A SOLUTION TO THE SOCIAL SECURITY CRISIS FROM AN MIT TEAM

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Franco Modigliani, Marialuisa Ceprini, Arun S. Muralidhar

Sloan Working Paper 4051 -- *November 1999 (Third Revision)*

SUGGESTED PASSAGES FOR THE HURRIED READER

The following passages highlight the essential novel contributions of our approach.

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Abstract and Executive Summary

We propose a "permanent solution" to the problem of financing Social Security (SS) which aims to ensure the maintenance of the current structure of *defined benefits*, while avoiding a sharp rise in contributions and permitting, instead, a significant decline. The solution replaces the existing unfunded pay-as-you-go (PAYGO) system of financing pensions with a new public system -the New Fund (NF)- that relies on the financing structure of traditional funded pension plans. The proposed structure of the NF can be characterized as follows: i) *fully funded, i.e.,* contributions are totally invested in (financial) assets which are eventually used as the sole source of financing pensions; ii) offering *defined real benefits,* based on; iii) a *fixed rate of return on contributions* guaranteed by the sponsor who, in turn; iv) is responsible for managing the accumulated funds with the expectation of at least recouping the promised rate. The novelty is that the sponsor of the pension fund would be the Government, on behalf of all its eligible citizens, that the benefits are guaranteed in real terms through a guaranteed real rate of return (using an innovative swap

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transaction), and that participants will be entitled to *individual accounts.*[1]

The PAYGO system must be discarded as financially unsound and unreliable as the contributions -basically a mandated saving- are used entirely to finance pensions, and thus, to support consumption. As the capacity to pay current pensions is dependent on income earned by currently active participants, the contributions required for given benefits are highly sensitive to unforeseeable changes in the demographic structure and the growth trend of productivity. To illustrate, the Social Security system in the United States (and much of the world) is becoming incapable of delivering the promised benefits at current contribution rates, despite generous subsidies from the government budget, due to the unforeseen decline in the growth rates. To keep Social Security solvent would require an increase in contributions of about 50 percent, by the middle of next century. Yet, there is no assurance that even this major adjustment would prove long lasting. In any event, if growth is small, required contributions become crushing; *e.g.,* the contribution required by the middle of next century to pay for today's benefits is estimated at 17 percent of taxable wages.

In contrast, the mandated saving in a fully funded system is invested entirely in (financial) assets and, by the time of retirement, the gradual accumulation and the return thereof provide the sole source for the pension. The substantial lifetime accumulation contributes to raise national savings and the capital stock and the income thereof enriches the country and, in addition, makes it possible to substantially reduce

[1] We would also favor indexation of the retirement age to life expectancy.

the contributions needed to finance the benefits, under any reasonable assumptions about the outlook for the return to capital as compared with prospective income growth. For instance, by opting for a funded system, the current contribution could be reduced by half in the next 50 years, whereas, according to current projections (intermediate assumptions) the PAYGO would require an increase of some 50 percent, or a levy three times larger than with funding! In addition, as the pension is paid from capital and not from the contribution of younger participants, the required contribution is *unaffected by changes in population structure* and depends only to a minor degree on changes in productivity growth. Its main determinant, instead, is the (long run average) return on the financial investment, but even variations in this variable, within historically realistic limits, would not require drastic changes in the contribution rate. Finally, under PAYGO, any attempt to change, and especially lower, benefits and contributions runs into the "transition problem" (see below). This problem does not arise with a funded system.

The lower cost-to-benefit ratio, greater flexibility and superior financial solvency with stable contributions, make the fully funded system vastly superior to PAYGO. This conclusion also suggests that there is no basis for stopping at any intermediate solution, short of full funding.

One might be misled into confusing the NF solution g proposed here, based on funding and individual accounts, with the alternative, frequently proposed, for the U.S. and even extensively implemented in South America, referred to with the misnomer of "privatization" of

Social Security. The basic feature of the latter approach consists of diverting mandated contributions from the public pension system to *individual accounts* for investment in a portfolio of marketable securities, managed by chosen private providers (generally within regulatory constraints). In reality, this so-called privatization differs from, and is inferior to, the proposed NF solution in five respects.

- First, the South American alternative inevitably results in a defined contribution scheme (DC) that is inferior to defined benefit scheme (DB) as it greatly increases the risk borne by individuals. This is especially serious for poorer and less sophisticated participants who are least equipped to bear this risk.[2]

- Second, it fosters inequalities by causing equal compulsory contributions to result in different pensions within a cohort and across cohorts, with some pensions altogether inadequate for sustenance. The very spirit of a public pension scheme, aiming at a modest replacement rate, demands that participants should not be allowed to gamble with their retirement nest egg. It has been proposed that the consequences of socially unacceptable low outcomes can be avoided by guaranteeing a minimum outcome portfolio returns are too low, the government could provide a supplement. (See, for example, the reforms of Mexico and Chile and the Archer Swan plan for the U.S.) But this approach significantly increases the cost of the pension system by increasing the average benefits above that resulting from

[2] See Modigliani and Ceprini (1998d) , Modigliani and Ceprini (1999b), Muralidhar and van der Wouden (1998a).

providing all participants with a defined benefit related to average return, and distributes the increase in a capricious way Indeed those who do better keep the surplus. While those who below minimum must be covered by additional outlays of the system. And, the problem is aggravated by the fact that the system encourages irresponsible risk taking. Defined contribution schemes are acceptable for voluntary saving, but not for the compulsory component.

- Our defined benefits system clearly shifts to the government the risk that the return on the market portfolio may fall short of the return guaranteed to the NF. Under a mandated DB scheme this risk is minimized. Moreover, the government is in a far better position to absorb this risk because of its size and because, with infinite life, it can redistribute the risk of a single cohort over a large number of cohorts. Furthermore, it would de facto bear this risk (and at a higher level) in the defined contribution case, if, *de jure* or *de facto*, it insured some minimum outcome. [3]

- Third, it is more efficient to offer means-tested pensions and ensure redistribution objectives from DB schemes than from DC schemes. DB schemes, like the current SS, provide a valuable service to society by offering means-tested pensions. This would be extremely difficult and expensive to provide under a DC umbrella. In our DB scheme, this goal could be ensured implicitly through the structure of the fund and explicitly, through appropriate rules, for instance, by making the ratio of the annuity

[3] See Heller (1998) and Muralidhar and van der Wouden (1998a).

to terminal accumulation a decreasing function of the size of the terminal accumulation, relative to the average.

- Fourth, management of individual portfolios can be very costly, especially, for those with small portfolios. In South America, the charges by the government-authorized funds have supposedly run up to 20% of contributions.[4] Instead, in the fully funded NF scheme, all of the participants' assets would be pooled and invested in a fully-indexed portfolio. Managing the fully indexed portfolio of the government is a purely mechanical operation that, we know, can cost no more than a small fraction of 1%. Equally important, the passive indexation immunizes the NF from the critique that politicians will manipulate the fund's growing assets.

- Fifth, this approach lends itself to portfolio diversification over large regions such as Euroland, the Pacific and Caribbean islands. Not only will countries benefit from economies of scale and international diversification, but pooling diversified groups of participants will also lower liability risk.[5] Finally, moving to a funded system permits introducing other significant innovations, discussed in the text.

In the past, a major obstacle in moving from an unfunded to a funded scheme has been the presumed high cost of transition that must be paid by the current and/or future generations. Indeed the contributions necessary to build the new fund cannot simply come

[4] See Guerrard (1998).
[5] See Muralidhar and van der Wouden (1998b).

from diverting the contributions to PAYGO to the NF because PAYGO needs those contributions to pay the pensions to those who have acquired the pension right trough earlier contributions. Those contributions have to be paid to the New Fund in addition to the old Social Security system.

Drawing on the basics of pension finance, we have developed an operational method for carrying out the transition at small and bearable costs for every generation, proceeding very gradually and relying on alternative allocations. We apply our approach to the United States[6] and show that, by relying on a combination of contributions by the government (using budget surpluses already promised to SS in the President's proposal in the Mid-Session Review of the Budget) and investment policy (investing efficiently the Trust Fund and future contributions), it is possible to complete the transition from PAYGO to a fully funded system with contributions eventually *reduced by as much as two-thirds, without any increase in contribution* along the way. The time required to *complete* the transition is not well defined. In the first place the approach to he new steady state could be nearly asymptotic. But what is more relevant is that we demonstrate, that for any given rate of return, there are multiple possible transition paths that involve a trade-off between the timing of reductions in contributions and length of time to final equilibrium. In a sample simulation shown in Table 3 and the appendix we show that although the steady state may only be reached by the end of the third quarter of the next

[6] As the approach is general, it can be applied to other countries as well. See Modigliani and Ceprini (1998a), Modigliani and Ceprini (1998b), Modigliani and Ceprini (1998c), Modigliani, Ceprini and Muralidhar (1999), Modigliani and Ceprini (1999b), Modigliani and Ceprini (1999c), for the application of this approach to the case of Italy.

century, we can begin cutting contributions as early as 2030, at the rate of some 1% per decade.

We conclude with a plea that the lucky occurrence of a large surplus *not* be used to cut taxes or increase current spending, nor to temporarily fix the inefficient, unreliable, poorly designed PAYGO system. Instead, we propose to use the surplus in a productive way, in the best interest of the country, both for the present and especially for the future, by making the transition to the more efficient and reliable funded system.

THE PLAN AND A LOW-COST TRANSITION TO A FUNDED SYSTEM

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1. The New Fund (NF)

The centerpiece of our plan is the creation of a new public fund (NF), which like Social Security (SS) is financed by *mandated contributions,* and will offer *defined benefits,* but which will be *fully funded,* and establish *individual accounts*. The defined benefit will be ensured by a guaranteed return on contributions.

Each participant's contributions will be credited to an individual account, together with the accrued returns. However, for investment purposes, all the funds will be pooled and invested in a single, highly diversified "indexed" portfolio consisting of an appropriate *share of the market portfolio of publicly traded financial assets.* Despite its diversification, the return of this portfolio would be somewhat risky and variable. But a defined benefit system requires a rate fixed in advanced. To achieve this result, we stipulate that the Government should stand ready to "swap" the return of the NF portfolio against a guaranteed *real* rate of return. This rate would be around 4-5% at the present time, and not necessarily fixed forever, but changed as little as possible, and then only for younger people[7]. This approach clearly shifts to the government the risk that the return on the market portfolio may fall short of (or exceed) the return guaranteed to the NF. However, this simply extends to the Government public pension plan a practice that has been standard in traditional funded pension plans where the sponsor assumes a risk that would otherwise fall on the individual, and on a far larger scale. We deem that the sponsor, and

[7] By doing so, the scheme is fully funded for the promised benefit, which is critical to ensure solvency. Further, this arrangement is unlikely to impact the markets significantly, which is a fear that many opponents of investing in the equity markets have voiced. Another alternative would be to vary the contribution rate to achieve the same replacement rate.

especially the government, is in a far better position to absorb this risk because of its size and because, with indefinite life, it can redistribute the risk of a single cohort over a large number of cohorts. Furthermore, it would *de facto* bear this risk as well (and at an even higher level) in the defined contribution case, if *de jure* or *de facto* it insured some minimum outcome[8].

The creation of individual accounts has a number of advantages, as will soon appear. One important consideration is that through a periodic and frequent receipt of a statement of their account, participants will learn to appreciate that the compulsory contribution is not a tax, but rather saving. And, they will reacquire a confidence in the ability of the system to deliver the promised pension[9] that in recent times has been seriously eroded[10]. It is proposed that after a transitional period (described in the following section), the NF will replace completely the current PAYGO system.

1.1 Description of the basic transition mechanism

In the transitional period, the NF will operate alongside the current SS. The NF will "pay" pensions from the very beginning, *following the rules appropriate to a funded system – i.e.,* will pay pensions to those who reach the retirement age (in so far as they have contributed to NF), by annuitizing the participant's credit balance on that date, using the fixed rate. Note the difference with the rules of a PAYGO system, where pensions are paid from the beginning also to

[8] See Heller (1998) and Muralidhar and van der Wouden (1998a).
[9] See Modigliani and Ceprini (1998d).
[10] Many corporate plans are adopting a similar structure under the title of "cash balance plans."

people who have never contributed, like those already retired, and to older people that made only partial contributions.

Social Security will be responsible for paying that portion of the pensions due under the current rules that are not being paid by the NF, and in addition remains responsible for collecting all needed contributions. (For ease of exposition, we will initially assume that these contributions, together with any other needed measures, have been calibrated so as to ensure that SS will be able to meet its promises during the transition period, or most of it.)

The NF is to be financed by a contribution consisting of a fixed share of the wage. This share is uniquely determined by the mandated replacement rate, by the return on NF investment and several other parameters as explained in I.2 below.[11] Our plan specifies that this contribution is to be paid by Social Security by transferring to NF the needed portion of the contribution collected from participants. Since the contribution collected by SS is by assumption equal to its pension obligations, the transfer to the NF results, as is well known, in a current account deficit of SS that has to be made up somehow. By whom and how will be discussed below.

The flow of pensions paid by NF to pensioners will, initially, be tiny as few participants will have reached the retirement age and they will have very small balances, having contributed to the fund only for a short time. During this period most of the contributions will go to increase NF assets However, the flow will grow rapidly, because those

retiring will have larger and larger balances than previous cohorts, as they will have contributed longer to the fund. As the flow of pensions from NF rises, the pensions to be paid by SS will shrink, and this will enable SS to reduce the amount (rate) of contributions that it needs to collect from the participants.

The key idea of our solution is that, the NF flow of pensions will keep growing until the NF reaches "maturity" ("maturity" is reached when everybody in the system will have contributed throughout his "contributive" life at the same rate). At that time, provided the *permanent contribution rate has been set at the appropriate level consistent with the rate of return and demographics,* the flow of pensions NF generates will equal the flow of benefits that are to be paid by the old PAYGO system. At this point, there will no longer be a need for SS to either pay pensions or collect contributions, and it can therefore be abolished. Participants will continue to pay only the permanent contribution to NF, and we can expect that contribution to be vastly lower, as shown below. Note that the time it takes for the NF to reach maturity, permitting the *full* abatement of the contribution to some 6%, is very long, not less than the length of the standard contributive life plus the length of retirement-something on the order of some 60 years.

In the next sections, we first show that the contribution rate required with a funded system is in general appreciably lower than under PAYGO and then will illustrate the proposed mechanics of the

[11] Since the rate of return and contributions determine the replacement rate for given demographics, policy makers need to ensure consistency in these choices. A model for the funded scheme is provided in Asad-Syed, Muralidhar and van der Wouden (1998).

transition to full funding, and its effects, with the help of some simulations.

2. Overview of contributions required under PAYGO vs. a funded system

We begin by reviewing the forces that determine the required (equilibrium) contribution rate, under the two alternative financing approaches PAYGO and FUNDING. This relationship depends on a number of parameters. Some of these are "exogenous", i.e. outside the direct control of policy makers, while others primarily reflect decisions of the policy makers.

In the first group, the most important are:

i) the rate of growth of real income (y), and its two components (items ii and iii);
ii) the growth of the labor force (n);
iii) productivity growth (q);
iv) longevity (e); and
v) the rates of return on various financial assets, and their volatility.

The policy determined parameters include:

i) the standard retirement age, which together with longevity determines the average duration of pensions;
ii) the portfolio in which the accumulated capital of the fund is invested (important mostly for a funded scheme since under PAYGO there is supposed to be no significant accumulation)

iii) the so-called "rate of replacement", or the ratio of the pension received to some measure of income earned while working and contributing. The specification of the replacement rate involves detailing what measure of income should be used (e.g., terminal versus life-time average) and how it is related to the years of contribution.

The effect of the major parameters on the required contribution rate under different financing schemes is illustrated in Tables 1A and 1B which also serve to support our contention that, under realistic assumptions, a funded system is far more efficient economically as well as less "at risk" than PAYGO.[13]

The calculations in the tables assume the following parameters: 40 years of contributions and a replacement rate of 50% of life average income (if the replacement rate were different, all the contribution rates reported would change in proportion). As for average length of life after retirement, we show the implications of two alternative assumptions. In the left portion of the tables, we assume life expectancy of 16 years, which happens to be the level anticipated around the middle of next century in the report of the OASDI trustees (the Report), under the so-called "low cost" assumptions. On the right hand side, life expectancy is assumed to be 18 years, corresponding to the "intermediate cost" assumptions. *It is further assumed that the assets of the fund are invested in the 'indexed portfolio' of all marketable securities, and swapped for the indicated real interest rate.*

[13] We have also examined the impact of indexing pensions to wage growth and the contributions to NF are relatively stable to this form of indexation.

2.1 The PAYGO scheme

Table 1A shows an estimate of the ratio of current pensions to contemporaneous (taxable) wages, or the so-called "cost ratio" of the Report, for different parameter values. However, under a PAYGO financing scheme, since pension outlays must, by and large, be paid out of current contributions, the cost ratio also measures the ratio of required contributions to wages or the "equilibrium contribution rate".

The main thing to note in Table 1A is the extreme sensitivity of the contribution rate to growth parameters of population (n) and productivity (q), and hence their sum, (y). The required contribution rate declines as population growth (n), increases, through the well-known age pyramid effect. The lower (n), the higher the ratio of retired beneficiaries to active workers that must support them with their contribution, and hence the higher the required contribution rate and the quantitative effect is impressive. The effect of productivity growth is more complex, but it works in the same direction and is quantitatively very similar. Thus the required contribution depends essentially on the sum: (n + q = y). It is seen from the Table that a decline in (y) by two percentage points from two to zero requires a rise in contribution of some *nine percentage points* from 11 to 20%. But for many of the countries in Europe (e.g. Italy) the replacement rate is up to 80% of *terminal income*, which means around 100% of average income, the figures in the table must be doubled. In particular, with a productivity growth closer to 1 ½%, and little population growth the table suggests an equilibrium contribution of 20-25%, which is close to what SS levies actually are in those countries.

In short, with PAYGO financing, the required contribution is much too susceptible to small and very plausible changes in prospective growth and therefore *cannot provide the basis for a reliable system, i.e.,* which is not continuously threatened by major crises, such as the current one.

2.2 The funded scheme

Consider next Table 1B that reports the contribution needed under a funded system. A comparison with Table 1A reveals in striking fashion the much greater efficiency of the funded system in the sense of a much smaller required contribution for given benefits. As explained earlier, the reason for the difference is that, in the funded scheme, a large portion of the pensions is paid not from the cash contribution, but by the interest on the accumulated wealth. Take for instance the case most favorable to the funded system in Table 1: a zero growth of income, 6% rate of return on investment and 18 years retirement. Here the PAYGO contribution is 22.5% versus only 3.5% for the funded system! Such a difference may seem impossibly large: how can the funded system deliver pension amounting to 22.5% of current wages with a contribution 19 percentage points lower? The answer, of course, is to be found in the accumulation of earning assets under the funded scheme. By the time the funded system reaches maturity, the NF holds assets amounting to about 3.2 times wages, the return on which at 6% is sufficient to fill the gap.

To be sure, the above illustration is rather extreme, but the difference remains large even for more realistic cases. For instance, let us consider the long run growth assumptions for the U.S. corresponding to the so-called " intermediate cost" projections. The corresponding contribution required under PAYGO is shown in Table 1 by the shaded entry in the right side of Table 1A, namely17.2%. We see from the corresponding column of Table 1B that the required contribution for the funded system is less than 4% for a rate of return of 6%, and for a rate of return of 5% it is just over 5% or more than 2/3 lower. Even with a return as low as 4% (roughly the current real rate on U.S. Treasury Inflation-proof bonds) the equilibrium contribution is but 7% or 60% lower.

Tables 1A and 1B also bring out several other aspects in which a funded system dominates PAYGO financing[14]. The first is that, in a funded system, the required contribution is not only independent of (n), but also hardly affected by (q), and then in the direction opposite than under PAYGO: namely it declines if (q) declines. The second is that, surprisingly, even changes in life expectancy (e) have only a small impact. A rise in (e) from 16 to 18 years, which is a fairly large one, requires an increase in contribution of only around 20 basis points, while under PAYGO the increase is over 200 basis points. Thus, in practice, the required contribution depends only on the rate of return. However, even for changes in the rate of return, the change in contribution for say a 200 basis decline from 6% to 4% requires a change in contribution of the order of 300 basis points, much smaller

[14] See also Feldstein (1997).

than the nearly 800 basis points change required under PAYGO for a 2 percentage point decline in (y).

To summarize, the results of this section provide the evidence for the claim set out in the abstract that both on ground of cost-to-benefit ratio, of flexibility and of stability of required contributions with respect to likely changes in parameters, the fully funded system is vastly superior to PAYGO.

3. The transition path-some simulations

In order to clarify the mechanism to transition the public pension system from PAYGO to funded, we present two simulations: a hypothetical stationary economy and the "intermediate cost" case projected by the Social Security Administration (SSA). For simplicity, in both cases we ignore the issue of survivor pensions. This aspect is modeled more efficiently in a complete actuarial model. *We rely instead on the approximation that life expectancy for the entire economy* (*i.e.,* accounting for both participants and dependents) is equal to the life expectancy indicated for the two simulations.

3.1 A hypothetical stationary economy

Our first simulation, presented in Table 2 and Figure 1 is purely hypothetical and to facilitate the exposition assumes zero values for both (n) and (q) (population and productivity). The other parameters have the same values as in Tables 1A and 1B[15], except that life expectancy is taken as 15 years. Under these assumptions, the cost ratio, and hence the required contribution for PAYGO, is 18.75% (15/40 x 0.5)[16]. For the funded system, we assume a rate of return of 6% and the *permanent* required contribution is 3.13%. This is the "equilibrium" contribution rate to NF that, if paid by the all active (and by the retired when they were active), and supplemented by the return on its assets, would enable the fund to cover the cost ratio of 18.75%.

[15] This includes working life of 40 years and 50% replacement on life-average income.
[16] Fifteen retirees paid 50 cents on the dollar by forty active participants implies an 18.75% contribution from the active taxable payroll.

The table gives a year-by-year account of the relevant variables that are expressed as a percentage of taxable payroll. However, for present purposes, we believe that the essential characteristic of the transition process under our proposal can be conveniently understood by taking a close look at Figure 1 and its main series as follows:

i) the "cost ratio" or the pensions due relative to wages that, by assumption, is fixed at 18.75%, and is represented by the horizontal curve at that height;

ii) the contribution to the New Fund (NF), shown by the dotted line. That contribution must eventually reach the *equilibrium* level of 3.1%, but we elect to start lower, at 2%, to keep down the cost for the older generations who will have no advantage from the reform. It is raised permanently to the equilibrium level between 2023 and 2027, as the rising inflow of the NF pensions permits an offsetting reduction of the contribution to SS and thus avoids an increase in total contributions;

iii) the NF pensions curve, represented by the line starting at zero and terminating in the vicinity of the cost ratio, shows the path of the flow of pensions provided by the NF (the key variable in our approach). As expected, it starts out negligibly small, gathers momentum for the first 45 years, but then slows down as NF approaches maturity, and the flow of pensions approaches the cost ratio (but never quite reaches it in our graph because we have rounded off the contribution to 3% and maturity is reached only after 82 years, i.e. 40 plus 15 years after the contribution is raised to the equilibrium level in the year 2027);

iv) the path of the required contribution rate to the new pension system, represented by the steadily decreasing curve so labeled, and which is the other key variable. The required contribution (as a percentage of wages) consists clearly of the pensions to be paid, or cost ratio (18.75%), plus the contribution to the NF, *minus* the amount of NF pensions that are being paid to participants. Since the first two items are fixed, the rise in the NF pensions permits the reduction of the pensions paid by, and hence the levies raised by Social Security. In the initial stretch (22 years) the NF contribution is 2%. So the total contribution starts at 20.75% or 2% above the PAYGO rate, but decreases from year to year at the same rate as NF rises. By the year 2022, as the NF flow reaches 2%, it is back at the original level (18.75%). From that point on, the needed contribution falls below that of the PAYGO system and decreases continuously as a mirror image of the rising NF pensions; the NF flow "crowd out", as it were, the required contribution rate until, at maturity (82 years), it is reduced to the equilibrium rate of 3.1%, compared with the PAYGO rate of 18.75%. This huge difference is made possible by the large buildup of assets in the NF, which is shown in col. (6) of Table 2, reaching 2.6 times wages, and the return thereof in col. (7). By maturity the interest flow amounts to 15.6% per year which, together with the contribution rate of 3.1% covers the 18.75% cost ratio.

But, as was pointed out earlier, the transition to the more efficient system involves a cost - that of funding the unfunded

liabilities of PAYGO- which requires initially raising the contribution to the system. We can measure the transition cost by the amount of such added contributions: they are represented in the graph by the difference between the required contributions and the PAYGO cost ratio. This difference is also shown by the curve labeled "transition cost" in the lower left-hand corner. It is seen that the cost starts at 2% and declines gradually, becoming negligible around the 20th year and disappearing by year 23, when the NF pensions begin to exceed the contributions. This cost of transition from a permanent 18.75% to 3.1% per year contribution appears surprisingly small, with our approach, less than 1.5% of payrolls per year, on the average, for some 20 years. This is in sharp contrast with the common perception that the transition cohorts have to pay, through their life, a double contribution: one to the old SS and one to the new funded system.

The next question: how might that cost be allocated?

There are many ways to spread the cost between different groups. For instance, one could place the burden on the current workers by increasing their contribution rate, to the level indicated by the "required contribution" curve, or on the current retirees by lowering pensions temporarily. Either action or any combination of the two would reduce consumption and increase saving. Alternatively, the government could absorb the transition cost, and the employees' contributions would remain constant until the transition cost ceases, and then decline thereafter as shown by column (6). The government contribution, in turn, could be financed by increased public saving through higher taxes or lower government consumption, or finally by borrowing and increasing government debt, with the burden falling on

future generations. It must be understood however that the latter method would be counterproductive, for the increase in debt would offset the new saving of the NF, thus negating one of the important benefits of funding, namely that of increasing national saving and capital.

A drawback of our proposed transition plan is that it takes a long time to produce its beneficial effects. A quarter of a century is needed before any reduction in contributions and even the half-life takes nearly 50 years, but this is the price one pays for avoiding a heavy burden on an early generation. The *key point* is that *the final gain is enormous, and the cost is modest.*

3.2 The existence of alternative paths

We have seen that, at maturity, the required contribution coincides with the equilibrium one, and that to this equilibrium contribution corresponds a unique equilibrium level of net assets in terms of wages. This equilibrium level can in fact be computed readily from the cost ratio and the required equilibrium contribution, given the interest rate, as follows: at maturity, the NF pensions, expressed in terms of wages, must be equal to the cost ratio. But the NF pensions coincide with its income, which is the sum of the equilibrium contribution and the return on equilibrium assets. Hence, the equilibrium of assets is given by the difference between the cost ratio and the NF contribution divided by the fixed real rate of return. (Thus,

for the simulation of Table 2, the equilibrium asset/wage ratio is (15.75-3.13)/0.06= 2.6).[17]

An important implication is that whenever the system has accumulated an amount of net assets/wages equal to the equilibrium ratio, then it has reached a position of long run equilibrium, (equivalent to maturity) in the sense that it can pay the benefit embodied in the cost ratio, with a permanent required contribution equal to the equilibrium contribution rate. In the above example, if the system manages somehow to accumulate a net-worth-wage ratio of 2.6, then it can pay the 18.75% benefit ratio, but with a contribution rate of 3.1%, (instead of 18.75% under PAYGO) because the difference is covered by the return on the assets accumulated. This conclusion is important because it is intuitively clear that there must be many possible ways of accumulating the equilibrium wealth-wage ratio. In other words, while our simulation shows one possible path resulting in the accumulation of the equilibrium wealth, there must be many other paths arriving at that result. Clearly this observation has important implications in terms of broadening the paths accessible by our approach. We cannot afford to pursue this subject here, but for the sake of concreteness, we should like to suggest a simple exercise.

In the example of Table 2, the reduction in contribution does not become effective until 30 years after the reform is initiated; but after 30 years the decline is fairly rapid, some 30 basis point per year initially and reaching 50 basis point in the 40's. This clearly raises question of intergenerational equity. Could one 'smooth' the gains

[17] With growth, one would need to adjust the denominator, thereby leading to a higher ratio.

from the reform by assuring some gains for earlier generations while reducing those of some later generations? For instance, we may want to begin cutting the contribution, say 5 years earlier; in Figure 1 this would mean that the contribution curve is one percentage point below the original one and must presumably remain below at least till the year 2027. This can be seen to be perfectly possible, but on the condition that, at some later point in time, the alternate path crosses the old path and remains, at least for a while, above it. The reason can be explained (roughly) by the consideration that the height of the contribution line at any point is a major determinant of the slope of the path of wealth accumulation. Hence, in the period when the contribution is lower, wealth accumulates more slowly, falling below the standard path. Therefore in order for the net asset ratio to reach the equilibrium level, it must at some later date catch up by growing faster, which means a contribution rate above the standard. It is in principle even possible to maintain the alternate path below (or at least never above) the equilibrium path until the terminal year of the standard version (2082). However, in this case the asset ratio will be too low and therefore the contribution rate will have to remain for a while above the long run equilibrium value of 3.1%. The principle should be clear; one can improve the lot of the older generations, but only at the expense of the younger ones (who however are privileged by the standard solution).

3.3 The transition for the U.S. "intermediate cost" case

3.3 - i) Basic Assumptions

Table 3, Figure 2 and Figure 3 report the result of a "realistic" simulation. We highlight the key issues in this section and leave the more detailed evaluation of the table and figures to the Appendix. In this simulation, the hypothetical values of the first simulation are replaced by the values directly relevant to the current American situation: these are the values estimated in the Social Security Trustees Report, for what is regarded as the most likely outlook, i.e., for the so-called *intermediate cost* case.

In addition, we assume a more conservative rate of return of 5% instead of 6%, on both Trust Fund assets and assets of the NF, to make sure that the success of our plan is not merely the result of what some may regard as an "overly optimistic" estimate of the rate of return. We address the appropriateness of this return assumption in Section 4. Finally, we assume that Congress will adopt the President's proposal in the Mid-Session Review of the Budget and transfer the Administration's proposed share of on-budget surpluses to Social Security.

Unfortunately, the Administration's analysis suggests that, if the current contribution rate is maintained, this large infusion can only postpone the date of the exhaustion of the Trust Fund to the end of the 2040's. By then, the contribution rate under PAYGO is expected to increase a bit to about 11% and the cost ratio is expected to amount to

17%. Hence, if we retain the PAYGO system for the promised benefits, after the middle of the next century, the contribution would have to jump dramatically from 11% to 17%. Alternatively, one would have to enforce a 1/3 decline in the benefits (reneging on past promises) or some combination of these two unsavory measures. In short, the Administration's plan *does not provide a long-term solution* to the Social Security crisis, in contrast to our plan, which not only ensures a permanent solution, but also offers a drastic decline in contributions.

3.3 - ii) A bird's eye view of the contribution path for alternative proposed approaches

The above considerations are illustrated in Figure 2, which provides a convenient bird's eye view of what can be achieved through our reform, in comparison with some main alternatives. In the figure, the line CR provides a measure of the path of contributions that would have to be levied under PAYGO financing, in the absence of the Trust Fund and the pledged government contributions.

The 'wavy' curve, labeled "administration" shows the behavior of contributions needed to maintain solvency under the Administration's program. Up to 2050, the contributions are kept at the current level. This level is initially higher than the cost ratio, permitting a further growth of the Trust Funds, spurred by the government contribution promised by the Clinton program. **B**ut as the cost ratio rises quickly, because of the slowing down of labor force and productivity growth, while the contribution rate remains relatively stable there is a continuing reduction of the surplus that eventually

turns into a growing deficit. For a while, that deficit can be covered by drawing down the Trust Fund. But by around 2050, the Trust Fund is exhausted and to keep the system solvent, as indicated above, some combination of raising drastically contributions and/or slashing deeply benefits will need to be undertaken.

The third curve, shown by the solid line, represents one possible path of the contribution that is achievable with our approach: Our path coincides with that of the Administration until the year 2040. By that date, the SS Trust Funds have grown vigorously from 23% of wages to 66%, thanks to the SS surplus and the government contribution through 2015; and in addition, the NF has accumulated assets amounting to 135 % of wages (see Table 3). At that point it is possible to cut the contribution for the first time below the administration program by ½ percentage point (from 11.3% to 10.8%). Although that reduction is accompanied by some deficit in the Social Security current account, this can be made up by drawing on the Trust Fund. By 2051, the contribution is reduced by another ½ percentage point, just at the time when the Administration's plan calls for a 50% rise in contributions. Furthermore, under the Clinton program the contribution rate continues to rise past 17%; whereas under our plan we are able to continue to cut the contribution by half a percentage point every five years till 207l, when the reduction is by one percentage point (from 8 to 7%). Finally, in 2076, the contribution can be cut down one last time to the steady state level of 5.2%.

Figure 2 is helpful in countering certain criticisms that have been raised against the implementation of our approach. Specifically it has been objected that, even granting that our program is capable of insuring a smooth transition to a fully funded system, there l is no valid reason to jettison the existing PAYGO system undertaking the rather extensive reforms that we are proposing, including a totally new pension system and individual accounts. One justification for this view is that there is no real short-term crisis in sight if we keep the current structure. After all, with the help of the government intended subsidization, and the small investment of the Trust Fund in equity, we can go passed the middle of the next century without raising contributions or cutting benefits. Are we not making a big fuss for what might happen after most of the people now alive will be dead?

This argument is really untenable. It is true that we normally do not take current measures for things that might occur in the far future; but this is because there typically is great uncertainty about the implications of the occurrence and about the effectiveness of measures taken far in advance. But in the present instance, because of the predictable nature of demographic development and the sluggishness of productivity growth, we can be pretty sure that if we irresponsibly retain the current PAYGO system, by the middle of the next century pension payment much in excess of current contribution will have exhausted accumulated reserves and plunge the SS in a financial quandary, no resolvable without a huge rise in contribution and or cut of benefits. Furthermore, as our simulations show, the measures needed to avoid that trauma must be started a long time earlier, like right now. Failure to do so would be irresponsible.

A second argument is based on the consideration that the deficit of the current system is not really that serious. The SSA has calculated that up to 2075 the receipts are short of promised benefits by only some 2% of payrolls: thus we could solve the problem for at least the next ¾ of a century, while maintaining PAYGO by opting for an immediate rise in contribution from the current 11 to say 13%. But this approach-call it the M solution-produces a path of contributions that is dramatically worse than ours as can be seen from figure 2. In this figure the M contribution path is represented by a horizontal line at a height of 13%. It is seen that contributions are uniformly 2% higher for the first 40 years and that the difference grows steadily thereafter, reaching at least 8-percentage point by mid seventies, and probably even more thereafter.

A detailed year-by-year account of the simulation is provided in Table 3 and discussed in the Appendix.

4. Issues relating to the choice of the rate of return

In this section, we take up three issues relating to the choice of the rate of return. First, we examine whether the level of 5% real is reasonable. Next, we examine whether funding outperforms PAYGO because of the selected rate of return. Finally, we evaluate what is the potential impact on the rate of return from the substantial increase in wealth under funding.

4.1 Description of the swap contract

In our "miraculous" simulations, we have used as illustration rates of return of 6% and 5%. It has been suggested that our apparent ability to solve the problem permanently, while substantially reducing contribution rates, is due entirely to the fact that we use unrealistic assumptions about the rate of return.

It is, of course, true that even our 5% rate is much higher than that assumed in the Administration's plan that envisages a gradual investment of the TF in equities, but with a maximum limit of 16%. As a result, even though that plan assumes a fairly high return on equities of 7%, the overall rate of return is less than 3.5%. It is also true that, had the Administration's proposal used, say, a 5% rate of return, it might have been able to ride over the mid-century crisis without raising contributions-though it still would have resulted in maintaining indefinitely the current contribution rate of 12% as compared with that of our proposal of just over 5%.

But, does this imply that our proposal should be dismissed as of no practical value? Or, does it instead support the conclusion that the Administration may be missing the opportunity to provide a lasting solution to the Social Security problem?

The point is that the choice of the rate of return on the assets accumulated in the system is not a matter of personal preference or even of prudence (imposed on others). There are, in fact, objective criteria to support our choice versus that of the Administration. Specifically, the difference between our assumed overall rate of return and the Administration's does not come from our assuming fictitiously high returns from stocks and bonds respectively (if anything our assumptions are more conservative). The difference comes entirely from the *weighting* of the two components: the Administration chooses an arbitrary number of (not more than) 16% in equities, whereas we recommend including equities and debt instruments in proportion to their market capitalization. Equivalently, the NF portfolio should be a proportionate share of the market portfolio of all marketable securities-equities and debt. This is consistent with the proposition that a market portfolio is an efficient portfolio. But more fundamentally, it rests on the consideration that the rate of return promised to the forced saving in Social Security should approximate, as closely as possible, the (marginal) return on capital, i.e., the number of dollars per year that an investment of $100 adds to GNP before taxes, on average over a suitable stretch of time.

One can obtain an approximate measure of this quantity from the average return to equities, (using the hypothesis that in the long run Tobin's Q should be one), but one must take into account two important adjustments. First, the return to equity corresponds to profit, and profit is not a satisfactory measure of the return to capital, whenever the firm is financed partly by debt (it has a "levered" capital structure). Rather, the return on capital is the return of a portfolio consisting of all its shares and all its bonds (or an equal fraction of each); or equivalently a weighted average of the return on equity and the interest rate on debt, weighted by the share of each instrument in the "market capitalization" of the firm (the sum of the market value of equity and debt). But this is precisely the procedure we advocate: to invest in an indexed portfolio consisting of an appropriate share of the market portfolio. Now a quick perusal of available data (e.g., Federal Reserve Flow of Funds Accounts of the U.S.) suggests that the share of equity in total capitalization is *substantially* higher than 16%; on average, it is closer to 70%.

If the administration had used this realistic set of weights, it would have come up with a rate return on capital of nearly 6%, compared with our "conservative" 5%.

But 6% is an estimate of return on total corporate capital *after* corporate income taxes. From it, one can derive an estimate of the pre-tax return on *total* capital, allowing for a prevailing leverage of around 1/3, a real interest rate on market debt of some 3-4%, and a corporate income tax of the order of 30%. The result is an estimate of about 8%,

divided as follows: 1% for interest and 7% to equity before tax. Of this, 0.3 x 7% or 2.1% is earmarked to pay taxes, leaving 4.9 as the net of tax return to the stockholders (but this return is on the equity capital, which is 70 of the total so that the after-tax rate of return on equity is 7%as stated above). The 8% pre-tax return is of course the sum of the 6% after tax return of the market portfolio plus the 2% tax going to the Treasury. It is also encouragingly close to a well-known estimate of Poterba (1998) that concludes that, "the pre-tax return on capital in the corporate non-financial sector has averaged 8.5% over the 1959-1996 period."[18]

We do not propose that the government should guarantee a fixed real rate of 8.5% (or even 8%), because we are fully aware that the return from equity is subject to a great deal of risk and that the market commands a *risk premium* for exchanging the market equity stream for a fixed interest stream. Based on this consideration, we like to offer a tentative suggestion that the Treasury should swap the market equity stream for a sure real interest rate of 5%. This would give the Treasury an expected *risk premium of some 3-3½%.* Indeed, when the NF invests its accumulation in the unlevered market portfolio, the expected return *to the treasury* can be taken as the expected pre-tax return on total capital of 8-8½%, of which 6-6½ is the portfolio return, and the remaining 2% represents the increment in Corporate Income tax receipts. Without pretending to settle the current debate about the appropriate risk premium, we submit that 3% is a reasonable premium for the Treasury, given its long life and the externality in the form of

[18] See Poterba (1998).

improvement in the welfare of participants by making it possible to offer defined benefits.

But, if the swap is such a "reasonable" deal, could it not be offered by private investors or speculators? The answer, of course, is that the risk premium earned by Treasury is much larger than that accruing to private investors, because it alone benefits from the externality resulting from the rise in tax revenue.

It must be recognized however that the estimate of an extra 2% return to the Treasury from incremental tax revenue could be biased. For it rests on the assumption that all the NF investment in the market portfolio of corporate securities is accompanied by an equal expansion in the availability of those securities, or, equivalently, that all other holders of market securities do not reduce their holdings in response to the NF acquisition. This, of course, need not be true: for instance, it is conceivable that the rise in saving due to NF would reduce foreign lending and lead to a decline in foreign investment in domestic stocks. If this should happen, our estimate of the tax gain is overestimated. On the other hand, the increased capital stock increases not only profits but also other income such as labor's and the flow of tax revenue therefrom. (See for example Feldstein, who follows this route to estimate the increase in tax receipts and ends with a very similar estimate.) To this extent, our estimate is downward biased. Presumably only experience could establish the true effect.

From an operational point of view, one could imagine that, at the time the swap is arranged, the Treasury would set up a sinking

fund which would be credited (or debited) the difference between the return of the market and the fixed rate (say, our 5%) plus an estimate of the extra taxes generated by the increase in the capital stock. A lower and upper limit would be established for the sinking fund. If it went above the upper bound, the surplus could be transferred to the budget and at the same time consideration would be given to raise the fixed swap rate and reduce contributions accordingly. Corresponding actions would be taken if the sinking fund went below the lower limit.

4.2 How the rate of return affects the merits of alternative schemes

There is one more question concerning the rate of return that requires brief discussion. Does the advantage of the funded system over PAYGO depend on a high rate of return? Here one must distinguish between the merits of the systems in the long-run equilibrium, and the problems of transition from one system to the other. With respect to the first question, the answer is straightforward-the funded system dominates the PAYGO, provided that the rate of return on capital exceeds the rate of growth of income. Indeed, this is clearly the necessary and sufficient condition for the equilibrium contribution rate under funding to be lower that of PAYGO. (It will be recognized that this conclusion is in line with a well-known proposition about dynamic optimization of per capita consumption). It is hardly conceivable that this condition could fail to hold always, or at least as far ahead as one can see.

However, the situation is somewhat different when one deals with the transition problem. If, at the start of the transition, the PAYGO system is such that it can take care of its pension obligations without raising the contribution rate, then our system will insure a transition in finite time no matter what the rate of return, without any increase in contributions (except for an initial additional contribution by participants or by the Government that is necessary to get the NF accumulation started). The rate of return would of course affect the equilibrium contribution and the length of the transition.

The situation is different when the system of PAYGO is not self-sustaining and is heading for insolvency, as is the case for the U.S. and many other countries[19]. This is true in particular for the U.S. where, in the absence of a Government subsidy, the system would run into deficits by the end of the first quarter. And, even with the proposed program of generous government subsidies, it would not be able, beyond some point, to deliver the promised benefits without a hefty increase in PAYGO contributions. In this situation, one part of the NF flow and TF interest must be used to plug the growing hole due to the rising cost ratio-or equivalently to the increasingly negative SS balance. There is then no guarantee that our system, even with the assumed Government contribution, can deliver the "miracle" of transforming a PAYGO system into a fully funded one, in *finite time and without ever raising contributions,* unless the rate of return is high enough.

[19] See Modigliani, Ceprini and Muralidhar (1999)

We have not established what is the precise minimum feasible rate, but we have run a few more simulations, not reported here, from which we have established that the "miracle" is still possible with a rate of 4.5%, though at the cost of raising the equilibrium contribution to 6%, lengthening the transition period to 90 years (as compared with 70 with 5% return), and delaying the first cut in contribution for 70 years (instead of 40). However, we recall that these standard paths can be modified utilizing a trade-off between the time of the first cut and the duration of the transition period. It appears that the shortest possible transition path is some 65 years, but the earliest (and only) cut also requires 65 years.

On the other hand, with a 4% return the "miracle" is no longer possible because the system is never able to accumulate enough assets so that the return on these assets together with the equilibrium contributions are sufficient to cover the terminal cost ratio. Even in this case, the full transition is possible, but it will require some additional contributions by the Government and/or the participants.

4.3 Impact of the increase in the stock of capital on the rate of return

The last issue that must be recognized is that of the possible feedback of the introduction of a fully funded system on the rate of return. There is no question that by the time the funded system has reached equilibrium, it will result in a substantial increase in the amount of *national* capital.[20] To illustrate, we have shown that with a 5% rate of return and a 50% replacement rate of average income, the NF net assets should amount, in steady state to roughly, 3.1 times the wage bill; or nearly 2.3% of national income, since the wage bill is around 75% of national income.[21] Now, the ratio of private wealth to national income can be placed at around 4.5; thus, the new system would imply a rise in the wealth-income ratio by an impressive additional 50%. However, this is not the full story for the effect on interest rates should depend on the growth of productive tangible capital, which is less than wealth because the latter includes the holding of government debt. If we eliminate this component, the ratio of capital to income has recently tended to be just below 4. Therefore, the rise in the capital-income ratio could be close to 57%. Such a development could have a significant effect in reducing the interest rate. But one must be cautious in accepting the above estimate, remembering that the rise in the NF wealth could induce some offsetting reduction in personal wealth holding, and that, in an open economic system, what one should focus on is not the growth in American capital, but in "world" capital.

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[20] See Alicia Munnell,: "Reforming Social Security. The case against individual accounts". Draft for National Tax Journal, 8/12/99. HIS criticism has also been elaborated in personal correspondence

5. Possible innovations

It was mentioned earlier that our proposal lends itself to two important innovations: (i) private provision of retirement plans in competition with the public scheme, and (ii) the ability to borrow some portion of the funds. We briefly describe design features that permit such innovations. Both innovations are made feasible by the creation of individual accounts, in a defined-benefit scheme that is fully funded. However, both innovations are better implemented in later stages of the reform and will be addressed in greater detail under separate cover.

5.1 Private provision of retirement plans in competition with the public system

Firms in the private sector can be permitted to offer competing schemes subject to the provision that the schemes that they offer be no worse than the public pension scheme. For example, companies may choose to offer their employees such a service and any asset management or insurance firm could provide investment products to these organizations.[22] Alternatively, investment companies could offer such services directly and participants can maintain their accounts with authorized firms. Institutions in the United States are already permitting employees to opt out of SS, but under our scheme, there will be a minimum replacement rate they will need to offer for equivalent contributions. However, these firms will need to be licensed and regulated to

[21] This calculation is made assuming a 1% growth rate and a one year lag between the first contribution and the first pension payment..

ensure that they provide the guaranteed return necessary to assure a higher replacement rate and that the participant's funds are not at risk of being depleted (through either market or credit risk). In addition, their pensions would have to be adequately portable. This will clearly require close monitoring and further the establishment of an agency that insures individuals against the risk of retiring poor. The United Kingdom has permitted private firms to compete with the public system, but there have been issues with misappropriation of funds that have threatened the further development of such an option. Undoubtedly there are many other reform proposals, under which the private sector could be permitted to offer investment products to participants; but an important feature of our scheme, is that the benchmark for the provision of such services will be transparent.

5.2 Temporary borrowing from pension reserves

The more contentious proposition is permitting individuals to borrow against accumulated funds in their individual accounts, with strict repayment rules. The main merit of such a proposal is to correct a serious shortcomings of standard Social Security systems, namely that the credit accumulated toward a pension is a completely illiquid asset. The ability to borrow imparts some liquidity to the wealth accumulated in the NF account. Experience with the 401(k) type of accounts suggests that this feature is especially valuable to younger households that are frequently liquidity constrained. It would result in a substantial reduction in the cost of borrowing that

[22] However, the tax advantage to the Treasury will be difficult to compete against.

would presumably be set equal to the guaranteed rate (say 5%) plus some small transaction fee, compared with interest rates in the 15-18% range charged by credit card companies. The risk of default on such loans could be mitigated through strict penalties for non-performance, as is confirmed by experience with the 401(k) loan program.

6. Achieving Redistribution Goals through the NF

It was stated earlier that the NF supports redistribution implicitly and that means-testing can be provided explicitly as well by adjusting final annuities. We briefly describe the implicit mechanism of the redistribution of wealth from the rich to the poor.

Under any social security scheme, an economy average wage growth rate is used to determine an economy-wide contribution rate. In the case of the NF, under the Intermediate cost scenario, a 1% growth rate, for given demographic conditions. a 5% real return and a 5.2% contribution rate would provide a replacement rate of 50% of average lifetime income. However, consider a participant with a 2% growth rate in salaries. In an individual setting, this participant should contribute 5.54% to achieve a 50% replacement rate all else being equal. Therefore, by contributing 5.2%, the effective replacement rate for the high salary growth individual (rich participant) is 46.65%. For a participant with a 0% growth in salaries (poor participant), the replacement rate is proportionally higher at 53.43% for a 5.2% contribution. In this fashion, the NF implicitly supports welfare objectives of redistribution.

7. Conclusion

In this paper, we have endeavored to show how the current Social Security structure of defined benefits, whose future is seriously threatened, can be permanently preserved by gradually replacing the current pay-as-you-go financing with a new, *fully funded, defined-benefits* system (the New Fund). The new scheme can also support the welfare objectives of traditional SS schemes. This conclusion is supported by many considerations among which the following are crucial:

First, under PAYGO the contributions, which are in effect compulsory saving, are used to finance the pensions and hence consumption. In the new funded system, these savings are invested in financial assets that grow large by the time of retirement and produce a return that makes it possible to reduce the required cash contribution below the PAYGO contribution by a large factor, typically ½ to two-thirds.

Second, PAYGO is financially unsound and forever at risk of insolvency because the contribution required for the promised benefits is highly sensitive to variations in population structure and productivity growth. With a funded system, the contribution is largely invariant from either variable. It is sensitive to the rate of return on financial assets, but moderately in the relevant range. The funded NF would be gradually accumulating a large pool of assets credited to individual accounts, of the order of 2½-3 times wages.

We recommend investing these assets in a strictly indexed portfolio of all marketable securities, (equity and debt), managed by the government and/or private managers on the basis of the lowest bidder. Such a portfolio has desirable efficiency properties and leaves no discretion to those in charge of the NF. We further advocate allocating the assets to individual accounts: i) to make participants more aware of the relation between their contributions and the growth of their balance, ii) to eliminate the temptation of Congress to divert the NF assets to other purposes and iii) to make possible for participants to borrow from their accounts.

Unfortunately, there are costs in the transition from the PAYGO to the funded system as saving needs to be boosted, at least temporarily, to fund the unfunded pension liability. We lay out an operational program for the transition in which these costs are shown to be transitory and contained within moderate limits-something like an additional payroll levy averaging some 3.2% for some 15 years. We argue that these costs can and should be absorbed by the Government by redirecting to the NF the share of the large budget surplus anticipated over the next 15 years, which the Administration as well as Congress seems to be ready to pledge toward saving the PAYGO system. In this case, the transition will involve no direct burden in the form of larger levies ever, but this is achieved at the cost of making the transition long-many decades.

We suggest that our permanent solution is preferable to that presently advocated by the Administration, which is but a temporary one, and also to the set of proposals that goes under the misnomer of

"privatization" of Social Security. These proposals generally involve only partial funding, and hence a substantially higher long-run contribution rate. But, what is worse, their basic feature is the principle of mandated contributions to individually managed accounts. These are not only much more expensive to manage, but also imply giving up the social welfare promoting principle of *defined benefits* in favor of a *defined contributions* approach with its serious risks-especially for poorer, less sophisticated participants-and high cost to government if a minimum outcome is guaranteed.

APPENDIX

A detailed account of the transition for the U.S. with the "intermediate costs" assumptions

Table 3 is organized by "transactors" of which there are three: the participants in the pension fund (or households), the old Social Security (SS), and the New Fund (NF).

The participants receive the pensions that are shown in col. (6) as ratio to wages-the so-called "Cost Ratio'' (CR). These figures are taken from the projections made by the SSA for the intermediate cost case. They represent the best estimate of the amount of pensions that must be paid if past promises of benefits are to be honored. CR rises consistently (cf. Fig. 2), though by the third quarter of the next century it tends to stabilize just over 17%. The next column (7) shows the path of contributions made possible by our plan. Up until 2030, it is the contribution rate estimated by the Social Security Administration (SSA) and thereafter it is set at levels *selected by us* to ensure *an early reduction in contributions consistent with a smooth transition to the final steady state*. The essential fact here is that, by the end of the third quarter, this contribution can be "permanently" cut to just over 5% while maintaining the benefits at the promised level (the Cost Ratio) and keeping the system (now NF) solvent.

The path of contributions made possible by our approach is reported in col. (7) and shown in Fig. 2. The equilibrium contribution is just over 5%, or less than 1/3 of the terminal cost ratio. It is reached only at the beginning of the last quarter of next century. But what is

important is that we can begin to cut the contributions much earlier. In our simulation we begin cutting as early as 2030, and we continue cutting at a rate of roughly one percentage point per decade, so that by 2060 the contribution has declined from 11.3 to 8.4, or half-way to the steady state of 5.2% which is the *equilibrium contribution rate for a funded system earning a 5% sure return on its assets, and promising a replacement rate of 50% of lifetime average salary.* It is calculated along the lines of Table 1B, for the growth estimates shown there, which are consistent with the SSA projections and parameters. By contrast, as can be seen from Fig. 2, the Administration program calls for *raising* the contribution to over 17%.

This remarkable result is achieved through the growth of the NF, which receives regular contributions from the participants and pays pensions *according to the rules of a funded system.* There is some leeway in the path of the contribution except that, at some point, they must become and remain equal to the equilibrium rate (5.2% in our case). In our simulations we have assumed that the contribution begins in the year 2021 at the equilibrium rate of 5.2%, cf. col. (1). The specific choice was related to the desire to hold down the indebtedness of SS as discussed below, but does not affect the long-run solution.

As can be seen from col. (3) and (5), a funded system which starts anew *applying those rules* will be paying increasingly large pensions [col. (3)] and accumulating assets [col. (5)] until the system reaches maturity, i.e., everybody in the system has contributed at the equilibrium rate throughout his life. In our case, maturity is reached by the year 2020 + 40 working years + 18 of pensions, or around 2078.

As confirmed by col. (3), by that time the pensions paid by NF stabilize at 17%, which is the amount to be paid, or CR, of col. (6); thus, they totally crowd out the SS pensions.

To verify this, consider the transition path of Social Security to the NF as reported in cols. (8) through (13). Until 2020, SS continues to work precisely as under PAYGO, in terms of contribution collected and pensions paid. But in those 20 years it runs a very substantial surplus [col. (12)] which goes to increase the Trust Fund and comes from three sources:

i) a surplus of contributions [col. (8)] over pensions [col. (11)]

ii) the government contribution for 15 years [col. (9)] taken from the Mid-Session Review of the Budget, and

iii) the return on the rising Trust Funds which is assumed to be 5% (adjusted down by growth of 1%) and hence much higher then that assumed in the Administration's program.[23]

By 2015, the Government subsidy comes to an end, but the surplus remains positive, through the interest component, and TF grows to 1.2 times wages. However, starting with the next year, SS begins to transfer to the NF 5.2% out of the contribution of 11.1% of wages it is collecting. Thus, the contribution going to SS is cut down to 5.9% and the surplus turns negative requiring a liquidation of the TF. This deficit remains quite large because of the rise in pensions or Cost Ratio and because of the depletion of the TF. It reaches a peak of nearly 5% in the late 30's and early 40's, but then begins to decline owing to the growth of NF pensions that reduces the amount of

pensions paid by SS [col. (11)]. Nonetheless, a deficit continues and gradually reduces the Trust Fund until 2060 when it is completely depleted.

At this critical juncture, our plan calls for Social Security to continue to pay the pension for which it is responsible, as given in col. (11) by borrowing temporarily to make up for the deficit. This decision results in a temporarily negative net worth (debt) of the TF that grows for a few years. We interpret this negative net worth, or net debt, as reflecting the need to pay the promised pension in the face of *temporarily* insufficient revenue. We regard the operation as *innovative* yet *financially sound.* Indeed, we see no reason for concern that a temporary small debt could be a source of financial embarrassment. The debt accumulates to a maximum of but 8.3% of wages, in about 8 years. It is then scheduled to be repaid rapidly as the SS returns into a growing surplus, thanks to the continuing growth of NF pensions. In essence, what we have here is an operation conducted in the spirit of intergenerational smoothing, or equity. By borrowing now we allow the older generation to reap some of the benefits of lower contributions at the expense of the younger who would reap the entire advantage of the reform, by placing on them the burden of repaying the debt.

By the late 70's, the reformed system reaches a steady state in which NF collects the single contribution of 5.2%, which, when added to the interest earned on it assets, is sufficient to pay pension representing 17% of taxable wages. Furthermore, the SS surplus and

[23] Note that in computing the interest rate-related growth in the Trust Fund of col. (13) the previous year's level must be capitalized at a rate equal to the real rate less the rate of growth of real wages

Trust Fund are both zero (col. 12 and col. 13 in year 2080). This allows for eliminating Social Security completely since it no longer has any pension to pay, hence no contribution to collect, and essentially zero net worth in its Trust Fund.

One obvious last question: from where does Social Security borrow? The answer should be obvious: from the NF, which by that time (2060) will command assets amounting to over 2.75 times wages. Furthermore, the lending rate should be the same 5% real indexed rate that NF earns on its assets, so there is no arbitrage.

We must emphasize that the simulation presented above is but a sample of the many paths that can be achieved through our approach. In particular, we have indicated that the cut in contribution could start earlier or later, but with the consequence of lengthening or shortening the time needed to reach steady state. The final choice must depend on considerations of intergenerational equity. More generally, our path can be flexibly adjusted along the way in response to changes in the forecasted path of relevant variables, e.g., a deterioration in the future cost ratio could be accommodated by a slower reduction in the contribution rate or relatively small adjustments in the permanent contribution rate.

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which is around 1%; hence we use a capitalization rate of 4%.

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Table 1A

Cost and Contribution Rates for Alternative Systems and Selected Scenarios
Assumptions: Working Life = 40 Years; Average Salary = 50% Replacement

	Cost Ratio = *Pay-as-you-go* Scheme Contribution Rates for Different Scenarios							
	Retired Life - 16 Years				Retired Life - 18 Years			
	Real Productivity Growth				Real Productivity Growth			
	0%	1.00%	1.40%	2.00%	0%	1.00%	1.40%	2.00%
Population Growth								
0%	20.00%	15.40%	13.40%	11.90%	22.50%	17.20%		
1%	15.05%	11.70%	10.40%	9.00%	16.77%			
2%	11.24%	8.80%	7.00%	N/A	12.41%			N/A

Table 1B

	Cost Ratio = *Funded* Scheme Contribution Rates for Different Scenarios							
	Retired Life - 16 Years				Retired Life - 18 Years			
	Real Productivity Growth							
	0%	1.00%	1.40%	2%	0%	1.00%	1.40%	2%
Return on Assets								
0%	20.00%	20.11%	20.15%	20.23%	22.50%	22.62%	22.67%	22.75%
1%	15.05%	15.33%	15.45%	15.63%	16.77%	17.08%	17.21%	17.41%
2%	11.24%	11.60%	11.75%	11.97%	12.41%	12.81%	12.97%	13.22%
3%	8.33%	8.70%	8.86%	9.10%	9.12%	9.53%	9.70%	9.96%
4%	6.13%	6.48%	6.63%	6.86%	6.66%	7.04%	7.21%	7.46%
5%	4.49%	4.80%	4.93%	5.14%	4.84%	5.17%	5.32%	5.54%
6%	3.26%	3.53%	3.64%	3.82%	3.50%	3.78%	3.90%	4.09%
Approx. replacement on final salary	50%	41%	38%	34%	50%	41%	38%	34%

Year	New Fund					Household			Social Security	
	Sources		Uses							
	Contributions to New Fund	New Fund Accrued Interest = (5)t-1 * 0.06	New Fund Pensions	New Fund Surplus =(1)+(2)-(3)	New Fund Assets = (5)t-1 + (4)	Pensions / Cost Ratio	Contributions to Pensions without Govt Subsidy	Contributions to Pensions with Govt Subsidy	SS Pensions = SS Contributions =(6) (3)	Transition Cost
	(1)	(2)	(3)	(4)	(5)	(6)	(7a)	(7b)	(8)	(9)
0	2.00%	0%	0.00%	2.00%	2.00%	18.75%	20.75%	18.75%	18.75%	2.00%
1	2.00%	0.00%	0.01%	1.99%	3.99%	18.75%	20.74%	18.75%	18.74%	1.99%
2	2.00%	0.01%	0.02%	1.99%	5.98%	18.75%	20.73%	18.75%	18.73%	1.98%
3	2.00%	0.02%	0.03%	1.99%	7.97%	18.75%	20.72%	18.75%	18.72%	1.97%
4	2.00%	0.03%	0.05%	1.98%	9.95%	18.75%	20.70%	18.75%	18.70%	1.95%
5	2.00%	0.05%	0.08%	1.97%	11.92%	18.75%	20.67%	18.75%	18.67%	1.92%
6	2.00%	0.08%	0.12%	1.96%	13.88%	18.75%	20.63%	18.75%	18.63%	1.88%
7	2.00%	0.12%	0.16%	1.96%	15.84%	18.75%	20.59%	18.75%	18.59%	1.84%
8	2.00%	0.16%	0.21%	1.95%	17.79%	18.75%	20.54%	18.75%	18.54%	1.79%
9	2.00%	0.21%	0.27%	1.94%	19.73%	18.75%	20.48%	18.75%	18.48%	1.73%
10	2.00%	0.27%	0.34%	1.93%	21.66%	18.75%	20.41%	18.75%	18.41%	1.66%
11	2.00%	0.34%	0.42%	1.92%	23.58%	18.75%	20.33%	18.75%	18.33%	1.58%
12	2.00%	0.42%	0.50%	1.92%	25.50%	18.75%	20.25%	18.75%	18.25%	1.50%
13	2.00%	0.50%	0.60%	1.90%	27.40%	18.75%	20.15%	18.75%	18.15%	1.40%
14	2.00%	0.60%	0.71%	1.89%	29.29%	18.75%	20.04%	18.75%	18.04%	1.29%
15	2.00%	0.71%	0.83%	1.88%	31.17%	18.75%	19.92%	18.75%	17.92%	1.17%
16	2.00%	0.83%	0.96%	1.87%	33.04%	18.75%	19.79%	18.75%	17.79%	1.04%
17	2.00%	0.96%	1.09%	1.87%	34.91%	18.75%	19.66%	18.75%	17.66%	0.91%
18	2.00%	1.09%	1.23%	1.86%	36.77%	18.75%	19.52%	18.75%	17.52%	0.77%
19	2.00%	1.23%	1.39%	1.84%	38.61%	18.75%	19.36%	18.75%	17.36%	0.61%

20	2.00%	1.39%	1.55%	1.84%	40.45%	18.75%	19.20%	18.75%	17.20%	0.45%
21	2.00%	1.55%	1.72%	1.83%	42.28%	18.75%	19.03%	18.75%	17.03%	0.28%
22	2.00%	1.72%	1.90%	1.82%	44.10%	18.75%	18.85%	18.75%	16.85%	0.10%
23	2.10%	1.90%	2.09%	1.91%	46.01%	18.75%	18.76%	18.75%	16.66%	0.01%
24	2.30%	2.09%	2.29%	2.10%	48.11%	18.75%	18.76%	18.75%	16.46%	0.01%
25	2.50%	2.29%	2.50%	2.29%	50.40%	18.75%	18.75%	18.75%	16.25%	0.00%
26	2.70%	2.50%	2.74%	2.47%	52.87%	18.75%	18.72%	18.72%	16.02%	0.00%
27	3.00%	2.74%	2.98%	2.76%	55.62%	18.75%	18.77%	18.77%	15.77%	0.00%
28	3.00%	2.98%	3.25%	2.74%	58.36%	18.75%	18.51%	18.51%	15.51%	0.00%
29	3.00%	3.25%	3.53%	2.72%	61.08%	18.75%	18.23%	18.23%	15.23%	0.00%
30	3.00%	3.53%	3.83%	2.70%	63.77%	18.75%	17.92%	17.92%	14.92%	0.00%
31	3.00%	3.83%	4.15%	2.68%	66.45%	18.75%	17.60%	17.60%	14.60%	0.00%
32	3.00%	4.15%	4.49%	2.66%	69.11%	18.75%	17.26%	17.26%	14.26%	0.00%
33	3.00%	4.49%	4.87%	2.63%	71.74%	18.75%	16.89%	16.89%	13.89%	0.00%
34	3.00%	4.87%	5.26%	2.61%	74.35%	18.75%	16.50%	16.50%	13.50%	0.00%
35	3.00%	5.26%	5.67%	2.59%	76.93%	18.75%	16.08%	16.08%	13.08%	0.00%
36	3.00%	5.67%	6.12%	2.55%	79.48%	18.75%	15.63%	15.63%	12.63%	0.00%
37	3.00%	6.12%	6.59%	2.53%	82.01%	18.75%	15.16%	15.16%	12.16%	0.00%
38	3.00%	6.59%	7.10%	2.49%	84.50%	18.75%	14.65%	14.65%	11.65%	0.00%
39	3.00%	7.10%	7.64%	2.47%	86.97%	18.75%	14.12%	14.12%	11.12%	0.00%
40	3.00%	7.64%	8.22%	2.42%	89.39%	18.75%	13.54%	13.54%	10.54%	0.00%
41	3.00%	8.22%	8.77%	2.45%	91.83%	18.75%	12.98%	12.98%	9.98%	0.00%
42	3.00%	8.77%	9.31%	2.47%	94.30%	18.75%	12.45%	12.45%	9.45%	0.00%
43	3.00%	9.31%	9.82%	2.49%	96.79%	18.75%	11.94%	11.94%	8.94%	0.00%
44	3.00%	9.82%	10.32%	2.50%	99.29%	18.75%	11.44%	11.44%	8.44%	0.00%
45	3.00%	10.32%	10.79%	2.53%	101.82%	18.75%	10.97%	10.97%	7.97%	0.00%
46	3.00%	10.79%	11.23%	2.56%	104.37%	18.75%	10.52%	10.52%	7.52%	0.00%
47	3.00%	11.23%	11.65%	2.58%	106.95%	18.75%	10.10%	10.10%	7.10%	0.00%
48	3.00%	11.65%	12.05%	2.61%	109.56%	18.75%	9.71%	9.71%	6.71%	0.00%
49	3.00%	12.05%	12.41%	2.64%	112.20%	18.75%	9.35%	9.35%	6.35%	0.00%
50	3.00%	12.41%	12.73%	2.68%	114.87%	18.75%	9.02%	9.02%	6.02%	0.00%

51	3.00%	12.73%	13.03%	2.71%	117.58%	18.75%	8.73%	8.73%	5.73%	0.00%
52	3.00%	13.03%	13.29%	2.74%	120.32%	18.75%	8.47%	8.47%	5.47%	0.00%
53	3.00%	13.29%	13.52%	2.77%	123.09%	18.75%	8.24%	8.24%	5.24%	0.00%
54	3.00%	13.52%	13.70%	2.82%	125.90%	18.75%	8.05%	8.05%	5.05%	0.00%
55	3.00%	13.70%	13.85%	2.86%	128.76%	18.75%	7.91%	7.91%	4.91%	0.00%
56	3.00%	13.85%	14.00%	2.85%	131.61%	18.75%	7.76%	7.76%	4.76%	0.00%
57	3.00%	14.00%	14.16%	2.84%	134.45%	18.75%	7.60%	7.60%	4.60%	0.00%
58	3.00%	14.16%	14.33%	2.83%	137.27%	18.75%	7.42%	7.42%	4.42%	0.00%
59	3.00%	14.33%	14.51%	2.82%	140.09%	18.75%	7.24%	7.24%	4.24%	0.00%
60	3.00%	14.51%	14.70%	2.81%	142.90%	18.75%	7.05%	7.05%	4.05%	0.00%
61	3.00%	14.70%	14.91%	2.80%	145.70%	18.75%	6.85%	6.85%	3.85%	0.00%
62	3.00%	14.91%	15.12%	2.79%	148.48%	18.75%	6.63%	6.63%	3.63%	0.00%
63	3.00%	15.12%	15.35%	2.77%	151.25%	18.75%	6.40%	6.40%	3.40%	0.00%
64	3.00%	15.35%	15.59%	2.76%	154.01%	18.75%	6.16%	6.16%	3.16%	0.00%
65	3.00%	15.59%	15.85%	2.74%	156.75%	18.75%	5.90%	5.90%	2.90%	0.00%
66	3.00%	15.85%	16.10%	2.76%	159.51%	18.75%	5.66%	5.66%	2.66%	0.00%
67	3.00%	16.10%	16.33%	2.77%	162.27%	18.75%	5.42%	5.42%	2.42%	0.00%
68	3.00%	16.33%	16.55%	2.78%	165.05%	18.75%	5.20%	5.20%	2.20%	0.00%
69	3.00%	16.55%	16.76%	2.79%	167.84%	18.75%	4.99%	4.99%	1.99%	0.00%
70	3.00%	16.76%	16.96%	2.81%	170.65%	18.75%	4.80%	4.80%	1.80%	0.00%
71	3.00%	16.96%	17.14%	2.82%	173.47%	18.75%	4.62%	4.62%	1.62%	0.00%
72	3.00%	17.14%	17.30%	2.84%	176.30%	18.75%	4.45%	4.45%	1.45%	0.00%
73	3.00%	17.30%	17.45%	2.85%	179.15%	18.75%	4.30%	4.30%	1.30%	0.00%
74	3.00%	17.45%	17.58%	2.87%	182.02%	18.75%	4.17%	4.17%	1.17%	0.00%
75	3.00%	17.58%	17.69%	2.89%	184.91%	18.75%	4.06%	4.06%	1.06%	0.00%
76	3.00%	17.69%	17.78%	2.91%	187.82%	18.75%	3.97%	3.97%	0.97%	0.00%
77	3.00%	17.78%	17.85%	2.93%	190.75%	18.75%	3.90%	3.90%	0.90%	0.00%
78	3.00%	17.85%	17.90%	2.95%	193.70%	18.75%	3.85%	3.85%	0.85%	0.00%
79	3.00%	17.90%	17.93%	2.98%	196.68%	18.75%	3.83%	3.83%	0.83%	0.00%
80	3.00%	17.93%	17.93%	3.00%	199.68%	18.75%	3.83%	3.83%	0.83%	0.00%
Infinity	3.13%	15.62%	18.75%	0.00%	260.33%	18.75%	3.13%	3.13%	0.00%	0.00%

0.5%

	New Fund					Household		Social Security						
	Sources		Uses					Sources			Uses			
	Contributions to New Fund	New Fund Accrued Interest= $[(5)_{t-1}]$*.04	New Fund Pensions	New Fund Surplus =(1)+(2)-(3)	New Fund Assets =$(5)_{t-1}$+(4)	Pensions or Cost Ratio	Contributions to Pensions	Contributions to SS = (7)-(1)	Government Subsidy	Trust Fund Accrued Interest = $(13)_{t-1}$*0.04	Social Security Pensions = (6)-(3)	Social Security Surplus= (8)+(9)+(10)-(11)	Trust Fund= $(13)_{t-1}$+(12)	Total Assets =(13)+(5)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1998	**0.00%**	0.0%	0.00%	0.00%	0.00%	9.70%	10.93%	10.93%	0.00%	0.00%	9.70%	1.23%		
1999	**0.00%**	0.0%	0.00%	0.00%	0.00%	9.62%	10.93%	10.93%	0.00%	0.00%	9.62%	1.31%	23.68%	
2000	**0.00%**	0.0%	0.00%	0.00%	0.00%	9.62%	10.82%	10.82%	2.10%	0.95%	9.62%	4.25%	27.92%	27.92%
2001	**0.00%**	0.0%	0.00%	0.00%	0.00%	9.65%	10.84%	10.84%	1.70%	1.12%	9.65%	4.01%	31.93%	31.93%
2002	**0.00%**	0.0%	0.00%	0.00%	0.00%	9.67%	10.85%	10.85%	2.20%	1.28%	9.67%	4.66%	36.59%	36.59%
2003	**0.00%**	0.0%	0.00%	0.00%	0.00%	9.69%	10.85%	10.85%	2.00%	1.46%	9.69%	4.62%	41.21%	41.21%
2004	**0.00%**	0.0%	0.00%	0.00%	0.00%	9.71%	10.86%	10.86%	2.40%	1.65%	9.71%	5.20%	46.41%	46.41%
2005	**0.00%**	0.0%	0.00%	0.00%	0.00%	9.73%	10.87%	10.87%	2.50%	1.86%	9.73%	5.50%	51.91%	51.91%
2006	**0.00%**	0.0%	0.00%	0.00%	0.00%	9.76%	10.87%	10.87%	3.00%	2.08%	9.76%	6.19%	58.09%	58.09%
2007	**0.00%**	0.0%	0.00%	0.00%	0.00%	9.79%	10.88%	10.88%	3.40%	2.32%	9.79%	6.81%	64.91%	64.91%
2008	**0.00%**	0.0%	0.00%	0.00%	0.00%	9.89%	10.89%	10.89%	3.80%	2.60%	9.89%	7.39%	72.30%	72.30%
2009	**0.00%**	0.0%	0.00%	0.00%	0.00%	10.00%	10.90%	10.90%	4.10%	2.89%	10.00%	7.90%	80.20%	80.20%
2010	**0.00%**	0.0%	0.00%	0.00%	0.00%	10.10%	10.91%	10.91%	4.30%	3.21%	10.10%	8.32%	88.51%	88.51%
2011	**0.00%**	0.0%	0.00%	0.00%	0.00%	10.33%	10.93%	10.93%	4.50%	3.54%	10.33%	8.64%	97.16%	97.16%
2012	**0.00%**	0.0%	0.00%	0.00%	0.00%	10.55%	10.94%	10.94%	4.60%	3.89%	10.55%	8.88%	106.03%	106.03%
2013	**0.00%**	0.0%	0.00%	0.00%	0.00%	10.78%	10.96%	10.96%	4.60%	4.24%	10.78%	9.02%	115.05%	115.05%
2014	**0.00%**	0.0%	0.00%	0.00%	0.00%	11.00%	10.97%	10.97%	4.50%	4.60%	11.00%	9.07%	124.13%	124.13%
2015	**0.00%**	0.0%	0.00%	0.00%	0.00%	11.23%	10.99%	10.99%	0.00%	4.97%	11.23%	4.73%	128.85%	128.85%
2016	**0.00%**	0.0%	0.00%	0.00%	0.00%	11.56%	11.01%	11.01%	0.00%	5.15%	11.56%	4.61%	133.46%	133.46%
2017	**0.00%**	0.0%	0.00%	0.00%	0.00%	11.88%	11.03%	11.03%	0.00%	5.34%	11.88%	4.49%	137.94%	137.94%
2018	**0.00%**	0.0%	0.00%	0.00%	0.00%	12.21%	11.05%	11.05%	0.00%	5.52%	12.21%	4.36%	142.30%	142.30%
2019	**0.00%**	0.0%	0.00%	0.00%	0.00%	12.53%	11.07%	11.07%	0.00%	5.69%	12.53%	4.23%	146.53%	146.53%
2020	**0.00%**	0.0%	0.00%	0.00%	0.00%	12.86%	11.09%	11.09%	0.00%	5.86%	12.86%	4.09%	150.62%	150.62%
2021	**5.20%**	0.0%	0.00%	5.20%	5.20%	13.14%	11.11%	5.91%	0.00%	6.02%	13.14%	-1.21%	149.41%	154.61%
2022	**5.20%**	0.2%	0.01%	5.40%	10.60%	13.43%	11.13%	5.93%	0.00%	5.98%	13.42%	-1.51%	147.90%	158.50%
2023	**5.20%**	0.4%	0.03%	5.59%	16.19%	13.71%	11.14%	5.94%	0.00%	5.92%	13.68%	-1.82%	146.08%	162.27%
2024	**5.20%**	0.6%	0.07%	5.78%	21.97%	14.00%	11.16%	5.96%	0.00%	5.84%	13.93%	-2.12%	143.96%	165.92%
2025	**5.20%**	0.9%	0.11%	5.97%	27.93%	14.28%	11.18%	5.98%	0.00%	5.76%	14.17%	-2.43%	141.53%	169.46%
2026	**5.20%**	1.1%	0.17%	6.15%	34.08%	14.49%	11.20%	6.00%	0.00%	5.66%	14.32%	-2.66%	138.87%	172.95%
2027	**5.20%**	1.4%	0.24%	6.32%	40.40%	14.70%	11.21%	6.01%	0.00%	5.55%	14.45%	-2.89%	135.98%	176.38%
2028	**5.20%**	1.6%	0.33%	6.49%	46.89%	14.90%	11.23%	6.03%	0.00%	5.44%	14.58%	-3.11%	132.87%	179.76%
2029	**5.20%**	1.9%	0.43%	6.65%	53.54%	15.11%	11.24%	6.04%	0.00%	5.31%	14.69%	-3.33%	129.55%	183.08%
2030	**5.20%**	2.1%	0.54%	6.80%	60.34%	15.32%	11.26%	6.06%	0.00%	5.18%	14.78%	-3.54%	126.01%	186.35%
2031	**5.20%**	2.4%	0.66%	6.95%	67.29%	15.41%	10.77%	5.57%	0.00%	5.04%	14.75%	-4.14%	121.87%	189.16%
2032	**5.20%**	2.7%	0.81%	7.09%	74.37%	15.50%	10.78%	5.58%	0.00%	4.87%	14.69%	-4.24%	117.63%	192.01%

2033	**5.20%**	3.0%	0.96%	7.21%	81.59%	15.59%	10.79%	5.59%	0.00%	4.71%	14.63%	-4.33%	113.30%	194.89%
2034	**5.20%**	3.3%	1.14%	7.33%	88.91%	15.68%	10.80%	5.60%	0.00%	4.53%	14.54%	-4.41%	108.89%	197.80%
2035	**5.20%**	3.6%	1.33%	7.43%	96.34%	15.77%	10.81%	5.61%	0.00%	4.36%	14.44%	-4.48%	104.41%	200.75%
2036	**5.20%**	3.9%	1.53%	7.52%	103.87%	15.76%	10.32%	5.12%	0.00%	4.18%	14.23%	-4.94%	99.47%	203.34%
2037	**5.20%**	4.2%	1.76%	7.60%	111.46%	15.67%	10.32%	5.12%	0.00%	3.98%	13.92%	-4.81%	94.66%	206.12%
2038	**5.20%**	4.5%	2.00%	7.66%	119.12%	15.66%	10.33%	5.13%	0.00%	3.79%	13.66%	-4.75%	89.91%	209.03%
2039	**5.20%**	4.8%	2.26%	7.70%	126.83%	15.66%	10.33%	5.13%	0.00%	3.60%	13.39%	-4.66%	85.24%	212.07%
2040	**5.20%**	5.1%	2.53%	7.74%	134.57%	15.73%	10.34%	5.14%	0.00%	3.41%	13.20%	-4.65%	80.60%	215.16%
2041	**5.20%**	5.4%	2.82%	7.77%	142.33%	15.71%	9.84%	4.64%	0.00%	3.22%	12.90%	-5.03%	75.56%	217.90%
2042	**5.20%**	5.7%	3.11%	7.78%	150.12%	15.69%	9.84%	4.64%	0.00%	3.02%	12.58%	-4.92%	70.64%	220.76%
2043	**5.20%**	6.0%	3.42%	7.79%	157.91%	15.68%	9.85%	4.65%	0.00%	2.83%	12.26%	-4.79%	65.86%	223.76%
2044	**5.20%**	6.3%	3.73%	7.78%	165.69%	15.66%	9.85%	4.65%	0.00%	2.63%	11.93%	-4.64%	61.22%	226.91%
2045	**5.20%**	6.6%	4.06%	7.76%	173.45%	15.64%	9.85%	4.65%	0.00%	2.45%	11.58%	-4.48%	56.74%	230.19%
2046	**5.20%**	6.9%	4.41%	7.73%	181.19%	15.66%	9.36%	4.16%	0.00%	2.27%	11.25%	-4.82%	51.91%	233.10%
2047	**5.20%**	7.2%	4.76%	7.68%	188.87%	15.68%	9.36%	4.16%	0.00%	2.08%	10.92%	-4.68%	47.23%	236.10%
2048	**5.20%**	7.6%	5.13%	7.62%	196.49%	15.70%	9.37%	4.17%	0.00%	1.89%	10.57%	-4.51%	42.73%	239.22%
2049	**5.20%**	7.9%	5.52%	7.54%	204.03%	15.72%	9.37%	4.17%	0.00%	1.71%	10.20%	-4.32%	38.41%	242.44%
2050	**5.20%**	8.2%	5.92%	7.44%	211.47%	15.74%	9.38%	4.18%	0.00%	1.54%	9.82%	-4.10%	34.30%	245.77%
2051	**5.20%**	8.5%	6.34%	7.32%	218.79%	15.81%	8.88%	3.68%	0.00%	1.37%	9.47%	-4.42%	29.89%	248.68%
2052	**5.20%**	8.8%	6.77%	7.18%	225.97%	15.87%	8.89%	3.69%	0.00%	1.20%	9.10%	-4.22%	25.67%	251.64%
2053	**5.20%**	9.0%	7.22%	7.02%	232.99%	15.94%	8.90%	3.70%	0.00%	1.03%	8.72%	-3.99%	21.68%	254.67%
2054	**5.20%**	9.3%	7.69%	6.83%	239.82%	16.00%	8.90%	3.70%	0.00%	0.87%	8.31%	-3.75%	17.93%	257.75%
2055	**5.20%**	9.6%	8.18%	6.62%	246.44%	16.07%	8.91%	3.71%	0.00%	0.72%	7.89%	-3.47%	14.47%	260.90%
2056	**5.20%**	9.9%	8.68%	6.37%	252.81%	16.15%	8.42%	3.22%	0.00%	0.58%	7.47%	-3.67%	10.80%	263.61%
2057	**5.20%**	10.1%	9.21%	6.10%	258.91%	16.23%	8.43%	3.23%	0.00%	0.43%	7.02%	-3.36%	7.44%	266.36%
2058	**5.20%**	10.4%	9.76%	5.80%	264.71%	16.31%	8.43%	3.23%	0.00%	0.30%	6.55%	-3.03%	4.42%	269.13%
2059	**5.20%**	10.6%	10.33%	5.46%	270.18%	16.39%	8.44%	3.24%	0.00%	0.18%	6.06%	-2.65%	1.77%	271.94%
2060	**5.20%**	10.8%	10.92%	5.09%	275.27%	16.47%	8.45%	3.25%	0.00%	0.07%	5.55%	-2.23%	-0.47%	274.80%
2061	**5.20%**	11.0%	11.53%	4.68%	279.95%	16.53%	7.95%	2.75%	0.00%	-0.02%	5.00%	-2.27%	-2.73%	277.22%
2062	**5.20%**	11.2%	12.12%	4.28%	284.23%	16.59%	7.96%	2.76%	0.00%	-0.11%	4.47%	-1.82%	-4.55%	279.68%
2063	**5.20%**	11.4%	12.68%	3.89%	288.12%	16.64%	7.96%	2.76%	0.00%	-0.18%	3.97%	-1.39%	-5.94%	282.18%
2064	**5.20%**	11.5%	13.21%	3.52%	291.64%	16.70%	7.97%	2.77%	0.00%	-0.24%	3.50%	-0.96%	-6.90%	284.74%
2065	**5.20%**	11.7%	13.71%	3.16%	294.80%	16.76%	7.97%	2.77%	0.00%	-0.28%	3.05%	-0.56%	-7.46%	287.34%
2066	**5.20%**	11.8%	14.18%	2.82%	297.61%	16.80%	7.48%	2.28%	0.00%	-0.30%	2.63%	-0.64%	-8.10%	289.51%
2067	**5.20%**	11.9%	14.62%	2.49%	300.10%	16.84%	7.48%	2.28%	0.00%	-0.32%	2.23%	-0.27%	-8.38%	291.72%
2068	**5.20%**	12.0%	15.02%	2.18%	302.28%	16.89%	7.48%	2.28%	0.00%	-0.34%	1.86%	0.08%	-8.30%	293.99%
2069	**5.20%**	12.1%	15.40%	1.89%	304.18%	16.93%	7.49%	2.29%	0.00%	-0.33%	1.53%	0.43%	-7.87%	296.31%
2070	**5.20%**	12.2%	15.74%	1.63%	305.80%	16.97%	7.49%	2.29%	0.00%	-0.31%	1.23%	0.75%	-7.12%	298.68%
2071	**5.20%**	12.2%	16.05%	1.38%	307.19%	17.01%	7.00%	1.80%	0.00%	-0.28%	0.97%	0.55%	-6.57%	300.61%
2072	**5.20%**	12.3%	16.32%	1.17%	308.36%	17.06%	7.00%	1.80%	0.00%	-0.26%	0.74%	0.80%	-5.77%	302.58%
2073	**5.20%**	12.3%	16.56%	0.98%	309.33%	17.10%	7.00%	1.80%	0.00%	-0.23%	0.54%	1.02%	-4.75%	304.58%
2074	**5.20%**	12.4%	16.76%	0.82%	310.15%	17.15%	7.01%	1.81%	0.00%	-0.19%	0.39%	1.23%	-3.52%	306.63%
2075	**5.20%**	12.4%	16.92%	0.69%	310.84%	17.19%	7.01%	1.81%	0.00%	-0.14%	0.27%	1.40%	-2.12%	308.72%
2076	**5.20%**	12.4%	17.04%	0.59%	311.43%	17.19%	6.01%	0.81%	0.00%	-0.08%	0.15%	0.58%	-1.54%	309.88%
2077	**5.20%**	12.5%	17.13%	0.53%	311.96%	17.19%	6.01%	0.81%	0.00%	-0.06%	0.06%	0.69%	-0.86%	311.10%
2078	**5.20%**	12.5%	17.17%	0.51%	312.46%	17.19%	5.76%	0.56%	0.00%	-0.03%	0.02%	0.51%	-0.35%	312.11%
2079	**5.20%**	12.5%	17.17%	0.53%	312.99%	17.19%	5.51%	0.31%	0.00%	-0.01%	0.02%	0.28%	-0.07%	312.92%
2080	**5.20%**	12.5%	17.17%	0.55%	313.54%	17.19%	5.31%	0.11%	0.00%	0.00%	0.02%	0.09%	0.01%	313.55%
2081	**5.20%**	12.5%	17.17%	0.57%	314.11%	17.19%	5.20%	0.00%	0.00%	0.00%	0.02%	-0.02%	-0.01%	314.11%

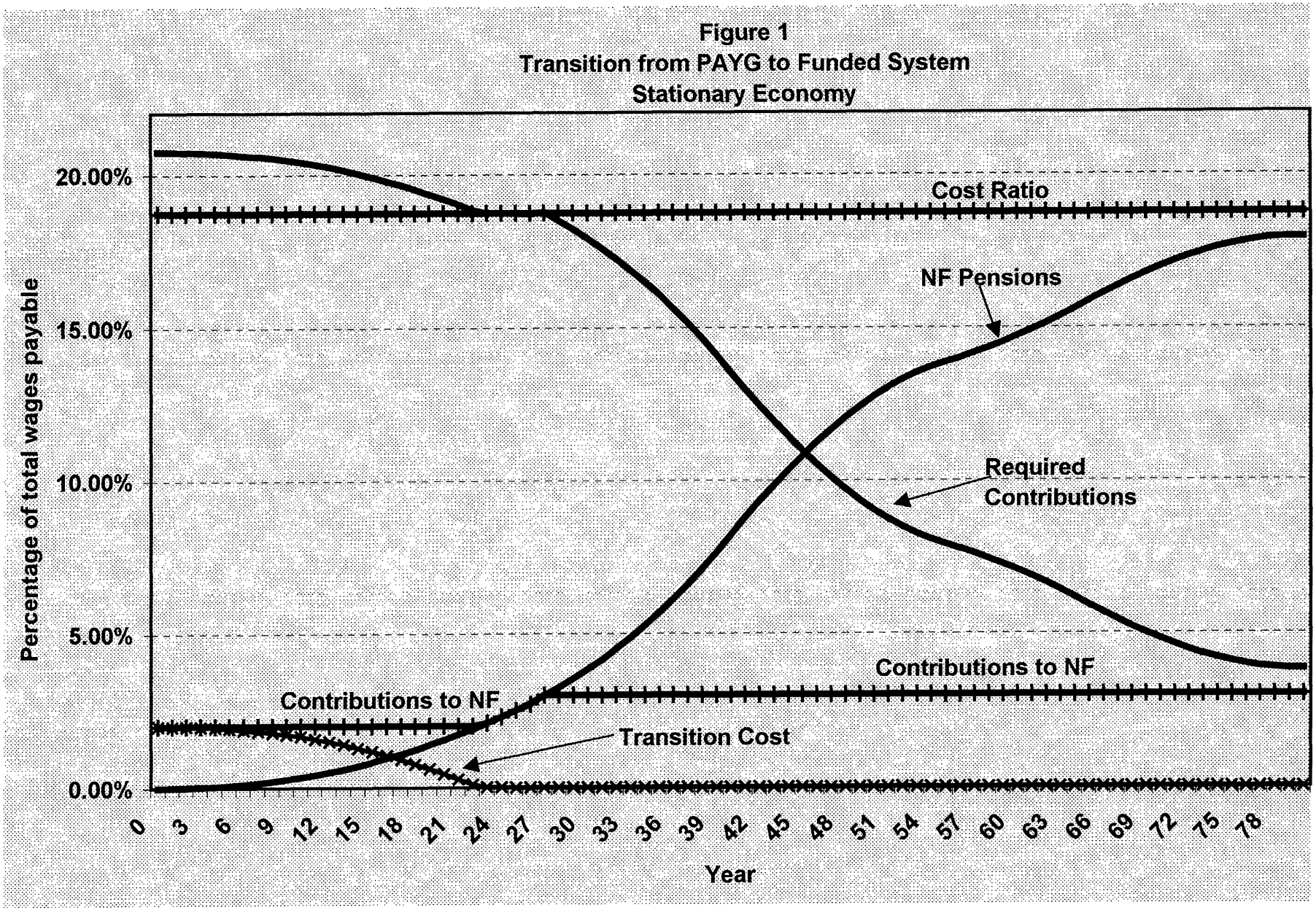
Figure 1
Transition from PAYG to Funded System
Stationary Economy
Percentage of total wages payable
20.00%
15.00%
10.00%
5.00%
0.00%
Cost Ratio
NF Pensions
Required
Contributions
Contributions to NF
Contributions to NF
Transition Cost
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75 78
Year

Figure 2
Comparison of Contribution Rates under Different Reform Scenarios