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SOCIAL SECURITY AND INDIVIDUAL WELFARE: PRECAUTIONARY SAVING, LIQUIDITY CONSTRAINTS, AND THE PAYROLL TAX

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ABSTRACT

Recent advances in the examination of efficiency gains from dynamic tax reforms have used simulation models to isolate intragenerational and/or intergenerational effects. Important considerations having to do with uncertainty or capital market imperfections are frequently missing from such a framework. In this paper, we focus on the welfare gains from introducing social security retirement annuities, given lifetime uncertainty and borrowing restrictions.

Our principal findings are four. First, given the considerations mentioned above, "precautionary saving" exceeds life-cycle saving (that would have taken place in the absence of lifetime uncertainty), lending further support to the notion that the perfect-certainty version of the life-cycle model provides an inadequate explanation of observed saving behavior. Second, the introduction of an actuarially fair social security system leads to a significant partial equilibrium increase in lifetime consumption and welfare, accompanied by a reduction in the capital stock. The increase in lifetime welfare is reduced, however, and in many cases eliminated, when borrowing restrictions are imposed. Third, extending the model to general equilibrium, we find that the partial equilibrium gains in lifetime welfare from participation in social security are offset by the interaction of higher steady-state interest rates and binding liquidity constraints. Finally, replacing the proportional payroll tax with a progressive tax (essentially a linear tax with an exemption), we show that age-specific tax schemes can restore much of the potential gain from introducing social security.

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I. INTRODUCTION

It has been recognized for some time in applied public economics that discussion of the impact of taxation and public programs on individual welfare (as well as on such aggregate measures of interest as the saving rate or the capital stock) requires an explicit analysis of agents' intertemporal budget constraints.[1] Recent advances in the examination of efficiency gains from dynamic tax reforms have used simulation models to isolate intragenerational and/or intergenerational effects.[2] Analytical techniques have also been used to examine marginal tax changes (see for example Judd, 1985).

Two important considerations are missing from such a framework. First, most of these exercises have assumed perfect certainty. Many government programs, most notably social insurance programs, affect agents' lifetime budget constraints to the extent that the private insurance markets (against uncertainty over length of life, job loss, catastrophic illness, etc.) are incomplete. It is possible to think of the "event-conditioned" transfer programs that comprise social insurance as relaxing constraints on individual consumption. For example, one of the primary goals of the social security retirement program is the maintenance of consumption in old age. Outside of social security, Hamermesh (1982) 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. In this paper, we focus on social security retirement annuities both because of their importance in the existing literature on tests of the life-cycle model and because of the way in which they are financed.

Since the pioneering paper by Feldstein (1974), studies have examined the impact of social security over the 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.[3] Extending this discussion of the impact of social security on pre-retirement consumption, some recent studies[4] have shown in the context of lifetime uncertainty that even an actuarially fair, fully funded social security system can raise lifetime welfare. Hence previous partial equilibrium estimates of the impact of social security on consumption drawn solely from the consideration of the intergenerational wealth transfers at the introduction of the system may even be too small.

Second, the specification of a **lifetime** budget constraint may be too narrow a description of restrictions on individuals' optimizing behavior in the presence of capital market imperfections. Actual limitations on borrowing appear in upward sloping interest rate schedules, collateral requirements, and quantity restrictions. Hayashi (1982) found that approximately twenty percent of all consumption in the U. S. is accounted for by liquidity-constrained consumers. Flavin (1984) 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.[5] We find that the presence of liquidity constraints reduces substantially the welfare gains from introducing social security annuities.

These two qualifications are certainly related. The extent to which agents can spread the benefits from participation in social security annuities over their lifetimes depends on the degree to which capital markets permit consumption-smoothing when current resources are insufficient. More important, since social security is financed through a proportional payroll tax on current earnings, payroll taxes depress consumption dollar for dollar when liquidity constraints are binding. Including realistic limitations on borrowing introduces the possibility that increasing the provision of social security coverage (financed by the payroll tax) may leave individuals worse off in terms of utility gained from lifetime consumption, while at the same time increasing potential lifetime resources. In general, one expects that an optimal tax structure should reallocate this burden over an individual's lifetime.

Our approach suggests an extended view of analyzing the impact of social insurance programs and tax reform on lifetime consumption in the presence of restrictions on private trades. Such a framework will facilitate analysis of fiscal policy changes on steady-state levels of individual welfare and national saving, and may permit reconciliation of observed individual saving behavior with that predicted by the life-cycle model.

We organize our analysis of the importance of capital-market imperfections (market failure in the private provision of annuities and borrowing restrictions) in describing the impact of social security on individual welfare and the capital stock as follows. In section II, we investigate the relevance of borrowing restrictions and uncertainty over longevity for the size of the capital stock. In particular, we find that the stock of "precautionary saving" far exceeds the size of the capital stock accounted for by the life-cycle model in the absence of lifetime uncertainty, corroborating recent findings by others that the perfect-certainty version of the life-cycle model cannot explain observed saving behavior.

In section III, we take up the partial equilibrium effects on individual consumption. For any plausible set of assumptions about underlying parameters, social security generates a significant increase in lifetime consumption and welfare accompanied by a reduction in the capital stock if borrowing restrictions are absent. The partial equilibrium increase in individual welfare is reduced, and in some cases eliminated, when borrowing restrictions are imposed. The substantial difference suggests the importance of reexamining the proportional payroll tax finance of social security.

In section IV, we extend the model to general equilibrium, with endogenous factor prices. Partial equilibrium gains in lifetime welfare from participation in social security are offset by the interaction of higher steady-state interest rates and binding liquidity constraints. The steady-state welfare cost of social security under proportional payroll tax finance is in general substantial. Section V illustrates the ability of alternative proposals for financing social security to alleviate the problem created by the interaction of borrowing constraints and the proportional payroll tax. Age-specific tax schemes can restore much of the potential gain from participating in social security annuities.

Conclusions and directions for future research are discussed in section VI.

II. LIFETIME UNCERTAINTY, BORROWING RESTRICTIONS, AND INDIVIDUAL SAVING BEHAVIOR

Our emphasis in this paper is on lifetime uncertainty and social security, though many of the results are applicable to other types of uncertainty and social insurance. Consideration of the impact of uncertain longevity on "precautionary" saving has figured prominently in analyses of consumption. Yaari's (1965) seminal paper showed that with an uncertain lifetime, intertemporal utility maximization can dictate saving for the probability of living longer than expected. More recent applications to public pension schemes have appeared in Davies (1981), Sheshinski and Weiss (1981), Abel (1983), and Hubbard (1983, 1984b).

Before considering social security per se, we begin by analyzing the potential contribution of "uncertainty saving" (here against variable longevity) to the size of the capital stock. That contribution could be an important part of the explanation for the finding by Kotlikoff and Summers (1981) that pure "life-cycle" wealth is dwarfed by the stock of wealth from intergenerational transfers in accounting for the capital stock. Their analysis — conducted in a certainty model — seems to imply that planned bequests are an important motive for individual saving.[6] To the extent that precautionary saving is significant, however, modifying the basic life-cycle model to include uncertainty may account for much of the failure of the basic life-cycle model to explain observed wealth-age profiles (particularly among the aged).

Such precautionary saving is necessary because of market failure in the private provision of old-age annuities. This market failure is likely because of asymmetries of information between individuals and insurers, the classic adverse selection problem discussed by Rothschild and Stiglitz (1976) and elaborated in the context of social security by Eckstein, Eichenbaum, and Peled (1985). Friedman and Warshawsky (1985) show that under plausible assumptions about risk aversion, the returns on life annuity contracts actually offered in the market would not be purchased by optimizing individuals.[7]

In this study, we do not explicitly model the reason for the absence of annuity markets. We assume that they simply exist neither prior to nor after the introduction of the social security system. This is an appropriate assumption given our focus on the importance of the interaction of liquidity constraints and the social security system. By ruling out **all** annuities, we make the impact unrealistically large, biasing the results in favor of social security. If we were to add reasonable features such as overpriced annuities, manipulative bequest motives (Bernheim, Schleifer, and Summers, 1984), or altruistic bequest motives, the value of social security annuities would decline. The importance of liquidity constraints would not be affected, however, implying that our negative results would be more likely to hold.

In this section, we derive consumption-age and wealth-age profiles given lifetime uncertainty, and contrast the resulting size of the capital stock with that from a similar model in which lifetime is certain. Consider the following life-cycle model. Agents are assumed to be selfish, in that no bequests are desired. Individuals live for a maximum of T years, working only for the first R years; the retirement age of R is taken as exogenous, and labor is supplied inelastically. The probability of surviving through period t is p_t for each t. Our simulations begin at the beginning of individuals' working lives (assumed to be age twenty). Retirement occurs at model age forty-five. The maximum model age to which one can survive is ninety.

Following Yaari (1965) and Barro and Friedman (1977), we let utility be additively separable across periods, and let utility from consumption $U(C_t)$ be evaluated contingent on being alive at time t. That is, individuals choose C so as to maximize

$$(1) \qquad \int_0^T pU(C)e^{-\rho t}dt,$$

subject to

$$(2) \qquad \dot{A} = w + rA + B - C \;, \qquad A(0) = 0,\; A(T) \geq 0,$$

where C, ρ, and r represent consumption and the (constant) subjective discount rate and interest rate, respectively. A represents the stock of accumulated assets. A dot over a variable denotes a time rate of change. The income stream w represents labor earnings; B includes resources from unplanned bequests from the previous generation.[8]

Assuming that the utility function is of the isoelastic form, we can rewrite (1) as

$$(3) \qquad \max_C \int_0^T \frac{1}{1+\beta}\, p\, C^{1+\beta} e^{-\rho t} dt,$$

where β is the coefficient of relative risk aversion. Note that if h(t)dt is the probability of death during (t, t+dt), the hazard rate, the problem becomes

(4) $$\max \frac{1}{1+\beta} \int_0^T e^{-\int_0^T (\rho+h(s))ds} C^{1+\beta} dt.$$

subject to (2). Denoting the marginal utility of consumption conditional on being alive by λ and the sum of the rate of time preference and the hazard rate reflecting lifetime uncertainty by $\tilde{\rho}$, the differential equations describing the time paths of consumption and asset accumulation are given by

(5a) $$\dot{\lambda} = (\tilde{\rho} - r)\lambda \text{ , and}$$

(5b) $$\dot{A} = r A + w + B - \lambda^{\beta^{-1}} \text{ ,}$$

together with the boundary conditions $A(0) = A(T) = 0$.

Within the framework of the model described above, we can simulate the effect of lifetime uncertainty on the size of the capital stock. The total capital stock is aggregated up from age-specific individual asset stocks assuming a population growth rate of one percent per annum. Individuals in the certain-lifetime case are assumed to die at the average age of death in the population. Data on average survival probabilities are taken from Faber (1982). The individual age-earnings profile is taken from Davies (1981).[9] The rate of time preference ρ is assumed to equal 0.015.[10]

There is some evidence on the value of β in the literature. In their study of household portfolio allocation, Friend and Blume (1975) estimated the coefficient of relative risk aversion to be in excess of 2.0. Farber's (1978) estimation of preferences of United Mine Workers from collective bargaining agreements yielded estimates of the coefficient of relative risk aversion of between 3.0 and 3.7. Hansen and Singleton (1983) found estimates of the coefficient of relative risk aversion between 0 and 2.0. In our simulation exercises, we use four values of β(-.9, -2, -4, and -6) along with three alternative values of r (.02, .04, and .06).

Bequests are incorporated in the simulations as follows. Using information on p_t over the life cycle, a distribution of initial bequests can be generated. We consider intergenerational transfers from a generation of single "parents" to the next generation. Iteration proceeds for a given set of parameter values until an individual would transmit (in expected present value) the same bequest he receives. As our principal concern is with the first-order effects of lifetime uncertainty (and later social security) on the aggregate capital stock (and hence output and consumption), we do not discuss the impact of lifetime uncertainty or social security on the steady-state **distribution** of bequests (e.g., Abel, 1983). Given our emphasis on life-cycle patterns of consumption and savings, it is important that we do not aggregate intertemporally. We must allow the individual to live for several periods if we are to get a quantitative idea of the importance of liquidity constraints. We use a year as our unit of time; we shall see that a year is large enough that any substantially greater unit would involve too much aggregation. However, given this fineness in our intertemporal consumption patterns, it would be numerically intractable to calculate a steady-state rational expectations distribution of bequests. Therefore, all individuals are assumed to receive the weighted-average bequest regardless of their particular family mortality history. The implicit assumption is that individual bequests are taxed away by the government and redistributed lump-sum to individuals. To model the observation that these bequests are most likely to occur when the recipient is in early middle age, such receipts are assumed to be obtained after twenty periods.[11]

Table 1 below illustrates the importance of lifetime uncertainty for the size of the capital stock by reporting values for the aggregate savings-income ratio (K/Y) in the certain-lifetime and uncertain-lifetime cases, the ratio of the capital stocks in the two cases, and the value of average unplanned bequests as a fraction of lifetime earnings. The simulation results in Table 1 illustrate clearly the significance of uncertainty over longevity for explaining the stock of savings. For all assumptions about the interest rate or the coefficient of relative risk aversion, unplanned bequests accompanying lifetime uncertainty are significant relative to lifetime earnings, and capital-income ratios are substantially higher in the uncertain-lifetime case. Aggregate capital stocks implied by the life-cycle model with certain longevity are small relative to those implied by the uncertain-lifetime case under similar assumptions; for example, the ratio of the former to the latter is 0.22 for the plausible case wherein $r = .02$ and $\beta = -2$. The unrealistically low K/Y ratios in the certain-lifetime case lend further support to the finding in Kotlikoff and Summers (1981) that the basic life-cycle model can explain only a small portion of the aggregate capital stock. Our finding of the importance of precautionary saving could help to explain this discrepancy without relying on intentional bequest motives.

An additional critique of standard life-cycle models is that borrowing restrictions inhibit the ability of individuals to carry out their optimal age-consumption profile. One such limitation — and the one which we employ in our work — is a collateral restriction, so that net worth must be nonnegative at all times. That this restriction is most likely to be binding for the young implies that consumption will be shifted to later in life for the representative individual, and the aggregate capital stock will be larger than it would have been if capital markets were not subject to this restriction.

The imposition of a borrowing restriction of this form requires motivation. Here we rely on observed collateral requirements for borrowing in U.S. capital markets, i.e., the restricted access to "consumption loans." Institutional motivations for the constraint include legal restrictions prohibiting the inclusion of human capital as an asset in bankruptcy proceedings or, also for our purposes, the assignment of future social security benefits. Allowing individuals to borrow some fixed "small" amount would increase significantly the numerical complexity of the problem, without qualitatively altering the results. Taken together, our assumptions about market failure in the private provision of annuities and borrowing restrictions should introduce no bias _a priori_, since the former magnifies the potential impact of social security on lifetime welfare, and the latter reduces it.

When we impose the constraint that net worth must be nonnegative at all times, we substantially change the nature of the consumer's optimization problem. The budget constraint in (2) becomes

$$(2') \qquad \dot{A} = w + r A + B - C , \; A(t) \geq 0, \text{ for all } t.$$

The first-order conditions must be altered to take into account this state constraint (see Kamien and Schwartz, 1982, for a discussion of such problems). The new arbitrage equations become

$$(5a')\begin{cases}\dot{\lambda} = (\tilde{\rho} - r)\lambda, & \text{if } A > 0 \text{ or } \lambda > U'(w), \\ \lambda = U'(w), & \text{if } A = 0 \text{ and } \lambda \leq U'(w),\end{cases}$$

$$(5b')\begin{cases}\dot{A} = 0, & \text{if } A = 0 \text{ and } \int_0^t B(s)\,ds \text{ is continuous at } t, \\ \dot{A} = w + rA + B - \lambda^{\beta^{-1}}, & \text{otherwise.}\end{cases}$$

If assets are positive or if wages exceed consumption, then (5a) still holds. Otherwise, consumption is limited to current earnings. This divides the consumer's problem into constrained and unconstrained periods of time. (5b') governs how these intervals meet. At the moment when $A \geq 0$ becomes binding, it imposes the tangency relation between A and the constraint.

Tables 2 and 3 point up the additional relevance of liquidity constraints for the size of the capital stock in the certain-lifetime and uncertain-lifetime cases, respectively. In each table, we report the number of periods in youth during which the constraint is binding, the value of the aggregate capital-income ratio (K/Y) in the unconstrained and constrained cases, and the loss in individual lifetime welfare expressed as a percentage of lifetime earnings (Δ). In all cases, the aggregate capital-income ratio is higher in the constrained regime, and individual welfare costs due to the constraints are substantial (particularly for risk-averse individuals). Table 4 summarizes the combined effect of lifetime uncertainty and borrowing constraints on the size of the capital stock.

III. UNCERTAINTY LIFETIMES AND SOCIAL SECURITY: INDIVIDUAL WELFARE AND THE CAPITAL STOCK

Social Security and Individual Saving Behavior

In an earlier paper, Hubbard (1984b) showed that public provision of annuities through compulsory public pensions (social security) leads to partial equilibrium increases in individual welfare and national saving. A brief outline of such a social security system follows. Individuals are compelled to pay a payroll tax t_s on gross wages, from which the social security system is funded. During retirement they receive an annuity benefit S in each period t until death. The asset accumulation constraint (in the absence of borrowing restrictions) becomes

$$(6) \qquad \dot{A} = rA + w + B + S - C \;, \; A(T) = 0.$$

If benefits are set according to a replacement rate of the terminal wage, then the economy-wide actuarially fair benefit S satisfies the condition that

$$(7) \qquad S\int_R^T p\, e^{-rt}dt = t_s \int_0^R pwe^{-rt}dt.$$

Hubbard (1984b) shows that, in the absence of borrowing restrictions, the system generates an increase in the propensity to consume out of lifetime resources. This increase in lifetime consumption occurs even in a system which is actuarially fair and fully funded.

In Table 5 below, we simulate the partial equilibrium impact on initial participants of the imposition of an actuarially fair social security system financed by a proportional payroll tax of six percent.[12] Percentage changes in the capital-output ratio and average bequests as a fraction of lifetime earnings are reported, as is the change in lifetime welfare (expressed in terms of a percentage change in initial lifetime earnings). Two features of the results in Table 5 are noteworthy. First, the system generates very large initial declines in the capital stock. Given the dramatic reduction in the size of accidental bequests shown in the table, this is not surprising.[13] Second, potential welfare gains to initial participants from introducing an actuarially fair social security system are significant for plausible parameter values.

Liquidity Constraints and the Partial Equilibrium Gains from Social Security

Of course, much of the partial equilibrium welfare gain from the introduction of social security comes about because of increases in **pre-retirement** consumption made possible by the annuity provisions. With a nonnegativity constraint on net worth, however, the social security payroll tax depresses pre-retirement 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 decreasing actual consumption due to the interaction of the payroll tax and restrictions on borrowing.

The extent to which social security depresses pre-retirement consumption depends in part 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 anticipated bequest, the greater is desired consumption in each period of life. On the other hand, received inheritances also improve the ability to pay for current consumption.

The imposition of borrowing restrictions mitigates the effects of social security on individual lifetime consumption and the aggregate capital stock noted earlier. Because the system is financed by a proportional payroll tax on earnings, forced saving occurs in youth. In the simulation exercises reported in Table 6 that follows, we illustrate the impact of the introduction of social security on the aggregate capital stock, average bequests relative to lifetime earnings, and individual lifetime welfare. The numbers in the last set of columns represent the gains in lifetime welfare from participating in social security expressed as a percentage of lifetime earnings. As before, the simulations are conducted over four values of β and three values of r. In all cases, the social security payroll tax is set equal to six percent; the system is by construction actuarially fair and fully funded.

The first set of columns in Table 6 illustrates the importance of the restriction on borrowing against future net earnings for consumption even under a moderate social security tax with consumption constrained to be no more than current resources for at least 10 periods at an interest rate of .02. For modest risk aversion ($\beta = -2$), the gains in lifetime welfare reported for this case in Table 6 are substantially smaller than the potential gains in the absence of borrowing restrictions. For greater risk aversion, $\beta = -4$, the gains are trivial when the interest rate is .02, and at interest rates of .04 or .06, the operation of the social security system actually leads to a **loss** in lifetime welfare, as it does for all cases when $\beta = -6$. These results suggest the importance of both uncertainty and the method used to finance the system in explaining the impact of social security on individual saving behavior. Before returning to the issue of financing the system in section V, we take up in section IV the problem of considering these effects when factor prices are endogeous.

IV. GENERAL EQUILIBRIUM, STEADY-STATE IMPACTS OF SOCIAL SECURITY ON INDIVIDUAL WELFARE AND THE CAPITAL STOCK

To examine seriously the welfare effects of social security under different assumptions about capital market imperfections, we must analyze the new steady state after the system is introduced. Changes in the steady-state capital stock will affect the level of output and consumption per head, and hence the lifetime utility of a representative agent. Members of the first generation in the system benefit both from the increase in lifetime resources from the uninsured previous generation and the gains from participating in social security annuities.[14] The reduced value of accidental bequests permits smaller gains in consumption for succeeding generations. Hence, to consider the potential welfare gains from compulsory pensions, the tradeoff between the benefits to early participants and the costs of a lower capital stock to subsequent generations must be examined.

The partial equilibrium effects of social security on individual saving will be dampened in a general equilibrium analysis of the impact on aggregate capital formation, once factor price changes are taken into account. Such considerations have been examined in the certainty models. For example, Kotlikoff (1979a) used a life-cycle model with certain longevity and a Cobb-Douglas production technology to consider the impact of a pay-as-you-go social security system on the capital stock. For plausible parameter values, he found that the positive lifetime wealth increment traceable to social security caused a twenty-percent decrease in the steady-state capital stock. While this effect is certainly substantial, it is roughly half of his calculated partial equilibrium effect which is directly related to the excess of the present value of benefits over the present value of contributions.

To examine the impact of savings against lifetime uncertainty on aggregate saving we assume that output is produced according to a Cobb-Douglas production function in capital and labor, with a capital share equal to α. Factor markets are assumed to be competitive, so that capital and labor are paid their marginal products. That is, the interest rate (r) and base wage rate (w) are such that:

(8) $r = \alpha k^{\alpha-1}$, and

(9) $w = (1-\alpha)k^{\alpha}$,

where k represents the capital-labor ratio.

Within this framework, the steady state can be solved for as follows. A guess is made for k. Solutions for r and w are then generated from the marginal productivity conditions to produce individual consumption and wealth profiles. The resulting aggregate consumption and capital stock in intensive form are compared with the initial guess, and iteration proceeds until convergence is reached.

As in the partial equilibrium case, a second calculation of the value of the steady-state bequest must also be made. Within the routine described above, each parameterization of r and w generates a different expected bequest, which is then transferred to the child.

We pursue our analysis of the general equilibrium impact of social security on the capital stock and individual welfare in four steps in Table 7. In all cases, α is assumed to equal 0.3, and $\rho = 0.015$. First, we compute the initial steady-state values of the interest rate, capital-output ratio, average bequest relative to lifetime earnings, and lifetime welfare in the absence of social security for each of the four values of β. Those results are reported in the northwest corner of Table 7. As expected, higher levels of risk aversion are associated with higher average bequests and capital stocks, and hence lower steady-state interest rates.

Introducing actuarially fair social security financed by a proportional payroll tax of six percent in the northeast corner of Table 7, the interest rate and initial bequest are held constant from the original no-social-security steady state. As the third column shows, average bequests are reduced substantially, as the initial generation to participate in social security obtains the dual benefits of a high initial bequest and access to social security annuities. Partial equilibrium welfare gains are recorded for the $\beta = -.9$ and $\beta = -2$ cases. The added burden of payroll contributions to social security during youth causes welfare losses for the two higher measures of risk aversion ($\beta = -4$, $\beta = -6$). Moving to the southwest corner, the interest rate is still fixed at its initial steady-state level, but a new steady-state bequest is computed. The capital stock and lifetime welfare continue to decline relative to their counterparts in the no-social-security steady state.

Finally, in the southeast corner of Table 7, the new steady state is computed. As expected from the substantial reduction in bequests and the capital stock, steady-state interest rates increase considerably. The interaction of the higher interest rates and lower earnings with the contribution of payroll taxes to binding liquidity constraints leads to significant reductions in lifetime welfare. For example, in the $\beta = -.9$ case, a 3.8 percent partial equilibrium increase in lifetime welfare becomes a 14.7 percent reduction in the new steady state.

We do not mean to imply that these calculations represent an accurate description of the historical impact of social security on the capital stock in the U.S. Participants in social security have, for example, obtained returns much greater than the actuarially fair return. The assumption of complete market failure in the private provision of annuities leads to a large effect on desired lifetime consumption from the introduction of social security annuities. While the annuity market in the U.S. is very imperfect, it is not nonexistent; Kotlikoff, Shoven, and Spivak (1983) point to family risk-sharing arrangements, and Hubbard (1984a) identifies the importance of private pensions as annuity substitutes. Constraints due to the proportional payroll tax finance are, however, unaffected by this qualification. In the next section, we illustrate the importance of liquidity constraints for these impacts by examining an alternative financing method.

V. "PROGRESSIVE TAXATION" AND THE WELFARE GAINS FROM SOCIAL SECURITY

To examine more carefully the influence of the method of financing social security on its impact on the capital stock and individual welfare, we now remove the assumption of proportional payroll tax finance. In its place we institute a progressive social security tax in which the first fifteen working periods are exempt from payroll taxation. To preserve comparability with our previous results, the retirement benefit is kept the same as under the proportional tax case where $t_s = .06$. A new, higher flat tax rate is instituted in the sixteenth period to maintain the average actuarial fairness of the system. The use of an exemption (effectively, an "earned income credit") alleviates the added contribution to the social security payroll tax to liquidity constraints on consumption. 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.[15] Cross-sectionally, the use of the exemption corresponds to progressive taxation.

Partial equilibrium results for the impact of social security on lifetime welfare (comparable to Table 6) are presented in Table 8. Simulations are run over four values of β and three values of r as before. The top entry in each cell represents the gain in lifetime welfare (expressed as an equivalent percentage of lifetime earnings) from participating in the "progressive-tax-financed" social security system. The numbers in parentheses below are the corresponding gains from the "proportional-tax-financed" system in Table 6. Gains are positive in all cases in Table 8, and for many parameterizations are substantially higher than in the proportional-tax-financed case. We are exploring these results further in extensions allowing for elastic labor supply. That age-specific tax schemes can restore much of the potential gain from participating in social security puts in a new light claims based on "perfect markets" models that large welfare costs necessarily accompany progressive taxation.

VI. CONCLUSIONS

One of the original goals of the social security old-age benefit program was the maintenance of consumption in retirement. Over the past decade, however, many theoretical and empirical studies have focused on the impact on pre-retirement consumption of the provision of social security annuities. For example, with uncertainty over longevity 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 welfare. When borrowing against future resources is limited, however, the use of proportional 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 simulation models under various assumptions about individual preferences and technology, we analyze the impact of precautionary saving against lifetime uncertainty and borrowing restrictions on individual welfare and the capital stock in the presence and absence of social security annuities. Our principal conclusions are four. First, we find that precautionary saving exceeds life-cycle saving (that would have taken place in the absence of lifetime uncertainty), lending further support to the notion that the perfect-certainty version of the life-cycle model provides an inadequate explanation of observed saving behavior. Second, the introduction of an actuarially fair social security system leads to a significant partial equilibrium increase in lifetime consumption and welfare, accompanied by a reduction in the capital stock. The increase in individual welfare is reduced, however, and in some cases eliminated, when borrowing restrictions are imposed.

Third, extending the model to general equilibrium, we find that the partial equilibrium gains in lifetime welfare from participation in social security are offset by the interaction of higher steady-state interest rates and binding liquidity constraints. Indeed, the steady-state welfare cost of social security under proportional payroll tax finance can be substantial. Finally, replacing the proportional payroll tax with a progressive tax (essentially a linear tax with an exemption), we show that age-specific tax schemes can restore much of the potential gain from participating in social security.

This last finding suggests fruitful extensions of our research. Since such schemes correspond cross-sectionally to progressive taxation, the results cast doubt on recent claims of the inherent welfare costs associated with progressive taxation. By modeling labor-supply responses to tax-induced changes in the net wage, more formal methods of optimal taxation can be applied.

While we focus on the social security system, our approach should be more generally applicable to examinations of fiscal policy in life-cycle models. Social security provides an appropriate starting point for analysis, since realizing the large potential welfare gains from the insurance features of the system depends importantly on agents' ability to smooth consumption over the life cycle. An obvious application of the emphasis on precautionary saving is to types of uncertainty other than that over longevity, and appropriate social insurance programs. In addition, to the extent that liquidity constraints play an important role, conclusions about the welfare effects of such policy reforms as switching from progressive to proportional income taxation, changing the tax base from income to consumption, or lowering taxes on capital income while raising labor-income taxes will have to be reexamined.

Footnotes

[1]See for example the survey in Kotlikoff (1984).

[2]The focus of such analyses is generally on switching tax regimes, say from a proportional general income tax to a proportional consumption or wage tax. See for example Summers (1981), Auerbach and Kotlikoff (1983), Evans (1983), and Seidman (1984). Auerbach, Kotlikoff, and Skinner (1983) have considered progressive taxation as well.

[3]Feldstein's results have by no means gone unchallenged; see for example Barro (1974, 1978), Leimer and Lesnoy (1982), and the reply to Leimer and Lesnoy in Feldstein (1982). Cross-sectional evidence has been supportive of the proposition that social security has reduced individual saving; see Feldstein and Pellechio (1979), Kotlikoff (1979b), Blinder, Gordon, and Wise (1981), Diamond and Hausman (1984), King and Dicks-Mireaux (1982), and Hubbard (1983).

[4]See for example Sheshinski and Weiss (1981), Abel (1983), and Hubbard (1984a,b).

[5]Additional evidence in support of the importance of liquidity constraints in the U.S. is provided by Hayashi's (1985) study of data from the 1963 Survey of Consumer Finances. Bernanke (1984) found no evidence against the permanent income hypothesis in his examination of expenditures on automobiles. Automobile loans are, however, self-collateralized, while our discussion focuses primarily on non-collateralized consumption loans.

[6]Distinguishing the extent to which intergenerational transfers represent **planned** bequests is important for analyses of the effects of government debt policy or social security policy on individual consumption.

[7]To illustrate the unimportance of non-pension annuities in the U.S.,only about one percent of households surveyed in the 1962 Survey of Financial Characteristics held any annuities, with holdings of less than 0.1 percent of household net worth for those who did (see Projector and Weiss, 1966).

[8]The corresponding problem for the certain-lifetime case would be to maximize

$$\int_0^D U(C)e^{-\rho t}dt, \text{ subject to } \dot{A} = w + rA - C ,$$

where D is the expected date of death in (0,T) in the uncertain-lifetime case.

[9]As in Davies (1981, p. 572), the lifetime path of mean noninvestment income E is approximated from ages 20 to 65 by a fourth-order polynomial:

$$E(t) = 36,999.4 + 3520.22t - 101.878\, t^2 + 1.34816\, t^3 - 0.00706233\, t^4.$$

Since the marginal loss due to a tighter liquidity constraint is negligible if the constraint is light and greater when the constraint is tight, losses due to the liquidity constraint are convex in the tightness of the constaint. This indicates that the losses that arise are **underestimated** by examining an **average** earnings pattern, since the distribution of earnings patterns would include some with much tighter constraints as well as some with looser constraints.

[10] Our results in the absence of borrowing restrictions are qualitatively robust to changes in ρ ($\rho<r$). We chose a rate of 1.5 percent, which we believe to be "on the low side" of previous studies, so as to avoid overemphasizing the effect of the liquidity constraint. That is, higher values of ρ would increase desired consumption in youth, magnifying the loss in welfare from the borrowing restriction.

[11]The results reported are not very sensitive to changes in the timing of the receipt of the bequest after twenty periods.

[12]We chose a moderate payroll tax rate between the rate assessed at the beginning of the system and the much higher rate in place now. The results are not qualitatively sensitive to the choice of the payroll tax rate. When the wealth nonnegativity constraint is introduced in the next section, welfare losses from the interaction of the borrowing constraint and the payroll tax increases with the tax rate in a nonlinear fashion.

[13]For example, Kotlikoff and Spivak (1981) report very large welfare gains from the introduction of a perfect annuity market.

[14]Of course, the extent to which this benefit can be realized depends on the extent to which borrowing constraints are binding when young. As shown before, liquidity constraints can sharply reduce gains in consumption due to social security even in a partial equilibrium model.

[15]The model presented here assumes that labor is supplied inelastically in all periods. 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 Burkhausser and Turner (1978).

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TABLE 1

LIFETIME UNCERTAINTY, THE CAPITAL STOCK, AND BEQUESTS

	$(K/Y)_{CL}$ β				$(K/Y)_{UL}$ β				(K_{CL}/K_{UL}) β				Expected Bequest as a Percentage of Lifetime Earnings β			
	−.9	−2	−4	−6	−.9	−2	−4	−6	−.9	−2	−4	−6	−.9	−2	−4	−6
r=.02	1.93	1.28	1.02	0.93	3.63	5.97	8.00	9.04	.57	.22	.12	.10	9.2	15.8	22.2	25.7
r=.04	5.29	2.56	1.34	0.93	7.45	6.69	6.86	7.10	.70	.35	.17	.11	19.1	20.6	23.4	25.1
r=.06	7.35	3.61	1.67	0.97	9.40	7.13	6.15	5.88	.67	.41	.21	.13	38.5	26.7	23.8	23.3

Note: "CL" and "UL" refer to the certain-lifetime and uncertain-lifetime cases, respectively. All cases are unconstrained; i.e., no borrowing restrictions are imposed.

TABLE 2

LIQUIDITY CONSTRAINTS, THE CAPITAL STOCK, AND INDIVIDUAL WELFARE

(CERTAIN-LIFETIME CASE)

	Periods Constrained β				Unconstrained β				Constrained β				Δ β			
	-.9	-2	-4	-6	-.9	-2	-4	-6	-.9	-2	-4	-6	-.9	-2	-4	-6
r=.02	9	10	10	11	1.93	1.28	1.02	0.93	3.09	2.71	2.56	2.52	-1.8	-6.4	-20.5	-35.2
r=.04	4	8	10	11	5.29	2.56	1.34	0.93	5.53	3.44	2.69	2.46	-0.3	-4.6	-20.0	-35.4
r=.06	2	6	9	10	7.35	3.61	1.67	0.97	7.37	4.13	2.82	2.42	-0.1	-3.4	-19.3	-34.8

Note: Δ is expressed as a percentage of lifetime earnings.

TABLE 3

LIQUIDITY CONSTRAINTS, THE CAPITAL STOCK, AND INDIVIDUAL WELFARE
(UNCERTAIN-LIFETIME CASE)

	Periods Constrained β				K/Y Unconstrained β				K/Y Constrained β				Δ β			
r=.02	9	8	7	7	3.63	5.97	8.00	9.04	4.86	7.11	9.01	9.99	-3.6	-7.2	-16.1	-26.5
r=.04	4	7	8	8	7.45	6.69	6.86	7.10	7.70	7.37	7.79	8.11	-0.9	-5.4	-18.1	-31.5
r=.06	2	5	8	9	9.40	7.13	6.15	5.88	9.42	7.49	6.94	6.86	-0.1	-4.0	-18.7	-33.3

Note: Δ is expressed as a percentage of lifetime earnings.

TABLE 4

CONTRIBUTIONS OF LIFETIME UNCERTAINTY AND BORROWING RESTRICTIONS TO THE CAPITAL STOCK

	$(K_{CL,NC}/K_{CL,C})$				$(K_{CL,C}/K_{UL,C})$				$(K_{CL,NC}/K_{UL,C})$			
	β				β				β			
	-.9	-2	-4	-6	-.9	-2	-4	-6	-.9	-2	-4	-6
r=.02	.61	.46	.39	.36	.68	.38	.27	.24	.41	.18	.10	.08
r=.04	.95	.71	.47	.36	.71	.42	.30	.25	.67	.30	.14	.09
r=.06	.99	.84	.55	.36	.67	.45	.32	.27	.67	.37	.17	.10

Note: "CL" and "UL" refer to the certain-lifetime and uncertain-lifetime cases, respectively. "NC" and "C" refer to the absence and presence of borrowing constraints.

TABLE 5

SOCIAL SECURITY, THE CAPITAL STOCK AND INDIVIDUAL WELFARE
(NO LIQUIDITY CONSTRAINTS)

	Percentage Change in K/Y β				Percentage Change in Bequests as a Fraction of Lifetime Earnings β				Δ β			
	-.9	-2	-4	-6	-.9	-2	-4	-6	-.9	-2	-4	-6
r=.02	-48.2	-58.1	-58.9	-57.9	-88.0	-83.5	-79.3	-76.7	4.4	8.2	11.1	12.6
r=.04	-27.7	-50.4	-65.2	-70.1	-80.1	-94.2	-98.3	-98.8	5.4	6.6	7.7	8.1
r=.06	-17.0	-32.0	-36.5	-39.3	-73.8	-95.5	-97.5	-98.3	6.1	3.8	1.9	1.3

Note: Δ is expressed as percentage of lifetime earnings. Δ and the percentage change in K/Y are measured with respect to the corresponding no-social-security cases under lifetime uncertainty.

TABLE 6

LIQUIDITY CONSTRAINTS AND SOCIAL SECURITY:

THE CAPITAL STOCK AND INDIVIDUAL WELFARE

	Periods Constrained				Percentage Change in K/Y				Percentage Change in Bequests as a Fraction on Lifetime				Δ			
	β				β				β				β			
	-.9	-2	-4	-6	-.9	-2	-4	-6	-.9	-2	-4	-6	-.9	-2	-4	-6
t_s = .06																
r=.02	13	12	11	10	-29.4	-39.2	-42.4	-42.7	-82.1	-77.1	-72.9	-70.2	3.5	4.5	0.1	-4.3
r=.04	5	9	12	13	-24.5	-39.0	-47.8	-51.4	-78.6	-89.5	-93.3	-94.5	5.0	3.9	-1.8	-5.2
r=.06	2	7	11	12	-16.7	-29.1	-31.4	-32.8	-73.6	-93.6	-95.8	-96.6	5.9	2.4	-3.5	-5.6

Note: Δ and the percentage change in K/Y are measured with respect to the corresponding no-social-security cases under lifetime uncertainty.

TABLE 7

GENERAL EQUILIBRIUM EFFECTS OF SOCIAL SECURITY

ON THE CAPITAL STOCK AND INDIVIDUAL WELFARE*

	Initial Steady State				Imposition of Social Security (Fixed r, Fixed Bequest)			
	r	K/Y	b	Δ	r	K/Y	b	Δ
β=-.9	.035	8.51	21.1%	---	.035	6.86	6.9%	+3.8%
β=-2	.031	9.62	26.9	---	.031	7.79	10.2	+0.3
β=-4	.024	12.48	35.8	---	.024	10.18	17.8	-4.5
β=-6	.020	14.66	42.1	---	.020	12.23	24.3	-4.9

	Imposition of Social Security (Fixed r, Bequest Adjusts)				Imposition of Social Security (New Steady State)			
	r	K/Y	b	Δ	r	K/Y	b	Δ
β=-.9	.035	5.51	4.1%	-8.2%	.044	6.74	3.5%	-14.7%
β=-2	.031	4.78	3.8	-9.0	.058	5.22	1.8	-27.9
β=-4	.024	5.90	7.6	-6.9	.061	4.87	1.1	-37.2
β=-6	.020	7.34	11.7	-7.4	.063	4.78	1.0	-41.8

* In all cases, $\rho=0.015$, and $t_s=0.06$. Δ is measured with respect to changes from the initial no-social-security steady state. b represents the average bequest as a percentage of lifetime evenings.

TABLE 8

PROGRESSIVE TAXATION AND SOCIAL SECURITY:

REASSESSING THE IMPACT ON INDIVIDUAL WELFARE.

Δ

	$\beta=-.9$	$\beta=-2$	$\beta=-4$	$\beta=-6$
r = .02	4.2% (3.5)	6.3% (4.5)	4.3% (0.1)	1.4% (-4.3)
r = .04	5.1 (5.0)	5.3 (3.9)	2.7 (-1.8)	0.6 (-5.2)
r = .06	6.0 (5.9)	4.0 (2.4)	0.8 (-3.5)	0.2 (-5.6)

Note: Δ is measured with respect to the corresponding no-social-security cases under lifetime uncertainty, with borrowing restrictions imposed. Individuals are exempt from social security taxation for for the first fifteen working periods. Numbers in parentheses are the welfare gains from imposing a social security system of identical size financed by a proportional payroll tax.