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THE GAINS FROM PENSION REFORM

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We classify social security pension systems in three dimensions: actuarial versus non-actuarial, funded versus unfunded, and defined-benefit versus defined-contribution systems. Recent pension reforms are discussed in terms of these dimensions. Shifting to a more actuarial system reduces labor-market distortions, although limiting the scope for redistribution. Shifting to a funded system may increase saving, redistribute income to future generations and distort contemporary labor supply. A partial shift to a funded system helps individuals diversify their pension assets. A shift from a defined-benefit to a defined-contribution system means that income risk will be shifted from workers to pensioners.

The Gains from Pension Reform

1. Introduction

The contemporary discussion of pension reform has been initiated mainly by concern for the long-term financial viability of existing government-operated pension systems. In some countries, particularly in Latin America and Eastern Europe, such systems have more or less broken down. In developed OECD countries, the situation is less dramatic. In the future, however, serious problems are likely to emerge as a result of anticipated developments in demography and productivity growth. For instance, while the average contribution rate in the EU today is 16 percent, a recent report by the EU Commission (2001) estimates that it has to be increased to 27 percent in 2050 if the present rules are kept unchanged. Predictions for the United States are usually less gloomy. According the Social Security Administration (2001), the contribution rate in the U.S. social security system would have to increase from today's 12.4 percent to 17.8 percent in order to balance the system in 2050, again with unchanged rules.[2]

Needless to say, predictions like these have spurred a host of proposals for pension reform, some of which have already been implemented. Why, then, is there so much disagreement on this issue, even among highly competent economists? One reason is simply that pension reform is a very complex issue. Another is that reform proposals often combine pension reform itself with various auxiliary fiscal policy measures, often undertaken to mitigate undesirable side effects.

Our ambition is not to provide a comprehensive survey of the enormous literature in this field. Instead, we want to highlight some basic principles of pension reform, and to disentangle various efficiency, distributional and stability aspects. To avoid getting bogged down in detail, we base our discussion on a unified analytical framework in the context of a generic overlapping generations model. Such a model automatically

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[2] The contribution rate that would be necessary to finance current benefits is 10.5 percent in the U.S.; the difference between this figure and the 12.4 percent in the text reflects the current surplus in the U.S. social security system.

focuses on real economic transactions (such as consumption and labor supply), rather than financial recordings (such as government debt). The model also highlights the distribution of income among generations, which is an important aspect of pension systems. The overlapping generations framework allows us to illuminate the fact that many objectives of pension reform could alternatively be brought about by general fiscal policy, i.e., by an appropriate combination of taxes, transfers and government borrowing – a point forcefully made in generational accounting (Laurence J. Kotlikoff 2002).

After outlining a taxonomy of pension systems (Section 2), we briefly discuss the consequences for income distribution, saving and labor supply of introducing a pay-as-you-go system (Section 3). We then address the effects of reforming such a system (Section 4). Next, we analyze the consequences of shifting, fully or partially, to an actuarially fair, funded system (Section 5). Finally, we discuss risk and the risk-sharing properties of pension systems (Section 6). Section 7 offers a brief summary along with examples of recent pension reforms and reform proposals in various countries.

2. Mandatory Pension Systems: A Taxonomy

Comparisons of pension systems, and discussions of pension reform, are usually based on the distinction between defined benefit and defined contribution systems.[3] Instead, for our purposes, we have chosen a three-dimensional classification: defined contribution *vs*. defined benefit, funded *vs*. unfunded, and actuarial *vs*. non-actuarial pension systems. By the term defined contribution we mean that the contribution rate is exogenous while benefits are endogenous. By contrast, in a defined benefit system, the benefit is either a fixed lump sum or an amount determined by the individual's previous earnings, implying that future contribution rates have to be endogenous for the pension budget to balance. The second dimension, referring to the degree of

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[3] This distinction is not always very clear. A defined contribution system is often identified as a fully funded, actuarially fair system with an exogenous contribution rate; cf., for instance, Robert Merton (1983), Laurence Thomson (1998), Peter A. Diamond (2002) and the EU Commission (2001). The reason why we do not use this definition is that we want to separate issues of funding, actuarial fairness, and the exogeneity of contributions or benefits.

funding, is straightforward: while in an unfunded (pay-as-you-go) system aggregate benefits are financed by a tax on currently working generations, in a fully funded system benefits are financed by the return on previously accumulated pension funds. The third dimension is somewhat subtler. In the insurance literature, the term "actuarial" is used to describe two quite different features. One feature is macroeconomic, and refers to the long-run financial stability (viability) of the system; a stable system is said to be in "actuarial balance".[4] The other feature is microeconomic, and refers to the relation (link) between contributions and benefits at the individual level; we will refer to this feature as "actuarial fairness". We assume that any pension system has to be financially stable (i.e., be in "actuarial balance"). But within the class of financially stable pension systems, different degrees of actuarial fairness may be chosen.[5]

Real-world systems are rarely clear-cut in any of these dimensions. They often include actuarial and non-actuarial, as well as funded and unfunded components. Moreover, while some elements of real-world pension systems are defined-benefit, others are defined-contribution. Nevertheless, it is useful to keep all three dimensions separate when analyzing alternative pension systems. Each dimension highlights an important aspect of pension systems: risk sharing, aggregate saving, and labor market efficiency.

To begin with, we disregard issues of risk and focus on labor market efficiency and aggregate saving, hence on the actuarial/non-actuarial and the funded/non-funded dimensions.[6] This gives us four generic pension systems, illustrated in the corners of the box (trapezoid) in figure 1. Unfunded (pay-as-you-go) systems can be either completely non-actuarial (position I) or have strong actuarial elements – what we call "quasi-actuarial" (position II). Funded systems can similarly be either completely non-actuarial (position III) or actuarially fair (position IV). While the marginal return

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[4] This terminology is used by, e.g., Diamond (2002). It also coincides with the definition of "actuarial" in Palgrave (1994).

[5] The notion of actuarial fairness appears under different guises in the literature. Whereas Kotlikoff (1996, 1998) uses the term "degree of linkage", Robert Fenge (1995) calls an actuarially fair system "intragenerationally fair".

[6] Basically, the same two dimensions have been emphasized by, e.g., Alan J. Auerbach and Laurence J. Kotlikoff (1987, Chapter 10), John Geanakoplos, Mitchell and Stephen P. Zeldes (1999), and Martin S. Feldstein and Jeffrey Liebman (2002) – although to some extent with different terminologies.

on the individual's contributions is equal to the market rate of interest in an actuarially fair, fully funded system, it is equal to the growth rate in the tax base in a quasi-actuarial system (see section 3.2). Since the growth rate is usually lower than the interest rate, we have depicted position II as somewhat less actuarial than position IV. Figure 1 is useful not only in a theoretical context, but also when characterizing actual reforms in various countries (Section 7), as well as when interpreting the results of numerical simulations of reforms.

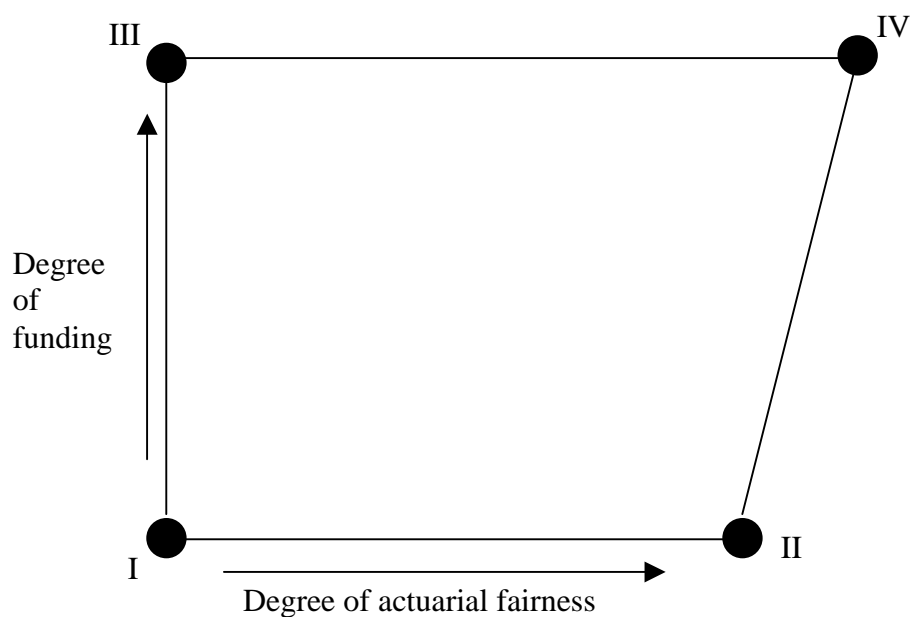*Figure 1: A taxonomy of social security systems*

If the defined contribution/defined benefit dimension were unrelated to the other two dimensions, both defined-contribution and defined-benefit systems would be found in each corner of figure 1. It is difficult, although not impossible, to construct systems in positions II and IV as anything other than defined contribution systems, since pension

benefits are then, by definition, closely tied to contributions.[7] In positions I and III, it is easier to conceive of systems that are either defined contribution or defined benefit.

Our three-dimensional classification facilitates separating the consequences of a pension system for work incentives (highlighted by the actuarial/non-actuarial dimension), capital formation (highlighted by the funded/unfunded dimension) and risk sharing (highlighted by the defined benefit/defined contribution dimension). Regardless of the immediate objectives of a pension reform, it can often be described as a movement in these three dimensions. Movements along the first dimension are discussed in Section 4, along the second in Section 5, and along the third in Section 6.

3. Introducing a Pay-As-You-Go System

3.1 Arguments for Introducing a Mandatory System

When discussing of pension reform, it is important to recognize the reasons for having a mandatory system in the first place. A well-known justification is to prevent free-riders from exploiting the altruism of others.[8] Another justification is based on paternalism: a mandatory system prevents myopic individuals from ending up in poverty in old age. Traditionally, the term "myopic" refers to individuals who, quite irrationally, do not realize their need for resources as they grow older. A more recent view of myopic behavior is that an individual, albeit concerned about future needs, tends to discount the near future at a higher discount rate than the distant future (such as the retirement period). At each point in time, he would like to save for retirement, but he continually postpones commencement of that saving until the next period (like a smoker who decides to quit smoking "tomorrow" rather than today). This type of discounting, which has been labeled "hyperbolic" or "quasi-exponential" (in contrast to ordinary, exponential discounting), has been documented in numerous psychological experiments.[9] Since a person of this type lacks self-discipline, he is

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[7] A system that could be characterized as an actuarially fair DB system has, however, been suggested by Franco Modigliani and Maria Luisa Ceprini (2002); we discuss this proposal in subsection 6.2 below.

[8] For a formal treatment of this issue, see Kotlikoff (1989).

[9] See the surveys by George-Marios Angeletos *et al*. (2001) and Shane Frederick, George Loewenstein and Ted O'Donoghue (2002). The mathematical properties of alternative discounting functions and the

well served by some kind of commitment device. It is sometimes argued that such a device could consist of a mandatory pension system, that prevents him from procrastinating; this point has been made by David Laibson, Andrea Repetto and Jeremy Tobacman (1998). So far, however, there does not seem to be any formal political-economy model that explains how such a self-disciplinary device could be introduced and maintained by collective decision-making.

Two further arguments for mandatory systems are related to limitations in financial markets. First, the market for annuities is rather undeveloped, due, for instance, to adverse selection. Second, a pay-as-you-go system introduces a new type of "asset", a pension claim whose yield is tied to the growth in the country's tax base, and this provides an opportunity for better portfolio diversification. This observation serves as a rationale for having at least some pay-as-you-go component in a country's mandatory pension system.

Moreover, there are distributional arguments for a pay-as-you-go system, based on the well-known fact that the introduction (and expansion) of such a system is a gift to the first cohorts, paid for by subsequent cohorts in the form of an implicit tax on labor earnings. One argument simply assumes that a majority of self-interested voters in a country will opt for a pay-as-you-go system, thereby giving a gift to itself. It may then be asked why subsequent generations (who will pay for the gift) later on continue to support the system; this issue has been discussed by Thomas F. Cooley and Jorge Soares (1999). One conceivable explanation is that workers of generation t fear discontinuing to finance the retirees of generation $t-1$ since they would then expect generation $t+1$ to do the same to them in the future; this would harm cohorts that have already paid mandatory contributions for a number of years. Another distributional argument for the introduction of a pay-as-you-go system that provides a gift to the first generation is altruistic. As the general standard of living in society at large increased dramatically during the 20th century, it could be argued that many of the elderly, who had very low incomes during a large part of their lives, were entitled to share the increased living standard of active workers. A pay-as-you-go system turned

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microeconomic foundations of such functions are discussed in Maria Saez-Marti and Jörgen Weibull (2002).

out to be a simple way of achieving this. Let us look at these issues of intergenerational redistribution more closely.

3.2 Budget Sets with a Pay-As-You-Go System

While the first generation in a mandatory pay-as-you-go system receives a gift, the nature and size of the implicit tax on subsequent generations depend on the rate of return on their contributions. In a non-actuarial, fully funded system, the rate of return for the average individual is equal to the market rate of interest, while the marginal rate of return to any specific individual is zero. In an actuarially fair, fully funded system, by contrast, both the average and the marginal returns are equal to the interest rate.

To clarify the rates of return in pay-as-you-go systems, we use a simple two-period overlapping generations model where the representative individual in generation t works during the first period of life, with a wage rate w_t and labor supply ℓ_t. He faces a contribution rate τ_t to the pension system, and he receives a pension benefit b_t in the second period of life. The return on his contribution is then given by $1 + return = b_t / (\tau_t w_t \ell_t)$. Letting n_t denote the number of individuals in generation t, a balanced pension budget requires $n_t b_t = \tau_{t+1} n_{t+1} w_{t+1} \ell_{t+1}$. Substituting b_t from the budget balance equation into the expression for the individual's rate of return yields

$$1 + return = \frac{\tau_{t+1}}{\tau_t} \frac{n_{t+1} w_{t+1} \ell_{t+1}}{n_t w_t \ell_t} \equiv \frac{\tau_{t+1}}{\tau_t}(1 + G_{t+1}) \,,$$

where G_{t+1} denotes the growth rate of the aggregate wage sum. If the contribution rate is constant across generations, the rate of return is clearly G_{t+1} – a result first derived by Paul A. Samuelson (1958). In most of this paper, we study situations where τ and G are constant across generations, which means that the subscripts of these variables may be suppressed. Since we want to compare different pension systems of the same size, in the case of non-actuarial systems with exogenous benefits $\bar{b}$ we also assume that the benefit level is raised over time so that the system constitutes an unchanged fraction of the national economy. Under these conditions, the average rate of return in

any pay-as-you-go system is G. In a quasi-actuarial system, both the average and the marginal returns to the individual are G, while in a completely non-actuarial system, the marginal return is zero.[10]

We can now derive the budget constraints of the individual. As before, we use subscripts to denote the generation, while superscripts now denote the period of life (1 or 2) of the individual. For instance, c_t^1 and c_t^2 refer to consumption in period 1 and period 2, respectively, of an individual belonging to generation t. For simplicity, and without much loss of generality, the individual is assumed to have no labor income in the second period of life. We also follow the convention in the literature of abstracting from the possibility that the individual has initial wealth in the first period in addition to labor earnings. In principle, nothing would change if this assumption were dropped. For brevity, we write the individual's earnings $y_t \equiv w_t \ell_t$.[11] Letting R denote the real rate of interest, the budget set of an individual in any pension system can be written

$$c_t^2 = \left(y_t(1-\tau) - c_t^1 \right)(1+R) + b_t, \tag{1}$$

where b_t is the individual's pension benefit. If the system is completely non-actuarial, hence if $b_t = \bar{b}_t$, the effective marginal tax rate on labor is τ. If, on the other hand, the system is quasi-actuarial, we have $b_t = (1+G)\tau y_t$, where G denotes the rate of change in the tax base $n_t y_t$ (n_t, as before, denoting the number of individuals in generation t). Substituting this into (1) and rearranging, we obtain[12]

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[10] If G and τ change over time, the implicit return will differ from G_{t+1}. For instance, in a defined-benefit system where benefits are proportional to the individual's previous earning, the return is the growth rate in the previous period, G_t. In a system with lump-sum benefits that do not change over time (i.e., where the pension system becomes a smaller and smaller fraction of a growing economy), the rate of return will be equal to the growth rate of the labor force in the previous period, $n_t / n_{t-1} - 1$. See John Hassler and Assar Lindbeck (1997, p. 5).

[11] The consequences of including traditional income taxes on labor and capital are discussed in Section 4.2. For the time being, we assume that there are no such taxes.

[12] If, instead, the system were actuarially fair and fully funded, substituting $b_t = (1+R)\tau y_t$ into (1) would yield the budget constraint $c_t^2 = (y_t - c_t^1)(1+R)$, which is the same budget constraint as if there were no pension system at all. In this sense, an actuarially fair, fully funded system is equivalent to no system whatsoever. This conclusion presumes that the individual is at an internal optimum; corner solutions are considered later.

$$c_t^2 = \left[y_t \left(1 - \tau \frac{R-G}{1+R} \right) - c_t^1 \right](1+R) . \tag{2}$$

We see from (2) that a quasi-actuarial pay-as-you-go system implies an effective tax rate (average and marginal) on labor equal to $\tau(R-G)/(1+R)$. Clearly, this marginal tax rate is smaller than the marginal rate, τ, in a completely non-actuarial system. Although the *marginal* tax wedges on labor differ between a non-actuarial and a quasi-actuarial pay-as-you-go system, the *average* tax rate is the same, namely $\tau(R-G)/(1+R)$. This observation is simply a mirror image of the fact that the average return is the same, namely G, in all generic pay-as-you-go pension systems. We also note that regardless of the degree of actuarial fairness, a pay-as-you-go system does not introduce any tax wedge on saving;[13] the individual can still save with the return R. This holds both when R is unaffected by the pension system (for example, in a small open economy) and when R is influenced by the system.

Table 1 summarizes how the intergenerational distribution of income depends on the relation between R and G. Gains are indicated by a plus and losses by a minus sign.

Table 1: Intergenerational redistributions
from introducing a pay-as-you-go system.

	$R > G$	$R = G$	$R < G$
Generation 1	+	+	+
Later generations	–	0	+

If $R > G$, which currently is regarded as the normal situation (with a capital stock below the golden rule level), the first generation gains at the expense of subsequent

generations. In the golden rule case, by contrast, where $R = G$, the gift to generation 1 does not have to be paid by any subsequent generations. Disregarding the special difficulties of evaluating the welfare effects of an enforced change in the time profile of consumption of liquidity-constrained individuals, the gift to generation 1 thus constitutes a free lunch. As for the dynamically inefficient case where $R < G$, not only does generation 1 get a free lunch, so do subsequent generations as well.

The individual's budget set is not fully described by equation (1). It is reasonable to assume that an individual cannot borrow with his pension claims as collateral. Since we have assumed that the individual has no labor income in period 2, the following inequality must then also hold:

$$c_t^1 \leq y_t (1 - \tau). \tag{1'}$$

That is, the individual's first-period consumption cannot be larger than his first-period disposable income. We refer to an individual for whom (1') is binding as *liquidity-constrained*. Such an individual's behavioral responses to policy changes differ from those of individuals who are non-constrained. Somewhat paradoxically, most studies of pension systems do not explicitly consider liquidity-constrained individuals, in spite of the fact that the systems were originally introduced partly in order to influence the behavior of such individuals (myopic as well as free riders).

3.3 Does Aggregate Income Change When Introducing a Pay-as-you-go System?
Clearly, when $R \leq G$, there is an aggregate income gain, since no generation loses. Hence, when looking at aggregate outcomes, the only analytically interesting case is when $R > G$. To begin with, we assume that labor supply and factor prices are exogenous. It is then straightforward to show that the answer to the question in the headline is "No" (provided the market interest rate, the marginal product of capital and the intergenerational discount rate coincide; see below).

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[13] This holds for a generic pay-as-you-go system. Qualification may be required when considering various institutional features in real-world systems. For example, if benefits are means-tested, with benefits falling by the amount of an individual's wealth holding, there will be a distortion of saving.

We first note that each generation's aggregate pension benefits are equal to the next generation's aggregate contributions:

$$n_t b_t = \tau n_{t+1} y_{t+1}.$$ (3)

This, in fact, is the very definition of a pay-as-you-go system. But it is also possible to write equation (3) as

$$n_t b_t = \sum_{s=t+1}^{\infty} \tau \frac{R-G}{1+R} n_s y_s \frac{1}{(1+R)^{s-t-1}}.$$ (4)

Equation (4) simply says that each generation's benefits are also equal to the capital value of the *net* tax payments of all subsequent generations, the effective tax rate being $\tau(R-G)/(1+R)$.[14]

Since this also holds for the special case where $t = 1$, the introduction of a pay-as-you-go system is a "wash" for all generations taken together, as long as we abstract from behavioral adjustment: the gift to the first generation is exactly equal to the capital value of the losses of future generations. In our simple two-period overlapping generations model with inelastic labor supply and an exogenous R, there are neither aggregate income gains nor aggregate income losses to society from introducing a pay-as-you-go system. This amounts to pure redistribution, where one generation's income gains are exactly matched by other generations' income losses. This is a familiar conclusion in the social security literature; see, for instance, Feldstein and Liebman (2002). Indeed, it is an application of well-known equivalence theorems in public finance (Kotlikoff 2002, section III).

Note that this result is independent of the relative size of R and G. This may seem counterintuitive since the loss to future generations depends on the difference $R - G$.

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[14] To show that (4) is equivalent to (3), we substitute $n_s y_s = n_t y_t (1+G)^{s-t}$ into (4) and obtain

$$n_t b_t = \sum_{s=t+1}^{\infty} \tau(R-G) n_t y_t \left(\frac{1+G}{1+R} \right)^{s-t}.$$

A larger difference between R and G might therefore be expected to make the introduction of a pay-as-you-go system less favorable. But the algebraic exercise above shows that this conjecture is false. The economic intuition is straightforward: with a higher interest rate, the discount rate increases in the same proportion. Thus, the higher opportunity cost to the individual associated with a pay-as-you-go system when R increases is simply "discounted away" when we calculate capital values.[15] Consequently, our conclusion about the "wash" also holds when R and G change endogenously, due to general equilibrium effects, as long as there are no behavioral distortions; this point has also been made by Kotlikoff (2002, section III). Of course, if the marginal product of capital is higher than the market interest rate, and if capital formation declines as a result of the pay-as-you-go system, there may be an economic loss to society – a point made by Feldstein and Liebman (2002). (The reasons why the market interest rate and the marginal product of capital may differ are discussed in subsection 5.4.)

So far, we have used the market interest rate R for discounting income among generations. This seems reasonable enough if we are interested in potential Pareto improvements, since the changes in aggregate capital values then are crucial. But we should not confine ourselves to Pareto-sanctioned policy changes. Consequently, it is far from self-evident that the market interest rate R should be used as the *intergenerational* discount rate D.[16] For example, if $D < R$, the gift to the first generation is clearly worth less than the aggregate costs to all subsequent generations. Instead of being a "wash", the introduction of a pay-as-you-go system now results in an aggregate income loss to all generations taken together. But if $D < R$ actually represents society's distributional preferences, it is difficult to explain why a pay-as-

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Carrying out the summation to infinity, and rearranging, the right-hand side simplifies to $\tau n_t y_t (1 + G)$. This is equal to the right-hand side of (3); thus (3) and (4) are equivalent.

[15] Another issue is whether R should be interpreted as the interest rate before or after capital income tax, when such a tax exists. If we are interested in microeconomic incentives, it is obvious that R should be the after-tax interest rate. A different situation arisis when calculating capital values of gains and losses, as in (4). As pointed out by Feldstein and Liebman (2002), R should then be interpreted as the interest rate before capital income taxes. The reason is that the representative individual gets back the capital-tax payments via government spending in one form or another. Thus, even in the presence of capital income taxation, equation (4) holds: the gift to generation 1 is exactly equal to the capital value of the costs imposed on all subsequent generations.

[16] This point has been made forcefully by Thomas C. Schelling (1995), who argues that a subjective discount rate should be used instead, thereby reflecting preferences associated with the intergenerational distribution of income.

you-go system, with a gift to the first generation, was introduced in the first place. Hence, it may be more natural to assume that at least those who initially decided to introduce a pay-as-you-go system (rather than a mandatory funded system) held the view that $D > R$. With such redistributional preferences, the introduction of a pay-as-you-go system would constitute an aggregate gain in terms of subjectively discounted income streams. This point is merely a reformulation of the earlier mentioned justification for introducing a pay-as-you-go system, namely to favor the first generation.

3.4 Consequences for Labor Supply and Saving

The behavioral effects of introducing a pay-as-you-go pension system are related to two features of that system: the lump-sum gift to the first generation and the effective tax $\tau(R-G)/(1+R)$ on the labor supply of all subsequent generations. Assuming that the introduction of a pay-as-you-go system has already been announced during the working life of the first generation (those who receive a gift), and that leisure is a normal good, there will be an unambiguous reduction in labor supply of that generation. Clearly, this effect is not caused by any distortions to the behavior of generation 1; it is a pure income effect. Shrinkage of the budget sets for subsequent generations, by contrast, implies counteracting income and substitution effects. Thus the net effect on the labor supply of subsequent generations is probably rather modest. But it is unavoidable that the substitution effects will distort the labor supply, regardless of whether it falls, rises or remains constant. After all, the distortion is tied to the substitution effect. This distortion is, of course, larger in a completely non-actuarial system, where the marginal tax wedge is τ, than in a quasi-actuarial system, where it is $\tau(R-G)/(1+R)$.

The effects on aggregate saving during the lifetime of the first generation are straightforward in the context of a simple life-cycle model. Sticking to the assumption that the pay-as-you-go system has been announced during that generation's working life, and provided that not only leisure but also consumption is a normal good, the representative individual of that generation will increase his consumption in both periods. This holds both for liquidity-constrained and non-constrained individuals.

Thus, aggregate saving falls during the working life of generation 1, again reflecting a pure income effect, due to the lump-sum gift to that generation.[17]

There are, however, some qualifications to this simple view, even if we disregard the issue of liquidity-constrained individuals. It is well known that if Ricardian equivalence holds (Robert J. Barro, 1978), there will be no effect at all on aggregate saving. It is, however, equally well known that Ricardian equivalence relies on rather unrealistic assumptions, i.e., that there are no liquidity-constrained individuals, that all individuals have children, and that taxes are not distortionary. Another qualification is that the negative effect on labor supply will not only reduce hours of work, but also result in earlier retirement. This will modify the conclusion above of negative effects on saving, since the individual is then induced to save more during his active years to finance a longer retirement period; this is Feldstein's (1974) "induced retirement effect".

These considerations abstract from general equilibrium effects on factor prices. In qualitative terms, they are straightforward. An induced fall in aggregate saving reduces the capital stock over time, which tends to lower real wages and to raise real interest rates (except in an economy with a linear production technology or a small economy with internationally integrated capital markets); see Olivier Jean Blanchard and Stanley Fischer (1989, Chapter 3). The fall in real wages tends to reduce both consumption and saving, and perhaps also labor supply, while the rise in interest rates tends to reduce real investment. In this sense, a pay-as-you-go system "crowds out" real investment also via general equilibrium effects, in the same way as government debt does.

Thus, theoretical considerations are not sufficient to make unambiguous predictions about the effects on aggregate saving of introducing a pay-as-you-go system. Most empirical studies in the US conclude, however, that the introduction resulted in a substantial drop in private saving and the capital stock. Feldstein (1974, 1996b) estimates the fall in private saving at about 60 percent. According to a general

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[17] The effects on aggregate saving in the future are somewhat more complex and depend on the composition of the population in terms of liquidity-constrained and non-constrained individuals.

equilibrium simulation study by Auerbach and Kotlikoff (1987, Table 10.1), the introduction of the US social security system led to a decline in the capital stock after twenty years by around 20 percent, and to a fall in real wages by about 5 percent. While welfare, measured as wealth equivalents, increased by about half a percentage point for the favored generations, it fell by 4–5 percent for more distant generations. In similar studies for Germany, Bernd Raffelhüschen (1993) arrived at more or less the same results; for references to other simulation studies, see Georg Hirte and Reinhard Weber (1997). It should be noted, however, that none of these studies of welfare effects distinguishes explicitly between liquidity-constrained and non-constrained individuals. Moreover, the calculations do not include the potential welfare gains for society at large of having a mandatory pay-as-you-go pension system in the first place.

4. Making the System More Actuarial: A Move from I to II

Most countries contemplating pension reform today start from systems in the neighborhood of position I in figure 1. Some countries limit their ambitions to marginal (parametric) reforms by either reducing benefits or raising contribution rates, without changing the basic rules of the system. Other countries change the benefit rules in an actuarial direction, while maintaining a pay-as-you-go system; for instance, in a country where the pension has been based on the best five years of an individual's working life, it may now be based on the best 10 or 15 years. Such a change can be characterized as a horizontal move to the right in figure 1. Still other countries undertake systemic reforms of their pay-as-you-go systems, by a radical shift from a position close to I to a position close to II, with individual, so-called notional accounts of pension claims. In the generic case, these accounts are credited with an annual return equal to G, and the pay-as-you-go system thus mimics a fully funded system – although with a lower rate of return. James Buchanan (1968) seems to have been the first to propose such a system. While the main rationale for introducing a system of this type is to improve the economic efficiency and financial stability of the pension system, it may also have important consequences for the distribution of income.

4.1 Efficiency

We saw in Section 3.2 that while the marginal tax wedge on labor is τ in a non-actuarial system, it is $\tau(R-G)/(1+R) \equiv \tau\left[1-(1+G)/(1+R)\right]$ in a quasi-actuarial system. Shifting from position I to position II in figure 1 thus reduces the marginal tax wedge on labor by $\tau(1+G)/(1+R)$. Is this change large or small?

When answering this question, it should be noted that the growth rate and the interest rate in these expressions refer to entire life spans rather than to single years. A numerical example illustrates the magnitudes involved.[18] Assume that an individual starts to work at age 20, retires at 64 and lives for another twenty years. On average, he may be said to pay his contribution at age 42 and receive his pension at age 74. Thus, the value of the contribution grows for 32 years.

The tax wedge may now be written $\tau\left[1-(1+G_1)^{32}/(1+R_1)^{32}\right]$, where R_1 is the yearly interest rate. For instance, if $\tau = 0.2$, $G_1 = 0.02$ and $R_1 = 0.04$, a move from a non-actuarial to a quasi-actuarial pay-as-you-go system reduces the tax wedge by 10.8 percentage points, from 20 to 9.2 percent. Since the tax distortion is proportional to the square of the tax rate, the reduction in the distortion is larger, the higher is τ. A reduction in the effective tax rate from 20 to 9.2 percent could thus result in a sizeable efficiency gain.[19] This assumes, of course, that individuals actually perceive the reduction in the tax wedge, which may not be the case for those who are myopic in the traditional sense of the term.

Although such a reform creates a positive substitution effect on labor supply, there is no counteracting income effect for the representative individual, since the average tax rate is unchanged. Thus labor supply will increase as a result of the reform, and labor earnings rise (provided real wages do not fall much as a consequence). Hence, aggregate saving is also likely to increase (out of higher labor earnings), resulting in a gradual rise in the capital stock, in spite of the fact that the reform has no direct effect

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[18]This discussion was inspired by conversations with Martin Feldstein and Laurence Kotlikoff.

[19] The more similar G_1 and R_1, the larger the reduction in the tax wedge. For example, if $G_1 = 0.02$ and $R_1 = 0.03$, most of the tax wedge will be removed; it is reduced by 14.6 percentage points (from 20 to 5.4 percent).

on saving. Except in the case of a linear production technology or a small, open economy, interest rates would fall and real wages rise. The fall in interest rates, in turn, would accentuate the reduction in the marginal tax wedge, since $\tau(R-G)/(1+R)$ will fall as R goes down.

The reduction in the tax wedge cannot be evaluated realistically without considering the level of other taxes in the economy. Ideally, effects of the tax implicit in a pension system should be analyzed within the framework of optimal taxation. If there are taxes on capital income but not on labor earnings and pensions, the implicit tax rate imposed on labor by a quasi-actuarial pay-as-you-go system would be smaller than the previously derived rate $\tau(R-G)/(1+R)$. The opportunity cost of being forced to save at the low return G, rather than R, is lower when there is a tax on capital income. By contrast, if there is a tax on labor income but not on capital income, the effective tax wedge is obviously larger than $\tau(R-G)/(1+R)$. If there are taxes on both labor and capital income, the size of the tax wedge depends on the relation between these tax rates.[20] In the remainder of our theoretical discussion, we abstract from such taxes in order to concentrate on factors related to the pension system itself. Needless to say, numerical simulations should include all types of taxes.

Obviously, a reduction in the marginal tax wedge affects aggregate labor supply not only through an increase in hours of work but also through later retirement. The importance of the latter labor-supply aspect is indicated by the fact that while the statutory retirement age in the EU countries is usually 65, the actual retirement age is 58-59 years in many countries, and the average employment rate for the age group 55-64 is as low as 38 percent.[21] These figures are probably mainly the result of

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[20] If there is a tax t_ℓ on labor and a tax t_R on capital, it is easy to show that the effective tax rate on labor is

$$\tau \frac{R(1-t_R)-G}{1+R(1-t_R)}+t_\ell\left(1+\tau\frac{1+G}{1+R(1-t_R)}\right).$$ Assume $t_\ell=0$. Then, even if $R>G$, it may well happen that

$R(1-t_R)$ is close to G, which would mean that a quasi-actuarial pay-as-you-go system does not impose a marginal tax wedge on labor.

[21] European Commission (2001, pp. 175-177). In a cross-country study, Gruber and Wise (1999b, pp. 28.35) have found a positive correlation between the average implicit tax rate and the degree of early retirement. Tryggvi Thor Herbertsson and Michael Orzag (2001, p.10) report that the cost in terms of reduced GDP due to early retirement amounts to more than 10 percent of GDP for several countries; the OECD average hovers around 6 percent.

institutional features in the pension system, namely heavy subsidies of early retirement, often implying that the capital value of future pensions cannot be raised by working longer. (Jonathan Gruber and David A. Wise 1999a and 2002, and Axel Börsch-Supan and Joachim K. Winter 2001). The entire contribution rate is then, in fact, a tax. Thus, making a system quasi-actuarial also requires the removal of subsidies to early retirement and the closure of various "pathways" to retirement (such as generous rules for long-term unemployment, long-term sick leave, and disability pension for elderly workers). The quantitative importance of raising the effective retirement age may be substantial. A simulation study by the European Commission (2001, Table 8, p. 199) concludes that if the effective retirement age could be increased to 65, GDP per capita in 2050 would be 13 percent higher than otherwise. As a consequence, the consumption of the working-age population and of pensioners would increase by 11 and 16 percent, respectively.

A shift to a quasi-actuarial pension system will not only reduce the marginal tax wedge, it will also make the system more transparent because an individual's pension wealth would be continuously recorded in his notional account and reported to him. When considering his retirement decision, the individual can clearly see that remaining in the labor force for another year would increase his future yearly pension benefits in three ways (John B. Williamson 2001, p. 21): first, by including another year's return on the notional assets already in his account; second, by adding yet another year's contribution to the account; and third, by basing the pension benefit on fewer years of projected life expectancy at the time of retirement.

But even if all subsidies to early retirement were removed, and the system became completely quasi-actuarial, the implicit tax wedge would still vary over the life cycle. It will be higher in early than in late working life.[22] Forced saving at a yield lower

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[22] This can be illustrated in the three-period case. Using the same notations as before, we can write the individual's budget constraint

$$c_t^1 + \frac{1}{1+R}c_t^2 + \frac{1}{(1+R)^2}c_t^3 = y_t^1(1-\tau) + \frac{1}{1+R}y_t^2(1-\tau) + b_t^3\frac{1}{(1+R)^2},$$

where the benefit is $b_t^3 = \tau y_t^1(1+G)^2 + \tau y_t^2(1+G)$. Substituting this into the budget constraint and rearranging, we obtain

than R is more costly early in life, since contributions are then locked in at a low yield over a longer period. Thus, even with a rather strong link between contributions and benefits, such as in the case of a quasi-actuarial pay-as-you-go system, intertemporal substitution of labor supply will still be prevalent, with incentives to work less when young and more when old. In an optimal-taxation framework, there is perhaps an argument for letting the contribution rate τ increase with age in a quasi-actuarial system, in order to bring about tax smoothing over the life cycle.

Any efficiency gains from reducing the tax wedge on labor have to be compared to consequences for other dimensions, such as income distribution and income insurance. We now turn to the redistribution issue, while the insurance aspect is dealt with in Section 6.

4.2 Distributional Aspects

When shifting from non-actuarial to generic quasi-actuarial benefit rules, it becomes more difficult to use the pension system for redistribution within generations. But when comparing such a system to a non-actuarial system, it should be kept in mind that institutional features, such as tying pensions to the best x or last y years, make today's non-actuarial systems less progressive than is usually presumed. Such rules tend to favor those with a steep lifetime income profile. Since they are often high-income earners in a lifetime perspective, the rules frequently imply redistribution from low-income to high-income earners. Indeed, a number of empirical studies indicate that real-world non-actuarial systems are sometimes hardly progressive at all.[23] Moreover, most non-actuarial systems result in redistribution between genders. In some countries, women (who usually work fewer years than men) tend to be favored by such systems for the same reason as high-income earners are. Bluntly

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$$c_t^1 + \frac{1}{1+R}c_t^2 + \frac{1}{(1+R)^2}c_t^3 = y_t^1\left[1-\tau\left(1-\left(\frac{1+G}{1+R}\right)^2\right)\right] + \frac{1}{1+R}y_t^2\left[1-\tau\left(1-\frac{1+G}{1+R}\right)\right].$$

The effective tax wedge on period 2 labor supply is now $\tau\left(1-(1+G)/(1+R)\right) \equiv \tau(R-G)/(1+R)$, just as in the two-period case analyzed above. The tax wedge on period 1 labor, however, is $\tau\left(1-(1+G)^2/(1+R)^2\right)$, which is higher than the period 2 wedge if $R>G$.

[23] See, for example, Liebman (2001) and Julia Lynn Coronado, Don Fullerton and Thomas Glass (2000) on such aspects for the US, and Ann-Charlotte Stahlberg (1990) for the Swedish pension system.

formulated, in such countries, non-actuarial systems redistribute income from poorly educated men to highly educated women. This redistribution tends to disappear if the system is made more actuarial. In fact, a shift to a quasi-actuarial system may not be as regressive as expected when only generic systems are considered.

In reality, many of the new quasi-actuarial systems also allow pension rights for activities outside the labor market. The most common examples are parents who stay home to take care of young children, individuals in higher education, in military service, or those living on unemployment or disability benefits. Formally, some actuarial properties of the pension system are retained, but the government pays additional money from the general budget to the pension system, crediting the notional accounts of these individuals. Moreover, in Section 7, we discuss how new quasi-actuarial systems are often combined with a basic, or guaranteed, pension in order to eliminate poverty among the elderly. As a result, it could well be that dominating distributional objectives *within* generations may, in fact, be more accurately achieved by shifting to a quasi-actuarial system, if it is supplemented by a basic or guaranteed pension. Then, of course, the implicit tax in the overall pension system will be larger than $\tau(R-G)/(1+R)$, and the efficiency gain correspondingly mitigated.

What happens to the distribution of income *among* generations? Since the return to the average individual is the same in non-actuarial and quasi-actuarial systems, a shift from one system to the other does not have any direct effects on the intergenerational distribution of income. General equilibrium effects may, of course, modify this conclusion. If the reduction in the marginal tax wedge results in higher earnings due to increased labor supply (including higher retirement age), saving is boosted indirectly. The aggregate capital stock would then be expected rise, thereby increasing the welfare of future generations of workers via higher real wages.

4.3 Financial Stability

A pension system is regarded as financially stable if the capital value of expected pension payments is equal to the capital value of the revenues to the system from

contributions.[24] The reason why issues of financial stability are problematic is that attempts to guarantee stability have consequences for income distribution and economic efficiency. If such consequences could be disregarded, shocks to productivity growth and demography would not threaten the financial stability of the system, in the sense that stability could be achieved simply by changes in contribution rates (in a defined benefit system) and in benefits (in a defined contribution system).

It is often claimed that a quasi-actuarial pension system (sometimes called a "notional defined-contribution" system) is more financially stable than a non-actuarial system. One conceivable justification for this view is that such a system mimics a fully funded system in certain respects. More specifically, a quasi-actuarial system may be equipped with property rights similar to those of a fully funded system. In an actuarially fair, fully funded system, the pension is based on the return on the individual's own contributions, and pension claims are regularly reported as an individually owned financial asset. Analogously, in a quasi-actuarial system with individual (so-called "notional") accounts, the pension is also based on the individual's own accumulated contributions – although as a rule the rate of return differs from the market rate of interest. In neither of these systems is the individual guaranteed a specific rate of return. The rate of return is, however, determined by simple and transparent rules: by the market interest rate in an actuarially fair system, and by the growth rate in the tax base in a quasi-actuarial system. The argument that a quasi-actuarial system is more stable than a non-actuarial one then seems to rest on the notion that the public is more likely to accept changes in pensions that are determined by such rules than by *ad hoc* government intervention.

The Samuelson (1958) rule, whereby financial stability is achieved in a pay-as-you-go system if the government provides a rate of return equal to the growth rate in the tax base, seems simple and transparent enough. It was originally developed in the context of a two-period overlapping generations model, where it holds regardless of whether the variations in G are due to demographic factors (n_t), to changes in hours of work of the representative individual (ℓ_t), or to changes in the representative individual's

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[24] This should hold in the aggregate. For actuarial fairness, it should also hold for the individual.

real wage (w_t).[25] In a multi-period overlapping generations context, however, such a rule may not balance the pension budget in each period (where a period refers to a generation's working life).

Let us look at a three-period overlapping generations model.[26] As before, subscripts denote the generation, and superscripts the period of life (1, 2 or 3) of the representative individual in a generation. For instance, $n_{t-1} w_{t-1}^2 \ell_{t-1}^2 \equiv n_{t-1} y_{t-1}^2 \equiv Y_{t-1}^2$ is aggregate labor income of generation $t-1$ in its second period of life.

Assume first that the aggregate wage sum grows at the steady-state rate G. At time t, a permanent technological shock occurs in the productivity level, which favors the skills of elderly workers and simultaneously renders young workers less attractive on the labor market than before. In other words, we examine a case where experience gains in importance. More specifically, suppose that income in period 1 is $Y_s^1(1-\mu)$ for generation $s \geq t+1$, and that income in period 2 is $Y_s^2(1+\mu)$ for generation $s \geq t$. (Thus, Y_s^i denotes the hypothetical income if the shock had not occurred, and is assumed to grow at the rate G.) The growth rate in the aggregate wage sum between periods t and $t+1$ is then given by

$$\frac{Y_{t+1}^1(1-\mu) + Y_t^2(1+\mu)}{Y_t^1 + Y_{t-1}^2} \equiv 1 + G^*,$$

while the growth rate in all other periods is equal to the old steady-state rate G. For this particular type of shock, the system will run a deficit if the government actually

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[25] While several of the countries that have recently implemented quasi-actuarial systems have promised the participants a rate of return on their notional accounts equal to G (i.e., the rate of growth in $n\ell w$), other countries have promised another rate of return. For example, the notional accounts in the new Swedish system guarantee a rate of return equal to the average wage rate, w. This implies that a source of instability has been built into the system in the event of changes in n or ℓ, which will be dealt with by an *ad hoc* "break mechanism" when financial instability threatens.

[26] This issue was called to our attention by Ole Settergren; see Salvador Valdés-Prieto (2000) for a more general analysis of this issue.

provides a rate of return equal to G^* on the notional accounts in period t, and G in all other periods.[27]

Other types of shocks, however, may be consistent with financial stability, even in the multiperiod case. One example is when a productivity shock is confined to young workers. It is often argued that the IT revolution implies such a shock, to which the pension system under consideration would be robust.

The main point of these simple examples is that the short-term stability properties of a specific pension system in the real world cannot always be properly evaluated within the context of a two-period overlapping generations model. For certain types of shocks, a multi-period model is a more appropriate analytical tool, and calls for a quantitative simulation model, in which the stochastic process underlying the disturbances is carefully specified. From a policy point of view, the simple rule of providing a rate of return on notional accounts equal to each period's growth rate does not necessarily guarantee financial stability in the short run. (It should then be noted, however, that "short run" in this case refers to the lifetime of a generation.) This means that in some cases the government may be forced to violate the simple "Samuelson rule" in order to achieve financial stability.

4.4 Overall Assessment

A shift from a completely non-actuarial pension system (of defined benefit type) to a quasi-actuarial system (of defined contribution type) tends to increase efficiency in the labor market. Moreover, the possibilities to redistribute income within generations disappears in principle. But this problem may not be very serious in reality, because many high-income groups in existing non-actuarial systems have special advantages

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[27] To show this, we denote the two rates of return received by generation t during its two active periods by x_t^1 and x_t^2, respectively, and write the condition for budget balance

$\tau Y_t^1 (1+x_t^1)(1+x_t^2) + \tau Y_t^2 (1+\mu)(1+x_t^2) = \tau Y_{t+2}^1 (1-\mu) + \tau Y_{t+1}^2 (1+\mu)$. Substituting $Y_t^1 (1+G)^2$ for Y_{t+2}^1 and $Y_t^2 (1+G)$ for Y_{t+1}^2, one sees immediately that this equation is satisfied for $x_t^1 = x_t^2 = G$ if $\mu = 0$. It is easy to show that for $\mu > 0$, setting $x_t^2 = G$ implies that the other root must satisfy $(1+x_t^1) = (1+G)(1-\mu)$. Comparing this condition to the expression for $1+G^*$ in the text, it can be shown that for budget balance, x_t^1 must be smaller than G^* since the absolute value of $(Y_t^2 - Y_{t+1}^1)/(Y_{t-1}^2 + Y_t^1)$ clearly is smaller than unity.

and because quasi-actuarial systems can be combined with special features, including a basic pension or a guaranteed pension. Finally, it is likely that the financial stability of the system will be greater in a quasi-actuarial than in a non-actuarial system. The reason would be that in the former type of system, the individuals have only been promised a rate of return equal to the growth rate in the tax base, regardless of what the growth rate happens to be.

Another issue is whether a shift from a non-actuarial to a quasi-actuarial system can result in a Pareto improvement. This question may be formulated as a general question regarding the design of the tax/transfer system. Assume an affine tax function, defining disposable income as $y_{disp} = b + (1-t)w\ell$, where $b \geq 0$. Suppose we want to cut the tax rate t for efficiency reasons, and reduce the intercept b correspondingly, in order to maintain budget balance. Clearly, if all individuals are identical, everyone would gain if b were reduced to zero[28] – abstracting from income risk. This would also be the case if the income difference among individuals were sufficiently small, since low-income individuals would then gain more from removal of the tax distortion than they would lose from less redistribution. By continuity, this holds up to a certain size of the reduction in b. For a given value of pre-tax income inequality, b has to be kept above a certain minimum level so as not to harm low-income groups.

Let us now apply this general analysis of tax functions to our earlier discussion of pension reform. A generic non-actuarial pension system corresponds to the affine tax function above, with $b > 0$ and $t = \tau$. A quasi-actuarial pension system corresponds to the case $b = 0$ and $t = \tau(R-G)/(1+R)$. Thus, a shift from a non-actuarial to a quasi-actuarial pension system can be described simply as a shift from an affine to a linear tax function. Our analysis suggests that a partial shift to a quasi-actuarial system, supplemented by a basic pension $\bar{b}$, can result in a Pareto improvement if $\bar{b}$ is made large enough.

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[28] Whether t should be reduced all the way down to zero depends on whether the government has to finance other expenditures, too.

5. Shifting to a Funded System: A Move from II to IV

Three often-mentioned arguments for shifting to a funded system will be discussed below: i) the individual would receive a higher return on his mandatory saving; ii) aggregate national saving would increase; and iii) better risk diversification of pension claims could be achieved. The first two arguments are addressed in this section, and the third in Section 6. Two other arguments, both of which are conspicuous in the political discussion of pension reform, are not dealt with in this paper. One maintains that a shift to a funded system will contribute to a larger and more developed domestic capital market, thereby increasing efficiency in the allocation of real investment. This was a prominent argument in discussions of the shift to a mandatory, funded system in Chile in the 1980s. A more ideological argument is that a mandatory, funded system will make the entire population stakeholders in equities; this could heighten tolerance for private ownership and the profitability of firms.[29]

In a shift from a quasi-actuarial to an actuarially fair, fully funded system, an individual will experience two changes in his budget constraint: he will receive a market return on his mandatory savings (rather than a return equal to the growth rate in the tax base), and he may have to pay a new tax in order to honor the claims of the old pay-as-you-go pensioners. This new tax could, of course, be imposed on any tax base, such as income or consumption. For the time being, let us assume that the tax is applied to labor earnings only, in analogy with the contribution rate in the old pay-as-you-go system.[30]

Let $\hat{b}_T$ denote the post-reform per capita pension benefit actually granted to the representative individual in the last pay-as-you-go generation, generation T. The aggregate pension payment to that generation after the reform then is $n_T \hat{b}_T$. In the case

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[29] One special aspect of these two arguments has been emphasized by Andrew W. Abel (2001). He argues that if transaction costs are high in the stock market, pension funds with considerable economies of scale in such transactions will make the stock market accessible to small investors. The weight of this argument may have diminished in recent years, in the sense that cheap retail outlets for mutual funds are now available to everyone.

[30] In fact, the choice of tax base and the issue of compensating old pension claims are related. For instance, unlike a payroll tax, income taxes and consumption taxes also hit the old pay-as-you-go pensioners.

where all old pay-as-you-go claims are fully honored, $\hat{b}_T = b_T$, where b_T is the per capita pension originally promised to generation T under the old pay-as-you-go system. If, instead, the claims are not fully honored, generation T would make a loss $n_T b_T - n_T \hat{b}_T$.

Denoting the new tax rate of generation s by θ_s, the tax vector $\theta \equiv (\theta_{T+1}, \theta_{T+2}, \theta_{T+3}, ...)$ has to satisfy the budget constraint

$$n_T \hat{b}_T = \sum_{s=T+1}^{\infty} \theta_s n_s y_s \frac{1}{(1+R)^{s-T-1}} . \tag{6}$$

We start with a mechanical calculation of gains and losses for all generations, assuming labor supply to be exogenous (as in subsection 3.3 on the consequences of introducing pay-as-you-go system). Our next step is to take behavioral adjustments into account. Finally, we look at general equilibrium effects including the consequences for factor prices.

5.1 Does the Shift Give Rise to an Aggregate Income Gain?

Under the same conditions as in subsection 3.3 the answer is "No". This can be shown in a very compact way if we disregard behavioral adjustment among individuals. As a result of the reform, the representative individual in generation $s \geq T+1$ has to pay the new tax $\theta_s y_s$, in addition to the contribution $\tau^* y_s$, in his first period of life. We here use τ^* to denote the post-reform contribution rate, which may or may not be equal to the old contribution rate, τ. In his second period, instead of receiving a pay-as-you-go pension $\tau y_s (1+G)$, he now receives a funded pension $\tau^* y_s (1+R)$. The present discounted value (PDV) of the change in disposable income then is

$$PDV_s = \left(\tau \frac{R-G}{1+R} - \theta_s \right) y_s .$$

The reason why this capital value is independent of τ^* is that the new system is actuarially fair. The discounted sum over all generations from generation $T + 1$ is

$$\Sigma PDV = \sum_{s=T+1}^{\infty} \left[\tau \frac{R-G}{1+R} - \theta_s \right] n_s y_s \frac{1}{(1+R)^{s-T-1}} . \tag{7}$$

To evaluate ΣPDV, we rewrite the budget equation of the old pay-as-you-go system (4), with $t = T$, as

$$n_T b_T = \sum_{s=T+1}^{\infty} \tau \frac{R-G}{1+R} n_s y_s \frac{1}{(1+R)^{s-T-1}} . \tag{8}$$

Substituting the right-hand sides of (6) and (8) into (7), we obtain

$$n_T b_T - n_T \hat{b}_T = \Sigma PDV .$$

In other words, if the pay-as-you-go system is replaced by a fully funded system, and generation *T* is *not* completely compensated, the income loss to that generation would be exactly equal to the capital value of the income gains to all subsequent generations. If, instead, generation *T* is fully compensated (i.e., all claims are honored), the capital value of all future gains would be zero. Note that this conclusion holds regardless of the time profile of the new tax vector $(\theta_{T+1}, \theta_{T+2}, \theta_{T+3}...)$. A shift from a quasi-actuarial to an actuarially fair system will not result in a Pareto gain in terms of income. This conclusion, which has been reported by several authors,[31] is hardly surprising since all conceivable behavioral adjustments have so far been assumed away. Again, this holds regardless of the size of the difference *R – G.* The result is a mirror image of our earlier result (subsection 3.3) that when a pay-as-you-go system is introduced, the income gain to the privileged generation is exactly equal to the capital value of the income losses to all subsequent generations.

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[31] See, for instance, Nicholas Barr (2000), Feldstein (1995), Peter R. Orszag and Joseph E. Stiglitz (2001), Robert J. Shiller (1999), Hans-Werner Sinn (2000) and Diamond (2002).

5.2 Intergenerational Redistribution

While there is no aggregate income gain, and hence no Pareto improvement, some generations will lose and others gain from the reform depending on the time profile of the tax-rate sequence $(\theta_{T+1}, \theta_{T+2}, \theta_{T+3}...)$ and hence on the combination of tax financing and debt financing of the old pay-as-you-go claims. For simplicity, we assume that the θ vector is such that the old pay-as-you-go claims are fully honored; thus equation (6) holds with $\hat{b}_T = b_T$. Among such θ vectors, a useful benchmark case is that the government borrows exactly as much as is required to set θ_s equal to the implicit tax rate under the old pay-as-you-go system:

$$\theta_s = \bar{\theta} \equiv \tau \frac{R-G}{1+R}, \quad \forall s \geq T+1. \tag{9}$$

If, instead, $\theta_s > \bar{\theta}$ for small values of s, and $\theta_s < \bar{\theta}$ for large values of s, we call the θ vector *front-loaded*, since a relatively large tax burden is placed on the generations immediately after the removal of the pay-as-you-go system. In this case, there will be only a moderate build-up of government debt. In the extreme case with $\theta_{T+1} = \tau$ there will be no debt at all, since the first generation has to bear the entire burden of honoring the claims of the old pay-as-you-go pensioners; $\theta_s = 0$ for all $s \geq T+2$. Individuals in generation $T+1$ would pay just as much as before to the preceding generation, although now without receiving any pension benefit in return later on. In the context of pension reform, it is usually said that in this case, individuals in generation $T+1$ have to pay a "double contribution". Their total payment $\theta_{T+1} y_{T+1} + \tau^* y_{T+1}$ to the pension system then becomes $\tau y_{T+1} + \tau^* y_{T+1}$, which is equal to $2\tau y_{T+1}$ for the case where $\tau^* = \tau$. By contrast, the θ vector is *back-loaded* if $\theta_s < \bar{\theta}$ for small values of s, and $\theta_s > \bar{\theta}$ for large values of s. Such a vector means that considerable government debt will be built up, and a relatively large burden will be placed on future generations.

The concepts of front-loaded and back-loaded θ vectors are crucial when analyzing the consequences of pension reform for aggregate saving and labor market distortions. It is, however, also useful when studying the income gains and losses of different

generations when the intergenerational discount rate $D \neq R$. It is tempting to conjecture, as in Feldstein (1995) and Feldstein and Liebman (2002), that the discounted value of the income gains to all subsequent generations will be positive if a subjective discount rate $D < R$ is used.[32] The conjecture does not hold in general, however. Whether the discounted income sum is positive or negative also depends on the time profile of the θ vector. This can be shown as follows. With D rather than R as the intergenerational discount rate, equation (7) becomes

$$\Sigma WPDV = \sum_{s=T+1}^{\infty} \left[\tau \frac{R-G}{1+R} - \theta_s \right] n_s y_s \frac{1}{(1+D)^{s-T-1}}, \qquad (7')$$

expressing the welfare-weighted income sum with the discount factors $1/(1+D)^{s-T-1}$ as intergenerational weights. There are two cases where this expression is zero: the benchmark case when $\theta_s = \bar{\theta}$ (regardless of the relative sizes of D and R), and the case when $D = R$ (as shown in section 5.1, regardless of the shape of the θ vector). If the θ vector is front-loaded, and the subjective discount rate is smaller than the market rate, it follows that (7') is positive, and hence an aggregate income gain is brought about.[33]

5.3 Behavioral Adjustments: A Positive Analysis

Let us now allow for behavioral adjustment. Our starting point is the change in the budget constraint when shifting to a fully funded system. The new constraint is simply obtained by deducting the new tax payment $\theta_s y_s$ from equation (1) and setting $b_s = \tau y_s (1+R)$. This gives

$$c_s^2 = \left[y_s (1-\theta_s) - c_s^1 \right](1+R) \quad s \geq T+1, \qquad (10)$$

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[32] This would have been a parallel to our earlier result that the introduction of a PAYGO system reduces the aggregate capital value of income when $D < R$.

[33] The reason why Feldstein (1995) and Feldstein and Liebman (2002) obtain the result that a shift to a funded system increases the welfare-weighted income sum $\Sigma WPDV$ if $D < R$ is that front-loading is implicit in their analysis. They assume that the absolute per capita tax payment is constant across generations while the tax base is growing, which means that the tax rate θ_s falls over time.

There is one more case when $\Sigma WPDV > 0$, namely when $D > R$ and the θ vector is back-loaded. For all other configurations of (D, R) and the θ vector, the result of increased funding is either a wash or a loss.

$$c_s^1 \le y_s(1-\tau^* - \theta_s), \tag{10'}$$

where, as before, the last inequality reflects the assumption that borrowing with expected future pensions as collateral is not allowed. Here, τ^* denotes the contribution rate, and hence the size, of the funded system that replaces the pay-as-you-go system (where the contribution rate was τ).

First, we consider those who are not liquidity-constrained, i.e., individuals for whom inequality (10') is not binding. We see that the new contribution rate does not appear in their post-reform budget constraint (10). This reflects the fact that for a non-constrained individual, an actuarially fair system is equivalent to no system at all. All behavioral responses, therefore, depend solely on the new tax rate, θ_s. In the benchmark case, when $\theta_s = \bar{\theta} \equiv \tau(R-G)/(1+R)$, the individual's post-reform budget constraint (10) looks the same as the pre-reform constraint (2). Thus, in this special case, there are no effects on either labor supply or aggregate saving. Private saving of non-constrained individuals would increase, but the effects on aggregate national saving are fully offset by reduced government saving, since the benchmark tax vector $\bar{\theta}$ requires the government to borrow in order to finance the old pay-as-you-go claims. A shift from a quasi-actuarial pay-as-you-go system to a fully funded, actuarially fair system, where the old pay-as-you-go claims are financed by the benchmark θ vector, is equivalent to no reform at all. Abstracting from liquidity-constrained individuals, a shift to a fully funded system is not sufficient for aggregate saving to increase; we also need some assumptions about the shape of the θ vector.[34] It is, however, natural to expect that a front-loaded θ will reduce consumption of non-constrained individuals and hence increase national saving.[35]

There is an interesting trade-off between saving and distortions of labor supply. A front-loaded θ vector tends to increase aggregate saving by reducing the post-reform

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[34] Political economy considerations may modify this conclusion. For instance, Martin S. Feldstein and Andrew Samwick (2001) assume that the government may ultimately use a budget surplus for increased spending. In such a case, aggregate national saving may rise if a budget surplus is transferred to individual pension accounts.

[35] There is a complication here since labor supply may also change, which may lead to an increase in consumption due to higher earnings. We would expect this effect to be rather small, however, due to counteracting income and substitutions effects.

private consumption of early generations (provided consumption in both periods of life is a normal good), at the cost of a larger distortion of labor supply of these generations. Variations in the time profile of the θ vector thus redistribute both labor-market distortions and consumption across generations. The consequences for labor supply are likely to be modest for both early and late generations, since the income and substitution effects work in opposite directions. The increased saving, which could be substantial, applies only to those generations for which $\theta_s > \bar{\theta}$ (as long as liquidity-constrained individuals are disregarded). Later generations will increase their consumption and hence contribute to a reduction in aggregate saving.

For the liquidity-constrained individuals, behavioral responses are driven by the constraint (10'). This means that the degree of front-loading of the θ vector is not important *per se* for these individuals. Their consumption will fall if the post-reform constraint (10') is tighter, for given earnings, than the pre-reform constraint (1'), i.e., if $\tau^* + \theta_s > \tau$, which may well be the case for some cohorts even with a back-loaded θ vector.

There are thus two ways to augment aggregate saving in connection with a shift to a fully funded system. One method is to squeeze liquidity-constrained individuals in early generations by setting $\tau^* + \theta_s > \tau$. The other is to squeeze both liquidity-constrained and non-constrained individuals in early generations by a front-loaded θ vector.

This discussion relies on a simple life-cycle model. Several modifications of this model have been suggested in the literature on pension reform. If Ricardian equivalence applies, a front-loaded θ vector would have no effect on aggregate saving; altruistic parents would reduce their bequests by the same amount as the tax increase. Thus, to the extent there are "Ricardian" individuals, the increase in aggregate saving is mitigated. Another modification is Feldstein's (1974) "induced retirement effect". Since a front-loaded θ vector will stimulate earlier retirement, the fall in consumption is accentuated, hence also the rise in aggregate saving. In other words, "Ricardian" effects and induced retirement effects modify the conclusions of the life-cycle models in different directions when a pay-as-you-go system is replaced

by a fully funded system. Moreover, specific institutional arrangements in various countries affect labor supply and savings decisions. When studying pension reform in a specific country, it is therefore important to take explicit account of such arrangements; this is, in fact, usually attempted in numerical simulation models.

So far, this discussion of behavioral adjustments to a shift to a funded system has abstracted from general equilibrium effects. The effects on real wages and interest rates are straightforward. Except for the case of a back-loaded θ vector, aggregate saving will increase, and so will the capital stock. As a result, real wages will rise, and real interest rates will fall[36] – except for the extreme case of a linear production technology, or a small open economy for which interest rates are exogenously given by the world market. Thus the tendency for disposable income to decline as a result of a front-loaded θ vector will be counteracted by rising wages, which boost both private consumption and private saving. The fall in interest rates is usually assumed to reduce saving (although the effect is theoretically ambiguous). Of course, the quantitative importance of these general equilibrium effects cannot be assessed without numerical simulations; cf. subsection 5.5.

5.4 Behavioral Adjustments: A Normative Analysis

The result in subsection 5.2 that a shift to a fully funded system cannot give rise to an aggregate income gain, when we sum over all generations, relied on the assumption that there are no behavioral adjustments. Let us now look at the possibility of increasing economic efficiency, and of achieving a Pareto improvement, when such adjustments are taken into account. Of course, this could always be achieved if the old pension claims were financed by a lump-sum tax, rather than by a distortionary θ vector.[37] But since this is unrealistic, the basic problem of the transition would simply be assumed away.

Fenge (1995) addressed the Pareto question in a model without liquidity-constrained individuals. Formally, he assumed that the old pay-as-you-go system is retained, but

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[36] In theoretical general equilibrium analyses of pension reform, strongly simplifying assumptions are necessary to obtain manageable results. For instance, Diamond (1997) assumes exogenous labor supply in his general equilibrium analysis.

[37] This is the approach used by Stefan Homburg (1990) and Friedrich Breyer and Martin Straub (1993) to achieve a Pareto improvement when shifting from a pay-as-you-go to a fully funded system.

that an actuarially fair, fully funded system is added on top of it. Clearly, this cannot result in any Pareto improvement because, in this case, a fully funded actuarially fair system is equivalent to no system at all; this result has also been derived by Breyer (1989). At first glance, it may seem as if Fenge did not actually study a shift from a pay-as-you-go to a fully funded system, since he retains the pay-as-you-go system. But his experiment is, in fact, equivalent to abolishing the pay-as-you-go system and financing the transition by the benchmark vector $\bar{\theta}$. As we have seen, such a reform has no behavioral consequences for non-constrained individuals. Thus there is no possibility of Pareto improvement. [38]

Fenge's (1995) analysis was limited to what we have called the benchmark vector $\bar{\theta}$. Is there some other θ vector that could result in a Pareto improvement? In the analytically trivial case where the economy is located on the "wrong" side of the Laffer curve for at least one generation, this is of course possible. But then the tax rate should be reduced for that generation anyway, regardless of whether a pension reform is in the offing or not.

Taking general equilibrium effects into account, a lower tax rate for one generation may also lead to higher real wages for future generations, via higher saving from increased labor earnings. Disregarding the possibility of "Laffer effects", such a policy will create a temporary budget deficit. But higher wages for future generations would make it possible to raise higher tax revenue from these generations, thereby amortizing the government debt, without harming their welfare. Although this would constitute a Pareto improvement, such a policy should also be pursued independently of pension reform, since the income tax is obviously suboptimal to begin with.

But can a net gain to the national economy be achieved by mandatory pension saving? Moreover, can such a gain be distributed to all generations, so that a Pareto improvement is achieved? If the rate of return on capital were equal to the market interest rate, the gain in present-value terms from increasing the capital stock would obviously be zero. But Feldstein (1996a) and Feldstein and Liebman (2002) have

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[38] The same result has been derived formally in a somewhat different context by Kotlikoff (2002, Section III) and Antonio Rangel (1997). The result illustrates the earlier mentioned equivalence theorems in public finance; cf. Henning Bohn (1997) and Kotlikoff (2002).

argued that the marginal product of real capital, ρ, may be greater than the market rate of interest, R. Clearly, additional investment, yielding a rate of return ρ, discounted by the discount rate $R < \rho$, will then have a positive present value and hence bring about a net income gain to society as a whole. One explanation for such a difference between the marginal product of capital and the market rate of interest may be that a corporate income tax drives a wedge between these variables:[39]

$$\rho(1 - t_c) = R. \tag{11}$$

An obvious conclusion is that a removal of the wedge would eliminate the distortion, boost capital formation and increase aggregate income in the economy. A first question then is whether increased funding in the pension system could serve as a complement to a reduction in t_c. A second question is whether increased funding could be a substitute for a reduction in t_c.

The answer to the first question is that forced aggregate saving would free economic resources for investment by reducing the consumption of early generations.[40] The justification for this may be that all resources for domestic investment cannot be imported. In the presence of non-tradeables, reduced domestic consumption is necessary to avoid tendencies to increased inflation. A Pareto improvement is not possible, however, because squeezing the consumption of some generations requires that they are not compensated later on; if they were, their life-time resources would remain unchanged, and there would be no initial reduction in their consumption.[41]

Suppose, however, that it is politically impossible to lower the corporate income tax and that the government instead tries to use increased funding as a substitute. In an open economy, the real capital stock is independent of domestic saving, and thus increased domestic saving would only increase the financial claims on the outside

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[39] This explanation has been emphasized by Feldstein (1996a) and Feldstein and Liebman (2002).

[40] This could be brought about either by a front-loaded θ vector (for non-constrained individuals) or by a flat, or even somewhat back-loaded θ vector that makes the constraint tighter for liquidity-constrained individuals.

[41] For liquidity-constrained individuals, initial consumption can be squeezed even if their initial income loss is fully compensated later on. The effect on the utility they experience is a moot question, however.

world. It is therefore not possible to exploit the difference between ρ and R by shifting to a funded system. In a closed economy, squeezing early generations does lead to a higher domestic capital stock via falling interest rates, but these early generations cannot be compensated. If they were, their consumption would not decline, and there would thus be no room for increased capital formation. The conclusion is that a Pareto improvement is impossible when increased funding is used as a substitute for a reduction in the corporate income tax.[42]

There may be another type of efficiency argument for increased funding. If the capital stock is below the golden rule level, it may be advantageous to increase it. This could in principle be achieved by a pension reform with a front-loaded θ vector (in the case of a closed capital market). It should be noted, however, that the golden rule refers to efficiency in a long-run steady state, which means that movement toward a golden rule level does not imply a Pareto improvement. Future generations will certainly gain from such a policy, but it is unavoidable that present generations lose.

This brings us to distributional justifications for a shift to a funded system. One such argument builds on the observation that a number of cohorts granted gifts to themselves not only when the pay-as-you-go system was initially introduced, but also when the contribution rate was gradually increased. These policies raise an ethical question, in the sense that many of the losing generations had no voting rights – indeed may not even have been born – when the policy decisions were taken.

A shift to a funded pension system, with a front-loaded θ vector, would be a way to "claw back" some of the gains from those cohorts that were responsible for the introduction and expansion of a pay-as-you-go system. Such a policy, however, would be a rather blunt instrument. First, in order to hit those who gained from the introduction and are now retired, we would need an income tax or a consumption tax, rather than a higher payroll tax. Second, unless the θ vector could be made age-

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[42] Another proposal to boost capital formation in the connection with a pension reform has been presented by Pascal Belan, Philippe Michel and Pierre Pestieau (1998). Their reasoning is based on an endogenous growth model with a positive externality in capital formation, and they show that a Pareto improvement can in fact be achieved by abolishing the pay-as-you-go system, letting people rely on subsidized private pension saving instead. In the context of this model, where liquidity constraints on

dependent, not only older workers (who may have been favored by the pay-as-you-go system), but also younger cohorts (who were disfavored) would have to pay the front-loaded extra tax.

Sinn (2000) has put forward another redistributional argument for increased mandatory saving. He suggests policies that boost the accumulation of physical capital in order to compensate for the fall in *human* capital accumulation due to low fertility of the currently active generation. Since this generation decided to have fewer children than earlier generations, which could be regarded as a breach of an implicit intergenerational contract, it should be forced to pay an extra contribution, which is invested in pension funds.

5.5 Numerical Simulations

A partial step towards a quantitative general equilibrium analysis of pension reform in the U.S. has been taken by Feldstein and Samwick (1998). They assume endogenous labor supply and capital formation, while factor prices are exogenous.[43] The initial situation in their study is represented by a pay-as-you-go system with weak linkage between contributions and benefits (90 percent of the contribution rate τ is a tax) and by other taxes on labor summing to 20 percent. The old pension claims are assumed to be fully honored, and are financed by a payroll tax.

In their basic scenario, Feldstein and Samwick assume a growth rate in the tax base of 2.5 percent, and a return on real capital of 9 percent. The large difference between rates of return in the two systems explains why they obtain relatively large post-reform welfare gains for future generations at a rather modest cost to the early generations. The long-run contribution rate could be reduced drastically, from 12.4 to

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individuals are not considered, the same Pareto gain could, however, be achieved simply by subsidizing private saving without abolishing the pay-as-you-go system.

[43] The first numerical simulations with endogenous factor prices were carried out by Laurence S. Seidman (1986) under the same assumption of exogenous labor supply as in theoretical general equilibrium models. He assumed that the claims of the old pay-as-you-go pensioners are not fully honored. Since this would harm the older and benefit the younger cohorts, he did not conduct a Pareto experiment. For reasonable parameter values for the U.S., the break-even age for winning and losing generations in this policy experiment turned out to be around 30-35 years.

somewhat more than two percent, without lowering benefits.[44] The long-term income gain to future generations would be in the order of magnitude of 5 percent of GDP.

Recent numerical studies of pension reform with endogenous factor prices are based mainly on variations of the Auerbach and Kotlikoff (1987) simulation model.[45] Kotlikoff (1996, 1998) carried out a full general equilibrium analysis of a shift to a fully funded system in the U.S., assuming endogenous capital formation, labor supply and factor prices. As expected, the gain to future generations from such a shift would be particularly large when the linkage between contributions and benefits in the old system is weak (hence starting close to position I in our *Figure 1*), when other taxes are high and the transition is financed by taxes on consumption rather than income or labor earnings.[46] For most simulations, Kotlikoff reports long-term increases in GDP of about 10 percent. Typically, the contribution rate would have to be raised initially, but will eventually end up a few percentage points lower than the initial level. Depending on the method of financing old claims, on the initial degree of linkage, and on whether the transition generations are compensated or not, he reports increases in steady-state lifetime utility of between 1 and 10 percent. However, if taxes are raised abruptly for early generations (that is, if there is extreme front-loading), labor supply is distorted to such an extent that *all* subsequent generations may lose from the pension reform. This result illustrates the trade-off between forced saving and distorted work incentives.

The earlier mentioned general equilibrium study by the European Commission (2001) analyzes a shift to a fully funded system in the European Union. The study is based on a model by Kieran McMorrow and Werner Roeger (2002) and differs from the Auerbach-Kotlikoff framework in assuming a non-competitive (unionized) labor

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[44] In similar calculations for the EU, Feldstein (2001, p. 5) reports that the future payroll tax could be cut from 30 to 9.45 percent in the long run by shifting to a fully funded system.

[45] See Laurence J. Kotlikoff, Kent A. Smetters and Jan Walliser (2001) for a comprehensive list of references to the simulation literature.

[46] In economies with high taxes on income, one reason why consumption taxes are more favorable than other taxes is that it may be advantageous to smooth taxes over many tax bases. Another argument may be that consumption taxes do not distort saving decisions. A third reason is that a consumption tax functions as a capital levy, which is non-distortive – provided that it is not expected to be repeated. The case for a consumption tax is further strengthened if there is no constraint to keep the living standard of the old pay-as-you-go pensioners unchanged. The capital-levy property of such a tax then hits the pensioners as well. This helps explain why simulation models arrive at the result that the highest steady-state welfare is obtained when the transition is financed by consumption taxes.

market. If a transition to a fully funded system were financed by a "double contribution", the total contribution rate (in our terminology, $\tau^* + \theta$) would initially have to be raised to 28 percent, although it would gradually drop to about 20 percent in 2050 and to 17 percent in 2100 (European Commission, 2001, p. 208). This experiment would lead to a long-run increase in GDP of 5 percent, i.e., a change of the same order of magnitude as reported by Feldstein and Samwick (1998) and Kotlikoff (1996, 1998) for the United States. The EU Commission has pointed out that this GDP increase is significantly smaller than what would result if the effective retirement age were raised to 65 years while maintaining the pay-as-you-go system (which gave a GDP increase of 13 percent; p. 199). If a higher retirement age is combined with funding, a modest additional GDP gain can be achieved.

Is it then possible to compensate the generations working immediately after the reform, so as to bring about a Pareto improvement by shifting to a fully funded system? Kotlikoff (1996, 1998) studied this possibility for several different scenarios. In the most favorable case (modest front-loading, zero linkage in the old pay-as-you-go pension system combined with old claims financed by a consumption tax), a Pareto-sanctioned shift to a fully funded system is possible. In this case, steady-state lifetime utility would increase by 4 percent.

Hirte and Weber (1997) carried out simulations for Germany, also based on the Auerbach and Kotlikoff (1987) framework. The initial conditions in their study are characterized by positive but weak linkage between contributions and benefits (with 90 percent as a tax), reflecting the current German pay-as-you-go system, and a public good financed by taxes on capital, consumption and income. In contrast to Kotlikoff (1996, 1998), Hirte and Weber use distortionary (income or consumption) taxes not only to honor the old pay-as-you-go claims, but also to compensate losers during the transition. When compensating all losers, they find that an increase in steady-state welfare, expressed in wealth equivalents, of 7-8 percent, can be achieved by combining tax smoothing and a shift of the tax base to income or consumption taxes.[47]

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[47] As shown by Johann K. Brunner (1996), the possibility of a Pareto improvement is smaller if there is intra-generational heterogeneity.

Raffelhüschen (1993) concludes that Germany could achieve a modest efficiency gain from shifting to a fully funded system by using a combination of borrowing and taxes to finance the old pensioners and by compensating losers. D. Peter Broer, Ed W. M. T. Westerhout and A. Lans Bovenberg (1994) use a variant of the Auerbach-Kotlikoff model to analyze a reduction in the size of the Dutch pay-as-you-go system. They show that a Pareto improvement is possible when the pay-as-you-go pensioners are compensated by some fraction of the returns from the funded system. This gain is achieved mainly because there is only a weak link between contributions and benefits in the old pay-as-you-go system.

Note, however, that in the models discussed above, a Pareto improvement is possible only if the old pay-as-you-go system did not already comprise a tight link between contributions and benefits. Shifting from the neighborhood of position I to position IV in figure 1 may well result in a Pareto gain,[48] but the same gain can be achieved without funding, simply by shifting from position I to II.[49] Adding a vertical move from position II to position IV would not yield any further efficiency gains since the claims of the old pay-as-you-go pensioners still have to be honored.

Finally, there is the dilemma of specifying the individual's intertemporal preferences in a realistic manner. It is somewhat paradoxical to analyze pension reform assuming traditional, exponential discounting when the existence of mandatory pension systems has been motivated by the fact that individuals are myopic, for example expressed in hyperbolic discounting. This raises potentially important issues for future research.[50]

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[48] Moving from a completely non-actuarial pay-as-you-go system to an actuarially fair, fully funded system, with the old claims financed by the benchmark vector $\overline{\theta}$, will reduce the tax wedge on labor by $\tau(1+G)/(1+R)$; cf. Subsection 4.1. This would not have any direct impact on aggregate saving. Implementing instead a somewhat front-loaded θ vector could result in some reduction in the tax wedge, as well as an increase in aggregate saving.

[49] Auerbach and Kotlikoff (1987, p. 158) have estimated the efficiency gain for the US economy of moving from I to II. They find that such a shift increases full lifetime resources by between 7.6 and 15.1 percent depending on how other government spending is financed (namely by proportional or progressive income taxes).

5.6 A Question of Framing?

So far, we have identified two types of pension reform that may create welfare gains to society. First, strengthening the linkage between contributions and benefits may result in a Pareto improvement due to less distortions in the labor market. Second, a shift to a funded system may increase aggregate saving, which in turn will increase aggregate income over generations if the return on real capital happens to be higher than the market interest rate. Only the first measure, however, is intrinsically related to the design of the pension system. The second could, in principle, also be achieved by ordinary fiscal policy measures without changing the pension system. Thus, the second type of pension reform may be regarded as a way of *framing* policy measures that would otherwise be politically infeasible. Another example of framing is when a pension reform is combined with changes in the tax base or in the time profile of taxes (in the fashion discussed in Section 5.4).

Apart from Pareto welfare improvement (via less labor-market distortion), there is the issue of intergenerational redistribution. This could also be achieved by general fiscal policy measures. A shift to a funded pension system as a means to redistribute income across generations could, therefore, also be regarded as a matter of framing. For instance, changes in the intergenerational income distribution in favor of future generations may be achieved by raising taxes today in order to amortize public debt. If such a measure is not politically feasible, a pension reform is a potential vehicle for *de facto* achieving the desired objective.

All this leads us into deep water. For example, who really wants higher national saving and a redistribution of income in favor of future generations? Obviously not the majority of the electorate; otherwise, it would not have been necessary to deceive it by disguising the contemplated redistribution. In any event, the scholarly debate on the pros and cons of a shift to a funded system usually does not invoke a need to frame redistribution in terms of pension reform.

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[50] For attempts to address these issues in connection with retirement decisions, see Peter A. Diamond and Botond Köszegi (2002) and Ayse Imrohoroglu, Selahattin Imrohoroglu and Douglas H. Joines (2002).

6. Risk and Risk Sharing

Up to this point, we have neglected risk and risk sharing. A primitive way of introducing risk would be to interpret the interest rate, R, and the growth rate in the tax base, G, as certainty equivalents. Indeed, this is what we have implicitly done so far. A more explicit treatment of risk is called for, however, by including variances and covariances of the rates of return. This implies that we regard pension claims as part of an individual's total asset portfolio (subsection 6.1). The next step is to examine how risk is shared within and among generations (subsection 6.2). This brings up the third dimension in our classification of pension systems, namely the distinction between defined contribution and defined benefit systems.

6.1 A Portfolio Approach

Since a pay-as-you-go system provides a new "asset" (pension claims with an uncertain yield tied to the growth rate of the tax base), the government solves a missing market problem. Such a system may, therefore, contribute to a welfare improvement, in the form of a more favorable trade-off in risk/return space – provided R and G are not perfectly correlated. In figure 2, curve AA shows the available risk/return combinations when there is no mandatory pension system at all. We now assume that a pay-as-you-go system is introduced, and that it is characterized by a risk/return combination corresponding to point P. If the "pay-as-you-go asset" (the "paygo asset" for short) had been fully divisible and marketable, like a so-called "Shiller bond",[51] the new frontier available to the investor would be located above the AA frontier. This is a direct consequence of adding a new "asset" that is not redundant or dominated by a combination of existing assets. We call this hypothetical frontier (not depicted in figure 2) the "Shiller frontier".

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[51] Shiller (1993) has advocated the introduction of a bond whose yield is tied to the growth rate of GDP. Although this does not exactly correspond to a paygo asset, it is fairly close. To the best of our knowledge, this proposal has not yet been implemented in any country. Bohn (2002) has advocated
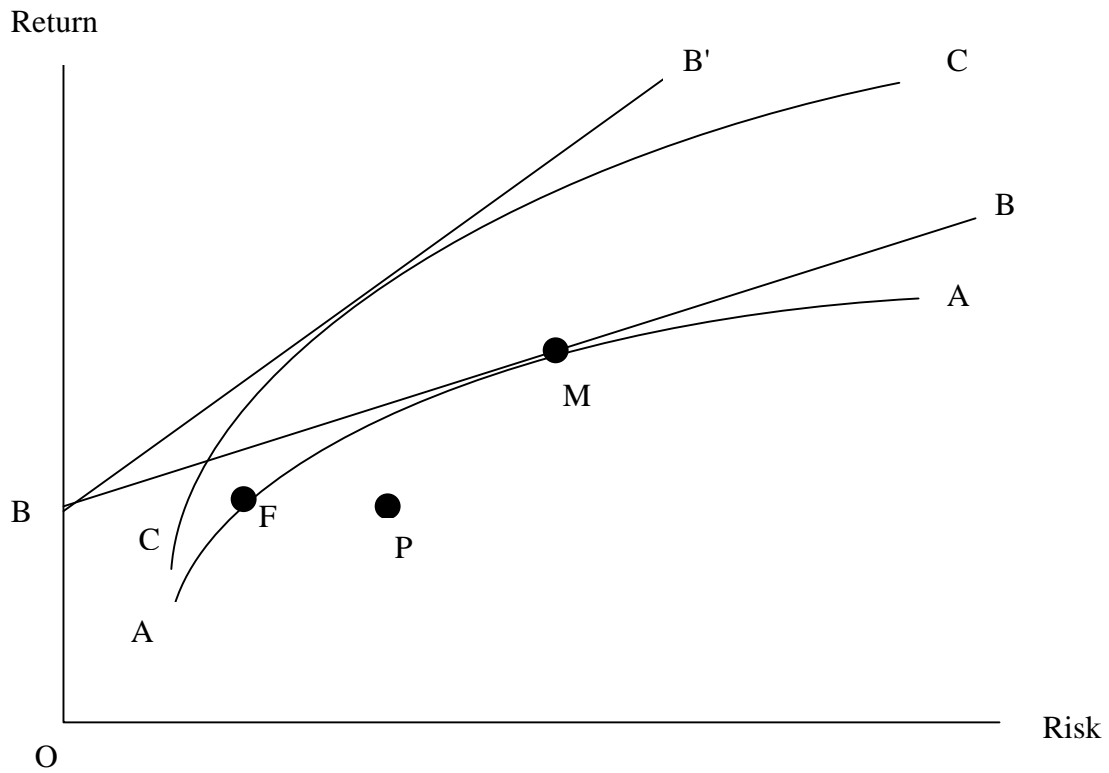
Return

B'   C

B   A

B

C

M

F   P

A

O   Risk

*Figure 2: Risk-return portfolio opportunities in mandatory pension
systems*

government bonds indexed to wages and demographic variables; such bonds would constitute a
marketable and divisible paygo asset.

In reality, however, a pension asset in a mandatory pay-as-you-go system is indivisible and non-marketable. For some individuals, the pay-as-you-go system will be too large, for others too small, as compared to the amount of Shiller bonds he would choose voluntarily. Thus, the efficient frontier associated with a mandatory pay-as-you-go system is located below the Shiller frontier. Whether it will be above or below the AA frontier depends on three factors: the size of the pay-as-you-go system, the wealth of the individual, and the covariance between the paygo asset and other assets. In figure 2, we have drawn the efficient frontier, depicted by the curve CC, above the AA curve – but it could just as well be below AA. A non-constrained individual will then choose a combination of the risk-free asset, traditional risky assets, and the mandatory paygo asset – a position located somewhere on the capital-market line BB' in the figure.

For a liquidity-constrained individual, on the other hand, the introduction of a pay-as-you-go system means that he will be confined to point P. According to the government's revealed preference, point P is superior to point O, which the liquidity-constrained individual would choose in the absence of a mandatory system. Indeed, this is one reason why a pay-as-you-go system is introduced in the first place.

What happens now if the government decides to shift to a fully funded system? If the shift is total, the paygo asset disappears. A non-constrained individual can then choose a risk/return combination along the capital market line BB that is tangent to the original efficiency frontier AA – just as if there were no mandatory system whatsoever; see footnote 12. Theoretically, this conclusion holds not only if the individual can choose among many competing pension funds, but also if there is a single government-operated fund – provided that well-functioning derivatives markets exist, and that the individual is able and willing to transact in these markets. This is probably not a very realistic assumption, however.

It is even more difficult for a liquidity-constrained individual to pursue fully offsetting transactions when there is a central pension fund. For instance, he may be unable to put up the margin required to make the necessary transactions (like selling stocks short); he is also likely to be quite unfamiliar with the functioning of derivatives

markets. Therefore, the portfolio choice of a central fund will probably affect liquidity-constrained individuals more than those who are non-constrained.

At this point, it is important to recognize that the rate of return should be net of administrative costs. It is generally agreed that administrative costs tend to be much higher in funded than in pay-as-you-go systems. The cost differential may well be between 0.3 and 1.5 percent of pension wealth, with the lower figure referring to index funds. In fact, the costs have been even higher in Chile and the U.K., which has lead to severe criticism. However, administrative costs can be cut. One way is to require all pension funds in a mandatory system to be confined to index portfolios; another is to put a cap on the administrative costs of individual funds, perhaps thereby forcing them to choose index portfolios.[52]

Since R and G are not perfectly correlated in the real world, portfolio diversification is an argument for a partial rather than a total shift to a funded system. Indeed, this is the solution recently chosen by a number of countries (see section 7). But even such a mixed system restricts an individual's choice since he faces a government-imposed restriction on the amount of paygo asset to be held. Whatever composition of the mixed system the government chooses, the amount of the paygo asset may be too large for some individuals (in particular, some low-income earners) and too small for others (in particular, some high-income earners) – as in the case of public goods.

Rate-of-return risk in pension systems is associated not only with fluctuations in the growth rate of the tax base and the rate of return in financial markets, but also with political risk. When discussing the latter, it is important to realize that new political interventions in the pension system do not always increase the risk for the individual. If the economy is unexpectedly hit by a shock that was not contemplated when the system was designed, early intervention may reduce the likelihood of more far-reaching interventions in the future. Thus, it is useful to distinguish between policy measures that counteract the consequences of exogenous macroeconomic shocks ("market risk") and policy measures undertaken to placate various interest groups or political parties.

We argued in Section 4.3 that political interventions are less likely in pension systems with strong property rights. Hence, political interventions would be less likely in quasi-actuarial than in non-actuarial pay-as-you-go systems, and even less likely in actuarially fair, fully funded systems. But political risk is not absent in the latter type of system. It takes two forms. One concerns the allocation of the pension fund assets to different sectors, regions and firms. The problem here is that politicians may intervene in this allocation, motivated by party politics. In some countries, such interventions have, in fact, resulted in very low (and in some cases negative) return on government-controlled pension funds; see World Bank (1994, p. 95). Political risk is likely to be lower in the case of decentralized, privately run funds with individual accounts than in a single, central fund operated by the government; the property rights are likely to be stronger, thereby limiting the risk for political intervention in the management of the funds.[53] In principle, the political risk of fund management may, however, be diversified by having several government-operated funds, rather than one fund, with different politicians in different funds.

A related issue is who should exercise ownership in companies where pension funds own shares, for instance, by making political appointments to the boards of these firms. If government-initiated pension funds are very large as compared to a country's economy, there is a risk of vast nationalization and politization of the national economy. Here, too, the risk of political abuse is probably smaller in a system with competing, decentralized private funds. Higher administrative costs associated with decentralized fund management then may be regarded as the price to be paid for minimizing the risk of misuse of political power. The importance of these considerations is illustrated by the sheer size of the funds involved. If all government-operated pension systems were fully funded, the funds would correspond to 200-300 percent of GDP. This would basically correspond to the size of the total stock of real capital.

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[52] For information about administrative costs, see Olivia S. Mitchell (1998), Mamta Murthi, J. Michael Orszag and Peter R. Orszag (1999) and Diamond (1999).

[53] But not even privately managed funds with individual accounts are wholly immune to political intervention. Historically, some governments have imposed restrictions on the portfolios of such funds, mostly in order to favor government "pet" projects, or have unexpectedly introduced extra taxes on the returns of pension funds when these returns have been regarded as particularly conspicuous (Denmark and Sweden in the 1980s and 1990s are examples).

Regardless of whether the political risks are higher or lower in a funded system than in a pay-as-you-go system, it is reasonable to assume that they are *different* and therefore not completely correlated. Differences in political risk provides an additional argument for diversification of pension claims, i.e., for a mixed system, combining pay-as-you-go and funded systems, as argued above.

6.2 Risk Sharing

Pension systems distribute risk differently along three dimensions: among generations, within generations, and over an individual's life cycle. A comprehensive analysis of risk and risk sharing in all these dimensions would require a quantitative general equilibrium analysis. Still, some insight can be gained from theoretical considerations, which we pursue here; this issue is discussed in some detail in Lindbeck (2000). Let us begin with the distribution of risk among generations.

Intergenerational risk. Issues of intergenerational risk sharing are particularly apparent in the context of pay-as-you-go systems. In such a system of the defined-contribution type, hence with a fixed contribution rate, fluctuations in the real wage rate w influence the disposable income of both workers and contemporary retirees in the same direction. This means that risk in w is shared between workers of generation t and individuals of generation $t-1$ when retired. Abstracting from general equilibrium effects, we call this *direct risk sharing*. It does not take place in either fully funded systems or pay-as-you-go systems of the defined-benefit type (since pensions in the latter case are either exogenous or predetermined as a fraction of the pensioner's earlier income).[54] Direct sharing of risk is also straightforward in the case of fluctuations in the number of workers, n. In a pay-as-you-go system of the defined contribution type, such fluctuations only affect the pensions of the preceding generation. Thus, this specific demographic risk is borne by the retirees. By contrast, in a pay-as-you-go system of the defined-benefit type, workers bear the entire burden of shocks in both w and n. In fact, in the case of changes in w, they have to bear a double burden: if w falls, not only will they earn a lower wage, they are also forced to pay a higher contribution rate in order to balance the pension budget.

We may note that not only the distributional, but also the efficiency effects of shocks differ between defined-contribution and defined-benefit systems. If the latter type of system is hit by a negative shock in G (regardless of whether it is induced by a change in w or n), the tax wedge necessarily increases since the contribution rate has to be raised. By contrast, the effects on the tax wedge in a defined-contribution system are more intricate. In the case of a quasi-actuarial system, where the tax wedge is $\tau(R-G)/(1+R)$, the wedge will certainly increase if G falls. It is, however, important to distinguish between the current G (which affects the distribution between contemporary workers and retirees) and the G expected to prevail during the next generation's working life (which is relevant for the tax wedge formula). This means that a fall in G that is expected to be temporary will not affect the tax wedge faced by contemporary workers, even though it has distributional consequences. Only if the change in G is expected to persist during the working life of the next generation will it affect the tax wedge of today's working generation. Thus, in non-actuarial defined-benefit systems, both temporary and persistent changes in G will influence the tax wedge, via changes in τ. By contrast, in quasi-actuarial defined-contribution systems, only persistent changes in G will affect the tax wedge, via changes in the expected value of G.

There are also *indirect* risk-sharing mechanisms associated with general equilibrium effects. For example, in a funded system, a fall in w, n or the number of hours of work, ℓ, will reduce the resources available to the young to buy the unloaded assets of the elderly. This lowers asset values and the return on previous pension savings. Reasoning along these line has led some authors (Barr 2000, and EU Commission 2001, p. 184) to argue that the risks are, at least in principle, rather similar in pay-as-you-go and funded systems. But this holds only for a closed economy. In an open economy, domestic financial instruments are much less affected by shocks to the income of the active population. Moreover, since domestic pension funds can diversify by investing in foreign assets, a funded system in a small open economy can be virtually immune to domestic shocks to demography and productivity. By contrast,

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[54] For a discussion of different aspects of risk-sharing, see Shiller (1999), Øystein Thøgersen (1998) and Andreas Wagener (2001).

a pay-as-you-go system is, by definition, entirely dependent on the domestic economy.

If high priority were given to avoiding large changes in the relation between incomes of workers and contemporary pensioners due to various shocks, a convenient solution would be a system with a fixed ratio between the incomes of these groups, $b/w\ell$. Such a system, proposed a long time ago by Richard A. Musgrave (1981), requires that τ be continuously adjusted to guarantee financial balance. The individual may still receive pension benefits in proportion to previous contributions, and thus the system could be said to have actuarial elements.

A special type of intergenerational, or rather inter-cohort, risk is related with *annuitization*. This risk arises when a stock of pension wealth is transformed into an annuity, i.e., a flow of pension benefits after retirement. Even individuals of approximately (although not exactly) the same age could face very different capital-market situations at the time of retirement, and hence receive quite different pension annuities.

The annuitization risk could be quite substantial. For instance, Gary Burtless (2000) has shown that with *fixed* annuities, U.S. workers retiring in 1974 would have received only half the replacement rates as workers retiring in 1968.[55] This risk may be reduced by providing a *flexible* annuity instead, so that pension wealth remains invested in the individual's account throughout the retirement period (although it will gradually be reduced as time goes by). This means that the annuitization risk would be replaced by an ordinary rate-of-return risk.[56] Indeed, this is often the way annuitization risk is dealt with in private pension schemes, as well as in some funded government-run schemes.[57]

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[55] A similar problem emerges if the pension portfolio is shifted once-and-for-all from equities to bonds. Thomas E. MaCurdy and John B. Shoven (1999) study an asset swap by a trust fund from bonds to stocks in a given year. The probability that such a swap will be a failure is found to be 25-30 percent (p. 20-21).

[56] Martin S. Feldstein and Elena Ranguelova (2001) report that with variable annuities, this risk could be rather modest. For instance, a 67 year old has a 15 percent chance of receiving less in a fully funded scheme (60 percent stocks and 40 percent bonds) than under present US pay-as-you-go rules. The probability of receiving 50 percent less is roughly 2 percent (table 1 and p. 15).

[57] A more radical solution would be to hand over the entire pension wealth to the individual at the time of retirement. He could then choose his own investment strategy and the consumption profile during

Uncertainty about remaining life expectancy, i.e., longevity risk for an individual's cohort, is another element of the annuitization risk. The annuity could either be kept constant after retirement, or be gradually adjusted to changes in the cohort's life expectancy during the retirement period. In the former case, the cohort longevity risk is borne by the insurance provider after retirement. In the latter case, when the annuity is gradually adjusted to changes in life expectancy, the individual bears cohort longevity risk during his entire lifetime.

Intragenerational risk. While defined benefit systems (regardless of whether they are pay-as-you-go or fully funded) do not contribute directly to risk sharing among generations, they can certainly function as a risk-sharing device *within* generations. For instance, in the case of a basic pension, fluctuations in earnings do not result in corresponding fluctuations in pensions. The risk-sharing properties of the pension system are then similar to those of a progressive income tax.[58] Due to specific institutional arrangements, however, certain elements in defined benefit systems in the real world accentuate rather than mitigate intragenerational income risk. One example is when the pension is tied to earnings during the *x* last years of work, rather than to lifetime earnings. Individuals who turn out to have low incomes late in life will then suffer a low income when retired.

Another type of intragenerational income risk is associated with family dissolution. Historically, non-actuarial pension systems have included simple rules for allotting incomes among family members after the breakup of a family, basically in the form of pensions to widows and their children. By contrast, in a (quasi-) actuarial system with individual accounts, the pension is closely tied to the individual income earner. Without special arrangements, income risk due to the dissolution of a family is therefore larger in systems with individual accounts than in many existing pension systems. The family member with the lower market income, usually the woman, would therefore be exposed to a higher risk in a pension system with individual

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retirement. Such a solution, however, would fail to fulfill some of the objectives of a mandatory system, such as dealing with free-riding and myopia.

[58] Kjetil Storesletten, Chris I. Telmer and Amir Yaron (1999) have computed the insurance value of this type of risk sharing. For parameters assumed to be realistic, the welfare gain from reduced income

accounts. One remedy might be to give each spouse a property right to the other's pension wealth. This is straightforward in the case of formal marriages, where similar arrangements are already in place for other types of property, but is more difficult to implement in the case of cohabitation.

An additional aspect of the distribution of intragenerational risk in the case of funded defined contribution systems is that the return risk will vary among individuals if there are many funds to choose among, rather than one central fund. Depending on differences in skill and luck, otherwise similar individuals may end up with widely different pensions. This illustrates the trade-off between freedom of choice and ambitions of the authorities to achieve an even distribution of income among pensioners.

Risk distribution over the life cycle. Pension systems may redistribute not only income but also income risk over the life cycle. It is useful to discuss this issue in terms of the renowned "veil of ignorance", i.e., the notion that an individual does not yet know his type, as reflected in future earnings, when he takes important decisions. In a defined contribution system, there is uncertainty concerning w, while the fixed contribution rate τ may be known. There is also uncertainty about the return on contributions, since R and G are not guaranteed in advance. By contrast, in a defined benefit system, there is uncertainty not only about w but also about τ, since the latter has to be adjusted to achieve budget balance. On the other hand, the pension benefit may be known in advance. Indeed, with a fixed benefit $\bar{b}$, there is no uncertainty at all concerning the pension, while in a defined benefit system with a fixed replacement rate (such that $b = \gamma w \ell$) there is uncertainty about the pension behind the veil of ignorance solely as a result of uncertainty about w. All this means that a pension reform represented by a shift from a defined benefit system to a defined contribution system will remove one source of uncertainty from the first period of an individual's life (uncertainty about τ), but introduce a new source of uncertainty in the second period of life (uncertainty about R or G). It is difficult to judge *a priori* whether such a shift in the distribution of risk elements over the life cycle is favorable or not.

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risk in the current U.S. social security system corresponds to between one and two percent of lifetime income.

Presumably, this depends not only on the assumed utility function, but also on the properties of the stochastic processes underlying the shocks.

Modigliani and Ceprini (2000) have suggested a solution to some of these risk problems. They envisage partly funded, actuarially fair system with a single fund investing in marketable securities and with equities allocated to a broad stock-market index. Since there is only one fund, intragenerational risk associated with many different funds, with different returns, is avoided – at the cost of abolishing portfolio choice according to individual preferences. Intergenerational risk is removed by a guaranteed real rate of return of five percent per annum. The annuitization risk of retirees (indeed, inter-cohort risk) is thereby also removed. The five-percent return is achieved through a swap between the fund and the Treasury; in exchange for the return derived from the fund's portfolio, the Treasury pays a fixed real return of five percent.

The proposal combines features from defined benefit and defined contribution systems. It is defined contribution, and actuarial, in the sense that pensions are based on the individual's paid contributions, that the rate of return is R, and that the contribution rate is fixed. But it has elements of a defined-benefit system in that throughout the individual's lifetime, he has reason to be confident about the pension benefits he has earned so far. This certainty, however, is acquired at the cost of greater uncertainty for taxpayers, who have ultimately issued the five percent return guarantee. A remaining problem with a central fund, of course, is that it is vulnerable to political risk – in particular, the risk associated with the exercise of ownership and control of firms.

In highlighting the possibilities of diversifying risk in pension systems, we have pointed out that such diversification can be accomplished in several dimensions. It is, in general, advantageous to combine funded and pay-as-you-go systems, since they have different risk characteristics, with respect to both market risk and political risk. It is probably also a good idea to combine a defined contribution system with some elements of a defined benefit system. Defined contribution systems provide (direct) risk sharing among generations, while defined benefit systems may provide risk

sharing within generations. Indeed, most countries offer a basic pension (at a rather low level) as an important element of the entire mandatory pension program.

7. Concluding Remarks

In this paper, we have tried to systematize and clarify various issues that have been prominent in recent discussions of pension reform. To this end, we have applied a three-dimensional classification of pension systems: actuarial versus non-actuarial, funded versus pay-as-you-go, and defined contribution versus defined benefit systems. Each of these dimensions is associated with a special aspect of pension reform: labor-market distortions, aggregate saving, and considerations of risk, respectively.

We have emphasized that efficiency gains in the labor market can be achieved by strengthening the link between contributions and benefits in a pay-as-you-go system. Indeed, in a quasi-actuarial system, where the individual's marginal return on mandatory pension saving is equal to the growth rate in the tax base, the labor-market distortion is minimized. We have shown that this opens up a possibility of a Pareto improvement. Moreover, it is commonly held that a shift to a quasi-actuarial system with an exogenous contribution rate (i.e., a contribution-based system) will increase the financial stability of the pension system, in the sense that politicians then have not made any promises concerning future pension benefits.

What, then, are the gains from shifting from a quasi-actuarial to an actuarially fair, fully funded system? No further efficiency gains are possible in the labor market if the claims of the old pay-as-you-go pensioners are granted. This explains why, under certain circumstances, a shift to a fully funded system would be a "wash" in terms of aggregate income across generations. We discuss three cases where this conclusion does *not* hold.

The *first* case is when the return on real capital is higher than the market interest rate, which means that an aggregate income gain across generations could be achieved by higher capital formation. There are two ways to bring about such increased capital

formation in connection with a shift to a funded system. One is to squeeze both liquidity-constrained and non-constrained individuals, by making the extra tax, necessary to grant the old pay-as-you-go claims, front-loaded. This means that the tax weighs more heavily on earlier than on later generations after the reform. The other method to increase aggregate capital formation is to squeeze only liquidity-constrained individuals, which can be achieved even without front-loading. We show, however, that increased capital formation by mandatory saving, regardless of who is squeezed, does not result in a Pareto improvement.

The *second* case where a shift to a funded system is not only a "wash" occurs when we use an intergenerational discount rate that is lower than the market rate. We show, however, that such an aggregate income gain can be brought about only if the new tax, used to finance the old pay-as-you-go claims, is front-loaded. Such a reform certainly does not imply a Pareto improvement, since early generations have to be squeezed also in this case.

A *third* case concerns issues of risk. Although the introduction of a pay-as-you-go system creates a new type of asset, the compulsory nature of the system will force some individuals to hold unbalanced portfolios, with the "paygo asset" constituting too large a part of their entire portfolios. Replacing part of that asset with funded pension claims will then lead to better portfolio diversification for those individuals. This is the case, in particular, if the pension funds are allowed to invest in foreign assets, because pensions would then be less exposed to what happens in the domestic economy. Since the political risk is also likely to differ between pay-as-you-go and funded systems, this further strengthens the portfolio diversification argument for a mixed system.

We also discuss how different pension systems distribute risk among generations, within generations, and over an individual's life cycle. It turns out that the distinction between defined-contribution and defined-benefit systems is crucial for such an analysis. For instance, as may be expected, a defined-contribution system tends to shift relatively more risk to the retired population, while a defined-benefit system shifts relatively more risk to the workers. Risk sharing among generations is less obvious in funded than in pay-as-you-go systems, though it may occur via general

equilibrium effects in countries where the domestic capital market is not fully integrated internationally.

Several quantitative simulations suggest that a shift from a pay-as-you-go to a fully funded system can be designed in such a way that rather modest sacrifices of early generations will result in large gains for future generations. Whether such a reform is worth undertaking then depends on preferences concerning the intergenerational distribution of income. Regardless of the reasons for redistribution in favor of future generations, this can, however, be accomplished by ordinary fiscal policy measures, quite outside the realm of pension reform. Why, then, is pension reform often suggested as a means of increasing domestic capital formation and redistributing income in favor of future generations? The answer is presumably that pension reform is a way of *framing* policies that may otherwise be politically difficult to achieve, such as by general fiscal policy. Indeed, empirical research in economic psychology has shown that framing influences individuals' perception of policies with identical content.

How, then, should we characterize recent changes in the mandatory pension systems of various countries? There is a strong tendency today to reform existing pension systems in the direction of increased actuarial fairness, and to combine pay-as-you-go and funded elements. The reforms also reflect a trend towards individualization. Since pension systems with strong linkage require individual accounts with continuous reporting of the individual's pension wealth, whether notional or actual, the pension wealth becomes more transparent, equipped with stronger property rights, and portable across national borders. Greater individualization probably reflects three contemporary changes in society: more individualistic preferences (as empirically studied by Ronald Inglehart), increased globalization, and the new information technology that facilitates handling of individual accounts. It is interesting to note that the trend towards individualization is not limited to government-operated pension systems. Occupational pensions have also undergone a transition from employer-provided defined benefit systems to funded systems with personal retirement accounts.

In order to accommodate the demand for more individualized social security, the individual could be given greater freedom in deciding when to use the mandatory pension savings during the life cycle. This does not only imply a flexible retirement date, but also arrangements for utilizing part of the savings for specific purposes during working life, such as paying for an adult education, buying a home, or starting a firm.[59] Such arrangements can be made in funded as well as unfunded systems; the two most well-known systems, namely those in Singapore and Malaysia, are funded, however.

Against the backdrop of our analysis above, let us take a look at actual reforms in various countries.[60] We start with parametric reforms, which are often pursued in order to restore financial stability. Next, we move on to systemic reforms.

Most *parametric* pension reforms during the last decades have been designed to guarantee better long-term financial stability of the pension systems. A common measure has been to gradually increase the contribution rate τ. Indeed, in many countries it has been raised from a few percentage points, when the systems were launched, to 15 or 20 percent today.[61]

In the light of political difficulties and concern over economic distortions connected with increases in the contribution rate, we have, however, recently seen a trend towards financial consolidation via cuts in benefits – often using rather innovative methods. The purpose has then been to reduce the capital value of benefits in order to respect the system's intertemporal budget restriction. In some cases, this has been achieved by reducing the nominal value of yearly pension benefits (either by cutting a flat benefit or, in the case of earnings-based pensions, reducing the replacement rate). This has recently been done in, for instance, Greece, Hungary, Italy, Korea, Portugal and Switzerland. New Zealand has used a more indirect method to reduce the

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[59] An early proposal along these lines is that of Gösta Rehn (1961). More elaborate plans have been developed by Stefan Fölster (1999) and J. Michael Orszag and Dennis S. Snower (1999).

[60] Our examples of changes in pension systems are mainly based on from OECD (2000) and the papers in Martin S. Feldstein and Horst Siebert (2002).

[61] In some countries, the contribution rate has been kept down by channeling general tax revenues to the mandatory pension system. Germany is one example, where in the late 1990s around 27 percent of pension benefits were financed in this way (Holger Bonin, 2002, p. 1).

replacement rate, namely to cut the ratio of pensions to the average wage of contemporary active workers.

There are also examples of selective benefit cuts, hitting only part of the population. Some countries have imposed stricter eligibility rules for receiving any pension at all. Belgium, Germany and the U.S. have increased the number of years necessary to qualify for a pension, and Iceland and Italy have done the same for public-sector employees.

But it has probably been more common to reduce the real value of pension benefits by shifting from wage indexation to price indexation of pension benefits. Basically, this has been done connection with recent pension reforms in Sweden and Japan. The pension reform in Germany in 2000 combines changes in wage and price indexation. A shift from gross to net wage indexation was followed by a shift to price indexation, both with the explicit purpose of limiting future increases in contribution rates (Bonin 2002). Another way is to manipulate the price index, for instance, by excluding components that have shown a tendency to rise particularly fast (like oil, in the 1980s).

Without touching yearly benefits, their capital value has instead been reduced in some countries by raising the retirement age. Examples are Germany, Italy, Japan, New Zealand and the U.S. In some cases, higher retirement age has been limited to particular groups, such as women (in the U.K. and Belgium) or public-sector employees (in Italy).

In fact, raising the effective retirement age is a powerful way to restore financial stability. A double effect is then achieved: a simultaneous increase in the number of workers, and a decrease in the number of eligible pensioners. In the previously mentioned study by the European Commission (2001) on the consequences of raising the effective retirement age to 65 years, it is concluded that an otherwise necessary increase in the social security contribution from 16 percent in 2000 to 27 percent in 2050 could thereby be limited to 20.5 percent (pp. 191-199). This result should be compared to an outright reduction in benefits. For instance, according to the EC study,

a drastic reduction in the replacement rate from 74 to 58 percent would still require an increase in social security contributions to 22.7 percent by 2050 (p. 198).[62]

In response to the dramatic fall in labor-force participation among elderly workers (Gruber and Wise, 1999a, 2002), many developed countries have stiffened the rules for early retirement, by either raising the minimum age for, or reducing the subsidies to, early retirement. Germany and Italy have implemented both types of changes. Of course, countries whose systems have recently been rendered more actuarially fair have automatically reduced existing subsidies to early retirement. Some countries have also limited the access to various "pathways" to early retirement, including disability pensions and the transformation of long-term unemployment among older workers into early retirement. For instance, the Netherlands has considerably stiffened the rules for disability pensions, while the pathways via long-term unemployment have been partly closed in Austria, Denmark and Germany. Another way of limiting early retirement has been to facilitate part-time rather than full retirement.[63]

Whatever methods are used to make pension benefits less generous, politicians have often chosen either to postpone the implementation of cuts, or to phase in the cuts slowly over a long period of time; these empirical regularities have been emphasized by John McHale (1999). The latter option seems quite reasonable in order to give people time to adjust to new rules. But postponing implementation raises the risk of time inconsistency; future governments might continue to postpone the cuts.

So much for parametric changes. Turning now to *systemic* pension reforms, we illustrate a few such reforms in figure 3.[64] For instance, pre-funding (i.e., raising the contribution rate in anticipation of future demographic changes) in the U.S. and Canada social security systems may be regarded as a (modest) systemic change in the

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[62] The intergenerational distribution effects would be drastically different in these two experiments. According to the study, the consumption of the working-age population would increase by 6.4 percent while that of pensioners would fall by 7.6 percent by 2050 in the case of a reduced replacement rate. By contrast, in the case of a higher effective retirement age, the consumption of working-age population and pensioners would increase by 10.8. and 16.3 percent, respectively. The favorable effects on the consumption of pensioners are, of course, the result of a longer working career (European Commission 2001, pp 198-199).

[63] This works both ways, stimulating workers to choose not only part-time retirement instead of full retirement, but also part-time retirement instead of full-time work.

sense of a move in the direction of a funded system, though still with very weak actuarial elements. [65] This is illustrated as an upward movement of the U.S. and Canadian systems in the figure. Similar moves have been undertaken in France, Ireland and the Netherlands. Moreover, in the late 1990s, various proposals to add an actuarially fair, fully funded element to the U.S. system were vividly discussed – with considerable controversy as to whether the fund(s) should be centralized or decentralized (see the Advisory Council on Social Security, 1997).
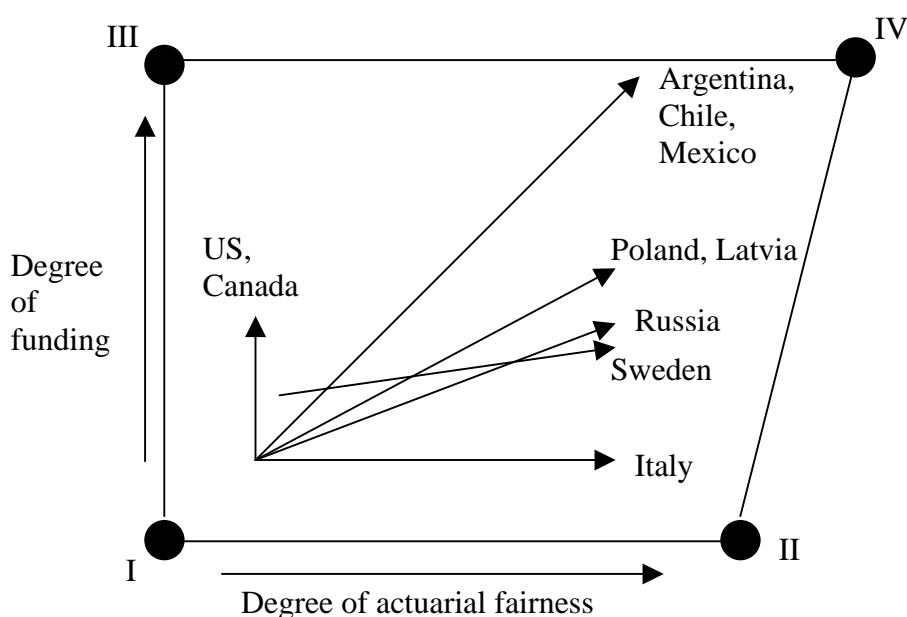

Figure 3: Current pension systems and planned reforms in several countries

Several countries (e.g., Italy, Latvia, Poland and Sweden) have recently moved from quite non-actuarial pay-as-you-go to quasi-actuarial systems with notional accounts. Such schemes are often combined with partial funding with individual accounts (see Mats Persson 1999, and Louise Fox and Edward Palmer 2001). Russia is planning a similar reform. Chile, Argentina and Mexico have made a full shift from non-actuarial

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[64] The illustrations are only schematic; an interesting research project would be to pinpoint the countries with more empirical precision.

[65] This could be regarded as a systemic change since there would be a large increase in the trust fund relative to the annual expenditures of the system. In an "intermediate cost" projection, this relation will

pay-as-you-go to actuarially fair, fully funded systems (Diamond and Valdés-Prieto 1994). These countries have simultaneously equipped their funded systems with government guarantees that individual retirees will receive no less than in the previous pay-as-you-go system.

Instead of shifting to more funding in their mandatory systems, some countries (mainly the United Kingdom and Germany) have recently encouraged private pension solutions. In the U.K., the supplementary earnings-related pension system (SERPS) from the 1970s was reformed in the 1980s by allowing individuals to "contract out". In the 1990s, this contracting-out alternative has been made more favorable for low-income groups (Phil Agulnik 1999). In Germany, downsizing of the original, rather non-actuarial pay-as-you-go system has been combined with strong subsidization of private, fully funded pensions (Hirte and Weber 1997). As in the U.K., the actuarial elements of the new system have been reduced somewhat by special provisions for low-income groups. Since the reforms in these two countries rely to a large extent on voluntary, rather than mandatory, pension saving, they are not depicted in figure 3. In the context of the figure, however, arrows somewhat similar to those of Poland and Latvia could represent these reforms.

Most of these reforms also have implications for the way different types of risk are shared in connection with disturbances, since they usually imply a change from defined benefit to defined contribution systems. In our terminology, this means that future shocks would be dealt with by changes in benefits rather than contribution rates. Thus, risk is shifted from workers to pensioners. Some of these reforms, however, affect the distribution of risk not only between workers and retirees, but also within these groups. In quasi-actuarial systems, or in fully actuarial systems with a centralized fund, shocks to the rate of return (G and R, respectively) affect everyone in the same proportion. By contrast, in a system with decentralized fund management, shocks affect each individual differently depending on his choice of fund. Thus we would in this case expect a larger intra-generational dispersion in realized pensions.

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have increased from about 25 percent in 1985 to about 250 percent in 2015 (Edward M. Gramlich, 1998, p. 32).

In summary, any pension system has its advantages and disadvantages. It therefore seems useful to combine different systems, along our three dimensions: actuarial fairness, funding, and risk sharing. In fact, real-world pension systems, do just that – often by incorporating four levels of pensions: (i) a basic pension, equal for everyone, or a guaranteed pension, below which no no-one's benefits will fall; (ii) a supplementary, mandatory pension, related to previous earnings or contributions; (iii) occupational pensions, often the result of collective bargaining; and (iv) voluntary, private pensions.

Recent pension reforms have mainly affected the second of these levels, in some countries by shifts to quasi-actuarial (sometimes denoted "notional defined-contribution") and/or actuarially fair, fully funded systems. The trend towards individualization is clearly reflected in levels (ii) and (iii) by a shift to individual accounts (notional or real). Strong expansion of level (iv) is also underway in several countries. This expansion is mainly spontaneous, but in some countries (e.g., Germany and England) it has been encouraged by government policies. These reforms do not diminish the need for basic, or guaranteed, pensions. Quite the contrary; growing reliance on quasi-actuarial and actuarially fair systems, which in themselves do not encompass any systematic intra-generational redistributive elements, makes it even more imperative to maintain a safety net to prevent poverty in old age.

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