (0.51%)	-$49 ($21)	--- ---	-$4 ($22)	$34 ($87)
Levels	**3.27%** **(0.42%)**	**3.12%** **(0.47%)**	**3.06%** **(0.39%)**	**2.72%** **(0.40%)**	**$162** **($88)**	**$128** **($80)**	**$130** **($77)**	**$70** **($46)**
Tax Increase	--- ---	0.10% (0.11%)	0.20% (0.10%)	0.50% (0.62%)	--- ---	$36 ($19)	$30 ($20)	$84 ($101)
COLA	-0.10% (0.11%)	--- ---	0.08% (0.14%)	0.40% (0.63%)	-$36 ($19)	--- ---	-$5 ($20)	$52 ($90)
Levels	**3.22%** **(0.43%)**	**3.08%** **(0.47%)**	**3.02%** **(0.40%)**	**2.48%** **(0.51%)**	**$117** **($85)**	**$86** **($75)**	**$94** **($74)**	**$33** **($41)**
Tax Increase	--- ---	0.12% (0.10%)	0.20% (0.10%)	0.68% (0.73%)	--- ---	$27 ($17)	$23 ($17)	$82 ($101)
COLA	-0.12% (0.10%)	--- ---	0.09% (0.14%)	0.58% (0.74%)	-$27 ($17)	--- ---	-$3 ($15)	$51 ($89)
Levels	**3.28%** **(0.42%)**	**3.13%** **(0.47%)**	**3.08%** **(0.39%)**	**2.28%** **(0.61%)**	**$97** **($74)**	**$73** **($65)**	**$78** **($63)**	**$14** **($41)**
Tax Increase	--- ---	0.12% (0.11%)	0.20% (0.09%)	0.85% (0.79%)	--- ---	$22 ($16)	$21 ($15)	$81 ($94)
COLA	-0.12% (0.11%)	--- ---	0.08% (0.15%)	0.73% (0.79%)	-$22 ($16)	--- ---	-$4 ($13)	$56 ($83)

For each cohort, the numbers in boldface are the rates of return and net lifetime transfers (and their standard errors in parentheses beneath) of the hypothetical worker under the reform proposal listed horizontally. The second and third rows of each birth cohort show the median difference between the reform on the left and the reform above, and the standard errors are in parentheses. In other words, positive numbers indicate that the reform on the left provides higher money's worth measures, and negative numbers favor the reform listed above.

Table 9
Median Rates of Return and Lifetime Transfers (x $1,000) for Workers
Low-Income Two -Earner Couples, Comparisons Across Reforms

	Tax ?	COLA	NRA	Price Ind.	Tax ?	COLA	NRA	Price Ind.
Levels	**3.42% (0.40%)**	**3.21% (0.45%)**	**3.08% (0.37%)**	**3.18% (0.30%)**	**$159 ($67)**	**$120 ($65)**	**$120 ($59)**	**$119 ($40)**
Tax Increase	--- ---	0.23% (0.11%)	0.36% (0.10%)	0.26% (0.38%)	--- ---	$41 ($15)	$41 ($16)	$45 ($59)
COLA	-0.23% (0.11%)	--- ---	0.12% (0.15%)	0.02% (0.39%)	-$41 ($15)	--- ---	$1 ($18)	$1 ($53)
Levels	**3.28% (0.43%)**	**3.14% (0.48%)**	**2.98% (0.40%)**	**2.88% (0.35%)**	**$104 ($51)**	**$79 ($48)**	**$76 ($44)**	**$59 ($29)**
Tax Increase	--- ---	0.14% (0.11%)	0.31% (0.11%)	0.38% (0.52%)	--- ---	$23 ($11)	$27 ($12)	$44 ($53)
COLA	-0.14% (0.11%)	--- ---	0.14% (0.15%)	0.26% (0.53%)	-$23 ($11)	--- ---	$3 ($13)	$22 ($48)
Levels	**3.24% (0.43%)**	**3.13% (0.48%)**	**3.01% (0.40%)**	**2.68% (0.41%)**	**$84 ($47)**	**$69 ($43)**	**$66 ($40)**	**$36 ($25)**
Tax Increase	--- ---	0.10% (0.11%)	0.24% (0.10%)	0.52% (0.64%)	--- ---	$17 ($10)	$19 ($11)	$45 ($55)
COLA	-0.10% (0.11%)	--- ---	0.14% (0.15%)	0.45% (0.65%)	-$17 ($10)	--- ---	$1 ($11)	$31 ($50)
Levels	**3.19% (0.44%)**	**3.08% (0.48%)**	**2.98% (0.41%)**	**2.43% (0.53%)**	**$62 ($46)**	**$46 ($40)**	**$48 ($39)**	**$16 ($22)**
Tax Increase	--- ---	0.10% (0.10%)	0.24% (0.10%)	0.70% (0.76%)	--- ---	$12 ($9)	$14 ($10)	$45 ($55)
COLA	-0.10% (0.10%)	--- ---	0.14% (0.14%)	0.62% (0.76%)	-$12 ($9)	--- ---	$1 ($8)	$29 ($49)
Levels	**3.28% (0.43%)**	**3.16% (0.47%)**	**3.04% (0.40%)**	**2.24% (0.63%)**	**$52 ($40)**	**$40 ($36)**	**$40 ($33)**	**$6 ($22)**
Tax Increase	--- ---	0.10% (0.12%)	0.24% (0.10%)	0.90% (0.82%)	--- ---	$10 ($8)	$12 ($9)	$44 ($52)
COLA	-0.10% (0.12%)	--- ---	0.12% (0.15%)	0.80% (0.82%)	-$10 ($8)	--- ---	$1 ($8)	$32 ($46)

For each cohort, the numbers in boldface are the rates of return and net lifetime transfers (and their standard errors in parentheses beneath) of the hypothetical worker under the reform proposal listed horizontally. The second and third rows of each birth cohort show the median difference between the reform on the left and the reform above, and the standard errors are in parentheses. In other words, positive numbers indicate that the reform on the left provides higher money's worth measures, and negative numbers favor the reform listed above.

Table 10
Median Rates of Return and Lifetime Transfers (x $1,000) for Workers High-Income Two-Earner Couples, Comparisons Across Reforms

	Tax ?	COLA	NRA	Price Ind.	Tax ?	COLA	NRA	Price Ind.
Levels	**2.14% (0.39%)**	**1.89% (0.45%)**	**1.83% (0.37%)**	**1.90% (0.31%)**	**$41 ($137)**	**-$29 ($135)**	**-$54 ($118)**	**-$29 ($91)**
Tax Increase	--- ---	0.25% (0.11%)	0.31% (0.09%)	0.24% (0.37%)	--- ---	$71 ($31)	$97 ($34)	$70 ($126)
COLA	-0.25% (0.11%)	--- ---	0.07% (0.14%)	-0.03% (0.39%)	-$71 ($31)	--- ---	$27 ($39)	-$8 ($116)
Levels	**2.00% (0.41%)**	**1.82% (0.47%)**	**1.73% (0.38%)**	**1.62% (0.36%)**	**-$1 ($98)**	**-$38 ($95)**	**-$58 ($83)**	**-$70 ($69)**
Tax Increase	--- ---	0.17% (0.11%)	0.27% (0.10%)	0.35% (0.51%)	--- ---	$34 ($23)	$58 ($27)	$70 ($112)
COLA	-0.17% (0.11%)	--- ---	0.09% (0.15%)	0.20% (0.52%)	-$34 ($23)	--- ---	$23 ($27)	$38 ($103)
Levels	**1.99% (0.41%)**	**1.82% (0.46%)**	**1.76% (0.38%)**	**1.44% (0.43%)**	**-$3 ($86)**	**-$31 ($80)**	**-$44 ($71)**	**-$85 ($68)**
Tax Increase	--- ---	0.12% (0.11%)	0.21% (0.10%)	0.51% (0.63%)	--- ---	$17 ($21)	$37 ($25)	$75 ($117)
COLA	-0.12% (0.11%)	--- ---	0.07% (0.15%)	0.41% (0.64%)	-$17 ($21)	--- ---	$18 ($24)	$58 ($107)
Levels	**1.94% (0.42%)**	**1.78% (0.47%)**	**1.74% (0.39%)**	**1.18% (0.54%)**	**-$9 ($78)**	**-$24 ($72)**	**-$36 ($65)**	**-$89 ($70)**
Tax Increase	--- ---	0.14% (0.10%)	0.21% (0.10%)	0.69% (0.74%)	--- ---	$14 ($17)	$27 ($22)	$75 ($116)
COLA	-0.14% (0.10%)	--- ---	0.08% (0.14%)	0.57% (0.75%)	-$14 ($17)	--- ---	$13 ($18)	$56 ($106)
Levels	**2.02% (0.41%)**	**1.85% (0.46%)**	**1.80% (0.38%)**	**1.02% (0.64%)**	**$1 ($59)**	**-$16 ($56)**	**-$23 ($49)**	**-$86 ($79)**
Tax Increase	--- ---	0.14% (0.12%)	0.21% (0.09%)	0.87% (0.80%)	--- ---	$12 ($16)	$24 ($19)	$76 ($107)
COLA	-0.14% (0.12%)	--- ---	0.06% (0.15%)	0.74% (0.80%)	-$12 ($16)	--- ---	$9 ($17)	$65 ($99)

For each cohort, the numbers in boldface are the rates of return and net lifetime transfers (and their standard errors in parentheses beneath) of the hypothetical worker under the reform proposal listed horizontally. The second and third rows of each birth cohort show the median difference between the reform on the left and the reform above, and the standard errors are in parentheses. In other words, positive numbers indicate that the reform on the left provides higher money's worth measures, and negative numbers favor the reform listed above.