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SOCIAL SECURITY AND UNSECURED DEBT

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ABSTRACT

Most young households simultaneously hold both unsecured debt on which they pay an average of 10 percent interest and social security wealth on which they earn less than 2 percent. We document this fact using data from the Panel Study of Income Dynamics. We then consider a life-cycle model with optimizing and "rule-of-thumb" households and explore ways to reduce this inefficiency. We show that both allowing households to use social security wealth to pay off debt and exempting young households from social security contributions (but in both cases requiring higher contributions later later in life) leads to increases in welfare for both types of households and significant increases in consumption and saving, and reductions in debt, for optimizing households.

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1 Introduction

The starting point for our analysis is the observation that currently households have about $700 billion in unsecured debt on which they pay roughly 10 percent interest and $11 trillion of social security wealth on which they earn less than 2 percent interest.[1] As a nation, we are apparently borrowing on credit cards and saving in a passbook savings account, something that Gross and Souleles (2002) describe as, "puzzling, apparently inconsistent with no-arbitrage and thus inconsistent with any conventional model."

We focus on the old-age portion of social security and explore this topic in three steps. First, in Section 2, we examine the composition of individuals who own both non-collateralized debt and social security wealth. In an economy with heterogenous agents, it is possible that the households that have the debt and the households that have the wealth are different. We use data from the Panel Study of Income Dynamics to show that this is generally not the case. In our sample of households under the age of 40, 62 percent of households have unsecured debt. We show that if households could access their social security wealth to pay off debt, only 17 percent would still have debt. And for that 17 percent, total debt would be dramatically reduced; for the 90th percentile household in the debt distribution, unsecured debt would fall from 84 percent to 33 percent of that household's average income.

In Section 3, we construct a dynamic life-cycle portfolio choice model. We follow Campbell and Mankiw (1989) and others by assuming that the world is populated by two types of households: optimizing households that use financial assets to maximize utility and "rule-of-thumb" households that simply set consumption equal to income. Evidence from the consumption literature suggests that households roughly break

[1] Our measure of unsecured debt is "consumer revolving credit" from the Federal Reserve Board – which was $725.0 billion in May 2003. Davis, Kubler and Willen (2003) argue that the interest rate on unsecured debt, taking default into account, is roughly 10 percent in real terms. The value of social security wealth, defined as "the present actuarial value of the Social Security benefits to which the current population will be entitled at age 65 (or are already entitled to if they are older than 65) minus the present actuarial value of the social security taxes that they will pay before reaching that age," comes from Feldstein and Ranguelova (2001). Leimer (1994) calculates that the internal rate of return on social security contributions is 1.7 percent.

into these two categories, especially with respect to retirement.[2] For the optimizing households, we adapt a model developed by Davis, Kubler and Willen (2003). In that model, households can invest in stocks and bonds and can also take out unsecured loans. We specify that the interest rate on unsecured debt (i.e., the borrowing rate) exceeds the interest rate on bonds (i.e., the lending rate). Such an assumption is consistent with the pattern of observed interest rates.[3] We show that our parameterization of this model can roughly match the life-cycle borrowing behavior documented in Section 2.

In Section 4, we analyze the effects of two policy experiments aimed at alleviating the inefficiency of simultaneous debt and social security holdings. In our first experiment, we allow households currently in the social security system to access their social security wealth to pay off debt. In our second experiment, we build on an idea due to Hubbard and Judd (1987) and exempt young households from social security contributions. Under both proposals, households would contribute more to social security (via higher taxes) later in life to compensate for their reduced contributions while young. Such an assumption ensures unchanged social security benefits upon retirement. Both of the above proposals lead to increases in saving, reductions in debt and substantial increases in lifetime certain equivalent consumption. Table 1 summarizes some key results in the paper. For example, moving from our existing system to one where households under 30 are exempt from contributing to social security (but are forced to make up the taxes later in life) raises certain equivalent consumption by 3.4 percent for optimizing households and 3.3 percent for rule-of-thumb households.

It is easy to see that exempting young households from social security taxes will tilt household social security contributions so that they are more in line with desired life-cycle saving. Given realistic income profiles, most households under the age of 30 want to borrow not save. But what is surprising is that the exemption also reduces the distortions that result from the fact that social security requires investment of all contributions in an asset that pays 2 percent interest and does not allow any

[2]See the discussion in Section 1.1 below.

[3]See Davis et al., 2003.

investment in equity which has historically returned 8 percent. We illustrate this surprising fact in Section 4.

Finally, we draw attention to one other possibility offered by our experiments. By either giving an exemption or allowing a withdrawal but requiring higher contributions later, the government effectively loans money to households. We call the interest rate on such loans the internal borrowing rate (IBR). The conditions we impose imply that the IBR equals the internal rate of return on social security investment. But the welfare gains from these "loans" are so big that the government could charge a higher IBR and still make households better off. Table 1 shows that a combination of the age 40 exemption and an increase in the IBR from 2 percent to 5 percent still leads to a significant increase in welfare for both types of households. We also show that raising the IBR would significantly improve social security finances. In other words, we show that the government could borrow at 2 percent, lend at 5 percent and still make households better off!

Before continuing with the paper, we draw the reader's attention to five important aspects of our analysis.

First, social security has a purpose in our setup. That purpose comes from the existence of rule-of-thumb households. Table 1 shows that eliminating social security altogether makes optimizing households better off than any of our proposed policy changes. This is a consequence of the fact that households can at least replicate social security privately in our setup. But for rule-of-thumb households, eliminating social security would be catastrophic as it is their only resource to fund consumption in retirement. In this sense, our analysis follows Feldstein (1985), who writes, "The principle rationale for such mandatory programs is that some individuals lack the foresight to save for their retirement years." Our goal is to build a social security system that is "paternalistic" in the sense of Diamond (1977), but we also take into account the needs of optimizing households, for whom mandated social security may be welfare reducing.

Second, we do not make any assumption about how social security is funded. Nor do we take any stand on changing the financing of the social security system. Our main vantage point is that of the individual household, which contributes money to social security while working and receives benefits in retirement with certainty. We use the internal rate of return estimated by Leimer (1994) to link contributions with benefits, but we do not assume that the social security system invests the contributions in an individual account or in a pension fund. However, we measure the effects of various social security schemes on the difference between annual contributions by workers and annual retiree benefits at various points in time – in other words how our proposals would affect the solvency of a pay-as-you-go system. But, it should be stressed again that our policy experiments are designed to leave the benefit portion of social security unchanged.

Third, we assume that households do not face any longevity risk. This is an important omission as some researchers argue that by providing an indexed life annuity, social security allows households to manage longevity risk.[4] Further, they argue that markets fail to provide such annuities. This benefit of social security is missing from our model. However, none of our proposed schemes – except our "straw man" of eliminating social security altogether – have any effect on the retirement portion of social security. Thus the benefits shown in Table 1 and elsewhere in the paper are incremental to the social benefits of a mandated, indexed life annuity.

Fourth, in all of our policy experiments, we require that households contribute at least as much in present value terms and receive exactly the same benefits as they do in the current system. For example, we consider allowing households to remove their wealth from social security to pay off debt. But we do not allow them to "opt out" of social security at all – in fact their subsequent contributions go up. So our experiment is completely different from, for example, Smetters and Walliser (2002), who allow household to leave social security entirely. In addition, our model preserves the "commitment" aspect of social security. Some researchers (Akerlof, 1998, for example) have argued that households do not trust themselves to save and vote for a government program that makes it illegal for them not to. The options we consider change only the life-cycle structure of social security not the level of contributions:

[4] See Abel (1986) and Eckstein, Eichenbaum and Peled (1985), among others.

social security will still require that households save enough to guarantee an income equal to 43 percent of their average working income in retirement.

Finally, the main point of the paper – that the ideal life-cycle profile of contributions is not flat – applies equally well to any tax. Given the choice, households with a hump-shaped income profile would rather pay less income tax when young and more income tax when middle-aged. We focus on social security for two reasons. First, unlike income taxes, the explicit purpose of social security is to smooth life-cycle consumption. So it is particularly ironic that the contribution structure does precisely the opposite at certain points in the life-cycle. Second, a progressive income tax approximates the ideal life-cycle structure by lowering tax rates when income is low. Since social security taxation is, in fact, regressive, not progressive, it is a natural target for our analysis.

Before proceeding with the main body of the paper, we conduct a brief literature review. In our concluding section, we discuss some additional limitations of our analysis.

1.1 Literature review

This paper builds on earlier work in four fields: social security, consumer credit, life-cycle portfolio choice and consumption.

Many researchers have explored the effects of social security on the economy. For a survey, see Feldstein and Liebman (2002). We draw the reader's attention to three particularly relevant papers. Feldstein and Ranguelova (2001) propose that we replace the current pay-as-you-go social security system with individual accounts in which households can invest in equity and calculate the effects on retirement income. They find that people typically do better with individual accounts although there is a small probability that they will do worse. Hubbard and Judd (1987) look at a dynamic general equilibrium model of social security in which households face borrowing constraints.[5] They show, as we do, that an exemption from social security

[5] Imrohoroglu, Imrohoroglu and Joines (2003) make a similar point.

contributions early in the life-cycle yields substantial welfare benefits. Our set-up is much richer in that we include risky assets and borrowing in the household portfolio choice set and consider rule-of-thumb as well as optimizing households. On the other hand, our model is set in partial equilibrium. In the conclusion, we briefly discuss general equilibrium aspects of the problem and other relevant literature. Imrohoroglu, Imrohoroglu and Joines (2003), like Hubbard and Judd, consider a dynamic general equilibrium model. However, they allow households to have time-inconsistent preferences, building on the idea of Akerlof (1998), among others, that social security exists precisely because time-inconsistent household demand a commitment device. In their model, social security "may raise or lower welfare depending on the strength of time inconsistency." Their results for time-inconsistent households contrast with our results for "rule-of-thumb" households for whom social security is unambiguously welfare improving.

Gross and Souleles (2002), Durkin (2000) and Kennickell, Starr-McCluer and Surette (2000), among others, have documented the increasing importance of unsecured debt – and in particular credit card debt – in household portfolios.

Researchers have recently started to focus attention on the effects of borrowing limitations on life-cycle portfolio choice.[6] We build on this literature by extending a model due to Davis, Kubler and Willen (2003). Davis, Kubler and Willen limit borrowing not through a cap on the amount but by introducing a wedge between the cost of borrowing and the risk-free interest rate. They argue that a wedge is both empirically evident and that a model that incorporates a wedge leads to a more realistic profile of life-cycle portfolio holdings. Campbell, Cocco, Gomes and Maenhout (2001) explore the effects on portfolio choice and utility of allowing households to invest some of their social security wealth in equities in a life-cycle model with no borrowing. They find that a combination of smaller contributions and investment in equities leads to substantial welfare increases.

[6]Some examples include Constantinides, Donaldson and Mehra (2002) who explore the effects of borrowing limitations on asset pricing. Gomes and Michaelides (2003) explore the effects of participation costs in conjunction with borrowing limitations.

Altig and Davis (1992) consider the effects of a wedge between borrowing and lending rates in an overlapping generations model. They find that the wedge dramatically affects the timing of bequests. Our findings, that a wedge affects the optimal timing of contributions, are similar in spirit.

Finally, recent work in the consumption literature motivates our decision to categorize consumers as optimizing or rule-of-thumb. Researchers have shown that consumers roughly matching the two definitions coexist in the data, particularly with respect to retirement. Bernheim, Skinner and Weinberg (2001) argue that drops in household consumption at retirement "are consistent with 'rule of thumb'... theories of wealth accumulation." Both Hurst (2003) and Scholz, Seshadri and Khitatrakun (2003) argue that an optimizing model describes consumption behavior at retirement for roughly 80 percent of the population and while a rule-of-thumb model describes the remaining 20 percent.

2 Empirical facts about borrowing and social security

2.1 Data

The *PSID* is a large, nationally representative survey, started in 1966 that tracks social and economic variables of a given household over time. Each year, the survey gathers demographic information such as age, race, family composition and education levels of all members in each household. Among other information, individuals report their labor market participation and earned labor income.

On occasion, the *PSID* supplements the main data set with special modules. In 1984, 1989, 1994 and 1999, the *PSID* asked households extensive questions about their wealth. Specifically, households report holdings of cash, stocks, bonds, mutual funds, saving accounts, checking accounts, government savings bonds, Treasury bills, Individual Retirement Accounts, bond funds, cash value of life insurance policies, valuable collections for investment purposes, and rights in a trust or estate.

Additionally, respondents report the value of their main home, the value of their outstanding mortgage debt, and their net positions in other real estate, businesses and vehicle ownership. Of particular interest to this study is the respondents' report of their holdings of unsecured debt (including store and credit card debt, student loans and other personal loans).

The time-series aspect of the PSID makes it ideal for measuring social security wealth. While the PSID does not have actual social security records for each respondent, social security wealth can be computed using the household's detailed earnings history coupled with the social security tax tables.[7]

Given that the PSID measures wealth (and indebtedness) at five year intervals starting in 1984, we focus our analysis on the 1999 wealth supplement. There are two reasons for this approach. First, in order to compute social security wealth, we need a long history of earnings for each individual in the survey. Using the 1999 data thus allows us as many as 31 annual observations of individual earnings. Second, innovation in financial markets resulted in an explosion in credit card use between the late 1980s and the late 1990s. Focusing on more recent time periods, therefore, may provide a more representative picture of a household's steady state holdings of unsecured debt. However, for completeness, we redid our analysis for a sample of 1989 households and our main conclusions were unchanged.

Our main sample included all household heads in the 1999 PSID between the ages of 22 and 40. We focused on younger households since most unsecured borrowing occurs among younger households. Unfortunately, we do not have full earnings histories for all households heads in the sample. To see why, note two things. First, the PSID only tracks core PSID members over time. A core PSID member is either an original respondent from 1968 (when the survey started) or a descendent of an original sample member. Second, given PSID definitions, the male is classified as the household head for all married and cohabiting couples. As a result, for some male PSID heads, earnings histories only extend back to the date that they married into the survey. Rather than imputing the missing income history for these household heads, we restrict our

[7]See `http://www.ssa.gov/OACT/HOP/hopi.htm`.

sample to include 1) all single headed households (both male and female) and 2) all married households where the head has complete earnings histories. Given that all the households in the 1999 PSID under the age of 40 are descendants who are equally likely to be men or women, our restriction does not bias our analysis in any way. In summary, our 1999 PSID sample includes all unmarried households with heads between the age of 22 and 40 and married households with heads between the age of 22 and 40 where the head also has a complete earnings history. The resulting sample size was 2,077 households. For robustness, we also examine only single households where the head is between 22 and 40. This latter sample included 850 households.

2.2 Discussion of data

Our analysis of the data reveals three key facts. First, young households have large amounts of unsecured debt. Table 2 shows some descriptive statistics about our sample. 62 percent of households under the age of 40 have positive amounts of unsecured debt. The median and mean amount of debt held for households in our sample was, respectively, \$1,200 and \$6,400. For those that hold positive amounts of debt, the median debt held was \$5,600 while the mean amount of debt held was \$10,500.[8] The results are equally striking when comparing total household debt in 1999 to the household head's current 1999 income. The median debt to income ratio is 5 percent; the mean is 36 percent.[9] Households who have positive unsecured debt tend to be slightly younger, more likely to be married and less likely to be black. Income of the household head is not a strong predictor, however, of the household's

[8]All dollar amounts in this paper are in 1996 constant dollars.

[9]Unlike the Survey of Consumer Finances (SCF), the PSID does not distinguish between total debt and revolving debt. Some households may have a positive amount of debt at anytime during the month for transaction reasons. These households may intend to payoff the debt before they accrue any interest charges. We would like to focus on households that hold revolving debt (i.e., who carry balances forward from month to month). Of those households who report positive credit card balances in the PSID, most hold more debt than can be justified by a transaction motive. In our sample, we find that 46 percent of all households (or 75 percent of households with debt), have accumulated debt greater than one month's worth of income. This finding is consistent with data from the 1995 SCF which finds that 56 percent of all households pay interest on their credit card balance on a monthly basis (Gross and Souleles, 2002).

propensity to have debt. This result is not surprising given that both low income and high income households hold little, if any, unsecured debt. Low income households are unable to obtain debt, despite their desire to borrow, while high income households have less need to borrow. Among households that have some debt – i.e. 62 percent of our sample – the median debt to income ratio is 22 percent and the mean is 58 percent.

If individuals are constrained by social security contributions, we would expect that those households with debt would have a negative net asset position. To explore this question, we define three measures of household wealth. First, we examine household "total net worth," which includes vehicle holdings, real estate equity (including main home equity), business equity, stocks, corporate bonds, cash, checking accounts, saving accounts and Treasuries less unsecured debt.[10] Second, we create a measure of liquid assets by subtracting illiquid assets from our measure of net worth. We define illiquid assets as business equity, housing equity and vehicle equity. We refer to this measure as "net liquid assets." Finally, we realize that cash, saving accounts, and checking accounts may be used to make monthly purchases. As a result, they are not measures of the stock of a household's wealth. To account for this, we remove these resources from our measure of net illiquid assets. Essentially, our measure of "net financial wealth" is the sum of stock wealth plus bond wealth less non-collateralized debt.

Most of the households in the sample have positive net worth in spite of their unsecured debt. Table 3 shows that only 16 percent of the total sample and 26 percent of those with positive debt have negative net worth. However, most of total net worth is accounted for by home equity and assets, which provide limited liquidity (net vehicle equity, for example). If we look at "net financial assets," we get a completely different picture. Table 3 shows that 50 percent of the households in the sample have negative net financial assets and 82 percent of the households with unsecured debt

[10]The is the full PSID wealth definition. See Hurst, Luoh and Stafford (1998) for a thorough discussion. Up through the top 2 percentiles, the PSID wealth data compares very well to the SCF wealth data (Juster and Stafford, 1999).

have negative net financial assets. Our sample does indicate that some households do have positive holdings of stocks and bonds at the same time that they have unsecured debt. To see this, look at Table 2, which shows that the median household with positive debt has net financial assets equal to -16 percent of income but debt equal to 22 percent of income. In other words, if they used their financial assets to pay off debt, they would could reduce their debt load from 22 percent of income to 16 percent. However, the PSID data tells us neither the interest rate on the debt nor the return on the assets. If the return on stocks is sufficiently high or the interest on the debt is sufficiently low, such debt reduction would not be sensible. By contrast, the interest rate on unsecured debt always exceeds the interest rate on social security contributions.

The life cycle profile of debt is as expected. Young households have steep income profiles, on average. As a result, the PIH would predict that young households should be indebted. As they age, and their income profiles flatten out, the propensity to be in debt should diminish. These predictions are borne out in the data. Table 4 shows that the median debt to income ratio rises slightly from 13 percent between age 22 and 24 to 14 percent between ages 25 and 27 before falling sharply to 3 percent between age 37 and 39. Variations for the 75th percentile household are more dramatic. Table 4 shows that the debt-to-income ratio for the 75th percentile household rises from 45 percent for households aged between 22 and 24 to 54 percent households aged 25 to 27 before falling to 20 percent for households aged 37 to 39.

Indebtedness is highly skewed. In the whole sample, the median household debt to income ratio is just 5 percent. Table 5 shows that a quarter of households have debt to income ratios of more than 29 percent and 10 percent have debt to income ratios of more than 84 percent. Just focusing on those households with some debt, we see that the debt distribution is still quite skewed. 25 percent of households have debt to income ratios of less than 8 percent. However, 25 percent also have debt to income ratios of more than 53 percent. And 10 percent have debt to income ratios that exceed 120 percent.

Social security wealth is considerable for young households. Table 2 shows that total social security contributions for both the with-debt and the without-debt samples are broadly similar. For the median household in our sample with debt, the social security wealth to income ratio is 64 percent and for the mean household is 85 percent. As expected, given social security rules and life-cycle income profiles, social security wealth rises rapidly over the life cycle. Table 4 shows that social security wealth to income ratio grows from 22 percent of income for households aged between 22 and 24 to 120 percent of income between for households aged 37 to 39.

Most interestingly, the data bears out our basic claim that households could wipe out much of their unsecured debt if they had access to their social security wealth. To measure the effects of social security wealth on debt, we construct "social security augmented debt" by subtracting social security wealth from household debt. If social security wealth exceeds debt for a particular household, then social security augmented debt equals zero. Table 5 shows what happens to the distribution of debt when we allow access to social security wealth. In the whole sample, the incidence of unsecured debt falls from 62 percent of households to 17 percent. Of those households that have debt, 72 percent can eliminate it when they have access to social security wealth. For those that cannot eliminate their debt, the level of indebtedness falls dramatically. The 90th percentile household has debt equal to 84 percent of income; after gaining access to social security wealth the 90th percentile household has debt equal to 33 percent of income. Among those households with some debt, the debt to income ratio of the 75th percentile household falls from more than half to just 4 percent. It should be noted that these numbers should be seen as upper bounds. Given the structure of the PSID, we can only measure the actual social security wealth for one member of the household. Debt, however, is for all household members.[11]

In terms of aggregates, the decline in total debt and total interest paid for the U.S. economy resulting from allowing households under 40 to use the social security wealth to pay off non-collateralized debt is large. Table 6 shows some aggregate

[11] We experimented with imputing the spouse's social security wealth given the spouse's current age and work status. Under plausible assumptions, the percent of households with positive debt after also allowing access to the spouse's social security wealth falls to 14 percent.

calculations. Using PSID sample weights and census data, we calculate that allowing households to pay off non-collateralized debt with social security wealth would reduce total household debt by more than \$100 billion and reduce total annual household interest payments by \$11.5 billion per year – or about \$500 for every household that has non-collateralized debt.

3 A life-cycle model

We now construct a model of life-cycle consumption with social security. Our household enters the labor force at age 21, retires and no longer receives labor income after age 65 and dies at age 80 with certainty. We assume that labor is supplied inelastically and that household income evolves deterministically over the life-cycle. The assumption of inelastic labor supply is a strong one, and we revisit the issue in the last section. Our solution for optimizing households allow for stochastic variation in labor income but we go with a deterministic specification for two reasons. First, our focus is on the life-cycle aspects of borrowing and saving, not the high-frequency variation. Second, Davis, Kubler and Willen (2003) show that the predictions of our model for wealth accumulation for relatively impatient households with labor income risk are similar to those of our model with more patient households with no labor income risk. To account for this, we estimate the model with different time discount rates.

Households can trade three financial assets: They can buy equity with stochastic net return $\tilde{r}_E$, bonds at a net risk-free rate r_L, and borrow at the rate $r_B \geq r_L$. Households can buy unlimited positive quantities of stocks and bonds and can borrow unlimited positive amounts but they cannot take short positions in equity or bonds, nor can they borrow negative amounts. We impose the condition that a household must pay off all debts before it dies, which implies that the household cannot borrow more than the present value of all its future labor income discounted at the borrowing rate r_B.

We consider two types of households: An *optimizing* household chooses a plan for consumption, borrowing and asset holdings at date t to maximize:

$$\mathrm{E}_t \sum_{a=t}^{T} \beta^{a-t} \frac{\tilde{c}_a^{1-\gamma}}{1-\gamma}$$

where c_a is consumption at age a, E_t is the expectations operator conditional on time-t information, β is a time discount factor. A *rule-of-thumb* household does not take advantage of financial markets at all and sets consumption equal to income less mandated contributions to social security while working and equal to social security benefits when retired.

We solve the model for optimizing households computationally using methods developed in Judd, Kubler and Schmedders (2002). For details on our numerical solution, see the appendix to Davis, Kubler and Willen. Table 7 lists key features of our parameterization of the model. We draw the reader's attention to three aspects of our parameterization.

First, our choice of asset returns follows Campbell (1999). We set the annual risk-free investment return to 2 percent, the expected return on equity to 8 percent and the standard deviation of equity returns to 15 percent. All returns are in real terms.

Second, Davis, Kubler and Willen (2003) present evidence that the borrowing rate exceeds the riskless lending rate by 10 percentage points. Of those ten percentage points, charge-offs for uncollected loans (i.e., defaults) account for 1.3 percent of the loan value. Conservatively, we assume that the marginal and average borrower are the same and thus we specify a wedge equal to 8 percent, which yields borrowing rate of 10 percent. Our model is partial equilibrium, so we don't attempt to explains the origins of the wedge between borrowing and lending rates. However, Dubey, Geanakoplos and Shubik (2003) and Bisin and Gottardi (1999) present general equilibrium models in which the prices paid by buyers and the prices received by sellers of financial assets diverge because of asymmetric information.

Third, for the life-cycle income processes, we adopt parameter values estimated by Gourinchas and Parker (2002) from the Consumer Expenditure Survey (CEX) and the Panel Study of Income Dynamics (PSID), adjusted as described in Davis, Kubler and Willen. The Gourinchas and Parker (GP) labor income series is after-tax and we make the simplifying assumption that income taxation would be invariant to our proposed schemes.[12]

To carry out the welfare comparisons, we use certainty-equivalent consumption levels. To obtain certainty-equivalent consumption, we first calculate lifetime expected utility, U, for a given consumption profile. We then find the constant level of consumption, $\overline{c}$, that yields the same level of lifetime expected utility. That is, we solve

$$\sum_{a=t}^{T} \beta^{a-t} \frac{\overline{c}^{1-\gamma}}{1-\gamma} = U \quad \text{for} \quad \overline{c} = [\frac{1-\gamma}{\sum_{t=0}^{T} \beta^t} U]^{\gamma-1}. \tag{1}$$

3.1 Social security system

Our social security system works in the following way. Households pay a proportional tax while working. Upon retirement, optimizing households receive a lump-sum payment equal to the value of an annuity paying a fixed fraction of the average of the highest 35 years of income. Rule-of-thumb households receive the annuity.

Our system differs from the real social security system in three fundamental ways:

First, both contributions and benefits are strictly proportional to income whereas in the real social security system, contributions and benefits vary non-linearly with income. Let's focus on the contributions first. In the real world, social security contributions are a fixed portion of income up to a cap. Thus household contributions to social security are a declining fraction of income. In our model, there is no cap but this omission actually strengthens our results. We argue below that the one problem with social security is that it forces households to save when their income is relatively low. The real system makes the problem worse by *raising* the tax rate as income goes down.

[12]Gokhale, Kotlikoff and Neumann (2001) show that by redistributing income over the life-cycle, pension plans can have adverse tax consequences. In some of our policy experiments, we potentially change the life-cycle profile of pre-tax income significantly (by increasing the employer contribution to social security) which could affect many aspects of household decision-making. We do not attempt to model these effects. However, we remind the reader that in our policy experiment of exempting households from social security prior to age 30, these effects will be small.

How do benefits differ between our social security system and the real one? In our model and in the real world, social security benefits depend on income in the highest 35 years of income. However, in the real world, the proportion of one's income that one receives in retirement depends on the level of one's income. Specifically, the marginal increase in retirement income for a dollar of labor income falls with income. Thus, the real social security system reduces relative income for those who have done relatively well and increases relative income for those who have done relatively poorly. In essence, the social security system provides a sort of income insurance for households. Since income is non-stochastic in our model, such a feature would not play a significant role, but it does mean that our model ignores a potential benefit of a social security system. However, in all our policy experiments (aside from the straw man of eliminating social security altogether), the benefits portion of the social security system remains unchanged.

Second, we give a lump-sum to optimizing households rather than an annuity in retirement. We do this because in our model an annuity reduces household welfare. To see why, note that in our model households can replicate an annuity with a lump sum if they want and can often do better, for example, if they want their consumption to slope down. Thus, if we eliminate social security, welfare improves even in the absence of any other distortion. We view this as a problem for the model in light of arguments, discussed in the introduction, that private annuity markets generally cannot replicate the annuity provided by social security. By eliminating the annuity feature from social security, we ensure that the method of provision of benefits is not a liability for social security. As noted above, our policy experiments typically have no effect on the retirement portion of social security – they guarantee exactly the same payment stream as the existing system. So whatever welfare benefits an annuity confers are preserved in our policy experiments. We do, however, report the annuity value of the lump sum as a percentage of income for comparison purposes.

Third, we build on an idea due to Hubbard and Judd (1987), who propose that the social security system exempt young households from contributing. For example, we consider a social security system in which only households over the age of 30 contribute. To maintain the relationship between contributions and benefits, we adjust the level of contributions later in life so that the total discounted contributions under all plans are identical. Below, we discuss this adjustment in depth.

Table 7 shows the basic parameters of our social security system. We draw the reader's attention to two possibly unfamiliar terms: "internal lending rate" and "internal borrowing rate." The internal lending rate (ILR) is the implied rate of return on social security contributions in our system and is usually referred to as the "internal rate of return" in the literature. For example, in our model, the ILR equals the rate of return on investment of contributions that yields the retirement lump-sum benefit we select. We actually work backwards: we choose a level of contributions and an internal lending rate to get our lump-sum benefit. Leimer (1994), in a widely cited article, calculates that the internal lending rate on social security contributions of those currently entering the social security system is 1.7 percent We round up and assume that the internal lending rate is 2.0 percent. In our baseline scenario, this implies that the replacement rate in retirement equals around 43 percent.[13]

The notion of an internal borrowing rate (IBR) relates to our analysis of alternative social security arrangements. In our simulations, we will consider two policy experiments. First, we will allow households to withdraw money from the social security system to pay off debts. Second, as mentioned above, we allow households to push back the point in the life cycle at which they start to contribute to social security. To maintain balance between contributions and benefits, we increase the level of contributions later in the life-cycle. We view the reduction in contributions (from either the exemption or the withdrawal) as a loan: we allow households to increase their after tax income today in exchange for a reduction in income in the future. Reducing contributions today at a cost of increased contributions later in life is tantamount to giving a household a loan from current social security contributions to be paid back in installments at some point in the future. We call the interest rate on this loan the internal borrowing rate. In our baseline scenarios, we set the internal borrowing rate

[13]The Social Security Administration in 2003 states that their target replacement rate is 42 percent (See `http://www.ssa.gov/kc/fact_sheet_14_exp.htm`).

equal to the internal lending rate. We also consider scenarios in which the internal borrowing rate exceeds the internal lending rate. The existing social security system does allow some of this sort of "borrowing": the earlier a household retires, the lower the level of benefits the household receives. In effect, when a household retires early, it borrows against future benefits. Simple calculations show that the implied internal borrowing rate roughly equals the internal lending rate when a household opts for early social security benefits.[14]

3.2 Basic results of the optimizing model

In this section, we outline the basic implications for life-cycle consumption and portfolio choice of our model for optimizing households. For a thorough discussion of the results of the model, see Davis, Kubler and Willen (2003). In the discussion that follows we will use the term "private saving" to measure total wealth of the household not including social security wealth. Note that our "lump-sum" assumption means that for optimizing households all wealth in retirement is "private saving." Four aspects of the solution are relevant to our discussion of social security.

First, the relationship between equity holdings and the borrowing rate is non-monotonic. Consider a small modification to the baseline scenario in which the expected return on equity is 8 percent and the borrowing rate is 8 percent. With this specification, no one would ever borrow money to buy equity since such an investment would have zero expected return and would increase household exposure to risk.

Suppose we lower the borrowing rate: Equity holdings go up. Even a small reduction in the interest rate would turn borrowing to buy equity into a winning proposition. Thus, reductions in the borrowing rate increase equity demand. Conversely, suppose we raise the borrowing rate: Equity holdings will also go up. Households borrow for consumption purposes early in life and as they age, they pay off the debt. Until they pay off the debt, however, purchasing equity makes no sense; the expected return on borrowing to buy equity is now negative. Thus, if we raise the borrowing

[14]Authors' calculation using benefit and life expectancy information from the Social Security Administration web site.

rate, households borrow less for consumption purposes, which means they need to spend less time paying off their debts, which means that they can start saving (and, as a result, buying equity) sooner. So equity demand reaches a minimum when the borrowing rate equals the expected return on equity. Since we choose a borrowing rate of 10 percent, which exceeds, but not by much, the expected return on equity, we can say two things about our model. First, household demand for equity will be relatively low in all our simulations. And second, no household will ever simultaneously hold debt and equity.

As one would expect in a life-cycle model, borrowing (saving) and equity holding are highly sensitive to the shape of the age-income profile. Panels 1-5 of Table 8 show consumption, stock and bond holdings, debt, and social security wealth for households age 22 to 39. Panel 1 shows our baseline specification in which the life-cycle profile is the "pooled" estimate from Gourinchas and Parker. Two features of the borrowing profile stand out. First, the level of borrowing is considerable – peaking at 45 percent of income between the ages of 28 and 30. Second, for the baseline household, borrowing has a hump-shaped profile. The household accumulates debt from age 21 until roughly age 30 and then starts paying it off. Figure 1 shows the age income profiles for different educational attainments as estimated by Gourinchas and Parker. Panels 2 to 4 show the estimates of our model with these alternative age-income profiles. High school educated households (Panel 2) borrow significantly less than the baseline; college educated households (Panel 3) borrow significantly more. Notice from Figure 1 that the age-income profile is less steep for high school educated households, particularly before age 30, compared to the baseline. In contrast, Figure 1 also shows that the age income profile for college educated households is much steeper than the baseline until age 30. One interesting thing to note is that college educated households only accumulate debt from age 22-24 – after that they decumulate. With a flat income profile (Panel 4), households never borrow and by the age 37 to 39 period, accumulate assets worth more than three times annual income; households in the baseline specification accumulate none by the age of 39. Panel 5 shows that increasing the subjective discount factor reduces debt and increases asset accumulation, as one would expect.

With reasonable parameters, the model can generate life-cycle borrowing patterns similar to those we observe in the data. Our baseline household has a life-cycle debt accumulation pattern roughly matches that of the 25th percentile household in Table 4. The household in the model starts a little lower, accumulates more and its debt level peaks a little later. Both the high school educated household and the baseline household with a high discount factor generate borrowing patterns similar to the median household. The focus of this paper is on debtors, which motivates our choice of a household that is roughly the median debtor as our baseline.

Lastly, the gains from equity ownership are quite small in this model. How much is the right to trade equity worth to households? The column labeled "equity benefit" in Table 8 shows the percentage increase in certain equivalent lifetime consumption of a household which can trade equity compared to one that cannot. For our specifications with realistic age-income profiles, the ability to invest in equity increases lifetime consumption by 2 to 3 percent. To put this number in perspective, the gains are on the order of 40 percent in the standard Merton-Samuelson version of this model. Why does equity ownership have so little effect on lifetime consumption in our model? The reason is simple. In the Merton-Samuelson model, households can borrow at the return on riskless bond (i.e., 2 percent in this model). Households can realize arbitrarily large returns with no investment by borrowing at 2 percent and investing in equity with an expected return of 8 percent. Crucially, they can also use low interest unsecured borrowing to borrow against these future excess returns and increase their current consumption accordingly. In our model, equity does afford substantial increases in consumption; however, those increases occur late in life and thus have a comparatively small impact on lifetime utility. This is due to the fact that household income is low while young and it is expensive for households to borrow. Such a model with a wedge between borrowing and lending rates predict equity holdings that are more in line with household data.

3.3 Effect of social security over the life-cycle for optimizing households

Our simulations show that for optimizing households the existing social security system leads to significantly higher levels of debt, lower private savings, lower consumption and lower utility. We first discuss life-cycle aspects of social security and then consider overall measures. The deleterious effect of social security for optimizing households follows directly from our assumptions about borrowing. A household that can borrow at the riskless rate can undo social security completely. For example, as Geanakoplos, Mitchell and Zeldes (1999) point out, only a borrowing constrained household stands to gain from investing social security in equities, since an unconstrained household would have invested the optimal amount in equity anyway.

Figure 2 shows results of our simulations with our baseline social security system. What are the differences between the choices optimizing households with and without social security?

First, the upper left panel of Figure 2 shows that the household with social security accumulates significantly more debt. Initially, the differences are quite small; at age 26, social security leads to a small increase in debt. But at age 30, the household without social security stops accumulating additional debt whereas the household facing social security continues. The contrast is most stark at age 34: the household with social security has more than $10,000 dollars of debt and the same household without has none.

Why don't households stop borrowing completely when we eliminate social security? Eliminating social security has two effects. On one hand, it increases current income relative to retirement income, which increases saving. At the same time, households are liberated from the internal rate of return for a large portion of their investments. The upper left panel of Figure 3 illustrates this point. The line marked "existing" shows the percentage of household saving (including social security wealth) allocated to equities in the existing system – which is zero until age 40 and never exceeds 50 percent. The line marked "optimal" shows the percentage for a household that faces no social security system – which equals 100 percent except for a couple of years shortly before retirement. The change in portfolio returns tilts total household income and induces borrowing early in life.

Second, social security depresses stock and bond holding throughout the life-cycle but increases total saving early in the life cycle. The reduction in stock and bond holding under a system with social security follows from the increased borrowing documented above. Households are forced to save when they do not want to. As a result, they borrow to increase consumption. In our model, households that borrow never invest in bonds or stocks because the cost of borrowing always exceeds the returns on stocks and bonds. Thus, the wealth accumulation phase of the life-cycle only starts when the debt phase ends – and social security pushes that age back from 36 to 41 (see the upper right panel of Figure 2.) But if we include social security wealth, the picture is quite different. Forced social security saving exceeds debt from the beginning which means that total wealth for households with social security is always positive (see the lower left panel of Figure 2) . By contrast, households without social security have negative total wealth until they emerge from debt at age 35.

Third, social security depresses consumption throughout the life-cycle. As the lower right panel of Figure 2 shows, the social security-induced consumption gap is roughly constant at a little more than $1000 dollars until shortly before retirement. Throughout working life, social security drives down after-tax income. Households can (and do) borrow to make up for the forced social security, saving. But, initially, households without social security borrow comparable amounts and don't pay social security yielding higher overall consumption. When households without social security start to accumulate wealth at age 35, the gap actually narrows slightly and then widens shortly before retirement as the effects of higher investment in equities, described above, kick in.

Overall, social security depresses consumption, increases debt, decreases saving and decreases utility for optimizing households. Table 9 shows that on a population weighted basis, households with social security (Panel 1) consume $2,000 less per year on average, have $1,600 more debt and save about $40,000 less than otherwise identical households that face no social security (Panel 11). Eliminating social security raises lifetime certain equivalent consumption by 7.5 percent.

3.4 Effect of social security over the life-cycle for "rule-of-thumb" households

The top panel of Figure 4 shows that for a rule-of-thumb household, social security provides a reasonable approximation to the optimizing portfolio rule. The dashed line marked "income" shows pre-social security income. If there were no social security, a rule-of-thumb household would consume nothing in retirement. With our preference specification, such a household would have infinitely negative utility – certain equivalent consumption would be zero. Social security reduces income during a household's working life and increases it in retirement, as show by the line market "post-SS income." The line marked "optimal" shows the optimal consumption of a baseline forward-looking household which does not participate in social security. For clarity, we assume that this optimizing household does not trade equity either. Clearly, social security generates a much better consumption stream for the rule-of-thumb household. But it still has problems. Early in life, consumption is too low; in middle age, it is too high; and in retirement, it is too low again.

4 Alternate social security policy proposals

We consider two policy experiments. First, we take households that are already in the social security system and have accumulated both social security wealth and unsecured debt and we look at the benefits of using social security wealth to pay off debt. We call this the *payoff* proposal. Second, we consider the whole life-cycle and try to design a social security system that doesn't force households to both borrow and save at the same time. Specifically, we evaluate a proposal to exempt young households from contributing to social security. We call this the *exemption* proposal.

We evaluate policy proposals using four criteria. First, does the policy proposal prevent optimizing households from simultaneously borrowing and holding social security wealth – the problem with which we motivated this paper? More generally, what happens to household consumption, saving and debt? Second, what are the welfare consequences for optimizing and rule-of-thumb households? Third, we compare our proposals with much-discussed alternatives that seek to raise the internal rate of return, or in our parlance, the internal lending rate. And finally, for the exemption proposals, we ask how the proposal affects the average household net contribution to social security.

For all our experiments, we require that the replacement rate in retirement equal or exceed the replacement rate in the existing social security system.

4.1 The payoff proposal

According to Table 2, our average debtor household is around age 30 and has average debt around 60 percent of income. Suppose we take such a household and assume that they have social security wealth equal to their debt (in reality, their social security wealth is higher). Consider the following policy proposal. Allow that 30-year-old household to withdraw cash from social security. To make sure this is an admissible plan, we require that the household increase its subsequent contributions from 10.6 percent of labor income to 12.8 percent of labor income which assures us that the retirement replacement rate equals the 43 percent guaranteed by the existing system.[15] This proposal is not relevant for rule-of-thumb households since in our model such households do not accumulate debt.

How well does this payoff proposal do? First, does the payoff proposal eliminate the problem of simultaneous unsecured borrowing and social security investment among optimizing households? The answer is not completely. The upper left panel of Figure 5 shows debt and social security wealth with our proposal ("reduced debt") and without ("existing"). Household use most but not all of their social security wealth to pay down debt. A small portion is used to finance increased consumption.

[15] 12.8 percent would be the tax rate necessary to pay for the withdrawal of 60 percent of income from accumulated social security wealth to pay off existing debt.

To maintain the higher level of consumption, the household continues to borrow small amounts until age 33 at which point it starts to pay off the debt. Since households must continue to make social security contributions, our proposal does not eliminate the problem of simultaneous debt and borrowing although it reduces it dramatically. As discussed above, eliminating the debt allows households to save in equities earlier (and reduce debt payments) resulting in a wealth effect, which in turn causes households to want higher consumption.

Second, the payoff proposal greatly increases utility the optimizing households. Table 10 shows that our proposal (Panel 2) raises certain equivalent consumption by 2.1 percent for optimizing households versus the existing social security system (Panel 1). To put this in perspective, Panel 5 of the table shows that eliminating social security altogether would raise certain equivalent consumption for optimizing households by almost 10 percent.

Third, the payoff proposal compares well with alternative proposals for social security. Panels 3 and 4 of Table 10 show the effects on utility of increasing the internal lending rate but otherwise keeping the social security system as is. Allowing households to use social security to pay off debt yields a welfare payoff equivalent to an increase in the internal lending rate (ILR) of between 3 and 4 percent for an optimizing household. For a rule-of-thumb household, an increase in the ILR generates a much bigger increase in utility than our proposal. The difference in effects for different types of households results from the unwillingness of rule-of-thumb households to trade equity on their own. Optimizing households already buy some equity on their own, so their effective "lending rate" is much higher than the return on social security. But for rule-of-thumb households, increasing the ILR is akin to forcing them to invest in equity with consequently large welfare improvements. We will return to this theme in the next section when we consider our proposal for exemptions to social security contributions.

To help illustrate the payoff proposal, we suggest an alternative interpretation. What we are doing here is allowing household to spend money now (to pay off debt) on condition that they pay money later in the form of increased social security contributions. In other words, our household is borrowing money. Specifically, our household borrows 60 percent of income and pays it back in 35 annual installments each one equal to 1.7 percent of annual income – the difference between the standard social security contribution and the one necessary to pay off the debt. It is easy to see that the interest rate on the loan equals the ILR. But who is the household borrowing from? One way to view it is that the household is borrowing from itself. Later on, we will argue that the sensible interpretation is as a loan from the government but when the internal borrowing and lending rates are the same, either interpretation is valid. So what the household is really doing is investing social security wealth in a loan to itself. The calculations show that reallocating a social security portfolio into loans to oneself is equivalent to reallocating your social security portfolio into an asset that pays a little more than 3 percent return for sure.

4.2 The exemption proposal

In this section, we propose changes in the age structure of social security contributions. Specifically, we build on Hubbard and Judd's idea (1987) to ameliorate the life-cycle effects of social security by providing young households with an "exemption" from social security contributions. Recall that we require the households increase their contribution after the exemption expires to assure that their retirement replacement rate equals the replacement rate in the existing system. We consider three age-based exemptions: no contributions before age 30; no contributions before age 40; and no contributions before age 50. As we discuss in the conclusion, the latter two policies will require large changes in the household's marginal tax rate after exemption expires. Such changes in the tax structure could induce changes in household behavior which we abstract from at this time. However, the before age 30 exemption requires very small changes in the marginal tax rate after the age of 30. As a result, the labor supply effects of changing tax rates after the age 30 exemption expires would be negligible.

Again we return to the four questions posed in the beginning of this section. First, do these policy proposals prevent households from simultaneously borrowing and holding social security wealth? Yes; Figure 6 shows that all three exemption programs ensure that households have no debt by the time they start contributing to social security. For the age 40 and 50 exemptions, this result is not surprising. The upper left panel of Figure 2 shows that with the current social security system, households pay off most of their debt by age 40 anyway. But even with the age 30 exemption, households are out of debt by the time social security taxes take effect. Optimizing households anticipate the 12.9 percent permanent drop in income that will occur at age 30 and start saving in advance.

More broadly, the payoff proposal improves the general household balance sheet. Table 9 shows per capita levels of of consumption, debt and savings for optimizing households under the different exemption plans (panels 2, 3, and 4, respectively). Panel 1 of Table 9 shows the baseline model with the existing social security system. Panel 11 of Table 9 shows the results of the model with no social security system. The age 30 exemption leads to an almost complete elimination of unsecured debt. Households increase consumption and save slightly more. Why do both consumption and saving go up? As we explained in Section 3.1, an exemption as we define it can be interpreted as a loan: it raises income today in return for a reduction in future income. There is, however, a key difference between an exemption and unsecured debt in our model: instead of paying a credit card company 10 percent, an exempted household pays the government 2 percent. Delaying contributions to social security until later in the life cycle leads to continued increases in saving and consumption but also to increases in debt. Why do both debt and saving go up? The longer the exemption, the steeper the income profile when young (see the bottom panel of Figure 4). At the same time, the longer the exemption, the bigger the discontinuous drop in income when the exemption ends. The sharp future decline in income causes a household to increase saving today.

Second, what happens to utility? The exemption generate substantial increases in utility for both optimizing and rule-of-thumb households. The age 30 exemption increases certainty equivalent consumption by roughly comparable amounts for optimizing and rule-of-thumb households – 3.4 and 3.3 percent respectively. An age 40 exemption helps both types of households – but the gains are bigger for the optimizing households – 5.5 percent versus 4.8 percent. And age 50 exemption generates a large welfare gain for optimizing households – 6.7 percent of annual consumption. In contrast, the age 50 exemption results in a small reduction in welfare for the rule-of-thumb household vis-a-vis the age 40 exemption. For the optimizing household, the age 50 exemption reduces the burden of social security by about 90 percent (6.7 change in utility/7.5 change in utility). In the next section, we explain why the exemptions work so well.

Third, how do the utility gains from the payoff proposal compare to gains to simply raising the internal lending rate? For both optimizing and rule-of-thumb households, the answer depends on whether we change contribution rates when we increase the internal lending rate. Suppose we assume that contribution rates remain the same as it is currently. Then for optimizing household, exemptions clearly dominate (see panels 5, 6, and 7 of Table 9). Even an increase in the internal lending rate to 5 percent increases certain equivalent consumption by an amount less than that for the age 30 exemption. By contrast, for rule-of-thumb households, raising the internal lending rate is a winning proposition. Raising the ILR to 3 percent generates gains comparable to those of the exemptions but higher ILRs lead to much larger welfare gains (compare panel 4 of Table 9 to panel 7 of Table 9). This welfare gain for rule-of-thumb households should not be surprising. If we leave contribution rates constant and increase ILR, replacement rates in retirement must increase dramatically. For example, a 5 percent ILR leads to a replacement rate of 88 percent of pre-retirement income, holding contributions constant. In that case, the decline in cash flow at the time of retirement for rule-of-thumb households is small. Stabilizing income during retirement has large welfare benefits for rule-of-thumb households.

Now suppose we we simultaneously lower withholding rates when we increase the ILR so that the replacement rate in retirement remains constant at 43 percent. Now the results are reversed. The gains to rule-of-thumb households are relatively small. An increase of the ILR to 5 percent generates a welfare increase in between the age 30 and the age 40 exemptions. For optimizing households, however, the gains are much larger: an increase in the ILR to 5 percent yields welfare increases comparable to the age 40 exemption. Why are the effects so different? For rule-of-thumb households, the opportunity to invest at 5 percent is extremely valuable – since they don't invest in equity (or in anything). But for optimizing households, even a 5 percent ILR is still less than they get investing in equity at 8 percent.

Finally, how do our proposals affect the net household contributions to social security. As we said in the introduction, we make no assumption here about how social security is funded. As far as households are concerned, social security withholds contributions and pays out benefits. But social security is basically a pay-as-you-go system and its long run solvency depends on taking in as much in contributions as it pays out in benefits. In other words, the solvency depends on having non-negative net contributions. So we ask how the payoff proposal (and raising the ILR) would affect the level of net contributions. To answer this question, we assume that aggregate wage growth equals the baseline ILR of 2 percent. This means that if there were no population growth, social security would always take in exactly as much in contributions as it pays out in benefits. In addition, our exemptions should have no effect on net contributions. In fact, given the year 2000 population distribution, our exemptions do affect net contributions. The age 40 to age 50 group is relatively large and so the age 30 and age 40 exemptions shift contributions to that group, which raises net contributions. The age 50 exemption shifts contributions away from the age 40 to 50 group and reduces net contributions. In contrast, raising the ILR always leads to a deterioration in the level of net contributions. However, proposals to raise the ILR are always paired with proposals to generate additional income through investment in stock. But our results on net contributions illustrate that we can generate significant welfare improvements without investing in stock or reducing the solvency of the social security system. In Section 4.4, we show by changing the internal borrowing rate we improve the solvency of social security while preserving some of the welfare benefits.

4.3 Approximating optimal policy rules

Let's first consider the rule-of-thumb households. First, we consider existing social security. The top panel of Figure 4 shows that the existing social security system lowers consumption to below the optimal level early in life and allows it to exceed the optimal level in middle age and to fall short of the optimal level in retirement. The bottom panel Figure 4 shows after-social security income for the three exemptions compared to optimal consumption for a household that can't trade equity. All three exemptions increase consumption early in life and lower it in middle age. In each case, the cost of the exemption is a discontinuous fall in consumption at the start of the exemption. The cost of the discontinuity illustrates why rule-of-thumb households prefer the age 40 to the 50 exemption in spite of the fact that from age 50 to retirement the age 50 exemption almost exactly matches the optimal profile.

For the optimizing households, the explanation for the success of the exemptions is more complex because social security not only interferes with savings decisions but also with portfolio allocation decisions. We first consider the saving decision and then the portfolio allocation decision. The top right panel of Figure 3 shows total saving (including social security wealth) in excess of the no-social security optimum for a baseline household under four scenarios: the existing social security system; and social security with the three age-based exemption rules. As the picture shows, deviations from the optimum get progressively smaller as we extend the exemption.

We note two odd features of the excess saving. First, households in all the social security systems oversave relative to the no social security benchmark until roughly age 60. For households in the existing social security system, this is not too puzzling – the system forces them to save when they would actually like to borrow. But in the age 40 and age 50 exemptions, forced saving starts *after* the household would have started saving anyway. So why do they oversave even before the exemption starts? The reason is that the exemption leads to a discontinuous but predictable drop in income (17.9 percent for the age 40 exemption and 30.4 percent for the age 50 exemption, see Table 9). Households engage in private saving in anticipation of this – which you can see in the lower panel of Figure 3, which shows what we call excess private or non-social security saving.

The second odd feature of the life-cycle excess saving profile is that households in all the social security systems undersave relative to the no social security benchmark after roughly age 60. Why does this happen? The lower panel of Figure 3 shows that private saving falls relative to the non-social security benchmark when the exemption ends – the forced saving crowds out private saving. Since the return on private saving is much higher than the return on forced saving, wealth accumulates much more quickly for households that don't have social security.

We now discuss how social security affects portfolio allocation and show that exemptions reduce the distortions generated by social security. The upper left panel of Figure 3 compares portfolio allocations to equities over the life cycle for the four social security schemes and the no social security optimum. In the absence of social security, households invest all their money in equities until quite late in the life cycle – which we see in the line marked "optimal" in the figure. Households invest almost all their money in equity in virtually all portfolio choice models with labor income which follows from the fact that financial wealth is a small fraction of total wealth – which includes human capital – until late in the life cycle. Thus households can invest almost all their financial wealth in equity but still have relatively low exposure to it. Under the existing social security system, equity's share never exceeds 50 percent and is zero for much of the life cycle. Before the age of 40, households facing the existing social security system engage in no private saving – all their saving is forced and all forced saving is invested at the internal lending rate – 2 percent in our case.

The top right panel of Figure 3 shows that exemptions close the gap. For the age 40 and 50 exemptions, households never invest less than 50 percent in equities and invest 100 for much of the life cycle. Why? The basic reason is that with exemptions, households engage in considerably more private saving. Consider first a household with the age 30 exemption. They start saving before they reach 30 in anticipation of a decline in income when the exemption ends. At age 30, they start dissaving to maintain consumption, but by the age of 35, they are accumulating again and all their accumulation goes into equity. Now consider a household facing an age 40 or age 50 exemption. In both cases, they save entirely in equities in anticipation of the exemption. Then when the exemption ends, they start to draw down their private saving and replace it with forced saving, which they cannot invest in equities.

To quantify the effect of exemptions on optimal saving and on optimal portfolio allocation, we conduct the following exercise. Table 11 shows the effects of exemptions in the Hubbard-Judd scenario in which there are no risky assets. We note three things. First, the increase in certain equivalent consumption from eliminating social security altogether is much smaller – roughly \$1,000 compared with the \$1,700 in the risky asset scenario. Second, an age 30 exemption wipes out about 70 percent of the portfolio loss and an age 40 exemption wipes out 97 percent. By contrast, when there are risky assets, an age 30 exemption only eliminates 45 percent of the portfolio loss and an age 40 exemption eliminates about 70 percent. As the top right panel of Figure 3 shows, going from the age 40 exemption to the age 50 exemption brings portfolio allocation much closer to the optimal level.

4.4 Raising the internal borrowing rate

In Section 4.1, we characterized exemptions as loans from the government to the household to pay the social security contribution that year. The exemptions, as discussed in the previous two sections, implicitly assume an internal borrowing rate (the interest rate on the loans) equal to the internal lending rate which roughly equals the riskless lending rate. What if the government charged a higher borrowing rate? Since households already pay 10 percent for unsecured debt as it is, why should we require the government to charge only 2 percent?

In Table 12, we show the effects of higher borrowing rates on households when we introduce an age 40 exemption and charge different internal borrowing rates. According to our results, social security could charge as much as 7 percent interest and still make both types of households better off. The main upside for social security is an obvious increase in net contributions to social security. Using a 5 percent borrowing rate, for example, would more than double net contributions using 2000 population weights. Using 2020 population weights, a 5 percent internal borrowing rate would turn a per capita deficit for social security into a per capita surplus.

5 Conclusion and directions for future research

In this paper, we show that the current social security system leads many households to save at low interest rates and borrow at high interest rates. We show empirically that simply allowing households to use the money they have paid in to the social security system to pay off debt would allow many households to get out of debt completely and others to dramatically reduce their exposure to high interest unsecured debt. We then considered two policy experiments aimed at resolving this problem in the context of a life-cycle model with both optimizing and rule-of-thumb households. First, we considered allowing households to use the money in social security to get out of debt. And then we considered options to change the age structure of social security to prevent households from borrowing while they also contribute to social security. We found that both proposals, but in particular the latter, solved the problem in question and led to significant increases in household welfare, consumption and saving and reductions in high-interest unsecured debt.

We showed that our options generated comparable and often higher welfare increases than popular proposals to increase the return on investment in social security. And they do so without any major administrative change to the social security system. There are no individual accounts. There is no uncertainty about returns. And it preserves the basic functions of social security: it does not subject rule-of-thumb households to politically unacceptable risks.

There are, however, two limitations of our analysis with respect to optimizing households. First, we assume exogenous labor supply. Some of our policy experiments introduce major changes in both the level of social security taxes and the life-cycle profile of them. For example, compared to the existing system, the age 50 exemption leads to a significant reduction in taxes before age 50 and a huge increase in taxes after age 50. Such a change in the tax code could lead to major changes in life cycle labor supply. However, our preferred model of exempting households up to the age of 30 (as opposed to the age 40 or age 50 exemptions) results in large welfare gains and only requires an increase in the marginal tax rates after the age of 30 from 10.6 percent to 12.9 percent. Relative to changes in the social security tax rate observed over the last quarter century, this change is very small and would have minimal effects on household labor supply.

Second, we have constructed a partial equilibrium model. Obviously, if a policy change has significant partial equilibrium effects, one would imagine that it would have significant general equilibrium effects. Researchers have found, for example, that investing some of the social security trust fund in equities – which we modeled as an increase in the internal lending rate – would have significant macroeconomic effects (see Bohn, 1999, and Diamond and Geanakoplos, 2002, for examples).

A model that incorporates both endogenous labor supply and general equilibrium would strengthen our results significantly. However, as noted above, for one policy proposal – the age 30 exemption – neither extension should have a sizeable effect on our conclusions. First, the increase in withholding on labor income is very small – from 10.6 to 12.9 percent of income, comparable in magnitude to the increase in social security withholding that took place between 1980 and 1994. Second, Table 9 shows that an age 30 exemption has a small impact on consumption demand (a little more than a 1 percent increase) and a small impact on saving (a little more than a 4 percent increase). The main change is a dramatic reduction in consumer unsecured debt. Such a change could affect the wedge between borrowing and lending rates. Analyzing the general equilibrium affects of such a policy change on consumer credit markets would be a fruitful area for future research.

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Table 1: Summary of results. Number in box is certain equivalent lifetime consumption measured in thousands of 1987 dollars. Percentage difference from existing is in parentheses.

	Optimizing households	**"Rule-of-thumb" households**
Existing	Suboptimal portfolio choice 22.2 (-0.0%)	Reasonable pension 20.5 (0.0%)
No social security	Optimal portfolio choice 23.9 (7.5%)	Starvation 0.0 (-100.0%)
Age 30 exemption	23.0 (3.4%)	21.1 (3.3%)
Age 40 exemption	23.4 (5.5%)	21.4 (4.8%)
Age 50 exemption	23.7 (6.7%)	21.4 (4.6%)
Raise IRR to 4%	22.5 (1.4%)	21.9 (7.0%)
Age 40 exemption + Raise IBR to 5%	23.0 (3.4%)	21.1 (3.0%)

Notes:

1. See Section 3 for a complete description of the model.

2. See equation (1) for the calculation of certainty-equivalent (CE) consumption. Consumption is measured in 1987 dollars.

3. With no social security, rule-of-thumb households earn no income in retirement and thus consume nothing. Since utility is CRRA with RRA=3, certain equivalent consumption is zero.

Table 2: Descriptive statistics for 1999 PSID sample, by debt holding. Notes – Sample includes 1) all unmarried households with heads between the age of 22 and 39 and 2) married households with heads between the age of 22 and 39 where the head also has a complete earnings history. Head's total social security contributions are computed by the authors using the household heads earnings history and social security tax formulas. The contributions are accumulated from the head's first year in the labor force through 1998. Household net liquid assets are defined as the sum of cash, checking and saving balances, stocks, corporate bonds, and Treasuries less unsecured debt. Household net financial asses are defined as the some of stocks and corporate bonds less unsecured debt. Sample is split by households with no unsecured debt (column II) and households with some positive amount of unsecured debt (column III). All dollar amounts are reported in 1996 dollars.

		I	*II*	*III*	*IV*
			Sample by household unsecured debt level		
Variable		All	No debt	Positive debt	p-value of difference
Age of the household head		31.6	32.3	31.1	<0.01
Percent of households with...					
Sex of head = Male		0.83	0.84	0.83	0.58
Race of head = Black		0.12	0.16	0.09	<0.01
Married		0.55	0.50	0.58	<0.01
Unsecured debt		0.62	–	–	–
Head's 1998 labor income	Mean	33,600	35,400	32,500	<0.05
	Median	27,400	27,400	27,800	0.40
Numbers below all divided by income					
Head's total SS contributions	Mean	0.85	0.91	0.81	<0.01
	Median	0.64	0.68	0.62	0.02
Household unsecured debt	Mean	0.36	–	0.58	–
	Median	0.05	–	0.22	–
Household total net-worth	Mean	2.02	3.07	1.80	<0.01
	Median	0.66	1.00	0.48	<0.01
Household net liquid assets	Mean	0.24	0.78	-0.08	<0.01
	Median	0	0.08	-0.08	<0.01
Household net financial assets	Mean	0.04	0.50	-0.24	<0.01
	Median	0	0	-0.16	<0.01
Sample Size		2,077	844	1,233	

Table 3: Portfolio composition of PSID households under 40, by debt holding. "Cash" includes cash, checking and saving accounts. For other queries, see notes to Table 2.

	I	*II*	*III*	*IV*
	Sample by household debt level			
Variable	All	No debt	Positive debt	p-value of difference
Owning a home	0.44	0.44	0.44	0.81
Having positive cash	0.83	0.74	0.89	<0.01
Owning any stocks	0.22	0.22	0.22	0.99
Owning any bonds	0.17	0.15	0.18	0.06
Owning stocks or bonds	0.32	0.30	0.33	0.26
Owning cash, stocks or bonds	0.85	0.77	0.90	<0.01
Owning a business	0.09	0.10	0.09	0.91
Having negative net worth	0.16	0.01	0.26	<0.01
Having negative net liquid assets	0.39	0	0.63	<0.01
Having negative net financial assets	0.50	0	0.82	<0.01
Sample Size	2,077	844	1,233	

Table 4: Median ratio of net financial assets to income, by age range. See notes to Table 2.

Age range	Debt/Income by %ile			SS Wealth
	50	75	90	/Income
22 – 24	0.13	0.45	1.54	0.22
25 – 27	0.14	0.54	1.11	0.33
28 – 30	0.12	0.37	0.90	0.60
31 – 33	0.03	0.27	0.70	0.70
34 – 36	0.02	0.20	0.54	1.07
37 – 39	0.03	0.20	0.56	1.20

Table 5: Distribution of unsecured debt to income before and after adjusting for social security wealth. Notes – Data is from the 1999 PSID. Sample in columns I and II includes 1) all unmarried households with heads between the age of 22 and 39 and 2) married households with heads between the age of 22 and 39 where the head also has a complete earnings history (2,077 households). Sample in column II includes all unmarried households with heads between the age of 22 and 39 (513 households). Social security augmented debt is defined as unsecured debt less total accumulated social security contributions of the head. Social security augmented debt is constructed to be non-negative. In other words, if social security contributions exceed the household's unsecured debt, social security augmented debt is set equal to zero.

	I	*II*	*III*
	All households	All households with debt	Single households with debt
Panel A			
Percent with positive unsecured debt			
	0.62	1.00	1.00
Distribution of debt to income ratio			
25^{th} Percentile	0.00	0.08	0.09
50^{th} Percentile	0.05	0.22	0.25
75^{th} Percentile	0.29	0.53	0.60
90^{th} Percentile	0.84	1.20	1.72
Mean	0.36	0.58	0.79
Panel B			
Percent with positive social security augmented debt			
	0.17	0.28	0.31
Distribution of social security augmented debt to income ratio			
25^{th} Percentile	0	0	0
50^{th} Percentile	0	0	0
75^{th} Percentile	0	0.04	0.14
90^{th} Percentile	0.33	0.74	0.97
Mean	0.19	0.32	0.50

Table 6: Aggregate effects of allowing households to use social security wealth to pay off non-collateralized debt. All dollar amounts are in 1996 dollars. Data comes from the 1999 Panel Study of Income Dynamics. Debt reduction is calculated by using accumulated social security wealth to pay off existing non-collateralized debt. Non-collateralized debt assumes an interest rate of 10% while social security wealth assumes an interest rate of 2%. To compute total debt reduction for the U.S. population, we use 104 million households (Census Bureau), 36.6% of which have heads between the ages of 22 and 40 (PSID weighted data), and 60.8% of which have non-collateralized debt (PSID weighted data).

Average debt reduction for households with debt between the ages of 22 and 40 (1999)	$6,225
Average annual interest saving resulting from debt reduction for households with debt between the ages of 22 and 40 (1999)	$498
Total debt reduction for households aged 22 to 40 (1999)	$144.1 billion
Total annual interest saved by households aged 22 to 40 (1999)	$11.5 billion

Table 7: Parameter Settings

Parameter	Baseline	Alternative values
Relative risk aversion	3	
Annual discount factor	0.97	0.98
Age of labor force entry	21	
Age of retirement	65	
Age of death	80	
r_L	2%	
r_B	10%	
$\mathrm{E}(\tilde{r}_E)$	8%	
$\mathrm{std}\,(\tilde{r}_E)$	15%	
Social security parameters		
Start year	21	30,40,50
Contribution rate	10%	see tables
Internal lending rate	2%	see tables
Internal borrowing rate	2%	3%,4%,5%

Table 8: Consumption and portfolio choice for optimizing households over the life cycle as predicted by the model under various assumptions.

#	β	Profile	Equity benefit		22-24	25-27	28-30	31-33	34-36	37-39	22-39
1	0.97	Baseline	2.39	Consumption	16.8	18.0	19.2	20.5	21.8	23.3	19.9
				Stocks+bonds/Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				Debt/Y	0.27	0.40	0.45	0.42	0.32	0.16	0.33
				SS wealth/Y	0.30	0.58	0.85	1.12	1.40	1.67	1.06
2	0.97	High school	2.55	Consumption	16.4	17.5	18.7	20.0	21.3	22.7	19.4
				Stocks+bonds/Y	0.00	0.00	0.00	0.00	0.00	0.02	0.00
				Debt/Y	0.04	0.09	0.13	0.14	0.10	0.01	0.08
				SS wealth/Y	0.30	0.60	0.90	1.18	1.45	1.72	1.09
3	0.97	College	3.03	Consumption	19.9	21.2	22.6	24.1	25.7	27.0	23.4
				Stocks+bonds/Y	0.00	0.00	0.00	0.00	0.02	0.17	0.04
				Debt/Y	0.50	0.48	0.33	0.15	0.01	0.00	0.22
				SS wealth/Y	0.28	0.53	0.81	1.12	1.45	1.77	1.06
4	0.97	Flat	8.55	Consumption	22.8	23.8	24.7	25.7	26.8	27.9	25.3
				Stocks+bonds/Y	0.46	0.94	1.41	1.90	2.42	2.96	1.68
				Debt/Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				SS wealth/Y	0.31	0.64	0.99	1.36	1.75	2.16	1.20
5	0.98	Baseline	3.62	Consumption	16.4	17.7	19.0	20.5	22.1	23.4	19.8
				Stocks+bonds/Y	0.00	0.00	0.00	0.00	0.03	0.23	0.05
				Debt/Y	0.17	0.23	0.21	0.12	0.01	0.00	0.11
				SS wealth/Y	0.30	0.58	0.85	1.12	1.40	1.67	1.06

Notes:

1. All parameters are baseline (Table 7) unless otherwise indicated.
2. Consumption is measured in 1987 dollars.
3. Equity benefit measures the percentage increase in certain equivalent consumption yielded by investment in equity.

Table 9: Effects of exemptions. All amounts in thousands of 1987 dollars unless otherwise noted. See Table 10 for definitions.

#	Parameters of SS system				Utility		Population weighted *per capita*				
	Start age	With-holding	ILR	Repl. rate	Optimizing (Δ)	$C = Y$ (Δ)	Optimizing			$C = Y$	Net SS contrib.
							Cons.	Debt	Saving	Cons.	
1	21	10.6	2	43	22.2 (-0.0)	20.5 (0.0)	26.1	3.4	58.3	25.5	1.1
2	30	12.9	2	43	23.0 (3.4)	21.1 (3.3)	26.4	0.2	60.8	25.2	1.3
3	40	17.9	2	43	23.4 (5.5)	21.4 (4.8)	26.8	0.8	72.4	25.2	1.4
4	50	30.4	2	43	23.7 (6.7)	21.4 (4.6)	27.3	1.3	84.9	25.6	1.0
5	21	10.6	3	54	22.3 (0.6)	21.3 (4.0)	26.4	4.0	52.3	25.8	0.7
6	21	10.6	4	68	22.5 (1.4)	21.9 (7.0)	26.7	4.7	45.9	26.2	0.2
7	21	10.6	5	88	22.7 (2.3)	22.3 (9.1)	27.2	6.0	38.9	26.8	-0.5
8	21	8.6	3	43	22.7 (2.2)	20.8 (1.8)	26.7	3.4	60.2	26.0	0.6
9	21	6.9	4	43	23.1 (4.0)	21.1 (3.2)	27.2	3.4	61.9	26.5	0.1
10	21	5.4	5	42	23.4 (5.6)	21.3 (3.9)	27.5	3.5	63.5	26.9	-0.3
11	21	0.0	2	0	23.9 (7.5)	0.0 (-100.0)	28.1	1.8	99.0	26.9	0.0

Table 10: The effects of allowing households to use social security wealth to pay off debt.

#	Age 30 wealth		Parameters of SS system			Utility	
	Non-SS	SS	With-holding	ILR	Repl. rate	Optimizing (Δ)	$C = Y$ (Δ)
1	-0.6	0.6	10.6	2	42	25.3 (0.0)	21.9 (0.0)
2	0.0	0.0	12.8	2	43	25.9 (2.1)	22.6 (2.9)
3	-0.6	0.6	10.6	3	51	25.6 (1.1)	23.4 (6.9)
4	-0.6	0.6	10.6	4	64	25.9 (2.4)	24.7 (12.5)
5	0.0	0.0	0.0	2	0	27.7 (9.5)	0.0 (-100.0)

Notes:

1. ILR is the internal lending rate (See Section 3.1 for an explanation.)
2. Private saving equals stocks plus bonds minus debt.
3. Scenario is baseline (see Table 7).
4. Replacement rate is the annuity value of the lump-sum payment from social security as a fraction of the top 35 years of income.
5. Utility is certain equivalent consumption (see equation (1)).
6. Δ is difference from existing. case).

Table 11: Effects of exemptions. Scenario is baseline (see Table 7) except that households cannot trade equity. See Table 10 for definitions.

#	Parameters of SS system: Start age	Parameters of SS system: With-holding	Parameters of SS system: ILR	Parameters of SS system: Repl. rate	Utility: Optimizing (Δ)	Utility: $C=Y$ (Δ)	Population weighted *per capita*: Optimizing Cons.	Population weighted *per capita*: Optimizing Debt	Population weighted *per capita*: Optimizing Saving	Population weighted *per capita*: $C=Y$ Cons.	Population weighted *per capita*: Net SS contrib.
1	21	10.6	2	43	21.7 (0.0)	20.5 (0.0)	24.1	5.6	66.3	25.5	1.1
2	30	12.9	2	43	22.3 (3.1)	21.1 (3.3)	24.4	0.9	65.5	25.2	1.3
3	40	17.9	2	43	22.6 (4.4)	21.4 (4.8)	24.2	2.8	61.9	25.2	1.4
4	21	0.0	2	0	22.7 (4.5)	0.0 (-100.0)	24.2	3.2	77.4	26.9	0.0

Table 12: Effects of changes in the Internal Borrowing Rate (IBR) (See Section 3.1 for an explanation) for an age 40 exemption. Scenario is baseline (see Table 7) except where noted. See Table 10 for definitions.

#	Parameters of SS system				Utility		Population weighted *per capita*					
							Optimizing			$C=Y$	Net SS contrib.	
	Start age	With-holding	IBR	Repl. rate	Optimizing (Δ)	$C=Y$ (Δ)	Cons.	Debt	Saving	Cons.	2000	2020
1	21	10.6	2	43	22.2 (-0.0)	20.5 (0.0)	26.1	3.4	58.3	25.5	1.1	-0.1
2	40	17.9	2	43	23.4 (5.5)	21.4 (4.8)	26.8	0.8	72.4	25.2	1.4	0.0
3	40	21.6	4	43	23.1 (4.2)	21.2 (3.7)	26.4	0.6	74.5	24.6	2.0	0.6
4	40	24.0	5	43	23.0 (3.4)	21.1 (3.0)	26.1	0.4	76.0	24.2	2.4	1.0
5	40	26.9	6	43	22.7 (2.4)	20.9 (2.0)	25.8	0.3	78.2	23.7	2.9	1.4
6	40	30.3	7	43	22.5 (1.2)	20.6 (0.7)	25.5	0.2	81.0	23.1	3.5	2.0
7	40	34.4	8	43	21.3 (-3.9)	20.3 (-1.0)	25.0	0.2	84.0	22.4	4.2	2.6
8	21	0.0	2	0	23.9 (7.5)	0.0 (-100.0)	28.1	1.8	99.0	26.9	0.0	0.0

Figure 1: Expected labor income profiles.

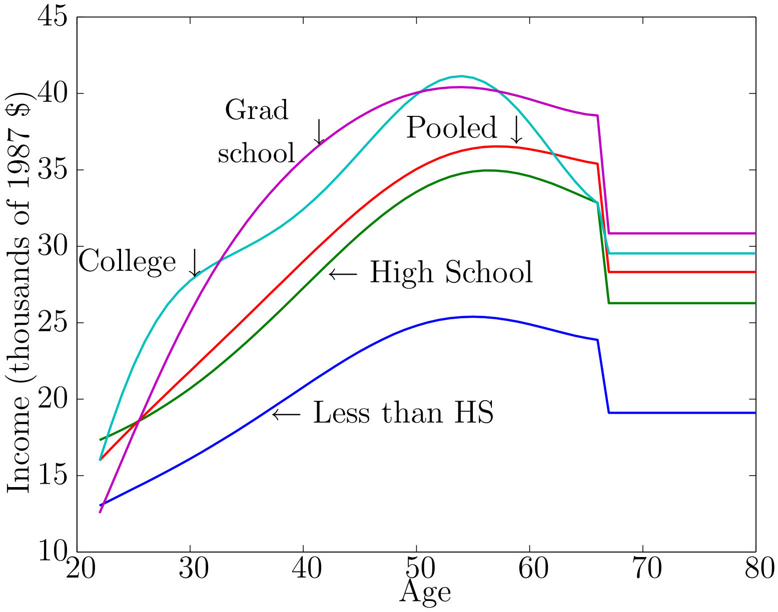

Figure 2: Effect of social security on various household indicators over the life cycle. Baseline specification.

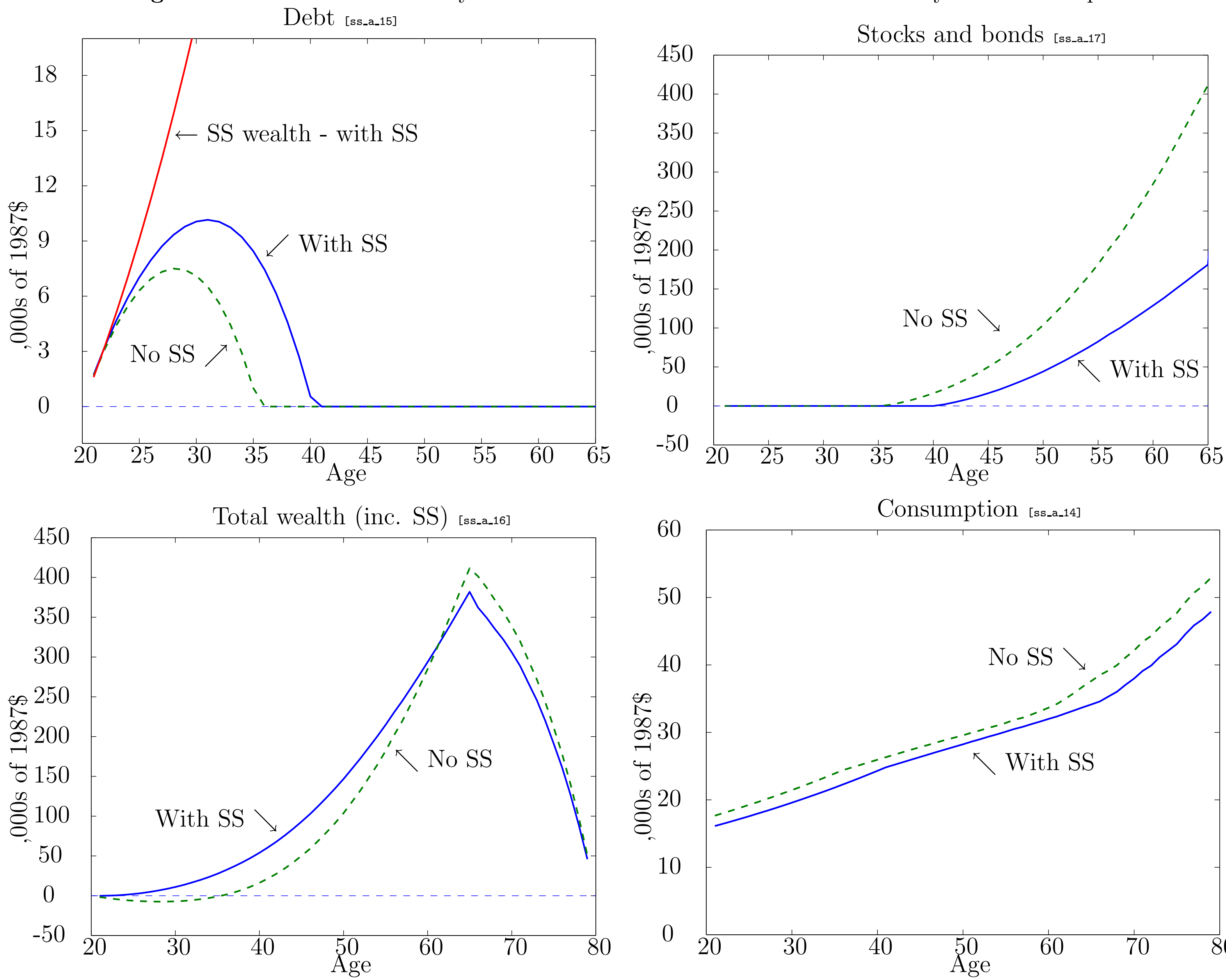

Figure 3: Excess saving over the life cycle for various different social security schemes. Excess saving equals the difference between total saving (including social security) under the listed scheme and total saving under the optimal scenario for the household in which there is no social security. Age 30 refers to an exemption ending at age 30 and so on. Existing is the existing system.

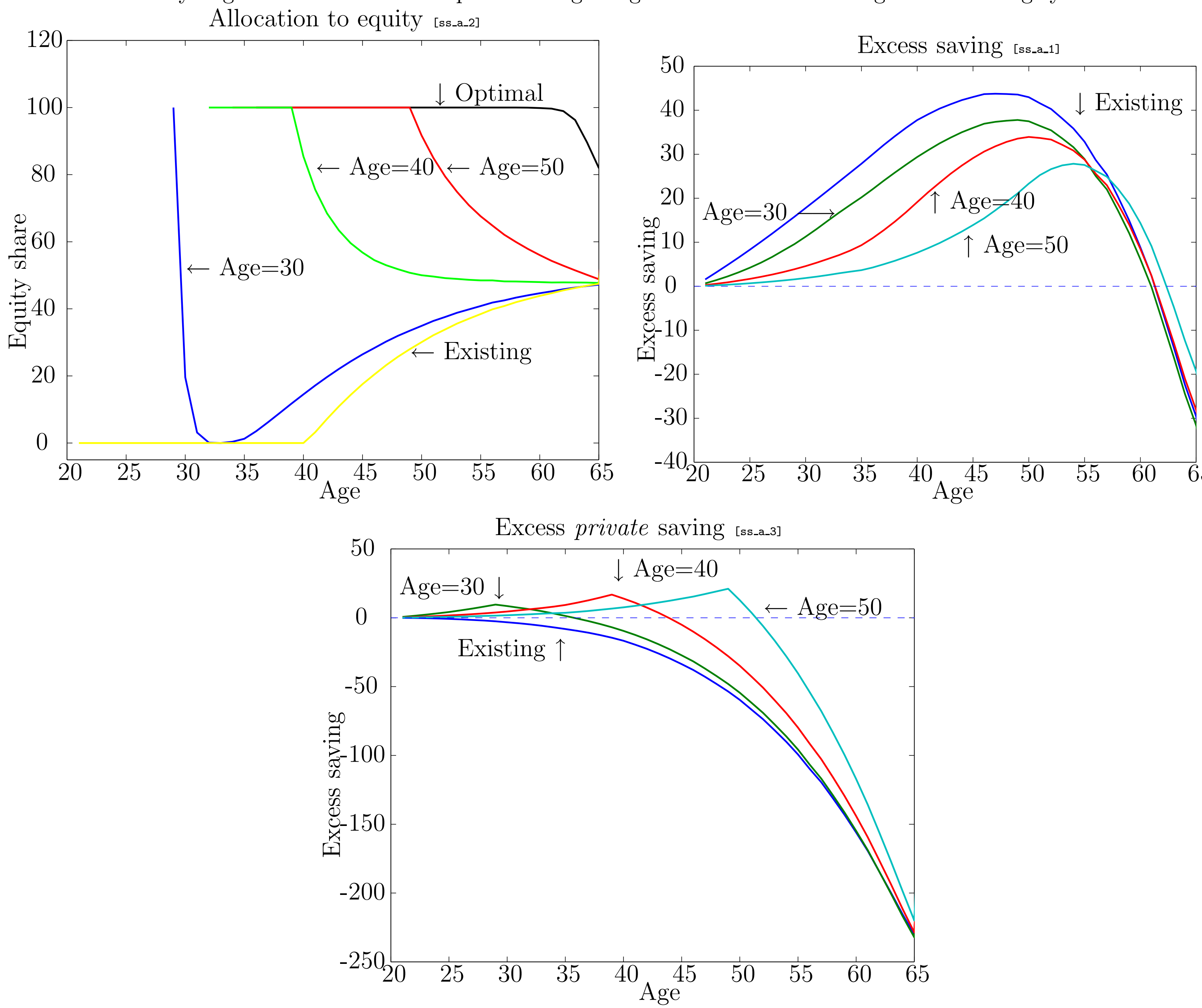

Figure 4: The effects of exemptions for rule-of-thumb households.

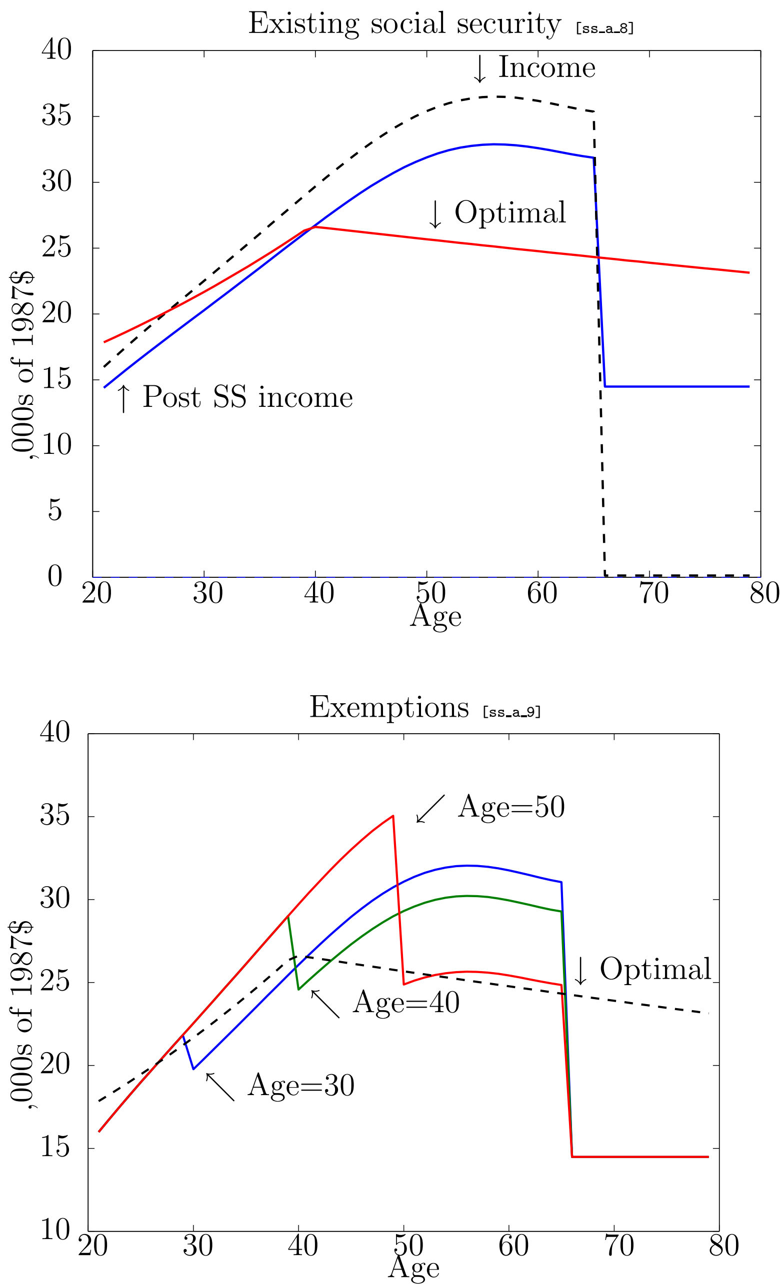

Figure 5: Effects of allowing households to use social security wealth to pay off debt for a household with debt equal to 60 percent of annual income.

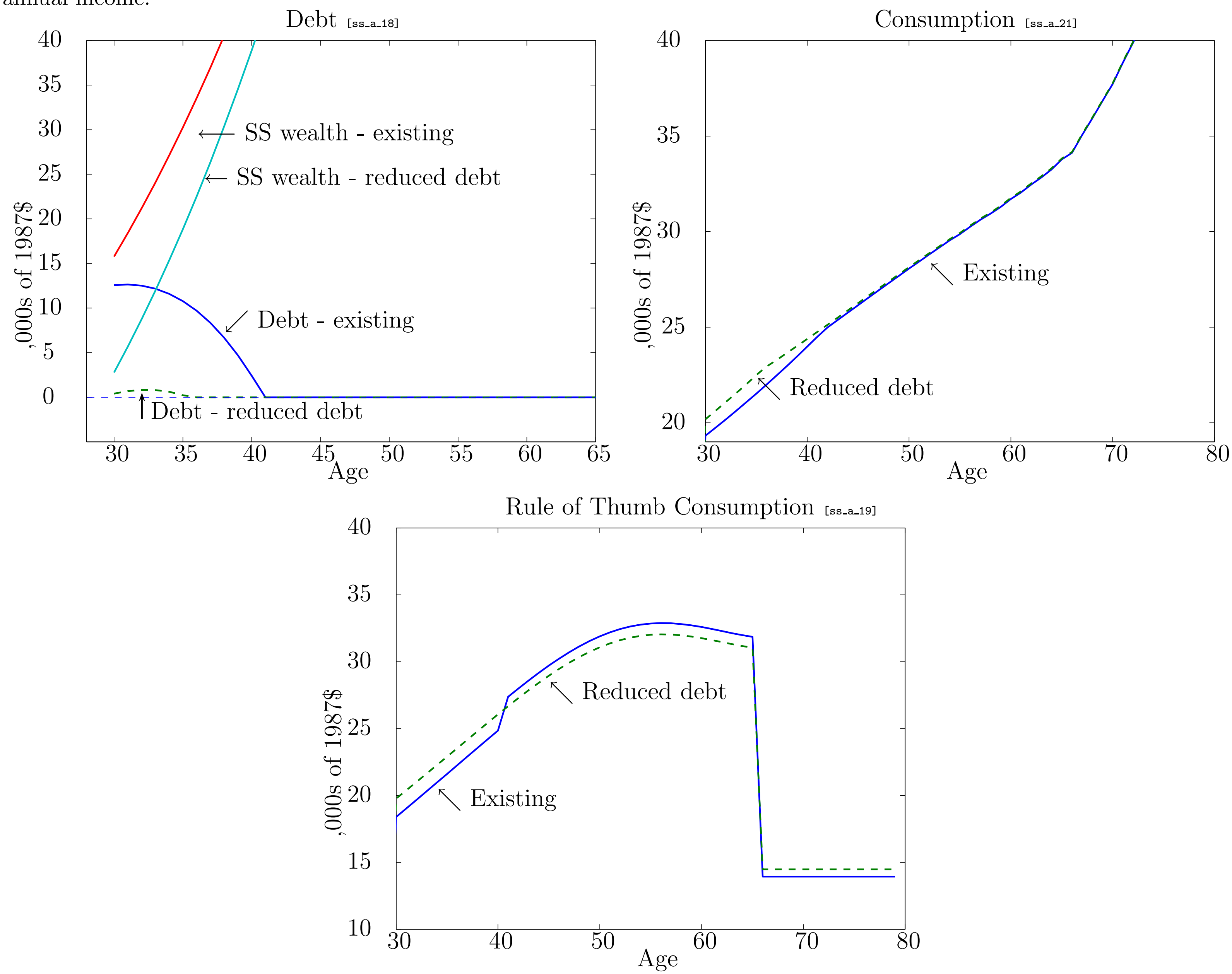

Figure 6: The effect of exemptions on debt and social security wealth.