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What Are the Gains from Pension Reform?*

by

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Abstract
This paper presents a unified analytical framework for the analysis of social security reform. It discusses reform along two dimensions: Pay-As-You-Go versus fully funded on the one hand, and actuarial versus non-actuarial on the other. Making the system more actuarial entails a trade-off between less distorted work incentives and intra-generational redistribution. Increasing the degree of funding entails a trade-off between more distorted work incentives, and redistribution in favor of future generations. If a PAYGO system already has strong actuarial elements, the additional welfare gain from making it fully funded derives from the possibility of portfolio diversification.

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1. Introduction

In many countries, pension reform is one of the most pressing issues on the political agenda. The issue is also heatedly debated among economists, but there is still no agreement about the nature and magnitude of welfare gains from various reform proposals.

In this paper, we address some basic principles of pension reform within a unified analytical framework, emphasizing efficiency aspects and redistribution across generations. In so doing, many problems that are important from a practical and administrative point of view are then left out, such as the division of pension rights when cohabitation is dissolved, consequences of international mobility of labor, and the political difficulties of adjusting contributions and benefits to changes in demography and growth.

After presenting our taxonomy of pension systems (Section 2), we discuss possible welfare gains within the context of existing Pay-As-You-Go systems (Section 3), and then examine whether additional gains can be achieved by shifting to fully funded systems (Section 4). We continue with an analysis of the consequences for saving (Section 5) and portfolio choice (Section 6). The paper ends with a brief summary (Section 7).

2. A Taxonomy of Pension Systems

In analyses of the potential gains from pension reform, the traditional distinction between defined-contribution (DC) and defined-benefit (DB) systems is sometimes of rather limited value. According to this taxonomy, a DC system, where an individual’s pension is directly related to his paid-in contribution, is distinguished from a DB system, where his pension is tied to "something else". Usually, however, DC systems are specified as fully funded systems with individual accounts, in which the return on an individual’s pension saving is equal to the return in financial markets. DB systems, by contrast, are usually specified as pensions tied, more or less closely, to an individual's previous earnings. Fixed benefits (equal for all) are then regarded as a special case of a DB system; see, e.g., Diamond (2000) and Thomson (1998).

Many important issues call for a more relevant taxonomy of pension systems. For instance, if we want to study how different pension systems distribute the effects of socioeconomic shocks among generations, a distinction between exogenous and endogenous contribution rates is more helpful (Lindbeck, 2000). In this paper, we examine the consequences of alternative pension systems for work, saving, the return on saving, and redistribution across generations. For this purpose it is useful to devise a taxonomy that highlights the distinction between actuarial and non-actuarial systems, as well as between funded and unfunded systems. This would give us the four "generic" pension systems illustrated in *Figure 1*. Of course, there are different degrees of actuarial fairness and different types and degrees of funding – an issue to which we return.

(Figure 1 about here)

Note that the distinction between PAYGO systems, with a yearly balanced pension budget, and funded systems, with intertemporal budget balance, is quite different from the distinction between actuarial and non-actuarial systems. Whether a system is funded or not is, in principle, independent of the benefit rules applied to pension payments. A system belonging to category III in *Figure 1*, for example, is funded even though it pays out a flat benefit, i.e., is completely non-actuarial. In fact, all funded systems without individual accounts (actual or notional) belong to this category. (Here, the purpose of the fund is to help finance aggregate pension expenditures, and hence to keep down and stabilize yearly contributions after the fund has been built up.) Moreover, a non-funded system in category II may have actuarial elements in the sense that there could be a close relation between an individual's benefits and his paid-in contributions.

To be more precise, in a non-actuarial system, the benefit of individual *i* is independent of that individual's earlier contribution:

$$b_i = \overline{b}_i . \qquad (1)$$

By contrast, according to our taxonomy, a pension system is actuarial if the benefits for individual *i* depend linearly on his earlier contributions. In a two-period framework, where the individual works and pays taxes during the first period of life, and is retired and receives a pension during the second period, we have (suppressing the time indices)

$$b_i = (1+a)t\, w_i \ell_i, \qquad (2)$$

where t is the contribution rate, w_i the individual's wage rate and ℓ_i his labor supply. The coefficient a is the return on the individual's contributions. If the individual chooses to work more (or to increase his effort in such a way that the wage rate goes up), the benefit will rise proportionally. For this to hold, we assume that $a > -1$ (for the extreme case of $a = -1$, there is no pension at all, neither actuarial nor non-actuarial).[1]

If the constant a is equal to the market rate of interest, we call the system fully actuarial, or actuarially fair.[2] If a is equal to something else, we call the system quasi-actuarial. Note that individual accounts (actual or notional) are required in order for benefit formula (2) to be applicable. Individual accounts are a prerequisite for a system to be actuarial or quasi-actuarial.

The definitions above refer to purely non-actuarial and (quasi-) actuarial systems. There are many intermediate cases. For instance, benefits may be related to contributions during only part of an individual's working life. In many countries, pensions comprise a given percentage of an individual's average earnings during the

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[1] Equation (2) refers to a two-period setting but is in fact general enough to fit into a multi-period framework. In such a case, $(1+a)$ should be regarded as a vector with elements corresponding to compound interest for different years. t is a scalar (the contribution rate is assumed to be constant over time) and $w_i \ell_i$ should be regarded as a vector, the elements of which are earnings at different dates. The yield represented by the vector a could vary over time, and might be stochastic, just like interest rates (for funded systems) and growth rates (for PAYGO systems). Since a multi-period framework complicates matters without yielding any additional general insight into the economics of the pension system, in most of the paper we adhere to the simple two-period setting of (2).

[2] In reality, there are many rates of interest. We return to this aspect in Section 6.

last *x* years of his career, or of earnings during the best *y* years.[3] There might also be floors and ceilings in the system, such that $b_i = \bar{b}_i^1$ for all $w_i \ell_i \leq y^1$, and $b_i = \bar{b}_i^2$ for all $w_i \ell_i \geq y^2$. Such systems, mixing actuarial and non-actuarial elements, cannot be fully captured by the simple two-period model underlying (1) and (2). Nevertheless, the benefits can in principle be written as a weighted sum of the two polar cases:

$$b_i = z \cdot \bar{b}_i + (1-z)t\ w_i \ell_i, \tag{3}$$

where *z* refers to the fraction of the individual's working life whose contributions do not affect benefits at all. The subsequent discussion is consistent with a benefit formula of this type.

In countries where pension reform is under consideration, the underlying system usually belong to category I, or an intermediate system between I and II.[4] In terms of *Figure* 1, a reform proposal may then be classified as either a *horizontal movement* to the right, or a *vertical movement* downwards.

Most reforms will have both distributional effects and efficiency effects (the latter via changes in tax distortions). Moreover redistributions may take place across as well as within generations.

3. A Move from I to II

Many countries have recently considered pension reforms in an actuarial direction within the framework of PAYGO systems – a horizontal move from I to II in our classification. By creating individual accounts based on individual contributions in a PAYGO system, such a system becomes quasi-actuarial. (A system of category II is often called a "notional defined contribution", or NDC, system.) The most

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[3] Here we encounter another distinction namely between earnings-based and contribution-based systems. In this paper we will not discuss this distinction. If the contribution rate t is constant over time, contribution-based and earning-based systems coincide.

[4] For discussions of pension reforms and reform proposals in different countries, see Gramlich (1996), Diamond (1996), and the papers in Siebert (ed., 1998), Feldstein (ed., 1998), and Feldstein and Siebert (eds., 2000).

straightforward way of achieving this is to make pension benefits proportional to the accumulated value of the contributions paid by the individual over his entire working life. Approximately the same outcome may be achieved if pensions are made proportional to the accumulated value of all *earnings* during working life, provided the contribution rate does not vary much over time. The main purpose of these types of reform, of course, is to improve work incentives via a reduction in the *marginal tax wedge* on earnings. We address this issue in the present section.

While a shift from a non-actuarial to a quasi-actuarial system is technically simple, it may be politically difficult. One reason is that it is impossible to avoid intra-generational redistribution in this case. Existing non-actuarial systems usually favor specific groups. For example, in a move to a quasi-actuarial system, women will experience losses in disposable lifetime income because they usually work fewer years than men. Moreover, a move from a system with lump-sum benefits (basic pensions) to a quasi-actuarial system disfavors individuals with very low income. It should be emphasized, however, that many existing PAYGO systems also include elements that favor upper-middle-class individuals at the expense of lower-middle-class income earners, such as manual workers. The explanation is that pensions in these systems are based on earnings during an individual's 10 or 15 best years. Such rules favor individuals with a steep income profile over their life cycle. Because such individuals often have a relatively high lifetime income, this specific element in today's PAYGO systems frequently redistributes lifetime income from middle-low to middle-high income earners.[5]

When an individual works one extra hour in a completely non-actuarial pension system (for example, a system with a lump-sum benefit), he pays an extra contribution $t\, w_{t-1}$, but his pension benefit, given by equation (1), is unaffected. Thus, the tax wedge on work is t. How much will the tax wedge be reduced by a move to a quasi-actuarial system? This question may be clarified by the two-period overlapping generations model in *Figure* 2. Here, we only consider a mature PAYGO system, and are not concerned with the start-up or termination of the system; these issues are discussed in Section 4 below.

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[5] See, for example, Ståhlberg (1990) for a study of the Swedish pension system from this point of view.

(Figure 2 about here)

In the figure, each individual's contribution during the first period of life is indicated by the notations below the line, while the benefit in the retirement period is indicated by the notations above the line. As before, an extra hour's work implies that the additional contribution $t\ w_{t-1}$ is paid. If the system is quasi-actuarial, an extra benefit $(1+g)t\ w_{t-1}$ is received, where g is the growth rate in the aggregate wage sum.

A fully actuarial, funded system is the natural benchmark when analyzing a quasi-actuarial PAYGO system. In the former system, the contribution is invested at the market rate of interest r, and the individual receives the extra pension benefit $(1+r)t\ w_{t-1}$ in period t as a result of one more hour of work in the previous period. The discounted value of that benefit, of course, is equal to the contribution $t\ w_{t-1}$; the individual gets back exactly what he has paid, and thus his intertemporal budget set is not affected. Therefore, no tax wedge on labor income is involved.

The discounted value of the difference in pension between a fully actuarial system and a quasi-actuarial system is thus

$$t\ w_{t-1} - t\ w_{t-1}\frac{(1+g)}{1+r} = t\ w_{t-1}\frac{r-g}{1+r}. \qquad (4)$$

This equation assumes that the wage rate w_{t-1} is the same for the two systems. From (4), we obtain a measure of the tax wedge in the quasi-actuarial system:

$$Tax\ wedge_{II} = t\ \frac{r-g}{1+r}\ .$$

The difference in the tax wedge between a non-actuarial PAYGO system and a quasi-actuarial PAYGO system is thus

$$Difference_{I,II} = t - t\,\frac{r-g}{1+r} = t\,\frac{1+g}{1+r}\,. \tag{5}$$

Is this a large number? Consider first the special case where the economy follows the golden rule, with $g = r$. The gain according to (5) is then t , that is, the entire tax wedge disappears in this case when moving from I to II in *Figure 1*.

But a more realistic scenario is that the economy does not follow the golden rule. Let us assume that $g < r$. Note that the growth rate and the interest rate in (5) refer to whole life spans, rather than to single years. A numerical example illustrates the magnitudes involved.[6] Assume that an individual starts to work at the age of 20, retires at 64 and lives for another twenty years. On average, the individual may be said to pay his contribution at age 42 and receive his pension at age 74. In a PAYGO system in which the contribution thus grows for 32 years, the yearly growth rate is denoted by g_1. On average, the pension is $t\,w_{t-1}(1+g_1)^{32}$.

This means that equation (5) above should be written[7]

$$Difference_{I,II} = t\,\frac{(1+g_1)^{32}}{(1+r_1)^{32}}\,, \tag{5'}$$

where r_1 is the yearly interest rate. If $t = 0.2$, $g_1 = 0.02$ and $r_1 = 0.04$, this formula yields the difference 0.107. That is, a move from a non-actuarial PAYGO system to a quasi-actuarial system reduces the tax wedge by 10.7 percentage points in this example, from 20 percent to 9.3 percent.

Since both the growth rate and the interest rate are uncertain, g_1 and r_1 should in principle be regarded as certainty equivalents.[8] It is therefore difficult to say whether 0.02 and 0.04 are realistic numbers. In principle, the more similar the two rates, the

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[6] This discussion was inspired by conversations with Martin Feldstein and Laurence Kotlikoff.
[7] In most of this paper, it is convenient to assume that an individual's working period is of the same length as his retirement period (this is, e.g., the case illustrated in *Figure 2*). In the calculation underlying equation (5'), however, the more realistic assumption of periods of different length is made since this does not add any extra complication.
[8] We postpone the discussion of risk considerations to Section 6.

larger is the reduction in the tax wedge. For example, if $g_1 = 0.02$ and $r_1 = 0.03$, equation (5') tells us that most of the tax wedge will be removed; the wedge is reduced by 14.6 percentage points (from 20 to 5.4 percent). If on the other hand $r_1 = 0.05$, the tax wedge is reduced by 7.9 percentage points only (from 20 to 12.1 percent).

4. A Move from II to IV

4.1 The Payments Flows

Let us now focus instead on a move from a quasi-actuarial to a fully actuarial system. We emphasize the gain (or loss) in *total* income of various generations, and hence the return on their forced savings, rather than the consequences for the *marginal* tax wedge on work as in the previous section; we return to the latter issue in Section 5.

Figure 3 illustrates the payment flows in the case of a move from a quasi-actuarial PAYGO system to an actuarially fair, fully funded system. The setup is basically the same as in *Figure 2*, but we now include more information because the pension claims of the old PAYGO pensioners have to be granted at the same time as the new pension system is built up.

(Figure 3 about here)

The last generation in the old PAYGO system, denoted generation 0 in the figure, was promised a benefit *b.* If the PAYGO system had been retained, this amount would have been financed by contributions of generation 1. We normalize the tax base $y_0 \equiv 1$ for generation 0. The tax base for generation 1, the first generation within the funded system, is then $y_1 = 1 + g$. For future reference, we thus note that

$$b = t(1+g). \tag{6}$$

As before, the diagram shows each generation's contribution in the first period of life below, and its pension in the second period above the line, respectively. For each generation, there are now two alternative expressions for contributions and two for benefits. The upper expression refers to the contribution (and benefit, respectively) within the old PAYGO system, while the lower expression denotes the contribution (and benefit) in the reformed, funded system.

Let us consider an arbitrary generation *t*. Under the old system, that generation would have paid a contribution $t(1+g)^t$ in the first period of life, and received a benefit $t(1+g)^{t+1}$ in the second period of life. After the reform, generation *t* would instead pay a contribution *plus* tax, $t(1+g)^t + q_t$ (where the tax q_t is used to finance the claims of the last PAYGO generation, i.e., generation 0), and receive benefit $t(1+g)^t(1+r)$ in the second period of life.

The size of the extra tax q_t will differ depending on how the claim *b* of generation 0 is financed after the move to a funded system. The time profile of the tax sequence $(q_1, q_2, q_3 ...)$ could be decided by the government according to its distributional preferences, under the restriction that the capital value of all these taxes has to equal the claim *b*. We now turn to some possible time profiles.

4.2 Gains and Losses

Under a quasi-actuarial system, the loss, i.e., the value of contributions *minus* the discounted value of benefits, for an arbitrary generation *t*, is

$$t(1+g)^t - \frac{t(1+g)^{t+1}}{1+r} = t(1+g)^t \frac{r-g}{1+r}, \qquad (4')$$

i.e., a generalization of equation (4) above.[9] This loss is a positive number since, by assumption, $r > g$, which means that the contributions paid are larger than the benefits received. In a mature PAYGO system, each generation incurs a loss by being forced to save at a return below the market interest rate. Since $g > 0$, the loss is increasing over generations.

[9] Here, too, we abstract from the induced changes in factor prices.

What is the corresponding loss in the new, actuarially fair system that replaces the PAYGO system? A generation may now have to pay both contributions to its own future pension and an extra tax to finance the obligation to generation 0. The difference between the total payments (contribution plus extra tax) and the discounted value of the benefit for generation *t* is

$$t\,(1+g)^t + q_t - \frac{t\,(1+g)^t(1+r)}{1+r} = q_t\,.$$

If there had been no extra tax (i.e., if generation *t* had not been obliged to help finance the claims of the last PAYGO generation), then the value of the payments minus the benefits would have been zero for that generation.

As regards some possible time profiles $q_1, q_2, q_3 ...$ for the extra tax, one alternative would be to let the first generation within the funded system pay a double contribution: $t\,(1+g) + q_1 = t\,(1+g) + t\,(1+g)$. For subsequent generations, it follows that $q_t = 0$ ($t > 1$).

But letting generation 1 bear the entire burden of the transition may not be regarded as fair. Another alternative would be to have the government issue a perpetual bond, letting all generations share the debt service equally. Thus we assume that $q_t = q, \quad t = 1, 2, 3, ...$ In this case, the government borrows $(b - q)$ in the capital market in the first period. This amount, together with the tax payment q of generation 1, is handed over to the last PAYGO pensioners, i.e., to generation 0. Each subsequent generation then pays an extra tax to cover the debt service $r(b - q)$. Since we require the tax on each generation to be the same, we have $q = r(b - q)$, i.e.,[10]

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[10] Another theoretical possibility is that the government borrows the entire amount amount *b* and gives it to generation 0. Since no interest is paid until one period later, generation 1 does not have to pay any extra tax in this case, while each subsequent generation pays an extra tax equal to *rb*; thus $q_1 = 0$ and $q_t = rb$ for $t > 1$. This assumption was made by Feldstein (1995). Although analytically attractive, this approach seems strange from a distributional point of view. When a move is made to a new pension system, the "transitional generation" would in such a case not have to pay anything for the transition; the entire burden would be shifted to subsequent generations (2, 3, 4, …).

$$q = b\frac{r}{1+r}. \tag{7}$$

In this special case, the loss incurred by generation *t* from a funded system is independent of *t*.

We now want to compare the loss to different generations under the old and the new system.[11] It is likely that the first generation in the reformed system would lose from the reform, in the sense that q is greater than $t\,(1+g)(r-g)/(1+r)$. Since the loss under the new system is constant over generations, while the loss under the old system grows exponentially, eventually there will be a generation that gains from the shift to the new system, i.e., there will be a *T* such that[12]

$$t\,(1+g)^T\frac{r-g}{1+r} = q = b\frac{r}{1+r}. \tag{8}$$

For all generations after generation *T*, the value of the left-hand side is greater then the value of the right-hand side. Taking (6) into account, (8) can be written

$$(1+g)^{T-1} = \frac{r}{r-g}$$

which has the solution

$$T = \frac{\ln\left(r/(r-g)\right)}{\ln(1+g)} + 1. \tag{8'}$$

This expression in fact proves our earlier conjecture that the first generation after the reform will lose: since the right-hand side of (8') is greater than unity, $T > 1$.

[11] The "initial" generation in the PAYGO system, which has received a gift, is not shown in *Figure 3*. Generation 0 is the *last* generation in the PAYGO system.

[12] Strictly speaking, a generation index can only be an integer. If the solution to equation (8) turns out not to be an integer, the winners from a reform are all generations with an index > *T*.

Let us illustrate the issue by a numerical exercise. As in the example in Section 3, we assume that the yearly interest and growth rates are $r_1 = 0.04$ and $g_1 = 0.02$, respectively. Since the time period is not a year, but a generation, which we assumed earlier to be 32 years, we obtain the thirty-two-year equivalents of the yearly rates as

$$r = (1.04)^{32} - 1 = 2.51$$
$$g = (1.02)^{32} - 1 = 0.88$$

Substituting these rates into the formula above, we obtain $T = 1.68$, thereby confirming our general reasoning. Thus, while generation 1 will lose from the reform, all subsequent generations will gain. It should be kept in mind that this example only serves to clarify the basic mechanism without claiming any high degree of numerical realism.[13] The result is however not overly sensitive to modest changes in parameter values. For example, if $r_1 = 0.03$ instead, we obtain $T = 2.30$, while for $r_1 = 0.05$ we get $T = 1.42$.

4.3 Is a Pareto Improvement Possible?

The example above, which showed that the first generation in the new system loses while subsequent generations gain from a reform, brings up the question of whether the losers could be compensated by the winners. More specifically, can a Pareto-efficient transition, from category II to category IV in *Figure 1*, be brought about by a suitable time profile of government debt?

Above, the two alternative shapes of the time profile $q_t, q_2, q_3...$ of the extra tax to finance the old PAYGO pensioners were (i) a double contribution by the transition generation, and (ii) an evenly distributed tax according to (7). In fact, the tax profile can also be designed in such a way that each generation receives the same lifetime income as if the old PAYGO system had been retained. Since the loss to an arbitrary

[13] In contrast to the calculation underlying (5'), we have now made the simplifying assumption that an individual's period of working life is of the same length as the retirement period. A more realistic estimate of the "break-even generation", with different lengths of working life and retirement, would require a rather complicated simulation model with a large number of overlapping cohorts. Simulation models of pension reforms have been employed by several authors, for example Feldstein and Samwick (1998), Kotlikoff (1998) and Gustman and Steinmeier (1998).

generation t under the old PAYGO system is given by (5), we simply choose q_t so that it is exactly equal to the loss to all participants of the PAYGO system:

$$q_t = t\,(1+g)^t \frac{r-g}{1+r}. \tag{9}$$

With such a tax, each generation t will be indifferent between the old PAYGO system and the new, funded system requiring each generation to pay the extra tax q_t. In order to satisfy the intertemporal budget constraint of the new pension system, the discounted value of this tax stream has to be greater than or equal to the claim of generation 0:

$$\sum_{t=1}^{\infty} q_t \frac{1}{(1+r)^{t-1}} \geq b.$$

Substituting from (9), this can be written

$$t\,(r-g)\sum_{t=1}^{\infty}\left(\frac{1+g}{1+r}\right)^t \geq b. \tag{10}$$

If (10) is satisfied as a strict inequality, the reform would constitute a Pareto improvement. Everyone would then be at least as well off as before the reform but there would also be some money left over that could be used to make someone strictly better off. Since $b = t\,(1+g)$ for the old PAYGO system to be viable, (10) can be written

$$(r-g)\frac{1+g}{r-g} \geq 1+g,$$

which obviously cannot be satisfied as a strict inequality. Thus a shift from the old PAYGO system to a funded system (i.e., a shift from II to IV in *Figure 1*) can never constitute a Pareto improvement.

4.4 Adding Individual Gains and Losses

Let us now assume that we are not interested in a Pareto improvement, but have a social welfare function which we use to aggregate individual gains and losses over generations. The loss to generation *t* of participating in the old PAYGO system was $t(1+g)^t(r-g)/(1+r)$. The capital value of this infinite stream of losses, discounted to the time of the reform (i.e., to the first period in life of generation 1), is

$$Loss_{PAYGO} = \sum_{t=1}^{\infty} \frac{t(1+g)^t(r-g)}{1+r} \frac{1}{(1+d)^{t-1}} = \frac{t(r-g)(1+g)(1+d)}{(1+r)(d-g)} \quad (11)$$

where d is the social discount rate, i.e., a discount rate used to compare incomes across generations. This is basically the same exercise as in Feldstein (1995). Shiller (1999) and Sinn (1999) present similar analyses, but do not make a distinction between *r* an *d*.

For the infinite sum in (11) to converge, we assume that $d > g$. The social discount rate d may be less than or greater than the market interest rate *r* (see below). Note that if $d = r$, then the capital value in (11) simplifies to $t(1+g)$ which is equal to *b* by (6). Note also that the sum in (11) is decreasing in d, which means that $Loss_{PAYGO}$ is greater than $t(1+g)$ for all $d < r$.

Since the loss to generation *t* of participating in the new, funded system is equal to q_t, the capital value of the losses of all generations is

$$Loss_{funded} = \sum_{t=1}^{\infty} q_t \left(\frac{1}{1+d}\right)^{t-1}. \quad (12)$$

We know that for the special case where $d = r$, this sum is equal to *b*. The sum is also decreasing in d, but we cannot say whether it is decreasing faster or slower than the sum in (11). To put some more structure on the problem, we apply one of the earlier alternatives for the tax profile, namely that the tax is the same for all generations: $q_t = q = br/(1+r)$. We can then rewrite (12) as

$$Loss_{funded} = \frac{br}{1+r}\frac{1+d}{d}. \qquad (12')$$

Clearly, (11) is greater than (12’) if and only if $d < r$. Thus, if and only if the social discount rate is lower than the market interest rate (when the extra tax is constant over generations) will social welfare increase by a move from II to IV. This was shown earlier by Feldstein (1995), who furthermore claimed that there is reasons to assume that $d < r$. Indeed, this raises a profound philosophical question: whether (and how) to discount for time among generations and not only within generations.

Two aspects should be noted when evaluating the above results. First, the reform under discussion is profitable only in terms of a value derived by aggregating in a specific way over generations. In other words, the analysis requires comparing individual incomes of different generations by means of a social welfare function. As we showed in the previous subsection, a move from II to IV can never be justified by the Pareto criterion. Second, the conclusion is based on the assumption $q_t = q$. For some other time profile of the tax q_t, the opposite conclusion may hold.

The case $d < r$ means, in fact, that the intergenerational income distribution is not optimal from the point of view of the chosen intergenerational discount rate, which reflects an intergenerational, distributional evaluation. We may alternatively say that the present saving rate, and the future capital stock, is suboptimal. Suppose we would, therefore, like to redistribute income from the present generation to future generations. This can obviously be accomplished by shifting to a funded social security system which, together with a suitable tax profile $\{q_t\}_{t=1}^{\infty}$ increases income for future generations (after time *T*) at the expense of present generations. But this objective could also be achieved without reforming the pension system. In principle, by retaining the old PAYGO system and imposing a suitable tax profile $\{q_t\}_{t=1}^{\infty}$, over generations, we can always bring about the desired redistribution. There is, in principle, no need to carry out a pension reform if the sole objective is to achieve such a redistribution.

In this perspective, the issue of pension reform could be rephrased as a question of *framing* intergenerational redistribution policy. Suppose we want to change the intergenerational income distribution in favor of future generations, but that such a change (for example, in the form of increased aggregate savings today, and/or faster amortization of the public debt) is not politically feasible. Pension reform could then serve to make a desired redistribution politically palatable by pretending to do something else. This takes us into deep water, however. For example, the question would arise as to who are really behind such a redistribution. This group is obviously not the electorate, since the electorate would have to be deceived by disguising the income redistribution. In any event, the scholarly debate on the pros and cons of a shift to a funded system usually does not invoke the need to frame the argument for intergenerational reforms in this way.

5. Effects on Savings

The analysis in Section 3 concerning the effects on work incentives of a shift from a non-actuarial to a quasi-actuarial system was straightforward. Here, we instead examine the consequences for saving. For simplicity, to begin with we disregard the effects on work (for example, by regarding labor supply as totally inelastic).

Figure 4a depicts, in a textbook-like manner, the budget set for an individual living for two periods, who works only during the first period. Income during that period is Y, which can be spent on consumption during the first (C_1) and second period (C_2). In the absence of a pension system, the individual would choose the optimal combination on the budget line *AY*, which would imply saving S_a.

Assume now that a PAYGO system is introduced. *Figure 4a* depicts the choice set of an individual who belongs to the first generation under the new pension system. This generation receives pensions without having paid any contributions. Hence, the introduction of a PAYGO system means that the budget line is shifted upward. If consumption in period 1 is a normal good, savings fall from S_a to S_b. But since the new budget line has the same slope as the old one, the introduction of a PAYGO system does not distort the savings decision; no tax wedge is driven between the market rate of interest and the interest received by an individual saver. The fall in savings depends only on an income effect since the first generation in the PAYGO system receives a lump-sum gift (in the second period) from subsequent generations. (We neglect possible intergenerational links via bequest.)

The change in wealth for subsequent generations is a mirror image of the situation for generation 1, as shown in *Figure 4b*. Before the introduction of any compulsory system, the individual earns Y in period 1 and saves S_a. The introduction of a PAYGO system has two effects. First, the individual has to pay a compulsory fee $tY \equiv Y - Y_D$ that reduces his disposable income Y_D while he is of working age. Second, the individual gets back $(1+g)(Y - Y_D)$ when old, with the capital value $(1+g)(Y - Y_D) / (1+r)$. For $g < r$, which is the case that we consider throughout, this value is less than the contribution $(Y - Y_D)$. Thus the new budget line will be located below the old one, as shown in the figure. For an arbitrary generation *t*, the horizontal distance between the old and new budget lines is equal to the present value of the tax payment $t\,(1+g)^t\,(r-g)/(1+r)$, as demonstrated in section 4.2 above (eq. 4'). Note again that the slope is the same for both budget lines. After having paid the compulsory contribution, in both cases the individual chooses his saving on the basis of the market interest *r*. If consumption in period 2 is a normal good, savings will fall also for the second generation (from S_a to S_b in *Figure 4b*).

This, however, is not the end of the story. Since both generations unambiguously reduce their saving, the capital stock falls. As a result, subsequent generations experience lower real wages, and thus lower earnings than if no PAYGO system had been introduced. Thus, there is a further inward shift of later generations' budget lines[14] - in addition to the shift caused by the present value of the tax $t\,(1+g)^t\,(r-g)/(1+r)$. Since a lower income normally results in lower saving (assuming consumption is a normal good) , the steady-state capital stock falls even

[14] In the figure, the slope of the budget line (i.e., the rate of interest) is assumed to be the same before the reform as after. This is a realistic assumption for an economy with a completely open capital market. In a closed economy, however, the lower capital stock might lead to a higher interest rate. If so, the new budget lines would be steeper than the old ones. But there is still no distortion of the savings decision involved. The income effect generates a change in the interest rate, but the intertemporal rate of transformation is nevertheless the same as the agent's intertemporal rate of transformation.

more. Note, however, that even though the introduction of a PAYGO system leads to a fall in the steady-state capital stock; again no savings distortion is involved.

The issue is further illustrated in *Figure 5*, where we show the change in the welfare of different generations as the result of introducing of a PAYGO system. Assume for simplicity that the economy is originally on a steady-state growth path, denoted by the dashed curve. It is immaterial to the argument whether this means a constant growth rate or a constant GDP level; in the figure we have depicted the situation as if it were the latter. At time T_1 a PAYGO system is introduced. This leads to a welfare gain for the generation working at that date, just as we saw in the indifference curve diagram in *Figure 4a*. The fall in the capital stock, however, drives the economy away from the golden rule. Steady-state consumption, and thus welfare, will be lower for all subsequent generations (the solid curve in *Figure 5a*) than if no PAYGO system had been introduced (the dashed curve).[15] Since there is no deadweight loss involved, the capital value of the lower level of wealth for all future generations is exactly equal to the gain in wealth for the first PAYGO generation.

This discussion refers to the introduction of a PAYGO system from scratch – or alternatively a shift from a fully funded to a PAYGO system (assuming no liquidity constrained individuals). The converse policy, i.e., of moving from II to IV in *Figure 1*, instead implies that some transition generation(s) will face a downward shift of the budget line(s), while subsequent generations will face upward shifts. The consequences of such a reform for the distribution of welfare across generations are shown in *Figure 6*. The steady-state welfare level under a PAYGO system is shown by the solid curve. At time T_2 this system is replaced by a fully funded system. At least some generation (depending on the time profile of the tax q_t) will then be forced to reduce its consumption, with and increased saving for the national economy as a result. The resulting higher capital stock will lead to higher welfare for future generations, at the expense of a transition generation.

[15] Here we disregard the free-rider problem that may provide a basis for government intervention in the provisions for old age. This is an argument for compulsory systems in general, and we abstract from that question in order to focus on the issue of funded vs. PAYGO systems.

Recall that we discussed three possible time profiles for the tax q_t. According to one alternative, the first generation pays a double contribution ($q_{T_2} = b$, while $q_t = 0$ thereafter). This is denoted by the dashed curve in *Figure 6.* In a second alternative, the tax is distributed evenly ($q_t = br/(1+r)$ along the lines of the discussion of gains and losses in section 4.2. This is denoted by the dotted curve. Clearly, the choice of time profile for q_t is a question of intergenerational distribution. Should the government hit one or a few generations hard, thereby securing a relatively quick return to the pre-PAYGO welfare level? Or should it, as denoted by the dotted line, spread the burden over a large number of generations, thereby only slowly approaching the higher (pre-PAYGO) steady-state welfare level?

Under the third alternative, q_t is set according to equation (9), which means that consumption is unaffected by a shift from II to IV. The economy will continue to follow the solid curve in *Figure 6*, depicting consumption in the case of a PAYGO system into an infinite future after the reform.

So far in this section, we have neglected the issue of work incentives (treating labor supply as inelastic) and instead focused on saving. It should, however, be kept in mind that a shift from a non-actuarial PAYGO system to a quasi-actuarial PAYGO system or to a fully actuarial system will also have indirect consequences for saving as a result of work incentives being less distorted. Specifically, it is reasonable to assume that aggregate labor supply would increase since the reduced tax wedges result in a substitution effect in favor of labor supply. Because both the actuarial and the non-actuarial systems run balanced budgets, there is no direct effect on the aggregate income of households. (There may be income effects on the labor supplies of individual households, but these tend to cancel.) Thus, we would expect the aggregate substitution effect on labor supply to dominate over the aggregate income effect, resulting in a rise in national income.[16]

[16] When calculating the welfare consequences of pension reforms, it is necessary to consider not only tax wedges, but also induced changes in factor prices, including those emerging from income effects.

Assuming that period 2 consumption is a normal good, the higher national income leads to increased savings, and the economy moves closer to a golden rule path. Thus, the gains to future generations will actually be higher than indicated in *Figure 6*.

By appropriate policy measures, these additional gains can also be enjoyed by the first few generations in the reformed system, i.e., by generations that would otherwise make a loss from the reform. Specifically, these generations can – at least in principle – be compensated for their losses. A move from I to IV can then bring about a Pareto improvement. This is in fact the mechanism behind the Pareto improvement from social security reform in Homburg (1990) and Breyer and Straub (1993), who have argued that a move to a fully funded system will be Pareto-improving since the marginal tax wedge is reduced, and part of the efficiency gain could be used to bail out the old PAYGO pensioners. But this efficiency gain is really derived from the horizontal move in *Figure 1*, not from the vertical move from II to IV, although the authors give the impression that the Pareto improvement is caused by the funding *per se*.

The discussion in this section highlights the distinction between “narrow” funding (a shift to a funded pension system without increased national saving) and “broad” funding (a shift to a funded system that raises the aggregate savings rate of the national economy); see Diamond (2000). In our framework, the choice between narrow and broad funding can be expressed in terms of choosing a tax profile $q_1, q_2, q_3, ...$ If early values of q_t are positive, then we have broad funding in the sense that the aggregate savings rate is increased. Future generations will then be able to enjoy a larger capital stock owing to the shift to a fully funded system. Clearly, proponents of funded pension systems often have, explicitly or implicitly, such a shift in mind. But then it is important to realize that this outcome requires $q_t > 0$ for one or two early generations. These higher tax rates constitute a redistribution from earlier to later generations, and also imply a higher marginal tax wedge on work for the former.

What then are the arguments for such a redistribution, when later generations will anyway be richer than earlier ones? Feldstein (1995, 1996) justifies a shift to a fully funded system by a second-best argument. Since saving incentives are distorted by the tax system, a social security reform may counteract these distortions and hence increase the capital stock. But there is a complication here: the higher capital formation then occurs at the cost of larger distortions on work due to the higher marginal tax rates q_t on labor.

Sinn (1999), on the other hand, suggests a shift to a funded system to compensate for a fall in *human* capital accumulation. This fall (which implies a fall in the aggregate growth rate *g* and thus in the yield of the PAYGO system) is the result of lower nativity of the working generation. Since a PAYGO system can be regarded as an implicit contract between generations, such a fall in nativity could be interpreted as a breach of that contract. Sinn simply wants the working generation to compensate the pensioners for this breach of contract by being forced to accept higher compulsory savings, with an increased accumulation of real capital as result.

While broad funding increases a nation's wealth, will it also increase the domestic stock of real capital (buildings and machines)? This depends largely on the degree of openness of domestic capital markets and a possible "home bias" in the portfolio choice of citizens. Historically, openness has certainly not been complete, and home bias has been a fact of life. It is likely that the ongoing internationalization process will gradually make these features recede. Before this occurs, however, we would expect not only a rise in financial claims on foreigners but also an increase in the domestic stock of real capital.

It is often noted that the domestic portfolio bias is particularly strong for investment in small family firms. From that point of view, there is a strong case for boosting domestic saving if we want to stimulate real capital formation among such firms. But pension saving is certainly not the best type of saving for that purpose. Small family firms need savings within the family itself or among personal friends and business friends. Thus, concern for family firms is an argument for lower taxes on saving and profits, rather than for a pension reform with broad funding, i.e., with higher initial taxes $q_1, q_2, q_3, ...$ on labor for early generations after a pension reform.

6. Reform within IV

While there are some efficiency gains in the labor market by moving from I to II (due to a reduction in the marginal tax wedge on labor), our discussion so far may give the impression that there are no additional efficiency gains by moving from II to IV. This impression, however, relies on a simplistic picture of the set of financial instruments available to fund managers.

Up until now, we have assumed that there is only one interest rate and that we live in a world without uncertainty. Once these unrealistic assumptions are relaxed, a new argument for introducing a fully funded system emerges: the advantage of diversification. From the point of view of an individual, the forced saving in a PAYGO system is invested in a single “asset”: the domestic tax base.[17] Since the growth rate *g* of the tax base is necessarily uncertain, investing in other assets, whose yields are not perfectly correlated with *g*, raises welfare. Such assets are made available in a compulsory pension system when shifting from II to IV. Thus welfare will increase by such a move, but not for the reasons usually set forth by the advocates of such a reform.[18]

Note, however, that this does not imply that PAYGO systems should be abandoned altogether. As pointed out by e.g. Persson (2000), a well-diversified pension portfolio should contain both the PAYGO “asset” and traditional, financial assets. Thus, in a well-diversified pension system, a certain percentage of the contribution $t\, w_i \ell_i$ should be allotted to a PAYGO component, while the rest should be paid into a funded component.[19]

Moreover, within the array of traditional, financial assets, there is no *a priori* reason to limit a portfolio to domestic assets. In fact, since the PAYGO component is by

[17] Since GDP is an aggregate over many production sectors, one might of course say that the tax base is a composite “asset”.

[18] It has been argued that there is no gain from shifting from a PAYGO to a funded system which invests in stocks. The higher yield on stocks is merely compensation for the higher risk. (cf. Mueller, 1998) This argument disregards the gains from diversification.

[19] In the new, Swedish system, the contribution rate t is 18.5 percent. Of this, 2.5 percentage points go to a funded component, while the remaining 16 percentage points go to a quasi-actuarial PAYGO system of category II. These fractions are the result of a political compromise.

definition domestic, hedging against country-specific shocks calls for a relatively large fraction of foreign assets in the portfolio.

Is the so-called "equity-premium puzzle" an additional reason to invest pension saving in stocks? Empirical studies indicate that over the last century, stocks have had a higher yield than required to compensate for risk.[20] It is a controversial issue whether this reflects an anomaly in the stock market, or whether traditional measures fail to cover all types of risk that are relevant for investors (for example, the risk of catastrophes). In both cases, however, the diversification argument still holds – although the argument for having a large fraction of shares in the portfolio is strengthened in the former case.

A particular feature affecting pension systems is political risk. It is reasonable to assume that this type of risk differs among systems. For instance, PAYGO systems are likely to be more subject to political manipulation than funded systems since property rights are better defined in the latter. If this observation is correct, this particular twist of the diversification argument strengthens the case for having at least some part of the system funded.

Unfortunately, it is difficult to determine what the probability distributions of different asset yields really look like. While it is easy to estimate variances and covariances for most assets over a time horizon of days, weeks, and years, the relevant investment horizon for a pension fund is several decades. For such long horizons, our empirical knowledge of the stochastic processes governing these yields is very limited. This limitation is particularly apparent in relation to political risk. There are simply no reliable estimates of the probability distributions for various forms of political manipulation of funded versus PAYGO systems.

Indeed, some types of political risks go beyond what can reasonable be handled within the context of standard portfolio analysis. One example is the temptation for politicians to buy shares in firms willing to invest in regions that are pivotal in coming elections. This might be regarded as a portfolio risk, though it may be difficult to

[20] See Siegel and Thaler (1997).

quantify. But there is also a risk that in the future, some politicians will insist that they, or their representatives, should be appointed to the boards of the firms in which government-operated funds own shares. Nationalization of share ownership – also via government-operated pension funds – is bound to create risk of politicization of the national economy. Technically, it is always possible to design rules according to which government-operated pension funds should only invest in some broad stock-market index (domestic and/or foreign), management of the funds should be outsourced to private institutions and these private institutions should exercise the voting power associated with these shares. But future politicians can always change such rules. In order to avoid politicization of the national economy, there is a strong case for letting individuals choose to hold their pension savings in private funds from the very beginning.

Administrative (and, in particular, marketing costs) will usually be higher with decentralized private funds than with centralized government-operated funds,[21] at least in highly developed countries. But it is often necessary to pay a price for minimizing the risk of the misuse of political power. Moreover, the administrative costs in privately run, compulsory pension funds can be brought down significantly, either by requiring them to opt for broad stock-market indices rather than individual stockpicking, or by putting caps on their administrative fees.

7. Summary and Conclusions

Instead of the traditional distinction between defined-benefit and defined-contribution pension systems, we have chosen a two-dimensional classification: non-actuarial versus actuarial, and funded versus PAYGO systems. Such a classification makes it simple to decompose the gains from pension reforms of various types. We have thus shown the following:

- Regardless of whether an initial system is funded (although without being fully actuarial) or PAYGO, increasing the actuarial elements of the system can always reduce the marginal tax wedge on work. We have illustrated this as a horizontal

[21] See for example Mitchell (1998) and Diamond (2000).

move to the right in *Figure 1*. Starting with a non-actuarial PAYGO system, and making it quasi-actuarial (a move from I to II) does not, however, remove the entire tax wedge if the market interest rate is higher than the growth rate of the tax base. For realistic numbers, around half of the tax wedge may disappear with such a reform.

- There is no additional welfare gain in the form of a reduced tax wedge on work, and an increased return on forced pension saving by moving from a PAYGO to a funded system – except via increased portfolio diversification. We have illustrated this as a vertical move in *Figure 1*. The reason is that the pension claims of the last PAYGO generation have to be honored. As has been shown by others (e.g. Sinn, 1999), the capital value of these claims is exactly the same as the capital value of the gross gain of having a return on pension savings equal to the market rate of interest rather than the growth rate of the economy. As we have seen, this holds regardless of the growth rate and the market interest rate. It is, of course, possible in principle to redistribute wealth among generations via pension reforms. But such redistributions can be achieved through an appropriate debt/tax policy, without having to reform the pension system.
- Aggregate saving can certainly be increased by moving from a PAYGO to a funded system. What is required for this result is that during the transition to a new system, earlier generations bear a considerable part of the burden of old pension claims. But such an increase in saving can also be achieved through an appropriate debt/tax policy, although it may be politically easier to accomplish by a pension reform than by a general tax increase. In such a case pension reform would be an example of the importance of "framing".
- As usual when choosing between tax and debt financing, there is a trade-off between the desire to increase aggregate saving and the desire to keep down the marginal tax wedge on work. Basically, this is also a conflict among generations which is difficult to avoid with pension reforms, and which accentuates the political problems that are associated with such reforms.
- The preceding points do not preclude the possibility of other types of efficiency gains from moving to a fully funded system. These gains derive from portfolio diversification. By combining a PAYGO and a funded system, an individual's forced saving would be invested in two types of "assets": one with a yield equal to

the growth rate of the tax base, the other with a yield equal to the market rate of interest. Since the latter type of asset comprises many different financial instruments, further diversification is of course possible for funded pension capital. Exploiting the so-called equity premium puzzle, i.e., by enjoying the apparent excess return on stocks, may enhance the gain from such a diversification.

- To limit the risk of politicization of the national economy, there are strong reasons to make the funds of compulsory pension systems private from the outset.

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