Chapter 32

SOCIAL SECURITY*

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Contents

Abstract

This chapter reviews the theoretical and empirical issues dealing with Social Security pensions. The first part of the chapter discusses pure pay-as-you-go plans. It considers the effects of introducing such a plan on the present value of consumption, the optimal level of benefits in such plans, and the empirical research on the effects of pay-as-you-go pension systems on labor supply and saving. The second part of the chapter discusses the transition to investment-based systems, analyzing the effect on the present value of consumption of such a transition and considering such issues as the distributional effects and risk associated with such systems.

Keywords

Social Security, pensions, retirement

JEL classification: H55

1. Introduction

As with all social insurance programs, the provision of old age pensions involves a trade-off between protection and distortion. Social Security benefits protect the aged from poverty and, more generally, from a sharp decline in the standard of living that could occur when regular earnings cease. But the provision of benefits that are conditioned on income or employment and the collection of the taxes needed to finance those benefits also create deadweight losses that result from changing the behavior of both the aged and the younger population. The optimal size and character of the Social Security program, therefore, involves a balancing of this protection and distortion just as the level and structure of the income tax system involves a balancing of distortion and distributional considerations.

Although these issues have in principle been around since the first Social Security programs, it is the rapid increase in current and projected budget costs associated with the aging of the population that has generated government interest in Social Security reform around the world. The imminent retirement of a large baby boom generation will cause these costs to accelerate rapidly during the next several decades. The ratio of retirement costs to GDP will then remain high because of the permanent increase in the relative number of retirees in the population. In the United States, the Social Security actuaries estimate that the cost of the Social Security program will rise from about 10% of covered earnings now to 15% of earnings by 2030 and to more than 18% of earnings in 2050 and beyond. This corresponds to an increase from about 4% of GDP now to about 8% of GDP after 2050, an increase that is equivalent to a 20% increase in total current federal government spending and to a 40% increase in the federal personal income tax[1]. The OECD estimates that the costs of maintaining the existing Social Security retirement programs will increase substantially more in most other countries because of differences in program design and projected demographic changes: by 2040 to 14% of GDP in France, 18% of GDP in Germany, and 21% of GDP in Italy [OECD (1998)]. Because of these fiscal pressures, governments around the world are implementing or considering major reforms in the existing Social Security programs, raising important and interesting analytic and policy questions for economists[2].

The taxes needed to support these programs are, of course, in addition to the basic income tax and to other payroll taxes used to finance health care and other

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[1] The Congressional Budget Office estimates that the combination of Social Security and Medicare will increase from 6.3% of GDP in 1999 to 9.3% of GDP in 2020 and 13.0% of GDP in 2040. See U.S. Congressional Budget Office (2000a,b). More detailed data on Social Security outlays and receipts are presented in the annual reports of the Social Security Trustees. These are also available online at http://www.ssa.gov.

[2] While this chapter touches on the experience in other countries, most of our examples and research findings relate to the United States. For a discussion of some of these issues in the European context, see the articles in the special issue of the *Scandinavian Journal of Economics* on Social Security in the 21st Century that was published in 2000 and the article by Banks and Emmerson (2000). For analysis related to emerging market countries, see James (1998a,b).

government activities and transfers. The political sensitivity to the prospect of a large tax increase has led to discussions in a wide range of countries of ways to slow the growth of future benefits as well as of ways to reduce the future burden of financing benefits by shifting from existing pure pay-as-you-go systems to ones that incorporate prefunding through investment-based components as well. For economists, the fact that the deadweight loss of a tax system increases with the square of the marginal tax rate makes the demographically-driven increases in projected tax rates a reason for more urgent examination of reform possibilities.

In this essay we focus on the cash benefit pension programs for the aged and disabled that are referred to in the United States as the Social Security program or, more technically, as the Old Age, Survivor and Disability Insurance (OASDI) program[3]. There are many parallel issues in the financing of medical care for the aged (the US Medicare program) and of the long-term institutional care provided in nursing homes [Feldstein (1999a)].

We begin with a discussion of the rationale for government provision of old age retirement benefits, provide a brief comment on the historical evolution of current Social Security systems, and then discuss alternative theories of the political economy of Social Security provision in light of the theoretical considerations and historical evidence. The essay is then divided into two parts. The first part deals with the economics of unfunded (i.e., pay-as-you-go) defined-benefit programs of the type that now exist in the United States and most other industrial countries. The second part of the essay deals with the implications of shifting in whole or in part to a prefunded defined-contribution (i.e., investment-based) system as many countries around the world are now doing or contemplating.

2. Government provision of retirement pensions: rationale and evolution

This section considers the rationale for government provision of the type of retirement pensions that are provided by the US Social Security program and comments briefly on the historical evolution of the program and on the theories of political economy that might explain the observed program and its evolution.

2.1. Alternative forms of retirement pensions

There are in principle many ways that a society can provide for the consumption of the older population. In the atomistic life-cycle model, individuals save during their working years and dissave during retirement. This may be institutionalized through

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[3] The theoretical models that we discuss refer to the more limited program of pension benefits but the numerical values, tax rate projections, and simulations of alternative policies all include survivor and disability benefits as well as the pension benefits.

corporate pension systems that reduce cash wages during working years and provide retirement benefits. Many societies, including the United States before the introduction of Social Security, assume that individuals will work until they are no longer able to do so and will then finance their consumption by a combination of their own saving and payments from their children, often in the form of living with their adult children.

If the government takes a more active role, it can do so by either mandating or subsidizing private accumulation of saving for retirement or it can provide benefits to individuals who are retired or who exceed some threshold age. The United States subsidizes but does not mandate such private saving through tax policies that encourage a combination of corporate pension plans and Individual Retirement Accounts [see Chapter 18 in Volume 3 of this Handbook by Bernheim (2002)]. Other countries mandate that individuals or their employers must contribute to defined-contribution retirement accounts for their old age (e.g., Argentina, Australia, Chile, and Mexico)[4]. In addition, the United States, like most other OECD countries, directly provides retirement benefits through a Social Security program.

Government Social Security can be either means-tested, with benefits depending on the income or assets of the recipient, or it can be a universal program in which benefits do not depend on the recipients' retirement income or assets[5]. In the USA and other OECD countries, the Social Security program is a universal one. Eligibility for benefits depends on the individual's age but not on the individual's financial status[6]. Until recently, benefits in the USA were not paid to individuals who earned more than a threshold amount, a feature that is now restricted to those under age 65 who want to claim early retirement benefits[7].

A useful four-way classification of pension programs divides them by two criteria: defined-contribution vs. defined-benefit and funded (i.e., based on accumulated assets) vs. unfunded (i.e., pay-as-you-go)[8]. All four possibilities exist in practice, with some countries having more than one type of plan for the same individuals at the same

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[4] See the separate discussions of these countries by Cottani and Demarco (1998), Edey and Simon (1998), Edwards (1998), Budd (1998) and Sales-Sarrapy, Solis-Soberon and Villagomez-Amezua (1998).

[5] "Universal" programs are sometimes defined in a different way to mean that benefits are paid based on residency rather than previous contributions.

[6] The situation in practice is a bit more complicated by the fact that benefits are subject to the income tax and are sometimes supplemented by a means-tested benefit in the Supplemental Security Income Program.

[7] This loss of benefits was partially offset by an increase in benefits when the workers eventually retired.

[8] See Diamond (1998a) and Geanakoplos, Mitchell and Zeldes (1998) for wideranging discussions of distinctions among and alternative combinations of defined-benefit and defined-contribution programs and of the combinations of funded and unfunded programs. Lindbeck (2002) discusses a richer classification of pension programs based on the response of benefits and of taxes to uncertain events (like demographic changes and changes in wage growth). Lindbeck and Persson (2000) emphasize a four way classification based on funded vs. unfunded and on actuarial vs. non-actuarial that is closer to the four way classification used in the current chapter.

time. Several countries are moving from unfunded defined-benefit plans to unfunded defined-contribution plans or to a mixture of the unfunded defined-benefit plans and funded defined-contribution plans.

In characterizing these four possibilities, it is useful to begin with *funded defined-contribution plans*. In the United States, most *private* pension plans are of this type. In such plans, employees have individual investment accounts to which they and/or their employer make periodic deposits. The rules of the plan define the maximum amount of contribution and the extent of employer matching. When these individuals reach retirement age, they make withdrawals or receive annuity payments based upon the value of the assets in their accounts, which reflect both the original contributions and the accumulated investment return. Several countries, including Argentina, Australia, Chile, and Mexico have adopted this framework for their public Social Security program, requiring employees and/or employers to deposit funds that are invested in a range of private and public securities.

Many older US corporate pension plans are *funded defined-benefit plans*. In such plans, companies accumulate funds in pension accounts (that are legally separated from the companies' other assets) and pay benefits to retirees that reflect the number of years that an employee has been with the company and the level of the employee's earnings in his or her pre-retirement years. These are defined-benefit plans in the sense that the rules of the plan define the benefits that an employee will receive in a way that is independent of the actual investment performance of the assets that have been set aside for this purpose. The company is responsible for providing the funds to meet these benefits and must do so in a way that causes the pension accounts to have assets approximately equal to the actuarial present value of the company's pension liabilities. Most state government pension plans in the United States are of this form.

Although the US Social Security program has accumulated some surpluses in an accounting trust fund, the US plan is more accurately described as an *unfunded defined-benefit program*. This was not always so. When the US Social Security system was created, it was designed to be a funded system to protect future retirees from possible changes in political support. Weaver (1982) quotes then Treasury Secretary Morgenthau's testimony to the Ways and Means Committee of the Congress in 1935:

> There are some who believe that we can meet this problem as we go by borrowing from the future to pay the costs. ... They would place all confidence in the taxing power of the future to meet the needs as they arise. We do not share this view. We cannot safely expect future generations to continue to divert such large sums to the support of the aged unless we lighten the burden upon the future in other directions. .... We desire to establish this system on such firm foundations that it can be continued indefinitely in the future.

However, opponents of funding, most notably Senator Arthur Vandenberg, argued that a government-controlled funded system would (1) lead the fund to be invested in inefficient social investments, (2) eliminate the public debt thereby weakening financial markets, (3) encourage the government to spend more money, and (4) lead to increases

in Social Security benefits[9]. In 1939 Secretary Morgenthau dropped his support for a fully-funded system, arguing instead that the system should maintain sufficient funding to pay roughly three years worth of benefits. In the early 1940s, Congress passed a series of bills postponing scheduled increases in the payroll tax, effectively turning the system into a pay-as-you-go system. According to Schieber and Shoven (1999), President Roosevelt continued to favor a fully-funded system. The payroll tax postponement in the Revenue Act of 1943 passed over a rare Roosevelt veto, and the postponement in the Revenue Act of 1945 passed after Roosevelt's death[10].

Thus, the system became a pay-as-you-go program with assets substantially less than its actuarial liabilities. The Social Security (OASDI) Trust Funds at the end of fiscal year 1999 had assets of $855 billion while the present value of the promised benefits is an estimated $9 trillion [Goss (1999)][11].

Finally, Sweden and Italy have recently switched from unfunded defined-benefit programs to unfunded defined-contribution programs. These programs, also known as "notional defined-contribution plans", credit individuals' accounts with the taxes that they and their employers pay and then accumulate these sums with an implicit rate of interest. Since there are no real investments, the implicit rate of interest is just a "notional" amount. When individuals reach retirement age, they can draw an annuity based on this accumulation, again reflecting the notional rate of interest. The effects of and rationale for such notional defined-contribution plans are discussed below.

In the United States and other countries with unfunded defined-benefit plans, individuals' benefits are positively related to the past earnings of those individuals. In the US, benefits rise less than proportionately with the past level of earnings; additional benefits are paid for current and surviving spouses and for dependent children. Many countries combine a flat or means-tested benefit that is independent of past earnings with an earnings related portion that is proportional to past earnings and years of contribution.

2.2. The rationale for government provision

What then is the rationale for a government pension program in general and, in particular, for a pay-as-you-go Social Security program that provides universal benefits that increase with past earnings and with the number of dependents? Why is there

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[9] The material in this paragraph is drawn from Schieber and Shoven (1999).

[10] One other aspect of the early history of the US Social Security system presaged current debates. Because benefits are determined by lifetime earnings, the US Social Security system requires the Social Security Administration to keep track of lifetime earnings histories for each worker. According to Rodgers (1998, p. 445), "The editors of the London *Economist* thought the idea of individually tracked lifetime accounts so extraordinarily expensive and administratively top heavy that it could not conceivably survive ... "

[11] The economic significance of the trust fund is discussed in Section 3.3.

any government program and why does it take this form instead of one of the other possibilities described above? [12]

The traditional rationale for government intervention in private markets is the existence of significant externalities or other market imperfections. Although it is difficult to identify any externalities that would justify a government role, the historic absence of a market for real annuities does imply a potential role for the government. The absence of such a market reflects not only the typical asymmetric information problem of any insurance market [Rothschild and Stiglitz (1970, 1971, 1976)] but also the difficulty of the private market to provide a real (i.e., inflation adjusted) annuity in the absence of a real security in which to invest. The relatively recent creation of US Treasury Inflation-Indexed Securities (i.e., US government bonds with maturities of up to 30 years with both principal and interest payments fully adjusted for changes in the price level) now provides the opportunity to create such real annuities and at least one US company (TIAA–CREF) has introduced a product based exclusively on investment in such securities. Although the asymmetry of information between the annuity buyer and the insurance company continues to be a problem in creating actuarially fair products for those interested in buying annuities, Brown, Mitchell and Poterba (2000) show that, for the average annuity purchaser today, the expected annuity payments are between 90 and 95% of his premium. A government rule requiring all individuals to annuitize the accumulated assets in a personal retirement account would eliminate the self-selection problem and allow all individuals to purchase annuities with payout rates similar to these [13].

The three most common rationales for the existing Social Security program are: (1) paternalism to counter individual life-cycle myopia; (2) the avoidance of counterproductive "gaming" of the welfare system by the aged; and (3) a desire to redistribute income among individuals based on lifetime earnings rather than a single year's income [14].

Although most American families accumulate only very small amounts of financial assets [15], it is not clear whether this is a reflection of inadequate life-cycle planning or

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[12] See Diamond (1977) for a general discussion of the rationale for Social Security.

[13] Brown, Mitchell and Poterba (2000) also show that for the average person (i.e., not the average annuity buyer) the annuity load factor would now be between 15% and 20%. Comparing this with the experience of actual buyers shows that adverse selection is responsible for about two-thirds of this gap between premiums and expected payments. Mandatory annuitization on the same terms for everyone would still redistribute based on differences in life expectancy.

[14] A common reason for government intervention in other markets is to foster the consumption of some particular kind of good or service like education, food, or health care. But since Social Security pensions are simple cash payments, the program cannot be justified as a politically expressed desire to encourage a particular form of consumption.

[15] The median financial assets of households with heads age 51 to 61 in 1992 was only $14 500 (authors' calculations from the Health and Retirement Survey). These financial assets include individual retirement accounts, but exclude Social Security wealth and private pensions (whether defined-benefit or defined-contribution).

of the displacement of personal financial asset accumulation by the anticipated benefits of Social Security and private pensions. Nevertheless, common observation suggests that there are many individuals who would not plan adequately for their old age and who would, in the absence of some form of government program, find themselves in poverty or at least with a substantially reduced consumption relative to their pre-retirement years. But even if the existence of such myopia is accepted as the reason for government action, why should it take the form of the government provision of benefits that are both universally provided and positively related to past earnings? The government might instead provide a universal common benefit (rather than one that is greater for individuals with higher preretirement incomes) or a uniform means-tested benefit.

The case for a benefit that increases with preretirement income can be made in terms of the greater personal distress that would result from a larger fall in income, or, equivalently, of a utility function structure that makes the marginal utility of retirement benefits higher for individuals with higher preretirement income[16]. The case against a means-tested benefit is that it might encourage some lower-income individuals to intentionally undersave during their working years so that, by gaming the system in this way, they will qualify for the means-tested benefit[17]. Neither of these first two reasons is necessarily compelling but they are sufficient to indicate why such a program might be appropriate; further analysis of these issues is summarized in Section 4.3 below.

A second rationale for Social Security is to prevent free-riding in the presence of altruism [Buchanan (1975), Kotlikoff (1987), Lindbeck and Weibull (1988)]. Specifically, if individuals know that other members of the society are altruistic and will provide for them if they reach old age without resources, then there will be an incentive for people to undersave and take advantage of the good will of others. This free-riding leads to an inefficient outcome that can potentially be ameliorated with a compulsory program of old age assistance.

Even if these considerations lead to the conclusion that there should be a universal government pension that is positively related to preretirement earnings, it is not clear why this should be done as a pay-as-you-go program rather than a funded program or, alternatively, by mandating that individuals save for their own old age.

Before looking at the basic economics of the pay-as-you-go program more explicitly, we comment briefly on some of the political economy arguments that have been

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[16] Consider a 2-period model in which individuals i and j work during the first period and retire in the second and in which each individual has an identical multiplicative utility function of the form $U_i = C_{i,1}^a C_{i,2}^{1-a}$. If (1) the first-period consumption of each individual is already given, (2) the individuals are completely myopic and therefore save nothing, and (3) the policy goal is to maximize $U_i + U_j$ subject to $C_{i,2} + C_{j,2} = B$ (the Social Security budget constraint), then the optimal retirement benefits are proportional to the first-period consumption: $C_{i,2} / C_{j,2} = C_{i,1} / C_{j,1}$.

[17] Whether a means-tested program is preferable to a universal program depends on the number of low-income people who would be hurt relative to a universal program and the number of higher-income people who would receive no benefits under a means-tested program. See Feldstein (1987b) and Section 4.3 below.

advanced to explain the current structure of Social Security programs and review some of the history of the actual programs.

2.3. Historical evolution [18]

Government administered old-age pensions for private sector employees were introduced by Germany in 1889, concluding a decade that had seen Germany pioneer sickness and accident insurance for industrial workers as well. The distinctive feature of the German approach to social insurance was that the programs were compulsory and contributory. In the case of old-age pensions, both employers and workers were required to make contributions [19], and benefits were paid out to disabled workers and to former workers who survived beyond the age of seventy. While the immediate political impetus for creating these programs was Chancellor Otto von Bismarck's desire to head off the incipient socialist movement and solidify urban working-class loyalty to the regime, the idea of insuring the risks faced by workers in industrial society had been spreading for some time. In particular, the German system had antecedents in the numerous mutual assistance societies self-organized by workers and guilds, Napoleon III's state-subsidized banks that provided voluntary disability insurance and old-age annuities, and compulsory insurance pools in high-risk industries such as mining and maritime.

While the German model of social insurance was discussed extensively around the world (and Germany heavily promoted the concept), its spread was quite gradual. By 1910, the only country that had fully adopted German-style compulsory and contributory systems was Austria [20]. Meanwhile, an alternative approach for providing income for the elderly, general-revenue financed means-tested old age pensions, was adopted in Denmark in 1891, New Zealand in 1898 and in Australia and Britain in 1908 [21]. The British system provided benefits to citizens over seventy who were poor and could pass a character test. Benefits were higher than under the German system and reached three times as many persons [22].

Old-age pensions were adopted at a relatively late date in North America. Canada introduced a non-contributory means-tested system in 1927. In the USA, state governments enacted means-tested old-age pensions funded out of general revenues during the 1920s, particularly after the stock market crash of 1929. By 1934, 28 states had old-age pensions and not one was contributory [Moss (2002)]. The US federal social insurance system was enacted in a single piece of legislation in the midst of the

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[18] This section draws heavily on Rodgers (1998), Ritter (1986), and Flora and Alber (1981).

[19] The government made some modest contributions from general revenues as well.

[20] Austria's initial social insurance system did not include old-age benefits.

[21] Britain did adopt the contributory approach for its health insurance system in the 1911 National Insurance Act. Between World War I and World War II, contributory old-age pension systems were adopted in Belgium, Italy and France.

[22] Rodgers (1998, p. 230).

Great Depression. The Social Security Act of 1935 created Unemployment Insurance, Aid to Dependent Children, Old Age Insurance (OAI), and Old Age Assistance (OAA). Old Age Insurance, a German-style compulsory contributory system, is what gradually evolved into Old Age Survivors and Disability Insurance, the program that Americans now think of as "Social Security". Old Age Assistance, a UK-style means-tested system (jointly funded by the federal and state governments), was replaced by Supplemental Security Income in the early 1970s[23]. Until the 1950s, benefits under OAA were larger than those from OAI, and it has been argued that it was only because the 1935 Act included OAA (which provided for immediate benefits to retirees in the midst of the depression) that it was possible to enact OAI [Costa (1998)].

While the emergence of old-age pensions in the late 19th century and the first half of the 20th century can be attributed to economic factors such as industrialization, urbanization, and increases in life expectancy, and to political developments such as the formation of nation states and their transformation into mass democracies, researchers have generally been unable to explain the order and extent to which countries adopted social insurance using variation in these economic and political factors. As Flora and Heidenheimer (1981) note, "the most democratic and capitalist of the European societies were not the first to develop the institutions and policies of the modern welfare state". Thus the empirical work in Flora and Alber (1981) finds little relationship between the adoption of social insurance programs and industrialization, urbanization, working class participation in politics, or suffrage rates in Western Europe. However, they do find that constitutional-dualistic monarchies were more likely to introduce social insurance systems than were parliamentary democracies. Cutler and Johnson (2000) estimate hazard models for the introduction of old age insurance and health insurance programs, and tentatively conclude that richer countries are more likely to institute minimum systems designed primarily to alleviate poverty while poorer countries are more likely to introduce universal insurance systems. They also find that autocratic countries are more likely to introduce insurance systems.

While nearly all industrial economies had some sort of old-age pension by the time of World War II, many of these systems were quite limited in both the share of the population they covered and the level of benefits that they provided. The 35-years following the war saw tremendous expansions in coverage and benefits levels in most countries, and a number of countries added contributory systems to their pre-war means-tested systems. In the USA, the original OAI system was amended in 1939, before the first benefits were paid out, to add benefits for dependents of retired workers and surviving dependents of deceased workers. Disability benefits were introduced in 1956 and expanded to dependents of disabled workers in 1958. Automatic cost of living increases in benefits were introduced in 1972, following a series of ad hoc increases in benefit levels. These expansions in benefits resulted in total OASDI payroll tax rates of

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[23] For histories of the US system see Lubove (1968), Weaver (1982), Miron and Weil (1997), Costa (1998), Schieber and Shoven (1999), and Moss (2002).

12.4% compared to the 6% long-run rates that had been scheduled under the 1935 and 1939 Acts. Over this time period, the share of the workforce that was covered by the system expanded greatly, from 43% in 1935 (the original system excluded agricultural workers, government workers, railroad workers, and the self-employed) to 96% today (some state and local government workers are still not part of the system).

The expansions in old-age pensions and in other social insurance programs accounts for a large share of the rapid growth in government spending as a share of GDP that occurred in most industrial democracies after World War II. For example, between 1953 and 1974 government spending in OECD countries grew from an average of 29% of GDP to an average of 39% of GDP, while transfer spending (of which Social Security is a major part) increased from 12% of GDP to 19% of GDP [Peltzman (1980)].

2.4. Political economy explanations of the existing Social Security programs

The historical evolution of Social Security programs shows that while the economic rationales for government provision can explain in part the emergence of such systems as industrialization took hold, it is clear that political factors have played an important role in the development of these programs. A number of economists have studied the political economy of Social Security with the aim of explaining why Social Security systems take the form that they do. In the process, these researchers have developed some additional efficiency arguments for government provision of Social Security beyond the classic ones discussed in Section 2.2.

One strand of this literature has tried to explain why Social Security expenditures are as large as they are given that the elderly are only a minority of the population. Possible explanations include that Social Security provides concentrated benefits and diffuse costs [24], that the elderly and older workers form a coalition [Browning (1975)], or that the elderly and the poor form a coalition in support of a redistributive Social Security system [Tabellini (1990)] [25]. Peltzman (1980) argues that the emergence of a relatively homogenous educated middle class voting block led to the large rise in transfer spending in the second half of the 20th century. He also noted that these demographic trends had crested and accurately predicted the deceleration of the growth in government after 1980. More recently, Mulligan and Sala-i-Martin (1999a) suggest that time and single-mindedness are important political resources and that the elderly's large endowment of these two resources can explain a number of features of Social Security systems. Bohn (1999) shows that for the voter of median age, the US Social Security system has a positive net present value, explaining why the system is politically viable even as rates of return have fallen.

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[24] As Tabellini (1990) points out, the costs per taxpayer of Social Security are so large that it is hard to see the concentrated-benefit diffuse costs argument as fitting in this case.

[25] Historically, all of the generations alive at the introduction of the US Social Security program were net beneficiaries because they were the "initial generations" in a pay-as-you-go system with subsequent program expansions.

Becker and Murphy (1988) attribute the existence of Social Security to an intergenerational compact between the old and the young. Specifically, parents provide investments in the human capital of their children and then receive a return on this investment in the form of Social Security benefits when the children are working and the parents are retired. Because children cannot be parties to a legally enforceable contract, the government needs to provide a mechanism for these transfers to occur. Rangel (2002) shows that in a majority rule system, the existence of programs like Social Security which transfer resources from the young to the old can give present generations the incentive to make investments that will primarily benefit future generations.

In a series of recent papers, Mulligan and Sala-i-Martin note that most existing Social Security systems create incentives for workers to leave the labor force when they reach the age of eligibility for Social Security benefits. They show that most existing positive theories of Social Security have difficulty explaining this feature of Social Security systems [Mulligan and Sala-i-Martin (1999b,c)]. Sala-i-Martin (1996) suggests one possible explanation for this feature: that there are positive externalities in the average stock of human capital and that therefore buying the elderly out of the labor force increases aggregate output[26].

3. The basic economics of pay-as-you-go Social Security

Although pay-as-you-go Social Security has existed since the days of Bismarck, it was Paul Samuelson's classic 1958 paper that first helped the economics profession to understand the basic economics of the pay-as-you-go system. In particular, it showed how a pay-as-you-go system produces an implicit rate of return equal to the rate of growth of the tax base. Following Samuelson, consider an overlapping generations model in which identical individuals each live for two periods, working a fixed amount in the first period and retiring in the second period. The number of individuals grows at the rate of n per period. There is no capital good in the economy; indeed, all products must be consumed in the period in which they are produced. In such an economy, individuals are not able to save privately for their old age. In a pay-as-you-go Social Security program each working generation transfers a fraction θ of its earnings to the concurrent retirees. Samuelson showed that such an arrangement gives each generation an implicit rate of return equal to the rate of population growth, a rate that Samuelson labeled the biological rate of interest.

To see why this occurs, let the number of workers at time t be L_t and the constant wage rate be w. The number of workers grows according to $L_{t+1} = (1 + n)L_t$. The aggregate tax paid by the working generation at time t is $T_t = \theta w L_t$. The benefit that this working generation will receive when it retires, B_{t+1}, is equal in a pay-as-you-go

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[26] See Mulligan (2000a,b) for further analyses of this issue.

system to the tax paid by the next generation, $B_{t+1} = T_{t-1} = \theta w L_{t+1}$. Thus, the ratio of the benefits received by the retirees to the taxes that those retirees paid when they were working is $B_{t+1} / T_t = T_{t+1} / T_t = L_{t+1} / L_t = 1 + n$.

Social Security is a desirable policy in this economy because it permits individuals to retire and consume despite the lack of any nonperishable good in the economy[27]. If technological progress causes the wage rate in the economy to rise at a rate of g, i.e., $w_{t+1} = (1 + g)w_t$, the Samuelson logic implies an implicit rate of return of approximately $n + g$ since $B_{t+1} / T_t = T_{t+1} / T_t = \theta w_{t+1} L_{t+1} / \theta w_t L_t = (1 + g)(1 + n)$.

In addition to providing a positive implicit rate of return for each generation of workers on the Social Security taxes that they have paid, the pay-as-you-go system also provides a one-time windfall to the initial generation of retirees that receives the initial benefit without having paid any tax during its own working years. Thus, in the absence of any durable capital asset (or fiat money), the introduction of a pay-as-you-go Social Security system is a pareto improvement.

3.1. The present value consumption loss caused by pay-as-you-go Social Security

The Samuelson-type calculations are also valid in an economy with a capital stock, but the Pareto-improving nature of Social Security no longer holds. The initial generations gain but future generations lose. More specifically, the initial generation of retirees receives a windfall of T_0 and each generation of workers receives an implicit rate of return of $(1 + n)(1 + g) - 1 = \gamma$ on the tax T_t that it pays. However, the existence of a capital stock implies that individuals could instead finance their retirement by saving and investing in actual capital goods where they would earn a real return of ρ[28]. In a dynamically efficient economy, the real rate of return ρ must exceed the rate of growth of the economy, γ [Cass (1965)]. Thus, each working generation incurs a loss because it receives a return γ on its Social Security taxes that is less than the return ρ that it would earn by investing those funds in the capital stock.

In a simple economy that is operating at a first-best equilibrium the present value of the consumption losses of all current and future working generations is just balanced by the windfall consumption that the initial retirees receive [Feldstein (1995a,c, 1998c), Murphy and Welch (1998)]. To see this, note that the initial retirees receive

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[27] Samuelson (1958) notes that the same ability of retirees to consume would also be achieved by the creation of a fixed stock of fiat money. Workers could exchange a fraction of their output for the money held by retirees. When the working generation retires, it could exchange its money holding for some of the output of the next generation. With a fixed amount of fiat money and a growing population, the money would be exchanged for more output than the retirees had paid when they were working, yielding the same rate of return of $1 + n$ on this money. Stated differently, with a fixed amount of money and a growing output, the price level would decline at a rate of $1 + n$, implying a real rate of return of $1 + n$ on the money balances.

[28] Diamond's justifiably famous 1965 paper extends the earlier Samuelson OLG model to include capital accumulation in this way.

a windfall of $T_0 = \theta w_0 L_0$. Each generation of workers pays Social Security tax of $\theta w_t L_t$ and receives a return of $\gamma \theta w_t L_t$. If those funds had instead been invested in the capital stock, the individual would have received a return of $\rho \theta w_t L_t$. Thus, the workers of generation t incur an income loss of $(\rho - \gamma) \theta w_t L_t$. This loss occurs during the retirement period of the individual's life; its present value as of the initial working period of the generation is $(\rho - \gamma) \theta w_t L_t / (1 + \rho)$. Since wages grow at g per period and the labor force grows at n, this generation's loss is equal to $(\rho - \gamma) \theta (1 + \rho)^{-1} w_0 L_0 (1 + \gamma)^t$. The present value of all of these losses (summed from $t = 0$ to infinity) is

$$\frac{\rho - \gamma}{1 + \rho} \theta w_0 L_0 \sum_{t=0}^{t=\infty} \frac{(1 + \gamma)^t}{(1 + \rho)^t} = \theta w_0 L_0 = T_0,$$

exactly equal to the windfall received by the first generation of retirees whose benefits are financed by the initial tax T_0. This demonstration that the introduction of a pay-as-you-go Social Security program induces no present value loss of consumption depends on very strong implicit assumptions that are generally not made explicit by those who assert the lack of a loss in present value: (1) the rate of return that the individual would receive on savings is equal to the marginal product of capital, i.e., there are no capital income taxes; (2) the marginal product of capital is the appropriate rate for the intergenerational discounting of consumption; and (3) the supply of labor is fixed so that the low rate of return on the Social Security tax paid by all working generations induces no deadweight loss.

To see the importance of these assumptions[29], begin by maintaining the assumption that the supply of labor is fixed. Let the real net rate of return that individuals receive on their saving be $r_n < \rho$, the difference reflecting the wedge that corporate and personal taxes on capital income place between the marginal product of capital and the net return to savers. Let the appropriate rate of discount for aggregating consumption across generations be denoted by δ. It might be argued that this is the same as the net return that individuals face (r_n). Alternatively, it can be argued that this social discount rate for aggregating consumption over generations should not be based on the preferences of existing individuals and the rate r_n at which they discount consumption within their own lives but that it should be equal to the rate at which the marginal utility of consumption declines between generations because of the growth of per capita consumption[30].

Consider now the present value loss to a representative member of the first generation of workers. This individual again pays a Social Security tax of θw_0. Let this

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[29] Feldstein (1995a, 1995c, 1998c). For an earlier discussion of these issues see Feldstein (1987a).

[30] The social rate of discounting consumption over different generations might also reflect a pure time preference. If consumption grows at rate g and the elasticity of the marginal utility function is ϵ, then $\delta = \epsilon g + \eta$, where η is the pure time preference rate at which utility is discounted.

tax reduce the individual's saving by some fractional amount of this: $s\theta w_0$. Thus, first period consumption falls by $(1-s)\,\theta w_0$. In the retirement period, the foregone saving would have produced $(1+\rho)\,s\theta w_0$ [31]. With the unfunded Social Security program, the retirees instead receive the Social Security benefits of $(1+\gamma)\,\theta w_0$. Thus, the change in the present value of consumption for the first cohort of workers due to the introduction of the pay-as-you-go program is

$$-(1-s)\,\theta w_0 - \{(1+\rho)\,s\theta w_0 - (1+\gamma)\,\theta w_0\}\,(1+r_n)^{-1}.$$

This simplifies to

$$-\theta w_0\,(1+r_n)^{-1}\,\{(r_n-\gamma)+(\rho-r_n)\,s\}.$$

Note that in the first best case in which there is no tax wedge on capital income $(\rho = r_n)$, this expression simplifies to $-(\rho-\gamma)\theta w_0/(1+\rho)$. In this case the amount of the pay-as-you-go tax that would otherwise have been saved (s) is irrelevant because that saving would earn a return at rate ρ and that return would be discounted by the same rate. The saving matters when $\rho > r_n$ and implies a loss of present value consumption for a member of the first generation of workers equal to $(\rho - r_n)\,s\theta w_0(1+r_n)^{-1}$. The other part of the present value consumption loss for this individual reflects the difference between the net-of-tax return and the implicit Social Security return. This is the present value consumption change for a single individual in the first generation of workers. The aggregate consumption change for that generation is thus

$$-\theta w_0 L_0\,(1+r_n)^{-1}\,\{(r_n-\gamma)+(\rho-r_n)\,s\}$$

and the corresponding aggregate change for any generation t is

$$-\theta w_0 L_0\,(1+r_n)^{-1}\,\{(r_n-\gamma)+(\rho-r_n)\,s\}\,(1+\gamma)^t.$$

Discounting this over all generations with a discount rate δ implies a total present value consumption loss of

$$T_0\,(1+r_n)^{-1}\,\{(r_n-\gamma)+(\rho-r_n)\,s\}\,(1+\delta)(\delta-\gamma)^{-1}.$$

In the special case in which there is no tax wedge $(\rho = r_n)$, this simplifies to

$$T_0(1+\rho)^{-1}(\rho-\gamma)(1+\delta)(\delta-\gamma)^{-1},$$

which exceeds T_0 if $\rho > \delta$, i.e., if the marginal product of capital exceeds the social discount rate. The condition $\rho > \delta$ implies that there is less than the optimal

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[31] We simplify by assuming that this entire amount would have accrued to the retiree generation; a portion of this would be in the form of the net return on saving $(1+r_n)s\theta w_0$ and the remainder would be in the form of additional tax receipts of the government $(\rho-r_n)s\theta w_0$ that could be used to reduce other taxes of this retiree generation or to provide explicit benefits to them. Individuals nevertheless discount at r_n because for each individual the return on that individual's incremental saving is just r_n. If individuals are myopic it would be more appropriate to assume that $r_n = \delta$, i.e., to substitute the social rate of discount of consumption for the private rate.

amount of capital in the economy (because of a suboptimal tax system or because Social Security benefits crowd out private saving, as discussed below). Only if the appropriate intergenerational discount rate is taken to be the marginal product of capital ($\delta = \rho = r_n$) does the loss to all working generations collapse to T_0 and therefore is equal to the windfall of the initial generation. More generally, however, with $(\rho - r_n)s > 0$ and/or $(r_n - \gamma) > 0$, there is a net present value loss.

To get a sense of the magnitude of the net loss in the more general case, consider an example in which the social discount rate equals the net-of-tax return to savers ($\delta = r_n$). This simplifies the expression for the loss to $T_0\{(r_n - \gamma) + (\rho - r_n)s\}(r_n - \gamma)^{-1} = T_0\{1 + (\rho - r_n)s(r_n - \gamma)^{-1}\}$. It is clear that since personal and corporate taxes make $\rho - r_n > 0$, this loss is greater than the initial windfall benefit of T_0 [32].

To evaluate the loss, assume that the annual marginal product of capital is 8.5% and the capital tax wedge is 50%, implying an annual net of tax return to individuals of 4.25%. Putting specific numerical values on these terms requires recognizing that the time period in this derivation is not a year but a generation. Taking that to be 30 years implies, for example, that $r_n = (1.0425)^{30} - 1 = 2.49$. Similarly $\rho = 10.56$ and, if the annual rate of real growth is 3%, $\gamma = 1.43$. Substituting these values into the expression implies a present value loss to current and all future working generations of $T_0\{1 + 7.61s\}$. If individuals would have saved even one-seventh of the money that they pay in Social Security taxes (i.e., if $s \geqslant \frac{1}{7}$), the present value loss of consumption is more than double the value of the windfall gain to the initial retiree generation.

Note that in thinking about the application of this to any actual Social Security program, the present value of the consumption losses reflect not only the initial creation of the program but also the subsequent program expansions. Each such expansion involves a windfall gain to those who are then retired or near retirement and losses to all current and future taxpayers. This is important in the United States because the program began with a combined employer–employee tax rate of only 2.0% and then expanded over the years to the current 12.4%.

3.2. The deadweight loss caused by the distortion of labor supply and of taxable labor income

The analysis of Section 3.1 assumed that the supply of labor during preretirement years is arbitrarily fixed and does not respond to the imposition of the payroll tax. A more realistic analysis would recognize that individuals do modify their behavior in response to the marginal tax rate on labor income. This induces a deadweight loss for each generation of taxpayers. Unlike the calculation in Section 3.1, there is no offsetting gain for the initial generation of retirees.

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[32] Note that $(r_n - \gamma) > 0$ since r_n is equal to the social discount rate in this example. If the discount rate were less than the growth rate γ, the series of consumption losses would not converge to a finite present value.

The relevant behavior includes both labor supply and the form of compensation that individuals receive. Labor supply for this purpose can be broadly defined as any change that alters the amount of taxable labor income, including not only the number of hours worked per year, but such other dimensions of labor supply as effort, training, location, risk taking, etc.. A labor income tax also distorts the form in which individuals are compensated, inducing the substitution of fringe benefits and nicer working conditions for the cash income that individuals would otherwise prefer. Both distortions create deadweight losses. The combined deadweight loss can be measured by the elasticity of taxable labor income with respect to the net-of-tax marginal rate (i.e., one minus the marginal tax rate on labor income); see Feldstein (1999b).

In the simple case in which there are no distorting capital income taxes (i.e., in which $\rho = r_n$) and in which forward-looking individuals correctly perceive the link between their Social Security taxes and benefits, the effective Social Security tax rate on the individual employee depends on both the statutory rate (θ) and the gap between the marginal product of capital and the pay-as-you-go rate of return as discounted to the time that the tax is paid $(\rho - \gamma)(1 + \rho)^{-1}$. If the pay-as-you-go implicit rate of return were equal to the marginal product of capital ($\rho = \gamma$) there would be no deadweight loss of the payroll tax, regardless of the statutory payroll tax rate (θ) because individuals would receive in Social Security benefits the same return that they would have obtained by investing those funds[33,34].

In fact, however, ρ is greater than γ and individuals appropriately regard the payroll contributions as an actual tax, although with an effective tax rate that is generally less than the full statutory rate. More specifically, the effective marginal tax rate that enters into the deadweight loss calculation is $t_1 = \theta(\rho - \gamma)(1 + \rho)^{-1}$. With the annual explicit rate of return of $\rho_a = 0.085$ on capital investment and the annual rate of return of $\gamma_a = 3\%$ on the Social Security contributions, the values of ρ and γ for the 30 year period (as discussed in Section 3.1) are $\rho = 10.56$ and $\gamma = 1.43$, implying an effective tax rate of $\tau_1 = 0.79\theta$. Thus, with the actual marginal statutory tax rate of $\theta = 0.124$, the effective marginal tax rate is $\tau_1 = 0.098$. In the extreme case in which individuals receive nothing back in benefits for incremental tax payments, the marginal return on those taxes is $\gamma = -1$ and the effective tax rate is $t_1 = \theta(\rho - \gamma)(1 + \rho)^{-1} = \theta$.

The actual incremental deadweight loss of the Social Security payroll tax depends also on the total marginal rate of other income taxes (say, τ_2). The incremental deadweight loss of the Social Security payroll tax (τ_1) for generation t can therefore be approximated by $\Delta\mathrm{DWL}_t = 0.5E(\tau_1^2 + 2\tau_1\tau_2)(1 - \tau_2)\, w_t L_t$ where $w_t L_t$ is the income subject to the payroll tax in generation t, and E is the elasticity of taxable earnings

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[33] This ignores the fact that individuals cannot borrow against future Social Security benefits. If the Social Security program shifts more consumption to the future than the individual would want, the program could involve an effective tax rate even if $\rho = \gamma$.

[34] During the initial phase in of a pay-as-you-go system, some members of the transition generations receive a return that is higher than the market return. For these individuals, the effective tax rate is negative, reducing the deadweight loss of the combined income and payroll taxes.

with respect to the net of tax share. Since $w_t L_t$ grows at rate γ, the present value of this deadweight loss for all generations (discounting at the social discount rate δ) is

$$\Delta\text{DWL} = 0.5E\left(\tau_1^2 + 2\tau_1\tau_2\right)(1 - \tau_2)^{-1} w_0 L_0 \frac{1+\delta}{\delta-\gamma}.$$

With the "other marginal tax rate" equal to $t_2 = 0.2$ (approximately the average marginal personal income tax rate in the United States), the incremental deadweight loss is $\Delta\text{DWL} = 0.031 E w_0 L_0 (1 + \delta)/(\delta - \gamma)$. If the value of the relevant tax elasticity is 0.5 [35], the incremental deadweight loss is (using the values of δ and γ from Section 3.1) $\Delta\text{DWL} = 0.051 w_0 L_0$. This is roughly 40% of the tax paid by the first generation ($T_0 = \theta w_0 L_0 = 0.124 w_0 L_0$).

The existence of capital income taxes reduces the magnitude of this deadweight loss because the gap between the after-tax return on savings and the implicit pay-as-you-go return on the payroll tax is smaller. Thus $\tau_1 = (r_n - \gamma)/(1 + r_n)\,\theta$. With an annual net return of 4.25% and a growth rate of 3%, the 30-year time periods imply $(r_n - \gamma)/(1 + r_n) = 0.3037$ and therefore $\tau_1 = 0.0377$. Thus, a 50% effective capital income tax reduces τ_1 by about 60%. The corresponding incremental deadweight loss is then $\Delta\text{DWL} = 0.017 w_0 L_0$, one-third of the incremental deadweight loss when there is no capital income tax.

The present value consumption loss to all working generations was calculated with the same parameter assumptions in Section 3.1 to be $T_0\{1 + 7.61s\}$. Subtracting the windfall gain to the initial generation (T_0) implies a net present value consumption loss to all generations of $7.61 s T_0$. By comparison, $\Delta\text{DWL} = 0.017 w_0 L_0 = 0.137\theta w_0 L_0$ with $\theta = 0.124$; thus $\Delta\text{DWL} = 0.137 T_0$. This is smaller than the net present value consumption loss for plausible values of the saving rate (s) but is nevertheless large in absolute size.

The magnitude of the incremental deadweight loss is relevant to the policy of notional defined contributions discussed above in Section 2.1. In a Social Security plan in which individuals see no relation between the taxes that they pay and the benefits that they eventually receive, $\gamma = -1$ and the deadweight loss reflects the entire payroll tax rate: $\tau_1 = \theta$. An argument in favor of the notional defined-contribution method is that each individual sees that the taxes paid are returned in the form of future benefits with an implicit rate of return of γ. If γ is close to the rate of return that individuals would otherwise receive on their saving, much of the deadweight loss associated with distorted labor supply is eliminated. More specifically, the effective marginal tax rate is reduced from θ to $\tau_1 = (r_n - \gamma)/(1 + r_n)\,\theta$. With annual values of the net return equal to 4.25% and the annual value of the implicit return on social

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[35] For evidence on the elasticity of taxable income with respect to the net-of-tax marginal tax rate, see Feldstein (1995b), Auten and Carroll (1999) and Gruber and Saez (2000). Note that those studies refer to the elasticity of total taxable income and not just of the payroll portion. As the equation makes clear, the change in the deadweight loss is proportional to the value of the elasticity.

security equal to 3%, this implies $\tau_1 = 0.3037\theta$. Note that even with a zero implicit rate of return on Social Security contributions ($\gamma = 0$), the understanding that taxes paid will eventually be returned in the form of benefits reduces the effective payroll tax rate to $\tau_1 = r_n/(1 + r_n)\theta = 0.71\theta$.

Although the Samuelson (1958) analysis explains why the overall rate of return in a pay-as-you-go program is equal to γ, the rates of return in any actual unfunded defined-benefit program can vary substantially among different individuals. Under US law, each individual's potential retirement benefits are based on that individual's "average indexed monthly earnings", i.e., on that individual's earnings relative to the average earnings in the economy. Only the earnings during the 35 years for which the individual's indexed earnings are highest are taken into account. A retired couple can receive the larger of either the combined amount of benefits based on their separate benefit calculations or a single benefit equal to 150% of the benefit of the higher earner. The surviving member of a couple after one member dies receives the higher of the survivor's own benefit amount or the amount to which the deceased spouse would have been entitled. Feldstein and Samwick (1992) calculate the effective tax rates for a variety of different demographic groups under US Social Security rules and find widely different effective tax rates. For example, young people and women often face the full marginal tax rate ($\tau_1 = \theta$) because young people are not in one of their highest 35 earning years and because women will receive benefits based on their husband's earnings. In contrast, a married man who is getting close to retirement age and who has a spouse who will claim benefits based on his earnings may face a negative marginal tax rate ($\tau_1 < 0$) because the additional dollars of earnings will raise the present value of future benefits by more than the tax that the individual pays. Feldstein and Samwick note that this heterogeneity of marginal tax rates increases the deadweight loss of the overall Social Security payroll tax if, as the evidence suggests, the elasticity of labor supply is greater for married women than it is for married men.

3.3. The trust fund in a pay-as-you-go system

In a pure pay-as-you-go system, the taxes paid in each year would be exactly equal to the benefits paid in that year. In practice, however, annual benefits are not literally equal to the taxes paid. In some years, tax receipts exceed benefits while in other years benefits exceed taxes. These differences may reflect simple cyclical fluctuations or an explicit policy to accumulate accounting and/or economic surpluses.

In the United States, the difference between annual benefits and taxes is reflected in a special government account known as the Social Security (OASI) Trust Fund. When taxes exceed benefits, the excess is credited to the Trust Fund while benefits in excess of tax receipts would reduce the Trust Fund balance. The Trust Fund is technically invested in special government bonds so that interest is added to the Trust Fund. Within the overall framework of the US budget accounts, the Social Security program is regarded as a separate or "off budget" activity. The overall annual budget surplus (or deficit) of the federal government is divided into an "off budget

surplus" (the sum of Social Security taxes plus the interest received on the Trust Fund balance minus the benefits paid and administrative costs of the program)[36] and an "on budget surplus" (the sum of all other receipts minus all other expenses, including the interest paid to the Social Security Trust Fund). The combination of the "off budget surplus" and the "on budget surplus" is the "unified budget surplus" and equals the net amount of government debt that the government can repurchase from the public. When these surpluses are negative, the unified budget deficit corresponds to the borrowing requirement of the federal government.

The Social Security Trust Fund is an accounting system that keeps track of the accumulated value of past Social Security surpluses. The corresponding economic reality is that the annual Social Security surpluses contribute to the overall ("unified") government budget surplus and therefore potentially to national saving and capital accumulation. This potential increase in national saving is realized if the existence of the Social Security surplus does not cause political decisions that reduce the on-budget surplus or cause on-budget deficits nor private decisions that change household saving.

It is of course not possible to assess with any precision the causal link between off-budget Social Security surpluses and the size of the on-budget surplus or deficit. It is, however, interesting to note what happened after the US Congress voted in 1983 to raise the Social Security payroll tax and to make other changes in order to accumulate a substantial Social Security surplus after the program had been run on a pay-as-you-go basis for many years. This legislative change was made in anticipation of the long-run aging of the population as a way of avoiding a substantial increase in the future payroll tax rate. The expectation at the time was that the Social Security surpluses would accumulate as a large Trust Fund balance that could be run down after the baby boom generation began to retire in about the year 2010. Selling the assets in the Trust Fund in this way would make it unnecessary to raise future payroll tax rates to pay for the increased volume of benefits.

The economic reality corresponding to this accounting plan was the idea of raising the nation's capital stock by the planned budget surpluses (and the equal increases in national saving). Running down the Trust Fund balances by selling government bonds in the future would decrease national saving at that time, permitting the increased consumption by retirees without requiring a decrease in consumption by the future workers. Although the government borrowing from the public that would result from selling the Social Security bonds to the public[37] would mean a slower growth (and possibly an actual decline) of the capital stock, the capital stock that would have accumulated by then would be so much larger than it would have been without the

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[36] The off budget surplus also includes the surplus of the Post Office. Although Medicare has a trust fund it is not currently an off-budget category.

[37] The Social Security Trust Fund would not literally sell bonds to the public but would redeem them from the Treasury which would, ceteris paribus, have to sell additional bonds to the public to offset these outlays.

1983 policy shift that the capital stock would remain larger for many years into the future.

In practice, the Social Security surpluses did occur and the Trust Fund did increase substantially, although not by nearly as much as originally planned (because of increases in early retirement, greater longevity, and lower interest rates on Trust Fund balances). But during the same years there were also large and persistent deficits in the "on budget" accounts, causing the unified budget to be in deficit until the year 1998. Although an explicit causal link between the large off-budget surpluses and the concurrent on-budget deficits cannot be established, it is certainly possible that the reduced size of the unified deficit that resulted from the large off-budget surpluses gave politicians a degree of comfort that permitted them to avoid the spending cuts or tax increases that might otherwise have been made.

Looking ahead, much of the political concern about Social Security reform in the United States focuses on the projection that the Social Security Trust Fund will be exhausted by sometime around 2038. More specifically, taxes are expected to exceed benefits until 2016. After that, the combination of taxes and interest on the Trust Fund balance will continue to exceed benefits until 2025. The Trust Fund will then begin to decline until all of the assets on the books of the Trust Fund are exhausted in 2038 [Board of Trustees (2001)]. If that occurs, benefits would have to be cut by about one-third to keep benefits within the amount of tax revenue, or payroll taxes would have to be increased by about 50% to maintain the initial rules linking benefits to past earnings. Alternatively, Congress could change the rules to permit Social Security benefits to be financed by income taxes or by general government borrowing.

Although the Trust Fund plays an important political role in discussions of Social Security, the Trust Fund is a legal and accounting construct without direct economic effect. The economics are that Social Security taxes currently exceed benefits, contributing to national saving. After 2014, taxes will be less than benefits and the Social Security financing will reduce national saving. Note that the transfer of interest payments from the on-budget account to the Social Security off-budget account does not alter national saving because it leave the unified budget deficit unchanged; the year 2025 is therefore not qualitatively different from earlier years. Once again, the overall effect on national saving will depend on how the political process responds to the Social Security deficits [Elmendorf and Liebman (2000)]. The net effect need not be negative if the Social Security deficits induce the government to increase its on-budget surplus or to take other steps to increase national saving by shifting from the existing pay-as-you-go system to one that is investment-based. We return to this below in Section 7.1.1, but first we need to consider the ways in which a pay-as-you-go system can be optimized.

4. Optimizing a pay-as-you-go system

Since the Social Security system in the United States and in most other industrial countries is an unfunded defined-benefit plan, it is worth asking how such a system

should be designed if it is constrained to be a pure pay-as-you-go program. Such a theory of optimal program design is similar to the two-level theory of optimal income taxation (see Chapter 21 in Volume 3 of this Handbook). In the current context, the problem is to select the parameters of a Social Security program that maximize a social welfare function subject to the constraint that each individual acts to maximize his own utility subject to the parameters of the program. The purpose of such an analysis is not to derive practical parameters but to understand better how different factors influence the optimal parameter values of a pay-as-you-go defined-benefit program.

A basic result of such an analysis is that the optimal Social Security program involves balancing the protection of individuals who are too myopic to save optimally for themselves against the losses that those who are not myopic incur because they are induced to provide for their retirement in a program with a low implicit rate of return[38]. A loss is incurred to the extent that the pay-as-you-go program crowds out other saving, with the loss an increasing function of the difference between the return on capital and the implicit return of the pay-as-you-go program. More generally, the larger the Social Security program, the more protection it offers to those who are too myopic to save for their old age but also the more it distorts saving, labor supply, retirement, and other behavior.

The following analysis simplifies by focusing only on the distortion to saving. The formal model presented here assumes that individuals' labor supply is fixed both during their working years and at the time of retirement. It also ignores differences in tastes and incomes as well as potential problems of risk.

4.1. A baseline case with complete myopia

To start the analysis and provide a baseline case, consider first the extreme assumption that all individuals are completely myopic, i.e., that they consume all available income during their working years and make no provision for the future. The analysis will then relax this assumption and consider individuals who are "partially myopic", i.e., who give too little weight to future consumption. The analysis follows the basic Samuelson (1958) framework of an overlapping generations life-cycle model. The specific optimization analysis is due to Feldstein (1985). We begin by focusing on the steady-state properties and then extend the analysis to an infinite-period model in which the first period is explicitly recognized.

Individuals work a fixed amount in the first period of their lives and are retired in the second. The size of the labor force grows at rate n per period according to $L_t = (1 + n)L_{t-1}$. At time t, the young generation pays payroll tax of $T_t = \theta w_t L_t$ and these funds are used to finance the benefits of the retirees. Since the number of retirees is L_{t-1}, the pay-as-you-go character of the program implies that total taxes

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[38] See Feldstein (1976a). Social Security also involves intergenerational transfers from future generations to current generations.

collected at time t is equal to the total benefits paid $T_t = B_t$ where $B_t = b_t L_{t-1}$ defines b_t as the level of benefits per retiree and implies that $b_t = \theta w_t (1 + n)$. In a representative year, the social welfare function can be stated as the sum of the identical utilities of the working population $\{L_t u[(1 - \theta) w_t]\}$ and the corresponding utilities of the retired population $\{L_{t-1} v[b_t]\}$. Because of the complete myopia assumption, the working generation consumes all of its after tax income and the retiree generation consumes only the benefits. Thus, the Social Welfare Function in year t can be written (after substituting the balanced budget condition that defines the benefit per retiree) as $W_t = L_t u[(1 - \theta) w_t] + L_{t-1} v[\theta w_t (1 + n)]$.

The first-order condition $dW_t/d\theta = 0$ in this simple case implies $u_t' = v_t'$. That is, it is optimal to divide income available in the economy at time t between the two groups to equalize the marginal utilities of workers and retirees. This full egalitarian prescription reflects the assumption that taxes have no distorting effect on any form of behavior. If the utility functions are the same in youth and older age, $u_t' = v_t'$ implies that the arguments of the two functions must also be equal. Therefore, the first-order condition becomes $(1 - \theta^*) w_t = \theta^* w_t (1 + n)$ or $\theta^* = (2 + n)^{-1}$. This implies that the optimal ratio of benefits to the average wage is given by $\beta^* = b^*/w = (1 + n)/(2 + n)$.

Note that the optimal tax and benefit ratios in this case do not depend on the marginal product of capital or the implicit return on Social Security contributions. The reason for this is that with no distortions to saving or work effort, the Social Security program is essentially just an income redistribution program and is carried to the point where the marginal utility of income is the same to retirees and workers.

The optimal tax rate differs from $\frac{1}{2}$ because of the growing population. If the population were constant, n would equal zero and the optimal tax would take half of each worker's wages ($\theta^* = \frac{1}{2}$) and the optimal benefits would give retirees an amount equal to one-half of the wage of current workers ($\beta^* = \frac{1}{2}$). With a growing population, a tax rate of less than 0.5 leaves the workers with more than half of their wage while delivering a retiree benefit that is as large as the after-tax income of the workers. Since the time period in the model is a generation, the value of n is the rate of growth of the population over a generation; assuming a 30-year generation and an annual population growth rate of 1%, $1 + n = (1.01)^{30} = 1.35$. This implies that the optimal tax rate is $\theta^* = 1/2.35 = 0.43$ and that the optimal benefit–wage ratio is $\beta^* = (1.35)/(2.35) = 0.57$. Thus the workers retain 57% of their wage and the retirees get a benefit equal to 57% of the current wage rate (and therefore an even higher percentage of their own preretirement wage rate) [39].

[39] This calculation takes no account of the windfall benefit that would accrue to the first generation of retirees. Doing so would require modifying the problem to include some private funds to support consumption during retirement. We skip this type of example to shift directly to consideration of a model with partial myopia.

4.2. Balancing protection and distortion with partial myopia

A more realistic example in which individuals respond to changes in Social Security rules can give a richer understanding of the design of optimal Social Security programs [Feldstein (1985)]. To see this, extend the previous model to allow individuals to save an amount s_t during the first period of their life. First period consumption is therefore $C_{1,t} = (1 - \theta) w_t - s_t$ while second period consumption of the same generation (but experienced at time $t + 1$) is $C_{2,t+1} = s_t(1 + \rho) + b_{t+1}$.

The rationale for Social Security in such a model is that individuals do not give adequate weight to their future consumption. This can be represented by assuming that the individual chooses s_t to maximize $u[C_{1,t}] + \lambda v[C_{2,t+1}^a]$ where the individual's anticipated retirement period consumption $C_{2,t+1}^a = s_t(1 + \rho) + \alpha b_{t+1}$, where α indicates that the individual may anticipate less than the full amount of benefits. Thus, a value of $\lambda < 1$ implies that the individual underweights future utility while a value of $\alpha < 1$ implies that the individual underestimates the amount of Social Security benefit that he will receive.

The government selects the level of Social Security taxes (and therefore of benefits) to maximize the actual ex post well-being of the population:

$$\max_{\theta} W_t = L_t \left\{ u\left[(1 - \theta) w_t - s_t\right] + (1 + n)^{-1} v\left[s_{t-1}(1 + \rho) + b_t\right] \right\},$$

subject to $b_t = \theta w_t(1 + n)$ and to s_t being chosen by the individual to maximize $u[C_{1,t}] + \lambda v[C_{2,t+1}^a]$ subject to $C_{2,t+1}^a = s_t(1 + \rho) + \alpha b_{t+1}$. Note that in the government's optimization there is no discounting of retirement-period utility and that the argument of the retirement-period utility function is the actual retirement consumption, implicitly making $\alpha = 1$. The factor of $(1 + n)^{-1}$ weighting the retirement utility reflects the fact that there are only $(1 + n)^{-1}$ times as many retirees as there are individuals in the first period generation.

The optimal design of the program in this very stylized problem is to choose the value of θ in a way that balances the protection from myopic saving decisions ($\lambda < 1$) against the losses that occur because of the low implicit return on the pay-as-you-go program. To obtain an explicit closed-form solution, let $u[C_{1,t}] = \ln C_{1,t}$ and $u[C_{2,t}] = \ln C_{2,t}$, and $\alpha = 0$ [40].

With these assumptions, the optimal tax rate is given by

$$\theta^* = \frac{(1 + \lambda)(1 + \gamma) - \lambda(1 + \rho)(2 + n)}{(1 + \lambda)(1 + \gamma)(2 + n) - \lambda(1 + \rho)(2 + n)}.$$

The optimal level of taxes and benefits depends on the degree of myopia (λ), the implicit return on the Social Security contributions (γ), the return on real

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[40] The assumption that $\alpha = 0$ implies that individuals ignore the future Social Security benefits in making their life-cycle saving decisions. As a result, the Social Security program only reduces saving in this specification by reducing disposable income.

investments (ρ), and the relative numbers of workers and retirees $(1 + n)$. In the special case discussed in the previous section in which the individuals are totally myopic ($\lambda = 0$), $\theta^* = 1/(2 + n)$ as previously derived. More generally, taking the derivative of θ^* with respect to the parameters in this equation shows that $d\theta^*/d\lambda < 0$; an increase in the degree of myopia (a decrease in λ) raises the optimal size of the Social Security program. An increase in the implicit rate of return on Social Security contributions also increases the optimal size of the program: $d\theta^*/d\gamma > 0$. And an increase in the rate of return on regular investments raises the opportunity cost of the Social Security program and therefore reduces the optimal size of the program: $d\theta^*/d\rho < 0$.

Explicit numerical solutions of the more general case show that increasing the value of α from the currently assumed $\alpha = 0$ implies $d\theta^*/d\alpha < 0$. With $\alpha > 0$, a larger Social Security program would depress saving more (because individuals take the future benefits into account in deciding how much to save), imposing a bigger adverse effect if $\rho > \gamma$.

It is optimal to have any pay-as-you-go Social Security program in the context of this model only if $\theta^* > 0$. In the above expression, this is true only if the value of λ is less than the critical value $\lambda^* = (1 + \gamma)[(1 + \rho)(2 + n) - (1 + \gamma)]^{-1}$. At higher values of λ, the loss from substituting the low return Social Security benefits for the higher return real investments outweighs the protection that individuals receive through increased retirement income. Based on *annual* values of $\gamma_a = 0.03$, $\rho_a = 0.085$ and $n_a = 0.01$ and a 30-year time period, $\lambda^* = 0.098$. This implies that, in the current framework, individuals must be very myopic if any pay-as-you-go program is to be optimal[41]. If the promise of future benefits depresses savings ($\alpha > 0$) or if the implicit tax that results from $\rho - \gamma > 0$ distorts labor supply, the critical value of λ^* at which a pay-as-you-go program is optimal would be even lower.

This calculation focuses on the optimal Social Security program in a representative year and ignores the windfall gain that would accrue to the initial generation when a pay-as-you-go program is created. Taking that initial gain into account in determining the optimal value of θ requires maximizing the present value of all annual social welfare values: $S = \sum_{t=0} W_t (1 + \eta)^{-t}$ from $t = 0$ to infinity where η is the rate at which society discounts future welfare increments, i.e., future individual utilities[42]. Since the value of W_t increases more slowly than the size of the population (L_t), the

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[41] A value of λ as low as 0.098 implies that individuals would do very little retirement saving in the absence of Social Security. With the individual maximizing $\ln C_1 + \lambda \ln C_2$ subject to $C_2 = (w - C_1)(1 + \rho)$, an individual who shows no myopia (i.e., $\lambda = 1$ and therefore no discounting of second period utility) will consume half of his income during the working years $[C_1^* = (1 + \lambda)^{-1} w = 0.5w]$ and save the other half for retirement. In contrast, someone with $\lambda = 0.098$ would consume 91% of his income during his working years $[C_1^* = w/(1.098) = 0.91w]$ and save only 9% for retirement.

[42] Note that this is fundamentally different from the rate δ at which changes in the consumption of future generations is discounted in Section 3.1 above. As we noted in footnote 30, the rate δ at which such future consumption is discounted should reflect the rate at which per capita consumption grows (g), the elasticity of the marginal utility function (ε), and the pure time preference at which utility is discounted (η). If the elasticity of the marginal utility is constant, this implies $\delta = \varepsilon g + \eta$.

discounted sum converges if the rate of growth of population is less than the rate at which utility is discounted. If utility is discounted at a sufficiently lower rate, it is only the representative steady state value of W_t that matters.

The specific expressions for the optimal value θ^* and the critical value λ^* reflect the particular way in which the problem of individual myopia is parameterized. An alternative parameterization in which the population is divided into a fraction (μ) of individuals who make fully rational life-cycle saving decisions (i.e., for whom $\lambda = 1$) and a remaining fraction ($1 - \mu$) that is completely myopic ($\lambda = 0$) would also illustrate the idea that the optimal size of the pay-as-you-go Social Security program is an increasing function of the extent of myopia ($d\theta^*/d\mu < 0$) and a decreasing function of the cost of substituting a pay-as-you-go program for real saving ($d\theta^*/d\rho < 0$ and $d\theta^*/d\gamma > 0$) although with some completely myopic individuals it could not be optimal to have no program at all. The possibility that there is heterogeneity in the ability to make life cycle saving decisions does however suggest that it might be desirable to substitute a means-tested program for the universal program that has been analyzed in the current section.

4.3. Universal versus means-tested Social Security benefits

When we shift from a representative-agent model to one with heterogeneous individuals, it becomes meaningful and potentially optimal to have a means-tested program, i.e., a program that provides benefits at retirement age to those whose income would be below some threshold level[43]. In the context of the overlapping generations life-cycle model, this is equivalent to providing benefits only to individuals whose accumulated assets are below some level[44].

In a simple model with no labor supply distortion and no uncertainty, the desirability of having a means-tested program rather than a universal program is analyzed most simply in a model with three types of individuals: a completely myopic group ($\lambda = 0$), a high income group that has no myopia ($\lambda = 1$ and wage w_H) and a low income grow with no myopia ($\lambda = 1$ and wage w_L). Consider an economy with only a means-tested Social Security program. All working individuals pay the Social Security tax at rate θ. Since only some fraction of individuals (ϕ) receive benefits, the means-tested benefit per beneficiary is given by $\theta w^*(1 + \gamma)\phi^{-1}$ where $w^*(1 + \gamma)$ is the average wage on which the payroll tax is levied, i.e., w^* is the average wage during the earlier working years of the retiree generation (corresponding to w_H and w_L) and $1 + \gamma$ is the growth factor that raises that wage to the level on which the tax is levied to support the retirees.

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[43] The USA has such a means-tested program in addition to the basic universal program. The Supplemental Security Income program supplements the benefits of individuals over age 65 whose regular Social Security benefits and other sources of income are deemed to be too low. See McGarry (2002).
[44] See Feldstein (1987b) for an analysis of such a model.

For the completely myopic group there is no difference between the means-tested program and a universal program. In both programs, that group would consume all of its labor income and depend completely on the Social Security benefits provided to retirees. In contrast, the individuals with no myopia ($\lambda = 1$) decide whether to save (and thus forego the potential Social Security benefits) or to consume all of their earnings and depend in retirement on the Social Security benefits. They do so by comparing the utility levels achievable under the two alternatives. Assuming logarithmic utility, an individual of type i (where $i = $ H or L) who saves and is thus not eligible for the means-tested Social Security benefits[45] has lifetime utility equal to $Z_{\text{No SS}} = \ln C_1 + \ln C_2 = \ln[0.5(1 - \theta) w_i] + \ln[0.5(1 - \theta) w_i(1 + \rho)]$. In contrast, such an individual who decides not to save in order to qualify for the means tested benefit has lifetime utility equal to $Z_{\text{SS}} = \ln(1 - \theta) w_i + \ln[\theta w^*(1 + \gamma) \phi^{-1}]$ where w^* is the average wage on which Social Security taxes are levied and the parameter ϕ reflects the fraction of all retirees who receive benefits.

An individual chooses not to save in order to qualify for benefits if $Z_{\text{SS}} > Z_{\text{No SS}}$, i.e., if $\ln[\theta w^*(1 + \gamma) \phi^{-1}] > \ln 0.5 + \ln[0.5(1 - \theta) w_i(1 + \rho)]$. The likelihood that an individual will choose not to save increases with the level of benefits (and therefore with θ, w^*, $(1 + \gamma)$, and ϕ^{-1}) and decreases with the level of the individual's own wage relative to the average wage and with the rate of return on saving. If the level of the means-tested benefit is not set very high, the high wage group may choose to save while members of the low wage group will choose to consume all of their earnings and depend in retirement on the means-tested Social Security benefit. If so, the level of retirement consumption for this group may be less under the means-tested plan than it would be under the universal plan.

The public policy choice between a universal plan and a means-tested plan can be stated as a comparison of the total utility levels of the three different population groups under the two alternatives. The key disadvantage of the means-tested plan is that it induces a low-income group to avoid saving in order to qualify for the means-tested benefit and therefore leaves them with lower retirement consumption than they would otherwise have. For this group, the higher the benefit level, the more likely individuals are not to save and therefore the higher the tax rate has to be. In addition, the myopic high-income individuals will be worse off if the optimal level of benefits in the means-tested program is less than they would otherwise have received with a universal program. The advantage for the high-income group of rational savers is that they may be able to pay a lower payroll tax than they would in a universal program (because people like themselves do not get benefits) and save at a higher real rate of return. Which system is preferable depends on the relative numbers of individuals with different degrees of myopia and different income levels.

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[45] An individual with low enough income might save and still be eligible for the means-tested benefits. It would however never be optimal for such an individual to save for retirement since the means-tested program effectively imposes a 100% tax on all retirement period assets.

A richer class of models would have a bivariate distribution of wage rates and myopia values (λ's), would incorporate the adverse effect of higher taxes on labor supply, and might include the possibility of uncertain returns causing savers to qualify for the means-tested benefit.

4.4. Models with variable retirement

Diamond and Mirrlees (1978, 1986, 2000, 2002) analyze models in which workers face uncertainty about the length of their working lives[46]. In particular, there is a random chance in each period that they will become permanently disabled and therefore unable to work. In these models, the government cannot distinguish between those who are unable to work due to disability and those who simply choose not to work. Therefore, in order to optimize its Social Security system, the government needs to determine how best to provide benefits for those out of work in a way that balances protection for the disabled against work disincentives for the able.

The basic intuition behind these models can be seen by referring to Figure 1 which is based on a similar figure in Diamond and Mirrlees (1986). Consider first the case in which benefits for those who do not work are the same regardless of the age at which a person leaves the labor force. In addition, assume that the utility an individual derives from a given combination of leisure and consumption does not vary with age, and that there is no saving. Specifically, let utility be a function of consumption and leisure $U(C, L)$, where $L = 1$ indicates that the person works and $L = 0$ indicates that the person does not work. Furthermore, let C_1 indicate the consumption level from working and C_2 indicate the consumption level when retired (the level of the government provided retirement benefit). In this case, social welfare is maximized by setting retirement benefits at the highest level that will still have the able bodied remain
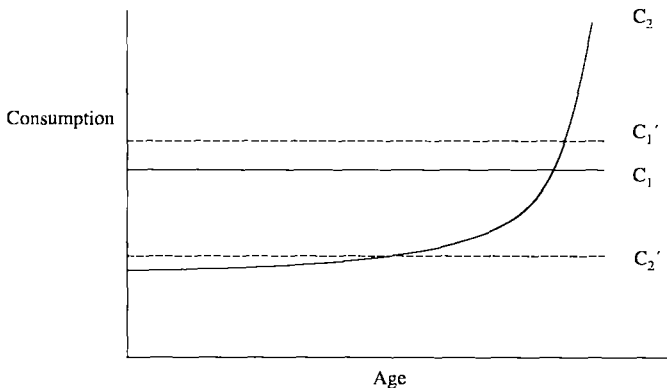

Fig. 1. A model of variable retirement.

[46] These models apply to funded systems as well as to pay-as-you-go systems.

in the workforce. Thus, the government sets C_2 so that $U(C_2, 0) = U(C_1, 1)$ [47]. These levels of consumption are illustrated with the dotted lines in Figure 1. The government sets consumption for workers at C_1' and consumption for retirees at C_2'. While the marginal utility of additional consumption for retirees exceeds that of workers, it is not possible to increase social welfare by raising C_2' and lowering C_1' because such a change would cause all workers to retire (i.e., it would result in $U(C_2, 0) > U(C_1, 1)$).

Diamond and Mirrlees show that it is possible to raise social welfare by switching to a benefit path that rises with a worker's date of retirement. In particular, with such a benefit structure it is possible to lower C_1 and provide additional benefits to retirees (who are assumed to have higher marginal utility of consumption than workers at the same level of utility). The basic intuition is that in the case of retirement benefits that rise with age, a worker who decides to leave the labor force will compare the utility from not working against not only the utility from working but also the foregone opportunity to receive higher retirement benefits in the future. This extra consideration makes it possible to pay higher retirement benefits without causing all workers to retire. Moreover, the optimum includes implicit taxation of work as part of providing insurance against a short career (in the presence of asymmetric information).

Diamond and Mirrlees (1978) consider a similar model in which saving is permitted. This model yields an additional result – that the optimal social insurance plan should be supplemented with an interest income tax. This result occurs because allowing people to reach old age with assets narrows the consumption difference between working and retiring and therefore reduces the level of retirement benefits that can be provided without causing able-bodied workers to leave the workforce [48].

4.5. Other aspects of pay-as-you-go program design

The level of benefits in a representative agent model, the choice between means-tested and universal programs, and the relationship between benefits and age are only three of the issues that arise in the design of a pay-as-you-go program. Other issues that could be studied with modifications of the existing model are the relation between benefit levels and pre-retirement earnings (i.e., the extent of redistribution in the benefit formula), the "normal retirement age" at which benefits are paid, and the treatment of married couples.

5. Behavioral effects: theory and evidence

The presence of a pay-as-you-go Social Security system changes the budget constraint faced by individuals and is therefore likely to change their economic behavior,

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[47] We assume, following Diamond and Mirrlees, that someone who is exactly indifferent between work and leisure will work.

[48] Feldstein (1990) provides an alternative model of the relationship between benefits and age.

particularly their saving, labor supply, and retirement decisions and their portfolio allocations. This section discusses each of these four types of behavioral responses in succession. For each, we consider theoretical models of the responses of individuals, the empirical evidence of the magnitudes of these responses, and, when appropriate, the aggregate impact on the economy.

5.1. Saving

5.1.1. Theory

In a simple life-cycle model, a pay-as-you-go Social Security system that taxes workers when young and provides them with retirement benefits when old will reduce the saving of individuals when young. In the special case of an actuarially fair program, provision of benefits reduces saving by an equal amount. In particular, consider a two-period model in which individuals work in the first period and are retired in the second period. For simplicity, assume that labor supply in the first period is fixed and normalized to equal one and that the lifetime utility function is additively separable:

$$Q = U(C_1) + V(C_2).$$

Consider a Social Security system that imposes a tax at a rate of θ on labor income in the first period and provides a benefit of B in the second period. Then first period consumption is

$$C_1 = (1 - \theta)\,w - S,$$

where w is the worker's wage and S is savings. With an interest rate on saving of r, second period consumption is

$$C_2 = S(1 + r) + B = [(1 - \theta)\,w - C_1](1 + r) + B.$$

The individual's first-order condition is

$$dQ\,dS = -U' + V'(1 + r) = 0.$$

Totally differentiating with respect to S, θ, and B yields

$$(wU'')\,d\theta + \left[U'' + (1 + r)^2 V''\right]\,dS + (1 + r)\,V''\,dB = 0.$$

To simplify, consider first an actuarially fair Social Security system (i.e., with $r = g$). Then $B = (1 + r)\,\theta w$ and $d\theta = dB/(1 + r)\,w$. Substituting this expression into the line above and rearranging yields $dS = -1/(1 + r)\,dB$. In other words, every dollar of expected discounted Social Security benefits reduces an individual's saving when
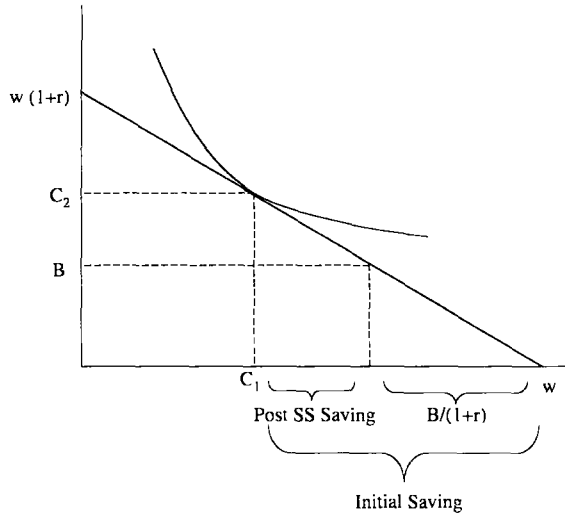
Fig. 2. Impact on saving of an actuarially fair Social Security system.

young by one dollar, allowing the individual to consume at the same combination of C_1 and C_2 as before the system was instituted.

Figure 2 illustrates this case. In the absence of Social Security, the individual consumes C_1 in the first period and C_2 in the second period. Therefore saving is $w - C_1$. This is indicated as "initial saving" on the figure. After the Social Security system is implemented, saving is reduced by the discounted value of future benefits, $B/(1 + r)$ (which equals the amount of payroll tax paid). But because the system is actuarially fair, the individual continues to consume the same amounts as before.

Simple modifications of the basic life-cycle model will lead dS/dB to deviate from $-1/(1 + r)$. For example, if an actuarially fair Social Security system provides benefits that are larger than the level of retirement consumption that is desired by the individual in the absence of Social Security and if it is illegal to borrow against future Social Security benefits, then the individual will reduce saving to zero, but will be unable to reach his pre-Social Security optimum. In this case, saving will fall by less than a dollar per dollar of future Social Security wealth[49]. As a second example, if an individual receives a negative net transfer from Social Security (i.e., the discounted value of the retirement benefit is less than taxes paid), the negative income effect from the transfer can produce changes in saving that are either greater or less than the discounted value of the Social Security benefit: this is illustrated in Figure 3 which is drawn so that consumption falls in both periods, implying that savings falls by less than the amount of the tax. Different preferences could, of course, cause first period consumption to

[49] See Diamond and Hausman (1984b) for empirical evidence suggesting that many US households cannot reduce their wealth in response to increases in Social Security benefits.
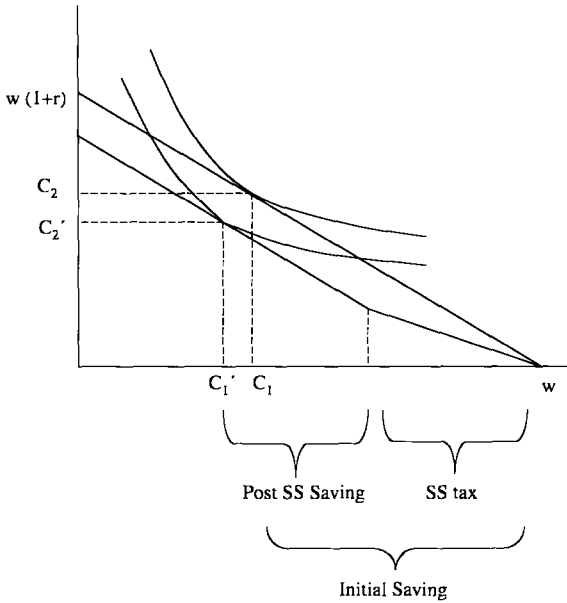
Fig. 3. Impact on saving of a Social Security system with negative transfers.

increase by more or less than this amount. As a third example, many Social Security systems create incentives that encourage workers to retire earlier than they otherwise would have. With additional years of retirement consumption to finance, individuals will desire additional retirement resources. Because this induced retirement effect goes in the opposite direction of the basic wealth replacement effect, the net impact of Social Security on saving is theoretically ambiguous [Feldstein (1974), Munnell (1974)] [50]. Thus, even for rational life-cycle savers, economic theory does not provide a simple answer to how saving will respond to a Social Security system. Myopic agents and workers who do not fully trust the government to provide the promised level of benefits will typically respond less than one to one to increases in Social Security benefits. In addition, saving done for reasons other than life-cycle consumption (bequests or precautionary motives for example) need not adjust at all in response to Social Security, though Hubbard, Skinner and Zeldes (1995) show that social insurance programs can significantly reduce precautionary saving as well.

At the aggregate level, determining the impact of Social Security on personal saving in a given year requires adding up the changes induced in the saving behavior of all individuals alive in that year. Even in a model in which individual saving responds dollar for dollar to Social Security wealth, the impact on national wealth will not in general be dollar for dollar.

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[50] See Feldstein (1977) for a two period model with endogenous retirement. Hu (1979) contains an extension of the endogenous retirement model to a Diamond economy.

To see this, consider first a stationary life-cycle economy in which the number of workers in each generation is constant, as is the wage level. In the absence of a Social Security system, the saving of the young is exactly offset by the dissaving of the old, and there is no net saving in the economy. Therefore, crowding out of saving by the Social Security system has no effect on the steady state equilibrium aggregate national saving rate – the reduced saving by the young is exactly offset by reduced dissaving of the old[51].

In an economy in which both the number of workers and the wage level are rising over time, the saving of the young will exceed the dissaving of the old. Therefore net aggregate saving will be positive, and a reduction in saving by individuals in response to Social Security will reduce aggregate saving.

To be more explicit, assume that each generation with L_t workers and an average wage level of w_t saves a fraction σ of their earnings. Thus, total saving by workers is $\sigma w_t L_t$. Retirees have income of $r\sigma w_{t-1}L_{t-1}$ on the capital $\sigma w_{t-1}L_{t-1}$ that they own. As life-cycle savers, they consume all of their assets and second-period income leading to total consumption by retirees of $(1 + r)\sigma w_{t-1}L_{t-1}$. Their saving during retirement (income minus consumption) is therefore negative and net saving in the economy is $\sigma(w_t L_t - w_{t-1}L_{t-1})$. This can be rewritten as $\sigma(g + n + ng) w_{t-1}L_{t-1}$ where $w_t = (1 + g) w_{t-1}$ and $L_t = (1 + n) L_{t-1}$.

With a pay-as-you-go Social Security system with a tax rate of θ, workers have net of tax earnings of $w_t L_t - \theta w_t L_t$ and with a one-for-one reduction in saving save $\sigma w_t L_t - \theta w_t L_t$. The elderly consume $(1 + r)(\sigma - \theta) w_{t-1}L_{t-1} + \theta w_t L_t$, where $\theta w_t L_t$ is the Social Security benefit. Therefore, net saving in the economy is $(\sigma - \theta)(w_t L_t - w_{t-1}L_{t-1}) = (\sigma - \theta)(g + n + ng) w_{t-1}L_{t-1}$, and Social Security reduces saving by $\theta(n + g + ng) w_{t-1}L_{t-1}$, a proportionate reduction of θ/σ.

To assess the empirical magnitude of this reduction, note that a life-cycle saver who expected to work three times as long as he was retired, would save roughly one-fourth of his income in each working year if the real net-of-tax rate is zero and less than that with a positive net-of-tax interest rate. In the USA the Social Security payroll tax is 12.4%. Therefore, such a model suggests a reduction of roughly one-half of aggregate saving due to Social Security (.124/.25) with a zero net-of-tax interest rate and somewhat more with a positive interest rate[52].

5.1.2. Empirical evidence

The ambiguous predictions of the impact of Social Security on saving that come from economic theory and the clear possibility that such impacts could be of an

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[51] Social Security can nevertheless depress the steady state size of the capital stock. When the pay-as-you-go Social Security system is introduced, the old receive a windfall and increase their consumption by an equivalent amount, reducing the size of the capital stock. The young can save less and the old dissave less in all future periods.

[52] Kotlikoff (1979a) compares partial and general equilibrium impacts on the capital stock in a life-cycle model with retirement effects and suggests that the impact might be somewhat smaller.

economically important magnitude have led to a large empirical literature that has tried to estimate the size of the impact. The papers in this literature can be grouped by the type of variation each uses to identify the impact: time-series, cross-sectional, and cross-country[53].

Feldstein (1974, 1982, 1996b) examined the time-series relationship between saving and Social Security wealth in the USA and consistently found that Social Security crowds out a significant share of overall private saving. In the most recent of these papers, he regressed real per capital consumption (C) on real per capita disposable income (YD), its lagged value (YD_{t-1}), real per capital household wealth (W), and real per capita Social Security wealth from 1930 to 1992 (excluding World War II years). Social Security wealth is defined as the present actuarial value of the future Social Security benefits to which current employees and retirees are entitled. He estimated (standard errors in parentheses):

$$C = 641 + 0.63\,YD + 0.074\,YD_{t-1} + 0.014\,W + 0.028\,SSW.$$
$$(0.06)\quad(0.053)\phantom{YD_{t-1}}(0.008)\quad(0.013)$$

Thus every dollar of Social Security wealth leads to 2.8 cents of additional consumption[54]. Since Social Security wealth in 1992 was $14.2 trillion (in 1992 prices)[55], the estimates imply that Social Security wealth raised personal consumption expenditures by $400 billion and therefore that personal saving was reduced by an equal amount. The coefficients on the disposable income variables further imply that saving was reduced by $16 billion by the difference between the Social Security payroll tax and the benefits paid. Since total private saving in 1992 (including both corporate and personal saving) was $333 billion, the $416 billion reduction in saving implied by these estimates is a 56% reduction of private saving from its potential level.

While these results show that there is a strong underlying correlation between the time paths of Social Security wealth and saving in the USA, the limited variation present in a regression of only 56 observations is not sufficient to definitively establish causality. A large literature has examined alternative time-series specifications both in

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[53] Surveys of this empirical literature are available in Aaron (1982), Atkinson (1987), Danziger, Haveman and Plotnick (1981), and U.S. Congressional Budget Office (1998).

[54] The time series of Social Security wealth in Feldstein (1974) contained a programming error for some of the later years. Leimer and Lesnoy (1982) showed that correcting the programming error reduced the value and statistical significance of the coefficient on Social Security wealth. Revisions of the National Income and Product Account data and extension of the sample in Feldstein (1996b) resulted in a coefficient (shown above) on the Social Security wealth variable just slightly larger and more statistically significant than the estimate in Feldstein (1974).

[55] This "gross" measure of Social Security wealth exceeds the unfunded obligations of the Social Security program because it does not take into account the future Social Security payroll taxes. Such taxes are of course taken into account in the calculation of disposable income. Regressions using a "net" Social Security wealth measure that subtracts the present value of the taxes to be paid by those who are currently in the labor force have coefficients of Social Security wealth that are correspondingly larger.

US data and around the world and has shown that it is possible to find specifications in which the relationship between Social Security wealth and saving is substantially reduced or eliminated. Most notably, Barro (1978) found mixed results from adding a variable measuring the government deficit to the basic Feldstein regression; Leimer and Lesnoy (1982) and Lesnoy and Leimer (1985) point out that workers are unlikely to be capable of calculating their exact future Social Security wealth and show that different plausible models of how individuals approximate their Social Security wealth lead to very different savings results; and Auerbach and Kotlikoff (1983b) conduct simulations with life-cycle consumers and show that estimates from time-series regressions in a Social Security system that has not reached steady state are highly sensitive to the exact time period chosen[56].

Because of the fragility of the time-series results, researchers have attempted to use other sources of variation to estimate the impact of Social Security on saving. In particular there is a large cross-sectional literature that relies on variation in Social Security wealth across individuals for identification. Beginning with Feldstein and Pellechio (1979), researchers have estimated regressions of the form

$$A_i = \alpha_0 + \alpha_1 f(YL_i) + \alpha_2 SSW_i + \alpha_3 X_i,$$

where A_i is the financial wealth of individual i (typically measured around the time of retirement), $f(YL_i)$ is some function of a proxy for lifetime income (often simply a quadratic function of current income), SSW_i is a measure of the present discounted value of future Social Security benefits, and X_i is a vector of demographic variables. The initial estimates by Feldstein and Pellechio using a 1963 Federal Reserve survey of asset holdings were that each dollar of Social Security wealth reduced the accumulation of other financial wealth by about 70 cents. Subsequent studies have typically confirmed the basic result that other financial wealth is reduced in response to Social Security wealth, though the estimated offsets are often lower than the initial estimates[57]. A review of this literature by the U.S. Congressional Budget Office (1998)

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[56] Other time-series studies include Munnell (1974) and Darby (1979).

[57] Kotlikoff (1979b), using data from the 1966 National Longitudinal Study, finds evidence that Social Security payroll taxes reduce saving, but does not observe the expected impact of future Social Security benefits on saving. Feldstein (1983) presents estimates between −.35 and −.72. Blinder, Gordon and Wise (1983) estimate that Social Security wealth reduces private wealth by −.39. Hubbard (1986) studies the responsiveness of financial wealth to both Social Security and pension wealth and estimates an offset of −.33 for Social Security wealth and −.16 for private pension wealth. Bernheim (1987) argues that the common approach of discounting both for time preference and mortality risk is misguided because such a procedure understates the true value of Social Security in the absence of a private annuity market [see, however, Joustein (2001) who emphasizes that in the presence of sufficiently strong bequest motives the true value of a marginal annuity payout stream is close to the actuarially correct value]. Using a Social Security wealth measure constructed by discounting only for time preference, he estimates an offset of 77 cents per dollar of Social Security wealth. Dicks-Mireaux and King (1984) examine Canadian data and estimate an offset of −0.2. Gullason, Kolluri and Panik (1993) re-run the Feldstein and Pellechio specification on more recent Survey of Consumer Finances data and do not find a statistically significant relationship between Social Security wealth and other wealth.

concludes: "Thus, despite the great variation among the estimates, the cross-section evidence suggestions that each dollar of Social Security wealth most likely reduces private wealth by between zero and 50 cents, with the most likely estimate lying near the middle of that range".

There is, however, a fundamental difficulty in interpreting these estimates. Social Security wealth is simply a non-linear function of lifetime income, marital status, and expected mortality. Since all three of these factors are likely to affect wealth accumulation decisions directly, the only thing identifying the coefficient on Social Security wealth is the functional form assumed for the other variables. This is, of course, a common issue in empirical public finance[58], and researchers in the Social Security saving literature since at least Feldstein (1983) have noted the problem and suggested that by using flexible specifications for income and the other variables that enter the Social Security wealth function, regressions would be identified by some of the more idiosyncratic features of the Social Security benefit formula[59]. But it is notable that the quasi-experimental approaches that have been used so successfully to solve similar identification problems in other areas of public finance have not yet been applied to this issue[60].

The final source of variation that has been applied to identify the impact of Social Security on private saving is cross-national variation. The Social Security systems of different countries vary in their generosity, and under the life-cycle model, countries with larger Social Security systems would be expected to have smaller levels of private saving. In practice, all else is not equal and it is quite difficult to construct comparable measures of Social Security wealth across countries. Thus, the estimated signs and magnitudes of the impact of the Social Security displacement effect differ much more widely in these studies than in the US time-series and cross-sectional literatures[61].

[58] See Feenberg (1987) for a discussion of this issue in the context of tax policy.

[59] Bernheim and Levin (1989) implement a particularly ingenious solution to this problem by using a direct measure of individuals' expectations of future Social Security benefits, effectively identifying the impact of Social Security from the idiosyncratic portion of expectations that is not correlated with true benefit levels.

[60] The lack of cross-state variation in Social Security benefits and the complications in specifying the time path on a saving impact from a single federal policy change make it more difficult to apply the quasi-experimental approach to this issue than to many others. One alternative is to examine whether the patterns of savings rates by different cohorts at various ages are consistent with what a life-cycle model would predict in response to expansions in Social Security benefits. Gokhale, Kotlikoff and Sabelhaus (1996) take such an approach and conclude that the postwar decline in US saving can be attributed to two factors: government redistribution to the elderly and an increase in the propensity to consume of older Americans.

[61] Cross-country studies include Barro and MacDonald (1979), Feldstein (1980), Horioka (1980) and Modigliani and Sterling (1983).

5.2. Retirement

There are three main channels through which a pay-as-you-go Social Security system could alter retirement choices. First, for myopic or liquidity-constrained individuals, a mandatory Social Security system will transfer income from working years to retirement years, and the income effect of this transfer would be expected to induce additional consumption of leisure late in life. If the creation or expansion of a Social Security system creates windfalls for people who are old at the time of the policy change, this will accentuate the income effect. Second, many Social Security systems are event-conditioned in the classic social insurance sense, meaning that the benefits are only available once a person is retired. Such systems often alter retirement incentives because the present discounted value of lifetime benefit payments is not independent of the choice of retirement date (even a system such as the US system that adjusts benefits for early retirement in a way that is on average approximately actuarially fair will alter retirement incentives for people whose life expectancy is higher or lower than average). Third, national Social Security systems may change social conventions regarding retirement dates, affecting the design of private pension plans, firm mandatory retirement ages (no longer legal in the USA), and worker tastes [62].

There were dramatic changes in the retirement behavior of men in most OECD countries over the 20th century. Costa (1998) reports that labor force participation rates of men aged 65 and over fell in the USA from 65% in 1900 to 18% in 1990 [63]. Over similar time periods, male labor force participation for this age group fell from 61% to 8% in Great Britain, 54% to 4% in France, and 58% to 5% in Germany.

Labor force participation fell at younger ages as well. For example, among US men ages 55–64, labor force participation fell from 91% in 1900 to 67% in 1990 [Costa (1998)]. Similar declines are apparent in the age at which US workers first claim Social Security benefits. Whereas in 1965 (three years after men first became eligible to claim benefits at age 62), 23% of workers claimed Social Security benefits at age 62, 23% claimed benefits at age 65 and 36% claimed benefits at an age above 65, by 1999, 59% were claiming benefits at age 62, only 16% were claiming them at 65, and 7% at ages above 65 [U.S. House of Representatives Committee on Ways and Means (2000)].

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[62] There are also channels through which Social Security could postpone retirement. For example, by making benefit payments unavailable until age 62, the US system may cause some liquidity constrained individuals to postpone retirement until they are eligible for benefits. Alternatively, by providing an efficient form of annuities, Social Security may raise the value of work for people approaching retirement, lengthening their worklife. See Crawford and Lilien (1981) for a discussion of the ways in which relaxing the assumptions of perfect capital markets, actuarial fairness, and certain lifetimes in standard life-cycle models tend to advance retirement dates. Kahn (1988) shows that liquidity constraints can lead individuals to retire early even in an actuarially fair Social Security system.

[63] Recent research by Quinn (1999) indicates that during the past 10 to 15 years the trend in the USA toward earlier retirement among men has leveled off and possibly reversed itself slightly.

Early retirement is even more common in most other OECD countries. In the USA 26% of men have left the labor force by age 59. However, 58% of men in Belgium, 53% of men in France and Italy, and 47% of men in the Netherlands have left the labor force by that age [Gruber and Wise (1999)][64]. Much of the reduction in labor force participation by men in their late 50s and early 60s has occurred since 1960. In the early 1960s, labor force participation was over 70% for 60–64 year olds in all 11 OECD countries studied by Gruber and Wise. By the mid-1990s, the rate was below 20% in Belgium, Italy, France, and the Netherlands, was about 35% in Germany, and 40% in Spain. The decline in the USA was relatively modest from 82% to 53%, and in Japan the decline was even smaller, from 83% to 75%. The trends toward earlier retirement are particularly striking in light of the impressive improvements in the health of older workers and in life expectancy, implying that successive cohorts of men are spending smaller percentages of their lives in the work force.

The studies in Gruber and Wise (1999) are the strongest evidence that Social Security systems affect retirement behavior. The individual country studies in that volume show that in country after country, relaxation of early retirement rules and expansions in benefits available at younger ages were followed quickly by trends toward early retirement. While some of the decrease in labor force participation by workers in their late 50s and early 60s likely resulted from the relaxing of liquidity constraints and changing of social norms brought about by these policy changes, there also appears to be a strong cross-country relationship between the level of implicit tax rates on continued work above the early retirement age and the level of labor force participation, with the implicit tax rate explaining more than 80% of the cross-country variation in unused labor capacity of 55 to 65 year olds.

Apart from these recent international studies of early retirement, however, it has been quite difficult for empirical researchers to establish a clear link between Social Security benefit levels and the century-long trend toward earlier retirement in the USA[65]. For example, while Boskin (1977) and Boskin and Hurd (1978) found large impacts of Social Security benefit levels on retirement, Burkhauser and Quinn (1983) found no impact. A series of authors employed quite different strategies in analyzing the Social Security benefit increases in early 1970 mostly with data from the Retirement History Survey. Cross-tabulations in Hurd and Boskin (1984) suggest that much of the decline in labor force participation by elderly men in this time period can be explained by the Social Security benefit increases. In contrast, analysis by Burtless (1986) and Burtless and Moffitt (1984) using non-linear budget set methods and by Hausman and Wise (1985) and Diamond and Hausman (1984a) using hazard models suggest that the Social Security benefit increases in this period did little to accelerate the long-run

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[64] Of the 11 countries studied by Gruber and Wise, only Japan, with 13%, had a lower share of men out of the labor force at age 59 than the USA.

[65] Surveys of this literature are available in Atkinson (1987), Danziger, Haveman and Plotnick (1981), Burtless (1999) and Coile and Gruber (2000b).

trend toward earlier retirement. Looking at the longer term patterns, Costa (1998) notes that 58% of the total decline in male labor force participation rates between 1880 and 1990 had already occurred by the time that the US Social Security system made its first payments. She notes that similar timing stories apply for other countries as well, suggesting that rising income can explain much of the decline in labor force participation at older ages until the 1960s.

Many of these early cross-section econometric studies of the impact of Social Security on retirement are susceptible to the same critiques as the estimates in the saving literature: the measures of Social Security benefits used are nonlinear functions of other variables that could plausibly effect retirement directly, and therefore the results are highly sensitive to the particular regression specification used. More recent research has tended to emphasize quasi-random identification strategies, careful modeling of the dynamic retirement incentives as suggested by Stock and Wise (1990) and Berkovec and Stern (1991), and greater attention to the particular aspects of the Social Security benefit formula that are producing the identifying variation. For example, Krueger and Pischke (1992) study the Social Security notch generation which received significantly less-generous benefits than those received by the generations that immediately preceded it and found essentially no impact of Social Security benefit levels on retirement. As a second example, Samwick (1998) uses the option value approach to carefully model year to year accrual of private pension and Social Security wealth, and finds that increases in private pensions explain substantially more of the post-war decline in labor force participation at older ages than does Social Security. Finally, Diamond and Gruber (1998) and Coile and Gruber (2000a) model the retirement incentives in the USA and provide measures of both the year to year accrual of retirement wealth from delaying retirement and the gain that would be achieved by postponing retirement to the optimal age. Among their findings are that the Social Security system does not result in a tax or subsidy on work for the median worker at ages 62–64, because increases in benefits from delaying receipt are quite close to actuarially fair. However, at older ages there is a significant tax on work because the current delayed retirement credit is not sufficient to compensate for time preference and mortality risk at those ages[66]. They also show that there is considerable variation in these incentives throughout the population. Coile and Gruber (2000a) show that substantial variation in the Social Security incentive variables remains even after controlling in a flexible way for current and past earnings, marital status, age, and age difference with spouse – suggesting that this residual variation can be used to identify the impact of Social Security on retirement in a credible way. Coile and Gruber (2000b) go on to perform estimation and conclude that forward-looking measures have a significant impact on retirement decisions[67].

[66] The credit is being increased between now and 2008, however.
[67] Another important empirical literature has examined the US earnings test [see Gruber and Orszag (2000) and Friedberg (1998, 2000) for recent treatments] and has typically found that the test has relatively small impacts on the labor supply of those affected by it.

On balance, it appears to us that when appropriate specifications are used, Social Security systems do appear to have important impacts on retirement behavior. However, significant uncertainty remains about the particular channels provoking these behavioral responses and the share of the overall decline in male labor force participation that can be explained by Social Security.

5.3. Pre-retirement labor supply

As we briefly discussed earlier, the Social Security payroll tax could increase marginal tax rates by as much as 12.4 percentage points and produce substantial deadweight loss if workers do not perceive a linkage between the taxes they pay and the benefits they receive. Since the payroll tax is larger than the income tax for 62% of US families [Mitrusi and Poterba (2000)], the effective marginal tax rates created by the Social Security system is an important issue. Payroll taxes in most other OECD countries are even larger than in the United States.

What makes the impact of the payroll tax on labor supply more complicated than that of the income tax is the possibility that workers perceive some or all of the linkage between taxes paid and benefits received. Feldstein and Samwick (1992), building on earlier work by Blinder, Gordon and Wise (1980), Gordon (1983), Browning (1985) and Burkhauser and Turner (1985), show that the Social Security benefit rules create net marginal tax rates from the payroll tax that differ substantially across the population depending on a worker's age, sex, marital status, and income. These net marginal tax rates are calculated as the payroll tax rate minus the present actuarial value (discounting for both time preference and mortality risk) of the additional social security benefits per dollar of additional earnings. The present value of the incremental benefits to which an individual becomes entitled by earning an additional dollar depends on the worker's age, sex (since mortality rates vary with sex), beneficiary status (whether the worker will claim benefits as a worker or as a dependent spouse), lifetime income (which determines the replacement rate segment of the benefit schedule that applies to the worker), and income during retirement (which determines the income tax rate that will be applied to Social Security benefits). Young workers who believe that they are not in one of their 35 highest years of earnings, secondary earners (typically wives) who expect to receive retirement benefits based on their spouse's earnings record, and low-income workers who expect to benefit from SSI receive no marginal retirement benefits for additional earnings and face the full payroll tax rate. Married men often face negative marginal tax rates since their additional earnings result in higher benefits for both themselves and their spouse. Older workers generally face lower (and often negative) marginal rates since their incremental benefits are not deferred as far into the future as those for younger workers are.

5.4. Portfolio composition

Social Security is likely to affect the asset holdings of individuals both because it will alter saving and because of its risk properties and covariance with other assets. Hubbard

(1985) estimates a model of portfolio composition using US cross sectional data and finds that the share of wealth represented by Social Security wealth is negatively correlated with holdings of other inflation hedges such as housing and equities as well as with annuities, which guard against longevity risk in a way similar to Social Security. In contrast, Dicks-Mireaux and King (1983) find essentially no impact of Social Security wealth on the composition of portfolios for a sample of Canadian households. Merton (1983) argues that an appropriately designed Social Security system can reduce the economic inefficiencies that result from the nontradability of human capital, allowing younger people to correct the portfolio imbalance in which they hold too much human capital relative to their holdings of physical capital. Merton, Bodie and Marcus (1987) discuss the extent to which private pension plans that are integrated with Social Security help insure against the risk of changes to the Social Security system.

6. Distributional effects of pay-as-you-go Social Security

Pay-as-you-go Social Security systems transfer large sums of money from workers to retirees. In the USA, the Social Security system took in $461 billion in (non-interest) revenue in 1999, mostly from payroll taxation of current workers and paid out $393 billion, mostly in benefit checks to retirees. This large redistribution of resources between individuals of different ages provides for 38% of the total income of households headed by someone of age 65 or older, and measured in a mechanical way causes major shifts in the income distribution by age, geographic region, and race. The true impact of Social Security on the income distribution cannot, however, be measured simply by observing annual flows of taxes and benefits. To the extent that a pay-as-you-go Social Security system is simply substituting for private life-cycle saving, large annual flows may have little impact on consumption patterns. Thus, measuring the impact of Social Security on the annual income distribution requires specifying a counter factual income distribution in the absence of Social Security.

Researchers generally have not taken this approach (which would be quite difficult given the range of possible behavior responses discussed above). Instead, they have focused on measuring ways in which existing pay-as-you-go systems treat different individuals differently over their lifetimes. Most pay-as-you-go systems deviate significantly from the actuarially fair systems described in the simplest models. Substantial intercohort redistribution occurs as systems expand benefit generosity and as demographic patterns change. Moreover, benefit formulas produce significant intracohort redistribution, much of it unrelated to lifetime income.

6.1. The returns to Social Security for different cohorts

The simple models above show that the initial generation in a pay-as-you-go system receives a windfall and that subsequent generations earn a steady-state rate of return

Table 1
Redistribution across cohorts in the US Social Security system (OASI)[a]

Birth cohort	Internal rate of return (%)	Aggregate lifetime net intercohort transfer evaluated in 1989 (billions of 1989 dollars)
1876	36.5	12.1
1900	11.9	112.0
1925	4.8	99.6
1950	2.2	14.0
1975	1.9	−8.0
2000	1.7	−15.2

[a] Source: Leimer (1994). Intercohort transfer calculation uses 2% real discount rate.

equal to the growth of the wage base. In practice, repeated benefit expansions over time have created a series of initial generations all receiving benefits that were many times higher than tax payments. Thus, in the USA, workers who paid payroll tax rates of 2 to 5% during their working years have been beneficiaries of payroll tax rates of 10 to 12% in their retirement years[68]. Table 1 shows internal rates of return and lifetime net transfers from Social Security for successive birth cohorts taken from Leimer (1994). The internal rate of return, i, is the return that equalizes the present discounted value of the total OASI taxes paid and benefits received for the cohort:

$$0 = \sum_{age=0}^{age=max\ age} \frac{benefits_{age} - taxes_{age}}{(1+i)^{age}}.$$

The net transfers received by the cohort are the present discounted value of benefits received minus taxes paid using a real discount rate, in this case 2%. We see that whereas the cohort that was born in 1900 received a rate of return of nearly 12% on its payroll taxes, a person born in 2000 can expect to receive only a 1.7% return on his or her taxes[69]. Similarly, while the accumulated (to 1989) value of the benefits received by members of the cohort born in 1925 was $100 billion more than the taxes the cohort members paid, future cohorts will receive substantially less in benefits than they pay in.

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[68] See Burkhauser and Warlick (1981), Moffitt (1984), Duggan, Gillingham and Greenlees (1993), Steuerle and Bakija (1994), and Caldwell et al. (1998).
[69] The numbers shown assume no change in Social Security tax or benefit rules in the future. Leimer (1994) contains additional results under various assumptions for how Social Security's long run deficit is eliminated.

6.2. Intracohort redistribution in the current US system

Because the benefit formula in the US Social Security system replaces a greater fraction of the lifetime earnings of lower earners than of higher earners, the program is generally thought to be progressive, providing a "better deal" to low earners in a cohort than to high earners in the same cohort. Recent research [e.g., Liebman (2002), Coronado, Fullerton and Glass (2000), Gustman and Steinmeier (2000)] has shown, however, that much of the intra-cohort redistribution in the US Social Security system is related to factors other than income. Specifically, Social Security transfers income from people with low life expectancies to people with high life expectancies (who receive benefits for a longer period of time), from single workers to the married (particularly one-earner) couples who receive spouse benefits, and from people who work for more than 35 years to those who concentrate their earnings in 35 or fewer years (since taxes are paid on all years of earnings but benefits are based only on the highest 35 years)[70]. These non-income-related factors often result in substantial variation in the amount of redistribution received by families with similar lifetime incomes. Moreover, since high-income households tend to have higher life expectancies and receive larger spouse benefits, some of the progressivity of the basic benefit formula is offset.

Recently four sets of researchers have constructed microsimulation models of the US Social Security system in order to analyze intracohort redistribution. Three of the papers find that Social Security does redistribute income from higher-earners to lower-earners, but not nearly as much as would be expected based on the benefit formula. The fourth paper concludes that by some measures, the current US Social Security is actually regressive. Caldwell et al. (1998) use a microsimulation model based on projections of marriage and earnings patterns for postwar generations. Overall they find that the lifetime net tax rate from Social Security is 5% for the 1950 birth cohort. They find that the lifetime net tax rate averages 2% for individuals with lifetime labor earnings below $200 000 (1997 dollars) and around 6% for individuals with lifetime earnings between $200 000 and $800 000. At life-time earnings levels above $800 000, net tax rates fall because the level of earnings subject to the Social Security payroll tax is capped. Liebman (2002) uses a data set that matches the Census Bureau's Survey of Income and Program Participation to the lifetime Social Security earnings histories of sample members. He applies current Social Security rules to data for a cohort that retired in the early 1990s and calculates the within cohort transfer that each individual either receives or pays as the present discounted value of the individual's lifetime Social Security benefits received minus taxes paid, discounted at the rate of return for the cohort as a whole. He finds that the total dollar value of the transfers from individuals receiving less than the cohort's internal rate of return to individuals receiving more than the cohort's internal rate of return is only 13% of total Social

[70] See Boskin et al. (1987) and Hurd and Shoven (1985) for early discussions of these issues.

Security benefits received by the cohort. Moreover, much of this redistribution is not related to lifetime income, and lower mortality rates and higher spouse benefits among higher income households offset a substantial share of the progressivity of the Social Security benefit formula, resulting in income-related transfers that are between 5 and 9% of Social Security benefits paid (depending on the measure of lifetime income used), or $19 billion to $34 billion, at 1998 aggregate benefit levels. He emphasizes the wide range of positive and negative transfers from Social Security received by people at the same lifetime income level. Building on earlier work in which they showed that immigrants receive a particularly good deal from the US Social Security system[71], Gustman and Steinmeier (2000) use a microsimulation model based on the Health and Retirement Survey linked to Social Security earnings histories. They emphasize that Social Security looks less progressive after grouping individuals into households and adjusting for variation in earnings by secondary earners than it does looking simply at retired worker benefits. Using a family measure of lifetime income that averages only those years with significant earnings, they find that the redistribution from Social Security increases benefits in the second decile by 7% and reduces them by 7% in the ninth decile. Coronado, Fullerton and Glass (2000) project future earnings and marriage patterns for a PSID-based sample. Ranking households by potential earnings (the lifetime earnings the household would have had if all adults had worked full time in every year) and taking into account the fact that wages above the taxable maximum are not taxed, they conclude that at a sufficiently high discount rate, Social Security is slightly regressive.

In interpreting these results, it is important to be aware that there are important interactions between the inter and intra cohort rates of return. Because Social Security benefit levels rise with income, higher-income members of cohorts that receive large net transfers will often receive higher dollar transfers than lower-income members of the cohort. Thus, Steuerle and Bakija (1994) emphasize that by this measure, the US Social Security system looked highly regressive in the past, but that this regressivity of Social Security is decreasing as rates of return decline.

6.3. General equilibrium consequences of pay-as-you-go Social Security

A Social Security system that alters saving and labor supply behavior will generally change the total amount of capital and labor supplied in the economy. These changes in factor supplies will alter wages and the returns to capital. Such changes can be important because individual responses to the changing factor prices can offset some of the direct impact of government policies, because these price changes alter the distribution of income between workers and owners of capital, and because the optimal

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[71] This occurs because pre-immigration years are averaged in as zeros in the Social Security benefit formula, moving immigrants into high replacement rate segments of the Social Security benefit formula [see Gustman and Steinmeier (1998)].

policy response to population aging is sensitive to how the demographic changes alter the relative supplies of capital and labor.

Kotlikoff (1979a) explores steady-state general equilibrium effects in a life-cycle model that generates a one for one saving offset. He finds that incorporating general equilibrium considerations in a growing economy produces additional offsetting income and substitution effects on saving. While the decline in wages induced by the lower capital stock lowers saving when young, the higher interest rate increases saving. In simulations with a Cobb–Douglas production technology calibrated to represent the US economy, the net effect is to dampen by about 50% the reduction in the capital stock caused by the Social Security system. However, the 20% steady state reduction in national saving implied by this model is still substantial.

Hubbard and Judd (1987) consider the general equilibrium impacts of Social Security in an analytic model with capital market imperfections. In particular, they assume market failure in the private provision of annuities and liquidity constraints that make it impossible to borrow against future wages. In the presence of annuity market failures, Social Security can produce significant increases in long-run welfare even while substantially reducing the capital stock. However, with borrowing restrictions, the forced intertemporal transfer of resources from working years to retirement years can substantially offset or eliminate these welfare gains. Hubbard and Judd's life-cycle numerical simulation model shows that the general equilibrium shifts in incomes between labor and capital have significant welfare implications in the presence of capital market imperfections because the fall in wages and rise in interest rates that accompanies the decline in the capital stock exacerbates the welfare losses from the liquidity constraints.

The Kotlikoff and Hubbard and Judd models compare long-run steady states. Auerbach and Kotlikoff (1983a, 1987) develop a dynamic life-cycle general equilibrium simulation model that computes exact transition paths under the assumption that agents act with perfect foresight about future factor prices. In this model, there are no capital market imperfections and retirement dates are fixed. In simulations of the transition to an unfunded Social Security system with a 60% benefit to earnings replacement rate, Auerbach and Kotlikoff (1987) find that in the long run, the capital stock falls by about 24%. In simulations which assume that workers perceive no linkage between Social Security benefits and taxes, labor supply initially falls slightly due to the substitution effect of the Social Security payroll tax. However as capital is crowded out, the income effect comes to outweigh the substitution effect, and long-run labor supply rises a bit compared with the initial steady state. Additional simulations show that welfare gains from making the benefit-tax linkage transparent are significant, suggesting a rationale for the notional account approaches to unfunded Social Security systems and identifying an important source of welfare gains from a switch from a defined-benefit unfunded system to a funded defined-contribution system [see Kotlikoff (1996)].

Cutler, Poterba, Sheiner and Summers (1990) and Elmendorf and Sheiner (2000) have conducted simulations that explore the optimal response of government policy to

population aging (caused both by declines in fertility and increases in longevity). They explain that the projected increase in the number of dependents per worker means that per capita consumption will decline in the future, and that this implies that we should increase saving now to finance some additional consumption later. However, there is a second offsetting effect. Because population aging is largely caused by a slow down in fertility and therefore in the growth of the labor force, the amount of additional capital necessary to sustain a given capital to labor ratio will fall over time, suggesting that we reduce saving now. For reasonable policy parameters, Elmendorf and Sheiner find that it is optimal (depending on the rate used to discount the well-being of different generations) to let future generations bear the full burden of population aging. It is important to emphasize that these simulations assume that we are currently at the optimal level of capital accumulation. If, as is likely the case, the current level of the capital stock is too low (because the tax system is not optimal and because Social Security benefits crowd out private saving), then there still may be a strong case for increasing saving now.

6.4. Social Security and the distribution of wealth

Because Social Security wealth is likely to substitute at least in part for other types of wealth (financial, housing, etc.), measures of the wealth distribution that ignore Social Security wealth can present a distorted picture of overall wealth. Feldstein (1976b) shows that conventionally measured wealth distributions look inconsistent with what a life-cycle model would produce, but that after adding back in Social Security wealth, the data are more consistent with life cycle saving behavior. Similar arguments apply for measures of the wealth distribution that ignore private pension wealth.

Gokhale, Kotlikoff, Sefton and Weale (2000) study the relationship between bequests and the distribution of wealth and show that Social Security may greatly increase the inequality in the wealth distribution in the USA by depressing bequests in low and moderate income households. Using a dynamic 88-period OLG model calibrated to study the intergenerational transmission of US wealth inequality via bequests, the authors show that because low-income households rely almost entirely on Social Security to finance their retirement consumption, all of their wealth is in an annuitized form, leaving nothing to bequeath to their heirs. In contrast, higher-income households have substantial bequeathable wealth which is passed along to their children as accidental bequests.

Angus Deaton, Pierre-Olivier Gourinchas and Christina Paxson (2002) study how risk-sharing institutions such as Social Security affect inequality. Their basic insight is that in the absence of such institutions, the inequality of the distribution of wealth will grow over time as the impact of random return and earnings shocks cumulate. Social Security, by substituting pay-as-you-go benefits for individual wealth accumulation, reduces the inequality of wealth and therefore of retirement consumption that would occur if there were greater reliance on individual savings.

7. Investment-based Social Security programs [72]

Many countries around the world are shifting from the traditional pay-as-you-go Social Security programs to programs that are completely or partially investment-based, i.e., in which funds are accumulated to pay future retirement benefits as they would be in a defined-contribution private pension system. The specific design of each program, the reasons for the change, and the mechanism of the transition differ with national economic and political conditions [73].

The primary motivation for making the shift is that the rate of return on incremental national saving permits future benefits to be financed with a lower rate of contribution during working years, eventually permitting a higher standard of living for both workers and retirees. This consideration becomes increasingly important as the prospects of an aging population raises the projected taxes needed to finance existing benefit-wage ratios. The transition to such a program does of course require additional saving (i.e., a reduction in current or near-term consumption) in order to take advantage of the high return.

This section begins by describing how a pure investment-based system would function after the transition to such a system was complete. Although a pure investment-based system is an analytically useful case to study, many of the actual programs involve a combination of an investment-based portion and a traditional pay-as-you-go system. Section 7.1 therefore ends with a discussion of such a mixed system. Section 7.2 discusses how a transition to an investment-based system could work in practice. Sections 7.3 and 7.4 discuss the issues of risk and distribution that arise with investment-based systems.

7.1. The economics of an investment-based system

A typical investment-based system is similar to a private defined-contribution plan with the exception that the government generally mandates the level of contributions that individuals and/or their employers must contribute. Each individual has a personal retirement account into which funds are deposited during working years. Those funds are invested in a portfolio of stocks and bonds and, at retirement age, the accumulated

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[72] We use the term "investment-based Social Security" to refer to a system in which individuals save and accumulate financial assets in individual accounts. Such a system thus involves what others have referred to as "prefunding", "privatization" and asset "diversification" [e.g., Geanakoplos, Mitchell and Zeldes (1998, 1999) and Orszag and Stiglitz (2001)]. We recognize that much of the economic effect of investment-based reforms could be achieved without *individual* accounts and we return to that issue below. The analysis in this section parallels the discussion in Feldstein (1998b) but draws on substantial new research that has been done since that was written, particularly research done as part of the NBER study of Social Security reform.

[73] See the separate essays in Feldstein (1998a) for discussion of these issues for Argentina, Australia, Britain, Chile and Mexico, and in Feldstein and Siebert (2002) for a discussion of these issues in several western and central European countries.

funds are used to finance an annuity or other periodic payout arrangement. In addition to mandating the level of contributions, the government may also regulate the types of assets in which the funds can be invested and specify the way in which funds can be paid at retirement.

7.1.1.   The impact on national saving

The effect on national saving of introducing such an investment-based program depends on how both households and the government respond. If individuals are fully rational life-cycle savers, the introduction of an additional mandatory saving program will have no net effect on national saving because individuals would simply reduce their previous saving by an equal amount [Auerbach and Kotlikoff (1987), Kotlikoff (1996), Mitchell and Zeldes (1996)]. Of course, in a world of such rational life-cycle savers there would be little justification for a Social Security program. If at least some individuals are myopic or do not save for some other reason, introducing a mandatory investment-based Social Security program would raise national saving. Since the evidence indicates that the median financial assets of US households on the verge of retirement is less than six months of income, a program of mandatory saving is likely to raise the national saving rate. Although some critics of investment-based reforms with individual accounts argue that they do not necessarily increase saving [e.g., Orszag and Stiglitz (2001)], even critics generally acknowledge the reforms would be likely to be implemented in ways that have a positive effect on national saving [Diamond (1998a), Geanakoplos, Mitchell and Zeldes (1998, 1999)][74].

Although households could in principle offset the mandatory saving in investment-based Social Security accounts by reducing other saving, this is particularly unlikely when the investment-based program substitutes for a pay-as-you-go program with the same benefits[75]. If the retirement income provided by the Social Security program is unchanged, even rational life cycle savers would have no reason to reduce their direct discretionary personal saving in response to a mandatory saving program. Moreover, to the extent that the investment-based program reduces the cost to individuals of providing their retirement benefits (i.e., by substituting a smaller amount of mandatory saving for a larger pay-as-you-go tax) individuals have higher disposable income. Although some of that higher income would be used to finance additional current consumption, some of it would also be saved to finance future consumption. The creation of personal retirement accounts may also induce some current non-savers to begin saving because they learn about the mechanics of portfolio investing or simply because they develop a sense of greater responsibility for their own old age.

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[74] The distinction between privatization (without prefunding) and prefunding is crucial here. Creating private accounts that are only notional would not raise national saving.

[75] That is, introducing an investment-based Social Security program where no Social Security exists might have a much smaller positive effect on saving because individuals could substitute one form of saving for another.

This analysis assumes that the deposits to the investment-based accounts are financed by additional household saving. An alternative that has been proposed is to use a portion of the existing and projected government budget surpluses to finance a relatively small investment-based Social Security program. Since the budget surpluses are already a component of national saving, the effect of this method of financing depends on what would otherwise be done with those budget surpluses. If they otherwise would have been maintained as surpluses and used to reduce the national debt, the shift of those funds to an investment-based Social Security program would have no effect on national saving. If however those projected budget surpluses would otherwise be used to finance additional government spending or tax cuts that lead to increased household spending, shifting those funds into Social Security personal retirement accounts would raise the national saving rate. This is true if the surpluses are in the Social Security program itself ("off-budget surpluses") or are in the non-Social Security part of the budget ("on-budget surpluses"). See Elmendorf and Liebman (2000) and Feldstein and Samwick (2000).

Even a pure debt-financed shift to investment-based accounts can increase national saving in a growing economy under suitable conditions. Section 7.1.3 examines an overlapping generation economy in which a pure pay-as-you-go system is replaced with a pure investment-based system. In the first period, however, the existing obligations to those who have paid into the pay-as-you-go system are compensated by issuing new national debt, so-called recognition bonds. These bonds are never amortized but remain in perpetuity. Nevertheless, as the example shows, the capital stock grows over time if population and wages are increasing.

7.1.2. The rate of return in investment-based accounts

The economically relevant rate of return in an investment-based system is the return that the nation as a whole earns on the additional national saving, i.e., the marginal product of capital for the national economy[76]. The return that portfolio investors earn in the personal retirement accounts is a net return after the federal, state and local governments have collected corporate and property taxes. The full pretax return on incremental capital in the US nonfinancial corporate sector was estimated by Poterba (1998) to have been 8.5% for the period from 1959 to 1996. Of this 8.5%, approximately 3% has been collected in taxes, with two-thirds of those taxes being federal corporate taxes.

Poterba's estimate of an 8.5% real return on nonfinancial corporate capital may overstate the overall marginal return on increased national saving for several reasons: some incremental saving goes into owner-occupied housing which has a low rate of

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[76] The equity premium over the return on debt is therefore not directly relevant. It is wrong to see the return on Social Security investment as a reflection of the equity premium. We return to the discussion of risk in Section 7.3. See also Feldstein (1996a).

return because of its favorable tax status; some saving goes abroad where foreign governments collect part of the return in the form of their taxes; stock options are being issued to employees as a form of compensation but are not reflected (negatively) in the net company earnings when the options are granted; and some of the apparent return to capital may actually be a return to patents, brands, and other things that create non-constant returns to scale. There are also reasons, however, why the 8.5% figure may understate the real return on incremental saving, including the fact that much of the corporate outlays on research and development, manpower training, etc. are really investments that should not reduce the current measure of profits by as much as they do with conventional accounting.

The real financial rate of return that would be earned in investment-based accounts, although less than the full incremental national rate of return because of the taxes paid by corporations, is a significant consideration because it is the financial return that determines the relation between the individuals' deposits in personal retirement accounts and the annuities that can be paid at retirement. During the 50-year period from 1946 to 1995, a portfolio consisting of 60% stocks (the S and P 500) and 40% corporate bonds had a mean real *level* return of 6.9% [77].

Some part of this financial return would undoubtedly be absorbed in administrative costs, a point emphasized in Diamond (1996, 1997, 1998a, 2000a) and by Murthi, Orszag and Orszag (2001) in their discussions of Chile and the UK. Although opinions differ about the likely magnitude of such costs, our judgement is that they need not be large in the USA and are likely to decline over time. Some US mutual funds offer stock and bond index funds with a fee of only 0.20% of assets or less. TIAA–CREF now offers a variety of options for fund accumulation and variable annuity payments at a cost of less than 40 basis points. Although these accounts have larger balances than most investment-based Social Security personal retirement accounts would have in the early years, they also incur costs of selling and of collecting funds that could be much less in a government-mandated program.

The essays in Shoven (2000) show that the cost of the asset management is small relative to the administrative costs associated with receiving and disbursing funds, providing services to investors, permitting frequent portfolio changes, etc. The cost of administering an investment-based system would, therefore, depend heavily on the range of services offered. Goldberg and Graetz (2000) describe an efficient system

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[77] Financial research generally refers to *logarithmic* rather than *level* rates of return. The mean real logarithmic return on the 60 : 40 portfolio during the same period was 5.9% with a standard deviation of 12.5%. With log normal returns, $E[\exp(r^*)] - 1 = \exp[Er^* + 0.5\,\mathrm{var}(r^*)] - 1$ where E is the expectations operator, r^* denotes the logarithmic rate of return, and $\mathrm{var}(r^*) = (0.125)^2$. With $Er^* = 0.059$, this implies that the mean level rate of return is $E[\exp(r^*)] - 1 = 0.069$. The sample mean return is somewhat sensitive to the exact period over which it is calculated. Extending the sample period to include more recent years would raise the rate of return. Starting the calculation with a later date would reduce the mean. Excluding the dramatic rise in share prices since 1995 causes a lower mean return than would be obtained for the most recent 50 years. Diamond (2000b) discusses whether similar returns can be expected in the future.

of administration that uses the existing Social Security Administration to collect funds and that limits the frequency of asset substitution. Future technological change would lower administrative costs by permitting more investor activity to be done electronically. The analysis in this essay assumes an administrative cost of 40 basis points, reducing the usable mean real return on a portfolio from 6.9% to 6.5%. The real return before all taxes would be reduced by a similar amount[78].

The substantially higher real return in the investment-based system than in a pay-as-you-go system permits any given level of benefits to be paid with a much smaller "contribution" during working years. A simple example will illustrate the nature and potential magnitude of this difference. Consider an individual who works from age 20 to 60 and then retires from age 60 to 80. He makes deposits to an investment-based plan each year during his working life and then receives an annuity each year during his retirement. The funds earn a real return of 6.5% during both the saving and the pay-out period. To simplify the calculation, assume that the deposit to the investment-based account is made at a single point in time at the mid-point of his working life, age 40. Similarly, replace the twenty year annuity with a single payment at the mid-point of the retirement life at age 70[79]. The funds are thus invested for 30 years. An investment of $1000 at age 40 would grow over 30 years at 6.5% to $6614. In contrast, in a pay-as-you-go program with an implicit rate of return of 2%, a "contribution" of $1000 at age 40 would grow to $1811, only 27% of the amount accumulated with the investment-based return over the same period. Equivalently, it takes $3.70 at age 40 in the pay-as-you-go plan to buy the same amount of retirement income at age 70 as $1.00 could buy in the investment-based plan with a rate of return of 6.5%. This implies that the benefits provided by a pay-as-you-go Social Security program with a 20% tax rate could be provided by an investment-based program with a saving rate of $20/3.70 = 5.4\%$. This of course is a statement about the long-run after a complete transition has occurred. In the transition, it is necessary to finance the pay-as-you-go benefits as well as accumulating the investment-based fund. Before discussing the practical aspects of a transition, we consider in more detail the gain that results from shifting from a pay-as-you-go system to an investment-based system.

The comparison between the 6.5% return on the financial assets and the 2% implicit return in the pay-as-you-go system ignores the issue of risk. An exact comparison is not possible because of the difficulty of quantifying the demographic and political risks in a pay-as-you-go system [see Section 7.3 below and Feldstein (1996a)]. Some have incorrectly argued that there are no gains from shifting from a pay-as-you-

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[78] In the long run, the extra capital accumulation would cause a decline in the marginal product of capital and therefore in the rate of return to portfolio investors. Calculations by Kotlikoff et al. (2002) indicate that even in the very long run the decline in the pretax real return would be less than 1 percentage point. With Cobb–Douglas technology, even a one-third increase in the capital stock would reduce the marginal product of capital by only about one-fifth, e.g., reducing the net return from 6.5% to 5.2%.

[79] Detailed calculations with annual contributions and withdrawals produce results that are very close to this simplified "center of gravity" inflow and outflow assumption.

go system to a investment-based system once risk is taken into account. However, Geanakoplos, Mitchell and Zeldes (1999, p. 137) calculate that for the population as a whole each dollar shifted from a risk-free government bond (or from an unfunded Social Security program) to an equity investment produces a present value gain equal to 59 cents, or one-fifth of the non risk-adjusted gain[80]. This calculation assumes that some individuals are unable to make equity investments now because of fixed learning costs and therefore have no risk aversion discount on the first dollar. For those individuals and that first dollar, the gain would be the full difference between the return on a risk-free government bond and an equity investment, equivalent in present value to more than two dollars per dollar transferred. The overall average amount is only 59 cents because (1) not all individuals are so constrained to begin and therefore have no gain from the shift, and (2) among those who are initially constrained, the net gain from shifting to equity declines with each additional dollar of risky equity in their portfolio.

7.1.3. The gain from prefunding Social Security[81]

There is substantial controversy about the potential gain from replacing a pay-as-you-go system with an investment-based plan. While the simple example in the previous section suggests a significant long-run potential gain, critics argue correctly that this ignores the inherited obligation to existing retirees and to those current workers who have accumulated claims on future benefits by contributing to the existing pay-as-you-go system [e.g., Geanakoplos, Mitchell and Zeldes (1998, 1999), Orszag and Stiglitz (2001)]. Because of differences in timing, it is not possible to evaluate the potential gain by comparing rates of return. Prefunding reduces the consumption of early generations and increases the consumption of later generations. This implies that the only meaningful comparison is in terms of the present value of the consumption of all generations, and therefore depends on the rate of discount at which society trades off the consumption of different generations.

This section, based on Feldstein (1995c, 1998c), shows that shifting to an investment-based system raises that present value if two conditions are met: the return on capital exceeds the implicit return in the pay-as-you-go program and the capital intensity of the economy is below the welfare maximizing level (i.e., the marginal product of capital exceeds the social discount rate of future consumption.) In some ways of financing the transition, a present value gain only occurs in a growing economy. Since the excess of the return on capital over the implicit pay-as-you-go return is a necessary condition for macroeconomic efficiency and a verifiable fact, and since all economies are experiencing positive economic growth, the present analysis shows that

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[80] This calculation ignores the political risk in a pay-as-you-go system. Taking such risk into account would increase the gain from shifting to the funded system.

[81] As we noted above, we use the term "prefunding" as a short-hand for the shift from a pay-as-you-go system to an investment-based system with real capital accumulation.

shifting from a pay-as-you-go to an investment-based system would produce a net present value gain if the marginal product of capital exceeds the social discount rate.

Previous analyses that concluded that a shift to a funded system would not increase the present value of consumption have implicitly assumed that the rate at which all future generations' consumption changes should be discounted is the same as the marginal product of capital [e.g., Breyer (1989), Shiller (1999), Sinn (2000)]. This is essentially the same issue that we noted in discussing the change in the present value of consumption that results from introducing a pay-as-you-go Social Security system where none exists (Section 3.1 above).

The key reason for the increase in the present value of consumption is the rise in national saving that results from the shift to an investment-based Social Security system. With the marginal product of capital greater than the consumption discount rate, the increase in saving causes a positive present value change in consumption. This of course implies that the gains in the present value of consumption could also be achieved by other policies that increase national saving. It is difficult, however, to think of other policies that could have as large an impact. Feldstein and Samwick (1998b) show that the accumulated assets in personal retirement accounts financed by saving 2% of earnings would eventually reach about 70% of the future level of GDP. In contrast, even a policy of budget surpluses that paid off the entire US national debt in a way that increased the capital stock by a dollar for every dollar of debt reduction would raise the capital stock by less than half of the current level of GDP. Moreover, the relevant policy issue in the analysis of investment-based Social Security reform is about the effect of Social Security reform and not about the potential effect of other policies.

The formal analysis in this section considers the analytically simplest case of a complete shift from a pure pay-as-you-go program to a completely investment-based one. The transition uses "recognition bonds" to compensate the existing retirees and others who have paid payroll taxes under the pay-as-you-go system. More specifically, the government recognizes its obligation to those who have already paid pay-as-you-go taxes by giving them explicit government bonds of equal value and then servicing that additional national debt in perpetuity[82]. In the overlapping generations framework used here, the initial generation of retirees is therefore completely unaffected by the transition[83]. Each future generation bears the burden of servicing the additional debt

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[82] This method of creating "recognition bonds" as an explicit part of the national debt has been a common feature of the Social Security reforms in Chile and other Latin American countries. The assumption that the additional national debt is serviced in perpetuity is just one possibility. The debt could of course be paid off more quickly by levying enough additional taxes on future generations. The transition analysis in Feldstein and Samwick (1997, 1998a) does not use explicit recognition bonds but implicitly assumes that the existing obligations are amortized over the period of years corresponding to the life of the employee who is in the youngest age group when the investment-based system begins.

[83] In a two-period overlapping generations framework, there are no current workers who have accrued claims on future benefits. All obligations of the pay-as-you-go system are to the initial retirees. They receive the recognition bonds in place of their benefits.

Table 2
Receipts and payments of overlapping generations

Social Security program and participants	t	$t+1$	$t+2$	$t+3$
Unfunded program				
Retirees (benefits)	$+T_t$	$+T_t(1+\gamma)$	$+T_t(1+\gamma)^2$	$+T_t(1+\gamma)^3$
Employees (taxes)	$-T_t$	$-T_t(1+\gamma)$	$-T_t(1+\gamma)^2$	$-T_t(1+\gamma)^3$
Change in aggregate consumption	0	0	0	0
Investment-based program				
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 service"	0	$-\rho T_t$	$-\rho T_t$	$-\rho T_t$
Change in aggregate consumption	0	$-\gamma T_t$	$[(1+\gamma)(\rho-\gamma)-\rho]\,T_t$	$[(1+\gamma)^2(\rho-\gamma)-\rho]\,T_t$

[a] Under the funded plan, retirees receive pay-as-you-go benefits at t and then receive the principal and earnings on their savings for all periods after t.
[b] Under the funded plan, employees save these amounts.

but also gains from earning a higher return on its savings than the implicit return that it would have received on the taxes that it would have paid in the pay-as-you-go system. Since the benefits of the initial retirees are unchanged, the net present value depends on the relative magnitude of the future retirement income gains and the future debt service requirements.

Table 2 shows the first four periods of the sequence of income and saving under an existing unfunded plan and the alternative investment-based plan. The process that begins at time t is equivalent to reducing the payroll tax on the then current generation of employees by T_t and issuing national debt in the amount of T_t. If that generation of employees is required to increase saving by making account contributions equal to the amount of the tax reduction, the incremental saving would be just enough to absorb the additional national debt[84]. The debt service during each period in the future is ρT_t [85].

[84] Even if the initial employees are required to save T_t in the mandatory saving fund, they may reduce or increase other saving in response to the income effect of shifting to the investment-based system. As long as there is a positive effect on saving, the conditions under which prefunding an unfunded Social Security program raises the present value of consumption are unchanged, but the magnitude of the gain is altered.

[85] The analysis ignores any potential difference between the interest rate that the government pays on its debt and the marginal product of capital. Although the government may pay a net interest rate that is less than the marginal product of capital, the fact that the increased national debt absorbs T_t of private

With the unfunded system, the taxes and benefits in each period are equal to each other and increase at the rate of growth of aggregate wages (γ); this is shown in the first three lines of Table 2. With the funded system, employees contribute to their personal retirement accounts the same amount that they would otherwise have paid in payroll taxes under the unfunded system[86]. These contributions starts with T_t at time t and then grows at rate γ; this is shown in row 5 of Table 2. Retirees receive benefits funded by a government transfer only in the first period of the transition (at time t)[87]. Future generations of retirees receive the income and principal from their personal retirement account saving. The amount of this retirement income is $T_t(1 + \rho)$ at time $t + 1$ and then grows at rate γ (i.e., in proportion to the earnings of each future generation). This is shown in row 4 of Table 2. Finally, the existence of the government debt reduces real income of each generation by a constant amount ρT_t [88]; this is shown in row 6 of Table 2.

At time t there is therefore 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 time $t + 1$, the retirees in the funded plan receive $T_t(1 + \rho)$, an increase of $(\rho - \gamma) T_t$ in comparison to the unfunded plan. Since some combination of employees and retirees bears the cost of the increased national debt (ρT_t), the net effect of prefunding on consumption at time $t + 1$ is negative, $-\gamma T_t$. This is shown in the final row of Table 2.

Table 2 shows that, while the negative cost of debt service remains constant at $-\rho T_t$, the retirees' gain from shifting to a funded plan increases in proportion to the growing level of aggregate wages $(\rho - \gamma) T_t(1 + \gamma)^t$. The effect of prefunding therefore eventually shifts from negative (i.e., starting with a negative $-\gamma T_t$ in period $t + 1$ to positive[89].

saving (and thereby displaces an equal amount of investment) implies that the lost return is the marginal product of capital times T_t.

[86] This assumption causes the gain from shifting to an investment-based system to take the form of increased benefits rather than reduced taxes. The analysis could alternatively assume that each future generation saves only enough to fund the original level of retirement benefits with the rate of return ρ.

[87] This transfer is financed by issuing "recognition bonds" since the employees at time t are no longer paying the payroll tax.

[88] The debt service involves levying a tax on employees and/or retirees at time t to pay the interest to holders of the debt. The real economic cost arises because the increased national debt absorbs the private saving of the transition generation of employees (and therefore displaces an equal amount of investment). The lost national income is therefore the reduction in the capital stock multiplied by the marginal product of capital, ρT_t.

[89] The decline in consumption in the initial periods is what produces the additional capital and allows for the present value consumption gains. Note that by paying debt service of ρT_t in each period, the debt from the recognition bonds remains constant and therefore declines as a share of the growing economy. If the debt service payments were reduced to $(\rho - \gamma) T_t$, the debt would remain constant as a share of the economy, and there would be no change in aggregate consumption in any period and no welfare gain.

Prefunding raises the present value of consumption if the discounted value of the increased retirement consumption $[\sum_{s=1}^{s=\infty}(\rho - \gamma)T_t(1 + \gamma)^{s-1}(1 + \delta)^{-s}]$ exceeds the present value of the debt service[90] $[\sum_{s=1}^{s=\infty}\rho T_t(1 + \delta)^{-s}]$. The present value of the net gain in consumption from shifting to an investment-based system is therefore $\text{PVG} = \sum_{s=1}^{s=\infty}(\rho - \gamma)T_t(1 + \gamma)^{s-1}(1 + \delta)^{-s} - \sum_{s=1}^{s=\infty}\rho T_t(1 + \delta)^{-s}$, or, equivalently, $\text{PVG} = [(\rho - \gamma)/(\delta - \gamma) - \rho/\delta]T_t$.

In this case, prefunding raises the present value of consumption (i.e., PVG > 0) if three conditions are met: $\rho > \gamma$ (the marginal product of capital exceeds the implicit return in the unfunded program), $\rho > \delta$ (the marginal product of capital exceeds the rate at which future consumption is discounted)[91] and $\gamma > 0$ (the economy is growing).

It is easy to provide an intuitive explanation of each of these conditions. First, an unfunded system has an inferior return to employees in each generation only if $\rho > \gamma$. If $\rho < \gamma$, the economy is dynamically inefficient and consumption can be raised permanently by reducing the initial capital stock[92]. Second, if $\rho < \delta$, additional saving reduces the present value of consumption. Note that both of these conditions are also the conditions that imply that the introduction of an unfunded program reduces the present value of consumption; see Section 3.1 above. If they are not satisfied, an unfunded program raises the present value of consumption and replacing it with a funded program therefore decreases the present value of consumption.

The additional condition that the economy be growing ($\gamma > 0$) 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 does not grow, the annual gain to retirees will remain constant at ρT_t, exactly the same as the cost of debt service.

It is possible to specify other transitions in which the shift to a funded system would increase the present value of consumption even if the economy is not growing. The key requirement is an increase in national saving. With perpetual recognition bonds, the bonds absorb all the new saving if there is no growth. But with other ways of funding the transition, it is possible to have additional saving even if there is no economic growth. The simplest example would be one in which the transition is funded by a lump-sum tax on retirees and initial workers. Since the primary effect of that tax would be a reduction in consumption, the mandated contributions of the workers to the Social Security investment accounts would not be absorbed by government debt or offset by reductions in saving.

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[90] Recall that the debt service represents the loss of income that results from the initial reduction of the capital stock.

[91] See the discussion of δ in Section 3.1 above. The condition $\rho > \delta$ also means that the capital stock is less than the welfare-maximizing size.

[92] See Aaron (1966), for a discussion of this in the context of Social Security.

The present value consumption gain from shifting to a funded system can be compared in an intuitively useful way with the present value of the consumption loss (PVL) that results from introducing an unfunded program. Section 3.1 showed that in an overlapping generations model this loss is given by:

$$\text{PVL} = T_0(1 + r_n)^{-1} \left\{ (r_n - \gamma) + (\rho - r_n)\, s \right\} (1 + \delta)(\delta - \gamma)^{-1} - T_0.$$

The assumption that each dollar of Social Security tax reduces private saving by one dollar ($s = 1$) is analogous to the assumption in the current section that the shift to a funded Social Security program adds one dollar to saving for every dollar of Social Security funding. With $s = 1$, the loss becomes

$$\text{PVL} = \left[(1 + r_n)^{-1} (\rho - \gamma)(1 + \delta)(\delta - \gamma)^{-1} - 1 \right] T_0.$$

The calculations of the present value of the gain from prefunding in Table 2 use the same discount rate for combining consumption changes between working years and retirement years for a given cohort and for aggregating over the consumption of different cohorts, implicitly setting $r_n = \delta$. With that same simplification, the PVL becomes

$$\text{PVL} = \left[(\rho - \gamma)(\delta - \gamma)^{-1} - 1 \right] T_0.$$

This can be compared with the present value of the gain from shifting to an investment-based program using perpetual recognition bonds:

$$\text{PVG} = \left[(\rho - \gamma)(\delta - \gamma)^{-1} - \rho/\delta \right] T_t.$$

The gain here is less than the corresponding loss (per dollar of program at the time of the change) because the unfunded obligation is funded by a perpetual recognition bond that depresses the capital stock permanently by T_t, lowering each future year's income by ρ_t and the present value of the consumption by $\rho T_t / \delta$. If instead the unfunded obligation were financed by a tax on retirees analogous to the windfall that retirees receive when the unfunded program is begun, the present value gain would become

$$\text{PVG} = \left[(\rho - \gamma)(\delta - \gamma)^{-1} - 1 \right] T_t,$$

exactly the same as the present value loss of creating an unfunded program. Note that in this case with lump sum financing of the transition there is a gain even if the growth rate is zero since $\rho/\delta > 1$. More generally, any method of financing the unfunded obligation that has a present value cost less than $\rho T_t / \delta$ would permit a present value gain even in an economy with no growth.

The present value consumption gains are in addition to the gain that results from reducing the deadweight loss that results from distorting work and retirement decisions.

In the long-run, the higher return in a funded system allows lower tax rates for all working individuals. The long-run reduction in the deadweight loss of labor distortion is thus not just a reflection of the change, if any, in the extent of intra-cohort redistribution. If the rate of return in the funded system (or in the funded portion of a mixed system) is equal to the net rate of return that individuals would receive in the market, the funded system eliminates the deadweight loss of the payroll tax (except to the extent that it requires individuals to save more for the future than they would otherwise want to do). For individuals for whom the funded Social Security rate of return exceeds the rate of return that they could earn in the market, the effective payroll tax rate is negative and helps to reduce the combined marginal tax rate of the income and payroll taxes. There is, however, a higher tax burden in the earlier years of the transition because individuals are paying both the mandatory saving and the existing payroll tax. The net effect on the present value of the deadweight losses depends on the relative sizes of the short-run losses from increased distortion and the longer-run gains from reduced distortion; see Feldstein and Samwick (1997, 1998a). The present value of these changes in the deadweight loss is a net gain for the same reason that the present value of the consumption is positive, i.e., because the future tax rate reductions are larger than the current tax rate increases. It would of course be possible in theory to get a long-run deadweight loss reduction without any short-run increase in the deadweight loss if the transition is financed by the equivalent of a lump-sum tax, e.g., by cutting the benefits of current retirees and/or the accrued benefit claims of current workers while giving full credit for the savings in individual Social Security accounts (see Kotlikoff (1996) for an example of such a gain).

7.1.4. Government funds or individual accounts

The consumption gains from an investment-based system do not depend on using a defined-contribution system with personal retirement accounts. One alternative that has received substantial attention in the United States and other countries is to place private stocks and bonds in a common account managed by the government or on behalf of the government[93]. Advocates of this approach [e.g., Aaron and Reischauer (1998), Diamond (1998a), Modigliani, Ceprini and Muralidhar (1999)] argue that it would reduce administrative costs relative to a defined-contribution system of individual accounts and would permit an explicitly redistributive defined-benefit system. They note also that a single fund would insulate retirees from the risk of market fluctuations[94].

It is clear that simply shifting the composition of the existing Social Security trust fund from government bonds to private securities without any increase in national

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[93] This was proposed by President Clinton in his 1999 State of the Union address. Aaron and Reischauer (1998) develop the idea and respond to some criticisms. Canada and Switzerland have created such centrally managed accounts.

[94] See Diamond (1998a) and Aaron and Reischauer (1998) for a discussion of these issues.

saving would raise the rate of return to the Trust Fund, thereby lengthening the period before its balance is exhausted, but would do nothing to increase national income. The extra return earned in the Trust Fund would be balanced by the lower return earned by those who sold the private securities and purchased government bonds[95].

Any gain to national income from increased investment must be the result of increased national saving. Indeed, if national saving is increased, either by requiring individuals to contribute to an enlarged fund or by using a budget surplus that would otherwise be used to finance public or private consumption, it does not matter whether those funds are invested in private stocks and bonds or in government securities. This was the strategy in the 1983 Social Security reforms discussed above. One potential advantage of investing in private securities through individual accounts is that it reduces the political risk that the government accumulation will be used to justify additional government outlays or tax cuts that reduce national saving.

Critics of investing in a common fund of stocks and bonds argue that it will eventually lead to inappropriate political interference in the economy. The government would have a substantial impact on the private economy by the kinds of stocks that it buys or specifically does not buy for the investment account. There could be political pressure to avoid stocks and bonds of tobacco companies, of companies that are foreign owned or that "export jobs" by producing substantial amounts abroad, of nonunion companies, of companies that may have violated anti-trust rules, etc. There would also be problems associated with the government as shareholder during hostile takeovers or as bondholder when there are bankruptcies or debt workouts. With the potential Social Security fund being as large as the entire GDP, these effects could be very substantial [Feldstein (2000)]. Defenders of a common fund argue that such interference could be avoided by a proper administrative structure[96].

Using a single fund would have administrative cost advantages because of economies of scale and avoiding the administrative costs of individual accounts. Balanced against this, a system of private individual accounts may encourage innovation in both products and administration as well as a higher quality of service.

For many people, a major advantage of an individual account investment-based system is apparently that it provides a sense of asset ownership and naturally facilitates making bequests to children or others. Feldstein and Ranguelova (2002) show that permitting the value of the personal retirement account to be bequeathed if the individual dies before age 67 raises the cost of achieving any given benefit level by about one-sixth (for example, from a payroll tax rate of 2.5% to a rate of 3.0%).

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[95] In a more complete general equilibrium context, the increased demand for riskier assets can either raise GDP [Diamond and Geanakoplos (1999)] or lower it [Abel (2001a)].

[96] Aaron and Reischauer (1998), Diamond (1998b) and Elmendorf, Liebman and Wilcox (2002) discuss these mechanisms.

7.1.5. Mixing pay-as-you-go and investment-based systems

Although completely replacing the pay-as-you-go system with an investment-based system is an analytically convenient way to discuss the general question of funded versus unfunded programs, much of the policy discussion in the United States is about a possible shift from the existing unfunded system to one that combines an unfunded pay-as-you-go program and an investment-based program that uses individual defined-contribution accounts. This is also the approach adopted in other countries including Sweden [Palmer (2002)], the UK [Budd (1998)], and potentially Germany [Rurup (2002)].

Although the net present value gain from shifting to a mixed system would of course be smaller than the gain from shifting to a pure investment-based system, the advocates of a mixed system offer two primary reasons for this alternative. First, a mixed system reduces the extent to which retirement income levels are sensitive to the financial market volatility of a pure investment-based system and to the demographic and political risks of a pay-as-you-go system. Although both types of risks remain, the combination of two different types of risks may present a smaller total risk [Merton (1983)]. Second, the pay-as-you-go portion of a mixed system could be used to achieve any politically desired redistribution among income and demographic groups. We return to both risk and distribution after discussing the issue of how a transition to a pure or mixed investment-based system could be done in practice.

7.2. The transition to an investment-based system

A common objection to an investment-based system is that the transition to such a system involves too much of a burden on the transition generation. Nearly all of the current Social Security tax rate of 12.4% is needed to finance the benefits of existing retirees. The idea of paying the tax to maintain those benefits while accumulating reserves for one's own retirement suggests to some that the tax rate would have to be doubled, an economically and politically impossible prospect. But such a doubling would not be required for two reasons.

First, the cost of maintaining the current benefits in an investment-based system is substantially less than the current payroll tax rate. The example cited in Section 7.1.2 above suggests that with a 6.5% real rate of return the long-run payroll cost of a funded system is only about 27% of the cost of an unfunded system with the same benefits. Even with a more conservative 5.5% real rate of return, the cost of a funded system would be only 36% of the cost of a pay-as-you-go system. Since the Social Security actuaries project a long-run cost of 19% of covered earnings, a funded system could be financed with personal retirement account savings of less than 7% of earnings.

Second, a transition could be done in a way that gradually substitutes personal retirement account annuities for pay-as-you-go benefits. As the investment-based annuities increase, the traditional pay-as-you-go benefits could be reduced without cutting the total retirement benefit from the two sources together. These reductions

in the pay-as-you-go benefits permit the corresponding tax to be reduced, permitting the personal retirement account contributions to rise without increasing the sum of the two "contributions"[97].

Feldstein and Samwick (1997, 1998a) develop such a transition for the US Social Security system using detailed economic and demographic assumptions provided by the Social Security Administration in the 1995 Trustees Report on the assumption that the entire marginal product of capital on additional saving could be credited to the personal retirement accounts[98]. More specifically, Feldstein and Samwick (1998a) showed that the transition to a completely investment-based system could be achieved over a long horizon while keeping the combination of the pay-as-you-go tax and the personal retirement account contribution to less than 14%, i.e., an increase of less than 1.6 percentage points on top of the initial 12.4% payroll tax rate. Within 25 years, the combined pay-as-you-go tax and personal retirement account contribution would be below the initial 12.4%. Within the 75 year projection period (for which the Social Security Administration provides demographic and economic projections) the pay-as-you-go tax is fully phased out and the originally projected benefits are financed by the investment-based annuities with a contribution rate of 3.25%[99].

The specific transition path determines how the burden of the transition is spread among different age cohorts and potentially among different generations. An explicit use of recognition bonds that are never amortized but that are serviced in perpetuity causes the burden to be spread over all generations; although at some point the future generations are net beneficiaries, the burden of debt service reduces their net gain. The Feldstein–Samwick method amortizes the cost over a relatively short period.

Who are the net gainers and net losers in any transition depends on what would otherwise have been done. For example, if the alternative to shifting to an investment-based system would be no change in the existing system until the trust fund is exhausted in 2038 and then an increase in the tax rate to maintain benefits, the shift to an investment-based system would impose an extra burden on those who are currently over 30 years old since that generation would otherwise be unaffected. Alternatively, if the pay-as-you-go system would be maintained by raising taxes immediately to a level that would permit benefits to be maintained with no future rise in the tax rate, the shift to an investment-based system would reduce the burden on the currently working

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[97] Alternatively, the use of "recognition bonds" could allow the obligations to existing retirees and workers to be paid over a wide variety of different longer time paths.

[98] This assumes that the government would credit the incremental corporate tax that results from the additional capital accumulation to the personal retirement accounts. The assumed rate of return on the personal retirement account contributions was thus 9%, the Rippe (1995) estimates before the 1997 revision of the national income and product accounts. Feldstein and Samwick reduce this total return to 8.5% following Poterba's (1998) analysis of the revised NIPA data and focus on the financial market return, which is substantially lower because of corporate taxes.

[99] In an alternative study (done a year later but published earlier) of a shift to a fully funded system, Feldstein and Samwick (1997) assumed that solvency was achieved in 2035 with a temporary tax increase.

generation. Feldstein and Samwick (1997, 1998a) provide explicit analyses of the gains for different age cohorts.

Kotlikoff, Smetters and Walliser (2001) develop a dynamic general equilibrium life-cycle simulation model that allows them to incorporate macroeconomic feedback effects as they study replacing the existing Social Security system with a privatized system of compulsory saving. In their baseline demographic simulation (which assumes that Social Security's financing gap is eliminated by raising the payroll tax), they find that capital per worker falls in coming decades as the higher payroll tax rates reduce saving by enough to offset the direct capital deepening from the slowdown in labor force growth. However, Social Security privatization provides large welfare gains for future generations, while requiring only small welfare losses for transition generations. Specifically, transition generations experience a 1 to 3% decline in welfare, while the welfare gains for future generations approach 20%. Moreover, the largest gains accrue to the lowest income classes.

In a later study, Feldstein and Samwick (1998b) analyzed the transition to a mixed system that combines the current 12.4% payroll tax rate and an additional 2% of covered earnings contributed to investment-based personal accounts. The analysis uses the economic and demographic assumptions of the 1998 Social Security Trustee's Report and assumes a real rate of return of 5.5% on the assets in the personal retirement accounts. This mixed system is able to maintain the benefits (including retirement, spouse, survivor, dependant and disability benefits) projected in current law [100]. The 2% personal retirement account contribution makes it possible to avoid the increase in the payroll tax to 19% that the Social Security actuaries project would otherwise be needed to maintain projected benefits. Thus, 2% of personal retirement account investments with a 5.5% real rate of return can replace somewhat more than 6% of payroll tax in a pay-as-you-go system [101].

The countries that have made the transition from a pay-as-you-go system to a mixed system or to a pure investment-based system have done so in quite different ways, reflecting national traditions and economic circumstances. Some countries, like England, had well developed financial markets and widespread share ownership. In others, like Chile and Argentina, the capital markets were not well developed and

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[100] The Social Security Trust Fund decreases but is never exhausted in this adjustment process.

[101] Using only the portfolio return to finance the personal retirement account annuities implies that the federal, state and local governments receive additional tax revenue equal to about 3% of the value of the increased capital stock, with about two-thirds of this going to the Federal government. The Feldstein–Samwick estimates of the accumulated personal retirement account assets implies that by 2030 the incremental Federal income tax is essentially enough to finance the entire 2% contribution to the personal retirement accounts. In effect, the external source of incremental saving can decline from 2% of earnings in the first year to zero after 30 years. Beyond that date, the initial 12.4% could also be reduced while still maintaining the initial projected level of benefits. See also Feldstein and Samwick (2000). These calculations are of course sensitive to the assumptions about the share of incremental saving that flows to domestic corporations rather than to housing and foreign investments; see Elmendorf and Liebman (2000).

relatively few citizens owned financial assets. The experience is a warning against seeking a single formula that is appropriate for all countries and a demonstration that countries with very different preconditions and different stages of financial development can successfully make the transition.

7.3. Risk aspects of investment-based Social Security reform [102]

All Social Security programs involve risks and different programs share these risks in different ways. In a pay-as-you-go system, demographic changes and long-term fluctuations in growth rates alter the tax rate needed to finance any given level of benefits. In an investment-based program, fluctuations in financial markets alter the value of assets and future pensions. In addition, individuals face the "longevity risk" of an unexpectedly long life if their retirement assets are not in the form of an inflation-adjusted life annuity [Brown, Mitchell and Poterba (2000)]. More generally, taxpayers and retirees face unnecessarily large risks in both pay-as-you-go and investment-based systems because there are inadequate opportunities for the international diversification of risk [Shiller (1999), Baxter and King (2001)].

Bohn's (2001) analysis of demographic risks in a neoclassical growth model showed that a pay-as-you-go defined-benefit program may be more efficient in dealing with the risk of birth rate surprises (in a closed economy) than a funded defined-contribution plan because declines in the birth rate that increase the needed tax revenue per worker also raise wage rates (and therefore payroll tax revenues) by reducing the labor–capital ratio.

In practice, the division of the pay-as-you-go risks between retirees and taxpayers is decided by the political process. McHale (2001) shows how key industrial countries, including the United States, have responded to demographic changes by reducing future pension benefits [103]. Rangel and Zeckhauser (2001) consider the risks of the political process in providing intergenerational transfers and conclude that neither the private market nor the voting mechanism can generate an optimal intergenerational allocation of risk.

In an investment-based program, the risk may be borne by retirees, taxpayers, or both. A system of individual defined-contribution accounts places the risk on retirees, although this risk can be reduced or eliminated by government guarantees or by market instruments. In contrast, placing the investments in a Social Security trust fund while promising defined benefits places the risk on future taxpayers, although this risk can be shifted to retirees if benefits are modified when the investment pool does not perform according to expectations. MaCurdy and Shoven (2001) show that substituting

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[102] This section draws on the papers in Campbell and Feldstein (2001)

[103] In 1983, the United States reduced benefits primarily by delaying the age at which full retirement benefits are available and making a portion of benefits part of taxable income. The US Social Security program was founded as a funded program because of a concern that future generations of voters might not support the benefits provided for in the legislation. See Section 2.1 above.

a stock portfolio for bonds would worsen Social Securities finances roughly 20% of the time, placing extra burdens on taxpayers or retirees. Abel (2001b), Bohn (1997) and Diamond and Geanakoplos (1999) analyze the consequences of such equity investments in a general equilibrium model. Abel's analysis shows that increasing the share of the Social Security trust fund invested in equities causes the economy's capital stock to grow more rapidly and the equilibrium equity premium to decline. Diamond and Geanakoplos (1999) also find that such Trust Fund diversification reduces the equity premium and note that it also raises the utility of workers who hold no equities and of a suitably weighted sum of all household utilities.

An investment-based system of defined-contribution individual accounts without government guarantees places all of the financial market risk of the program on the retirees. Feldstein and Ranguelova (1998, 2001a) examine the magnitude of these risks with a simulation model that assumes that personal retirement accounts accumulate a portfolio that is 60% in stocks (the S&P 500) and 40% in corporate bonds and then convert that portfolio to a variable annuity with the same mix of assets [104]. Using the 1998 demographic and economic assumption of the Social Security actuaries implies that the long-run pay-as-you-go tax rate needed to support the benefits projected in current law (the "benchmark" benefits) would be 18.4%. The simulation model is used to derive long-run risk distributions associated with different account deposit rates. These distributions reflect both the uncertain future mean return and the annual variations in rates of return conditional on that mean return [105]. Higher account deposit rates provide a greater "cushion" against the risks of poor market performance. In a pure investment-based system with a 6% personal retirement account saving rate, the median annuity at age 67 would be 2.12 times the benchmark benefits (implying a ratio of benefits to preretirement earnings of approximately 80%). There is less than one chance in five that the benefits would be less than the benchmark and only a 10% probability that the benefits would be less than 80% of the benchmark. There is however a 5% chance that the benefits would be less than 60% of the benchmark level and a 1% chance in 100 that they would be less than 40% of the benchmark level.

Increasing the personal retirement account saving rate to 9% (just less than half of the 18.4% tax rate that would have to be paid in the pure pay-as-you-go program) raises the median annuity at age 67 to 3.18 times the benchmark benefit and reduces

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[104] Assuming that the investment portfolio is the same for all individuals and remains the same through the individual's life ignores the important role that a system of investment-based individual account can play in tailoring risks to individual preferences and circumstances, a point emphasized by Campbell et al. (2001).

[105] The portfolio of 60% stocks and 40% bonds had a mean real logarithmic return of 5.5% and a standard deviation of 12.5% for the period from 1946 to 1995. The mean return in the future simulations is taken to be distributed with a mean of 5.5% and a standard deviation of 1.77 percentage points (the 12.5% sample standard deviation divided by the square root of the 50-year sample size.) The annual values during the accumulation and retirement phases are then conditional on this (stochastic) mean with an annual logarithmic return standard deviation of 12.5%.

the probability of getting less than the benchmark amount to under 10%. There is only a 1% chance of getting less than 60% of the benchmark. Explicit expected utility calculations with a constant relative risk aversion utility function show that individuals would prefer the distribution of potential annuity values associated with the 9% saving rate to the sure benchmark benefit if their risk aversion parameter is 3.1 or less [106, 107].

Although many individuals would therefore regard the upside potential as more than adequate compensation for the risk, there are three ways (either singly or in combination) that the risk of a defined-contribution investment-based program can be reduced. One way is to use a mixture of pay-as-you-go and investment-based programs, thus reducing the risk to just that portion of the benefits that are investment-based. Feldstein, Ranguelova and Samwick (2001) analyze such a program that combines a 12.4% payroll tax rate (the current US Social Security tax rate) with personal retirement account savings equal to 2.3% of the same earnings [108]. The analysis assumes that the personal retirement accounts and the subsequent annuities are invested in the stock-bond portfolio with a mean real logarithmic return of 5.5% and a standard deviation of 12.5%. The pay-as-you-go portion would pay benefits equal to somewhat less than two-thirds of the benchmark level of benefits (i.e., than two-thirds of the level of benefits projected in current law). The combination of this pay-as-you-go benefit and the personal retirement account annuity would provide a median retirement annuity equal to 1.27 times the benchmark benefit. There is less than one chance in 10 of receiving less than 80% of the benchmark benefit and less than one chance in 100 of receiving less than two-thirds of the benchmark amount.

A second way of reducing the risk to retirees is by an explicit government guarantee that shifts some or all of the risk of the financial market performance to future taxpayers. Feldstein and Ranguelova (1998) and Feldstein, Ranguelova and Samwick (2001) extend the analysis of the pure investment-based system described earlier in this section by introducing an explicit guarantee: if the personal retirement account annuity that results from saving 6% of earnings and investing it in the stock-bond portfolio described above does not equal or exceed the benchmark level of benefits in any year, the government pays retirees enough to close the gap. As noted above, with a 6% saving rate there is about one chance in five that benefits will be less than the benchmark for retirees at age 67 and one chance in 10 that the group will receive less

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[106] A relative risk aversion of 3.1 means that doubling the level of income causes the marginal utility of another dollar to fall by a factor of $2^{3.1} = 8.57$. Such an individual who contemplates two possible states of nature – an income of $20000 in the bad state and $40000 in the good state – would be indifferent between receiving $1 in the bad state and $8.57 in the good state. Someone with lower risk aversion would prefer the $8.57 option.

[107] The preference for the personal retirement account option is based solely on the comparison between the annuity payment distribution and the benchmark benefit without taking the lower contribution rate (the 9% mandatory saving versus the 18-plus percent tax) into account. Even someone who preferred the benchmark benefit to the riskier distribution might prefer the PRA option because of the lower contribution rate during working years.

[108] This analysis assumes that the pay-as-you-go benefits are riskless.

than 80% of the benchmark. Since each retiree cohort age 67 and older can receive a guarantee payment in any year and there is no offsetting of good years and bad years, the probability that the taxpayers will make a payment in any year is greater than the probability that any single cohort's annuity will fall short of the benchmark benefit. Nevertheless, the Feldstein–Ranguelova analysis shows that the probability that taxpayers will have to provide any guarantee payment (when retirees have saved 6% of their earnings) is less than 50%. There is only a 5% chance that the taxpayers would have to make a transfer as large as 12% of payroll and only a 1% chance that the taxpayers would have to pay as much as 14.8%[109]. Even with the 12% transfer, the combined cost of the transfer plus the 6% saving rate (for their own retirement) would still be less in that year than the 18.4% payroll tax that would be required in the pure pay-as-you-go system.

These calculations of the taxpayer transfer needed to close the gap between the benchmark benefit and 6% personal retirement account annuity ignore the additional corporate tax revenue that results from the increased capital stock. The calculations in Feldstein and Ranguelova (1998) show that incremental corporate tax revenue equal to 2% of the additional capital stock accumulated because of the individual retirement accounts (an amount equivalent to a tax rate of only about two-thirds of the statutory corporate tax rate) would be equal to about 6.3% of GDP and therefore about 15.7% of covered earnings. This extra tax revenue of 15.7% of covered earnings is enough to finance the entire transfer even in the worst 1% of cases[110].

Smetters (2001) warns that government guarantees of this type are effectively grants of put options to future retirees and that the market price of such options could be very large. According to Smetters, calculations based on a simplified model show that, even with a 12% saving rate, shifting to an investment-based system would reduce the unfunded liability of the government by more than one third only if the government guarantee is limited to less than the current benchmark Social Security benefits. Stated differently, because of the implicit price of risk in option pricing models, the value of the put option that the government provides in guaranteeing the benchmark level of benefits can be very high.

Thinking about the benchmark guarantee as a kind of put option suggests a third way that retiree risk could be reduced if there is no government guarantee or only a limited guarantee. Individual employees could buy such put options from the private securities market. An attractive way to finance the purchase of such a put option would be by selling a call option, i.e., by forgoing some of the potential for a very high level of benefits. In the language of financial derivatives, such a contract is a "collar" and can provide "put option" protection at no cash cost by selling a

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[109] These simulations are based on the average benefits for each cohort. Taking into account the distribution of benefits would increase government payments moderately because the gains of those above the benchmark would not offset the losses of those below the benchmark.

[110] See Elmendorf and Liebman (2000) for reasons why this may overstate the induced increase in tax revenue.

call option of equal value. Bodie (2001) discussed the possibility of such collars and presented examples of the type of collar that could be purchased with a single premium payment. Feldstein and Ranguelova (2001b) developed an explicit method for evaluating a "pension collar", [i.e., a collar associated with a series of asset purchases (the savings deposits to the personal retirement accounts) followed by a series of variable annuity payments [111]] and applied it to a mixed system in which the 12.4% pay-as-you-go tax finances two-thirds of the future benchmark benefits. The price of the put and call options reflect option pricing values that prevail in the current financial market.

The Feldstein–Ranguelova analysis showed that an individual who saves 2.5% of earnings in a personal retirement account invested in the 60 : 40 equity–debt portfolio can buy a collar that guarantees the benchmark level of benefits and provides for gains of up to 116% of the benchmark level (i.e., any gain above the 116% goes to the seller of the collar). Reducing the guarantee level to 90% of the benchmark increases the maximum gain to 150% of the benchmark while raising the saving rate to 3.0% permits guaranteeing the full benchmark while allowing a gain of up to 145% of the benchmark. As these examples show, one of the advantages of the collar approach is that it could, in principle, allow different individuals to obtain the mix of guarantee and upside potential that best reflects their personal taste. The use of the private market to trade risk through time in this way can effectively allow individuals to share risk with individuals of other generations. Unlike the simple overlapping generations model in which individuals work for only one period and then retire, in the actual economy retirees or those near retirement could shift risk via financial markets to younger workers who, because they have relatively little portfolio risk and a larger amount of human capital, would have a greater appetite for risk; as those younger workers age, they can shift the risk to yet younger cohorts.

In addition to the political risks of a pay-as-you-go system and the financial market risks of an investment-based system, there are also the individual longevity risks, i.e., the risk that individuals will live substantially longer than the normal life expectancy, running down their retirement assets if they are not fully annuitized. Brown, Mitchell and Poterba (2001) stress the importance of a life annuity and discuss the limited availability of such annuities in the current market. The existence of a universal investment-based system with mandatory annuitization would change the annuity market fundamentally and eliminate the self-selection problem that currently distorts the pricing of annuities.

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[111] There is a technical difficulty in evaluating such a collar because the prices of the assets in which personal retirement account deposits must be invested in future years are not known in advance. An evaluation equivalent to the basic Black–Scholes formula can nevertheless be obtained by the risk neutral evaluation method of Cox and Ross (1976).

7.4. Distributional aspects of investment-based reform [112]

Many investment-based Social Security reform proposals would increase the link between a worker's Social Security contributions and retirement income by making deposits in workers' individual saving accounts that are a constant proportion of their earnings. These proposals have led to concern that the amount of redistribution and poverty alleviation accomplished through Social Security would decline if an individual account-based system were established.

While the research discussed in Section 6 above on the redistribution in the current US system suggests that there is less redistribution to lose in moving to a new system than many people believe, it is nonetheless the case that low-income households would potentially be most vulnerable if a new system added significant amounts of market risk and that a reform that required equal percentage benefit cuts for all beneficiaries would likely cause the most distress at the bottom end of the income distribution.

In a mixed system, these concerns can be addressed by making what remains of the traditional defined-benefit program more redistributive, implicitly making the share of income subject to financial market risk rise with income. This is the approach taken in the Personal Saving Account plan of the 1994–1996 Social Security Advisory Council which converted the pay-as-you-go benefit into an equal benefit for all retirees and in legislation introduced by Senators Breaux and Gregg and Congressmen Kolbe and Stenholm who added a new minimum benefit for low-wage workers in order to insulate them from the cuts to the traditional benefit and market risk that are part of their plan.

Feldstein and Liebman (2002a) use the same micro simulation model as Liebman (2002) to explore how workers at different income levels fare under a mixed system. They find that with a 3% of payroll personal savings deposit added on top of the existing 12.4% of payroll pay-as-you-go system, essentially all demographic groups, including those groups that now receive particularly high returns from the current system, end up with higher levels of retirement income. Specifically, they study the long-run steady state after a transition to a mixed system that provides a total benefit equal to 61% of current law Social Security benefits (the amount that can be afforded in the long run without raising the 12.4% payroll tax) plus the proceeds from a 3% of payroll individual account. Some 94% of beneficiaries have higher benefits under the mixed system than under the traditional system, even though this is with a total long run contribution rate of only 15.4% rather than the 19% that would be necessary to maintain the pay-as-you-go system. There are also substantial reductions in the percentage of beneficiaries with benefits below the poverty line. These poverty gains are particularly large for high risk groups. For example, the percentage of widowed, divorced, and never married women with benefits below the poverty line falls from 26% to 9%. Among unmarried black retirees it falls from 53% to 21%.

[112] This section draws on the studies presented in Feldstein and Liebman (2002b).

While the gains in the long run from switching to a mixed system extend throughout the population, the percentage gains in retirement income are largest for high income individuals if deposits into the individual accounts are proportional to earnings. Feldstein and Liebman (2002a) show, however, that if the accounts are funded in a redistributive manner, it is possible to have equal percentage gains throughout the income distribution. In particular, if half of total account deposits are equal per capita contributions and half are proportional to earnings, then the accounts essentially match the observed redistribution of the current Social Security system.

In considering the redistributive properties of individual accounts, it is important to note that if annuitization is required and the annuitization occurs at a single price for the entire population, then individual accounts will provide the same sort of redistribution from those with short life expectancies to those with long life expectancies that is found in the current defined-benefit Social Security system. However, if only partial annuitization is required and accounts are therefore partially bequeathable then some of this redistribution based upon life expectancy (which typically flows from low earners to high earners) will be offset.

Feldstein and Ranguelova (2002) examine the potential magnitudes of the bequests that might result in an investment-based plan under different rules about bequests. Permitting employees who die before retirement to bequeath the assets in their Personal Retirement Accounts would reduce the funds available at age 67 by about one-sixth, implying for example that the same level of annuity could be achieved with a 3.6% PRA saving rate and preretirement bequests or a 3.0% PRA with no bequest. Brown (2002) analyzes the financial redistribution that would occur under various annuity and bequest options in an individual accounts program. A key part of his analysis is applying mortality rates differentiated by gender, race, ethnicity and education level to calculate the transfers that would take place between different groups under different assumptions about the structure of the annuity program. Among his findings is that mandating that each individual's retirement benefit be paid as a single life annuity can result in much larger transfers from high mortality groups (such as black males) to low mortality groups (such as white females) than would occur if joint life annuities or bequest options were allowed.

Finally, it is worth emphasizing that the general equilibrium effects of Social Security reform can have important distributional effects. Kotlikoff, Smetters and Walliser (2002) use a computable general equilibrium model to analyze how the shift to an investment-based system would change wages and interest rates. They conclude that an investment-based system would help the poor both because of the higher return on investment-based accounts and because of the increased capital per worker in the economy.

8. Conclusion

The size and social importance of the Social Security program will make this subject a central part of public finance in future years. The evolution of the systems in different

countries of the world will provide rich material for students of public finance and an important opportunity to contribute to evolving policy in this important public policy area.

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