The Intra-Generational Redistributive Effects of Social Security

Luis M. Cubeddu *

Universitat Pompeu Fabra

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Abstract

This paper provides a quantitative evaluation of the intra-cohort redistributive elements of the United States social security system in the context of a computable general equilibrium model. I determine how the well-being of individuals that differ across *gender, race* and *education* is affected by government social security policy. I find that females, whites and non-college graduates stand less to gain (lose) from reductions (increases) in the size of social security than males, non-whites and college graduates, respectively. Differences in mortality risk and labor productivity translate into differences in the magnitudes of capital accumulation and labor supply distortions, that are responsible for the observed welfare difference between types. Results imply that the current program is lifetime progressive across gender and education, yet lifetime regressive across race.

Keywords: Social Security, demographics, heterogeneity, redistribution, simulation.

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*Facultat de Ciéncies Económiques i Empresarials, Universitat Pompeu Fabra, Balmes 132, 08008 Barcelona, Spain (phone: 34-3-542-2673, fax: 34-3-542-2533, e-mail:cubeddu@upf.es). This is a revised version of the first chapter of my dissertation (University of Pennsylvania, 1995). I would like to thank Andrew Abel, Alan Auerbach and José-Víctor Ríos-Rull for very helpful discussion and guidance. I also would like to acknowledge participants at seminars at the University of Pennsylvania and the 1994 Latin American Econometric Society Meeting for helpful comments. The Boettner Institute provided financial support. As usual all disclaimers apply.

1 Introduction

A major question facing policy makers in most western economies is how best to guarantee a minimum level of support to it's growing elderly population. Future demographic outlook and recent slowdowns in economic growth have motivated the need to reevaluate the financial viability of public pension programs and the distribution of it's burden across generations. In addition, as unfunded pension schemes approach maturity the issue of how the tax burden is distributed between individuals belonging to the same generation has drawn increased attention. However, models that quantitatively explore the implications of government social security policy have almost exclusively focused on issues of inter-generational redistribution, disregarding altogether the intra-generational transfers that arise from large differences in life expectancy and labor productivity between individuals.

This paper aims to quantify the extent of intra-generational redistribution in the United States social security system.[1] I am particularly interested in studying how social security policy affects the well-being of individuals that differ across *gender*, *race* and *education*. For this purpose, I construct a general equilibrium, large overlapping generations (OG) economy where agents face uncertain longevity. Within the same age cohort types with different mortality probabilities and labor productivities coexist. Agents decide how much to work and how much to save in private assets for old age consumption. Retirement is mandatory and agents are not altruistically linked. The return to private savings and wages are determined by profit maximizing behavior of firms with standard neoclassical production technology. Government is responsible for administering the retirement insurance program. The program is pay-as-you-go and balanced budget, and incorporates many features of the United States social retirement system.

Related literature includes Auerbach & Kotlikoff (1987) who in an OG, general equilibrium, simulation model study the short and long-run implications of changes in social security policy. Imrohoroğlu, Imrohoroğlu, & Joines (1995) extend their model by assuming credit and insurance market imperfections and find that unfunded pension schemes may in certain cases enhance the steady state welfare of a dynamically efficient economy. However, both works disregard ex-ante differences in mortality risk and labor productivity between agents belonging to the same age cohort, and therefore are unable to quantify the extent of

[1] In this paper, social security is treated purely as a retirement insurance program. Survivor, disability and hospital insurance features are disregarded.

intra-generational redistribution inherent in unfunded pension schemes.[2] Perhaps, my work is closer in spirit to that of Fullerton & Rogers (1993), who quantify the distribution of the burden of the US tax system across 12 different life-time income groups. Unlike them, I categorize individuals of the same age according to gender, race and education. This allows me to consider not only differences in labor productivity but also differences in mortality probabilities. Finally, by focusing solely on the US social security program, I am able to model in detail many of the program's features.

In dynamically efficient economies, the return to unfunded pension schemes is less than the return to private savings. Since the program essentially forces an individual to substitute private assets for social security tax contributions, individuals will observe a welfare loss. The magnitude of the loss increases with the expected present value of the difference between the future income that could have been guaranteed by the displaced savings and the social security benefits. Given that the program does not discriminate on the basis of an individual's probability of dying early, the expected rate of return increases with an individual's life expectancy. In addition, a social pension program with a progressive tax-benefit link reward individuals with lower than average lifetime earnings, at the expense of those with higher than average lifetime earnings. The higher the return to social security the lower the observed welfare loss. Yet, comparing how the return to social security varies across individuals can help explain only part of the observed intra-cohort variability in well-being.

Differences in workers age-productivity profiles can also account for the variability in capital accumulation and labor supply inefficiencies brought about unfunded pension schemes.[3] The introduction of these programs will crowd out capital formation, cause interest rates to rise and wages to fall. The change in relative factor prices will encourage workers to increase labor effort and saving early in life, so to enjoy consumption and leisure later in life. Workers with later productivity peaks will not only observe a greater drop in the present value of their labor endowment, but will also find changes in their capital accumulation pattern and labor supply behavior more distortionary.

[2]In İmrohoroğlu et al. (1995), since agents cannot fully insure against unemployment risk, ex-post agents of the same age group may differ not only in their labor income but also in their asset holdings. The latter is due to differences in the employment history of individuals.

[3]Social security is financed through a payroll tax which distorts an individual's labor supply decision. The magnitude of the distortion is a function of both the age-specific net marginal tax rate and the shape of a worker's age-wage profile. Since agents in deciding how much to work perceive no linkage at the margin between social security benefits and taxes, marginal taxes will equal across types for all ages.

The benchmark economy, which attempts to approximate certain features of the US social security system, has an average replacement rate of labor income of 40%, a legal retirement age of 65, and a progressive tax-benefit formula. I simulate the steady state effects of eliminating social security on macroeconomic aggregates as well as the lifetime welfare of cohorts that differ in their gender, race and education. Results indicate that the steady welfare gain of doing away with the system is lower for females, whites and non-college graduates than for males, non-whites and college gradates, respectively.[4] They are on average 39.8% greater for males than females, 3.8% greater for non-whites than whites, and 9.1% greater for college graduates than non-college graduates. These results imply that the current system is lifetime progressive across gender and education, yet lifetime regressive across race. The latter result is sensitive to certain parameter specifications for preferences.

The remainder of the paper proceeds as follows. In Section 2 the economy's environment and competitive equilibrium are outlined. Section 3 describes the calibration procedures and section 4 outlines the algorithm solution. Welfare measures are defined in section 5. Results of policy experiments and sensitivity analysis are elaborated in section 6, while section 7 concludes and suggests extensions for further research.

2 The Model

The economy is inhabited by individuals that live a maximum of I periods each in overlapping generations. In each generation there are J agent types who differ according to life expectancy and labor productivity. The probability of surviving between age i and age $i+1$, for a type j agent is s_{ij}. Therefore, the unconditional probability of reaching age i for type j is $s^{ij} = \prod_{k=1}^{i-1} s_{kj}$. The share of age i, type j agents is denoted by μ_{ij}. All types grow at the exogenous rate λ_μ and population is to be stable in the sense that the cohort shares for each type are time-invariant.[5] This implies that the measure of all different types satisfy the following relationship:

[4]Since I am interested in evaluating the size of the intra-cohort redistribution inherent in the US social security system, I look at the gain or loss of each cohort relative to that of all other cohorts.

[5]A population's steady state growth rate is determined by its age-specific mortality and fertility rates (assuming these remain constant over time). If different agent types observe different survival probabilities, as is the case in this paper, in order for all types to grow at the same rate, fertility rates must also differ. Specifically, types with lower life expectancies have higher birth rates.

$$\mu_{i+1,j} = \frac{s_{ij}\mu_{ij}}{(1+\lambda_\mu)} \tag{1}$$

Time subscripts are ignored as the dynamic feature of the model is captured by the age subscript. Agents are endowed with one unit of time per period, that must be allocated between work and leisure. One unit of time of an age i, type j agent can be transformed into ε_{ij} exogenously given units of labor input.

2.1 Preferences

Preferences are given by the expected discounted utility of a time separable, twice continuously differentiable, strictly concave, utility function of leisure and a consumption good:

$$\sum_{i=1}^{I} \beta^{i-1} s^{ij} U(c_{ij}, l_{ij}) \tag{2}$$

where β is the annual discount rate, and c_{ij} and l_{ij} are respectively consumption and leisure, for an individual age i and type j. Every period earnings are divided between consumption and gross investment. Individuals accumulate assets to smooth consumption over time. In the presence of private annuities individuals can insure against mortality risk. These markets are established to avoid the issue of what to do with the assets of the deceased. Since the ex-ante mortality probability of each agent is public information, competitive insurers will offer annuities with different rates of return to agents with different life expectancies. I assume that agents of the same age cohort and type sign a contract in which survivors share assets of the agents that die. In this manner, next period's asset holdings are this period's savings divided by the probability of surviving. This implies that a type j agent faces the following budget constraint:

$$\begin{aligned} c_{ij} + y_{ij} &= Ra_{ij} + W(1 - l_{ij})\varepsilon_{ij}(1-\tau) + b_{ij} \\ y_{ij} &= a'_{i+1,j} s_{ij} \\ a_{1j} &= 0 \\ y_{I+1} &\geq 0 \end{aligned} \tag{3}$$

where a_{ij} is the accumulated net wealth, y_{ij} are the gross savings, b_{ij} are the retirement benefits, and $a'_{i+1,j}$ is next period's accumulated wealth, of an individual age i and type j. The return on asset holdings is R, the spot price of one unit of labor input in terms of the consumption good is W and the social security payroll tax is τ. Individuals retire at age I_R after which they rely on private savings and social security benefits for their old age consumption. Formally, $\varepsilon_{ij} = 0$, for $i \geq I_R$, and for all type j individuals. I assume workers in deciding how much to work perceive no linkage at the margin between social security benefits and taxes.

2.2 Technology

Firms maximize profits, taking factor and output prices as given. Technology is given by a neoclassical production function, $f(K, N)$, where K is the aggregate capital stock and N is the aggregate labor input. Capital depreciates at rate δ. Firms hire physical capital and effective labor until gross factor prices equal marginal products:

$$\begin{aligned} R &= f_1(K, N) + 1 - \delta \\ W &= f_2(K, N) \end{aligned} \tag{4}$$

2.3 Government

Government is responsible for administering the retirement insurance program. It levies a payroll tax on labor earnings to finance retirement transfers. The social security tax rate is the same for all those with labor earnings up to a maximum level, E^{max}. The system is pay-as-you-go and the budget is balanced each period, as revenues from payroll taxes equal outlays in the form of retirement benefits:

$$\sum_{j=1}^{J}\sum_{i=1}^{I} \mu_{ij} b_{ij} = \sum_{j=1}^{J}\sum_{i=1}^{I} \mu_{ij} \min\{W(1 - l_{ij})\varepsilon_{ij}\,;\, E^{max}\}\tau \tag{5}$$

Social security benefits correspond to a fixed proportion of an individual's lifetime average earnings. However, earnings of workers beyond the statutory maximum are not considered when computing an individual's average lifetime earnings. Earnings are indexed to account for labor productivity growth, λ_y. Wages prior to retirement age, I_R, are revalued so that they equal the wages of workers at the time they turned age $(I_R - 1)$. Average lifetime indexed earnings for an age i, type j individual is given by:

$$m_{ij} = \frac{\lambda_y^{I_R - 1 - i} \sum_{k=1}^{I_R - 1} \min\{W(1 - l_{kj})\varepsilon_{kj}\,;\, E^{max}\}}{(I_R - 1)} \tag{6}$$

Social security achieves it's progressivity not through graduated tax rates, but rather through the structure of benefits. The function relating retirement benefits and average lifetime earnings is highly redistributive, providing a much higher ratio of benefits to pre-retirement income to retirees with lower earnings history. Retirement benefits are given by:

$$b_{ij} = \begin{cases} 0 & for \quad i \in [1, ..., I_R - 1] \\ m_{ij}\eta(m_{ij}) & for \quad i \in [I_R, ..., I] \end{cases} \tag{7}$$

where $\eta(m_{ij})$ is the average earnings replacement rate for an age i, type j individual with average lifetime indexed earnings, m_{ij}. Government policy consist in announcing an average replacement rate, η_{avg}, a benefit formula, and setting taxes, such that the budget is balanced each period. I assume agents in the economy are atomistic in that they disregard the effect their labor supply decisions may have on the social security payroll tax.

2.4 Equilibrium

A competitive equilibrium corresponds to a feasible allocation and a set of factor prices, such that the individual's problem is solved for each generation, firms maximize profits, government balances it's budget and markets clear. Market clearing conditions for capital and labor markets are given by:

$$\begin{aligned} K &= \sum_{j=1}^{J}\sum_{i=1}^{I} \mu_{ij} a_{ij} \\ N &= \sum_{j=1}^{J}\sum_{i=1}^{I} \mu_{ij}(1 - l_{ij})\varepsilon_{ij} \end{aligned} \tag{8}$$

while the goods market clearing is:

$$\sum_{j=1}^{J}\sum_{i=1}^{I} \mu_{ij}(c_{ij} + y_{ij}) \leq f(K, N) + (1 - \delta)K \tag{9}$$

3 Model Parameterization and Calibration

3.1 Demographics

Agents are born into adulthood at age 20 and can live up to age 85, after which death is certain. The population is composed of 8 different lifetime cohorts that differ in gender, race and education. There are 2 gender types: male and female; 2 racial types: whites and non whites; and 2 education types: college and non-college educated. Lifetime cohorts differ in their life expectancy and labor productivity profile. To ensure a stable population, I assume that mortality rates remain constant over time and that all lifetime cohorts grow at the same constant exogenous rate. The assumption implicitly implies that that types with higher mortality risk observe higher birth rates.[6] Since I wish the stationary demographic structure of the model to match some general features of the current US population, I assume that the proportion of types at age 20 equals that found in the US for 1988.[7]

The annual rate of population growth, λ_μ, is assumed constant at 1.2%, which approximately correspond to the average US rate over the past 25 years. Age specific survival probabilities for education and gender are taken from the 1988 United States Vital Statistics Mortality Surveys. Mortality differences across educational groups achievement are taken from Elo & Preston (1992). They find that more educated cohorts, through greater access of material and informational resources such as diet, housing and health care service, will on average live longer. Surprisingly, education can help explain only about 18% of the mortality difference prevalent between whites and non-whites. Figures 3 and 4 show conditional survival probabilities for the different cohorts.

Age, gender and education specific labor productivities, ε, are compiled using CPS March demographic files for 1989-1991. The sample includes private sector employees, above the age of 19, not working in the agriculture sector. Earnings, for all different years were adjusted using the GDP deflator. For each age cohort and each individual type we compute per annum mean labor earnings and mean hours worked. Mean wages are calculated by simply dividing mean earnings by mean hours worked. The endowment of labor efficiency units is determined by dividing each cohort's average wage by the average wage of the selected sample. Figures 1 and 2 show how age-wage profiles differ according to gender, race and education. I use a polynomial of degree two in age to smooth the wage-age profile. The data show that females and non-college graduates reach their productivity peak before males and college graduates, respectively; early wage growth is considerably higher for college graduates than for non-college graduates; and for all ages whites earn higher wages than non-whites, even after controlling for education and gender.

Table 2 describes the demographic and economic characteristics of the population. We observe that females out-live males by an average of 5.1 years, yet their wages are 27.1% lower than those of males. Whites live on average 3.6 more years and have wages that are

[6]This condition is to some degree empirically satisfied. The data shows that while females, whites and college educated outlive males, non-whites, and non-college educated, the latter observe higher birth rates.

[7]While, the current US demographic structure is far from being stationary, as the proportion of non-whites and college educated people in the population has been increasing over time, the assumption allows for the existence of a stable population where different lifetime cohorts coexist.

13.6% higher than non-whites. Similarly, college graduates outlive non-college graduates by 0.8 years, and have wages that are on average 42.1% greater than wages of non-college graduates.

Since household composition changes significantly over the life-cycle due to marriage, divorce, death of spouse and number of dependents, I study the lifetime distributional impact of social security on single individuals rather than households. This approach is standard in models that study the life-cycle implications of tax policy (see Fullerton & Rogers (1993)). Therefore, I treat men and women as independent decision making units and disregard the intra-household resource allocation problem.[8]

3.2 Preferences and Technology

The expected lifetime utility of a type j agent is given by:

$$\sum_{i=1}^{I} \beta^{i-1} s^{ij} \frac{(c_{ij}^{\theta} l_{ij}^{1-\theta})^{1-\gamma}}{1-\gamma} \tag{10}$$

This functional form for preferences implies that the level of leisure is independent of productivity, and has the advantage that the parameters needed for it's calibration, β, θ, and γ, have been extensively studied in the literature. In addition, intertemporal separability of utility implies that leisure and consumption at different dates are net substitutes, and that the inverse of the degree of risk aversion equals the degree of intertemporal substitution.

All lifetime cohorts are endowed with the same preferences. The discount factor is normalized to account for productivity growth, λ_y, such that $\beta = \widehat{\beta}(1+\lambda_y)^{\frac{(1-\theta)}{(\gamma-1)}}$. The true discount factor, $\widehat{\beta}$, equals 1.011, and is taken from Hurd (1989) study of retired singles, where differences in mortality probabilities across gender and race are accounted for. Consistent with the Becker & Ghez (1975) finding that households allocate approximately one-third of their discretionary time to market activities, the consumption share parameter, θ, is 0.33. Given the stability of average hours worked since the second world war, the elasticity of substitution between consumption and leisure is taken to be 1. The risk aversion parameter, γ, or inverse of the intertemporal elasticity of substitution is 4. The choice represents a compromise between different life cycle models that explicitly account for leisure, and is

[8]Craig & Batina (1991) use a simple 2 period general equilibrium OG model to simulate the effect of spouse and retirement insurance on family labor supply. In their specification, households are used as welfare measuring units, since the marital status of the couple does not change over the lifecycle.

consistent with that used as in Auerbach & Kotlikoff (1987).[9] Different values for β and γ are chosen, as part of a sensitivity analysis.

Since factor shares of income have been constant over time, we chose a Cobb-Douglas production function, $f(K, N) = K^{\alpha} N^{1-\alpha}$. The value of the capital share parameter, α, depends on how the stock and flow of services from government capital and consumer durables; proprietors income and inventories are treated. Since my model contains no household production sector, no government investment and no explicit treatment of inventories, consistent with Cooley & Prescott (1995), I chose a value of 0.36. The depreciation rate, δ, is determined by the ratio of gross investment to capital, which according to National Income Accounts is approximately 0.76. The annual rate of productivity growth, λ_y, is assumed constant at 1.0%, which approximately correspond to the average US rate over the past 25 years. When I account for population growth and productivity growth, depreciation is 5.4 percent per annum.

3.3 Social Security

I treat social security purely as a retirement insurance program and disregard spouse, survivor, disability and health insurance features. Retirement benefits are indexed to labor productivity growth, the benefit structure is progressive and earnings are means tested. As dictated by current social security legislation, wages are revalued so that they equal the wages of workers at the time they turned 60. Individuals retire and receive social security benefits starting at age 65.[10]

Monthly social security benefits, known as the Primary Insurance Amount (PIA), are a function of the retired individual's Average Index Monthly Earnings (AIME).[11] Since the program achieves it's progressivity through the structure of benefits and not through graduated tax rates, benefits are structured so that the PIA increases with the AIME at a decreasing rate. The function relating the PIA to the AIME has three segments with sharply declining ratios of PIA to AIME. We calibrate these values using the legislation outlined in

[9]Given our preferences, the lower the degree of risk aversion, the less individuals care about consumption smoothing and the more willing are they are to substitute labor from periods of low wages to periods of high wages. In the presence of uncertainty, the lower the degree of risk aversion, the smaller the fraction of resources devoted to precautionary savings.

[10]Legislation passed in 1983 calls for a gradual increase in the age at which future retirees are able to receive full benefits. By 2022, the age will be 67.

[11]In computing an individual's AIME, I consider labor earnings for ages prior to retirement. Current legislation instead considers the highest 35 years of labor earnings.

the 1993 Social Security Handbook. The first \$401 of AIME entitled the retiree to a primary insurance of 90 cents per dollar of AIME. The next segment covered AIME values up to \$2420, where each dollar of AIME entitled the retiree 32 cents of benefits. Above that level, each dollar of AIME produced only 15% of primary insurance benefit. The average replacement rate to income in 1993 was approximately 45 percent and the average personal income close to \$1,920 per month. I define the replacement rate of an age i, type j individual with average annual lifetime earnings, $m_{i,j}$, as:

$$\eta(m_{ij}) = \begin{cases} 0 & for \quad i \in [1, I_R - 1] \\ \frac{\sum_{k=1}^{4} \pi_k \left(\min[m_{ij}; m_{k+1}^{bend}] - m_k^{bend} \right)}{m_{ij}} \eta_{avg} & for \quad i \in [I_R, ..., I] \end{cases} \tag{11}$$

where η_{avg} is the replacement rate for an individual with average labor earnings corresponding to m_{avg}. The fraction of primary insurance allowed per unit of AIME, between earnings bend points m_k^{bend} and m_{k+1}^{bend}, is defined as $\pi_k \eta_{avg}$.[12] Since earnings above \$4800 per month were not counted in computing a person's AIME, we calibrate E^{max} to equal 2.5 times the economy's average pre-tax labor earnings. Figure 5 relates the effective social security replacement rate to an individual's average annual lifetime.

4 Algorithm Description

The solution methodology, Gauss-Seidel method, is borrowed from Auerbach & Kotlikoff (1987). It involves solving a complicated set of non-linear equations that specify the households, firms and government optimization behavior. The algorithm starts with guesses for the capital to labor ratio, the age specific shadow wages and the social security tax rate. When the social security benefit formula is progressive we must also provide a guess for the economy's average labor earnings. Our capital to labor guess provides us with relative factor prices, which when combined with the shadow wage, social security tax rate and benefit formula allows us to solve for the optimal behavior of agents. The standard procedure in life cycle models is to go to the last period of an agent's life, where the future is no longer relevant, and solve for the behavior of the agent. In turn, this behavior would describe the nature of the future for agents of the previous age. The recursive nature of the problem allows us then to determine the behavior for agents of all ages.

[12] The bend points are as follows: $m_1^{bend} = 0$; $m_2^{bend} = 0.20 m_{avg}$; $m_3^{bend} = 1.25 m_{avg}$; $m_4^{bend} = 2.5 m_{avg}$. The fraction of PIA allowed per unit of AIME is calculated by multiplying the average replacement by π, where, $\pi_1 = 2.0$; $\pi_2 = 0.71$; $\pi_3 = 0.33$; $\pi_4 = 0.0$.

From the derived labor supply decisions we obtain new guesses for shadow wages. Aggregation of labor supply and saving decisions across all population subgroups provide us with a new guess for the capital to labor ratio. Using once more an agent's labor supply decisions we determine earnings for each type, and hence the new social security tax guess, from the government budget constraint.[13] Typically, 10-20 iterations are required to achieve convergence to a steady state equilibrium. The introduction of heterogeneity in age-cohort labor productivity and mortality risk only adds to the size and dimension of the problem in hand, but fundamentally does not alter the solution algorithm.

5 Measures of Welfare

Welfare for a type j individual, who faces a social security social security policy $\widehat{x}$, is defined as the expected discounted lifetime utility he derives from his optimal consumption and leisure contingency plan:

$$\Psi^j(\widehat{x}) = \sum_{i=1}^{I} \beta^{i-1} s^{ij} (c_{ij}(\widehat{x})^{\theta} l_{ij}(\widehat{x})^{1-\theta})^{1-\gamma} \tag{12}$$

The benchmark economy approximates the current social security program, where the average replacement rate to income is 40 percent, legal retirement age is 65, and the benefit formula is progressive. In order to quantify the welfare effects of departure from the benchmark economy, $\bar{x}$, I calculate the proportional increase or decrease in full life-time resources required to make an individual of type j indifferent between the benchmark economy and an alternative economy, $\widehat{x}$:

$$\Psi^j(\widehat{x}) = \sum_{i=1}^{I} \beta^{i-1} s^{ij} \{((1+\omega_j) c_{ij}(\bar{x}))^{\theta} ((1+\omega_j) l_{ij}(\bar{x}))^{1-\theta}\}^{1-\gamma} \tag{13}$$

Because the utility function is homothetic, an increase in an individual's wealth, provided factor prices are fixed, will bring about a proportional increases in the individual's lifetime consumption and leisure. To estimate the increase in resources required to make a type j individual, at birth, indifferent between the benchmark economy and the alternative economy, we solve for ω_j, such that:

$$\omega_j(\widehat{x}) = \{\frac{\Psi^j(\widehat{x})}{\Psi^j(\bar{x})}\}^{\frac{1}{(1-\gamma)}} - 1 \tag{14}$$

[13] Government announces an average replacement rate and benefit formula. Knowing how agents behave, it then sets a tax rate such that the budget is balanced each period.

The product of ω_j and an individuals expected present value of labor endowment, in the benchmark economy, represents the additional resources necessary to make an individual indifferent between the the two economies. The aim of our exercise is not to make pareto-like statements, but rather statements of the sort: "an individual is better or worse off in economy with social security policy $\bar{x}$, than if he or she were to live in an economy with social security policy $\widehat{x}$". In order to compare the overall welfare gains or losses associated with alternative social security arrangements, we need define a social welfare function. I assume that a type's lifetime resources is given a weight equivalent to it's measure at birth. The increase or decrease in the present value of labor endowment required to make all lifetime cohorts indifferent between the benchmark economy, $\bar{x}$, and the alternative economy, $\widehat{x}$, is given by:

$$\Omega(\widehat{x}) = \sum_{j=1}^{J} \mu_{1j}\omega_j(\widehat{x}) \frac{\sum_{i=1}^{I} s^{ij}\varepsilon_{ij}}{R(\bar{x})^{i-1}} \tag{15}$$

I report $\Omega(\widehat{x})$ relative to output and the present value of lifetime resources.

6 Findings

6.1 Aggregate Welfare Implications

The benchmark economy is one where the average replacement rate to income is 40%, legal retirement age is 65, and the benefit formula is progressive. Since I am interested in computing the extent of intra-generational redistribution inherent in the current system across different lifetime cohorts, I refrain from transition analysis, and focus solely on the long-run implications of policies that divert from the benchmark.[14] As is well documented in the literature, increases in pay-as-you-go social security will crowd out capital formation, which in turn will cause pre-tax wages to fall, interest rates to rise, and ultimately output to fall. Policy aimed at reducing the size of social security will bring about positive long-run macroeconomic effects. The model predicts that eliminating social security will increase steady state capital by 22.8%, aggregate output by 9.8%, aggregate consumption by 5.2%, and aggregate labor by 3.1%. The increase in full lifetime resources required to make all types indifferent between the benchmark economy and on where social security is absent

[14]Obviously, changes in social security for an initial transition period will affect the young and old very differently.

equals 2.52% of GNP and 2.57% of the economy's lifetime labor endowment. [15] The effect of policy changes on macroeconomic aggregates are found in Table 4.

Figures 6 through 9 show assets, net worth, consumption and hours worked profiles for an average white, male, non-college graduate. As predicted by standard life cycle models, individuals smooth consumption over the lifecycle by borrowing early, accumulating assets over the remainder of their working lives and dissaving after retirement. In the presence of social security, while agents need to save less for old age their net-worth in the absence and presence of social security is near equal. The effect on labor effort is understood as follows. Since individuals invest earnings at compound interest, a rise in the return to assets, product of unfunded social security, will encourage them to increase work effort early, save, and reduce work effort at a later age.

I find that capital accumulation and labor effort increase with an individual's life expectancy. Since individuals with higher expected life-spans need to finance a longer retirement, they will need to save and work more during their active period of life. Workers with later productivity peaks save less, as their earnings profile bears a closer resemblance to their optimal consumption plan.

6.2 Intra-Cohort Welfare Differences

In a pay-as-you-go system, the average return to social security is closely tied to population and labor productivity growth. The program does not discriminate on the basis of an individual's probability of dying early, so the expected rate of return increases with an individual's life expectancy. In addition, the progressive nature of the system will benefit individuals with below average lifetime earnings. The gross expected return to social security of a type-j agent, $R_{ss,j}$, is that which equates the present value of expected lifetime contributions to the present value of expected lifetime benefits:

$$\sum_{i=1}^{I} \frac{s^{ij} \min\{W(1-l_{ij})\varepsilon_{ij}; E^{max}\}\tau}{R_{ss,j}^{i-1}} = \sum_{i=1}^{I} \frac{s^{ij} b_{ij}}{R_{ss,j}^{i-1}} \tag{16}$$

Table 3 shows how these returns compare across individuals, population growth, and social security tax policy. Non-white male college graduates face the lowest returns, while white female college graduates face the highest. If a proportional tax-benefit formula were in place instead, females, whites and college graduates would observe higher returns simply

[15] These results are similar to those found in Auerbach & Kotlikoff (1987), who show a replacement rate of 60% reduces steady state capital by 24%, and that the welfare loss is about 6% of full-time resource.

because they live longer on average. In the presence of perfect annuities the expected return to private savings is equal across types. Since social security essentially forces individuals to hold an annuity, in dynamically efficient economies, a higher return to social security contributions imply a smaller difference between the return to private savings and social security. Therefore asset accumulation distortions are less severe for those with above average life expectancy and below average earnings.[16]

However, differences in the expected returns to social security can explain only part of the differences in well-being across types. Social security is financed through a payroll tax which distorts an individual's labor supply decision. Since agents do not perceive a link between the social security payroll tax and benefits at the margin, the marginal tax rate will equal across types for all ages.[17] The variability in capital accumulation and labor supply distortions are then due to differences in workers age-productivity profiles. Results indicate that workers with later productivity peaks find increases in social security more distortionary than workers with earlier peaks. Unfunded pension schemes crowd out capital formation, cause interest rate to rise, wages to fall and encourage workers to increase labor effort and saving early in life, so to enjoy consumption and leisure later in life. Therefore, workers with later productivity peaks will find changes in their capital accumulation and labor supply behavior more distortionary. Finally, workers with later productivity peaks will observe a greater drop in the present value of their labor endowment, as the relative return to capital increases.

Tables 6 and 7 show that in the long run all lifetime cohorts experience an increase in their private savings, labor effort and welfare as social security is eliminated. Interestingly, I find that workers besides increasing their labor effort, increase the productivity of their work by postponing effort to later in the lifecycle. A closer look at the results, tell us that types with higher returns to social security offset to a greater degree increases in mandatory contributions, by reducing their private savings. Therefore, doing away with social security will produce a greater increase in the private savings of females, whites and non-college

[16]The welfare loss increases with the expected present value of the difference between the future income guaranteed by the displaced savings and the social security benefits.

[17]If workers were to perceive a tax-benefit link, labor supply distortions would be mitigated. Workers with higher life expectancy and lower lifetime earnings would observe lower net marginal taxes and in turn lower labor supply inefficiencies. In addition, since net marginal taxes fall with age, workers would be encouraged to postpone their labor effort. Therefore, those with late productivity peaks will find changes in their labor supply less distortionary. A more elaborate discussion of these issues are found in Feldstein & Samwick (1992), who document social security net marginal taxes across age, gender, marital status and income class.

graduates, since these cohorts on average observe a higher return to social security.

In addition, I find that labor effort is less responsive to changes in social security policy for workers with later productivity peaks. Since doing away with social security implies eliminating the payroll tax and reducing the relative return to capital, individuals will not only be encouraged to increase their work effort but also shift it towards later in the lifecycle. Consequently, workers with late productivity peaks need not increase their work effort as much as those with early peaks, to achieve the desired consumption and leisure plan. Females, non-white and non-college graduates, observe a greater increase in their labor effort because they have on average earlier productivity peaks.

In evaluating the size of the intra-cohort redistributive elements of social security, I look at the gain or loss of each group relative to that of all other groups. If eliminating social security causes males to enjoy lifetime welfare gains that are greater than those of females then social security is said to benefit the latter group at the expense of the former. If the welfare gains of eliminating social security for all groups were equal, we would conclude that the system had no intra-cohort redistributive elements. Results indicate that welfare gains are greatest for cohorts whose private savings and labor supply are less responsive to changes in the system. Cohorts that have below average life expectancies, above average lifetime earnings and later productivity peaks stand more to gain from reductions in social security. In particular, I find that males, non-whites and college graduates experience a greater welfare gain from eliminating social security than females, whites and non-college graduates, respectively. These gains are on average: 39.8% greater for males than females, 3.8% greater for non-whites than whites, and 9.1% greater for college graduates than non-college graduates. Differences in life expectancy and labor productivity translate into differences in capital accumulation and labor supply distortions, that are in turn responsible for differences in welfare across types. These results imply that the current system is lifetime progressive across gender and education, yet lifetime regressive across race.

6.3 Sensitivity Analysis

In this section, I examine the robustness of the policy experiments. In particular, I test how my results change when I assume that private markets to insure against the event of death do not exist and when I change values for the risk aversion coefficient, γ and the subjective discount factor, β.

6.3.1 The No Annuities Case

Given that the empirical evidence suggests the near absence of private formal or informal markets to insure against uncertain longevity, I test how my results change when these markets do not exist.[18] In the absence of private annuities, the agent's problem is slightly different. Individuals still accumulate assets for life-cycle reasons, but now precautionary motives become relevant as uncertainty about an individual's life length induce saving to cover consumption in the event he or she lives longer than expected. In contrast to equation 3, gross savings is now given by:

$$y_{ij} = a'_{i+1,j} + \phi_{ij} \tag{17}$$

where ϕ_{ij} represents the lump-sum transfer of accidental bequests corresponding to an age i, type j individual. Government is now responsible for collecting and distributing the accidental bequests. I assume unintended bequests are taxed 100% and rebated back in lump-sum fashion to survivors of all ages.

$$\phi = \frac{R \sum_{j=1}^{J} \sum_{i=1}^{I} \mu_{ij}(1 - s_{ij})a_{ij}}{\sum_{j=1}^{J} \sum_{i=1}^{I} \mu_{ij}} \tag{18}$$

Finally, the computational algorithm for the no annuity case is slightly different. Besides providing starting guesses for the capital to labor ratio, the age specific shadow wages, the social security tax rate and the economy's average labor earnings; in absence of annuities a guess for the lump-sum transfer of accidental bequest must also be specified.

I find that the benefits of social security in the form of insurance provision for uncertain longevity are far outweighed by the cost of social security in the form of a lower capital stock.[19] The welfare gain associated with eliminating social security is only slightly less in the absence of private annuities than in their presence. Table 5 shows that, in an economy without annuities, the proportional increase in full lifetime resources required to make an individual indifferent between the benchmark economy and one where social security does not exist equals 2.36% of output. In the presence of annuities the welfare gain of eliminating social security is only 0.16% percentage points greater.[20]

[18] Engen & Gale (1993) show that only about 2 percent of the elderly own individual annuities.

[19] Imrohoroğlu et al. (1995) find that in an economy where agents are liquidity constraint and face uninsured mortality and employment risk, the gains of an unfunded pension scheme in terms of insurance provision can outweigh the costs in terms of a lower capital stock.

[20] The expected difference between the return to private capital and the return to social pensions is smaller

Next, I compare the difference in intra-generational well-being between an economy where annuities markets are present and one where they are absent. Since all types have the same degree of risk aversion, in the absence of annuities those with greater mortality risk have more to gain from insurance provision than those with lower mortality risk. I find that while in the absence of annuities social security continues to benefit females, whites and non-college educated at the expense of males, non-whites and college educated the welfare difference between these cohorts is smaller. The long-run welfare gains of eliminating social security are on average: 52.2% greater for males than females, 0.8% greater for non-whites than whites, and 6.3% greater for college graduates than non-college graduates (see Tables 8 and 9).[21]

6.3.2 Changes in The Degree of Risk Aversion

A fall in the risk aversion parameter, γ, is equivalent to an increase in the intertemporal elasticity of substitution, and hence an increase in the desire to postpone consumption. I find that lowering the risk aversion parameter, from $\gamma = 4$ to $\gamma = 3$, will increase the capital to output ratio in the benchmark economy by 12%.

Results indicate that capital accumulation is less responsive to changes in social security the lower the degree of risk aversion. Eliminating social security will cause aggregate capital to fall by 21.3% when $\gamma = 3$, yet by 22.8% when $\gamma = 4$. The degree of risk aversion will affect capital accumulation distortions in two ways. First, the inefficiency associated with intertemporal distortions increases with the degree of risk aversion. In addition, since capital accumulation falls with the degree of risk aversion, the difference between the steady state return to capital and the return to social security increases. These facts imply that the welfare gain of eliminating social security increases with the value of the risk aversion parameter. Table 5 details aggregate implications of changing parameter values for the discount factor and risk aversion parameter.

Finally, I find that a reduction in the risk aversion parameter will increase the intra-cohort difference in well-being. The welfare gains of eliminating social security are now

in the absence of private annuities, hence capital accumulation distortions are less severe. In addition, since the resulting marginal taxes are lower, so will be the labor supply distortions in the absence of these markets.

[21] In the absence of annuities, the expected return to private assets increases with an agents survival probability. Since the return to social security contributions increase with life expectancy, the expected difference between the return to private savings and social security need not fall with life expectancy, as is true in the case when private annuities are present.

52.3% greater for males than females, 7.6% greater whites than non-whites than whites, and 13.6% greater for non-college educated than college educated. For more details, see Tables 8 and 9.

6.3.3 Changes in The Discount Factor

In OG economies the market rate of discount exceeds the rate at which agents discount the future. Therefore, the lower the discount factor, the weaker are the incentives to postpone consumption and consequently the lower the economy's stock of capital. As predicted, lowering the discount factor from $\beta = 1.011$ to $\beta = 0.98$, will reduce the capital to output ratio in the benchmark economy by 30%, form 3.40 to 2.63.

In addition, I find that capital accumulation is less responsive to changes in social security policy, as we reduce the discount factor. Eliminating social security will cause aggregate capital to rise by 22.8% and 15.2%, for $\beta = 1.011$ and $\beta = 0.98$, respectively. Yet, the welfare gain associated with social security, as percentage of the present value of lifetime resource is 0.64 percentage points greater for $\beta = 0.98$.[22] While, on the one hand, a lower discount factor reduces saving incentives and hence capital accumulation inefficiencies, on the other hand, it implies greater inefficiencies, since the difference between the steady state return to capital and the return to social security is greater. Simulation results indicate the latter effect dominates the former (see Table 5).

Next, I evaluate how changes in the subjective discount factor might affect the magnitude of intra-generational redistribution. I find that increases in the rate of time preference will reduce the welfare difference between our lifetime cohorts. The welfare gains of eliminating social security are now 20.5% and 4.2% greater for males and college educated, respectively. However, in contrast to previous results, whites stand more to gain from reductions in social security than non-whites. While whites observe on average higher returns to social security contributions, they also observe on average later labor productivity peaks. As the desire to postpone consumption lessens, the positive effect of observing higher returns is outweighed by the negative effect of having later productivity peaks. Hence, whether social security is lifetime regressive or progressive across race, is very sensitive to changes in the discount factor.

[22]For smaller discount factors, the increase in full lifetime resources required to make all individuals indifferent between the benchmark economy and one where social security is absent is larger relative to the economy's present value of labor endowment.

7 Conclusions

This paper represents a first effort to provide a quantitative evaluation of of the intra-generational redistributive elements of the United States social security system, in the context of a general equilibrium model. Differences in life expectancy and labor productivity translate into differences in capital accumulation and labor supply distortions, that are in turn responsible for differences in the welfare of individuals that differ by gender, race and education. I find that the current program is lifetime progressive across gender and education, yet lifetime regressive across race. The latter result is sensitive to certain parameter specifications for preferences.

However, this paper has important short comings. It studies the lifecycle behavior of *single* men and women, and treats social security purely as a retirement insurance program. How then do we reconcile the finding that social security benefits females at the expense of males when in reality, men and women, as husbands and wives, make joint economic decisions? In addition, social security plays an important role in providing insurance to dependent spouses and survivors.[23]

A natural extension of this paper would be to re-evaluate the intra-cohort redistribution of social security (including spouse and survivor insurance) at the household level rather than at the individual level. In the proposed framework, a household would be characterized not only the age, sex and race of the head and corresponding spouse (if married), but also by it's marital status.[24] Since, non-white families are known to have more dependents, and face a greater likelihood of death of spouse, survival insurance transfers to this group might be greater. In addition, since the degree of household specialization between home and market activities is likely to differ according to the race and education of the married couple, retirement insurance transfers to dependent spouses may also differ across type.

Finally, by characterizing a household according to it's marital status, we could study the life insurance ownership patterns of families, and the extent to which social security survival insurance might crowd out private provision. Integrating spouse and survivor insurance in a modeling context where men and women make joint economic decisions, and face changes in their marital status is then likely to open a realm of unexplored policy questions.

[23]One quarter of all Old Age and Survivor Insurance (OASI) payments goes to survivors.

[24]Cubeddu & Ríos-Rull (1996), in a similar framework, study how changes in the patterns of household formation and dissolution affect savings at the household and aggregate level.

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Table 1: Efficiency Index by Age, Gender and Education

	White				Non-White			
	College		**Non-College**		**College**		**Non-College**	
Age	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
20-24	0.936	0.860	0.670	0.599	0.901	0.878	0.615	0.566
25-29	1.272	1.118	0.898	0.718	1.146	1.020	0.798	0.639
30-34	1.548	1.277	1.047	0.764	1.389	1.171	0.863	0.696
35-39	1.769	1.297	1.149	0.803	1.656	1.315	0.970	0.751
40-44	1.895	1.279	1.250	0.831	1.683	1.359	1.021	0.788
45-49	1.984	1.178	1.297	0.813	1.782	1.294	1.010	0.769
50-54	2.044	1.129	1.263	0.778	1.544	1.111	0.949	0.664
55-59	2.084	1.137	1.233	0.757	1.542	1.013	0.953	0.641
60-64	1.975	1.066	1.194	0.734	1.184	1.040	0.941	0.568
65 +	1.643	0.902	0.906	0.643	1.631	1.094	0.665	0.493

Table 2: Demographic and Economic Characteristics of Population

Population Type			**Life Expectancy**	**Average Productivity**	**Percent of Population**
Overall			73.70	1.000	100.00
Male	White	No-College	71.61	1.018	28.35
		College	72.09	1.659	9.52
	Non-White	No-College	66.65	0.991	7.66
		College	67.04	0.845	2.57
Female	White	No-College	76.87	0.725	30.37
		College	77.47	1.157	10.20
	Non-White	No-College	73.37	0.671	8.46
		College	73.90	1.159	2.87

Table 3: Expected Rate of Return of Social Security (Percent)

			Progressive Tax		**Flat Tax**
Population Type			$\lambda_\mu = 1.2$	$\lambda_\mu = 2.0$	$\lambda_\mu = 1.2$
Male	White	No-College	1.18	2.09	1.21
		College	0.53	1.53	1.31
	Non-White	No-College	0.82	1.69	0.64
		College	0.36	1.27	0.73
Female	White	No-College	2.18	2.98	1.87
		College	1.87	2.67	1.92
	Non-White	No-College	1.91	2.70	1.49
		College	1.55	2.36	1.59

Table 4: Social Security and Economic Aggregates

Benchmark Economy: $\eta = 40\%$, $I^R = 65$, Progressive Benefit Formula.

Perfect Annuity Markets: $\beta = 1.011$, $\gamma = 4$, $\theta = 0.33$								
Policy	τ (%)	**K/Y**	**K**	**N**	**C**	**Y**	$\Omega/PVLE$	Ω/Y
Benchmark	9.40	3.400	1.916	0.283	0.418	0.564	0.00	0.00
$\eta = 0\%$	0.00	3.803	2.354	0.292	0.440	0.619	2.57	2.52

Table 5: Sensitivity Analysis: Social Security and Economic Aggregates

Benchmark Policy: $\eta = 40\%$, $I^R = 65$, Progressive Benefit Formula.

No *Annuity Markets:* $\beta = 1.011$, $\gamma = 4$, $\theta = 0.33$								
Policy	τ (%)	**K/Y**	**K**	**L**	**C**	**Y**	$\Omega/PVLE$	Ω/Y
Benchmark	9.33	3.351	1.838	0.278	0.403	0.549	0.00	0.00
$\eta = 0\%$	0.00	3.834	2.330	0.285	0.431	0.608	2.36	2.44
Perfect Annuity Markets: $\beta = 1.011$, $\gamma = \mathbf{3}$, $\theta = 0.33$								
Policy	τ (%)	**K/Y**	**K**	**L**	**C**	**Y**	$\Omega/PVLE$	Ω/Y
Benchmark	10.04	3.813	2.393	0.296	0.445	0.628	0.00	0.00
$\eta = 0\%$	0.00	4.248	2.903	0.303	0.462	0.683	1.99	2.27
Perfect Annuity Markets: $\beta = \mathbf{0.980}$, $\gamma = 4$, $\theta = 0.33$								
Policy	τ (%)	**K/Y**	**K**	**L**	**C**	**Y**	$\Omega/PVLE$	Ω/Y
Benchmark	8.09	2.631	1.207	0.266	0.367	0.459	0.00	0.00
$\eta = 0\%$	0.00	2.825	1.391	0.275	0.386	0.492	3.20	2.20

Table 6: Lifetime Welfare Effects Eliminating Social Security

Perfect Annuity Markets: $\beta = 1.011$, $\gamma = 4$, $\theta = 0.33$				
Population	%Δ**K**	%Δ**H**	%Δ**H Eff.**	ω_j
Male	22.22	1.66	2.45	3.21
Female	23.18	3.68	3.96	1.94
White	23.26	2.55	2.99	2.55
Non-White	20.83	2.94	3.31	2.65
College	20.32	2.42	2.93	2.76
No-College	23.93	2.71	3.12	2.51

Table 7: Lifetime Welfare Effects of Eliminating Social Security

Benchmark Policy: $\eta = 40\%$, $I^R = 65$, Progressive Benefit Formula.

<table>
<tr><th colspan="7">Perfect Annuity Markets: $\beta = 1.011$, $\gamma = 4$, $\theta = 0.33$</th></tr>
<tr><th colspan="3">Population</th><th>%ΔK</th><th>%ΔH</th><th>%ΔH Eff.</th><th>ω_j</th></tr>
<tr><td rowspan="4">Male</td><td rowspan="2">White</td><td>No-College</td><td>24.29</td><td>1.71</td><td>2.53</td><td>3.10</td></tr>
<tr><td>College</td><td>20.18</td><td>0.88</td><td>2.03</td><td>3.55</td></tr>
<tr><td rowspan="2">Non-White</td><td>No-College</td><td>20.52</td><td>2.26</td><td>2.88</td><td>3.15</td></tr>
<tr><td>College</td><td>16.19</td><td>1.93</td><td>2.73</td><td>3.37</td></tr>
<tr><td rowspan="4">Female</td><td rowspan="2">White</td><td>No-College</td><td>24.53</td><td>3.58</td><td>3.88</td><td>1.89</td></tr>
<tr><td>College</td><td>21.32</td><td>3.89</td><td>4.12</td><td>1.93</td></tr>
<tr><td rowspan="2">Non-White</td><td>No-College</td><td>23.44</td><td>3.82</td><td>3.99</td><td>2.04</td></tr>
<tr><td>College</td><td>20.20</td><td>3.55</td><td>3.89</td><td>2.26</td></tr>
</table>

Table 8: Sensitivity Analysis: Lifetime Welfare Effects of Eliminating Social Security

No *Annuity Markets:* $\beta = 1.011$, $\gamma = 4$, $\theta = 0.33$				
Population	**%ΔK**	**%ΔH**	**%ΔH Eff.**	ω_j
Male	31.40	0.97	1.94	2.95
Female	23.47	3.32	3.72	1.93
White	26.87	2.10	2.67	2.43
Non-White	27.07	2.11	2.56	2.45
College	23.92	2.16	2.75	2.56
No-College	28.38	2.09	2.59	2.40
Perfect Annuity Markets: $\beta = 1.011$, $\gamma = \mathbf{3}$, $\theta = 0.33$				
Population	**%ΔK**	**%ΔH**	**%ΔH Eff.**	ω_j
Male	20.04	1.05	1.95	2.70
Female	22.27	2.92	3.21	1.29
White	21.67	1.89	2.41	1.96
Non-White	19.63	2.27	2.67	2.12
College	18.78	1.74	2.34	2.21
No-College	22.46	2.05	2.52	1.92
Perfect Annuity Markets: $\beta = \mathbf{0.980}$, $\gamma = 4$, $\theta = 0.33$				
Population	**%ΔK**	**%ΔH**	**%ΔH Eff.**	ω_j
Male	14.39	1.81	2.51	3.56
Female	15.68	3.57	3.86	2.83
White	15.67	2.55	2.96	3.20
Non-White	13.28	2.96	3.34	3.18
College	12.72	2.49	2.95	3.30
No-College	16.31	2.69	3.08	3.16

Table 9: Sensitivity Analysis: Lifetime Welfare Effects of Eliminating Social Security

No *Annuity Markets:* $\beta = 1.011$, $\gamma = 4$, $\theta = 0.33$						
Population			**%ΔK**	**%ΔH**	**%ΔH Eff.**	ω_j
Male	White	No-College	33.13	1.09	2.04	2.84
		College	27.92	0.42	1.78	3.32
	Non-White	No-College	32.86	1.13	1.83	2.84
		College	26.40	1.16	2.05	3.02
Female	White	No-College	24.29	3.16	3.54	1.14
		College	21.29	3.99	4.28	1.80
	Non-White	No-College	25.51	3.10	3.30	1.99
		College	22.33	3.35	3.76	2.04
Perfect Annuity Markets: $\beta = 1.011$, $\gamma = \mathbf{3}$, $\theta = 0.33$						
Population			**%ΔK**	**%ΔH**	**%ΔH Eff.**	ω_j
Male	White	No-College	22.08	1.12	2.03	2.56
		College	17.50	0.27	1.57	3.06
	Non-White	No-College	18.98	1.64	2.32	2.68
		College	14.73	1.28	2.16	2.95
Female	White	No-College	23.60	2.83	3.14	1.21
		College	20.45	3.10	3.34	1.30
	Non-White	No-College	22.53	3.09	3.26	1.41
		College	19.30	2.78	3.14	1.70
Perfect Annuity Markets: $\beta = \mathbf{0.980}$, $\gamma = 4$, $\theta = 0.33$						
Population			**%ΔK**	**%ΔH**	**%ΔH Eff.**	ω_j
Male	White	No-College	16.76	1.82	2.55	3.52
		College	11.46	1.16	2.14	3.82
	Non-White	No-College	12.73	2.39	2.96	3.44
		College	8.14	2.21	2.93	3.54
Female	White	No-College	16.84	3.46	3.77	2.81
		College	14.15	3.77	4.02	2.82
	Non-White	No-College	15.85	3.68	3.86	2.86
		College	13.00	3.56	3.90	2.95

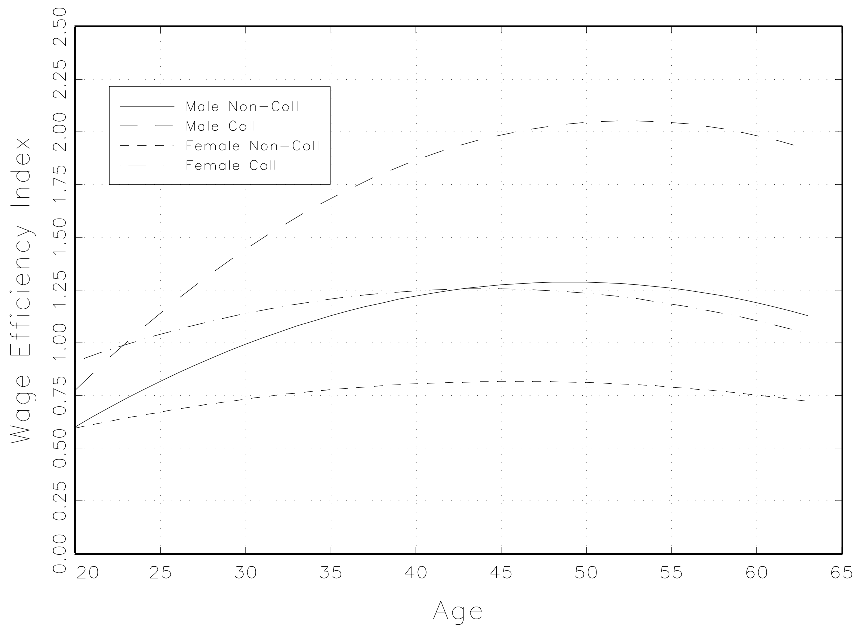

Figure 1: Wage Efficiency Index: Whites

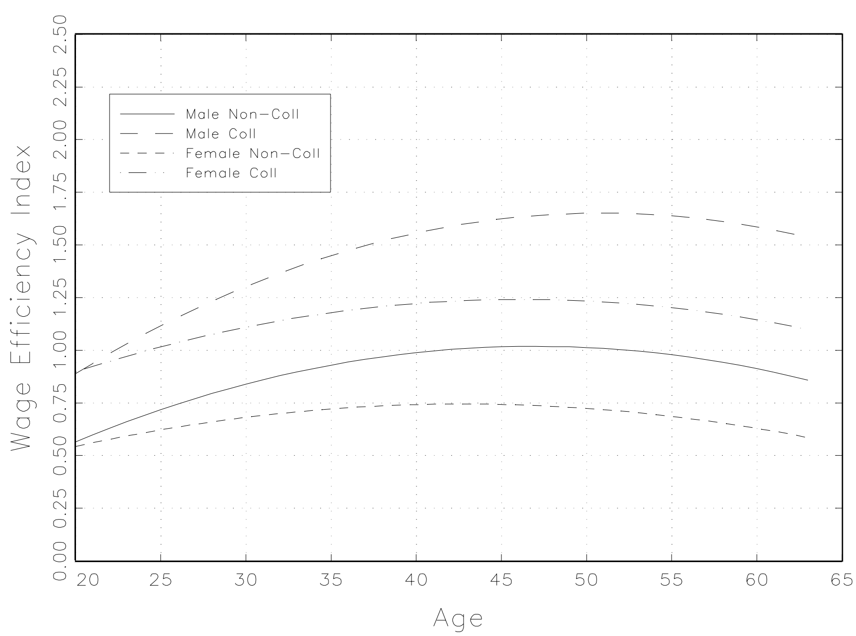

Figure 2: Wage Efficiency Index: Non-Whites

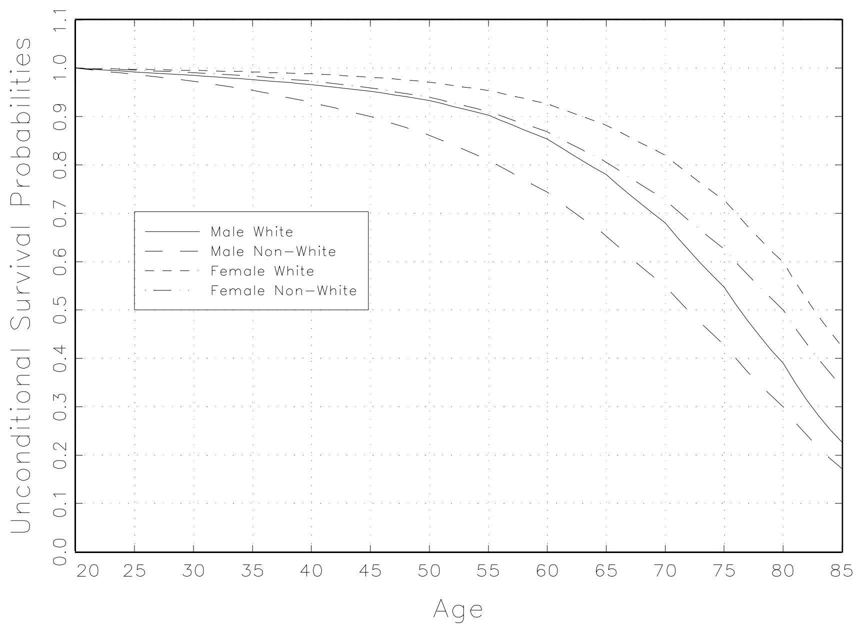

Figure 3: Unconditional Survival Probability: College Educated

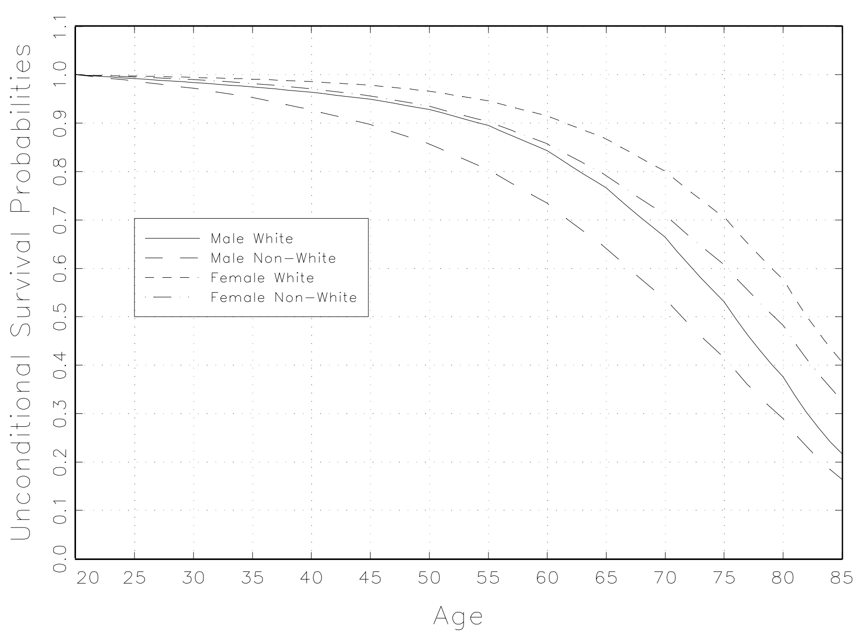

Figure 4: Unconditional Survival Probability: Non-College Educated

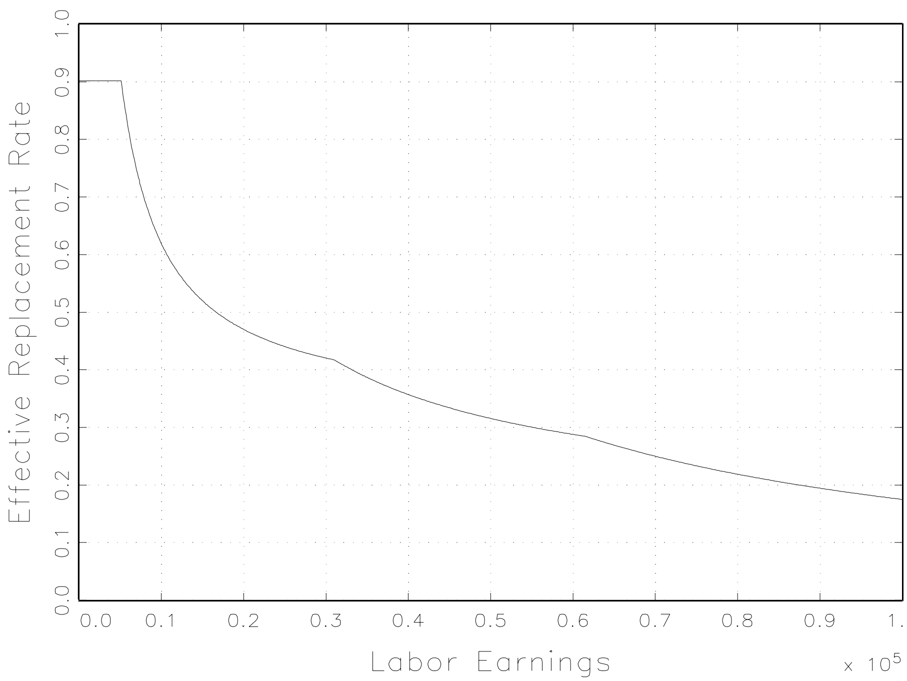

Figure 5: Effective Replacement Rate by Income: Social Security Handbook 1993

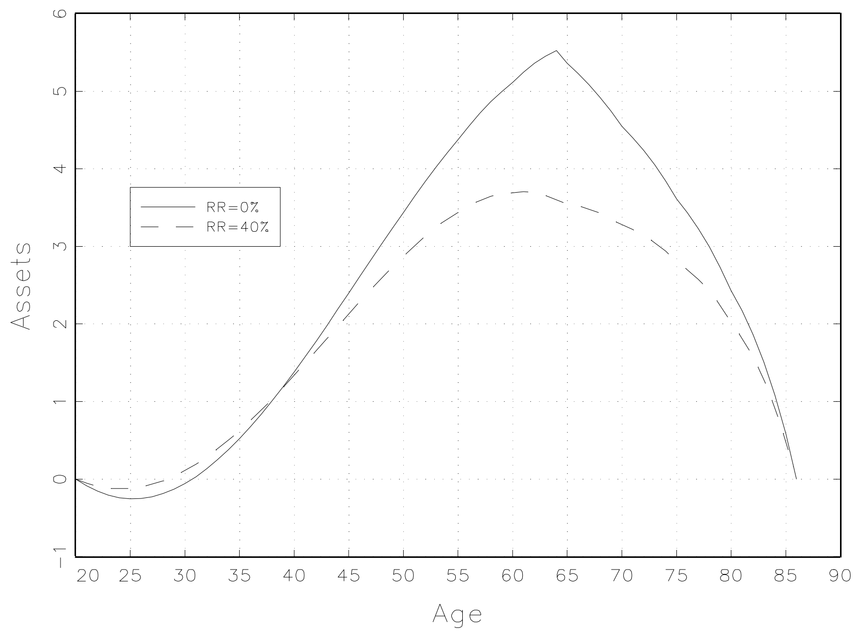

Figure 6: Assets Profile Across Social Security Policy (Male, White, Non-College)

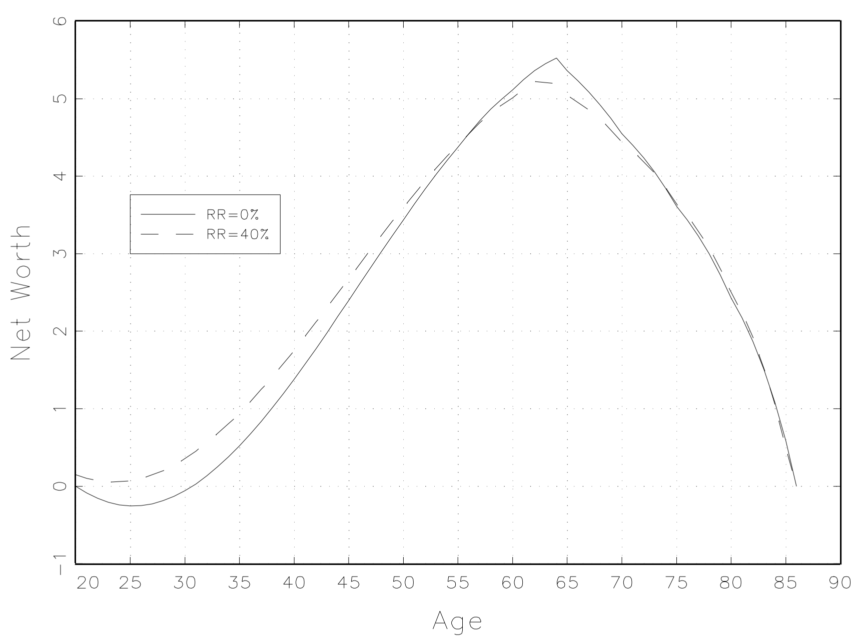

Figure 7: Net Worth Profile Across Social Security Policy (Male, White, Non-College)

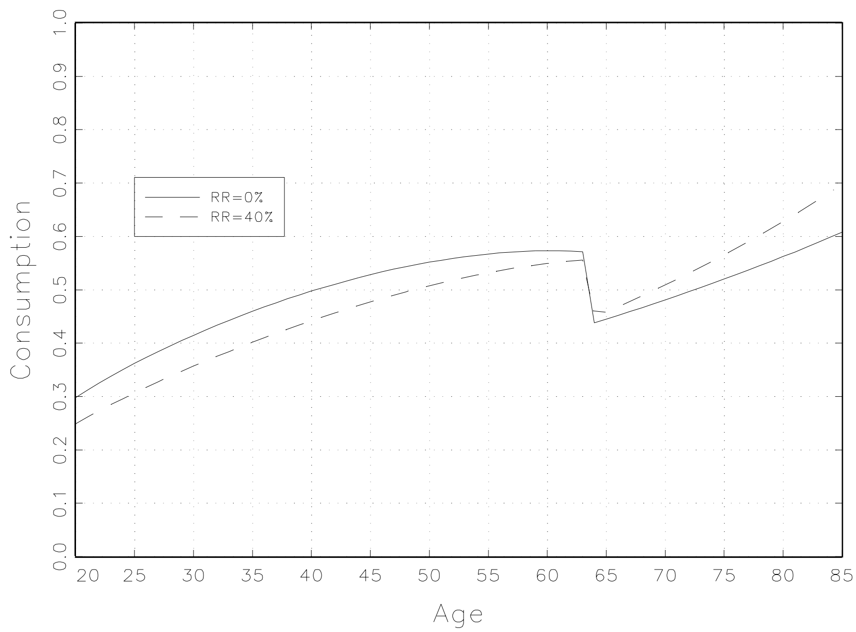

Figure 8: Consumption Profile Across Social Security Policy (Male, White, Non-College)

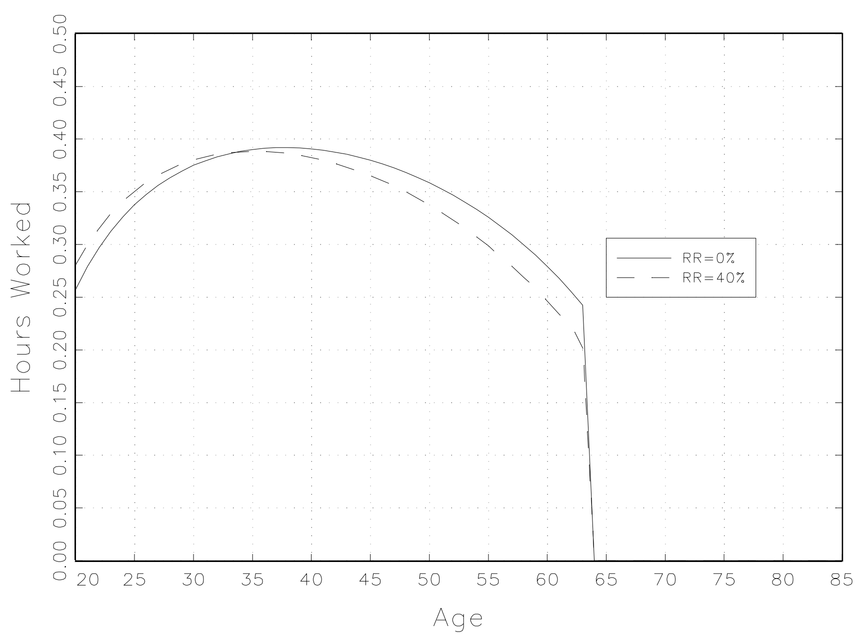

Figure 9: Hours Worked Profile Across Social Security Policy (Male, White, Non-College)