well enough understood. These are the subjects of NBER research currently under way.

Appendix
The Effect of Privatizing Social Security on Economic Welfare

This appendix presents a more formal analysis of the economic gains that result from shifting from an unfunded pay-as-you-go system of retirement benefits to a funded system.[37] The analysis clarifies the way that the welfare gain from privatization depends on the productivity of capital, the rate of growth of real wages, and the rate at which future consumption is discounted to the present. To simplify the analysis, I focus on the comparison of future consumption gains and current short-term consumption losses, ignoring the sizable deadweight losses associated with labor supply distortions that would be eliminated in the process of privatization.

The first section of this appendix reviews the simple analytics of replacing private saving with an unfunded social security system. The second section then builds on this to examine the potential gain from shifting from an unfunded system to a funded system, bearing in mind the obligations to existing retirees and employees. The analysis assumes that the shift to the funded system raises the national saving rate by the full amount of the taxes collected by the unfunded system, thereby substantially increasing the level of real benefits. The third section repeats the analysis of the second section with the alternative assumption that the funded system has a smaller contribution rate that is selected to provide the same level of benefits as the existing unfunded system.

There are a variety of possible mechanisms for dealing with the obligations to existing employees and retirees. The current analysis assumes that these obligations are converted to an explicit national debt (the so-called recognition bonds) that is then serviced in perpetuity. Alternative assumptions would implicitly involve different schedules for repaying the recognition debt without the formal creation of recognition bonds.

Surprisingly, there has been no explicit analysis of the conditions under which privatizing social security would increase economic welfare.[38] The po-

37. An earlier version of this appendix appeared as Feldstein (1995d).

38. Samuelson (1958) showed that the introduction of a pay-as-you-go program would raise the welfare of every generation in an economy in which there can be no capital stock (because all goods are perishable) and therefore no opportunity to earn a return greater than the rate of increase of the tax base. Aaron (1966) noted that a dynamically inefficient economy that is producing with a capital intensity greater than the golden rule level (i.e., in which the marginal product of capital is less than the rate of aggregate economic growth) could also raise economic welfare by introducing an unfunded social security program because doing so would reduce the initial excessive level

tential ambiguity of the effect occurs because, while each future generation would benefit from earning the higher return on real investments instead of getting a return equal to the rate of increase of the payroll tax base, these future generations would also be obligated to pay taxes to finance the interest on the extra national debt created in the process of privatization.[39] The question of whether privatizing social security raises economic welfare is therefore equivalent to asking whether the burden of financing the extra debt is less than the gain from the return on the incremental real saving.

The Welfare Loss of Introducing an Unfunded Social Security Program

Consider a simple overlapping generations (OLG) model with no social security program in which individuals live for two periods, earning w_t in the first period and saving s_t. If the marginal product of capital is ρ, the individuals consume $s_t(1 + \rho)$ in retirement.

Now introduce an unfunded social security program at time $t = 0$ financed by a payroll tax at rate θ. The proceeds of the tax are paid to the current retirees. In the next period, the population has increased by a factor of $1 + n$ and the common wage rate by a factor of $1 + g$. The taxes collected in that next period are therefore $\theta w_0(1 + n)(1 + g) = \theta w_0(1 + \gamma)$, where w_0 is the wage when the social security program is introduced. The members of the initial generation of employees thus receive $1 + \gamma$ dollars of benefits in retirement for every dollar of tax that they paid while working.

If the requirement to pay a social security payroll tax induces individuals to reduce their saving by an equal amount,[40] the loss of income in retirement is $(\rho - \gamma)\theta w_0$. The present value of this loss to the individual at the time that the social security program is introduced is $(1 + \rho)^{-1}(\rho - \gamma)\theta w_0$.

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of the capital stock. But, in the empirically relevant case in which the marginal product of capital exceeds the growth rate, the substitution of an unfunded social security program for capital accumulation can reduce economic welfare. Feldstein (1987b) presented an explicit formula for the welfare cost of social security's adverse effect on private saving similar to the analysis in the first section of this appendix. Feldstein (1985) derived the optimal level of benefits in an unfunded system and showed conditions under which that optimum would be zero. Feldstein (1995a) states the potential loss in present value consumption from introducing an unfunded program but does not discuss the consequences of switching from an unfunded to a funded system. Analyses by Auerbach and Kotlikoff (1987) and by Seidman (1983, 1986) have discussed the effects of reducing the benefits of existing retirees but not those of privatizing the existing system with benefits unchanged. Auerbach and Kotlikoff (1987) and Corsetti and Schmidt-Hebbel (1996) show that shifting to a funded system would raise welfare by reducing the distortions to labor supply caused by existing payroll taxes.

39. More fundamentally, future generations would lose the income generated by the capital stock that is crowded out by the creation of the new debt. This is equivalent to the interest on the national debt when the rate of interest paid by the government is equal to the marginal product of capital in the private economy.

40. Because the program reduces the present value of lifetime income, it would be expected to cause a fall in first-period consumption and therefore a less than one-for-one displacement of private saving by the social security tax. This effect reduces the magnitude of the loss from introducing an unfunded program.

If the number of employees is initially N_0, the loss to future generation t when the wage rate is $w_0(1 + g)^t$ and the labor force is $N_0(1 + n)^t$ is

$$(1 + \rho)^{-1}(\rho - \gamma)\theta w_0(1 + g)^t N_0(1 + n)^t = (1 + \rho)^{-1}(\rho - \gamma)\theta w_0 N_0(1 + \gamma)^t$$
$$= (1 + \rho)^{-1}(\rho - \gamma)T_0(1 + \gamma)^t,$$

where T_0 is the initial aggregate payroll tax and therefore the initial transfer to the first generation of retirees. If the appropriate rate for discounting consumption of future generations is δ,[41] the present value of the loss to employee participants of all generations (i.e., ignoring the gain to the initial generation of retirees) is

$$\text{(A1)} \qquad \text{PVL} = (1 + \rho)^{-1}(\rho - \gamma)T_0 \sum_0 [(1 + \gamma)^t/(1 + \delta)^t]$$
$$= [(1 + \delta)/(1 + \rho)][(\rho - \gamma)/(\delta - \gamma)]T_0,$$

Note first that, if the economy is at the golden rule level of capital intensity (i.e., that $\rho = \gamma$), there is no loss to any generation of employees. The transfer to the initial retirees is a clear Pareto improvement.

In reality, of course, $\rho > \gamma$, and each generation of employees incurs a loss.[42] Note, however, that, if $\delta = \rho$, the loss to future retirees just balances the transfer to the initial retirees (PVL $= T_0$) regardless of the difference between ρ and γ. In this case, the present value of the loss to all future generations is exactly equal to the value of the transfer to the initial retirees. If, however, the intergenerational consumption discount rate is less than the marginal product of capital, the loss exceeds T_0, and the introduction of an unfunded social security program reduces the present value of future incomes by more than the value of the transfer to the initial retirees T_0.[43]

The condition $\delta = \rho$ implies that the marginal rate of substitution between consumption in one generation and consumption in the next is equal to the marginal rate of transformation. Equivalently, the existing level of capital is optimal in the sense of maximizing the intergenerational social welfare function subject only to the constraint of the intergenerational production function. Equation (A1) implies that, if the economy is operating at this first-best optimum level of capital intensity, there is no loss from a small shift of consumption from future generations to the current generation. In the more relevant case in which tax rules or other distorting factors cause $\rho > \delta$, shifting a dollar from investment to current consumption reduces the present value of the total

41. The appropriate rate for discounting consumption across generations is discussed on page 25.

42. The relation of ρ and γ is discussed on page 24. See also Feldstein (1965) and Abel et al. (1989).

43. Equation (A1) implies PVL $> T_0$ if $\gamma > -1$ and $\rho > \delta$. Since γ is the growth rate of aggregate real labor income, $\gamma > 0 > -1$.

consumption stream. Such a shift from investment to current consumption is exactly what the introduction of an unfunded social security program does and why, if $\rho > \delta$, it causes the present value of consumption to fall.

Whether the introduction of an unfunded social security program does in fact reduce the present value of consumption depends also on the extent to which it provides benefits that raise the consumption of retirees who would otherwise have saved "too little" for their own retirement.[44] Such myopic behavior would be precluded by the assumption that $\theta w_t < s_t$, that is, that each individual's social security payroll tax is less than the amount that the individual would otherwise save. But, if some individuals would have saved less than the payroll tax, the evaluation must go beyond the present value calculation of equation (A1) to reflect the utility gain from providing benefits to "myopic" retirees in each generation. When there are enough myopic individuals, the gain from helping them by even an unfunded social security program can outweigh the loss associated with giving a lower return to rational savers.[45]

Although the balancing of this gain to myopes against the loss to rational savers is important in deciding whether to introduce a mandatory retirement program and in setting the scale of benefits, it is not relevant for deciding between a funded and an unfunded program since myopes would be protected at least as much under a funded program as under an unfunded program.[46]

The Welfare Gain from Privatizing Social Security

Privatizing social security requires recognizing the obligation to existing retirees and to others who have already paid payroll taxes under the pay-as-you-go system. This appendix models that recognition as the explicit creation of additional national debt of equal value that is serviced in perpetuity.[47] Each future generation therefore bears a burden because of the additional national debt that must be balanced against the higher retirement income[48] that results from substituting real saving for the pay-as-you-go program. Since a debt-financed privatization of social security does not reduce the benefits of existing

44. Feldstein (1985) analyzed the issue of inadequate individual saving by modeling the representative individual in a two-period OLG model as having a true lifetime utility function $u(c_1) + u(c_2)$ but acting while young to maximize $u(c_1) + \lambda u(c_2)$ with $\lambda < 1$ for "partial myopia" and $\lambda = 0$ for "complete myopia."

45. Feldstein (1985) derives the optimal level of social security benefits in an unfunded system by balancing the gains to myopes against the loss to those who would otherwise have saved optimally.

46. If the mandatory saving level in the funded program is as large as the tax in the pay-as-you-go program, retirement benefits are even higher in the funded program.

47. Feldstein and Samwick (chap. 6 in this volume) assume that the debt is not explicitly stated but that the retirees and existing employees receive the benefits that they have accumulated on the basis of past contributions to the unfunded program. No additional national debt remains after the last of these employees has died. This is equivalent to creating explicit national debt and amortizing it over the life of the youngest current employee.

48. The third section considers the alternative of lower pension contributions (instead of higher retirement benefits).

Table A.1 **Receipts and Payments of Overlapping Generations**

	t	$t+1$	$t+2$	$t+3$
Social security program and participants:				
Unfunded:				
Retirees (benefits)	$+T_t$	$+T_t(1+\gamma)$	$+T_t(1+\gamma)^2$	$+T_t(1+\gamma)^3$
Employees (taxes)	$-T_t$	$-T_t(1+\gamma)$	$-T_t(1+\gamma)^2$	$-T_t(1+\gamma)^3$
Net	0	0	0	0
Privatized:				
Retirees[a]	$+T_t$	$+T_t(1+\rho)$	$+T_t(1+\gamma)(1+\rho)$	$+T_t(1+\gamma)^2(1+\rho)$
Employees[b]	$-T_t$	$-T_t(1+\gamma)$	$-T_t(1+\gamma)^2$	$-T_t(1+\gamma)^3$
Debt	0	$-\rho T_t$	$-\rho T_t$	$-\rho T_t$
Net receipts	0	$-\gamma T_t$	$[(1+\gamma)(\rho-\gamma)-\rho]T_t$	$[(1+\gamma)^2(\rho-\gamma)-\rho]T_t$

[a]Under the privatized funded plan, retirees receive benefits at time t and then receive the principal and earnings on their savings for all $t > 0$.

[b]Under the privatize funded plan, employees save these amounts.

retirees, the welfare effect depends on the relative magnitude of the future retirement income gains and the future debt service requirements.

In the OLG model of the first section, the privatization process that begins at time t is equivalent to reducing the payroll tax on the current generation of employees by T_t and issuing national debt of T_t. If that generation of employees increases saving by the amount of the tax reduction, this incremental saving is just enough to absorb the additional national debt.[49] The debt service during each period in the future is ρT_t.[50]

Table A.1 shows the first four periods of the sequence of income and saving under the existing unfunded plan and the alternative privatized funded plan. With the unfunded system, taxes and benefits are equal to each other in each period and increase at the rate of growth of aggregate wages (γ). With the privatized funded system, (mandatory) saving is by assumption the same as the employees would otherwise have paid in payroll taxes. Retirees continue to receive transfer funded benefits only in the first period of the transition (at time t) and then receive the income and principle from their private saving. In

49. Although the initial employees are required to save T_t in the mandatory private saving fund, they may reduce (or increase) other saving in response to the income effect of privatization. If capital income taxes distort the lifetime distribution of each individual's consumption, a change in saving induced by these income effects will have a first-order effect on individual lifetime welfare. Taking this into account explicitly would not alter the condition under which privatizing an unfunded social security program raises the present value of consumption, but it would alter the magnitude of the gain.

50. Although the government may pay a net interest rate that is less than the marginal product of capital, the fact that national debt absorbs the private saving (and thereby displaces an equal amount of investment) implies that the lost return is the marginal product of capital. I return in the next section to the relation between the marginal product of capital and the net of tax yields on private securities and government debt.

addition, the existence of the government debt reduces real income (by crowding out private capital) in each period by ρT_t.

Note that, at time t, there is no difference between the outlays and receipts of retirees and employees under the existing unfunded plan and under the alternative debt-financed funded plan. At $t + 1$, the retirees receive $T_t(1 + \rho)$, an improvement of $(\rho - \gamma)T_t$ in comparison to the unfunded system. But some combination of retirees and employees must also bear the cost of debt service ρT_t. The net effect of privatization on consumption at time $t + 1$ is therefore $-\gamma T_t$.

Table A.1 shows that, while the negative effect of debt service remains constant at $-\rho T_t$, the retiree's gain from shifting to a funded plan increases in proportion to the growing level of aggregate wages $(\rho - \gamma)(1 + \gamma)^t$. The effect of privatization eventually shifts from negative to positive. Privatizing the system raises the present value of consumption if the discounted value of the increased retirement consumption ($\Sigma_{s=1}$ $[\rho - \gamma]T_t[1 + \gamma]^{s-1}[1 + \delta]^{-s}$) exceeds the present value of the debt service ($\Sigma_{s=1}$ $\rho T_t[1 + \delta]^{-s}$). The present value gain from privatizing is

$$\text{(A2)} \qquad \text{PVG} = \sum_{1} (\rho - \gamma)T_t(1 + \gamma)^{s-1}(1 + \delta)^{-t} - \sum_{1} \rho T_t(1 + \delta)^{-s}$$

or, equivalently,

$$\text{(A3)} \qquad \text{PVG} = [(\rho - \gamma)/(\delta - \gamma) - \rho/\delta]T_t.$$

Thus, PVG > 0, and privatization raises the present value of consumption only if three conditions are met: $\rho > \gamma$ (the return on capital exceeds the implicit return in the unfunded program), $\rho > \delta$ (the capital intensity of the economy is below the welfare-maximizing level), and $\gamma > 0$ (the economy is growing). Why does privatization raise the present value of consumption only when all three conditions are satisfied? First, an unfunded system has an inferior return to employees in each generation only if $\rho > \gamma$. If $\rho \leq \gamma$, the economy is dynamically inefficient, and consumption can be raised permanently by reducing the initial capital stock. Even if $\rho > \gamma$, the annual gains ($[\rho - \gamma]T_0$ $[1 + \gamma]^t$) have a present value that exceeds the initial transfer to retirees only if the marginal rate of transformation between present and future consumption exceeds the marginal rate of substitution between consumption in different generations ($\rho > \delta$). Both are also the necessary conditions for the introduction of an unfunded program to reduce welfare. If they are not satisfied, an unfunded program raises welfare (even if there are no myopic individuals), and replacing it with a funded private program is therefore welfare decreasing.

The additional condition ($\gamma > 0$) is now required to make the gain from increased retirement income exceed the cost of the additional national debt. A positive rate of growth is important in this context because the annual gain to retirees grows with the size of the economy while the cost of the increased national debt remains constant. If the economy did not grow, the annual gain to the retirees would remain constant at $(\rho - \gamma)T_t$, which, with $\gamma = 0$, is ρT_t, exactly the same as the cost of debt service.

Privatizing social security raises economic welfare only if the economy is growing because only in a growing economy does the shift to a funded program avoid the rising loss of an increasingly large unfunded program in the future. The privatization at time t just substitutes national debt for the existing social security liabilities with no net present value gain, but, in a growing economy, privatization prevents the automatic impositions of a larger inefficient social security program in the future.

For any realistic economy, all three inequalities are likely to be satisfied, and therefore a shift to a funded program is likely to raise economic welfare. The next section discusses the evaluation of γ, ρ, and δ and the implied present value gain from a debt-financed privatizing of the existing U.S. social security retirement benefits.

Parameter Values and the Estimated Net Gain

The values associated with the three key parameters (γ, ρ, and δ) that were discussed in the text of this introductory chapter imply the critical inequalities ($\rho > \delta$ and $\delta > \gamma > 0$) and provide the basis for calculating a theoretical estimate of the net gain from privatizing social security. More specifically, the experience in the United States since 1960 implies $\gamma = 0.026$ and $\rho = 0.093$. The text suggests that the certainty equivalent rate of return that replaces the return to portfolio investors with the yield on government bonds is 6.4 percent, which will be denoted $\rho^* = 0.064$. Finally, the corresponding certainty equivalent for the return on the unfunded program will be written γ^*. If the risk of the social security program is ignored, $\gamma^* = \gamma = 0.026$, while, if social security is deemed to be as risky as portfolio investments, $\rho^* - \gamma^* = \rho - \gamma = 0.093 - 0.026 = 0.067$.

The derivation of equation (A3) for the present value gain from privatizing social security implies that

$$\text{(A4)} \qquad PVG = [(\rho^* - \gamma^*)/(\delta - \gamma) - \rho^*/\delta]T_0.$$

Note that the γ^* in the numerator refers to the certainty equivalence return in the unfunded social security program. The value of γ in the denominator refers to the effect of the economy's growth on the future size of the program and therefore is not a rate of return subject to a certainty equivalence adjustment.

There are two conceptually different approaches to defining the appropriate rate of intergenerational discounting (δ). The first begins with the view that the generations are linked by family altruism so that the appropriate rate of discount between generations is the same as the rate of discount within generations. This implies that the relevant discount rate is the real net yield that individuals receive. If considerations of risk are ignored, this implies $\delta = (1 - \tau)r_N$, where τ is the marginal individual tax rate, and r_N is the return after corporate taxes but before individual taxes. With a relatively conservative estimate of $\tau = 0.2$, and with $r_N = 0.055$, this approach implies $\delta = 0.044$. If the real net return on government bonds is regarded as a more appropriate risk-adjusted measure, $\delta = r_{GN} = 0.010$. In either case, it is clear that $\rho > \delta$. Using $\delta = r_{GN}$ implies that $\delta < \gamma$ and therefore that the appropriate discount rate is less than the rate of growth of the social security program. In this case, the present values in equations (A1), (A2), and (A3) do not exist; the loss of income of an unfunded social security program $(\rho^* - \gamma^*)T_t(1 + \gamma)^s$ grows faster than the discount factor. But, although the present value is not defined, it is clear that the discounted loss of introducing an unfunded social security program exceeds the value of the initial transfer within a finite number of years. Similarly, the discounted gain from a debt-financed transition to a funded program exceeds the cost within a finite number of years.

The second approach to defining δ rejects the use of a market rate for intergenerational discounting on the grounds that the generations are not linked by operative bequest motives and that the preferences of the current generation should not determine the relative values to be put on consumption in future generations. The rate of discount must therefore be derived from the structure of the utility function. The common assumption of an additive separable constant elasticity utility function implies that $\delta = (\gamma - n)\eta$, where $\gamma - n$ is the rate of increase of per capita incomes, and η is the absolute elasticity of marginal utility.[51]

Between 1960 and 1994, the population growth rate was $n = 0.011$, implying $\gamma - n = 0.015$. Plausible values of the elasticity of the marginal utility function are generally taken to be about $\eta = 2$, implying that $0 < \gamma < \delta < \rho$, the condition that implies a positive but finite discounted value of the gains from a debt-financed shift from an unfunded to a funded social security program. Values of $\eta < 1.7$ imply $\delta < \gamma$ and therefore that the gains from shifting to a funded program grow faster than the discount rate. In this range, the present value gain from a debt-financed shift to a funded program increases without limit as the time horizon is extended. Only an implausibly high $\eta > 4.2$ would imply $\delta > \rho^* = 0.064$ and therefore a net loss from a debt-financed shift to a funded system.

Effect of Constant Benefits and Reduced Taxes

The calculations in the second and third sections may be regarded as unrealistic because they assume that the mandatory saving in a funded system would be as large as the contributions to the unfunded system. That may not occur because it would imply a much higher level of retirement income with no increase in net income during working years. An alternative "extreme" assump-

51. Let the social welfare function be $\sum u(c_t)$, where c_t is mean per capita consumption at time t and $u(c_t) = kc_t^{\eta+1}$. Then $1 + \delta = \text{MRS}(c_t, c_{t+1}) = (1 + \gamma - n)^\eta \cong 1 + (\gamma - n)\eta$.

tion is that contributions in the funded program are set to produce the same benefits as in the current unfunded system.

With this assumption, each generation of employees saves the fraction $(1 + \gamma)/(1 + \rho)$ times what it would pay as payroll tax with an unfunded system. This implies that the analogue to equation (A3) is

$$\text{(A5)} \qquad PVG = \{[(1 + \delta)/(1 + \rho^*)][(\rho^* - \gamma^*)/(\delta - \gamma)] - \rho^*/\delta\}T_t.$$

The difference is that the gross gain (before taking into account the debt service cost) is reduced by a factor of $(1 + \delta)/(1 + \rho^*)$, reflecting the fact that, with the smaller saving, the gain is reduced. If individuals were permitted to supplement mandatory saving and earn the return ρ^*, this reduction could be eliminated.

Other variations on the basic theme could be considered, including debt amortization instead of a perpetual increase in the debt. These have consequences for the intergenerational distribution as well as for the net present value gain.

Rather than consider more such possibilities in this simplified theoretical framework, it is better to study them with actual parameter values (as in Feldstein and Samwick, chap. 6 in this volume). But the current analysis has been sufficient to indicate why gains occur and how, in a qualitative sense, they are related to the rates of growth of wages, the productivity of capital, and the rate of consumption discount.

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