Social Security, Liquidity Constraints, and Pre-Retirement Consumption*

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I. Introduction

One of the primary goals of the social security retirement program is the maintenance of consumption in old age. In the past decade, since the pioneering paper by Feldstein [13], studies have examined the impact of the system on consumption over the entire life cycle and not just in old age. Empirical work has tested the impact on consumption of the individual wealth transfers accompanying the introduction of a pay-as-you-go social security system.[1]

Extending this discussion of the impact of social security on pre-retirement consumption, Hubbard [21] has shown in the context of lifetime uncertainty that even an actuarially fair, fully funded social security system can raise lifetime consumption. Hence, previous partial equilibrium estimates of the impact of social security on consumption drawn solely from consideration of the intergenerational wealth transfer at the introduction of the system are underestimates of the potential effect.[2]

An important assumption in the approaches cited above is that of perfect capital markets, i.e., that individuals can borrow against prospective gains from participating in the social security system. Such an assumption is at variance with actual limitations on borrowing (e.g., upward sloping interest rate schedules, collateral requirements, and quantity restrictions). Hayashi [18] found that approximately twenty percent of all consumption in the U. S. is accounted for by liquidity-constrained consumers.[3] Flavin [16] found that the estimate of the marginal propensity to consume is affected dramatically by the inclusion of proxies for liquidity constraints, suggesting that liquidity constraints are an important part of the observed excess sensitivity of consumption to current income.

Since its inception in 1935, Old Age and Survivors Insurance (OASI) provided

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1. Feldstein's results have by no means gone unchallenged; see for example [2;3], [26], and the reply [14]. Cross-sectional evidence has been generally supportive of the proposition that social security reduces individual saving [15; 24; 5; 9; 23; 19].

2. That result may not hold up in a general equilibrium analysis, in which the negative impact of social security on the capital stock is reflected in factor prices and consumption [25;20].

3. [17] discusses the role of Unemployment Insurance in removing liquidity constraints on recipients during unemployment. When social insurance is viewed in the framework of precautionary saving, its provision will in general affect lifetime consumption and not just consumption during the periods in which payments are received.

through the social security system has been financed by a payroll tax. Originally, revenue from the tax was to accumulate reserves and provide for a self-financing system. The initial tax rate of 1 percent (to be paid by both employer and employee) was levied on the first $3000 of an individual's wage income. Since the 1930s, and most dramatically over the 1970s and 1980s, there have been repeated increases in both payroll tax rates and the ceiling on taxable earnings. In 1956, Disability Insurance was added, creating the OASDI program. The applicable employer and employee tax rates for OASDI were 5.7 percent in 1984, with scheduled increases to 6.06 percent in 1988 and to 6.2 percent by 1990. The most recently provided component of social security insurance, Hospital Insurance (Medicare), was introduced in 1962, and is currently financed by a payroll contribution rate of 1.35 percent payable by both employer and employee. Hence, the combined OASDHI social security payroll tax rate is 7.05% for both employer and employee in 1984.[4]

Despite its ease of administration, the payroll tax has been criticized on both equity and efficiency grounds. First, the OASDI tax base differs substantially from total personal income, reflecting the exclusion of capital income and of wage income earned above the taxable ceiling. Second, because the payroll tax has no exemption but has a ceiling on taxable earnings, it falls more heavily (as a percentage of earnings) on low-income individuals than on high-income individuals. Finally, to the extent that the current social security system departs from its early insurance goals and functions as an income maintenance program, using general revenues to finance the system might alleviate the inflationary contribution of the payroll tax.

Surprisingly little attention has been paid, however, to the role of the social security payroll tax in augmenting constraints on consumption by lowering current earnings (by the amount of the tax) in a world in which borrowing against future earnings is severely limited.[5] The existence of restrictions on borrowing affects the interpretation of the impact of social security on pre-retirement consumption in two ways. First, constraining net worth to be nonnegative at all times reduces the ability of individuals to consume the effective increase in lifetime resources afforded by social security.[6] Cross-sectionally, this limitation is strongest for young individuals, whose current earnings are typically below their lifetime average earnings. Second, the use of the (proportional) payroll tax to finance social security reinforces the liquidity constraint when binding; that is, social security taxes reduce consumption dollar for dollar. Any reduction in social security taxes in this interval wherein consumption equals current earnings would raise lifetime welfare, even if the decline in revenue were offset by increased tax payments later in life.

This paper analyzes the contribution of the social security system to liquidity constraints on consumption, and examines the effects of alternative financing measures on individual consumption and lifetime utility. For simplicity, we focus only on the old-age annuity component of social security, and the role of personal income taxation is ignored. These abstractions facilitate a direct comparison of the benefits from participating in the social security annuity system with the costs in terms of liquidity constraints on pre-retirement consumption.

4. This discussion draws on information presented in [27, 86; 28, 493].

5. An exception is the proposal for an "earned income credit" discussed in [27, 93].

6. Even in the absence of liquidity constraints, the timing of taxation during the life cycle is important [32; 10; 11; 30]. To the extent that they exist, informal credit markets (through, say, intra-family borrowing) will mitigate the impact of policy-induced liquidity constraints on consumption.

Section II describes the impact of an actuarially fair, fully funded social security system on life-cycle consumption under both certainty and uncertainty over longevity. While social security theoretically has a greater effect on consumption in the uncertain-lifetime case, the actual effect when borrowing constraints are taken into account may be smaller. In many cases, the effect of the constraints is so severe as to yield net welfare losses to participants in social security.

Section III examines alternative means of financing the system, given the constraint of actuarial fairness for the representative individual. In particular, a scope for policy intervention would be to allow the individual to exchange consumption when young for higher taxes when old, a valuable trade because of the liquidity constraint. One policy change which could facilitate this is an exemption on social security taxes financed by a higher tax rate on wages in excess of the exemption level.[7] Some conclusions and directions for future research are presented in section IV.

II. Social Security in a Life-Cycle Model

In this section, we examine the likelihood of the occurrence of liquidity constraints on consumption in life-cycle models under both certainty and uncertainty over longevity—in the presence and absence of social security. The case in which lifetime is certain serves as a starting point for examining the impact of social security and borrowing constraints on consumption. In the absence of binding liquidity constraints, any impact of social security on lifetime consumption must come from a difference between the present values of expected benefits and taxes paid. With restrictions on borrowing, financing social security with a proportional payroll tax reduces lifetime utility. The uncertain-lifetime case is more interesting, since even an actuarially fair, fully funded social security system can raise lifetime consumption. Again, however, borrowing restrictions significantly alter the welfare effects of introducing social security.

Certain-Lifetime Case

As the simplest case, consider the following life-cycle model. Agents are assumed to be selfish, in that no bequests are desired. The retirement age Q is taken as exogenous, and individuals live $D > Q$ periods for certain. Individuals supply labor inelastically and receive a gross wage w_t in each period t during their working life; individual wages are assumed to grow over the working period at a constant rate g.

The lifetime utility function depends on consumption and is assumed to be additively separable across periods. The utility function is of the isoelastic form, implying constant relative risk aversion. That is, the consumer's intertemporal choice model is given by

$$\max \sum_{t=0}^{D} (1/\gamma)\, C_t^{\gamma}(1+\delta)^{-t}, \tag{1}$$

subject to

$$\sum_{t=0}^{D} C_t(1+r)^{-t} = w_0 \sum_{t=0}^{Q} [(1+g)/(1+r)]^t,$$

7. Cross-sectionally, such a policy would correspond to a type of life-cycle taxation.

where C, δ, and r represent consumption and the (constant) subjective discount rate and interest rate, respectively. γ is the elasticity of the marginal utility function.

Carrying out the optimization in (1) yields an optimal consumption stream of

$$C_t = C_0[(1+r)/(1+\delta)]^{t/(1-\gamma)}, \tag{2}$$

where

$$C_0 = w_o \sum_{i=0}^{Q}[(1+g)/(1+r)]^i \;/[\sum_{i=0}^{D}(1+r)^{i\gamma/(1-\gamma)}(1+\delta)^{-i/(1-\gamma)}]. \tag{3}$$

The associated end-of-period asset stocks A_t correspond to

$$A_t = \sum_{i=0}^{\tilde{t}}(1+r)^i w_{t-i} - \sum_{i=0}^{t}(1+r)^i C_{t-i},$$

$$\tilde{t} = t, i \epsilon (0, Q);\ \tilde{t} = Q, i \epsilon (Q+1, D). \tag{4}$$

If we constrain wealth to be nonnegative in all periods, then a liquidity-constrained interval exists whenever desired consumption C^* (given by equations (2) and (3)) exceeds the funds available for consumption, i.e., whenever

$$C_t^* > (1+r)A_{t-1} + w_t. \tag{5}$$

The introduction of a social security system with payroll tax rate t_s and annual retirement annuity benefit S changes the budget constraint in (1) to

$$\sum_{t=0}^{D} C_t(1+r)^{-t} = (1-t_s)w_0\sum_{t=0}^{Q}[(1+g)/(1+r)]^t + S\sum_{t=Q+1}^{D}(1+r)^{-t}. \tag{6}$$

Imposing the condition that the present value of benefits equal the present value of taxes paid restores the lifetime budget constraint to its initial form in (1). That is, when lifetime is certain and there are no limitations on borrowing against future earnings, a fair social security system has no effect on consumption. The wealth-age profile associated with (6) is just:

$$A_t = \sum_{i=0}^{\tilde{t}}(1+r)^i(1-t_s)w_{t-i} + \Gamma\sum_{i=Q+1}^{t}(1+r)^i S_{t-i} - \sum_{i=0}^{t}(1+r)^i C_{t-i}, \tag{7}$$

where $\tilde{t} = t, i \epsilon (0, Q); \tilde{t} = Q, i \epsilon (Q+1, D)$; and $\Gamma = 1, i \epsilon (Q+1, D')$; $\Gamma = 0$, otherwise. Substituting from the description of the optimal consumption stream and the budget constraint, we can rewrite (7) as

$$\begin{aligned} A_t = {} & (r-g)^{-1}(1-t_s)w_0(1+g)^{\tilde{t}}[(1+r)^{\tilde{t}+1} - (1+g)^{\tilde{t}+1}] + \\ & \Gamma(\sum_{i=Q+1}^{t}(1+r)^i)\left\{t_s w_0\sum_{i=0}^{Q}[(1+g)/(1+r)]^i / \sum_{i=Q+1}^{D}(1+r)^{-i}\right\} - \\ & \left\{w_0\sum_{i=0}^{Q}[(1+g)/(1+r)]^i/[\sum_{i=0}^{D}(1+r)^{i\gamma/(1-\gamma)}(1+\delta)^{-i/(1-\gamma)}]\right\} \times \\ & \sum_{i=0}^{t}(1+r)^{-i\gamma/(1-\gamma)}(1+\delta)^{i/(1-\gamma)}. \end{aligned} \tag{8}$$

If asset holdings are constrained to be everywhere nonnegative, then a liquidity-constrained interval exists whenever desired consumption C_t^* is such that

$$C_t^* > (1+r)A_{t-1} + w_t + S_t. \tag{9}$$

As an example, consider the case wherein $r = .04$, $\delta = .03$, $g = .02$, $\gamma = -1$, $t_s = 0$, $Q = 45$, and $D = 55$.[8] Using equations (8) and (9), consumption is constrained for the first 13 periods of an individual's working life. A social security payroll tax rate of 10 percent extends the constrained interval to 20 periods.[9] Allowing for greater risk aversion by setting $\gamma = -3$ changes those constrained intervals to 11 and 18 periods, respectively.

The effect of the liquidity constraints is, of course, to depress consumption when young and raise consumption later in life when earnings are higher. As such, they lower individual lifetime utility. At this juncture, no attempt is made to calculate the impact of borrowing restrictions and the social security tax on lifetime utility, as a fair social security system has no effect on individual consumption in the absence of liquidity constraints. In the next section, we allow for lifetime uncertainty, so that even an actuarially fair social security system affects individual consumption by providing a real annuity. The benefits to individuals from access to the social security annuities must be compared with the costs in liquidity constraints of financing social security by a proportional tax on earnings.

Uncertain-Lifetime Case

We now turn to the more realistic case of lifetime uncertainty. Stochastic lifetimes impart an insurance feature to social security, so that even an actuarially fair, fully funded social security system can increase consumption in all periods. Yaari's [34] seminal paper showed that with an uncertain lifetime, intertemporal utility maximization can dictate saving for the possibility of living longer than the expected lifetime to avoid deprivation in old age.[10]

The uncertain-lifetime case is developed using the following modifications to the certainty model presented earlier. The retirement age Q is still taken as exogenous, and individuals live at least Q periods. The probability of dying in the interval $(0, t)$ is p_t; by assumption p_t is zero in the interval $(0, Q)$. Individuals have an expected lifetime of D years, with $D' > D$ being the maximum age to which one can survive. Following Yaari [34] and Barro and Friedman [4], utility is again assumed to be additively separable across periods. Now let $U(C_t)$ be evaluated contingent on being alive at time t. The lifetime optimization problem in (1) becomes [11]

$$\max \sum_{t=0}^{D'} (1-p_t)(1/\gamma)\, C_t^{\gamma}(1+\delta)^{-t}, \tag{10}$$

subject to

8. The optimizing life is assumed to begin at age 20.

9. The assumed absence of a bequest motive obviously affects the results. However, average bequests of about 12 percent of lifetime resources would be necessary to forestall the liquidity constraints on consumption.

10. Other previous efforts in this area in the context of social security include the contributions of [8; 31]. [8] used a life-cycle model under uncertain lifetimes to address the phenomenon of slow dissaving in retirement. The presence of pensions in his simulation model (using Canadian data) reduced, but by no means eliminated, the effect of uncertainty on retirement consumption. In [31], the ultimate impact of social security on saving depends on the availability of a private annuity market, so that, at the optimum, the result in [34] holds. That is, private savings are reserved for bequests, while social security benefits are used to finance retirement consumption.

11. Individuals will die on average prior to reaching age D', but the lifetime budget constraint reflects the possibility that the individual will live through D'. In no case can the present value of consumption exceed lifetime resources. The problem is simplified here by making lifespan (and earnings) in the interval $(0, Q)$ nonstochastic.

$$\sum_{t=0}^{D'} C_t(1+r)^{-t} = A_0 + w_0 \sum_{t=0}^{Q} [(1+g)/(1+r)]^t,$$

where C, δ, and r are as before. A_0 represents initial resources from unplanned bequests from the previous generation.[12]

Unplanned bequests occur as long as opportunities to annuitize lifetime wealth are limited. Certainly, complete access to a fair annuity market would remove much of the influence of lifetime uncertainty on consumption. Individuals could exchange a portion of their labor income when young to smooth consumption in old age. Market failure in the private provision of annuities is likely because of asymmetries of information between individuals and insurers—that is, the classic "adverse selection" problem discussed by Rothschild and Stiglitz [29] and Wilson [33].[13] In addition, if individuals conjecture that the state will support them in deprivation, the need to purchase annuities is diminished. The analysis below of the social security system assumes complete market failure in the private provision of annuities.[14]

Compulsory public provision of retirement annuities through social security is one possibility. Returning to the social security system described under certainty, individuals are compelled to pay a payroll tax on gross wages at rate t_s, from which the social security system is funded. During retirement they receive annuity benefits S in each period t until death. The budget constraint in (10) becomes

$$\sum_{t=0}^{D'} C_t(1+r)^{-t} = A_0 + (1-t_s) w_0 \sum_{t=0}^{Q} [(1+g)/(1+r)]^t + S \sum_{t=Q+1}^{D'} (1+r)^{-t}. \quad (11)$$

The uniform actuarially fair benefit S must satisfy the condition that

$$S \sum_{t=Q+1}^{D'} (1-p_t)(1+r)^{-t} = t_s w_0 \sum_{t=0}^{Q} [(1+g)/(1+r)]^t. \quad (12)$$

Substituting the actuarially fair social security benefit into the budget constraint in (11) yields

$$\sum_{t=0}^{D'} C_t(1+r)^{-t} = A_0 + (1+t_s(\omega-1)) w_0 \sum_{t=0}^{Q} [(1+g)/(1+r)]^t \quad (13)$$

where ω arises because of the difference in discount rates under certainty and uncertainty and is equal to $(\Sigma_{t=Q+1}^{D'} (1+r)^{-t})/(\Sigma_{t=Q+1}^{D'} (1-p_t)(1+r)^{-t})$. Since $\omega > 1$, the system generates an increase in lifetime consumption. Note that this increased potential for consumption

12. Assuming that bequests are received at the beginning of the optimization period in the simulation exercises that follow yields an underestimate of the effects of borrowing restrictions on consumption.

13. [29] found that the competitive outcome may be inefficient, in that the imposition of a common contract in addition to the competitively supplied contracts may be Pareto-improving. An interpretation of this compulsory additional contract as social security has been offered by [10].

14. Analytically, the assumption of market failure is made for two reasons. First, the previous use in the literature of "perfect markets" and "market failure" assumptions as polar cases makes it a convenient benchmark. Second, the assumption of market failure in private annuities yields an upper bound to the partial equilibrium welfare gains from the introduction of social security. Hence, to the extent that borrowing restrictions substantially reduce even this latter gain, the welfare-improving effects of introducing a social security system financed by a proportional payroll tax are no longer clear.

occurs even in a system that is actuarially fair and fully funded (i.e., in which contributions are invested and earn the market rate of return r in each period).[15]

Unlike the certain-lifetime case, the presence of social security affects consumption even in the absence of capital-market imperfections. Given uncertain longevity, the optimal consumption stream is given by

$$C_t = C_0[(1+r)/(1+\delta)]^{t/(1-\gamma)}(1-p_t)^{1/(1-\gamma)}, \qquad (14)$$

where

$$C_0 = \left\{A_0 + (1+t_s(\omega-1))w_0 \sum_{i=0}^{Q}[(1+g)/(1+r)]^i\right\}/ \sum_{i=0}^{D'}(1+r)^{i\gamma/(1-\gamma)}(1+\delta)^{-i/(1-\gamma)}(1-p_i)^{1/(1-\gamma)}. \qquad (15)$$

The associated wealth-age profile is just

$$A_t = (1+r)^t A_0 + \sum_{i=0}^{\tilde{t}}(1+r)^i(1-t_s)w_{t-i} + \Gamma S \sum_{i=Q+1}^{t}(1+r)^i - \sum_{i=0}^{t}(1+r)^i C_{t-i}, \qquad (16)$$

where $\tilde{t}$ and Γ are as defined before.

In the absence of borrowing restrictions, the gain in individual lifetime welfare expressed as a fraction of lifetime earnings from introducing an actuarially fair social security system is substantial—21 percent when $r = .04$ and 16 percent when $r = .06$.[16] If initial resources are on average equal to 25 percent of lifetime earnings, these translate into 16.9 and 12.1 percent increases in lifetime consumption, respectively.

Further imposing the restriction that agents cannot borrow against future annuity benefits requires that nonpension wealth must be at least zero in period Q. The impact of social security annuities on comsumption will be mitigated, with reductions being greater the higher is the individual's subjective discount rate (δ) or the lower (in absolute value) is the intertemporal elasticity of substitution in consumption (γ). Table I below presents the increase in lifetime resources offered by the social security system when borrowing against annuity wealth is not permitted. In all cases, $r = .04$, $t_s = 0.10$, and A_0 is 25 percent of lifetime earnings. Recall that such a system would have generated an increase in lifetime consumption of 16.9 percent in the absence of consumption.

Of course, much of the gain in these cases come about because of increases in *preretirement* consumption made possible by the annuity provisions of social security. With a nonnegativity constraint on wealth, however, the social security payroll tax depresses preretirement consumption as long as the constraint binds, and increases consumption after the constraint ceases to bind. Hence the effect of an actuarially fair social security system is to increase *desired* consumption of the young, while reducing *actual* consumption due to the interaction of the payroll tax and restrictions on borrowing.

15. In reality, the initial cohorts participating in social security received a rate of return greater than the actuarially fair return [22]. This analysis focuses only on an actuarially fair system to point out that the negative impact of social security on individual saving does not hinge on such initial transfers. [20] points out that for plausible parameter values, the "uncertain lifetime" effect is likely to be as large as the "transfer effect."

16. These calculations were made using survival probabilities taken from [12].

Table I. Percentage Increase in Lifetime Consumption When Borrowing against Annuity Wealth Is Not Allowed*

		$\delta = .01$	$\delta = .02$	$\delta = .03$
$\gamma =$	-1	15.3	12.9	10.9
$\gamma =$	-3	15.3	13.9	12.7
$\gamma =$	-5	15.4	14.5	13.6

* In all cases, $r = .04$, $t_s = 0.10$, and A_0 is 25 percent of lifetime earnings.

Table II. Constrained Intervals in Consumption Profile*, $r = .04$

	$\delta = 0.03$			$\delta = .02$		
	$A_0/V_L = 0$	$A_0/V_L = .06$	$A_0/V_L = .25$	$A_0/V_L = 0$	$A_0/V_L = .06$	$A_0/V_L = .25$
$\gamma = -1$	0–30 (0–12)	3–32 (‡)	14–38 (‡)	0–32 (0–8)	4–36 (‡)	15–43 (‡)
$\gamma = -3$	0–27 (0–11)	3–30 (9–20)	10–45 (‡)	0–28 (0–9)	4–31 (‡)	13–39 (‡)
$\gamma = -5$	0–26 (0–11)	3–29 (10–17)	12–42 (‡)	0–27 (0–10)	3–30 (‡)	13–37 (‡)

	$\delta = 0.01$		
	$A_0/V_L = 0$	$A_0/V_L = .06$	$A_0/V_L = .25$
$\gamma = -1$	0–38 (0–5)	6–42 (‡)	20–45 (‡)
$\gamma = -3$	0–29 (0–7)	5–33 (‡)	15–51 (‡)
$\gamma = -5$	0–27 (0–8)	4–31 (‡)	14–38 (‡)

* In each instance the top interval is for the case wherein $t_s = 0.10$. The bottom interval is for the corresponding no-social-security case.

‡ No constrained interval.

The extent to which social security depresses pre-retirement consumption in this respect depends on the importance of bequests. Even in the absence of an explicit bequest motive, given uncertainty over longevity, transfers at death will be positive on average. Inheritances play two roles with respect to liquidity constraints. The larger is the bequest at the beginning of the (optimizing) life, the greater is desired consumption in each period of life. On the other hand, inheritances also improve the ability to pay for current consumption when young.

Table II that follows calculates the constrained interval in periods over which desired consumption (given by equation (14)) exceeds current resources for various assumptions about the discount rate, size of initial resources (A_0) relative to lifetime earnings (V_L), risk aversion, and the social security system modeled is actuarially fair. As before, the optimizing life is assumed to begin at 20, and the retirement age is taken to be 65.[17]

Table II constrasts the impact of liquidity constraints on consumption with no social security system and with a social security system with a payroll tax rate of 10 percent. As

17. Again, survival probabilities are taken from [12].

Table III. Welfare Gains from Participation in Social Security in Liquidity-Constrained Regime* (Expressed as a Percentage of Lifetime Resources)

	$r = .04$					
	$\delta = 0.03$		$\delta = .02$		$\delta = .01$	
	$A_0/V_L = 0$	$A_0/V_L = .25$	$A_0/V_L = 0$	$A_0/V_L = .25$	$A_0/V_L = 0$	$A_0/V_L = .25$
$\gamma = -1$	−0.2%	2.9%	1.3%	3.0%	4.1%	5.7%
$\gamma = -3$	−1.9	−4.5	−0.7	0.6	0.9	3.1
$\gamma = -5$	−4.0	−7.0	−2.9	−1.3	−1.7	0.6

* Each entry represents the welfare effect (expressed as fraction of lifetime resources) from moving from a proportional tax of $t_s = 0$ to $t_s = 0.10$ in the presence of liquidity constraints on consumption.

mentioned above, social security increases the constrained interval both by increasing desired consumption and by lowering after-tax earnings. In all cases, the imposition of social security dramatically lengthens the interval in which consumption is constrained to be at most equal to current resources.[18]

The impacts of the constraints on the welfare gains from participation in social security for different values of δ, γ, and initial resources relative to lifetime earnings are presented in Table III. In all cases, lifetime welfare gains are much smaller than in the absence of liquidity constraints. In many cases lifetime welfare is actually reduced by the imposition of the annuity system, as pre-retirement consumption is lowered at the expense of consumption in old age; this is particularly true for very risk-averse individuals. These welfare costs occur despite the potential (partial equilibrium) increase in individual welfare due to the operation of an actuarially fair social security system in a regime without borrowing restrictions.

III. Shifts in the Burden of Taxation over the Life Cycle

The theoretical models of Feldstein [13; 14] for certain lifetimes and Hubbard [21] for uncertain lifetimes both emphasize the impact of social security annuities on pre-retirement consumption. As the discussion in the previous section points out, however, when constraints on borrowing are binding, the large partial equilibrium reductions in individual saving predicted by those models are substantially mitigated.[19] Use of a proportional payroll tax to finance social security will enforce liquidity constraints on workers in early stages of the life cycle.[20]

18. These estimates are really an upper bound of the added impact of social security on liquidity constraints on consumption. The assumption of complete market failure in the private provision of annuities leads to a large effect on lifetime consumption from the introduction of social security annuities. While the annuity market in the U. S. is very imperfect, it is not nonexistent; [25] point to family risk-sharing arrangements, and [21] identifies the importance of private pensions as annuity substitutes. Constraints due to the (proportional) payroll tax finance are unaffected by this qualification.

19. Using data from the U. S. President's Commission on Pension Policy, [19] found that the impact of social security wealth on individual saving did depend on the ratio of net worth to permanent income. The mean offset estimated was 33 percent, though offsets greater than dollar-for-dollar were found for the wealthiest households.

20. [21] notes that with a ceiling on taxable income, access to the social security annuities is restricted for high-income individuals. In the context of liquidity constraints, low income individuals are hit relatively harder because of their greater effective participation in the system.

Table IV. Impact of Social Security on Lifetime Consumption and Welfare under Life-Cycle Taxation* ($r = .04$, $\delta = .03$, $\gamma = -1$)

Constrained Intervals

$A_0/V_L = 0$	$A_0/V_L = .25$
0–23	14–32
(0–30)	(14–38)

Gain in Lifetime Welfare (Expressed as a Fraction of Lifetime Resources)

$A_0/V_L = 0$	$A_0/V_L = .25$
7.5%	7.3%
(−0.2%)	(2.9%)

* The values in parentheses indicate the values from the previous case in which social security is financed by a proportional payroll tax t_s of 10 percent.

The use of an exemption (e.g., "earned income credit") alleviates the added contribution of the social security payroll tax to liquidity constraints on consumption.[21] By shifting the burden of the tax intertemporally through higher taxes later in life, the same present value of contributions can be collected with an increase in individual lifetime utility from consumption.[22]

For example, returning to the case wherein $r = .04$, $\delta = .03$, and $\gamma = -1.0$, the social security system financed by a payroll tax rate of 10 percent collected over the entire working period could be financed at the same present value of contributions with a payroll tax rate of 12.7 percent levied over the last ten periods of the working life. Given an assumed slope of the wage profile (g) equal to 0.02, such a policy change amounts to an exemption level of twice the value of the initial wage.[23] That is, the payroll tax is collected only from those individuals whose current wage is at least twice the initial wage. As a result of the shift in the tax burden, the constrained interval for consumption falls substantially, and much of the gain in the lifetime welfare with respect to the old social security system expressed as a percentage gain in lifetime resources is restored. That is, rearrangement of the tax burden permits partial realization of the gains from participating in the social security annuity system. Calculations for different values of initial resources are performed in Table IV.

The importance of the timing of taxation for determining the potential welfare gains from introducing social security is obvious from Table IV. First, effectively shifting the burden of the payroll tax over the life cycle substantially reduces the number of periods during which consumption is constrained to be at most equal to current resources. Second, the enhanced ability to smooth the gains from participating in the social security annuity system over the life cycle makes possible significant increases in lifetime welfare (expressed in Table IV as a percentage of lifetime resources). While the gains are smaller than they

21. See the discussion in [27, 93].

22. The model presented here assumes that labor is supplied inelastically in all periods. [7, 39–57] presents arguments that labor supply is not responsive to the payroll tax. That anticipated social security benefits affect the labor supply decisions of workers nearing retirement age is well documented. A negative labor supply response to the higher payroll tax would necessitate still higher taxes later in life. For a discussion of the impact of social security on pre-retirement labor supply, see [7].

23. Such calculations are, of course, likely to be sensitive to assumptions about the shape of the age-earnings profile.

would be in the absence of liquidity constraints on consumption, they still amount to the equivalent of about three years' earnings.

IV. Conclusions and Implications

While one of the original primary goals of the social security old-age benefit program was the maintenance of consumption in retirement, many theoretical and empirical studies have focused on the impact of gains from participation in social security on pre-retirement consumption. Given uncertainty over length of life and imperfections in private annuity markets, the introduction of even an actuarially fair social security system can generate a substantial increase in lifetime consumption and lifetime welfare. However, when capital markets are not perfect, so that borrowing against future resources is limited, the use of payroll tax finance for social security increases the incidence of liquidity constraints on the consumption of individuals whose current resources are low relative to their future resources.

Using a life-cycle model with lifetime uncertainty, some simulation exercises are performed for plausible parameter values to calculate the impact of borrowing restrictions on consumption and lifetime welfare both in the absence of and presence of social security. The introduction of actuarially fair social security raises desired consumption in all periods, but because of the payroll tax, it increases the number of periods over which consumption is constrained to be at most equal to current earnings. When social security is financed by a proportional payroll tax collected over the entire working life, the potential gains in lifetime welfare from participating in social security are significantly reduced because of the constraints.

However, to the extent that social security annuities are to function as an insurance program, the link between contributions and benefits must be maintained. Replacing the present payroll tax system with one that has an exemption but raises the same revenue over an individual's lifetime permits an increase in lifetime welfare over the no-social-security case. An obvious policy implication is that "earned income credits" used in personal income tax system may be useful in the context of social insurance programs as well.

The results presented here suggest fruitful extensions beyond the social security program. Analyzing the impact of taxation and public programs on individual welfare requires explicit consideration of agents' intertemporal budget constraints. Recent advances in the examination of efficiency gains from dynamic tax reform have used simulation models to isolate intra- and inter-generational effects. Two important considerations emphasized here —the role of uncertainty and the influence of capital-market imperfections—are usually missing from such a framework. Moreover, the optimal lifetime payroll tax schedule is likely to resemble life-cycle taxation for individuals and, given the structure of the model, progressive taxation for the economy. That efficiency result casts doubt on some previous findings that progressive taxation must necessarily be accompanied by large welfare costs.

References

1. Auerbach, Alan J. and Kotlikoff, Laurence J. "National Savings, Economic Welfare, and the Structure of Taxation," in *Behavioral Simulation Methods in Tax Policy Analysis*, edited by Martin Feldstein. Chicago: University of Chicago Press, 1983.

2. Barro, Robert J., "Are Government Bonds Net Wealth?" *Journal of Political Economy*, November/December 1974, 1095–1117.

3. Barro, Robert J. *The Impact of Social Security on Private Savings: Evidence from the U.S. Time Series.* Washington, D. C.: American Enterprise Institute for Public Policy Research, 1978.

4. Barro, Robert J. and Friedman, James W., "On Uncertain Lifetimes." *Journal of Political Economy*, August 1977, 843–49.

5. Blinder, Alan S., Gordon, Roger H., and Wise, Donald E. "Social Security, Bequests, and the Life Cycle Theory of Saving: Cross-Sectional Tests." Working Paper No. 619, National Bureau of Economic Research, Inc., January 1981.

6. Brittain, John A. *The Payroll Tax for Social Security*. Washington, D. C.: Brookings Institution, 1972.

7. Burkhauser, Richard V. and Turner, John A. "A Time-Series Analysis of Social Security and Its Effect on the Market Work of Men at Younger Ages." *Journal of Political Economy*, August 1978, 701–15.

8. Davies, James. "Uncertain Lifetime, Consumption and Dissaving in Retirement." *Journal of Political Economy*, June 1981, 561–78.

9. Diamond, Peter A. and Hausman, Jerry A. "Individual Retirement and Savings Behavior." *Journal of Public Economics*, February-March 1984, 81–114.

10. Eckstein, Zvi, Eichenbaum, Martin, and Peled, Dan. "Uncertain Lifetimes and the Welfare-Enhancing Properties of Annuity Markets and Social Security." *Journal of Public Economics*, April 1985, 81-114.

11. Evans, Owen J. "Tax Policy, the Interest Elasticity of Saving, and Capital Accumulation: Numerical Analysis of Theoretical Models." *American Economic Review*, June 1983, 398–410.

12. Faber, J. F. *Life Tables for the United States: 1900-2050.* U.S. Department of Health and Human Services, Social Security Administration, Actuarial Study No. 87, September 1982.

13. Feldstein, Martin S. "Social Security, Induced Retirement and Aggregate Capital Accumulation." *Journal of Political Economy*, September-October 1974, 905–26.

14. ———, "Social Security and Private Saving: Reply." *Journal of Political Economy*, June 1982, 630–41.

15. Feldstein, Martin S. and Pellechio, Anthony, "Social Security and Household Wealth Accumulation: New Microeconomic Evidence." *Review of Economics and Statistics*, August 1979, 361–68.

16. Flavin, Marjorie. "Excess Sensitivity of Consumption to Current Income: Liquidity Constraints or Myopia?" Working Paper No. 1341, National Bureau of Economic Research, May 1984.

17. Hamermesh, Daniel S. "Social Insurance and Consumption: An Empirical Inquiry." *American Economic Review*, March 1982, 101–13.

18. Hayashi, Fumio. "The Permanent Income Hypothesis: Estimation and Testing by Instrumental Variables." *Journal of Political Economy*, October 1982, 895–918.

19. Hubbard, R. Glenn. *The Financial Impacts of Social Security: A Study of Effects on Household Wealth Accumulation and Allocation.* Monograph 1983-3, Monograph Series in Finance and Economics, Salomon Brothers Center for the Study of Financial Institutions, New York University, 1983.

20. ———. " 'Precautionary' Saving Revisited: Social Security Individual Welfare, and the Capital Stock." Working Paper No. 1430, National Bureau of Economic Research, August 1984.

21. ———. "Uncertain Lifetimes, Pensions, and Individual Saving." Working Paper No. 1363, National Bureau of Economic Research, April 1984; forthcoming in *Issues in Pension Economics*, edited by Zvi Bodie, John B. Shoven, and David A. Wise. Chicago: University of Chicago Press, 1985, forthcoming.

22. Hurd, Michael and Shoven, John B. "The Distributional Impact of Social Security." Working Paper No. 1155, National Bureau of Economic Research, June 1983.

23. King, Mervyn A. and Dicks-Mireaux, Louis, "Asset Holdings and the Life Cycle." *Economic Journal*, June 1982, 247–67.

24. Kotlikoff, Laurence J., "Testing the Theory of Social Security and Life Cycle Accumulation." *American Economic Review*, June 1979, 396-410.

25. Kotlikoff, Laurence J., Shoven, John B., and Spivak, Avia. "Annuity Markets, Saving, and the Capital Stock." Working Paper No. 1250, National Bureau of Economic Research, December 1983.

26. Leimer, Dean R. and Lesnoy, Selig D. "Social Security and Private Saving: New Time-Series Evidence. *Journal of Political Economy*, June 1982, 606–29.

27. Munnell, Alicia A. *The Future of Social Security*. Washington, D. C.: Brookings Institute, 1977.

28. Musgrave, Richard A. and Musgrave, Peggy B. *Public Finance in Theory and in Practice*, Fourth edition. New York: McGraw-Hill, 1984.

29. Rothschild, Michael and Stiglitz, Joseph, "Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information." *Quarterly Journal of Economics*, November 1976, 629–50.

30. Seidman, Laurence S., "Conversion to a Consumption Tax: The Transition in a Life-Cycle Growth Model." *Journal of Political Economy*, April 1984, 247–67.

31. Sheshinski, Eytan and Weiss, Yoram, "Uncertainty and Optimal Social Security Systems." *Quarterly Journal of Economics*, May 1981, 189–206.

32. Summers, Lawrence H., "Capital Taxation and Accumulation in a Life Cycle Growth Model." *American Economic Review*, September 1981, 533–44.

33. Wilson, Charles, "A Model of Insurance Markets with Incomplete Information." *Journal of Economic Theory*, December 1977, 167–207.

34. Yaari, Menahem E., "Uncertain Lifetime, Life Insurance, and the Theory of the Consumer." *Review of Economic Studies*, April 1965, 137–58.